Ethiopian TVET-System

Basic Biomedical Equipment Servicing Level II

Based on May 2011 Occupational Standards

October, 2019

Module Title: Maintaining and repairing simple biomedical equipment

TTLM Code: EEL BES2 M09 TTLM 1019v1

This module includes the following Learning Guides

LG17: Prepares Maintenance protocol and Respond to client/ customer service request

LG Code: EEL BES2 M06 LO1-LG-17

LG18: Implements preliminary preventive maintenance protocol

LG Code: EEL BES2 M06 LO2-LG-18

LG19: Prepare the unit/equipment

LG Code: EEL BES2 M06 LO3-LG-19

LG20: Performing electrical safety testing

LG Code: EEL BES2 M06 LO4-LG-20

Lg21: Diagnose faults

LG Code: EEL BES2 M06 LO5-LG-21

LG22: Repair biomedical equipment

LG Code: EEL BES2 M06 LO6-LG-22

LG23: Check and calibrate basic biomedical equipment (BBE)

LG Code: EEL BES2 M06 LO7-LG-23

LG24: Re-commission BBE

LG Code: EEL BES2 M06 LO8-LG-24

LG25: Document preventive and corrective maintenance activities

LG Code: EEL BES2 M06 LO9-LG-25

Instruction Sheet	LG17: Prepares Maintenance protocol and Respond to client/ customer service request

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics –

- ✓ Covered biomedical equipment and accessories are identified
- ✓ Appropriate request form is received in accordance with institution protocols
- ✓ Update basic biomedical equipment inventory on the covered BBE is secured and used as reference for preventive maintenance preparation
- ✓ Repair history and equipment consumables are verified in line with the institution's procedure
- ✓ Appropriate checklist forms tools, test equipment, calibrating tools, fast moving consumables and personal protective equipment are secured in line with job requirements
- ✓ Prompt service is conducted on-site or in the workshop

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, **you will be able to –**

- ✓ Identify over biomedical equipment and accessories
- ✓ Receive appropriate request form in accordance with institution protocols
- ✓ Secure and use Update basic biomedical equipment inventory on the covered BBE as reference for preventive maintenance preparation
- ✓ Verify repair history and equipment consumables in line with the institution's procedure
- ✓ Secure appropriate checklist forms tools, test equipment, calibrating tools, fast moving consumables and personal protective equipment in line with job requirements
- ✓ Conduct prompt service on-site or in the workshop

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 6.
3. Read the information written in the information "Sheet 1, Sheet 2, Sheet 3 and Sheet 4, Sheet 5, Sheet 6" **in page 3, 50, 55, 60, 63, and 71** respectively.
4. Accomplish the "Self-check 1, Self-check 2, Self-check 3 and Self-check 4" , Self-check 5---", Self-check 6 **in page 48, 54, 58, 62, 69 and 72** respectively
5. If you earned a satisfactory evaluation from the "Self-check" proceed to "Operation Sheet 1" **in page 73.**
6. Do the "LAP test" **in page 74**

Information Sheet-1	**Identifying Covered biomedical equipment and accessories**

1. Biomedical equipment

Bio-medical **equipment's** are **devices** intended to diagnose, treat, or monitor the patient under medical supervision. These include:-

• Weighing scale (Infant/digital) • Clinical weighing scale • Gooseneck lamp/ Examining light • Oxygen gauge • Sphygmomanometer • Suction apparatus • Autoclave • OR/DR light • OR table	• Nebulizer • Rotator/Shaker • Electro muscular stimulator • Spectrophotometer • Uninterrupted power supply • Bag valve mask (Pediatric and Adult) • Anesthesia bag • Clinical oven

1.1. Weighing scale:

Laboratory Balances

Laboratory balances or micro-balances are used in hospital laboratories, pharmaceutical industry, research institutions and schools. They are designed to determine precisely very small weights. Resolutions of a thousandth of a gram are not unusual. Laboratory balances are sophisticated and sensitive electromechanical devices which need special care and knowledge in the usage, maintenance and repair.

In laboratories we usually find two types of balances: The precision balance and the analytical balance. The difference is the accuracy. Analytical balances are more precise

Precision balances

Precision balances are used to measure mass with a precision of up to 1 mg. They are widely used because their accuracy is high enough for the common measurements. They are highly reliable, robust and compact and nowadays all microprocessor controlled.

Analytical balances

Analytical balances are found in laboratories for the manufacture of pharmaceutical products, analysis, quality assurance or final checking. They are more precise, sensitive and more expensive. With a readability of 0.1 mg they are ten times more precise than precision balances. They are covered with a glass enclosure in order to limit measurement inaccuracy caused by dust and air flow.

Mode of operation

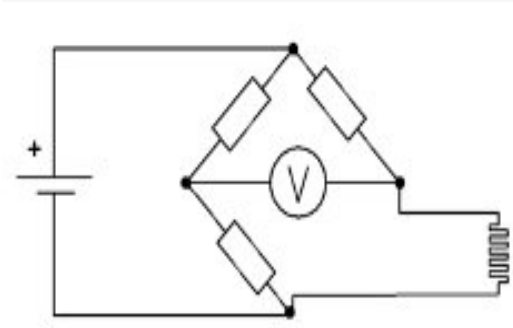
For electronic balances two different weight measuring technologies are used: Strain gauge and electromagnetic force restoration. While the strain gauge principle is used for all scales with higher limits and less accuracy like patient and baby scales, high quality analytical balances are all based on the principle of electromagnetic force restoration.

Strain gauge scales /also commonly called load cell.

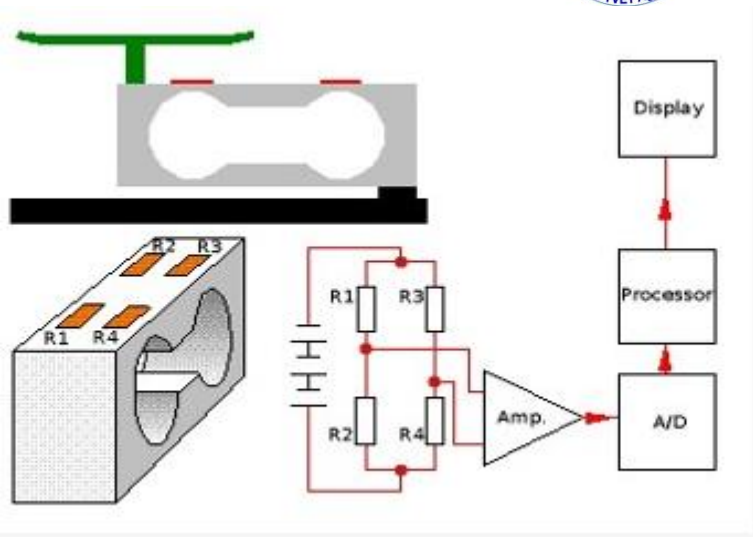
The working principle of the strain gauge is used for patient scales or baby scales where higher weights are measured and the measurement result within milligrams is not needed.

The unknown weight is measured by using a strain gauge. This is an aluminum beam, which is milled out in the Centre. To one end the weighing pan is attached, the other end is mounted to the base of the balance. A load on the pan creates as force and the aluminum beam gets deformed. Since at the thinnest part of the beam strain gauges are embedded, these length-sensitive resistors also get deformed and so change their resistance.

The following amplifier creates a voltage out of the current through the resistances and delivers a measurement voltage which corresponds to the weight



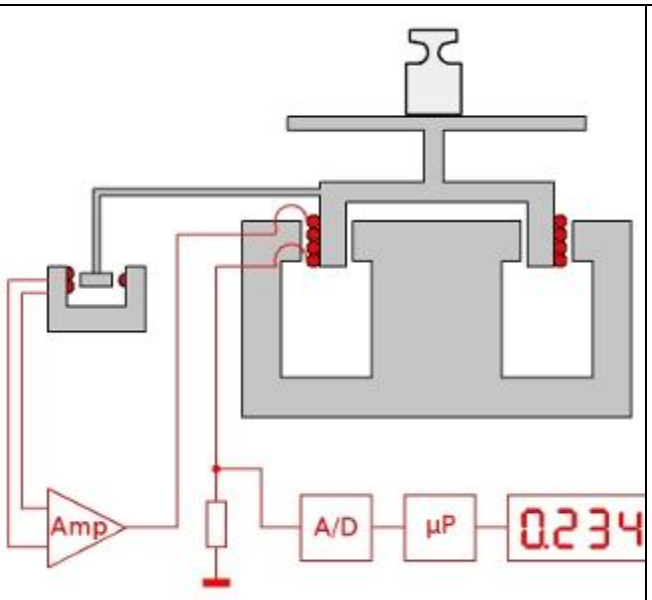
A standard resistor bridge (also called Wheatstone bridge) with three fixed resistors and a sensor resistor. When the bridge is in balance the output voltage is zero.

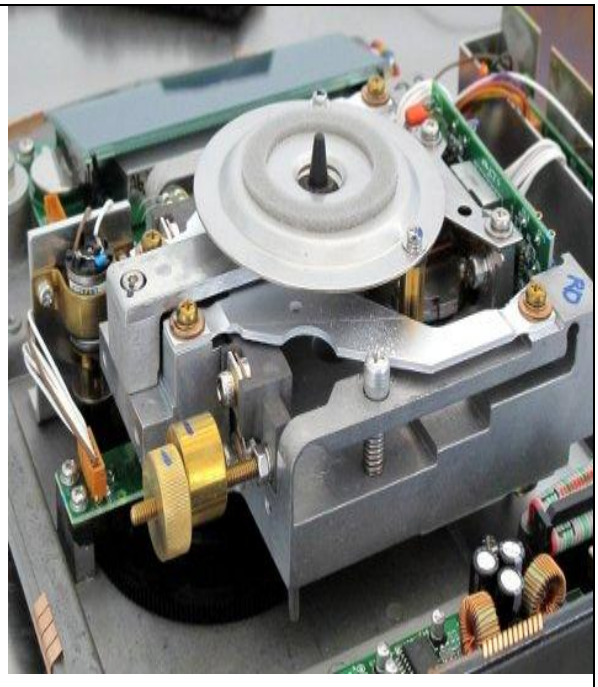


In practice often all four resistors are length-sensitive. The output voltage and the dynamic is higher and the sensitivity to disturbances smaller.

Electromagnetic force restoration balances

Balances based on the electromagnetic force restoration principle work completely different. Here not the force of the load weight is measured directly but a counteracting force is created which works against the weight. This force is measured when the weighing pan is in balance. The method allows more precise measurements than the load cell principle. The weighing pan with the unknown weight is attached to a force coil. The coil is floating in a magnetic field which is created by an amplifier. The amplifier delivers always the right current to keep the lever in balance, regardless of the weight on the pan. The information when the lever is balanced is given by a light barrier.





Preparations

Laboratory balances are sensitive instruments and a reliable measurement can only be expected when the balance is prepared correctly.

- Is the balance exactly levelled? Check the internal spirit level.
- Was the balance connected to the mains for at least 4 hours?
- Is the balance and the workplace absolutely clean?
- Do you know the maximum load? Never overload a balance.

Using procedures

This is just a short overview. By all means, read the user manual of your balance before.

- Do a calibration if needed.
- Press the tare key to zero the display.
- Weigh powders only on paper or small containers.
- Never touch samples or samples containers with your bare fingers. Wear gloves or use anti-magnetic forceps.
- Place the sample in the Centre of the weighing pan.
- Close the enclosure before starting the measurement.
- Wait until the stability indicator is displayed.
- Have you spilled chemicals on the balance? Clean up immediately.

Tare-Function

When a load is already on the balance, pressing the tare-button sets the display to zero. It is used when a samples comes in a container. First the empty container is measured, the tare-button is pressed and then the filled container is placed back. The result is the net weight.

Warm-up time

A laboratory balance should always be connected to the power. Don't disconnect the balance from the wall socket or power supply. Switch off the balance only with the key of the keypad. Even when it is switched off and the balance is in standby mode, the measurement unit is still powered and has the necessary operating temperature. The balance then can be used immediately after switching on.

If the balance was disconnected from the mains the balance has to warm up for at least 4 hours before the first weighing. Only then is the measurement accurate and reproducible.

Calibration with internal calibration weights

Modern analytical balances already have integrated calibration weights. Only a single key has to be pressed and the balance does the whole calibration process automatically.

First the balance is set to zero without any load on the sensor and then a mechanic places automatically an internal calibration weight on the sensor.

Calibration without internal calibration weights

Laboratory balances without internal calibration weights need external weights. The calibration has to be done manually by the user. That takes longer and the user has to work very carefully. But this does not mean, that a manual calibration is less precise.

Cleaning

After every usage and at the end of the day the balance has to be cleaned carefully.

- Keep the weighing pan and weighing chamber clean at all times.
- Use a fine paintbrush to remove sample residues. If possible remove the weighing pan for cleaning.
- Use an absorbent cloth to remove spilled liquids.
- If there is stain use a damp cloth and a mild soap solution for cleaning. Do not make the cloth too wet. Make sure that no moisture enters the balance. Wipe the balance with a soft and dry cloth afterwards.
- The glass of the weighing chamber of an analytical balance can be cleaned with a common window cleaner.

Preventive maintenance

The maintenance of balances covers cleaning and some test procedures. Internal adjustments should not be done. If the test results differ much from the balance's specifications, it is advisable to ship the balance to the manufacturer. The tests should be done on-site in the laboratory. Moving the balance to a workshop is anyway not a good idea. Any moving can cause additional problems.

Step 1: Inspection

Before starting any maintenance or repair, start with a short visually inspection:

- Is there any contamination or anything else unusual?
- Does the doors close/open smoothly?
- Do the switches work properly?
- Is the zero-point display stable (without a load)?

Step 2: Cleaning

- Use a fine paintbrush to remove sample residues. Often the weighing pan can be removed for easier cleaning.
- If there is stain, use a damp cloth and a mild soap solution. Do not make the cloth too wet. Make sure that no moisture enters the balance.
- Wipe the balance with a soft and dry cloth.
- The glass of the weighing chamber of an analytical balance can be cleaned with a common window cleaner

Step 3: Maintenance

If the sliding doors move sluggishly, take out the doors and clean the rails and the edges of the glass doors. Do not lubricate. Oil or grease absorb more dirt over time and the function gets worse.

This also applies for the interior of the balance: Do not lubricate anything. Just clean all components from dust and dirt. Any additional substance interfere with the balance's mechanic.

Step 4: Standard tests

Beside the calibration procedure some tests can be done, in order to verify the accuracy of the balance. The result of these tests will show the deviation from a perfect balance with no deviation at all.

The following performance tests can be done:

- Reproducibility (Repeatability)
- Corner load
- Linearity

Common problems

Malfunctions caused by sample residues and spilled liquids are typical for laboratory equipment. Also problems with the power supply can occur. A typical problem with load cell scales is, that they are sensitive to over-loading. An excessive load can permanently bend the load cell. Therefore, great care needs to be taken when using a scale with a load cell. The user should have a rough idea of how much an object weighs before placing it on the weighing pan. Bent load cells are not repairable and have to be exchanged

Most of the laboratory balances contain small batteries. The batteries do not run the balance but backup the stored microprocessor settings. Their lifetime is limited and should be replaced every two years.

Repair

Balances are often damaged by mishandling or contamination from water or chemicals. These problems require cleaning and testing as described in the Maintenance section. Rarely component have to be replaced. Laboratory balances consists in principle of two compact and integrated units: The computer controlled electronic unit and the mechanic with the sensor, often designed as a solid block. The two units are adjusted to each other and thus leave no space for repairs or adjustments. Only touch or modify them when you are sure what you do. Otherwise take hands off the sensors. You probably create more problems than you solve. Is the balance not working at all, you can have a closer look at the power supply.

In case of a more complex problem or inaccuracy the balance should be send to the manufacturer for repair.

Power supply

As mentioned above, the possibilities of a repair of a laboratory balance are limited. An exception is, as always, the power supply. Here is something to do for the technician. In case of malfunctions, we can check the fuse(s), the output voltage(s) and the electronics in between. It is quite a lot, because here often problems appear. Laboratory balances almost always have an external power supply (switch mode) and an internal voltage stabilization.

Here the view inside the balance:

1. The input socket with the plug from the external power supply. Plugs and sockets often have bad contact.
2. The glass fuse. In switch mode power supplies, also search for small, black plastic fuses. Remember: Blown fuses often have a cause.
3. A capacitor. Works together with the following coil as a filter for the DC input voltage.
4. Looks like a transformer, but is just a coil for filtering out any AC components of the DC voltage.
5. Three stabilizers for three different DC output voltages. In this case +12 V, -12 V and +5 V. They are easy to check. 7805 means Stabilizer for 5 V, 7812 for 12V. Left is input, Centre ground, right 5 V or 12 V output. Negative stabilizers (79xx) are different: Left is ground, Centre is in and right is voltage output the view inside the balance:

6. Capacitors for stabilizing the output voltages
7. Flat ribbon cable, which leads to the main board. Be careful with these cables. Once they are broken, they cannot be repaired. In such a case, exchange the cable against normal wire cables.

1.2. Gooseneck lamp/ Examining light

A gooseneck lamp is a type of light fixture in which a lamp or light bulb is attached to a flexible, adjustable shaft to allow the user to position the light source without moving the fixture or item to be illuminated. It is an adjustable floor lamp with a gooseneck arm for use in hospitals, surgical settings, clinics, rehabilitation centers, nursing homes, or any medical facility.

Gooseneck maintenance cheklist

fault	Most probable Couse	solution
No light	Electrical problem	Check for wire and

	Lamp failure **Switch failure**	**connection** **Change for appropriate lamp** **Change for switch with appropriate rating**
Movement Can't be adjusted	**Mechanical problem**	**Check for joint**

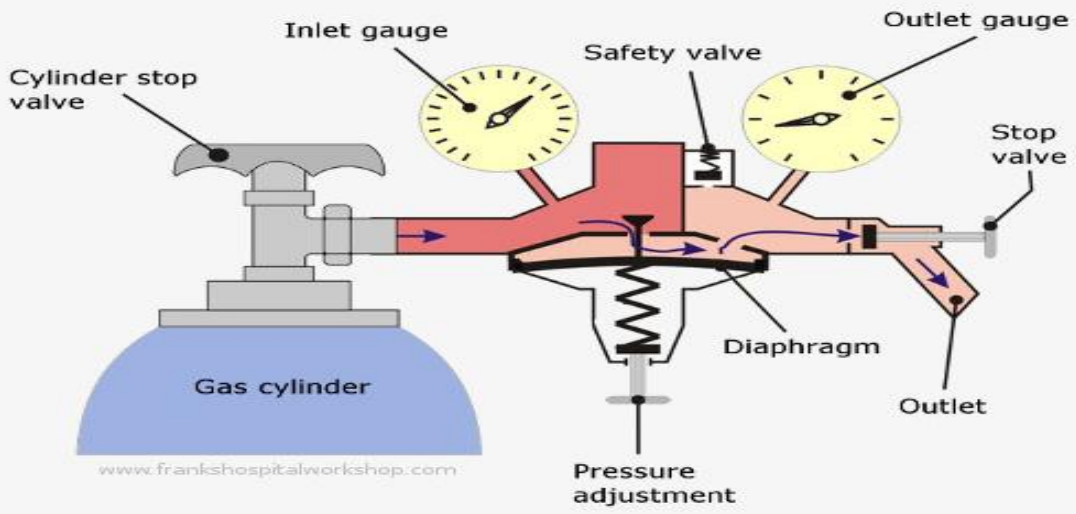
1.3. Oxygen gauge

Oxygen Flow control regulators and conserving devices are pressure reducing devices designed to regulate or lower oxygen pressure from a cylinder to levels that can be safely used by the patient. A Regulator simply regulates the (free) flow from an oxygen cylinder.

A pressure regulator is first of all a pressure reducer. It reduces the high cylinder pressure to a low, usable pressure for our applications. Furthermore, this outlet pressure is regulated and kept stable regardless of the filling level of the cylinder and how much gas (flow) is demanded. The pressure regulator usually has two gauges, one showing the cylinder pressure (which corresponds to the amount of gas in the cylinder), the other the reduced outlet pressure. Often this outlet pressure is adjustable with a knob or screw. For a typical anesthesia machine a gas pressure of 3 - 6 bar (45 - 85 PSI) is required.

Standard adjustable pressure regulator with gauges for cylinder pressure and outlet pressure

The main components of a pressure regulator are a diaphragm (sometimes a piston), a spring which is located on one side of the diaphragm and a valve on the other side.



Maintenance checklist of oxygen gauge

fault	Problem cause	solution
Gauge pointer don't move	Spring problem Pointer may be stack Adjustment knob blocked	Check for spring Clean for any moisture
No output gas	Adjustment knob not working	Check for blockage
leakage	Blockage leak	Check for leak

1.4. Sphygmomanometer

A sphygmomanometer, also known as a blood pressure meter, blood pressure monitor, or blood pressure gauge, is a device used to measure blood pressure, composed of an inflatable cuff to collapse and then release the artery under the cuff in a controlled manner and a mercury or mechanical manometer to measure the pressure. It is always used in conjunction with a means to determine at what pressure blood flow is just starting, and at what pressure it is unimpeded. Manual sphygmomanometers are used in conjunction with a stethoscope.

A sphygmomanometer consists of an inflatable cuff, a measuring unit (the mercury manometer, or aneroid gauge), and a mechanism for inflation which may be a manually operated bulb and valve or a pump operated electrically.

Blood pressure (BP) is the pressure of circulating blood on the walls of blood vessels. Most of this pressure is due to work done by the heart by pumping blood through the circulatory system.

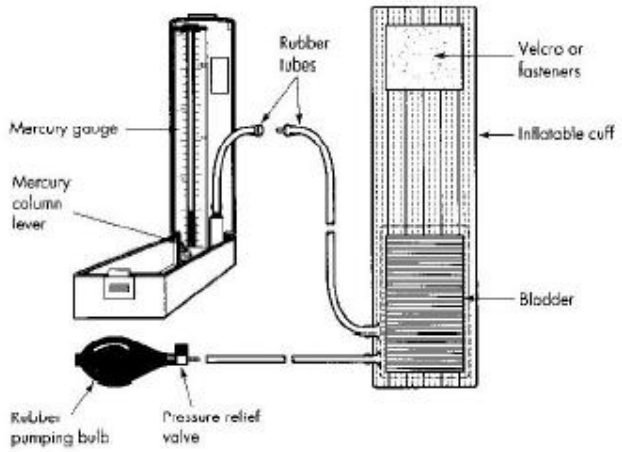
Function

Blood pressure is an indicator of several diseases as well as of general health. It is an easy screening test using simple equipment. A sphygmomanometer can be used to measure the blood pressure at the high point (systolic) and low point (diastolic) of the cardiac pressure cycle. Pressure is usually measured using a cuff on the upper arm.

How it works

The cuff on the arm is inflated until blood flow in the artery is blocked. As the cuff pressure is decreased slowly, the sounds of blood flow starting again can be detected. The cuff pressure at this point marks the high (systolic) pressure of the cycle. When flow is unobstructed and returns to normal, the sounds of blood flow disappear. The cuff pressure at this point marks the low (diastolic) pressure.

Pressure can be measured using a meter with dial (aneroid type), a mercury column or an electronic display. The sounds are normally detected using a stethoscope, but some electronic equipment uses a different, automatic technique with pressure sensors. The two methods do not always give the same results and the stethoscope method is generally seen to be more accurate for all types of patient.



User Maintenance Checklist Sphygmomanometers (B.P. sets)

Daily	
Cleaning	Check equipment is safely packed If mercury is spilled, seal unit and send to technician
Visual checks	Ensure all parts are present and are tightly fitted Check display is zero when cuff deflated
Function checks	Before use, check pressure rises and returns to zero

Weekly

Cleaning	Remove all dust and dirt with damp cloth or by hand
Visual checks	Remove or replace any cracked rubber parts
Function Checks month	Check correct operation of inflation bulb and valves Remove any batteries if not in use for more than one Inflate to 200 mmHg and check leakage is not faster than 2 mmHg in 10 seconds

Troubleshooting – Sphygmomanometers (B.P. sets)

	Fault	Possible Cause	Solution
1.	Mercury leakage OR Mercury not at zero level	Mercury leakage or overfilling	Refer to technician for correction
2.	Mercury is dirty	Oxidation of mercury	Refer to technician for cleaning
3.	Pressure does not increase easily OR Pressure increases after inflation	Valve or tube blockage	Remove and clean all valves and tubes. Reassemble and test
4.	Aneroid instrument does not return to zero	Zero setting has moved	Rotate collar on base until zero setting achieved and tighten. If still malfunctioning, refer to technician
5.	Pressure does not remain steady	Leakage of air	Isolate leak by closing off parts of tubing. Replace leaking section and retest

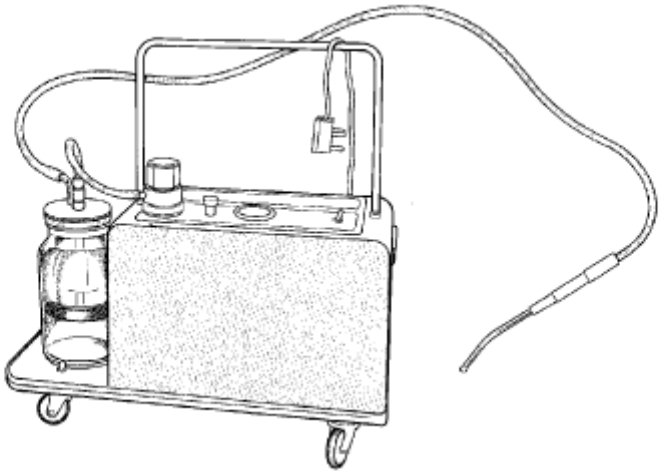
1.5. Suction apparatus

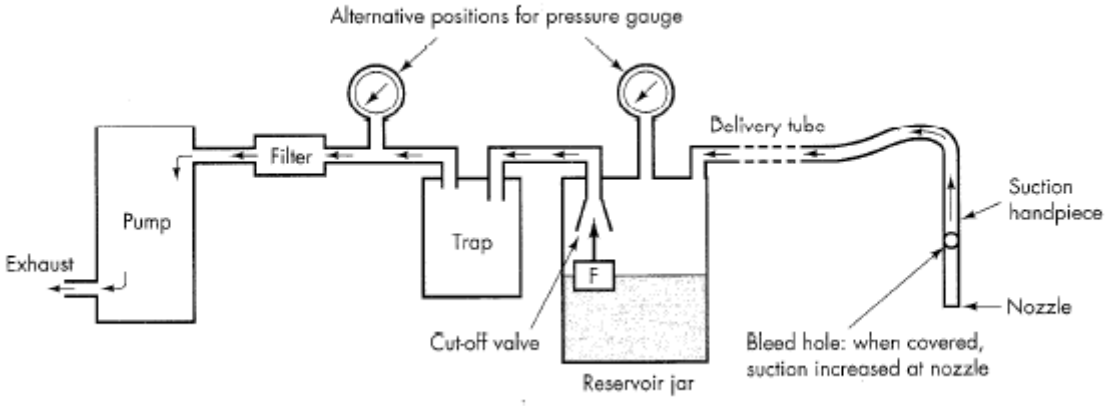
Function

Suction machines (also known as aspirators) are used to remove unwanted fluid from body cavities. They are found in operating theatres, delivery suites, ENT and emergency departments. Smaller specialized suctions are used in dental departments.

How it works

Suction is generated by a pump. This is normally an electrically powered motor, but manually powered versions are also often found. The pump generates a suction that draws air from a bottle. The reduced pressure in this bottle then draws the fluid from the patient via a tube. The fluid remains in the bottle until disposal is possible. A valve prevents fluid from passing into the motor itself.





Troubleshooting Suction machines

Fault	Possible Cause	solution
Machine is not running	No power from mains socket	Check power switch is on. Check mains power is present at socket using equipment known to be working. Contact electrician for rewiring if power not present.
	Fuse blown	Check for leaks or wire causing fuse to blow and correct this. Replace fuse with correct

		voltage and current rating. Test operation.
	Electrical cable fault	Try cable on another piece of equipment. Contact electrician for repair if required.
	Internal wiring or switch fault	Refer to electrician
Poor fluid flow, pressure gauge low	Tube /seal / bottle leaking or Disconnected	Close different tubes by bending. When pressure gauge changes, leakage point has been passed. Replaced damaged tube or seal.
	Air outlet valve blocked	Clean outlet valve
	Control valve stuck	Operate control valve through full range. Send for repair if stuck
	Internal or control error	Refer to technician
Poor fluid flow, pressure gauge high	Blocked filter or tube	Disconnect each tube one at a time. When air flow is stopped, blockage has been passed. Replace filter or unblock

		tube.
Filter discolored	Floating valve broken	Change filter, clean or replace floating valve
Electrical shocks	Wiring fault	Refer to electrician
Manual suction is jammed	Internal slider stuck	Refer to technician for greasing

User Maintenance Checklist Suction Machines

Daily	
Cleaning	➢ Wipe dust off exterior and cover equipment after checks ➢ Wash bottle and patient tubing with sterilizing solution
Visual checks	➢ Check all fittings and accessories are mounted correctly ➢ Check filter is clean
Function checks	➢ If in use that day, run a brief function check before clinic

1.6. Autoclave

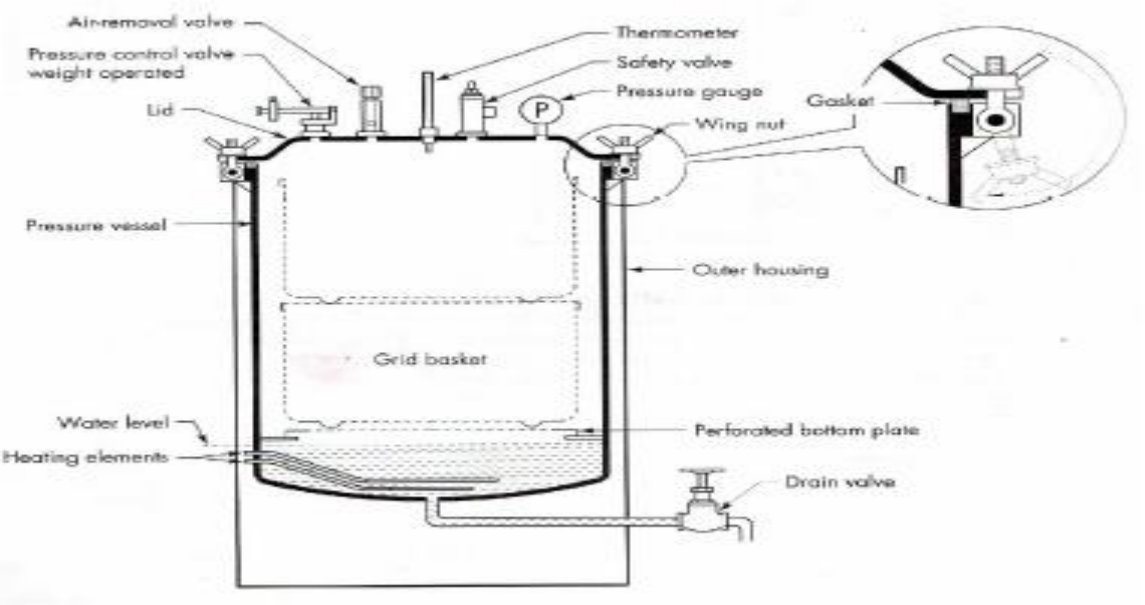
Function

Sterilization is the killing of microorganisms that could harm patients. It can be done by heat (steam, air, flame or boiling) or by chemical means. Autoclaves use high pressure steam and sterilizers use boiling water mixed with chemicals to achieve this. Materials are placed inside the unit for a carefully specified length of time. Autoclaves achieve better sterilization than boiling water sterilizers.

How it works

Heat is delivered to water either by electricity or flame. This generates high temperature within the chamber. The autoclave also contains high pressure when in use, hence the

need for pressure control valves and safety valves. Users must be careful to check how long items need to be kept at the temperature reached.



Troubleshooting Autoclaves and Sterilizers

Fault	Possible Cause	solution
Equipment is not heating	No power at mains socket	Check power switch is on. Replace fuse with correct voltage and current rating if blown. Check main0 s power is present at socket using equipment known to be working. Contact electrician for rewiring if power not present.
	Electrical cable fault	Try cable on another piece of equipment. Contact electrician for repair if required.

	Damaged heating element	Replace if broken
Pressure rises above the marked level	Blocked valve	Clean the pressure regulating valve, safety valve. Pressure vessel may be over filled. Retest autoclave under pressure with water only.
Steam is constantly escaping	Poor seal	Clean leaky valve and hole, replace if defective. Clean leaking seal or gasket, replace if broken.
Electrical shocks	Wiring fault	Refer to electrician

User Maintenance Checklist Autoclaves / Sterilizers

Daily	
Cleaning	➢ Cleaning Remove any dust / dirt with damp cloth and dry off ➢ Remove water and waste matter from inside
Visual checks	➢ Check all screws, connectors and parts are tightly fitted

	➢ Check all moving parts move freely, all holes are unblocked
Function checks	➢ Use troubleshooting guide if problems occur

weekly

Cleaning	➢ Unplug, clean inside and outside with damp cloth and dry off
Visual checks	➢ Check internal heating element connections are tight ➢ Replace heating element if covered with lime scale ➢ If plug, cable or socket are damaged, replace
Function checks	➢ When next used, check pressure / temperature gauges rise ➢ When next used, check there are no leaks

1.7. OR/DR light

Surgical light

Surgical light is also referred to as operation light or surgical light is medical device that intended to assist a medical personnel during surgical procedure by illuminating a local area or cavity of the patient .a combination of several surgical
light is often referred to as surgical light system.

There are different types of surgical light head

- Hyalite surgical light
- hylED surgical light
- **mobile surgical light**

Parts (hylite /hyled)

1. Ceiling cover
2. Flange tube
3. Swivel arm assembly
4. Spring arm
5. Monitor having arm assembly

6. Monitor
7. Light head assembly
8. Carrier arm camera

Mobile light parts

1. Light-head
2. Spring arm
3. Pole
4. Handle
5. Power module
6. Battery Indicator
7. AC Indicator
8. Castors
9. Base
10. Horizontal gimbal joint
11. Main Switch
12. Power connector

Troubleshooting

Warning: Disconnect the light from the power supply before attempting any of the Electrical checks mentioned below.

Problem	**Cause**	**Remedy**
Light will not turn on	1. Power to unit is off 2. Fuse is blown 3. Exposed wires are cut or damaged 4. Wire not connected correctly during installation 5. Wire connections made during installation have disconnected 6. No input power to light unit 7. Disconnected wires at power supply 8. No power output from power supply when input power to power supply is measured.	1. Turn on power (plug in unit) 2. Replace fuse/fuses (check for correct fuse) 3. Replace wire assembly 4. Check all wiring connections 5. Reconnect wires per the instructions 6. Check power input connections and circuit breakers 7. Reconnect wires 8. Replace faulty power supply
Light does not maintain its position vertically	✓ Spring tension or friction is incorrect. ✓ Additional equipment was added to unit.	✓ Adjust spring ✓ Remove additional equipment from arm.
Arm/Head assembly does not maintain its position horizontally (Orbital)	✓ Ceiling casting mount is not level. ✓ Ceiling casting mounting screw are loose.	✓ Level ceiling casting mount by shimming. ✓ Tighten ceiling casting mounting fasteners.

	✓ Arm/Head needs friction adjustment. Jack-Screw is loose.	✓ Tighten Jack-Screw.
Light head is loose (drifts) at yoke interface	✓ Head needs friction adjustment.	✓ Adjust light head (see light head friction adjustment)
Light head will not rotate at yoke interface	✓ Light head is against internal stop.	✓ Rotate head in opposite direction.
Articulating arm cannot be moved any lower	✓ Arm is against internal stop.	✓ Rotate arm in opposite direction.
Articulating arm cannot be raised any higher	✓ Arm is against internal stop.	✓ Rotate arm in opposite direction.

1.8. OR table

Preventive maintenance of surgical/or table

Here are a few daily, weekly, bi-weekly and monthly procedures to keep in mind during your scheduled PM for surgical tables:

Daily	✓ Check table casters for any accumulated debris and clean casters.
Weekly	✓ Check table casters for any accumulated debris and clean casters.
Bi-weekly	✓ Charge batteries ✓ Operate each table function. Operation should be smooth and quiet. If it is not, have a qualified technician repair the table. Never permit inexperienced, unqualified persons to attempt to make any repairs to the table.
Monthly	✓ Clean casters and floor locks; check for conductivity. ✓ Remove any oil (suture, floor wax, etc.) that may have accumulated on casters. ✓ Clean casters with a recommended solution. ✓ Lightly lubricate caster bearings

Troubleshoting tips of operating/surgical table

In the event of a malfunction, determine the following:

- Does the malfunction occur in all movements or only one movement?
- Does the malfunction occur in both up and down movements or only in one direction?
- Does the table move into a certain position(s) by itself?

List of components whose breakage causes malfunction in all table hydraulic functions:

- Pump
- Pressure release valve

If the malfunction is restricted to only one function, the problem is probably:

- in the lines
- in the selector valve
- in the cylinder

Problem	Cause
Table top will not remain at the adjusted height	• Leak in hydraulic cylinders, lines or connectors • Faulty valve • Dirt in hydraulic system
Operating table top will not rise	• Oil level low • Air in the hydraulic system • Faulty pump • Pressure release valve dirty or faulty
Mattress base will not lower properly	• Faulty pump • Air in the hydraulic system • Pressure in pressure accumulator too low
Operating table pulls to one side when being pushed	• Worn or dirty castor
Headrest or leg section angle adjustment does not stay in place or does not work at all.	• The gas spring is damaged • Gas spring is installed incorrectly • Release cable is loose or tight
Table top flexing.	• Air in the hydraulic system • Oil level too low

Activate Windows
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1.9. Nebulizer

Function

A nebulizer is a device used to administer medication in the form of a mist inhaled into the lungs. Nebulizers are commonly used for treatment of cystic fibrosis, asthma and other respiratory diseases. The reason for using a nebulizer for medicine to be administered directly to the lungs is that small aerosol droplets can penetrate into the narrow branches of the lower airways. Large droplets would be absorbed by the mouth cavity, where the clinical effect would be low.

How it works

The common technical principle for all nebulizers is to use oxygen, compressed air or ultrasonic power as means to break up medical solutions or suspensions into small aerosol droplets. These are passed for direct inhalation either through the mouthpiece of the device or a hose set. Gas powered devices use a small pump to force the gas through the solution and will normally have a filter for the gas inlet. Ultrasonic devices use a small crystal to generate vibrations in the solution that cause droplets to break off.

Troubleshooting Nebulizers

Equipment is not working	No power from mains socket	➢ Check power switch is on. Replace fuse with correct voltage and current if blown. Check mains power is present at socket using equipment known to be working. Contact electrician for rewiring if power not present.

	Electrical cable fault	➢ Try cable on another piece of equipment. Contact electrician for repair if required.
Machine is working but flow is absent or low	Filter is blocked Pipe is twisted or nebulizer chamber / mouthpiece is blocked. Worn out pump tubing Compressor (or air source) is broken obstructed or leaking	Clean filter Connect pipe properly, clean chamber / mouthpiece Replace tubing Remove any blocking material or call biomedical technician to fix the problem.
Inadequate nebulizing amount	Output adjustment not correctly set Mouthpiece cracked	Adjust output as directed in user Manual Replace mouthpiece Refer to biomedical

	Internal fault	technician
Electrical shocks or fuse keeps blowing	Wiring fault	Refer to electrician

User Maintenance Checklist Nebulizers

Daily

Cleaning	➢ Clean and sterilize mouthpiece and medicine chamber ➢ Wipe dust from machine and replace cover after checks
Visual checks	➢ Check all parts are present and tightly fitted ➢ Check all moving parts move freely, all holes are unblocked
Function checks	➢ Check the whole system function before use

Weekly

Cleaning	➢ Unplug, clean outside with damp cloth and dry off ➢ Clean filter and air chamber of compressor
Visual checks	➢ Clean chamber and tube seals, replace if damaged ➢ If mains plug, cable or socket are damaged, replace them
Function checks	➢ When next used, check for adequate nebulization. ➢ Check compressor fan is working without excessive noise.

1.10. Rotator/Shaker

A **shaker** is a piece of laboratory equipment used to mix, blend, or agitate substances in a tube or flask by shaking them. It is mainly used in the fields of chemistry and biology. A shaker contains an oscillating board that is used to place the flasks, beakers, or test

tubes. Although the magnetic stirrer has lately come to replace the shaker, it is still the preferred choice of equipment when dealing with large volume substances or when simultaneous agitation is required

1.11. Electro muscular stimulator

Benefits of Electric Muscle Stimulation
Electric muscle stimulation (EMS) can help treat musculoskeletal injuries or ailments.

EMS is a common and effective way to:

- ✓ Relieve discomfort and pain
- ✓ Reduce muscle spasms
- ✓ Restore muscle tone
- ✓ Rehabilitate parts of the body

The orthopedic specialists and physical therapists utilize EMS on those with any of the above-mentioned issues to help restore function, mobility and balance, and reduce pain.

How Electric Stimulation Works

Electric stimulation works by attaching stick-on pieces of equipment to the skin and using the control unit to transmit currents to targeted muscle groups. The control unit is where the timer, sensory knobs and other devices are located to produce the electric current. Two lead wires and two to four neuro stimulation electrodes are the tools that are attached to the skin to transmit the current. The machine may cause a number of unique sensations when turned on and applied to a specific muscle group.

TROUBLE SHOOTING of EMS
If the EMS Unit does not work or turn on:
Disconnect the power supply from the wall outlet and check the fuse in the back of the unit. Replace the fuse with an exact duplicate (available at most electronic stores) and try turning the unit on again. Be sure that the Russian Stim and Wave switch are both off (down) before turning on.
Please note: Even though a fuse may look okay, it may not be.
If your unit continually burns fuses:
Disconnect the wires, replace the fuse, turn off Russian Stim, turn off Wave switch and try turning on the unit. If the power comes on, make sure all the intensity controls are turned down and reconnect the lead wires. If the power light still does not come on, please contact Vitality web for troubleshooting at 800-796-9656.
Please note: Do not put the Russian Stimulation and Wave switches up (on) at the same time. Russian is an independent mode and having both switches in the on position will blow a fuse.
If the EMS Unit turns on but does not function properly:

1. Check all control settings. Are the electrodes in the proper position?
2. Check lead wires. Make sure all connectors are firmly seated.

3. Make sure the electrode pads have a good connection to your skin. If using the rubber electrodes, be sure to use water or a conductive gel to maintain the contact between your skin and the electrode pad.
4. Replace the lead wire cord set with another lead to check for broken wires.

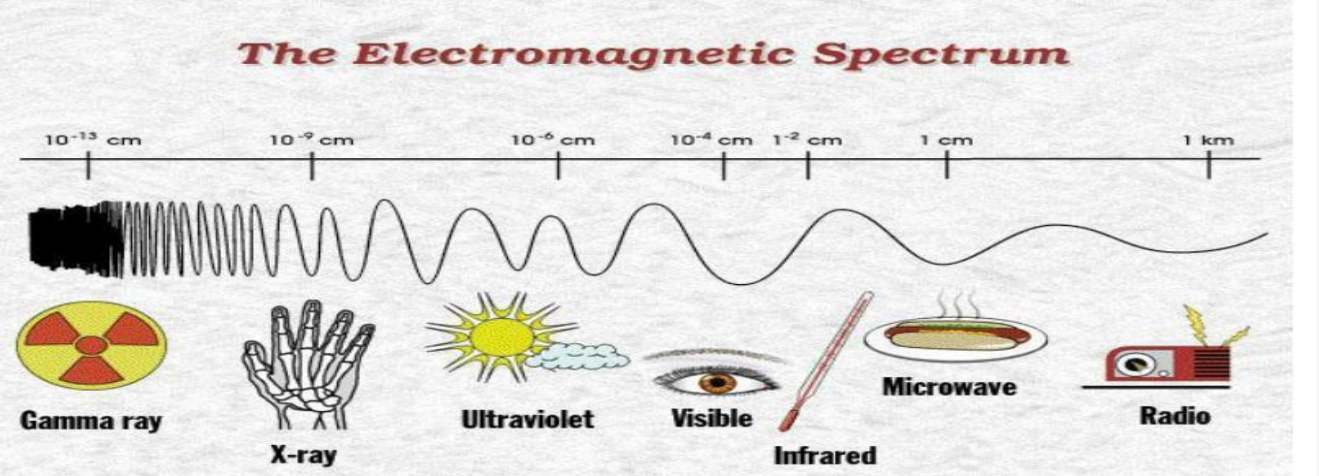
If one channel is on and cannot be turned off:
Disconnect and do not use. Contact Vitaltiyweb to have the unit repaired immediately.
If you feel a sharp tingling sensation when stimulating:
Make sure you have a good connection between your skin and the electrode pad. When using the rubber pads, be sure to use a conductive agent such as water or a conductive gel between your skin and the electrode pads. Make sure the pads are located over the muscle belly (thick areas of muscle). Try repositioning the electrode pads.

1.12. Spectrophotometer

In biological and chemical research, solutions are often quantified by measuring their degree of light absorption at a particular wavelength. A value called the *extinction coefficient* is used to calculate the concentration of the compound. Molecular biology laboratories use spectrophotometers to measure the concentrations of DNA or RNA samples. Microbiological and molecular biology laboratories frequently use a spectrophotometer to measure the growth of cultures of bacteria. DNA cloning experiments are often done in bacteria, and researchers need to measure the growth stage of the culture to know when to carry out certain procedures. They measure the absorbance, which is known as the optical density (OD), on a spectrophotometer. Before attempting to deal with: **What** and **how** spectrophotometer works, it is important to discuss **on:**

- ✓ light properties
- ✓ interaction of light with matter
- ✓ Types of light

Electromagnetic energy



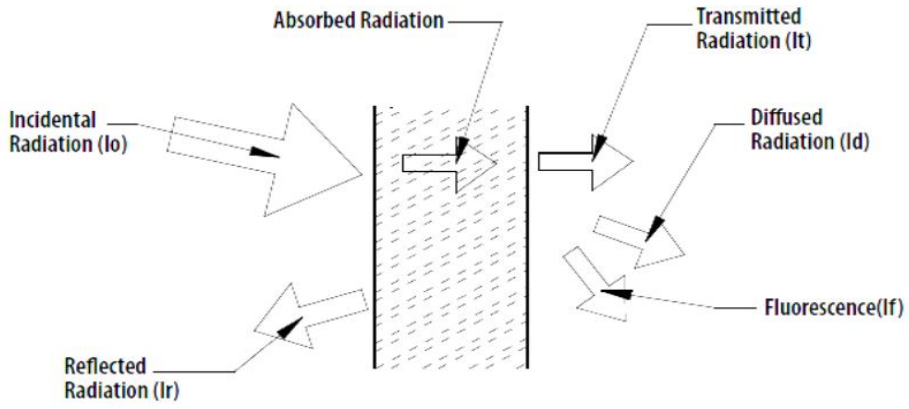
Light properties

- ✓ light is one **form of** electromagnetic energy
- ✓ In space, it has a constant velocity of 3 x 108 m/s.
- ✓ In other medium its velocity will be lower and calculated as:

$$v_o = c/n$$

Where:
n = Medium refraction index
upon interacting with matters light undergoes:

- Reflection
- Diffraction
- Absorption
- Polarization and
- Diffusion



Relationship of light interaction and matters property

- ✓ **Concentration** of specific matter in sample and the intensity of light **transmitted** through, is proportional
- ✓ Based on transmittance and absorbance concept

T =It/It

Where: T = transmittance
Io = intensity of incident light
Absorbance property

- ✓ the **concentration of light absorbing** molecules in a sample is proportional to the **absorbed light intensity**

A = εLC

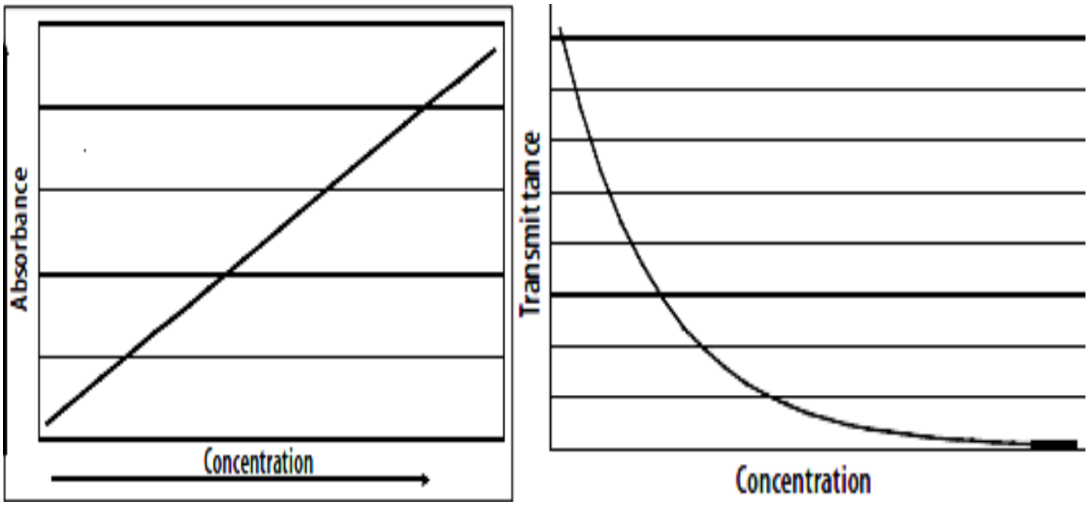
Where: A = absorbance
ε = absorbance coefficient
L = sample path length
c = concentration of molecules in the sample

Transmittance and absorbance relationship

$$A = \text{Log}_{10} \frac{1}{T}$$

$$= \text{Log}_{10} \frac{Io}{It}$$

Graphical interpretation of absorbance and transmittance



Spectrophotometer's important component

- The light source
- The monochromatic
- The sample carrier
- The detector system
- The reading system

Light source

Light source can be,

• tungsten lamp for visible light and

• deuterium lamp for ultraviolet light

• There is also long lasting xenon lamps emitting light in the visible and ultraviolet ranges

Monochromatic

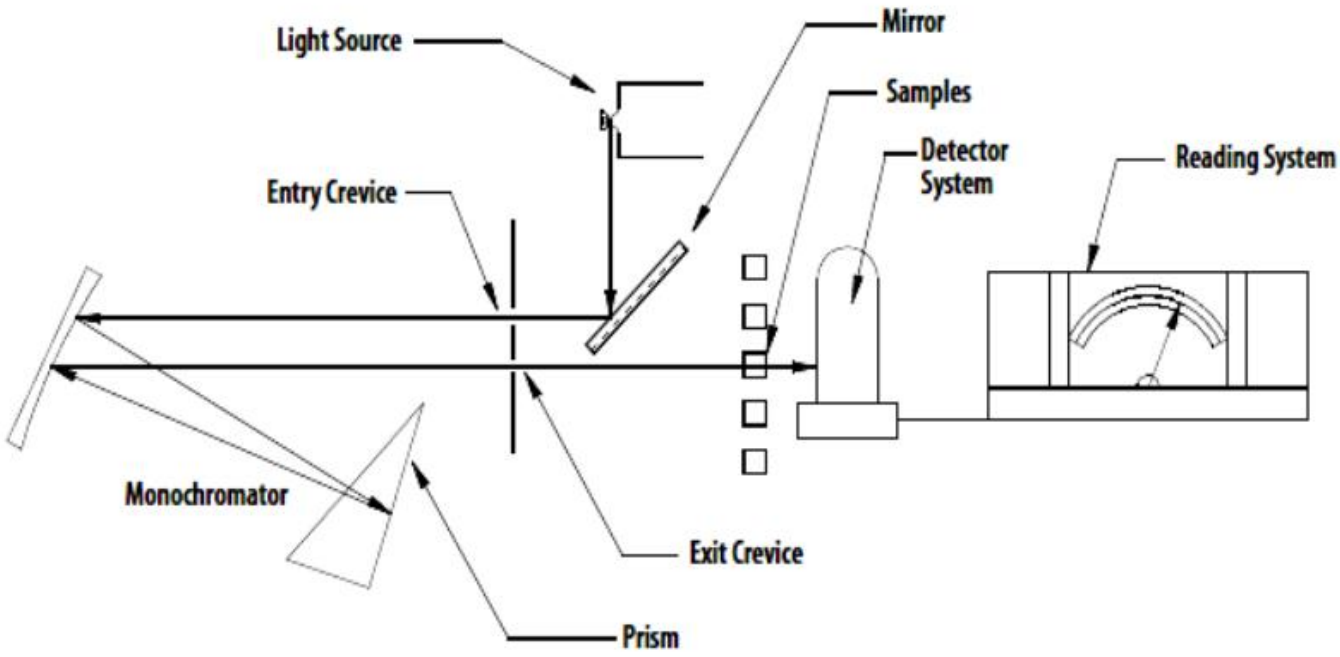
• monochromatic is used to ***disperse white light*** into waves of different wavelengths

• Radiation used in the sample reading is selected from this dispersed light waves

• Generally monochromatic limits the light radiation produced by the source and confines it to a determined area

Monochromatic

diagram



• **Sample holder**: Holds the sample to be analyzed.

Maintenance of spectrophotometer.

Safety Checks - Daily:

Check that electrical connections are fully coupled, that cords are not frayed and that there is no liquid on or about the spectrophotometer.

Unidentified spilt chemicals should be removed with extreme caution whilst wearing standard SimuLab PPE

- ✓ Carefully clean the sample holder, especially after using corrosive or salt solutions.
- ✓ Mop up any spilt liquids and brush any spilt chemical from the spectrophotometer and adjacent areas.
- ✓ Wash the cuvettes immediately after use (do NOT let the sample dry out in the cuvette). Rinse the cuvettes with deionized water at least three times, allow them to drain and dry them inverted

1.13. Uninterrupted power supply

An uninterruptible power supply (UPS) provides nearly instantaneous power when the main utility power source fails, allowing either time for power to return or for the user to shut down the system or equipment normally by closing running computer system applications and using the operating system to shut down the system.

The user has between five and 15 minutes to shut down a system normally or bring an auxiliary power source online to restore the power supply. In addition, most UPS systems also work to address power source electrical surges, sag voltage, voltage spikes, frequency instability, noise interference or harmonic distortion from the ideal sinusoidal wave form.

Major system inspection general

- ✓ Perform visual checks and operational tests of all UPS equipment and associated switchgear.
- ✓ Review maintenance logs and log all alarm operations and output
- ✓ Complete a functional checkout and test of the UPS diagnostic systems.
- ✓ Check environment, temperature, dust, moisture, room vents, etc.
- ✓ Clean and tighten all power connections at the input and output terminals, at all circuit breakers, and at the terminal posts and fuses on the rectifier and inverter legs. During the inspection, check all power cabling for abrasions and burns pots. Visually check components for signs of overheating, swelling, leaking, etc.. Visually check printed circuit board alignments.
- ✓ Replace air filters at regular intervals. Site conditions will determine how often the filters should be replaced, but generally, they will need to be replaced at least every 6 months in clean environments. If more frequent replacement is required, the cleanliness of the environment should be upgraded.
- ✓ Check and calibrate each system, to include switchgear and circuit breakers, meters, and alarm levels for frequency, voltage, current, transfer, trip, alarm, etc.

- ✓ Perform system and component functional tests on all UPS equipment to insure proper functioning within specified parameters.
- ✓ Run all UPS system diagnostics, and correct all diagnosed problems.
- ✓ Resolve any previous outstanding problems, review operation with user personnel, and report any power enhancement or equipment operation recommended changes.
- ✓ Replace control batteries at least every 2 years. If the control batteries have been used without inverter or bypass AC power, they may need replacement sooner.

UPS battery maintenance

The basic component that differentiates an UPS system from a power conditioner is the battery. If the batteries fail before the backup generators come on line, the critical power goes down. Improperly installed, poorly maintained, and inadequately tested batteries are common happenings. Only the fact that the backup generators are highly reliable and come on line in a few seconds prevents many UPS battery banks from failing long before their rated design life.

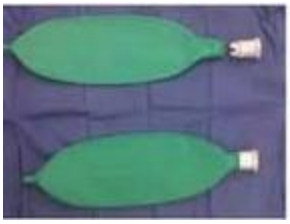
Maintenance costs and maintenance access generally are the greatest contributing factors to poorly maintained battery systems.

1.14. Bag valve mask (Pedia and Adult)

A bag valve mask, abbreviated to BVM and sometimes known by the proprietary name Ambu bag or generically as a manual resuscitator or "self-inflating bag", is a hand-held device commonly used to provide positive pressure ventilation to patients who are not breathing or not breathing adequately.

1.15. Anesthesia bag

The primary function of the reservoir bag during inhalation sedation is to provide a reservoir from which additional gas may be drawn should the respiratory demands of the patient exceed the gas flow delivered from the machine.



Daily maintenance of anesthesia bag

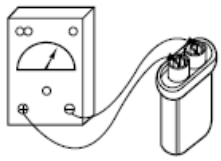
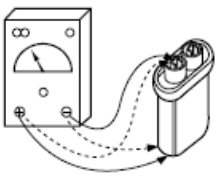
Clean breathing bags and tubes daily by soaking them in a solution of 3 parts water to 1 part Virkon 1%. Rinse them thoroughly to make sure no residue remains inside. Hang them up to dry for 24 hours.

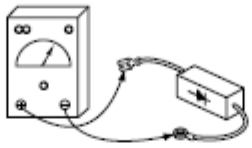
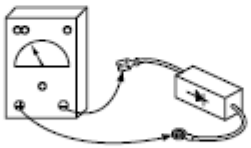
1.16. Clinical oven

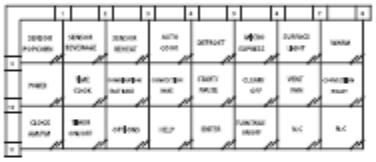
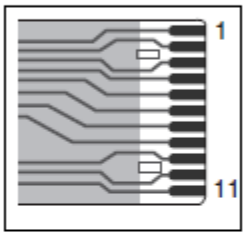
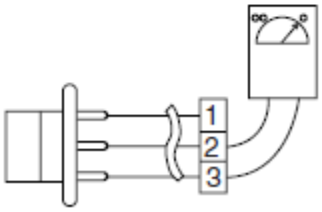
An oven is a thermally insulated chamber used for the heating, baking, or drying of a substance, and most commonly used in laboratories for drying.

Test procedures of clinical oven

COMPONENTS	TEST PROCEDURES	RESULTS
MAGNETRON (Wire leads are removed)	1. Remove wire leads. Install the magnetron seal in the correct position. Check that the seal is in good condition. 2. Measure resistance. (ohm meter scale:Rx1) • Filament terminal 3. Measure resistance. (ohm meter scale:Rx1000) • Filament to chassis	Normal reading: Less than 1 ohm. Normal reading: Infinite ohms. **NOTE:** Replace the magnetron, if the magnetron checks and all of the high voltage component tests are good, but the unit still does not heat a load.
HIGH-VOLTAGE TRANSFORMER (Wire leads are removed)	1. Remove wire leads. 2. Measure resistance. (ohm meter scale: Rx1) • Primary winding • Secondary winding to ground • Filament winding 3. Measure resistance. (ohm meter scale: Rx1000) • Primary winding to ground • Filament winding to ground	Normal(Approximately) 0.3 ~ 0.5 ohm 65 ~ 120 ohm Less than 0.2 ohm Normal readings: Infinite ohms. Infinite ohms.

COMPONENTS	TEST PROCEDURES	RESULTS
HIGH-VOLTAGE CAPACITOR	1. Remove wire leads. 2. Measure resistance. (ohm meter scale: Rx1000) (1) Terminal to terminal Ohm-meter  **Figure 25-a**	Normal: Momentarily indicates several ohm, and then gradually returns to infinite 
	(2) Terminal to case Ohm-meter  **Figure 25-b**	Normal: Infinite. 

HIGH-VOLTAGE DIODE	1. Measure continuity. Forward. (ohm meter scale: Rx1000) Ohm-meter  **Figure 26-a**	Normal:Continuity. Abnormal: Infinite. 
	1. Measure continuity. Reverse. (ohm meter scale: Rx1000) Ohm-meter  **Figure 26-b**	Normal: Infinite. Abnormal: Continuity. 
CONVECTION HEATER	1. Remove wire leads. 2. Measure resistance. (ohm meter scale:Rx1) 	Normal readings Resistance: Approx. 6 to 13 ohm Current: Approx. 13A Abnormal: Infinite or several.

COMPONENTS	TEST PROCEDURES	RESULTS
TOUCH KEY BOARD	Measure the resistance between terminal pins of connector KEY CONNECTOR. **NOTE:** When reconnecting the FPC connector, make sure that the holes on the FPC connector are properly engaged with hooks on the plastic fastener. MATRIX CIRCUIT FOR TOUCH KEY BOARD CONNECTOR(KEY CON)  **Figure 27**	Resistance value: When touched — Less than 400 ohms; When not touched — More than 1 mega ohm FPC CONNECTOR Top  **Figure 28**
SENSOR (For sensor model only)	1. Remove the 3 pin connector from PCB. 2. Measure resistance across pins 1 & 2. 3. Across pins 2 & 3. (ohm meter scale:Rx1)  **Figure 29**	Normal: Approximately 1 & 2: 3.1 Kohm; 2 & 3: ∞ at 68 ± 35°F Abnormal: Infinite or several.
THERMISTOR	1. Remove the connector from PCB. 2. Measure resistance across pins 1 & 3. (ohm meter scale: Rx1) 	Normal: Approximately 250 to 350 Kohm at 68 ± 35°F Abnormal: Infinite or several.

CHECKOUT PROCEDURES

(1) CHECKOUT PROCEDURES FOR FUSE BLOWING

PROBLEMS	CAUSES
Fuse blows immediately after the door is closed.	Improper operation of the primary interlock, secondary interlock switches and/or the interlock monitor switch.
Fuse blows immediately after the door is opened.	
Fuse blows when the door is closed and START key is touched.	Malfunction of the high voltage transformer; the high voltage capacitor including the diode, the magnetron, the blower motor or the circuit board.

1.17. CENTRIFUGE

Maintenance of Centrifuge

A laboratory centrifuge is a piece of laboratory equipment, driven by a motor, which spins liquid samples at high speed. There are various types of centrifuges, depending on the size and the sample capacity

Like all other centrifuges, laboratory centrifuges work by the sedimentation principle, where the centripetal acceleration is used to separate substances of greater and lesser density.

Figure 2.

Daily procedure in maintaining a centrifuge

I. Inspection before each run

• Visually check the carrier cups, trunnions and rotor for corrosion and cracks.

• If anything is found to be defective, replace it immediately or remove the equipment from service.

• Check for the presence and insertion of the proper cup cushions before each run.

ii. Quarterly and periodic checks

• At least quarterly checks need to be done

• Check the speed at all regularly used speeds with a stroboscopic light to verify the accuracy of a built-in tachometer or speed settings.

• Remember to record the results.

Problem	Checkpoint	Action taken
1. The "STOP" key lamp does not lit even if the "POWER" switch is turned on.	Is the power plug disconnected from the power outlet?	Insert the power plug into the socket.
	Is power supplied to the socket or knife switch ?	Inspect the power supply.
	Is the power supply voltage correct? (Note1)	Use a power supply in the correct voltage range.
2. The power is turned off immediately even if the "POWER" switch is turned on.	Is the power supply voltage correct? (Note1)	Use a power supply in the correct voltage range.
3. The lid does not open even if the "OPEN" button is pushed.	Is the "POWER" switch turn on?	Pull up the "POWER" switch to turn the power on.
	Is the <STOP> lamp lit or flashing?	Wait until the rotor is completely stopped.
	Does it open when the power switch is turned off and turned on once again in 10 seconds?	Check if an imperfect contact is not occurring with the power cable connection.
4. The motor does not spin.	Is the "POWER" switch turn on?	Pull up the "POWER" switch to turn the power on.
	Is the <STOP> lamp lit?	Go back to Problem 1. & 2. and check the power supply.
	Is the alarm <E1, E2, E3, E4, E6, E7> flashing on the "TIME" display ?	▶ Refer to pages 5-1, 5-3 and 5-4.
	Is the lid closing? (Note 2)	Close the lid firmly.

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5. The speed does not reach the set value even if the knob is turned.	Is the power supply voltage low? (Note 1)	Use a power supply in the correct voltage range.

Problem	Checkpoint	Action taken
6. Excessive vibration. or the error <E1.> lit.	Are buckets and tubes correctly distributed? (Note 3)	Distribute buckets and tubes correctly.When the error recurs, contact your nearest dealer for inspection.
	Do the buckets swing smoothly?	Spray lubricant to buckets and trunnion pins.
	Are the rotor knob or the rotor locking nut loose? (Note 3)	Fasten the rotor knob or the rotor locking nut securely.
	Check if the rotor is not loose.	Fasten the rotor locking bolt or the rotor locking nut securely.
7. An abnormal noise sounds.	Are buckets and tubes correctly distributed? (Note 3)	Distribute buckets and tubes correctly.
	Do the buckets swing smoothly?	Spray lubricant to buckets and trunnion pins.

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NO TE:

When operation centrifuge is interrupted by some abnormality, failure or for repairs, always turn off the "POWER" switch and attach "DO NOT USE" stickers to the rotor and the centrifuge before contacting your nearest dealer.

Copyright: Ethiopia Federal TVET Agency

1.18. Refrigerator

Maintenance of the Refrigerator- Freezer

Figure 5.

Daily records

- ✓ On a daily basis, monitor and record the temperature of the refrigerator. The thermometer should be placed into a liquid to permit stable temperature recording, or thermocouples may be used.
- ✓ On a daily basis, monitor and record the temperature of the freezer. The thermometer should be placed in anti-freeze to permit stable temperature recording.

Periodic checks

- ✓ Periodically when the door is opened check whether the fan is functioning.
- ✓ Monthly, check the door gasket for deterioration, cracks and proper seal. Seal problems are often seen when ice begins to build up in a freezer or the temperature is not holding. Periodically, petroleum jelly can be rubbed onto the door gasket to lubricate the material and to help maintain flexibility for a tight seal when the door is shut.
- ✓ Semiannually, clean the condenser tubing and air grill with a vacuum cleaner.
- ✓ Semiannually, check to ensure that the drain tubes are kept open.
- ✓ Annually, wash the interior with a warm solution of baking soda and water. Rinse with clean water, and dry. Also, wash the door gasket and water collection tray with a mild soap and water. If the gasket accumulates a black mold, scrub with 50% household bleach solution and a small brush. Rinse With clean water and dry.

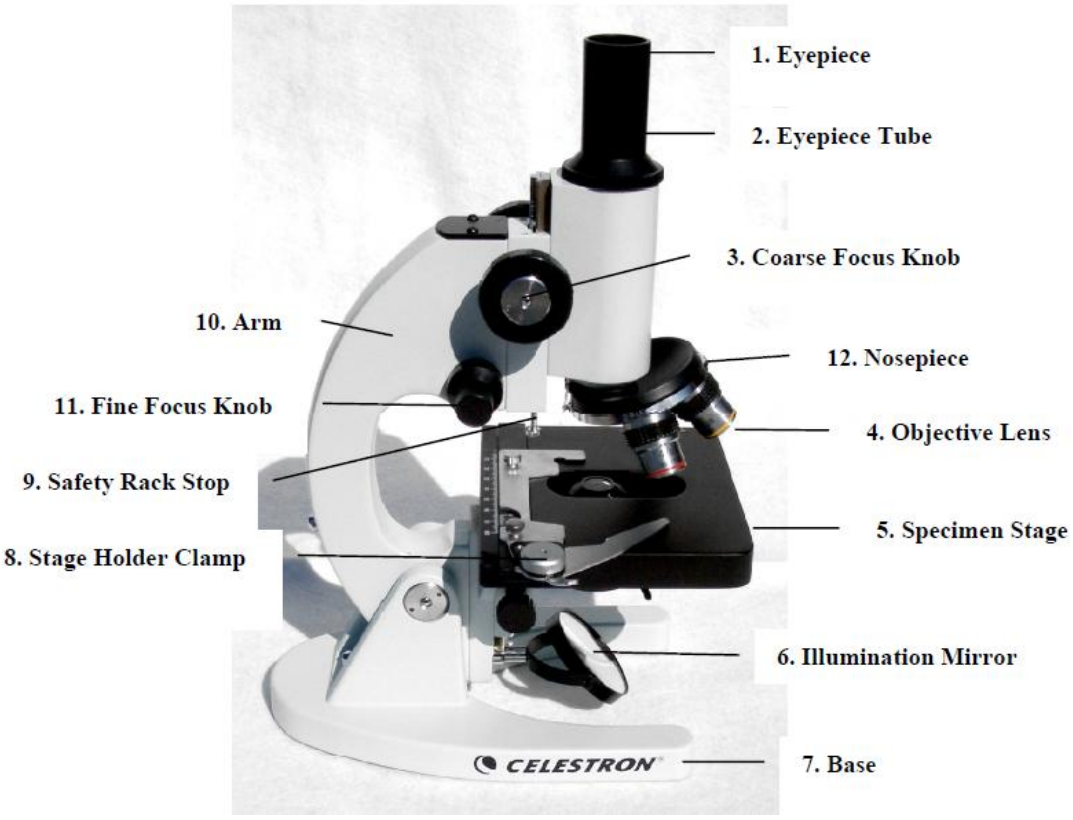
1.19. Microscope

What is a microscope?

A microscope is a high precision optical instrument that uses a lens or a combination of lenses to produce highly magnified images of small specimens or objects especially when they are too small to be seen by the naked (unaided) eye. A light source is used (either by mirrors or lamps) to make it easier to see the subject matter.

What is microscopy?

Microscopy is the use of a microscope or investigation by a microscope.



Maintenance of Microscope

Special care should be paid to each part of the microscope. Maintenance should be done according to a time schedule.

Daily procedure in maintaining a Microscope (X)

A. Optical surfaces

- ✓ Use a fine hairbrush to remove dust from all optical surfaces.
- ✓ Remove oil and finger marks immediately from the lenses with several thickness of lens tissue.
- ✓ Do not use any type of tissue other than lens tissue otherwise you may scratch the lens.
- ✓ Use very little pressure to prevent removal of the coatings of the lenses.

B. Cleaning Solutions (X)

- ✓ Use water-based solutions for normal cleaning.
- ✓ If you have to use organic solvents, use them in very small amounts and only if absolutely necessary to remove oil from the lens.
- ✓ Since microscope manufacturers do not agree on solvents to be used, each company's recommendations should be consulted.
- ✓ One recommended solvent is 1, 1, 1- trichloroethane; it is good for removing immersion oil and mounting media and will not soften the lens sealers and cements.
- ✓ Xylene, any alcohols, acetone, or any other ketones should never be used as cleaning fluids.

C. Lamp (X)

To remove oil received from fingers;

- ✓ Clean the lamp after it has been installed into the lamp holder, with lens tissue moistened in 70% isopropyl or ethyl alcohol.

2. Biomedical accessories

Accessories are items of equipment that are not usually essential, but which can be used with or added to something else in order to make it more efficient, useful, or decorative. Accessories are articles such as test equipment, tools, consumables and spares which you carry but which are not part of your main device.

Includes

Screwdrivers (assorted) Soldering iron/gun De-soldering tool Wrenches (assorted) Pliers (assorted) leaning Brush	Thermometer (digital & mercurial) Electrical Safety Analyzer Multi-tester (analog/digital) Utility knife Alignment tool

Self-Check -1	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Which of the of the following device is used for image magnification
   a) Autoclave
   b) Aspirator
   c) microscope
   d) OR table
2. What will happen when the concentration of solution is high?
   a) Transmittance increase
   b) Both transmittance and absorbance increase
   c) Absorbance increase
   d) Absorbance decrease
3. Which of the following is true about centrifuge?
   a) Works by transmittance principle
   b) Used for separation of substance
   c) Don't rotate if motor damaged
   d) B and c
4. Which of the following is true if the operation room light don't turn on
   a) Power unit is off
   b) Fuse is blown
   c) Exposed wires are cut or damaged
   d) Wire not connected correctly during installation
   e) all

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

Information Sheet-2	Receiving Appropriate request form

2. DIFFERENT TYPES OF FORMS

Correctness of the entry of different forms used in electrical work is necessary in order to acquire right, complete and accurate number of materials and tools needed in a specific electrical job. Here are samples of different forms used in electrical work.

2.1Purchase requisition is a document generated by a user department or store room personnel to notify the purchasing department items it needs to order, their quantity, and the time frame. It may also contain the authorization to proceed with the purchase. This is also called purchase request or requisition.

REQUISITION SLIP FORM

Name:
Project:
Location:
Classification:
Purpose:

NO.	QUANTITY	UNIT	DESCRIPTION	UNIT COST	TOTAL COST

REQUISITIONER TEACHER HEAD PRINCIPAL

2. Inventory are raw materials, work-in-process goods and completely finished goods that are considered to be the portion of a business's assets that are ready or will be ready for sale. Inventory represents one of the most important assets that most

businesses possess, because the turnover of inventory represents one of the primary sources of revenue generation and subsequent earnings for the company's shareholders/owners.

INVENTORY OF MATERIALS FORM

Name:

Section:

School:

Shop lab.:

Purpose:

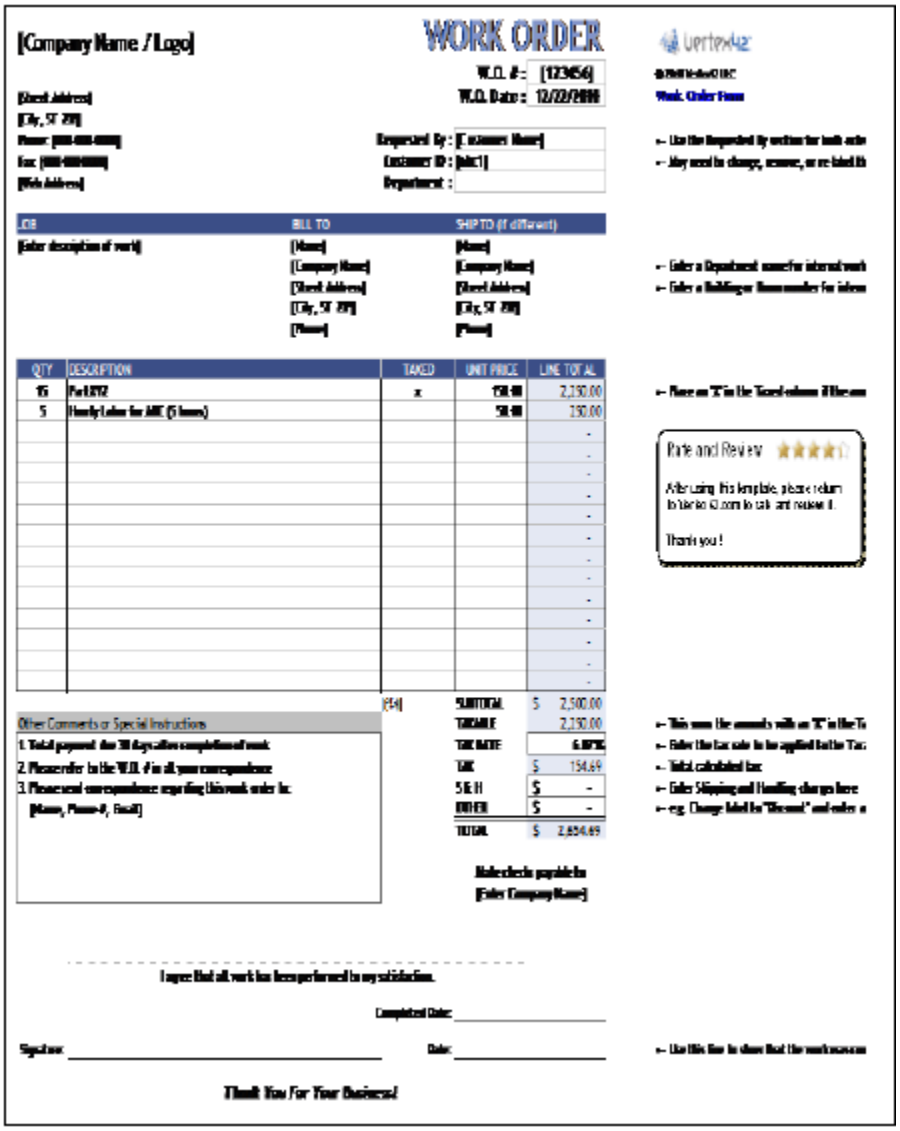
Tools/ Equip-ment	Qty.	No. of Functional	No. of not Functional but Repairable	No. of Condemn-able	No. of Borrowed	No. of Missing

REQUISITIONER TEACHER HEAD PRINCIPAL

Date:_____

3. **Job order or Work Order form** is a written instruction to perform a work according to specified requirements, within specified timeframe and cost estimates.

SAMPLE OF JOB ORDER FORM OR WORK ORDER FORM



[Company Name / Logo]

WORK ORDER

W.O. #: [123456]

W.O. Date: 12/22/2008

[Street Address]
[City, ST ZIP]
Phone: [000-000-0000]
Fax: [000-000-0000]
[Web Address]

Requested By: [Customer Name]
Customer ID: [optional]
Department:

JOB	BILL TO	SHIP TO (if different)
[Enter description of work]	[Name] [Company Name] [Street Address] [City, ST ZIP] [Phone]	[Name] [Company Name] [Street Address] [City, ST ZIP] [Phone]

QTY	DESCRIPTION	TAXED	UNIT PRICE	LINE TOTAL
15	Part #252	x	150.00	2,250.00
5	Hourly Labor for ARC (5 hours)		50.00	250.00
				-
				-
				-
				-
				-
				-
				-
				-
				-
				-
				-
				-
				-

Rate and Review

After using this template, please return to template.net to rate and review it.

Thank you!

	SUBTOTAL	$ 2,500.00
	TAXABLE	2,250.00
[5%]	TAX RATE	6.875%
	TAX	$ 154.69
	SHIPPING	$ -
	OTHER	$ -
	TOTAL	$ 2,654.69

Other Comments or Special Instructions

1. Total payment due 30 days after completion of work.
2. Please refer to the W.O. # in all your correspondence.
3. Please send correspondence regarding this work order to:
[Name, Phone #, Email]

Make checks payable to:
[Enter Company Name]

I agree that all work has been performed to my satisfaction.

Completed Date: _____

Signature: _____ Date: _____

Thank You For Your Business!

4. **BORROWER'S FORM** is a form used to request for tools and equipment needed for a particular job. It indicates the department that the borrower is connected, the date, the job that is to be done, who is the person to approve the request, when it was returned and if it was in good condition.

EQUIPMENT BORROWERS FORM

(Revised 31August2010; Accomplish in duplicate)

REQUEST NO: _____ *(do not fill up this item)* DATE: _____

MR / MS _____ _____ _____

(Please encircle) SURNAME GIVEN NAME MIDDLE

_____ _____ _____

ADDRESS: CONTACT NO. E-MAIL ADDRESS:

Please check:

□ Student Student No. _____ _____ Subject: _____

□ Dept Faculty Employee No. _____

□ Dept. REPS/Staff Department College: _____

□ Others Office Address. _____

Accompanying DGE-TCAGP Member: _____

PURPOSE: _____

INTENDED PERIOD OF USE: _____ to _____ LOCATION: _____

CHECKLIST OF REQUESTED ITEMS *:

** If more than 8 items, provide another attachment.*

*** Do not fill this part; to be countersigned by authorized staff upon receipt and return.*

RECOMMENDING APPROVAL (for DGE students): _____

Thesis Adviser/Faculty-in-Charge)

Borrower's Name in Print and Signature

Date: _____

(Fill this portion only during the time of borrowing.)

APPROVED:

_____

JUAN DELA CRUZ JR., Dr. Eng.

AG&ST Lab Coordinator

APPROVED:

_____

JUAN DELA CRUZ JR., Dr. Eng.

Chair, DGE and Director, TCAGP

This is to certify that:

1. I have read, understood, and agreed to the "Terms of Use for AG&ST Equipment" (back of this page).
2. I received the above listed equipment(s) completely and in good order.
3 JR.. I swear to use the above listed equipment(s) with due care and diligence.
4. In case of damage or loss, I shall be responsible for repair or replacement.

_____

(Borrower's Name over printed name)

To be accomplished upon return of equipment

Date returned: _____

All items in good condition? ____ YES ____ NO, (If no, please attach damage report)

Any missing item? _____ YES _____ NO, Please describe: _____

Received by: _____

Self-Check -2	Written Test

Directions: Accomplish the table.

COMMON TYPES OF FORMS	DESCRIPTION	PURPOSE
1.		
2.		
3.		
4.		

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

Information Sheet-3	Updating basic biomedical equipment inventory

1. Inventory

An inventory is a list of types of equipment with useful information for each piece of equipment. A useful inventory tells you:

a) What you own (type/sorts)
b) How much of it there is (quantity)
c) Where it is (location)
d) What condition it is in (status)
e) How far it is in its lifecycle (age/expected life)

An inventory database should be established to record and manage all items of equipment. This can be paper based or computerized, with paper back up. The following should be documented in the Inventory for each item of equipment:

- ✓ Description or type of the equipment
- ✓ Location of equipment (department/section/room)
- ✓ Inventory code number
- ✓ Name of manufacturer
- ✓ Model name and/or number
- ✓ Manufacturer's serial number
- ✓ Year manufactured or purchased
- ✓ Equipment risk classification (see section 3.3.1 below)
- ✓ Estimated total equipment lifespan*
- ✓ Current status/condition

2. Spare Parts Inventory

The equipment maintenance department should maintain a stock of the most commonly replaceable spare parts for the different types of equipment in the hospital. Items should be kept in a locked room with a stock control system in place. Spare parts should be stored according to manufacturer's instructions and should not be used beyond the expiration date. The inventory of spare parts should be managed using a 'stock and bin card' system.

Bin Card:

A Bin Card should be prepared for each spare part stored in the maintenance department. The Bin Card should be kept with the product inside the store. All transactions of the product to or from the store should be recorded on the Bin Card. The Bin Card should also include a column for the loss/adjustment of stock and a column for the stock balance. The stock balance should be updated after each and every transaction or adjustment.

Stock Card:

The Stock Card is similar to the Bin Card but is used to track stock based on issuing and receiving orders. The Stock Card should be maintained by the Head of the Maintenance Department. Whenever Stock Cards are updated the totals should be checked against those on the Bin Card and any discrepancies should be investigated.

Sample Inventory Data Collection Form

Inventory # _____
Type of Equipment: _____
Manufacturer: _____
Model: _____ Serial #: _____
Country of Origin: _____ Year of Manufacture: _____
Power Requirement: 220V 110V
Current State/Condition: Operable and in service
Operable and out of service
Reason out of service: _____
Needs maintenance
Not repairable
Needs to be discarded? Yes No
Spare parts available? Yes No
If yes, what, how many, and where are they located? _____
_____
Manuals Available: User manual # of copies _____ Location _____
Service manual # of copies _____ Location _____
Other (specify) # of copies _____ Location _____

Equipment Users:
Doctors Nurses Lab Technicians
Students Residents Other (specify) _____
Equipment owner (department), if any: _____
Contact Person and Telephone numbers: _____
Current location of equipment: _____

Will it move from here? No Yes If so, where? _____
Other notes (use back of paper if more room is needed:

_____
_____
_____

3. Why Maintain Inventory of Basic Biomedical Equipment

The most significant point to think at the start of your career is to acquire branded equipment. They must be made out of high-quality steel and manufactured for precision. Special consideration is given to balance so that the tool/equipment will be properly maintained and prevent loses. Since the technician/physician must work with his equipment daily, regular inventory of tools/equipment is very significant.

The initial cost of a minimum number of equipment is high but there is accompanying warranty guarantees satisfaction and many years of service. It is better, in the long run, to start with a few cautiously selected tools that will take care of your most common needs and then slowly build-up to a complete set. It is sometimes hard to identify and memorize the huge number of tools and equipment in the workshop, maintaining the inventory record is of great value.

Self-Check -3	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. bin card is
   a) a process of measuring absorbance of light
   b) is part of centrifuge
   c) Should be prepared for each spare part stored in the maintenance department.
   d) should be maintained by the Head of the Maintenance Department
2. Inventory of medical equipment includes?
   a) Location of equipment (department/section/room)
   b) Inventory code number
   c) Name of manufacturer
   d) Model name and/or number
   e) Manufacturer's serial number
   f) all
3. A useful inventory tells you:
   a) What you own (type/sorts)
   b) How much of it there is (quantity)
   c) Where it is (location)
   d) What condition it is in (status)
   e) How far it is in its lifecycle (age/expected life)
   f) All of the above

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

Information Sheet-4	Repair history and equipment consumables

4.1. Repair history

Maintenance records/ repair history are written notes that provide documentation about the upkeep of a certain piece of equipment. Most of the time when people talk about these sorts of records in an industrial setting they're referring to the formalized reports and files kept by fleet owners, industrial plant operators, or other business people engaged in some sort of work with machines. Keeping an adequate log of mechanical service and repairs in these scenarios is usually considered good business practice, and may also be required by law. Records are particularly useful in maintenance management because they help businesses ensure that their equipment is kept in good condition, and they also offer a way to manage and track repair and preventative upkeep expenses.

Records can also be used by individuals, however. Many people keep detailed records of personal automobile maintenance, and may also record service performed on home appliances like air conditioning units, back-up generators and medical equipment's.

.

SUMMARY OF REPAIR HISTORY
[For Defect(s) claimed ONLY]

CONSUMER: _____

VEHICLE YEAR/MAKE/MODEL: _____

DEFECT/NONCONFORMITY: _____DATE PURCHASED:_____

DATE IN	DATE OUT	REPAIR ORDER #	MILEAGE	ITEM/ACTION	NUMBER OF BUSINESS DAYS IN GARAGE	DAYS CONTESTED (MFG USE ONLY)

4.2. Consumable equipment

Laboratory Consumables are components of end products which are used for various experiments. Consumables are goods that must be replaced regularly because they wear out or are used up. Lab Consumables maybe disposable and reusable

Some example of laboratory consumable equipment's are:

Aluminum Foil Bags Beakers Bottle Accessories

Bottles Brushes Buckets Burettes

Burners Centrifuge Tubes Chemicals Reagents

Chromatography Cleaning Materials Containers Cuvettes and Sample Cells

Self-Check -4	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Which one of the following is not Consumable equipment?
   a) Aluminum Foil
   b) Bags
   c) Beakers
   d) None of the above
2. Repair history is,
   a) The document that tells about equipment status and quantity
   b) It informs doctor how to use the equipment
   c) written notes that provide documentation about the upkeep of a certain piece of equipment
   d) none of the above
   e) all

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

Information Sheet-5	Securing appropriate checklist tools forms

HAND TOOLS

The tool lists provided here are examples of the type of needs required by different sorts of maintenance staff. However, hospitals will need to personalize them to their own requirements.

If you have older equipment to maintain, you will also need the imperial version of:

- ✓ Allen keys
- ✓ Wrench
- ✓ screwdrivers
- ✓ Feeler gauges
- ✓ Spanners (open)
- ✓ Spanners (ring)
- ✓ Spanners (socket)
- ✓ Wrenches (box).
- ✓ soldering gun/iron
- ✓ electric drill and assorted bits

TEST EQUIPMENT

Testing of bio-medical equipment to ensure quality control in equipment's is becoming increasingly significant today when accuracy in diagnosis and effectiveness in treatment cannot be compromised at all.

Special test equipment: A biomedical team should have a range of test equipment to check the correct functioning of equipment and its compliance with electrical and other safety standards.

- ✓ Multi-meter
- ✓ Signal generator
- ✓ Oscilloscope
- ✓ Calibrators
- ✓ Gauges (assorted)
- ✓ Frequency Counter

What is a Multi-meter?

Multi-meter is a devise used to measure voltage, resistance and current in electronics & electrical equipment. It is also used to test continuity between 2 points to verify if there is any breaks in circuit or line.

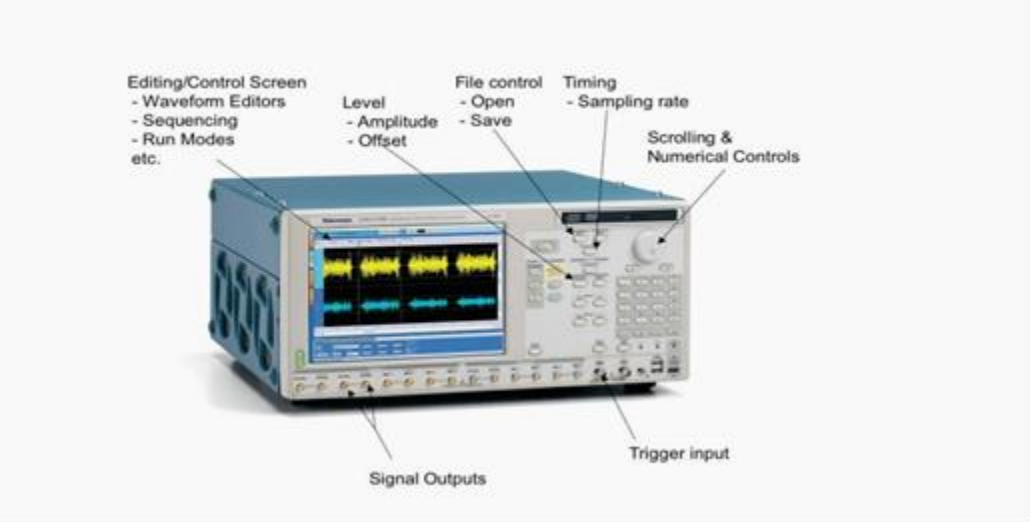
There are two types of multi-meter Analog & Digital

- ✓ Analog has a needle style gauge
- ✓ Digital has a LCD display

Signal generator

The signal generator is exactly what its name implies: a generator of signals used as a stimulus for electronic measurements. Most circuits require some type of input signal whose amplitude varies over time. The signal may be a true bipolar AC1 signal (with peaks oscillating above and below a ground reference point) or it may vary over a range of DC offset voltages, either positive or negative. It may be a sine wave or other analog function, a digital pulse, a binary pattern or a purely arbitrary wave shape.

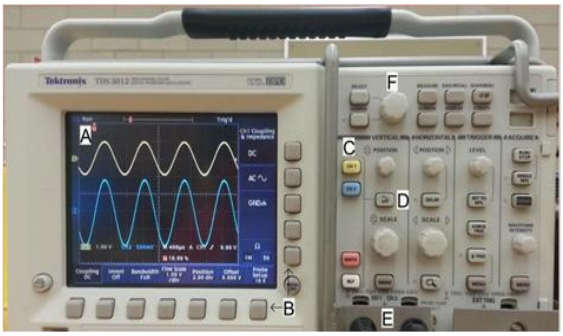
The signal generator can provide “ideal” waveforms or it may add known, repeatable amounts and types of distortion (or errors) to the signal it delivers. See Figure 2. This characteristic is one of the signal generator’s greatest virtues, since it is often impossible to create predictable distortion exactly when and where it’s needed using only the circuit itself. The response of the DUT in the presence of these distorted signals reveals its ability to handle stresses that fall outside the normal performance envelope



Oscilloscope

An oscilloscope, or scope for short, is an electronic test instrument that is used to observe an electronic signal, typically voltage, as a function of time. In other words it is a voltage versus time plotter. Oscilloscopes come in two basic types, analogue or digital, and support various features and functions useful for measuring and testing

electronic circuits. An oscilloscope is a key piece of test equipment for any electronics designer.



Tachometer: A tachometer is optical measurement equipment. It needs to 'see' the rotating object.

Oxygen analyzer: Analyzing the oxygen content in breathing machine, anesthesia machine, infant incubator and concentrator machine.

Calibrating tools

Testing and calibration of equipment ensures accuracy, effectiveness and long life of equipment's, which ultimately enables one to achieve the highest degree of quality control.

Testing and calibration

- ✓ Is extremely important in achieving quality control of the highest standard in medical equipment
- ✓ Is done with the help of specialized testing and calibrating equipment.
- ✓ Should be done at least once a year
- ✓ Can be done as per a range of national and international standards including – IEC606.1, EN60601.1, EN60601.2.4, EN61010, VDE0751, MDADB9801, HE 95, ANSI/AAMI and more.
- ✓ Can be done for almost the entire range of medical equipment's – including Defibrillators, Pulse Oxymeters , Infusion pumps , Patient Simulators, ventilators , Fetal Monitors, Patient monitors etc.
- ✓ Should be carried out by trained engineers.
- ✓ Should be concluded by documenting the test results and issuing a calibration report.

How is testing and calibration done?

Any measuring equipment or device needs to be tested and checked for its accuracy and calibrated whenever the need arises. Testing is done in accordance to domestic standards, very often this means, in accordance with manufacturers specifications, for both safety and performance test. The test results need to be formally documented.

Example - If a defibrillator supply is to be repaired and the manufacturer specifies safety test according to EN60601-2-24 to be performed after the repair of the defibrillator power supply, an EN 60601-2-24 test has to be done and the result has to be documented.

The European Medical Directive Describes in Article 12 (Conformity of systems)

Any natural or legal person who puts devices together within their intended purpose and within the limits of use specified by their manufacturers, in order to place them on the market as a system or procedure pack, shall draw up a declaration by which he states that:

- ✓ He/she has verified the mutual compatibility of the devices in accordance with the manufacturers instruction and has carried out this operations in accordance with these instructions; and
- ✓ He/she has packaged the system or procedure pack and supplied relevant information to users incorporating relevant instructions from the manufacturers; and
- ✓ The whole activity is subjected to appropriate methods of internal control and inspection.

OR -

If you install, connect to, or modify medical equipment, you are responsible for making a declaration of conformity. If you perform PM, service, or repair medical equipment you shall follow manufacturer's instruction.

<u>Fast moving consumables</u>

Medical consumables and equipment includes syringes, needles, sutures, staples, packaging, tubing, catheters, medical gloves, gowns, masks, adhesives and sealants for wound dressing and a whole host of other devices and tools used with a hospital or surgical environment.

Personal protective equipment

Personal protective equipment (PPE) is protective clothing, helmets, goggles, or other garments or equipment designed to protect the wearer's body from injury or infection. The hazards addressed by protective equipment include physical, electrical, heat, chemicals, biohazards, and airborne particulate matter.

Why is PPE important?

Making the workplace safe includes providing instructions, procedures, training and supervision to encourage people to work safely and responsibly.

Even where engineering controls and safe systems of work have been applied, some hazards might remain. These include injuries to:

- ✓ the lungs, eg from breathing in contaminated air
- ✓ the head and feet, eg from falling materials
- ✓ the eyes, eg from flying particles or splashes of corrosive liquids
- ✓ the skin, eg from contact with corrosive materials
- ✓ the body, eg from extremes of heat or cold

PPE is needed in these cases to reduce the risk.

Self-Check -5	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Testing and calibration is,
   a) Achieve quality control of the highest standard in medical equipment
   b) Is done with the help of specialized testing and calibrating equipment.
   c) Should be done at least once a year
   d) All of the above
2. A tachometer is
   a) Is used for measuring speed of rotating object
   b) Is a medical device used for blood counting
   c) Used to test and calibrate centrifuge
   d) A and c
3. Which of the following is not classified under hand tools
   a) Allen keys
   b) Wrench
   c) screwdrivers
   d) Feeler gauges
   e) Spanners (open
   f) None
4. Personal protective equipment (PPE) is
   a) protective clothing,
   b) helmets, goggles
   c) used for safety purpose
   d) all of the above

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

Information Sheet-6	Conducting on-site or in the workshop service

SHOP SERVICE

Shop service takes place at a service facility, which means you must transport your piece of equipment from your job site to the nearest shop location. With Machinery, you have immediate access to a state-of-the-art facility, service equipment and technicians who are committed to completing your repair quickly and effectively.

One of the benefits of in-shop service is the repairs on your equipment take place within a controlled environment that's free of dirt and protected from weather elements. This controlled environment is ideal for heavy equipment service because in some cases — like engine repairs or drive line maintenance, for example — exposure to dirt or extreme weather can cause more damage. Having the protection of a shop can be an asset for some repairs.

WHAT DOES SHOP SERVICE INCLUDE?

Shop service includes just about everything — equipment rebuilds, painting, repairs and maintenance to hydraulics, engines and undercarriages, in addition to oil sampling, welding and fabrication. The controlled environment, access to cutting-edge tools and trained Cat technicians make shop service a great option for all of these services.

Rebuilds — in an equipment rebuild, a repair person takes apart an entire piece of equipment piece by piece until it's unrecognizable. Then, talented and trained technicians rebuild it all using all new parts, resulting in a piece of equipment with a new product identification number and new warranty.

Painting — if your piece of equipment needs painting, shop service is your only option, which makes sense. You want a painter to apply a new coat of paint in a controlled environment, without worrying about the elements affecting your fresh paint job.

Hydraulics repairs and servicing — Hydraulics continue to get more and more complicated and many pieces of equipment rely heavily on them.

Self-Check -6	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. In site service include,
   a) printing
   b) Rebuild.
   c) Hydraulic repair
   d) All of the above
2. Shop service
   a) takes place at a service facility,
   b) transport your piece of equipment from your job site
   c) performed for large equipment
   d) all
3.

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

Operation Sheet 2	Techniques of maintaining and testing basic biomedical equipment

Techniques for basic biomedical equipment maintenance:

Step 1- Put on helmets, electrical and biological safety glove, safety shoos and OHS policies.
Step 2- Inspect tools and multimeters and also service manual are available and functional. Report any problems to the instructor.
Step 3- ask for equipment user about problem and audio/visual inspection.
Step 4- Check for functionality of receptacles, switches and circuit breakers with the help of multimeter if machine do not start.
Step 5- disconnect power plug/cables from the main power distribution and inspect for fault starting from power inlet to machine outlet
Step 6- reassemble step by step/ first out-last in principle/
Step 7- test equipment functionality using testing device and tools.

LAP Test	Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 8-12 hours.

Task 1: How do you measure resistance value of oven heating element using Multi-meter?

Task 2: How do you measure voltage using oscilloscope?

Task 3: How do you check and test speed of centrifuge using tachometer?

Task 4: How do you check oxygen purity using analyzer?

Task 5: What is the use of signal generator?

Instruction Sheet	LG18: Implements preliminary preventive maintenance protocol

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics –

- ✓ Communicating preventive maintenance program
- ✓ securing immediate surroundings of BBE from unnecessary hazards
- ✓ Performing basic biomedical equipment visual inspection
- ✓ Cleaning and sanitizing BBE in accordance with manufacturer standard

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, **you will be able to –**

- ✓ Communicate preventive maintenance program
- ✓ Secure immediate surroundings of BBE from unnecessary hazards
- ✓ Perform basic biomedical equipment visual inspection
- ✓ Clean and sanitize BBE in accordance with manufacturer standard

Learning Instructions:

7. Read the specific objectives of this Learning Guide.
8. Follow the instructions described below 3 to 6.
9. Read the information written in the information “Sheet 1, Sheet 2, Sheet 3 and Sheet 4, **in page 3, 6, 11 and 13** respectively.
10. Accomplish the “Self-check 1, Self-check t 2, Self-check 3 and Self-check 4” , **in page 5, 10, 112 and 16** respectively
11. If you earned a satisfactory evaluation from the “Self-check” proceed to “Operation Sheet 1” **in page 17**

Information Sheet-1	Communicating preventive maintenance program

1. **Types and approaches to Maintenance of Medical Equipment**

There are two types of maintenance:

1.1. Corrective Maintenance (or Repair): This is done to take corrective action in the event of a breakdown of the equipment. The equipment is returned repaired and calibrated.

1.2. Planned (or scheduled) Preventive Maintenance: This work is done in a planned way before repair is required and the scheduled time for the work circulated well in advance. It involves cleaning, regular function / safety tests and makes sure that any problems are picked up while they are still small.

The choice of approach for Preventive and Corrective Maintenance depends on the complexity of equipment

1.3. Maintenance by in-house trained technicians: The majority of the problems are relatively simple and can be corrected by a trained technician. Simple repairs and inspections are less costly when done this way. Vendors should provide training to in-house technicians at the time of installation and commissioning.

1.4. Maintenance by manufacturer or third party: For specialized and advanced equipment, the vendor should provide maintenance services through a combination of on-call services and a maintenance contract negotiated at the time of the purchase. It will rarely be economical to provide this level of service in-house.

1.5. Levels of Maintenance

There are three levels of maintenance commonly identified:

1.5.1. Level 1, User (or first-line): The user or technician will clean the filters, check fuses check power supplies etc. without opening the unit and without moving it away from the point of use.

1.5.2. Level 2, Technician: It is recommended to call the local technician when first-line maintenance cannot rectify a fault or when a six monthly check is due.

1.5.3. Level 3, Specialized: Equipment such as CT Scanners, MRIs etc. will need specialized engineers and technicians trained in this specific equipment. They are normally employed by third party or vendor companies.

1.6. Planned Maintenance of Medical Equipment

Planned preventive maintenance is regular, repetitive work done at scheduled intervals to keep equipment in good working condition. The activities under preventive maintenance involve

- ✓ routine cleaning,
- ✓ calibrating and adjusting,
- ✓ Checking for wear and tear and
- ✓ Lubricating to optimize working efficiency and to avoid breakdown.

Also consumables replacement like the fitting of new of filters etc. is done as part of this work.

Effective planning for preventive maintenance involves proper selection of the equipment to be included in the plan. Decisions must be made on what to include in order to reduce costs. Inexpensive units can be replaced or repaired if they break down, so need not always be included. The overriding consideration is cost effectiveness.

Self-Check -1	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. From the following which one is not part of preventive maintenance activities?
   a) calibrating and adjusting,
   b) routine cleaning,
   c) fixing power supply
   d) lubrication
2. Preventive maintenance?
   a) Planned
   b) May be performed by users
   c) Filter change
   d) all
3. Which one is true about level one maintenance?

a) Is performed by specialized personnel
b) It include equipment like CT, X-ray
c) Is first line or home users duties
d) Trained technician perform

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet-2	surroundings of BBE from unnecessary hazards

2.1. What is hazard?

The Occupational Health and Safety Regulation 2001 define a hazard as 'anything (including work practices or procedures) that has the potential to harm the health or safety of a person'.

Hazard is also a situation or thing that has the potential to harm a person. Hazards at work may include: noisy machinery, a moving forklift, chemicals, electricity, working at heights, a repetitive job, bullying and violence at the workplace.

Risk is the possibility that harm (death, injury or illness) might occur when exposed to a hazard.

2.1. Types of hazard?

Hazards can be grouped into five broad areas:

Physical e.g. noise, radiation, light, vibration

Chemical e.g. poisons, dusts

Biological e.g. viruses, plants, parasites

Ergonomic hazards or job related hazards

Psychological e.g. fatigue, violence, bull Ying.

2.1.1. PHYSICAL HAZARDS

Physical hazards include:

- ✓ Machinery
- ✓ Electrical power
- ✓ Noise
- ✓ Power and hand tools
- ✓ Working and walking surfaces
- ✓ Trip and fall hazards
- ✓ Ladders and scaffolds
- ✓ Heat and cold ventilation

2.1.2. Chemical hazard

	If you are working with cleaning products, bleaches, paints, and other chemical agents, you need to understand what a chemical hazard is as well as how to protect yourself.
	Chemical hazards include: ✓ liquids such a cleansers, ✓ acids, and paints ✓ vapors and fumes such as ✓ welding fumes ✓ gases such as carbon monoxide ✓ products that can catch fire or explode

2.1.3. BIOLOGICAL HAZARDS

Biological hazards include bacteria, viruses, insects, plants, birds, animals, and humans. The risks run from skin irritation and allergies to infections.

Dangers can come from:

- ✓ unclean restrooms
- ✓ mould and fungus
- ✓ bacteria
- ✓ insect stings
- ✓ animal bites
- ✓ poorly stored medical waste

2.1.4. ERGONOMIC HAZARDS

If your job is poorly designed, you can develop long term health problems. These problems can arise from simple things, like working for long periods in an awkward position or having to make the same motions over and over again.

Problems can come from:

- ✓ lighting
- ✓ chairs
- ✓ lifting

- ✓ repeated movements
- ✓ computer screens

2.1.5. PSYCHOLOGICAL HAZARDS

Those that are basically causing stress to a worker. This kind of hazard troubles an individual very much to an extent that his general well-being is affected

Stress can lead to long-term health problems. Headaches, anxiety, and impatience are early signs of stress.

Workplace causes of stress include:

- ✓ heavy workloads
- ✓ lack of control over the pace of work
- ✓ shift work
- ✓ noise
- ✓ working by yourself
- ✓ fear of job-loss
- ✓ conflict with the employer

2.2. Source of hazard?

Hazards can arise from:

- people
- the work environment
- the use of machinery and substances
- poor work design
- inappropriate systems and procedures

Examples of workplace hazards include:

Manual handling e.g. pushing, pulling, carrying, lifting

Work environment e.g. floor surfaces, noise, temperature machinery

Heat e.g. burns and scalds

Electricity e.g. electrocution

Recognising the hazards in a workplace and taking steps to eliminate or securing the hazard ensures the safety and wellbeing of all basic biomedical equipment's and users. It is easier and more effective to eliminate or control the hazard before serious injuries or damage result on BBE.

2.3. Difference between 'hazard' and 'risk'

A **hazard** is something that can cause harm, e.g. electricity, chemicals, working up a ladder, noise, a keyboard, a bully at work, stress.

Risk is the chance or probability that a person will be harmed or experience an adverse health effect once to a hazard. It may also apply to situations with property or equipment loss. A risk is the chance, high or low, that any hazard will actually cause somebody harm.

2.4. Risk assessment

The goal of all occupational safety and health programs is to foster a safe work environment. As a secondary effect, it may also protect co-workers, family members, employers, customers, suppliers, nearby communities, and other members of the public who are impacted by the workplace environment

A. Risk assessment is the process where you:

- ✓ identify hazards
- ✓ analyze or evaluate the risk associated with that hazard
- ✓ determine appropriate ways to eliminate or control the hazard

B. Factors that influence the degree of risk include:

- ✓ how much a person is exposed to a hazardous thing or condition
- ✓ how the person is exposed (e.g., breathing in a vapor, skin contact), and how severe are the effects under the conditions of exposure

Self-check

Self-Check -2	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

Given below is the list of common workplace hazards. Write at least three examples of each type of hazard.

1. Chemical hazard

_____
_____
_____

2. Physical hazard

_____
_____
_____

3. Biological hazard

_____
_____
_____

4. Ergonomic hazard or Job related

_____
_____

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet-3	Performing basic biomedical equipment visual inspection

3. Visual inspection

This is where the electrician will survey the electrical installation before he/she commences with the electrical testing. The visual inspection will highlight broken or cracked devices, where devices may have been installed in the wrong location, or if there have been overloading or over heating problems. Electrical testing with the use of electrical test meters, including:

3.1. Dead testing

3.1.1. **Continuity testing**: a test to check if there are any badly connected conductors (wires)

3.1.2. **Insulation resistance testing**: this test is to make sure that the electrical insulation material surrounding the conductors is intact.

3.1.3. **Polarity**: this test is to check that the connection are connected in the right sequence earthing arrangement testing: this check is to make sure that the earthing arrangement complies with regulations and that all connections are sound.

3.1.4. Live testing: Earth fault loop impedance testing: this test is to check that if a fault did occur, that the system meets requirements to cause a disconnection of the supply within the time limit specified

If anything dangerous or potentially dangerous is found, the overall condition of the electrical installation will be declared to be 'unsatisfactory', meaning that remedial action is required without delay to remove the risks to those in the premises.

Self-check

Self-Check -3	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. visual inspection is,
   a) it include changing of spare part
   b) done with the use of test equipment
   c) looking for broken part, misplacement
   d) must be performed with specialized personnel
2. Polarity test is
   a) this test is to check that the connection are connected in the right sequence
   b) is make sure that the electrical insulation material surrounding the conductors is intact
   c) to check if there are any badly connected conductors
   d) none of the above
3. Dead testing is,
   a. Live testing
   b) Insulation resistance testing
   c) Polarity
   d) All of the above

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet-4	Cleaning and sanitizing BBE in accordance with manufacturer standard

4.1. CLEANING AND SANITIZING

First of all, there IS a difference between clean and sanitary. “Clean”, means that soil and food are visibly removed from surfaces. When items are “sanitized” it means that those surfaces have a reduction of pathogens. There still may be microorganisms present, but they are at safe levels.

For sanitizing to be effective, surfaces must first be free of grease, soil and food particles. Sanitizers cannot penetrate through debris; so all debris must be removed before sanitizing. Measure the strength of the sanitizer with pH litmus papers to ensure it is the correct strength. If sanitizers are too strong they are toxic. If they are too weak they will not sanitize. The water temperature should be approximately 75°F.

4.2. Tools for Cleaning

To make the job of cleaning easier and more effective, it is important to use the right tool for the right job. It is also important to realize that is cleaning tools are not stored properly they can be the cause of contamination.

- ✓ **Buckets** - Provided labeled buckets for sanitizer. Sanitizer strength for Quaternary Ammonium is up to 200 PPM or per manufacturer’s recommendation. For chlorine the strength should be 50-100 PPM. Store the buckets away from food. Storing on the lowest shelves and off the floor is best. Change sanitizer solutions frequently. If the sanitizer becomes cloudy, it is too dirty to reduce bacteria on the wiping cloths.
- ✓ **Wiping Cloths** - Wiping cloths can spread harmful pathogens rather than clean surfaces if not used correctly. To prevent wiping cloths from being a source of contamination, store them in a sanitizer solution when not in use instead of leaving them on counters and cutting boards
- ✓ **Sponges** - Sponges must not be used in place of wiping cloths or used to wash dishes. Sponges often harbor bacteria that often cannot be killed by sanitizer solution.
- ✓ **Brushes** - Brushes help apply more pressure than wiping cloths. The bristles help loosen soil. If brushes are worn out they will not clean effectively and can be the source of contamination. Choose the right brush for the right job. Lacquered wood or plastic brushes with synthetic bristles work best

To be effective, cleaning and sanitizing must be 4 step process. Surface must be cleaned, rinsed, sanitized and allow to air dry

1

Clean the surface.

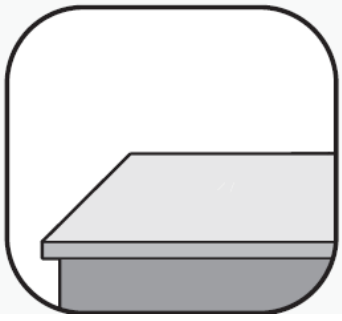
2

Rinse the surface.

3

Sanitize the surface.

4



Allow to air dry.

4.3. When to clean and sanitize

- ✓ Each time you use the equipment
- ✓ When you are interrupted during the task
- ✓ When you begin work with different type of activities

Self-check

Self-Check -4	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. When to clean and sanitize
   a) Each time you use the equipment
   b) When you begin work
   c) When you are interrupted during the task
   d) All
2. Which of the following is Tools for Cleaning
   a) Wiping Cloths
   b) Sponges
   c) Brushes
   d) Tachometer
   e) All except d
3. Which of the following true about sanitizing
   a) Is a process of decontaminating things
   b) Can be the first step for decontamination
   c) Is part of removal of derbies, dust
   d) None of the above

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Operation Sheet 1	Techniques of decontaminating procedures on simple biomedical equipment and accessories.

1.1. The techniques for decontaminating procedures on simple biomedical equipment and accessories

Step 1. Cleaning by using detergent or any other chemical,

Step 2. Rinse with sponge or clean piece of clothes,

Step 3. Sanitizing using chemical, high pressure or steam

Step 4. Allow to air for drying

Instruction Sheet	LG19: Prepare the unit/equipment

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics –

- ✓ Completing assembly check-up and fault symptoms
- ✓ Verifying repair history in line with the institution procedures
- ✓ Making required Service manuals and service information
- ✓ Cleaning the workplace in accordance with the institution procedure

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, **you will be able to –**

- ✓ Complete assembly check-up and fault symptoms
- ✓ Verify repair history in line with the institution procedures
- ✓ Make required Service manuals and service information
- ✓ Clean the workplace in accordance with the institution procedure

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 6.
3. Read the information written in the information “Sheet 1, Sheet 2, Sheet 3 and Sheet 4,” **in page 3, 6, 7 and 7** respectively.
4. Accomplish the “Self-check 1, and Self-check 4” , **in page 5, and 9** respectively

Information Sheet-1	Completing assembly check-up and fault symptoms

Assembly

When you perform repairs, you need a procedure that helps you take things apart and get them back together. The procedure here works for repairs that require you to take something apart and put back together again

TEST DURING ASSEMBLY

The test during assembly includes checks that are carried out during the course of the assembly operations of the units and/or of the general assembly of the machine.

The assembly phase brings together all pieces produced and those that have been purchased from external companies.

The assembly department is usually split into two sub-departments: one where the units are assembled, and one where the final machine assembly is carried out.

The individual units are assembled in the units assembly department; each unit that makes up the machine is assembled separately.

Once the assembly is finished, the individual units are taken to the final assembly sub-department, where they are joined together and where the final machine assembly is carried out.

The test during assembly is a particularly delicate check, since it is highly dependent upon the tester's individual skills.

This test has references which are very difficult to identify correctly.

Indications of a general nature are provided but, aside from this, the individual experience of the employee assigned the task of conducting the check is extremely important.

The assembly operations are identified by the assembly cycle similar to the processing cycle that identifies the processing sequences.

During the assembly cycle, the assembler is shown the sequence of operations to be followed.

The assembly tester is an assembler who has acquired significant experience, allowing him to act as a guide during the assembly operations.

The testing operations during the assembly must be planned by an assembly cycle at those points of the cycle deemed especially delicate from the quality standpoint.

These operations must be defined by means of suitable operational instructions and testing protocol that each company draws up based on its own experience.

The operational instructions accurately describe the methods that must be used in order to carry out the testing operations.

The testing operations during assembly usually concern:

- ✓ the functionality of the units
- ✓ alignments
- ✓ couplings between structures

An example of UNIT FUNCTIONALITY is the functional check of an operating head or of a cross carriage.

An example of ALIGNMENTS is checking the proper alignment of the supports of a translation screw of a linear axis and its nut.

An example of COUPLINGS BETWEEN STRUCTURES is the mounting of a slide and the base of the machine itself.

FINAL TEST AND INSPECTION

Basically, the final test and inspection of machine tools consists of a series of actions that can be described as follows:

Final internal test and inspection

- ✓ contractual preliminary test and inspection with the customer at the supplier's facilities
- ✓ contractual final acceptance test and inspection with the customer at the latter's facilities

Self-Check -1	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

4. The testing operations during assembly usually concern:
   a) the functionality of the units
   b) couplings between structures
   c) alignments
   d) all
5. Final internal test and inspection

   a) contractual final acceptance test and inspection with the customer at the latter's facilities

   b) contractual preliminary test and inspection with the customer at the supplier's facilities

   c) a and b

   d) all

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____
Rating: _____

Name: _____ Date: _____

Information Sheet-2	Verifying repair history in line with the institution procedures

Repair history

Maintenance records/ repair history are written notes that provide documentation about the upkeep of a certain piece of equipment. Most of the time when people talk about these sorts of records in an industrial setting they're referring to the formalized reports and files kept by fleet owners, industrial plant operators, or other business people engaged in some sort of work with machines. Keeping an adequate log of mechanical service and repairs in these scenarios is usually considered good business practice, and may also be required by law. Records are particularly useful in maintenance management because they help businesses ensure that their equipment is kept in good condition, and they also offer a way to manage and track repair and preventative upkeep expenses.

Records can also be used by individuals, however. Many people keep detailed records of personal automobile maintenance, and may also record service performed on home appliances like air conditioning units, back-up generators and medical equipment's.

SUMMARY OF REPAIR HISTORY
[For Defect(s) claimed ONLY]

CONSUMER: _____

VEHICLE YEAR/MAKE/MODEL: _____

DEFECT/NONCONFORMITY: _____ DATE PURCHASED: _____

DATE IN	DATE OUT	REPAIR ORDER #	MILEAGE	ITEM/ACTION	NUMBER OF BUSINESS DAYS IN GARAGE	DAYS CONTESTED (MFG USE ONLY)

. Fig: repair history format

Information Sheet-3	Making required Service manuals and service information

Service manuals

Factory service manuals (FSM) are the manuals provided by manufacturers which cover the servicing, maintenance and repair of their products. They were not originally offered to the public as they were developed for the dealerships so that their mechanics were able to fix their own products.

The service manuals is the documentation by which an organization provides guidance for members and employees to perform their functions correctly and reasonably efficiently.

Information Sheet-4	Cleaning the workplace in accordance with the institution procedure

Cleaning

The importance of a clean workplace. The workplace environment influences employees' productivity, performance and well-being. ... Maintaining a clean workplace is vital for employers to reduce their workers compensation claims and keep efficiency high.

Removal of Unnecessary Materials

All packing materials and other debris are removed from the medical equipment area. This helps ensure a clean, effective workspace for those employees who will be using the equipment on a regular basis. It also prevents contamination and other mishaps during work.

Why should we pay attention to housekeeping at work?

Effective housekeeping can help control or eliminate workplace hazards. Poor housekeeping practices frequently contribute to incidents. If the sight of paper, debris, clutter and spills is accepted as normal, then other more serious hazards may be taken for granted.

Housekeeping is not just cleanliness. It includes keeping work areas neat and orderly, maintaining halls and floors free of slip and trip hazards, and removing of waste materials (e.g., paper, cardboard) and other fire hazards from work areas. It also requires paying attention to important details such as the layout of the whole workplace, aisle marking, the adequacy of storage facilities, and maintenance. Good housekeeping is also a basic part of incident and fire prevention.

Effective housekeeping is an ongoing operation: it is not a one-time or hit-and-miss cleanup done occasionally. Periodic "panic" cleanups are costly and ineffective in reducing incidents.

Poor housekeeping can be a cause of incidents, such as:

a) tripping over loose objects on floors, stairs and platforms
b) being hit by falling objects
c) slipping on greasy, wet or dirty surfaces
d) striking against projecting, poorly stacked items or misplaced material
e) cutting, puncturing, or tearing the skin of hands or other parts of the body on projecting nails, wire or steel strapping

To avoid these hazards, a workplace must "maintain" order throughout a workday. Although this effort requires a great deal of management and planning, the benefits are many.

What are some benefits of good housekeeping practices?

Effective housekeeping results in:

- ✓ reduced handling to ease the flow of materials
- ✓ fewer tripping and slipping incidents in clutter-free and spill-free work areas
- ✓ decreased fire hazards
- ✓ lower worker exposures to hazardous products (e.g. dusts, vapours)
- ✓ better control of tools and materials, including inventory and supplies
- ✓ more efficient equipment cleanup and maintenance
- ✓ better hygienic conditions leading to improved health
- ✓ more effective use of space
- ✓ reduced property damage by improving preventive maintenance
- ✓ less janitorial work
- ✓ improved morale
- ✓ improved productivity (tools and materials will be easy to find)

Tools and Equipment

Tool housekeeping is very important, whether in the tool room, on the rack, in the yard, or on the bench. Tools require suitable fixtures with marked locations to provide an orderly arrangement. Returning tools promptly after use reduces the chance of it being misplaced or lost. Workers should regularly inspect, clean and repair all tools and take any damaged or worn tools out of service.

Self-Check -4	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Poor housekeeping can be a cause of incidents, such as:
   a) tripping over loose objects on floors, stairs and platforms
   b) being hit by falling objects
   c) slipping on greasy, wet or dirty surfaces
   d) striking against projecting, poorly stacked items or misplaced material
   e) all

2. benefits of good housekeeping
   a) reduced handling to ease the flow of materials
   b) fewer tripping and slipping incidents in clutter-free and spill-free work areas

c) decreased fire hazards
d) lower worker exposures to hazardous products (e.g. dusts, vapours)
e) all

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Instruction Sheet	LG20: Performing electrical safety testing

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics –

- ✓ Set-up appropriate test equipment and pre-testing procedure and establishing occupational health and safety practices
- ✓ Measuring line voltage, ground resistance and current leakage of the BBE
- ✓ Analyzing electrical safety test results with equipment manufacturer's safety standards
- ✓ Correcting electrical faults in accordance with equipment manufacture standards

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, **you will be able to –**

- ✓ Set-up appropriate test equipment and pre-testing procedure and establish occupational health and safety practices
- ✓ Measure line voltage, ground resistance and current leakage of the BBE

- ✓ Analyze electrical safety test results with equipment manufacturer's safety standards
- ✓ Correct electrical faults in accordance with equipment manufacture standards

Learning Instructions:

5. Read the specific objectives of this Learning Guide.
6. Follow the instructions described below 3 to 6.
7. Read the information written in the information "Sheet 1, Sheet 2, Sheet 3 and Sheet 4," **in page 3, 6, 12 and 16** respectively.
8. Accomplish the "Self-check 1, Self-check 2, and Self-check 3" **in page 5, 11, and 15** respectively

Information Sheet-1	**Set-up appropriate test equipment and pre-testing procedure**

Keys to proper setup of test equipment is proper location. The first step of proper test equipment setup is placing the equipment item(s) in the specified area of use. You need to have the equipment located in the area where it will be used, so a direct-to-site delivery process is extremely beneficial.

1. Electrical safety testing

Electrical safety testing is essential to ensure safe operating standards for any product such as medical equipment that uses electricity. Various governments and agencies have developed stringent requirements for electrical products that are sold world-wide. In most markets it is mandatory for a product to conform to safety standards promulgated by safety and standard agencies such as UL, CE, VDE, CSA, BSI, and CCC. To conform to such standards, the product must pass safety tests such as the high voltage test (also called as Dielectric voltage-withstand test or high potential test), Insulation Resistance Test, Ground (Earth) Bond & Ground Continuity Test & Leakage

Current Test (also called as Line Leakage Test, Earth Leakage Current Test, Enclosure Leakage Current Test or Patient Leakage Current Test)

2. Basic test equipment

The following items are used for basic measurement of voltages, currents, and components in the circuit under test.

- ✓ Voltmeter (Measures voltage)
- ✓ Ohmmeter (Measures resistance)
- ✓ Ammeter, e.g. Galvanometer or Milli-ameter (Measures current)
- ✓ Multi-meter e.g., VOM (Volt-Ohm-Milli-ammeter) or DMM (Digital Multi-meter) (Measures all of the above)
- ✓ LCR meter - inductance (L), capacitance (C) and resistance (R) meter (measure LCR values)

The following are used for stimulus of the circuit under test:

- ✓ Power supplies
- ✓ Signal generator
- ✓ Digital pattern generator
- ✓ Pulse generator
- ✓ Howard piA digital multi-meter

The following analyze the response of the circuit under test:

- ✓ Oscilloscope (Displays voltage as it changes over time)
- ✓ Frequency counter (Measures frequency)

And connecting it all together:

- ✓ Test probes

Self-Check -1	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

4. The following items are used for basic measurement of voltages, currents, and components in the circuit under test.
   a) Voltmeter (Measures voltage)
   b) Ohmmeter (Measures resistance)
   c) Ammeter
   d) all
5. The following are used for stimulus of the circuit under test:
   a) Power supplies
   b) Signal generator
   c) Digital pattern generator
   d) Pulse generator
   e) all
6. The following analyze the response of the circuit under test:

a) Oscilloscope (Displays voltage as it changes over time)
b) Frequency counter (Measures frequency)
c) UPS
d) A and B

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet-2	**Measuring line voltage, ground resistance and current leakage of the BBE**

2.1 High Voltage Test (Dielectric Voltage-withstand Test)

This test is carried out by applying a significantly higher than operating voltage to the device under test. In this test, the insulation of a product, stressed to a greater extent than under normal operating conditions, should not be breached for the product to pass. In most cases, the device is stressed to twice its normal operating voltage. During type testing, i.e. testing during designing a product or for a double insulated product, however, much larger voltage may be applied. For all electrical products, the high voltage test is a universal test, meaning that every unit should pass before it can be used.

2.2 Ground resistance

Is tested to determine the adequacy of the grounding of an electrical system.

2.2.1 How to Use an Ohmmeter to Measure Ground Resistance

Step 1

Connect your length of wire to a metal stake in the ground. Run the wire to your test location. Make sure that you have stripped back the insulation from both ends of the wire to allow for a good connection.

Step 2

Turn off the electricity at the testing location. You can either switch off the breaker for the circuit you're testing or you can switch off the main breaker for the house. Do not test a live circuit.

Step 3

Set your digital multi-meter to measure Ohms (likely shown by the Greek letter Omega). If you have multiple Ohm settings set it to less than 100 Ohms.

Step 4

Touch one lead to your test wire and the other lead to your test location – for example an outlet's third, ground plug (which is the small, round hole at the bottom of the outlet). Resistance should be less than 25 Ohms if the system is connected properly.

2.3 Leakage Current Test (Line Leakage Test)

Leakage current is the current that streams from either DC or AC circuit in an equipment to the ground or framework and can be from the output or input. If the equipment is not properly grounded, the current flows through other paths such as the human body. This mighty also occur if the ground is incompetent or is disrupted unintentionally or intentionally.

The leakage current in an equipment flows when an unintentional electrical connection occurs between the ground and an energized part or conductor. The ground may be the reference point of zero voltage, or the earth ground. Ideally, the current leaking from the power supply unit should flow through the ground connection and into the installations earth ground.

The inadequacies in the materials that build up the elements like the capacitors and semiconductors are the main cause of leakage current. These results in to small current leaking or flowing through the through the dielectric, in the case of a capacitor.

This measurement is done during the electrical safety test of a device. The currents flowing through the protective conductor or metallic parts of the earth are measured.

2.3.1 Why is Leakage Current Measurement Important?

Electrical system usually consists of a grounding technique that offers shield against a shock hazard if an insulation fault occurs. The grounding system comprises of a grounding rod that connects the instrument to the earth. If ever a disastrous failure of insulation between power line and conductive parts occur, the voltage will be pushed to

ground. The current that is created because of this event will flow, causing a circuit breaker to open or a fuse to blow thus avoiding a shock hazard.

Clearly, a shock hazard prevails if the earth or ground connection is intruded, either accidentally or intentionally. The possibility for a shock might be larger than assumed if there is case of leakage currents. Even in the scenario of no insulation failure, intrusion of leakage currents streaming through the grounding rod still pose a threat of electric shock to somebody meeting the ungrounded system and ground at the same time.

This is a huge concern when it comes to the field of medical applications, where a patient might be the receiver of the electric shock. A shock can be even fatal if the patient is weak or unconscious, or if the current flows to internal organs. The two-layered insulation offered in non-grounded equipment ensures protection. The security in this scenario is made sure because both coats of insulation are not likely to collapse together. Nevertheless, the situations that leads to leakage currents still exists and must be considered.

Hence, how can you eradicate or reduce the outcomes of leakage current? Measure the leakage current and then recognize the cause. Purpose of the Test is to measure the amount of current that passes through a person when that person touches an electrical product

2.3.2 What is done during Leakage Current Measurement?

- ✓ Meter particularly designed for determining leakage currents is utilized.
- ✓ The current streaming through the ground rod is quantified by attaching the meter in series with the earthing connection.
- ✓ The ground connection is unsealed and the current streaming to the neutral side of the power line is measured, for data processing equipment.
- ✓ The meter may also be connected between the outputs of the power supply and ground.
- ✓ Test conditions consists of exchanging the neutral connections and ac line and turning power switches on and off while monitoring the current.
- ✓ The test is done once the system has warmed to typical functioning temperature.
- ✓ The intention is to identify and measure the worst-case leakage current.
- ✓ For very small leakage currents, the meter is substituted with a network comprising of either a resistor or a resistor and capacitor grouping.
- ✓ The voltage drop throughout the network is then quantified using an ac voltmeter.
- ✓ Double-insulated equipment or ungrounded is verified by attaching the meter amid any touchable conductive part and earth.
- ✓ A copper foil of a specific dimension is placed on the housing, for a nonconductive housings, and the current flowing from it to ground is determined.

Type of Equipment	Maximum Leakage Current
Class I	0.75mA for hand held devices
	3.5mA for other devices
Class II	0.25mA
Class III	No hazardous voltages

2.3.3 How is Leakage Current Measurement Performed?

Direct Measurement

Direct measurement has precision and a meter especially designed for determining leakage currents is used. The current flowing in the ground conductor is measured by connecting the meter in series with the grounding connection of the device concerned.

Leakage current clamp meter is the most popular device used to measure leakage current. They are like the clamp meters utilized for finding load currents but gives considerably better results when quantifying currents less than 5mA. Generally, clamp meters wouldn't register such small currents. After we position the jaws of a clamp meter around a conducting rod or wire, the current reading is taken, and the value depends upon the intensity of the alternating electromagnetic field around the conductor. The clamp meter will identify the magnetic field around conductors like a wire armor cable, single core cable, a water pipe etc. The paired neutral and phase conductors of a single-phase circuit, or all live conductors of a three-phase circuit.

2.4 Testing different kinds of conductors:

When testing the grouped live conductors of a circuit, the magnetic fields produced by the load currents cancel each other out. Any uneven current coming from the conductors to ground is measured with a leakage clamp meter and must have a reading less than 0.1 mA.

If you performed an insulation test on a circuit that was powered down, the result would be in the range of 50MΩ or further, because the insulation tester utilizes s a dc voltage for checking, which do not consider the capacitive effect.

If you measured the same circuit loaded with office equipment, the result would be significantly different due to the capacitance of the input filters on these devices.

When a lot of parts of equipment are functioning on a circuit, the result will be collective, that is, the leakage current will be greater and could well be in the range of milliamps. Adding new pieces of equipment to a circuit protected by a GFCI could trip the GFCI.

And as the value of leakage current differs based on how the equipment is functioning, the GFCI may trip unintentionally.

When telecommunications equipment is present, the value of leakage indicated by a clamp meter may be considerably more than that resulting from insulation impedance at 60 Hz because, telecommunications system usually consists of filters that generate functional grounding currents and other gears that generates harmonics, etc.

2.5 Measurement of Leakage Current to Ground

When the load is switched on, the leakage current measured includes leakage in load equipment. If the leakage is adequately small with the load attached, then circuit wiring leakage is even smaller. If circuit wiring leakage alone is required, disconnect the load.

If you test single-phase circuits by clamping the phase and neutral conductor, the obtained amount will be any current streaming to ground.

Test 3 phase circuits by fastening a clamp around all 3 phase conductors. If a neutral is present, it must be clamped along with the phase conductors and the measured amount will be any current flowing to ground.

2.6 Measuring leakage current through the ground conductor

To quantity the sum of leakage streaming to the proposed earth connection, position the clamp around the ground rod.

2.7 Measuring leakage current to ground via unintentional paths to ground.

Clamping neutral/phase/ground all together recognizes uneven current that means leakage at a passage or electrical panel via unintended pathways to ground. If a connection to a water pipe or other electrical connections occur, similar inequality might happen.

2.7.1 Benefits of Leakage Current Measurement

Advantages of leakage current measurement are:

- ✓ The device under test is not placed into service, and its polarity need not be reversed
- ✓ No stressing due to high switching current

Leakage current can be a sign of the inefficiency of insulation on conductors. It is achievable to trace the cause of leakage current with the help of a low current leakage current clamp to interpret orderly measurements as needed. If required, this allows you to re-allocate loads all around the installation in a better unbiased manner.

Self-Check -2	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1 High Voltage Test

a) Is carried out by applying a significantly higher than operating voltage to the device under test.

b) Can be carried out by using autoclave

c) much larger voltage may be applied

d) All except b.

2. Advantages of leakage current measurement are:

a) The device under test is not placed into service, and its polarity need not be reversed

b) No stressing due to high switching current

c) Both a and b

3. Leakage Current is

a) The current that streams from either DC or AC circuit in an equipment to the ground

b) The current flows through other paths such as the human body.

c) Occur if the ground is incompetent or is disrupted unintentionally or intentionally.

d) all

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet-3	**Analyzing electrical safety test results with equipment manufacturer's safety standards**

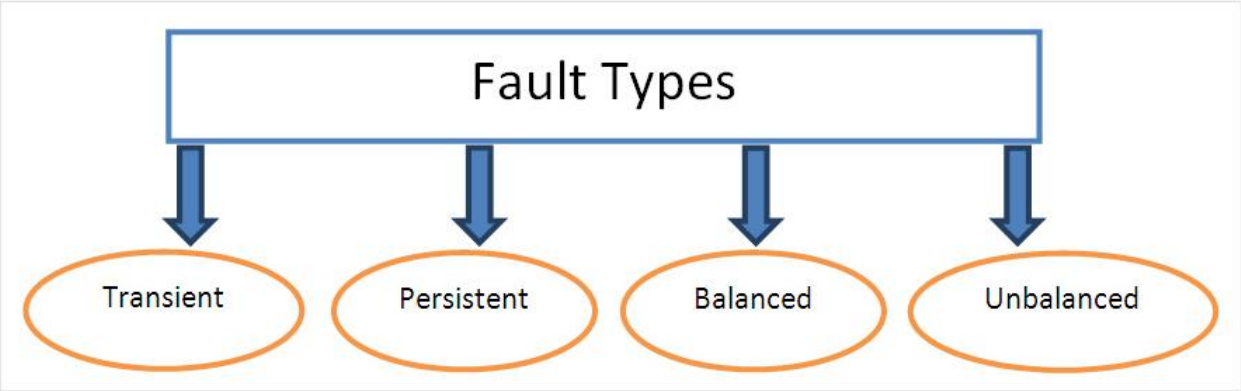
3.1 Introduction Fault

In an electric power system, a fault is any abnormal flow of electric current. For example, a short circuit is a fault in which current flow bypasses the normal load. An open-circuit fault occurs if a circuit is interrupted by some failure. In three-phase systems, a fault may involve one or more phases and ground, or may occur only between phases. In a "ground fault" or "earth fault", current flows into the earth. The prospective short circuit current of a fault can be calculated for power systems. In power systems, protective devices detect fault conditions and operate circuit breakers and other devices to limit the loss of service due to a failure.

In a poly-phase system, a fault may affect all phases equally which is a "symmetrical fault". If only some phases are affected, the resulting "asymmetrical fault" becomes more complicated to analyze due to the simplifying assumption of equal current magnitude in all

phases being no longer applicable. The analysis of this type of fault is often simplified by using methods such as symmetrical components.

3.2 Types of faults



3.2.1 **Transient Fault**

A transient fault is a fault that is no longer present if power is disconnected for a short time. Many faults in overhead power lines are transient in nature. At the occurrence of a fault power system protection operates to isolate area of the fault. A transient fault will then clear and the power line can be returned to service. Typical examples of transient faults include:

- ✓ momentary tree contact
- ✓ bird or other animal contact
- ✓ lightning strike
- ✓ conductor clash

3.2.2**Persistent Fault**

A persistent fault does not disappear when power is disconnected. Faults in underground power cables are most often persistent due to mechanical damage to the cable, but are sometimes transient in nature due to lightning

3.2.3Balanced (Symmetric Fault)

A symmetric or balanced fault affects each of the three phases equally. In transmission line faults, roughly 5% are symmetric. This is in contrast to an asymmetric fault, where the three phases are not affected equally. In practice, most faults in power systems are unbalanced. With this in mind, symmetric faults can be viewed as somewhat of an abstraction; however, as asymmetric faults are difficult to analyze, analysis of asymmetric faults is built up from a thorough understanding of symmetric faults.

3.2.4 **Unbalanced (Asymmetric Fault)**

An asymmetric or unbalanced fault does not affect each of the three phases equally. Common types of asymmetric faults, and their causes:

- ✓ line-to-line
- ✓ line-to-ground

- ✓ double line-to-ground

3.3Why Electrical Safety Testing is done?

Testing electrical and electronic products for electrical safety is intended to identify the potential risk of electrical shock to users.

How do We Conduct Electrical Safety Testing?

IEC 60335 is the most widely applied standard for electrical safety testing, especially for domestic appliances. Many safety testing standards in the world have been based on it. Electric safety testing will help

- ✓ Find any potential electric shock risks and fire hazards.
- ✓ Identify any defective electrical work.
- ✓ Highlight any lack of earthing or bonding.
- ✓ Tests are also carried out on wiring and fixed electrical equipment to check that they are safe.

3.4Benefits of Electrical Safety Testing

- ✓ Business Interruptions:

The more power your facility uses, the greater the risk of a failure. Electrical failures are inevitable without preventive maintenance.

- ✓ Life/Safety Risks:

Electrical distribution system malfunctions are now the leading cause of office structure and basic industry fire in the North America. DON'T RISK IT! Let us help!

- ✓ Utility Costs:

Without Preventive Maintenance the Electrical Distribution System itself can waste on average $1,000 to $4,000 in Electric Utility Cost annually! We can help to identify and eliminate these wasted costs!

- ✓ Surge Suppression:

80% of all transients are generated internally by starting and stopping of elevators, motors, heating and air conditioning equipment and manufacturing equipment. Electrical transients, which are spikes of current and/or voltage in a circuit, cause degradation in equipment which commonly get mistaken for manufacturer quality and equipment age. We can help develop a surge suppression plan to ensure the maximum possible protection of your assets.

- ✓ Power Quality Analysis:

Power quality problems cause loss of data and malfunction of computerized equipment. We can identify and help you eliminate these problems.

- ✓ Insurance/Certification:

Insurance companies lose millions of dollars each year due to electrical failure. When insurance companies lose so do their customers. More and more insurance companies

are encouraging their customers to participate in electrical preventive maintenance. It's a savings for all.

- ✓ Asset Management:

The average life expectancy of your Electrical Distribution System is only 15 years when electrical preventive maintenance does not exist. When your electrical system is cared for its life expectancy goes to an average of 30 years. We can help you plan for large upgrades, and avoid emergency repairs.

Self-Check -3	**Written Test**

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Benefits of Electrical Safety Testing
   a) Life/Safety Risks:
   b) Business Interruptions:
   c) Surge Suppression:
   d) All
2. Examples of transient faults include:
   a) momentary tree contact
   b) bird or other animal contact
   c) lightning strike
   d) conductor clash
   e) all
3. Common types of asymmetric faults,
   a) line-to-line
   b) line-to-ground
   c) double line-to-ground
   d) all of the above

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet-4	**Correcting electrical faults in accordance with equipment manufacture standards**

4.1Troubleshooting for Your Facility

Electrical control system issues usually happen with the worst possible timing. It's wise to be prepared with a troubleshooting plan. Often, we are quick to jump directly into fixing a problem when, in fact, it would benefit us to be methodical with our process. Here, we share a troubleshooting process that can help you navigate electrical troubleshooting for your facility.

- ✓ Gather Information. The first step of any electrical system troubleshooting exercise involves gathering as much information about the problem as possible. Instead of immediately diving in and haphazardly attempting anything to get the equipment running, first step back and determine how is the equipment supposed to operate, what technical documentation is available for the equipment, and is there someone familiar with similar equipment who may have experienced this same issue.
- ✓ Understand the malfunction and the role the malfunctioning equipment plays within the entire process. When you understand how the equipment and process

is supposed to work, you can better understand what part of it is not functioning correctly.

- ✓ Identify what can be measured so that you can identify items that are outside the acceptable range. For example, are there voltage readings or temperature readings that would help you evaluate the source of the problem?
- ✓ Identify the source of the problem using available data and analytical tools to isolate the defective component. This could involve isolating components and evaluating their circuit parameters or isolating the circuits by group when dealing with a complicated circuit.
- ✓ Correct/repair the damaged component.
- ✓ Verify the repair after completion. Once the repair has been performed, start the system to ensure it now runs as required. This is important because there may have been other underlying problems. For example, there may be an issue with a circuit causing a fuse to blow (such as a shorted electrical connection). If this is the case, additional troubleshooting will be required.
- ✓ Perform root cause analysis to determine what really caused the problem. Since one of the objectives of troubleshooting is to ensure the problem doesn't reoccur, it is important to determine what really caused the malfunction and take action to ensure a permanent solution is found.

Instruction Sheet	Lg21: Diagnose faults

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics –

- ✓ Identifying system faults using appropriate tools and test equipment
- ✓ Completing accurate diagnosis within the specified timeframe
- ✓ Documenting basic Biomedical Equipment failures
- ✓ Recording basic Biomedical Equipment failures or technical problems.
- ✓ Explaining fault/s, defects and range of the problems properly to the client

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, **you will be able to –**

- ✓ Identify system faults using appropriate tools and test equipment
- ✓ Complete accurate diagnosis within the specified timeframe
- ✓ Document basic Biomedical Equipment failures
- ✓ Record basic Biomedical Equipment failures or technical problems.
- ✓ Explaining fault/s, defects and range of the problems properly to the client

Learning Instructions:

9. Read the specific objectives of this Learning Guide.
10. Follow the instructions described below 3 to 6.
11. Read the information written in the information “Sheet 1, Sheet 2, Sheet 3 and Sheet 4 & 5,” **in page 3, 9, 10 and 11**respectively.
12. Accomplish the “Self-check 1,” **in page 8**

Information Sheet-1	Identifying system faults using appropriate tools and test equipment

5.1. DIAGNOSIS TECHNIQUES

Understand Process Of Disassemble and Assemble Of Electronic Equipment

Before knowing the technique in detecting fault, the need or function of the system must be known. Before starting the repairing work, we must know 4 aspects:

i. What type of the devices that will be repair?
ii. ii. What is the symptom of the devices?
iii. iii. Whether the devices has a schematic or not?
iv. iv. What is the appropriate technique to be use?

In first question, we should know the devices and their function (working style). For example, function of signal generator is to produce sinusoidal signal or square wave. Radio works as a receiver, to receive radio signal, process and produced audio. Television accept and process signal then produce picture and audio. From here, we can determine the equipment's faulty. While those second involves from result that are issued by the devices /equipment. For example no oscillation in signal generator, no voice from radio speaker, no picture on TV screen. That's what we call symptom. From here, we can determine which part of the circuit that does not function properly. We can spare time if our expectation is right. For that, schematic circuit is needed. From schematic circuit, we can concentrate on component which expected damage.

5.2. Know Fault Analyzed Techniques

TROUBLESHOOTING TECHNIQUES

5.2.1. PREPARATORY STEPS OF TROUBLESHOOTING TECHNIQUE

Before directly the conducting trouble shooting technique one has to first perform the following tasks:

Receive maintenance request

- ✓ Prepare
- ✓ PPE(personal protective equipment) o Cleaning material
- ✓ Melt meter to check electrical parameters
- ✓ Mechanical and electrical tool kits to trouble shoot
- ✓ Service manual

✓ Checklists to check qualitative and quantitative data

- ✓ Gather information about the equipment and the problem
  - Understand the equipment's design and operation
  - Draw out or locate schematic of device
  - Obtain and review history records to check for any recurring problems

Physical inspection

- ✓ Observe state of all components, for example:
  - ■ Relays energized or not
  - ■ Which lamps are lit
  - ■ Auxiliary equipment running or not
- ✓ Look for obvious visual clues to the cause
  - ■ Evidence of mechanical damage:
- ✓ Impact
- ✓ Chafed wires
- ✓ Loose components
- ✓ Parts lying in bottom of chamber
  - ■ Overheating
- ✓ Wiring
  - ■ Smell
- ✓ Burned insulation/wiring
  - ■ Sound
- ✓ To find the problem area
- ✓ Can indicate mechanical failures
  - ■ Touch (Carefully!)
- ✓ Hot areas indicate over heating

5.2.2. Analyze Faults Using Visual Techniques.

Fault analyzed technique can be arranged as follows:-

a. Burning effect

b. Shorting effect

c. Broken effect

d. Heat effect

When area or part that suspected faulty known, before making other tests, observe whether the component or printed circuit board around part either favorable or burnt, loose, broke and so on. For Example: broken fuse could be seen physically detected without using any tools, we also can observe if there is smoke, 'sparkling' or burnt. Sometimes component that burnt or 'sparkling' invisible to the naked eye, but it can be heard or smelt. For example, frequently high voltage converter sparkled if the insulator cracked but cannot see the effect only overheard 'hiss' sound or overheated converter only issued burnt smell.

5.3. Analyze Faults Using Signal Tracing And Injection Techniques.

Before tracing or injecting a signal, we should be preparing tester tools such as oscilloscope, audio generator and direct current supply (dc).

5.4. Analyze Faults Using Voltage Measurement Technique.

Voltage measuring technique is made after we know the damaged part. Voltage that first need to be known was the supply to that part. For example as in figure below, +12V supply should be in R1 and R3. If it is low or zero, this mean supply is not in normal condition.

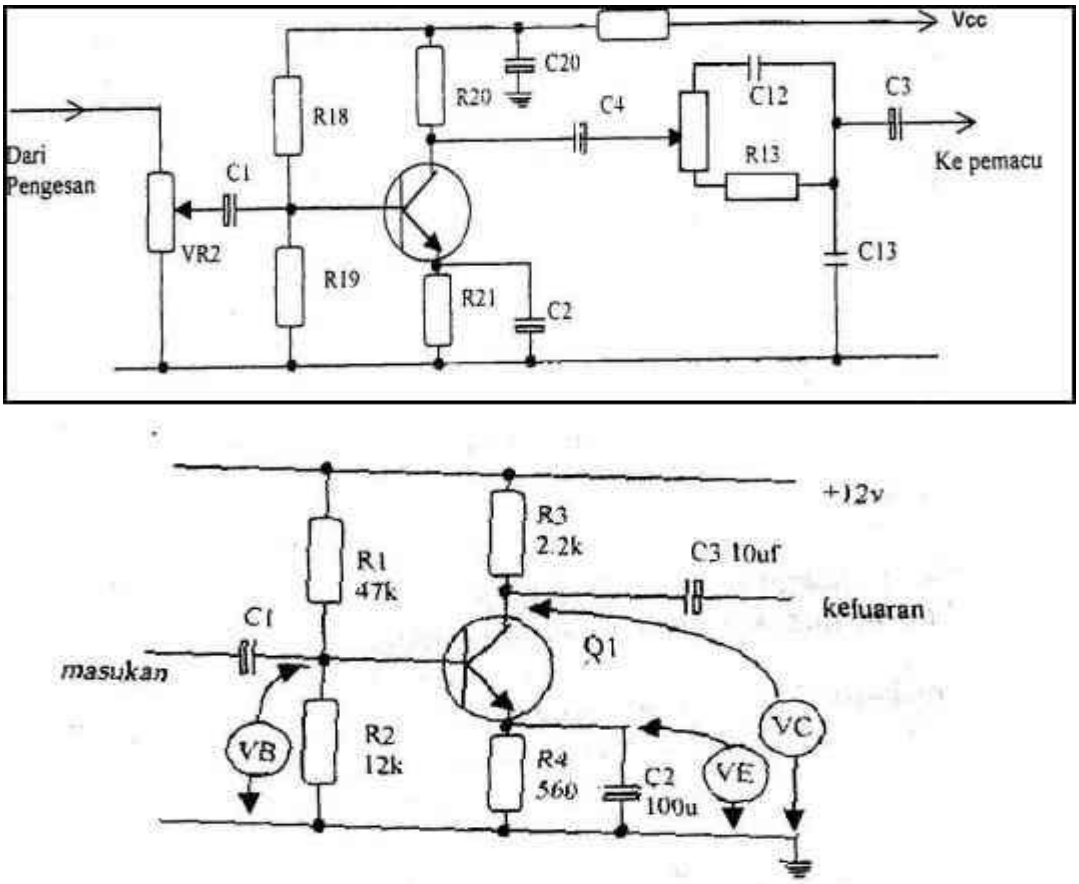


Figure 3.4: Voltage Measurement Technique

If supply voltage is normal, test voltage around active component .Active component here is Q1.To analyze voltage that measured, we should know normal voltage (undamaged). As an example, the normal voltage of Q1 are:

Collector C (Vc) = 5.5V

Base B (Vb) = 2.5V

Emitter E (VE) = 1.7V

Example 1

If C voltage= 0.1V, which components are damage and what kind of damage?

Answer: R3 open (no current flow to collector)

Example 2

If C voltage = 11.8V, what kind of damage?

Answer:

i. R1 open or
ii. CE Q1 open or iii. R4 open

Example 3

If B voltage = 0.1 V

Answer:

I. BE Q1 short circuit or

ii. R1 open circuit

Example 4

If voltage, E = 0V

Answer:

I. C2 short circuit or

ii. Emitter Q1 open circuit

5.4. Analyze Faults Using Resistance Measurement Technique.

This technique is suitable for component that may have specified resistance such as resistor, diode and transistor. Some certainty should be observed when making resistance measurement in circuit.

a. Resistant

When measure resistant value in a circuit, determine no low resistance, induction and converter in extension which related. To determine open resistance, make sure the value that written are same. If not, it mean that the

resistance open or changing high value. Measure at least twice by changing the polarity.

b. Diode

For certainty, resistance resistive low should be observed, then survey the resistance during forward and reverse biased. If the reading same as normal diode (outside circuit), the diode could be regarded in a good situation.

c. Transistor

Transistor resistance measurement are made like measuring it outside circuit. We should determine type of transistor whether NPN or PNP, no component of resistance resume between terminal. If measurement found to be normal that means transistor is in good condition.

Know Passive and Active Components Faults Analyze

Techniques Testing Passive and Active Component Using Test Equipment (Ohm Meter) By Identifying

I. **Resistance of resistors**

When measuring resistance in a circuit, determine no low resistance, inductor and transformer in extension which related. To determine open resistor, make sure the values that written are same. If not, it mean that the resistor is open circuit. Measure at least twice by changing the polarity.

ii. **Charging and discharging effect of the capacitors**

First method, before you test capacitor, make sure you use an analog millimeter set to time 1 ohm range and connect a capacitor to the test probe. See the panel if the pointer flick up and comes down or not, this represent charging and discharging. If it still cannot flick or no response then set your meter to time 10 ohm and then to 1k ohm and lastly to 10 kilo ohm range.

If it still don't flick then the capacitor under test have developed an open circuit. This is a rather old method to test capacitors because even though a capacitor can charge and discharge, this does not mean the capacitor value is good. Due to this problem, digital capacitance meter was developed.

Self-Check -1	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Fault analyzed technique can be arranged as follows:-

   a) Burning effect
   b) Shorting effect
   c) Broken effect
   d) Heat effect
   e) all

2. Before starting the repairing work, we must know:
   a) What type of the devices that will be repair?
   b) What is the symptom of the devices?
   c) Whether the devices has a schematic or not?
   d) What is the appropriate technique to be use?
   e) A and b
   f) all

3. Analyze Faults Using Resistance Measurement Techniques suitable for component
   a) Resistor,
   b) Diode
   c) Transistor.
   d) All of the above

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet-2	**Completing accurate diagnosis within the specified timeframe**

Scheduled maintenance is any maintenance that is arranged to be done ahead of time and within a predetermined period. It can either be a recurring task done at regular time intervals or a one-time task. Scheduled maintenance includes inspections, adjustments, regular service, and planned shutdowns

Maintenance represents down time for any treatment line so the quicker maintenance can be performed the better.

Information Sheet-3	Documenting basic Biomedical Equipment failures

Biomedical equipment include everything from tongue blades to magnetic resonance imaging machines to implanted heart valves. A suspect medical device is one that may be defective or may have malfunctioned, causing or contributing to an adverse event. Whether or not the suspect medical device injures a patient or caregiver, the problem must be reported.

What do I need to do if equipment fail?

If you know or suspect that a device is malfunctioning or defective, take it out of service. If the device has electronic memory, keep it plugged in so it maintains its memory.

If the patient was injured, assess him and treat his injuries appropriately, then immediately report the incident to his primary care provider, your nurse-manager, and the hospital risk manager.

Keep the device, its packaging, and anything else that may help investigators reconstruct the event. The manufacturer will need to inspect the device, and it could become evidence if the incident results in a lawsuit.

Document the incident in the medical record. Include the date and time of the event, changes in the patient's condition that have led you to suspect a device malfunction, and a full, objective, and chronologic description of the problem or event. Document your interventions, the patient's response to them, and any changes in orders.

Also document in the medical record all persons notified, dates and times of these notifications, and actions taken by those you've informed. Include the product names and therapy dates for any other medical products (drugs, biologics such as vaccines, devices) the patient was using at the time of the incident.

If a health care provider was injured, follow your facility's policy for documenting the injury on an incident report.

Information Sheet-4	Recording basic Biomedical Equipment failures or technical problems.

Documentation of all activities performed includes observations made, replacement of spare parts and follow up on previous sessions, including economic parameters shall be performed.

Information Sheet-5	Explaining fault/s, defects and range of the problems properly to the client

FAULT

A “fault” is another word for a problem. A “root cause” fault is a fundamental, underlying problem that may lead to other problems and observable symptoms. (It might not be directly observable). A root cause is also generally associated with procedures for repair.

A "fault" or "problem does not have to be the result of a complete failure of a piece of equipment, or even involve specific hardware. For instance, a problem might be defined as non-optimal operation or off-spec product. In a process plant, root causes of non-optimal operation might be hardware failures, but problems might also be caused by poor choice of operating targets, poor feedstock quality, poor controller tuning, and partial loss of catalyst activity, buildup of coke, low steam system pressure, sensor calibration errors, or human error. A fault may be considered a binary variable (”OK” vs. “failed”), or there may be a numerical “extent”, such as the amount of a leak or a measure of inefficiency.

A symptom is an observed event or variable value, needed to detect and isolate faults. If a symptom is the response to a question or an on-demand data request (when actively testing a system instead of just passively monitoring it), it is referred to as a test or test result.

Fault detection is recognizing that a problem has occurred, even if you don't yet know the root cause. Faults may be detected by a variety of quantitative or qualitative means. This includes many of the multivariable, model-based approaches discussed later. It also includes simple, traditional techniques for single variables, such as alarms based on high, low, or deviation limits for process variables or rates of

change; Statistical Process Control (SPC) measures; and summary alarms generated by packaged subsystems.

Fault diagnosis is pinpointing one or more root causes of problems, to the point where corrective action can be taken. This is also referred to as “fault isolation”, especially when emphasizing the distinction from fault detection. In common, casual usage, "fault diagnosis" often includes fault detection, so “fault isolation” emphasizes the distinction.

Instruction Sheet	LG22: Repair biomedical equipment

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics –

- ✓ Using safety equipment to protect self and others according to established OHS.
- ✓ Replacing defective components with equivalent spare parts/components
- ✓ Soldering Repair and/or replaced parts/components
- ✓ Doing necessary adjustment
- ✓ Applying necessary modification
- ✓ Substituting spare parts in accordance with the manufacturer's specification
- ✓ Performing BBE preventive maintenance procedures
- ✓ Performing corrective maintenance activity
- ✓ Observing care and extreme precaution in handling the unit
- ✓ Performing equipment set-up and start-up operation
- ✓ Setting equipment controls in accordance with manufacture's functional test standard
- ✓ Checking controls and start up signals with safety regulations
- ✓ Simulating BBE operation protocols
- ✓ Lubricating equipment in accordance with manufacturer standards
- ✓ Inspecting and set-up accessories of the covered BBE
- ✓ Replacing appropriate consumables equipment parts
- ✓ Completing functional test within the specified time

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, **you will be able to –**

- ✓ Use safety equipment to protect self and others according to established OHS.
- ✓ Replace defective components with equivalent spare parts/components
- ✓ Soldering Repair and/or replaced parts/components
- ✓ Do necessary adjustment
- ✓ Apply necessary modification
- ✓ Substitute spare parts in accordance with the manufacturer's specification
- ✓ Perform BBE preventive maintenance procedures
- ✓ Perform corrective maintenance activity
- ✓ Observe care and extreme precaution in handling the unit
- ✓ Perform equipment set-up and start-up operation
- ✓ Set equipment controls in accordance with manufacture's functional test standard
- ✓ Check controls and start up signals with safety regulations
- ✓ Simulate BBE operation protocols
- ✓ Lubricate equipment in accordance with manufacturer standards
- ✓ Inspect and set-up accessories of the covered BBE
- ✓ Replace appropriate consumables equipment parts

- ✓ Complete functional test within the specified time

Learning Instructions:

13. Read the specific objectives of this Learning Guide.

14. Follow the instructions described below 4 to 29.

15. Read the information written in the information “Sheet 1, Sheet 2, Sheet 3 and Sheet 4, Sheet 5 Sheet 6 Sheet 7 Sheet 8 Sheet 9 Sheet 10 Sheet 11 Sheet 12 Sheet 13 Sheet 14 Sheet 15 Sheet 16” **in page 4, 6, 8, 11, 13, 14, 15, 18, 19, 20, 21, 21, 22, 25, 26, and 27** respectively.

16. Accomplish the “Self-check 1, Self-check 2, Self-check 7, Self-check 13” **in page 5, 7, 17 and 24**

17. If you earned a satisfactory evaluation from the “Self-check” proceed to “Operation Sheet 1” **in page 28.**

Information Sheet-1	**Using safety equipment to protect self and others according to established OHS.**

Safety equipment

PPE is equipment that will protect the user against health or safety risks at work. It can include items such as safety helmets, gloves, eye protection, high-visibility clothing, safety footwear and safety harnesses

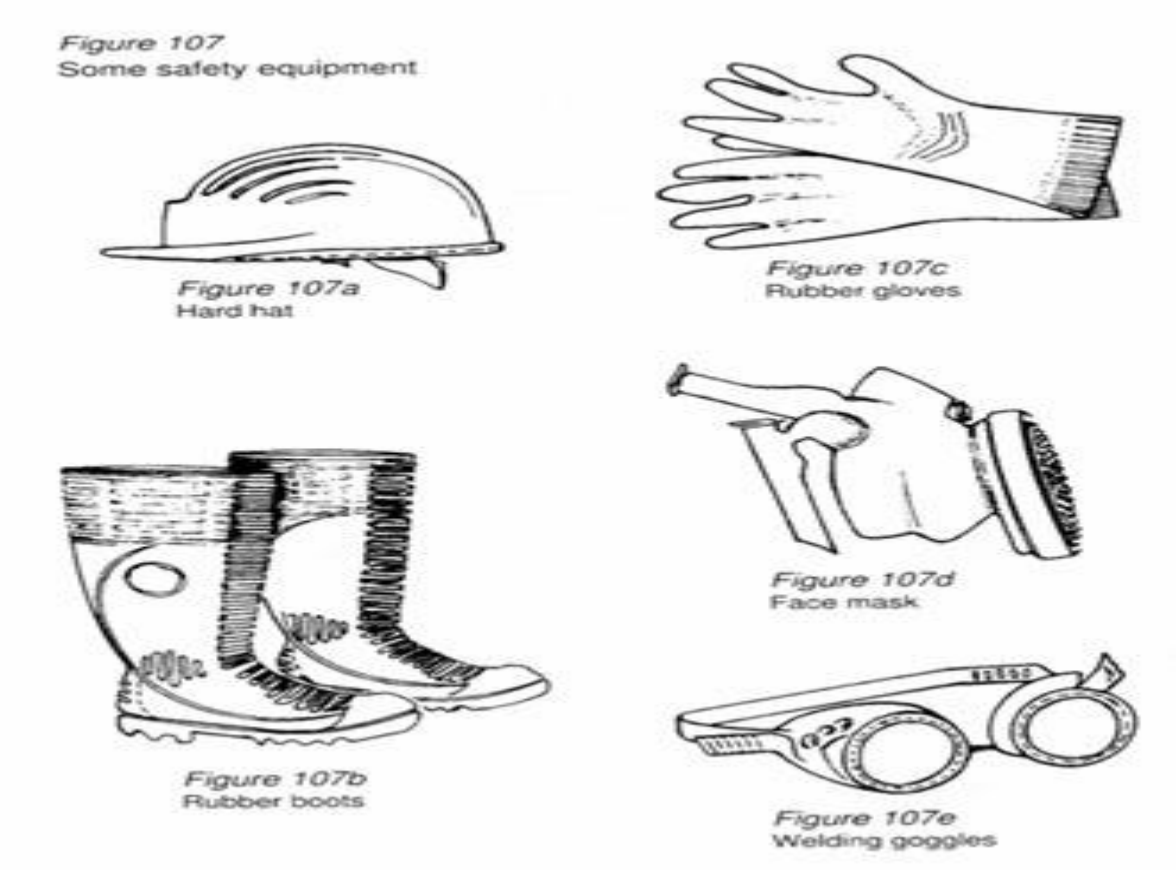


Figure 107
Some safety equipment

Figure 107a
Hard hat

Figure 107c
Rubber gloves

Figure 107b
Rubber boots

Figure 107d
Face mask

Figure 107e
Welding goggles

Self-Check -1	

	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

PART II: Multiple choice

7. Which one of the following is not PPE.

   A) gloves,
   B) eye protection,
   C) dosimeter
   D) high-visibility clothing

8. Which of the following is true about PPE
   a) protect the user against health or safety risks at work
   b) protect the equipment against inrush current
   c) used by maintenance team for safety
   d) a & c

PART II

True /false

1. Before any work, anybody should have to use PPE.
2. The use of glove is to protect our eye from damage during work.

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet-2	Replacing defective components with equivalent spare parts/components

A spare part: - spare, service part, repair part, or replacement part, is an interchangeable part that is kept in an inventory and used for the repair or replacement of failed units.

This section addresses the issue of how to dismantle some of basic biomedical equipment in order to replace faulty parts. The warnings below apply to all work inside the device.

- ✓ Before any work on an open device, you need to imperatively check if the high voltage capacitor is properly discharged.
- ✓ Before dismantling the device, remove the battery or the cell from its slot.
- ✓ The device contains circuits sensitive to electrostatic discharge. Some work on the medical device shall be performed in accordance with ESD rules. The repairs shall be performed on an antistatic mat connected to the earth and the operator shall wear an antistatic strap also connected to the mat. In the event of any work on the high-voltage part of the device, remove the antistatic strap.

Harm may occur when the spare parts used are not equivalent to the original parts:

- ✓ Loss of reliability of the equipment
- ✓ Deterioration of performances
- ✓ Increase of the safety RISKs

Recommendations:

There are several sources of spare parts:

- ✓ The device MANUFACTURER
- ✓ Other MANUFACTURERS
- ✓ Second-hand stockists
- ✓ The health care facility itself
- ✓ A service provider

Refurbishment

Refurbishment is the act of restoring the device to its original specifications and is normally carried out by the MANUFACTURER. Refurbishment may involve taking apart the medical equipment and replacing parts that show signs of wear or other loss of performance compared with new parts. Refurbishment, therefore, goes beyond repair but does not constitute a modification of the medical device or a change of intended use.

Self-Check -2	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

9. Which one of the following is not source of spare part.

   a) Manufacturer
   b) Second-hand stock lists
   c) The health care facility itself
   d) service provider
   e) None of the above

10. Which of the following is true about refurbishment

   e) constitute a modification of the medical device

   f) act of restoring the device to its original specifications

   g) carried out by the equipment users

   h) All

True /false

3. Before any work on an open device, you do not need to imperatively check if the high voltage capacitor.

4. Looking for specification to replace spare is not essential.

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

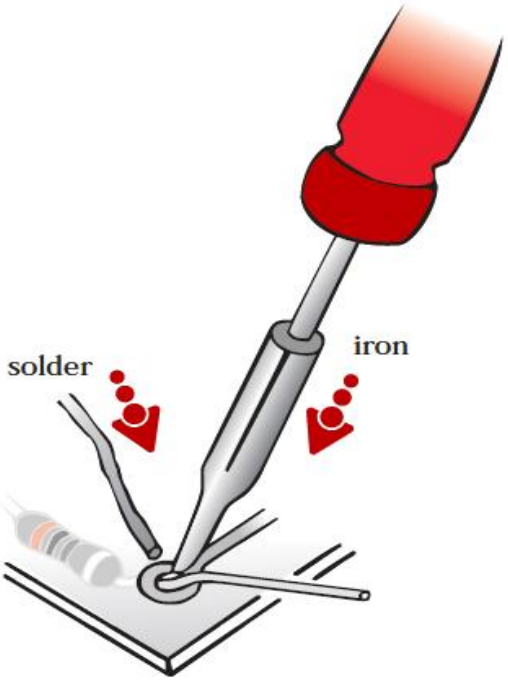
Information Sheet-3	Soldering Repair and/or replaced parts/components

Soldering: heating up a soft metal called solder on a piece of metal in order to join together or to attach electronic component to the board for circuit design.
Before going to solder components to boards, you must have to wear safety googles all the times

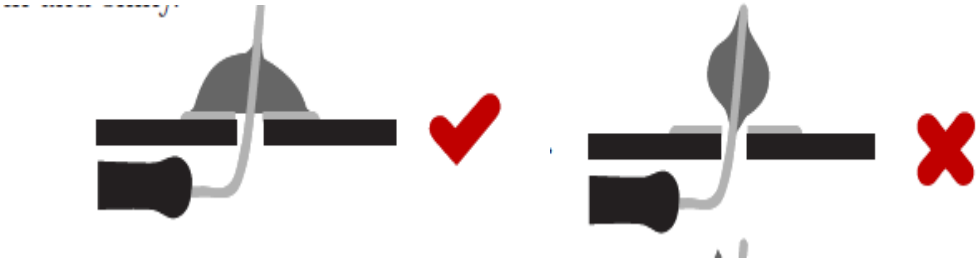
How to solder components?

- ✓ Bend the legs of a component outwards a little after fitting it to the board to keep it in place until it's soldered.
- ✓ The order in which you fit and solder components to the board is not particularly important but in general you should solder the resistors first, then the capacitors. After that solder the transistors and finally the rest of the components.
- ✓ Hold the soldering iron like a pen. Hold it by the handle only. In your other hand hold a piece of solder.
- ✓ Touch the tip of the iron against a component wire at the point where the wire comes through the board.
- ✓ Wait a second or so while the wire heats up.
- ✓ Touch the solder against the wire at the same time as the iron. Both the solder and the iron must be as close as possible to the hole.
- ✓ The solder will start to melt. Feed in more solder as it melts.
- ✓ Remove the iron and solder when the hole is covered with solder. It only takes a few seconds to solder a joint.

- ✓ Don’t touch the component or allow it to move until the solder has cooled (a few seconds).
- ✓ Put the soldering iron back in its stand in between use.
- ✓ Always wash your hands after handling solder.

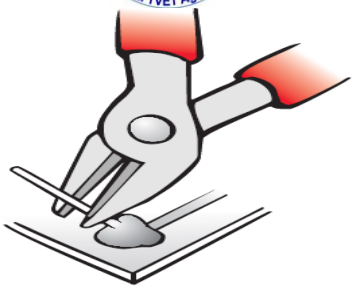


- ✓ Use the right amount of solder. Too little and it may not form a good joint. Too much and it may cause a short circuit. A good solder joint covers the solder pad and component wire completely and is smooth and shiny.

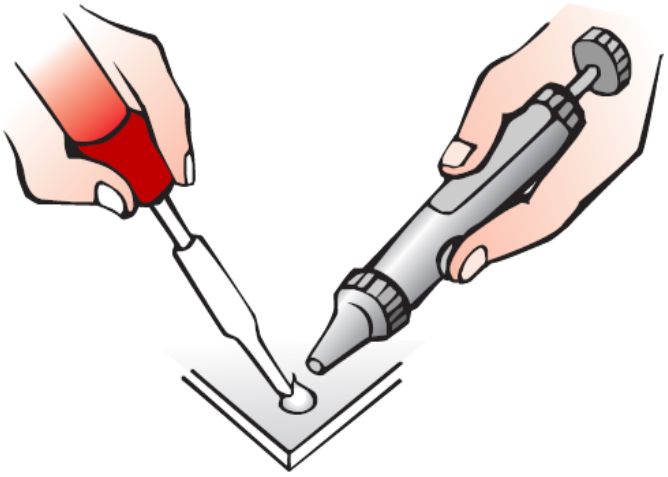


This is what a good joint looks like. **The solder has not spread over the pad properly.**

- ✓ Trim the legs of a component after it has been soldered. Clip the legs close to each solder joint.

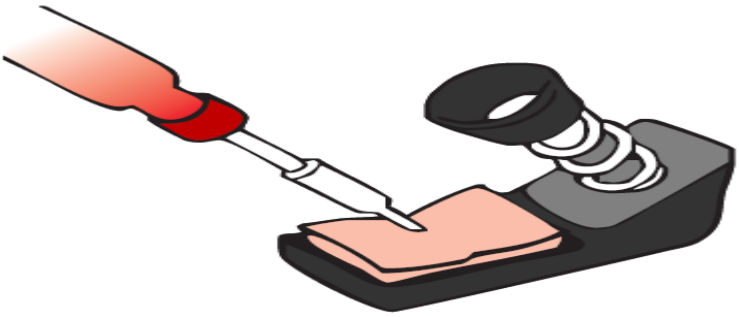


- ✓ Don’t fit and solder too many components before clipping their legs.
- ✓ Avoid soldering together the legs of components next to each other.
- ✓ If you make a mistake use a solder sucker to remove the solder.



- ✓ Treat any burns IMMEDIATELY with cold running water for ten minutes.

- ✓ Clean the tip of the hot soldering iron from time to time on a DAMP sponge.



Information Sheet-4	Doing necessary adjustment

4.1. **Calibration**

Medical Equipment Calibration is the process of ensuring the output quality of said equipment is at par with the industry defined standards. This is done to ensure that the functionality of the item, as well as the result/reading it provides, is accurate at the point of delivery.

The term “calibration” defines the comparison between the value indicated by an instrument and the corresponding real value, while “adjustment” defines the set of operations carried out on an instrument in order to have the given values measured with stated accuracy.

Tracking Instruments for Calibration Status

- ✓ Each instrument should be labeled with the unique identifier (e.g. serial number, model number, location, etc.)
- ✓ Calibration status of each instrument , the date of calibration, the next calibration date and the identification of person performing calibration should be readily available
- ✓ Appropriate systems to document calibration status must include calibration logs and calibration stickers

Calibration Process

- ✓ Written calibration procedures that use traceable calibration standards and/or calibration equipment.
- ✓ Qualified individuals (having the appropriate education, training, background and experience) responsible for calibrating & maintaining instrumentation

4.2. Medical Equipment Testing

Medical Equipment Testing & Calibration is the act of ensuring that all medical equipment is in full working order, and is calibrated to a known standard so as to ensure

that the reading/result/functionality of the item is accurate at the point of delivery to a patient. It is your responsibility to ensure that your medical equipment is in full working order and maintained through regular medical device testing.

Information Sheet-5	Applying necessary modification

Modification is another type of maintenance which is conducted to improve the performance of medical equipment by modifying or altering some physical or body change. This maintenance can usually be delayed until all resources are available.

Modifications of medical devices

Modification may have impact on the former conformity assessment of the medical device, primarily concerning safety, reliability and intended use. If so, the CE-marking is no longer valid and the product liability is seriously affected: both are based on the state of the Medical Device when it was put into service for the first time.

If the user substantially modifies a device, he becomes the MANUFACTURER of a new device, according to the MDD, and he must take legal and regulatory requirements into account.

Such a modified device can no longer be used under the original CE-marking. The device will still have to comply with the prevailing regulations, but a new CE marking is not needed, if the modification is for onsite use (i.e. within the same legal entity) only.

The original MANUFACTURER's responsibility and liability can be limited and the user or modifier may be exposed to legal action, if the device is involved in an adverse event.

If a device is used outside the original intended purpose, as indicated by the MANUFACTURER, the user must be aware that the device has not been validated for this off-label use by the original MANUFACTURER. Again, the responsibility and liability of the original MANUFACTURER are limited and the user will be exposed to legal action, if an adverse event occurs.

Recommendation

For any modification of the medical device the status of the documentation and instructions for use needs to be verified for compliance with the new hardware/software configuration, by the person responsible for the modification. That person should also fulfil the requirements imposed on a MANUFACTURER of medical devices, such as to perform a RISK analysis and, if needed, do RISK mitigation through RISK management.

Information Sheet-6	Substituting spare parts in accordance with the manufacturer's specification

6.1. Spare part

A spare part, spare, service part, repair part, or replacement part, is an interchangeable part that is kept in an inventory and used for the repair or replacement of failed units

Example of medical equipment spare part include:

Heating element	Fuse	Push button
Carbon brush	Sample tube	Lens
Lamp	Motor	tube
Filter	board	

Information Sheet-7	Performing corrective maintenance activity

Reactive Maintenance

Corrective maintenance is a maintenance task performed to identify, isolate, and rectify a fault so that the failed equipment, machine, or system can be restored to an operational condition within the tolerances or limits established for in-service operations.

Corrective maintenance is reactive in nature. Every time a product or system fails, repair or restoration must follow to restore its operability. The following steps constitute corrective maintenance:

- ✓ Once the failure has been detected, it must be confirmed. If the failure is not confirmed, the item generally is returned to service. This no-fault-found problem leads to a considerable waste of time at significant cost. It also entails carrying an unnecessarily large inventory all the time.
- ✓ If the failure is confirmed, the item is prepared for maintenance and the failure report is completed.
- ✓ Localization and isolation of a failed part in the assembly is the natural next step in corrective maintenance.
- ✓ The failed part is removed for disposal or repair. If disposed of, a new part is installed in its place. Examples of repairable parts and connections include broken connections, an open circuit board on a PCB, or a poor solder.
- ✓ The item may be reassembled, realigned, and adjusted after repair. It is checked before being put back to use.

The chief disadvantage of this maintenance procedure is the inherent amount of uncertainty associated with it. Similarly, the procedure is extremely reactive in nature, capable of shutting down an entire operation because of a single failure in a single machine under extreme conditions (often leading to a severe bottleneck and lost productivity). As a result of its drawbacks, another, more proactive maintenance method (recognizing that equipment needs periodic maintenance to function smoothly, which should be provided before a breakdown occurs) was developed.

Typical Causes of Equipment Breakdown

The causes of equipment breakdown may be as follows:

- ✓ Failure to replace worn out components/parts.
- ✓ Lack of lubrication.
- ✓ Neglected cooling arrangement/system.
- ✓ Indifference towards minor faults.
- ✓ External factors such as wrong fuel, too low or too high line voltage etc.
- ✓ Indifference towards equipment vibrations, unusual sounds coming out of the rotating parts and equipment getting too much heated up.

Objectives of Corrective Maintenance:

- ✓ To get equipment/machine back into operation as quickly as possible in order to minimize the interruption to production. These objectives are directly related with production capacity, costs of production, product quality and consumer satisfaction.
- ✓ To control the cost of the operation of repair shops.
- ✓ To keep the cost of repair crew under control, including regular and overtime of labor costs.

- ✓ To control the investment in replacement of parts/components that are used/required when machines are repaired.
- ✓ To control the investment required for back up machines. These replace manufacturing machines are needed until the repairs are completed.
- ✓ To perform the appropriate amount of repairs at each malfunction of the asset/equipment.
- ✓ To restore an asset in working order.
- ✓ To maintain the operation availability of the plant and infrastructural facilities
- ✓ To avoid any sudden and heavy failure (breakdown) in future.

Limitations of Breakdown Maintenance

- ✓ Breakdowns generally occur at inappropriate times. It may lead to a poor hurried maintenance and excessive delays in production schedules.
- ✓ It involves prolonged down time due to non-availability of requisite manpower and spare parts, they may lead to overtime practice also.
- ✓ It becomes impossible to plan workload and distribution of maintenance workforce for balanced and proper attention of all equipment's.
- ✓ Reduction in production output.
- ✓ There are increased chances of accidents and less safety for workforce.
- ✓ It leads to faster plant deterioration.
- ✓ Corrective maintenance cannot be employed for those industrial plants/enterprises which are regulated by statutory provisions for example boilers and cranes.
- ✓ The maintenance of product quality is difficult.
- ✓ Loss of direct profits.

Self-Check -7	**Written Test**

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Causes of Equipment Breakdown

   a) Failure to replace worn out components/parts.
   b) Lack of lubrication.
   c) Neglected cooling arrangement/system

   d) All of the above

2. Corrective maintenance is
   a) Is performed before equipment fail
   b) Is duties of the users
   c) Can be applied after equipment fail
   d) All
3. Which one of the following is not true about curative maintenance
   a) performed to identify, isolate, and rectify a fault
   b) Restore an asset in working order.
   c) may include spare part replacement and modification
   d) All of the above

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet 8	**Observing care and extreme precaution in handling the unit/medical device**

8.1. Medical device

A medical device is any product used to diagnose, cure, or treat a condition, or to prevent disease. They range from small and simple, like a blood glucose meter, to large and complicated, like a ventilator. You might use one at home or at work, or you may need one in a hospital.

To use medical devices safely

- ✓ Know how your device works. Keep instructions close by
- ✓ Understand and properly respond to device alarms
- ✓ Have a back-up plan and supplies in the event of an emergency
- ✓ Keep emergency numbers available and update them as needed
- ✓ Educate your family and caregivers about your device

8.2. Materials Handling Methods

Five Major Types of Materials Handling Methods:

Movement - involves the actual transportation or transfer of material from one point to the next.

Quantity - dictates the type and nature of the material handling equipment and also cost per unit for the conveyance of the goods.

Time -how quickly the material can move through the facility

Space - concerned with the required space for the storage of the material handling equipment and their movement, as well as the queuing or staging space for the material itself.

Control - tracking of the material, positive identification, and inventory management

Information Sheet 9	Equipment set-up and start-up operation

STARTUP

After the completion of repair, maintenance team or equipment users start up the equipment in a controlled way, verifying functions and making any needed corrections.

RUNOFF

Equipment runoff is the event that the maintenance team has been working towards. Once the engineers or technical man have completed Startup, they are ready to demonstrate equipment performance. The Runoff is the event that proves the equipment performs as promised. A performance test agreed upon in advance is performed for the customer and when the equipment passes, it is released to production.

Information Sheet 10	Equipment controls in accordance with manufacture's functional test standard

Medical devices are critical since they have a direct impact on human lives. To deliver safe and effective healthcare services to patients, the medical device maintenance team and manufacturers must follow testing as well as verification and validation practices that ensure quality and reliability of medical devices. Here is a high-level overview of implementing medical device testing strategies.

Microprocessor testing

In order to perform testing to the highest standards, medical devices must undergo solid electronic testing. Most of class II and III medical devices have microprocessor at its core. Hence, medical device testing starts with a microprocessor testing.

For an effective testing of transistors inside a microprocessor, it must provide access to their interconnections. However, the catch is, the testing team should carry out microprocessor chips' testing before installing it into a printed circuit board (PCB) for an increased testing effectiveness.

Tests for integrated circuits consider their logic gate functions and interconnection between them. Well-suited test methods can be selected from several industry-used test methods based on the requirements.

Automating the test

A test automation system is an electronic system developed with the purpose and consists of a computer, instruments and a software to carry and control test process. There are certain commercial test automation systems available in the market in

accordance with industry standards. However, the testing team can use a customized test system based on the need and requirements.

Validation process

Once everything is in place, the medical device test system must be validated, including software and hardware. The process of software and hardware validation for medical devices must be detail specific. The purpose of validation is to test if the device meets specific user needs or not.

Information Sheet 11	Checking controls and start up signals

Controls and start up signals are checked in accordance with manufacturer standard operating procedure and safety regulations

Information Sheet 12	BBE operation protocols

The following precautions will be used while operating equipment:

- ✓ Operator will be alert to situations which may damage equipment or injure personnel.
- ✓ Sufficient space is required around and above all mechanical equipment and electrical services to permit safe operation and to encourage good maintenance.
- ✓ Operator shall be familiar with the normal equipment sounds to be able to detect the abnormal.
- ✓ Operator shall investigate and report to Clinical Engineering
- ✓ Department abnormalities indicated by erratic meter responses, electrical flashing or arcing, burning smell, unusual grinding sounds of gears or other evidence of improper operation.
- ✓ The following list of general safety factors will be continuously monitored:
- ✓ Proper grounding of equipment.
- ✓ Current Biomedical Engineering Green Tag
- ✓ Accuracy of critical timing devices.
- ✓ Adequate physical mounting for support of installed items.
- ✓ Proper operation of safety valves.
- ✓ Serviceable good condition of electrical cords.
- ✓ Calibration of systems whose accuracy is absolutely essential in treatment or diagnosis.

Information Sheet 13	Equipment lubrication

Lubrication

Lubrication is the process or technique of using a lubricant to reduce friction and wear in a contact between two surfaces.

Lubricant

Lubricants can be solids (such as Molybdenum disulfide MoS2), solid/liquid dispersions (such as grease), liquids (such as oil or water), liquid-liquid dispersions or gases.

Lubricant is a substance that reduces friction, heat, and wear when introduced as a film between solid surfaces. Using the correct lubricant helps maximize the life of your bearings and machinery, therefore saving money, time, and manpower, thus making operations more efficient and more reliable.

Common examples of internal lubricants include fatty alcohols, esters (low esterification), and EVA wax. External lubricants provide metal release and help reduce process temperature. Common examples of external lubricants include PE waxes, paraffin, metal soaps, esters (high esterification), amides, and fatty acids.

Types of lubrication

There are three different types of lubrication: boundary, mixed and full film. Each type is different, but they all rely on a lubricant and the additives within the oils to protect against wear. Full-film lubrication can be broken down into two forms: hydrodynamic and elastohydrodynamic.

Boundary lubrication

Boundary lubrication exists when the operating condition are such that it is not possible to establish a full fluid condition, particularly at low relative speeds between the moving or sliding surfaces.

The oil film thickness may be reduced to such a degree that metal to metal contact occurs between the moving surfaces. The oil film thickness is so small that oiliness becomes predominant for boundary lubrication.

Boundary lubrication happens when

- ✓ A shaft starts moving from rest.
- ✓ The speed is very low.
- ✓ The load is very high.
- ✓ Viscosity of the lubricant is too low.

Examples for boundary lubrication:

- ✓ Lubrication of the rotor bearing in motor (mainly during starting and stopping of motor).
- ✓ Piston rings when the piston direction changes and if the relative speed is very slow.

Mixed lubrication

Mixed lubrication, also called partial lubrication, is an important lubrication regime in internal combustion engines. Both elastohydrodynamic lubrication and metal-to-metal contact occur in mixed lubrication. The load is supported partly by the fluid film and partly by the surface asperities.

Full film lubrication

At full film elastohydrodynamic lubrication the generated lubricant film completely separates the surfaces. Contact between raised solid features, or asperities, can occur, leading to a mixed-lubrication or boundary lubrication regime.

Self-Check -13	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Lubrication is

a). to reduce friction
b). to increase life time of equipment
c). smoothies speed of rotating part
d). all of the above

2. Boundary lubrication happens when

a) A shaft starts moving from rest.
b) The speed is very low.
c) The load is very high.
d) all

3. Types of lubrication includes:

a) boundary,
b) mixed
c) Full film.
d) All

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet 14	Inspect and set-up accessories of BBE

Inspection of medical equipment

The major objective of an inspection is to determine whether the equipment is operating in a state of control and in compliance with the regulations. The facility's commitment to quality is vital, regardless of the type of company or product that is being manufactured.

One important aspect of an inspection is to identify defective product, non-conforming product and system failures. The way in which companies investigate and correct objectionable conditions and deficient manufacturing and control systems is an important part of an inspection and typically illustrates the level of quality within a facility. accessories of the covered Basic Biomedical Equipment are inspected and set-up in accordance with institution and equipment manufacturer specification respectively

Information Sheet 15	Replacing consumables equipment

15. Consumable equipment

Consumable medical supplies are non-durable medical supplies that cannot withstand repeated use, are usually disposable. They include, but are not limited to,

- ✓ bandages,
- ✓ gasket/hard rubber,
- ✓ print paper,
- ✓ Carbon brush.

So those appropriate equipment consumables are replaced in accordance with manufacturer specifications.

Information Sheet 16	Completing Functional test

16. Test of Functionality

Once assembled, the medical equipment should be tested for functionality. Sometimes everything appears to be fine, but there may be a glitch that can't be seen. In addition to problems with the equipment itself, testing can uncover assembly mistakes before any permanent damage occurs. Therefore functional test is completed within the specified time as provided in the institution BBE preventive maintenance procedures and guidelines

Finally, after all inspections have been done and everything seems to be working properly, it's crucial that each applicable member of your staff is instructed on proper use of the medical equipment, especially if it's a new model that's not been used by your hospital before. Clear, detailed instructions prevent misuse, which could lead to poor patient care or damaging of the equipment. It's also important that instruction includes the hospital biomedical staff in order to facilitate shock-free operation and proper electrical grounding.

Operation Sheet 1	**Techniques of soldering components on boards.**

1.1. The techniques for soldering components on boards

STEP 1: Bend the legs of a component outwards a little after fitting it to the board to keep it in place until it's soldered.

STEP 2: The order in which you fit and solder components to the board is not particularly important but in general you should solder the resistors first, then the capacitors. After that solder the transistors and finally the rest of the components.
STEP 3: Hold the soldering iron like a pen. Hold it by the handle only. In your other hand hold a piece of solder.
STEP 4: Touch the tip of the iron against a component wire at the point where the wire comes through the board.
STEP 5: Wait a second or so while the wire heats up.
STEP 6: Touch the solder against the wire at the same time as the iron. Both the solder and the iron must be as close as possible to the hole.
STEP 7: The solder will start to melt. Feed in more solder as it melts.
STEP 8: Remove the iron and solder when the hole is covered with solder. It only takes a few seconds to solder a joint.
STEP 9: Don't touch the component or allow it to move until the solder has cooled (a few seconds).
STEP 10: Put the soldering iron back in its stand in between use.
STEP 11: Always wash your hands after handling solder.

Instruction Sheet	LG23: Check and calibrate basic biomedical equipment (BBE)

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics –

- ✓ Determining appropriate calibration procedures and parameters.
- ✓ Setting equipment calibration
- ✓ Simulating BBE operation
- ✓ Checking and verify calibration controls
- ✓ Adjusting necessary equipment adjustments
- ✓ Making final test to BBE This guide will also assist you to attain the learning
- ✓ Performance and functional test is conducted immediately after re-assembly
- ✓ Equipment status and performance is checked and ensured conformance with equipment manufacturer standard and other health safety regulations
- ✓ Complete and accurate documentation is prepared.
- ✓ Tools and test instrument are cleaned and cared as per organizational procedure
- ✓ Waste materials are disposed in accordance with hospital waste management and other environmental requirements

Outcome stated in the cover page. Specifically, upon completion of this Learning Guide, **you will be able to –**

- ✓ Determine appropriate calibration procedures and parameters.
- ✓ Set equipment calibration
- ✓ Simulate BBE operation
- ✓ Check and verify calibration controls
- ✓ Adjust necessary equipment adjustments
- ✓ Make final test to BBE This guide will also assist you to attain the learning
- ✓ Conduct performance and functional test immediately after re-assembly
- ✓ Check and insure equipment status and performance with equipment manufacturer standard and other health safety regulations
- ✓ Prepare complete and accurate documentation.
- ✓ Clean and clear Tools and test instrument as per organizational procedure
- ✓ Dispose Waste materials in accordance with hospital waste management and other environmental requirements

Learning Instructions:

12. Read the specific objectives of this Learning Guide.
13. Follow the instructions described below 3 to 18.
14. Read the information written in the information “Sheet 1, Sheet 2, Sheet 3 and Sheet 4, Sheet 5, Sheet 6, Sheet 7, Sheet 8, Sheet 9, Sheet 10” **in page 3, 8, 9, 10 ,12, 13, 14, 15, 15, and 16** respectively.

Information Sheet-1	Determining appropriate calibration procedures and parameters.

1. Testing and Calibration of Bio-Medical Equipment

For the health industry, be it hospitals or manufacturers of medical equipment– nothing counts more than the safety of a patient**.** Not surprising therefore that almost all quality conscious hospitals & medical equipment manufacturers have already made periodic testing and calibration of equipment's, a permanent feature in their quality control regimen that they strictly adhere to.

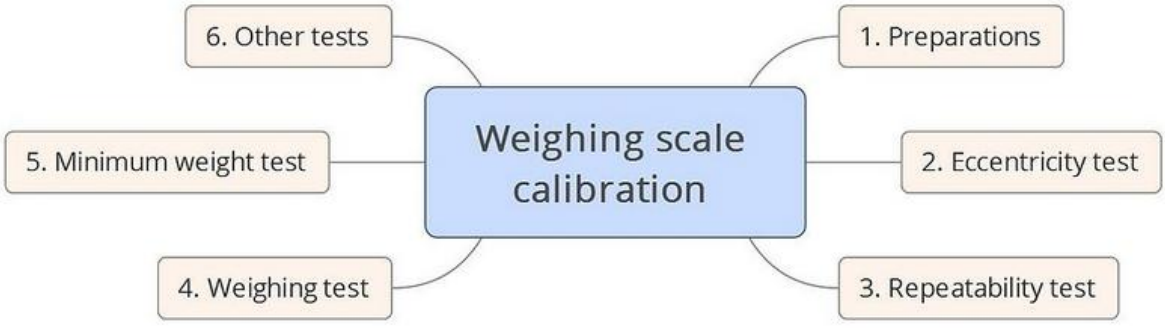
What is perhaps also significant is that the common thread across all such organizations is not their size or turnover but their dedication and commitment to quality and continuous improvement. Testing and calibration of bio-medical equipment to ensure quality control in equipment's is becoming increasingly significant today when accuracy in diagnosis and effectiveness in treatment cannot be compromised at all.

Testing and calibration of equipment ensures accuracy, effectiveness and long life of equipment's, which ultimately enables one to achieve the highest degree of quality control.

2. Testing and calibration

- ✓ Is extremely important in achieving quality control of the highest standard in medical equipment
- ✓ Is done with the help of specialized testing and calibrating equipment.
- ✓ Should be done at least once a year

2.1.Calibrating weighing scales/instruments



Let's start by looking at some of the preparations you should make before the calibration and then look at the different tests you should be doing.

2.1.1. Preparations before calibration

Before you can start the calibration of the weighing instrument, you should clarify a few things and get prepared.

You should find out the technical characteristics of the weighing instrument (max weight, d value), the accuracy requirement (max error allowed and uncertainty) and what to do if the calibration fails (adjustment).

Typically, the whole measurement range is calibrated and the calibration is performed in the location where the instrument is being used. Make sure you have enough weights for the calibration procedure available.

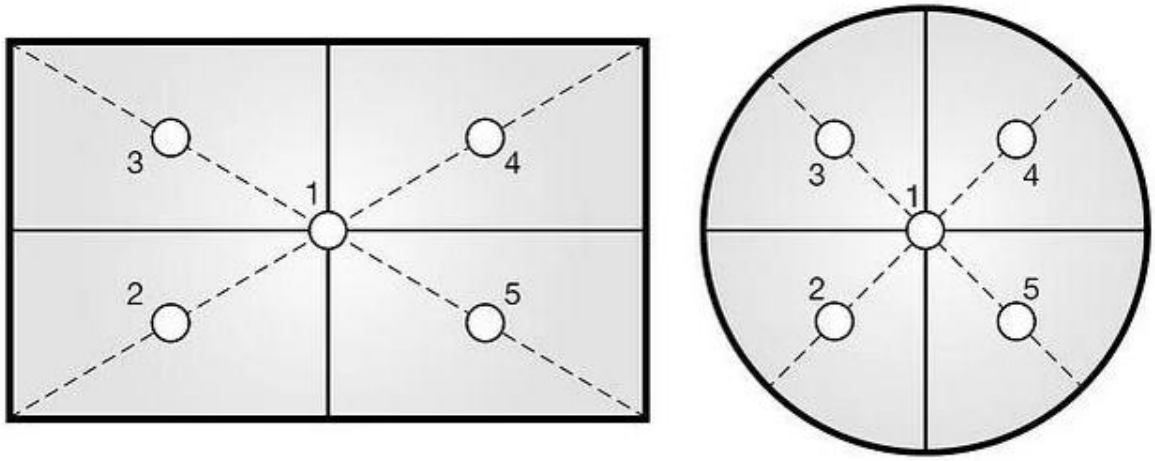
The weighing instrument should be switched on at least 30 minutes before the calibration. The temperature of the weights should be stabilized to the same temperature where the calibration is to be done.

The weighing instrument should be at a horizontal level, especially for small and accurate weighing instruments. Perform a few pre-tests by placing weights close to the maximum of the range on the instrument and to ensure it works normally.

2. Eccentricity test

In normal use of a weighing instrument the load is not always placed perfectly on the center of the load receptor. Sometimes the results of a weighing instrument can vary slightly depending if the load is placed in different locations on the load receptor. In order to test how much effect the location of the load has, the eccentricity test is performed.

In the eccentricity test, the reference load is placed in a few different specified locations on the load receptor. First, the load is placed in the center of the load receptor (the load's center of gravity) and the result is observed. Next, the load is placed in four different sectors of the load receptor, as illustrated in the picture below.



Procedure for the eccentricity test

The indication is zeroed before the test. The test load is placed to location 1 and indication is recorded. The test load is then moved to location 2 to 5 and indication is recorded in each location. Finally, the test load is placed again to location 1 to check that the indication has not drifted from the earlier indication in location 1.

The zero may be checked between each location to see that it has not changed. If necessary, the instrument can be zeroed in between each test.

Alternatively, you may also tare the instrument when the load is in location number 1, as this makes it easier to see any difference between locations.

3. Repeatability test

As any instrument, also weighing instruments may suffer from repeatability issues. This means that when the same load is measured several times, the result is not always exactly the same. To find out the repeatability of the instrument, a repeatability test is done.

The repeatability test is performed by replacing the same load on the same place on load receptor (to avoid any eccentricity error) multiple times. Test should be done in identical and constant conditions and with identical handling.

The load used should be close to the maximum load of the instrument. Often a repeatability test is done with one load only, but it can be done also with several different load values separately.

4. Weighing test

The purpose of the weighing test is to test the accuracy (calibrate) of the weighing instrument throughout its whole range in several steps, with increasing and decreasing weight.

The most common practice is the following: start with zeroing the instrument without any load. Set the loads of the first test point, wait for stabilization, and record the indication. Continue increasing the loads through all the increasing test points. Once the maximum load is recorded, start decreasing the loads through the decreasing test points.

Linearity

In a weighing test, using multiple points through the measurement range of the instrument helps to reveal any issues with linearity. Linearity issues means that the instrument does not measure equally accurate throughout the range. Even the zero and full span are correct, there may be errors in the middle of the range, which is referred as linearity errors, or unlinearity (or nonlinearity).

Hysteresis

Hysteresis is the difference in the indication when a test point is approached with increasing or decreasing weight. To find out any hysteresis issues in the instrument, you need to calibrate with increasing and decreasing points.

5. Minimum weight test

Minimum weight test is a test that is not always required to be done. This test is anyhow required within some industries, like the pharmaceutical industry.

The purpose of the minimum weight test is to find the smallest load that can be measured while still achieving reliable measurement results and fulfilling the accuracy requirements. When the measured value gets smaller, typically the relative error of the reading becomes higher. The weighing instrument should not be used to measure any loads smaller than the minimum load.

6. Other tests

There are also some other tests specified in the standards, although these are typically not done during a normal calibration, but can be done as a type of approval test or in the initial verification.

Example of these tests are:

- ✓ Tare test
- ✓ Discrimination test

- ✓ Variation of indication over time
- ✓ Test of magnetic interaction

2.2. Autoclave calibration parameter

Sample Calibration Procedure for an Autoclave

- ✓ Record the as-found calibration data (zero and gain) for each sensor to be calibrated.
- ✓ Using appropriate caution (shut the steam off and wait for the pressure to go to zero!), remove the sensors to be calibrated from the sterilizer, leaving their cables connected to the control system.
- ✓ Set the zero and gain to 0 and 1, respectively.
- ✓ If using a NIST-traceable dry block or oil bath place the sensor in the dry block or oil bath.
- ✓ If using a NIST-traceable temperature probe, place the temperature probe into a central position in the dry block or oil bath and the sensors as close to it as possible.
- ✓ Measure at the selected temperatures and record the standard and transducer data. You should wait for at least one minute at each temperature to allow the measurement to stabilize. Don't rush this step.
- ✓ Do a linear regression of the data collected. This is straightforward in Microsoft Excel [intercept () and slope () functions] with the standard's data on the y-axis and the sensor's data on the x-axis.
- ✓ Do a correlation as well [correl() function]. It should be at least 0.999999 (i.e. a very straight line).
- ✓ Enter the zero and gain values to the sterilizer controller to enter the calibration.
- ✓ Verify the calibration using at least one point like your process temperature. If more than one process temperature, then verify at each one. Then you will have an exact statement of the accuracy of the sensors.
- ✓ Re-install the sensors in the sterilizer.

Information Sheet-2	Setting equipment calibration

Medical device companies must have calibration procedures in place. Calibration of a device is carried out to minimize the uncertainty in measurements. It helps in reducing the errors and brings the measurement to an acceptable level. ... Therefore, the precision and accuracy of a device is of utmost importance.

We can divide Medical Equipment Calibration devices in to three types:

1. Electrical Safety Analyzers

2. Performance Analyzers

3. Simulators & Controllers

1. **An Electrical safety analyzer** is a device dedicated to a various range of electrical safety tests in order to check that the device under test is in compliance with electrical safety requirements.

2.The **Performance Analyzer** is a graphical data-analysis tool that analyzes performance data collected by the Collector using the collect command

The Performance Analyzer reads in such experiments, analyzes the data, and displays the data in tabular and graphical displays.

3.simulatosr and controllers

A simulation is an approximate imitation of the operation of a process or system; the act of simulating first requires a model is developed. ... Simulation can be used to show the eventual real effects of alternative conditions and courses of action.

Information Sheet-3	Simulating BBE operation

Simulation is a generic term that refers to an artificial representation of a real world process to achieve educational goals through experiential learning. Simulation based medical education is defined as any educational activity that utilizes simulation aides to replicate clinical scenarios. Although medical simulation is relatively new, simulation has been used for a long time in other high risk professions such as aviation. Medical simulation allows the acquisition of clinical skills through deliberate practice rather than an apprentice style of learning. Simulation tools serve as an alternative to real patients. A trainee can make mistakes and learn from them without the fear of harming the patient. There are different types and classification of simulators and their cost vary according to the degree of their resemblance to the reality, or 'fidelity'.

Information Sheet-4	Checking and verify calibration controls

Calibration Verification: Confirms the accuracy of your measurement of patient samples by proving that the values you receive are what you expect to receive. (CLIA rules define calibration verification as the determination of analyte in materials composed of a matrix similar to that of patient samples.

Calibration Standards

There are 3 types of standards in your tool calibration and control system:

1. **Primary Standards**: Those units or instruments of highest quality and stability which are periodically calibrated by the National Institute of Standards and Technology (NIST) or by other contract calibration services which have direct traceability to NIST. Primary standards are used in a controlled environment of 23°C ±2°C and relative humidity of 40% ±10% (when applicable).

2. **Transfer Standards**: Those units or instruments with proven stability are calibrated from primary standards in a controlled environment. Transfer standards are stored in a controlled environment of 23°C ± 2°C and relative humidity of 40% ±10% (when applicable).

3. **Working Standards**: Those units or instruments with proven stability that are calibrated from transfer standards.

You use working standards to measure product and process quality. Transfer standards are used to calibrate the working standards. These are traceable to NIST. Primary standards are usually kept at NIST or calibration labs and maintain NIST certification. All standards must be traceable to NIST.

Recommended Calibration Labels

Instrument Calibration Label

- ✓ Date of Calibration
- ✓ Calibration record number
- ✓ Calibration Due date
- ✓ Calibration Employee Signature.

Calibration Interval

Base the calibration interval on the instrument's stability, purpose, degree of usage, environment, past history of equivalent instruments and manufacturer's recommendations. You can use the below as a guideline:

Used Frequency	Calibration Interval
Daily	3 months
Every other Day	6 months
Once weekly	12 months
Once Monthly	24 months
Once Yearly	36 Months

Information Sheet-5	Adjusting necessary equipment adjustments

Adjustment of Equipment

The conditions of adjustment have already been described for parts of the equipment. We assume that the equipment is in rough adjustment and we set out the steps that should be taken to put it into perfect adjustment.

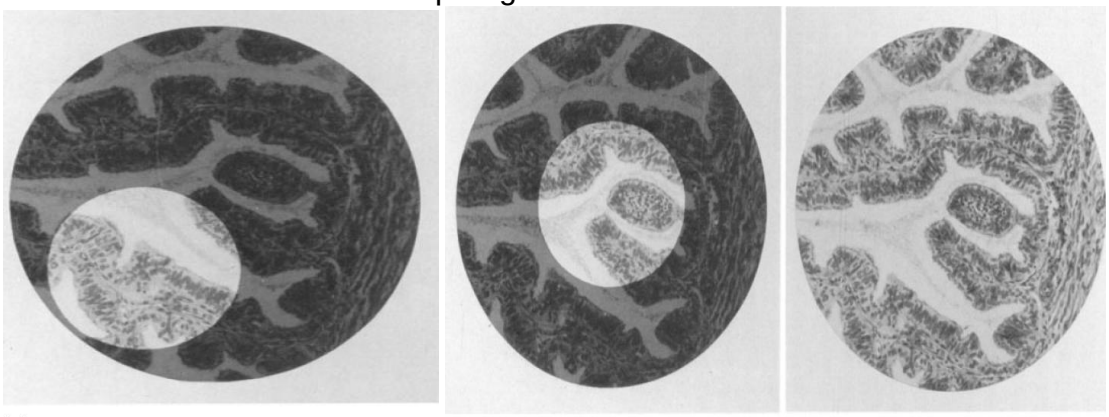
Microscope Axis and Stage-Rotation Axis

With rotatable stages a centering device is required to move the image of the rotation centre of the stage into the Centre of the ocular diaphragm (or photometer diaphragm). The centre of this diaphragm may be marked by a pattern, such as cross-wires (reticule), or a small circle. The centring device can be attached to the objective holder, the objective mount, or the stage. But correct centring is achieved if the centering device of only one of the three is operated, the others having pre-set and fixed adjustments. Objectives are supposed to be parcentric, but a slight correction of centring at each exchange of objectives may be required.

Luminous-Field Diaphragm

1. Look at the stage object and reduce the diameter of the luminous-field diaphragm until it is seen well inside the limit of the field.
2. Form a sharp image of this diaphragm (Fig. a). This is done in transmitted light by focusing the condenser; in reflected light it is done by moving the diaphragm or a lens between the diaphragm and the reflector along the axis of the illuminator.
3. Centre the diaphragm (Fig. b) and then open it out, until the whole field is just clear (Fig. c).

Centring should be available either on the diaphragm itself or else on the lens that images it on to the stage; one of these has to be pre-set by the manufacturer or else the observer cannot centre the diaphragm.



(a) b) (c)

Information Sheet-6	Making final test to BBE

Testing: Execution of a function of a system, subsystem, or channel to confirm that the function can be performed according to the requirements stated in the safety requirement specification (SRS).

Maintenance testing. Maintenance testing is a test that is performed to either identify equipment problems, diagnose equipment problems or to confirm that repair measures have been effective.

Medical Equipment Testing Categories

Quality is important for any product, but defects in medical devices can have immediate life or death consequences. Just about everything is classified by the risk of a defect occurring, including general medical equipment like scalpels, scissors, and autoclave suction.

That's in addition to external diagnostic tools such as blood analysis equipment; controlled medical equipment including catheters for the gastrointestinal tract, dental alloys and electronic endoscopes; and specially controlled medical equipment including orthopedic implants, balloon catheters, contact lenses and stent grafts, according to Shimadzu.

Medical equipment manufacturers implement a variety of evaluations to ensure the functionality, performance, and safety of their products, according to information provided by Shimadzu. The assessment of strength properties through physical testing is one such important item. Evaluation of the mechanical properties of variously shaped medical equipment requires the use of jigs suited to each piece of equipment.

Information Sheet-7	Conduct performance and functional test after re-assembly

TEST DURING ASSEMBLY

The test during assembly includes checks that are carried out during the course of the assembly operations of the units and/or of the general assembly of the machine.

The assembly phase brings together all pieces produced and those that have been replaced or maintained.

The assembly department is usually split into two sub-departments: one where the units are assembled, and one where the final machine assembly is carried out.

The individual units are assembled in the unit's assembly department; each unit that makes up the machine is assembled separately.

Once the assembly is finished, the individual units are taken to the final assembly sub-department, where they are joined together and where the final machine assembly is carried out.

The testing operations during assembly usually concern:

1. The Functionality of the Units

2. Alignments

3. Couplings between Structures

An example of **UNIT FUNCTIONALITY** is the functional check of an operating head or of a cross carriage.

An example of **ALIGNMENTS** is checking the proper alignment of the supports of a translation screw of a linear axis and its nut.

An example of **COUPLINGS BETWEEN STRUCTURES** is the mounting of a slide and the base of the machine itself.

INCOMING ACCEPTANCE TEST

This includes activities aimed at guaranteeing the company conformity of the products supplied by the maintenance team to the technical specifications contained in the order.

The incoming acceptance test is a test that checks external supplies, meaning that it looks outside the company and only verifies whether the finished product meets the requirements specified in the order, without worrying about the work process.

It is important to underline that all test actions have to start from a reference document: if this is not clear, the test cannot be carried out as it would not have any sense.

Information Sheet-8	**Checking and insure equipment status and performance**

Information Sheet-9	**Preparing complete and accurate documentation**

Information Sheet-10	Tools and test instrument are cleaned and cared

Cleaning of test equipment and tools

Types of hand tools and how to care for them

Always allow enough time to pack up properly when you've finished a job. Cleaning your tools and putting them back where they belong help. Maintaining a safe and efficient work environment can save everyone a lot of time and inconvenience.

Cleaning

1. Always clean your tools immediately after use.

2. Tools can be washed using a hosepipe and/or scrubbed with a wire brush.

3. Make sure that there is no risk of spreading pathogens while you are washing your tools.

4. Spray light oil on areas prone to rust.

Storage

1. Store tools in a dry, sheltered environment.

2. Place tools in racks for easy location and safety.

3. Place similar tools together so that people can see easily what is available.

Maintenance

1. Keep metal blades sharp and well-oiled.

2. Check any nuts, bolts, rivets, screws, blades, and springs regularly for wear or damage, and replace if necessary.

3. Sand wooden parts back regularly and oil with a 50/50 linseed oil and turps mix.

4. Label damaged tools, place them out of the way and tell your supervisor or maintenance person.

Instruction Sheet	LG24: Re-commission BBE

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics –

- ✓ Reassembled BBE in accordance with institution standard
- ✓ Cleaning BBE and its immediate surrounding with institution policy
- ✓ Communicating with appropriate staff that preventive maintenance procedure is done and brief's the same on equipment status as per institution standard

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, **you will be able to –**

- ✓ Reassemble BBE in accordance with institution standard
- ✓ Clean BBE and its immediate surrounding with institution policy
- ✓ Communicate with appropriate staff that preventive maintenance procedure is done and brief's the same on equipment status as per institution standard

Learning Instructions:

15. Read the specific objectives of this Learning Guide.
16. Follow the instructions described below 3 to 6.
17. Read the information written in the information "Sheet 1, Sheet 2 and Sheet 3 **in page 3, 5 and 8** respectively.
18. Accomplish the "Self-check 1, Self-check 2 and Self-check 3 **in page 4, 7 and 10** respectively

Information Sheet-1	Reassembled BBE in accordance with institution standard

Reassembling of basic biomedical equipment

Reassembly represents the completion of the equipment repair process that results in the piece of equipment being ready for use after maintenance.

Re assembling medical equipment after repair requires contamination free environments and calibration equipment to ensure the products are in excellent shape for use in emergency and surgical medical scenarios

Self-Check -1	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

True/false

4. Re assembling of medical equipment is performed in dust free area.
5. Re assembly is the first procedure of repair.
6. Re assembling is the act of doing circuit adjustment.

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet-2	Cleaning BBE and its immediate surrounding with institution policy

Basic cleaning concepts

The cleaning and disinfection of surfaces in hospitals and medical equipment is becoming increasingly important in the multi-barrier approach for preventing infection, in addition to hand hygiene and proper reprocessing of medical devices.

General sanitizing

To make a surface or area clean by removing dirt, germs or unwanted substances.

Bed rooms/restrooms

Bedroom cleaning includes the cleaning of toilets, fixtures and commodes. Bedrooms should be cleaned last, after completing the room because it may result in dust accumulation on the medical equipment found there. Shower walls should be thoroughly scrubbed at least weekly. Shower curtains should be changed at least yearly and as required.

Cleaning

The physical removal of dust, soil, blood and body fluids. Cleaning physically removes germs. It is accomplished with water, detergents and mechanical action. The key to cleaning is the use of friction to remove germs and debris.

Contamination

The presence of germs on hands or on a surface such as clothes, gowns, gloves, bedding, toys, surgical instruments, patient care equipment, dressings or other inanimate objects.

Cross-contamination

Cross-contamination is the transfer of harmful germs from one person, object or place to another.

Disinfectant

A product that is used on surfaces or medical equipment/devices which results in disinfection of the equipment/device. Some products combine a cleaner with a disinfectant.

Disinfection

The killing of germs. Surfaces and equipment must be cleaned first before applying disinfectant in order to kill germs.

Hospital clean is a measure of cleanliness routinely maintained in care areas of the health care setting. Cleaning practices are periodically monitored and audited with feedback and education.

- ✓ Floors and baseboards are free of stains, visible dust, spills and streaks.
- ✓ Walls, ceilings and doors are free of visible dust, gross soil, streaks, spider webs and handprints.
- ✓ All horizontal surfaces are free of visible dust or streaks (includes furniture, window ledges, overhead lights, phones, picture frames, carpets, etc.)
- ✓ Bathroom fixtures including toilets, sinks, tubs and showers are free of streaks, soil, stains and soap scum.
- ✓ Mirrors and windows are free of dust and streaks.
- ✓ Dispensers are free of dust, soiling and residue and replaced/replenished when empty.
- ✓ Appliances are free of dust, soiling and stains.
- ✓ Waste is disposed of appropriately.
- ✓ Items that are broken, torn, cracked or malfunctioning are replaced.
- ✓ High touch surfaces in client/patient/resident care areas are cleaned and disinfected with a hospital-grade disinfectant.
- ✓ Non-critical medical equipment is cleaned and disinfected between clients/patients/residents.

High touch areas

High touch surfaces are those that have frequent contact with hands. High touch surfaces in care areas require more frequent cleaning and disinfection than minimal contact surfaces. Cleaning and disinfection is usually done at least daily and more frequently if the risk of environmental contamination is higher (e.g., intensive care units).

Self-Check -2	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Cleaning include
   A). removal of debris
   B).blood and fluids
   C). disinfection
   D). all of the above
2. During sanitizing,
   A) the equipment does not cleaned
   B) equipment is disinfected
   C) dust and germ do not removed
   D) all
3. Which one of the following is not correct about high touch surface?
   A) Is frequently in contact with hands
   B) Is free from contamination
   C) It requires daily cleaning
   D) All

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

Information Sheet-3	Communicating with appropriate staff that preventive maintenance procedure

Preventive maintenance

Preventive maintenance (or preventive maintenance) is maintenance that is regularly performed on a piece of medical equipment to lessen the likelihood of it failing. It is performed while the equipment is still working so that it does not break down unexpectedly.

Goal of Preventive maintenance

The goal of a successful preventive maintenance program is to establish consistent practices designed to improve the performance and safety of the equipment at your property.

- ✓ Extends the useful lifecycle of assets
- ✓ Decreasing the need for capital replacements.
- ✓ Enhances the efficiency of equipment
- ✓ Keeping them running more efficiently and lowering power expenses.
- ✓ Enhances the performance of assets by increasing uptime.

Example of preventive maintenance

In practice, a preventive maintenance schedule may include things such as

- ✓ cleaning
- ✓ lubrication
- ✓ oil changes
- ✓ adjustments
- ✓ inspecting
- ✓ replacing parts

Communicating preventive maintenance with staff/user

Professionals in health and social care are personally accountable when they use medical devices and therefore must ensure that they have appropriate training on medical equipment preventive maintenance. This procedure is to ensure all staffs are trained in the use of medical devices as deemed necessary by their line manager. An

individual who uses the device in a way not intended, or against the instructions of the manufacturer may be liable for any consequences.

Self-Check -3	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. preventive maintenance is
   A). cleaning
   B).planned maintenance
   C). before failerity
   D). all of the above
2. which one of the following is not Example of preventive maintenance
   A) cleaning
   B) Lubrication
   C) Oil change
   D) None of the above
3. Which one of the following is goal of preventive maintenance?
   A. Extends the useful lifecycle of assets
   B. Decreasing the need for capital replacements.
   C. Enhances the efficiency of equipment
   D. Keeping them running more efficiently and lowering power expenses.
   E. All of the above

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Instruction Sheet	LG25: Document preventive and corrective maintenance activities

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics –

- ✓ Basic biomedical equipment checklist forms and other preventive and corrective maintenance documents are accomplished in strict observance of institution standards
- ✓ Reports are submitted to proper officer/office in accordance with institution policy
- ✓ Preventive maintenance documents are systematically kept and updated as per institution standards
- ✓ Health care equipment corrective maintenance form and other relevant reports are accomplished in strict observance of institution standards
- ✓ Reports are submitted to proper officer/offices in accordance with institution policy
- ✓ Corrective Maintenance documents are systematically kept and updated as per institution standards

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, **you will be able to –**

- ✓ Accomplished basic biomedical equipment checklist forms and other preventive and corrective maintenance documents in strict observance of institution standards
- ✓ Submit reports to proper officer/office in accordance with institution policy
- ✓ Keep and update Preventive maintenance documents systematically as per institution standards
- ✓ Accomplish Health care equipment corrective maintenance form and other relevant reports in strict observance of institution standards
- ✓ Submit reports to proper officer/offices in accordance with institution policy
- ✓ Keep and update Corrective Maintenance documents systematically as per institution standards

Learning Instructions:

18. Read the specific objectives of this Learning Guide.
19. Follow the instructions described below 3 to 7.
20. Read the information written in the information “Sheet 1, Sheet 2, Sheet 3 and Sheet 4, Sheet 5, Sheet 6 ” **in page 3, 4, 5, 6, X and 7** respectively.

Information Sheet-1	**Basic biomedical equipment checklist forms and other preventive and corrective maintenance documents**

Checklist form

A checklist is a list of items you need to verify, check or inspect. You should verify you are meeting the intent of every item on your checklist and possibly take notes, photos, audio, video or audio recordings related to that item.

A maintenance checklist is a document which contains a few items to be checked or reviewed for maintenance (e.g. autoclave, microscope, etc). It also points out the things which have been reviewed (usually marked) in order to avoid reviewing the same item more than once.

Preventative maintenance schedules

It is important to have a schedule and document for preventative maintenance of each item of equipment. This consists of a timetable stating when (and how frequently) maintenance should be done, and a list of maintenance activities for each item. These schedules should provide simple guidelines for all types of equipment, covering the tasks to be undertaken in the following areas:

Care and cleaning

Safety checks

Functional and performance checks

Maintenance tasks (changing bulbs, lubricating moving parts, etc.)

Information Sheet-2	Submitting Reports to proper officer/office

A report is a document that presents information in an organized format for a specific person and purpose. Although summaries of reports may be delivered orally, complete reports are almost always in the form of written documents.

Information Sheet-3	Keeping and updating Preventive maintenance documents

Record-keeping for maintenance

The preventative maintenance schedule for users can be accompanied by a weekly or monthly ‘tick sheet’ near the item of equipment, with a space for each day so that users can date and sign it, thereby showing that they have carried out the required tasks. This may include a space for users to indicate what spare parts, such as bulbs, were used. On a regular basis, the list of spare parts used should be noted in the central maintenance and repair record so that more spare parts can be ordered.

The central maintenance and repair record can be used to keep track of all other maintenance, including maintenance done by the in-house team, by vendors, or by service agents. The information captured should include the date, the equipment reference number, what was done, who did the work, and when next maintenance is due.

A key part of any preventive maintenance program is proper documentation of the work completed, ideally recorded directly into an electronic format, but also on paper. This can reduce the number of expensive repairs, increase operator accountability, make warranty claims easier, increase operator safety, identify trends, enhance visibility of individual asset health, and have significant positive impact on resale value

Information Sheet-4	accomplishing health care equipment corrective maintenance form and other relevant reports

Repair record report

The central maintenance and repair record can be used to keep track of all other maintenance, including maintenance done by the in-house team, by vendors, or by service agents. The information captured should include the date, the equipment reference number, what was done, who did the work, and when next maintenance is due.

The following Table shows what information about repairs should be recorded in the central maintenance and repair record, and what useful information this can provide.

What should be recorded	This provides information about…
The details of repair work done on each machine (including cause/suspected cause, and who carried out the repair) The date equipment has broken down, and the date it is repaired. The causes of any delays	The history of each machine Common problems The parts most frequently used What needs to be re-ordered What still needs to be repaired (which allows you to priorities the next week's tasks) The duration equipment is not in use (down-time) What the most common causes of delays are (skill, labor, spare parts, transport, bureaucratic delays, money) and what additional resources may be needed to complete work on time

Information Sheet-6	**Keeping and updating Corrective Maintenance documents systematically**

The central maintenance and repair record can be used to keep track of all other maintenance, including maintenance done by the in-house team, by vendors, or by service agents. The information captured should include the date, the equipment reference number, what was done, who did the work, and when next maintenance is due.

A key part of any corrective maintenance program is keeping and updating proper documentation of the work completed, ideally recorded directly into an electronic format, but also on paper. This can reduce the number of expensive repairs, increase operator accountability, make warranty claims easier, increase operator safety, identify trends, enhance visibility of individual asset health, and have significant positive impact on resale value

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