TVET CERTIFICATE III in Plumbing

BASIC ELECTRICITY

CSTBE 301

Carry out basic electrical works

Competence

Credits: 7

Learning hours: 70

Sector: Cnstruction

Sub-sector: Plumbing

Module Note Issue date: June, 2020

Purpose statement

This module describes knowledge and skills required to carry out basic electrical works. It describes the skills, knowledge and attitudes required for the trainee to Prepare the workplace/ site, Perform various electrical circuits, Perform measuring of circuits and Handover the work the work.

Table of Contents

LU & PC is linked in LO inside the content

Total Number of Pages: 67

Learning Unit 1 – Prepare the workplace/site

Introduction

Electricity is the flow of electrons from one place to another. Electrons can flow through any material, but does so more easily in some than in others. How easily it flows is called resistance. The resistance of a material is measured in Ohms.

Matter can be broken down into:

- **Conductors:** electrons flow easily. Low resistance.
- **Semi-conductors:** electron can be made to flow under certain circumstances. Variable resistance according to formulation and circuit conditions.
- **Insulator:** electrons flow with great difficulty. High resistance.

As electrons flow through a resistance, it performs a certain amount of work. It may be in the form of heat or a magnetic field or motion, but it does something. This work is called Power, and is measured in Watts. One Watt is equal to the work performed by 1 Amp pushed by 1 Volt through a resistance.

The three most basic components of electricity are:

- Voltage is like the pressure that pushes water through the hose. It is measured in volts (V).
- Current is like the diameter of the hose. The wider it is, the more water will flow through. It is measured in amps (I or A).
- Resistance is like sand in the hose that slows down the water flow. It is measured in ohms (R or Ω).

LO 1.1 – Identify tools, materials and equipment

- Content/Topic 1 Tools and Equipment

A. Tools and Equipment

A.1. Spanners:

a) Adjustable wrenches

- Used for turning bolts, nuts, and small pipe fittings.

b) Screwdrivers

- Flat-blade screwdriver: Installing and removing slot-head screws

- Star screwdrivers: Installing and removing special screws with special heads.

c) Hammer

- Diving and pulling nails
- Opening wooden crates and breaking plasterboard.

d) Electrical knife

A utility knife, or *box cutter,* is handy for cutting sheathing from non-metallic (Romex) cable, to cut off electrical tape, and to open cardboard boxes.

e) Hacksaw

- Cutting large conductors and cables
- Cutting conduit, metal, or bolts

<u>A.2. Pliers</u>

Pliers can be used for cutting, twisting, bending, holding, and gripping of wires and cables.

a) **Wire strippers**

Wire strippers are used to remove the insulation of wires.

- Stripping insulation from conductors
- Cutting small conductors
- Crimping wire lugs

b) **Side cutter pliers** (Lineman's pliers)

- Cutting large conductors
- Forming loops on large conductors
- Pulling and holding large conductors

c) Long-nose pliers

- Forming loops on small conductors
- Cutting and stripping small conductors

d) Combination pliers:

- Cutting and gripping wires

<u>A.3. Tape measure</u>

Measuring conduit and cable

A.4. Personal Protective Equipment (PPE)

PPE can be considered in the following categories, based on the type of protection afforded by the equipment:

- **Respiratory protection** for example, disposable, cartridge, air line, half or full face
- **Eye protection** for example, spectacles/goggles, shields, visors
- **Hearing protection** for example, ear muffs and plugs
- **Hand protection** for example, gloves and barrier creams
- **Foot protection** for example, shoes/boots
- **Head protection** for example, helmets, caps, hoods, hats
- **Working from heights** for example, harness and fall arrest devices
- **Skin protection** for example, hats, sunburn cream, long sleeved clothes.

A.5. Multimeter

A multimeter or a multitester, also known as a VOM (volt-ohm-milliammeter), is an electronic measuring instrument that combines several measurement functions in one unit. A typical multimeter can measure voltage, current, and resistance.

A multimeter is the combination of a DC voltmeter, AC voltmeter, ammeter, and ohmmeter.

A.6. Clamp meter

A clamp meter is an electrical test tool that combines a basic digital multimeter with a current sensor.

- Content/Topic 2 Materials

A. Wires/conductors

A conductor is a material (usually a metal such as copper) that allows electrical current to pass easily through.

Electrical wires may be made of copper or aluminum metal, both of which conducts electricity, but copper is a much better conductor than aluminum and a safer option. something such as an electrical wire, it is called conductivity.

B. Cables

An electrical cable is an assembly of one or more wires running side by side or bundled, which is used to carry electric current.

Classification of conductors

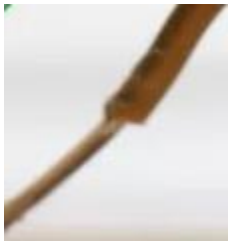
Wires and cables can be classified by the type of covering they have.

- Bare conductors: The most common use of bare conductor is in overhead electrical transmission and distribution lines.

- Insulated conductors: An insulation covered wire used in domestic wiring is called an insulated wire/conductor. It may be a single conductor wire (in case of aluminium conductors) or a stranded conductor wire (in case of copper conductors), They have a coating of insulation over the metals.

Stranded conductor wire

Single conductor wire



C. Clip connecters

Cable clips are essentially a cable mounting and management tool, used for securing cables and wiring to fixed points.

D. Scotch

The Scotch duct or sellotape may not provide good insulation especially in dump conditions. Besides, the adhesive material might be conductive. Dirt buildup on the heavy adhesive can cause a high resistance conduction across the wires.

E. Fastener

Fastener is a hardware device that mechanically joins or affixes two or more objects together. In general, fasteners are used to create non-permanent joints; joints that can be removed or dismantled without damaging the joining components.

F. Fixing

Fixing is the action of fastening something in place.

G. Circuit breaker

A **circuit breaker** is an automatically operated electrical switch designed to protect an electrical circuit from damage caused by excess current from an overload or short circuit.

H. Lamps

An electric light is a device that produces visible light from electric current.

An **electric lamp** is a conventional **light** emitting component used in different circuits, mainly for **lighting** and indicating purposes.

I. Socket

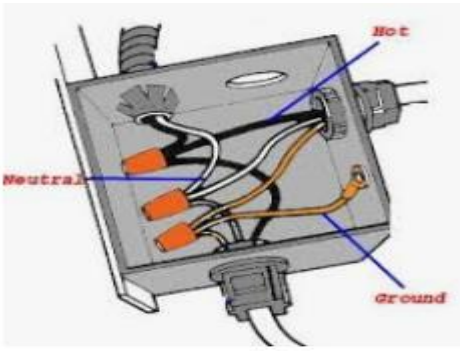
Electrical sockets or outlets allow us to plug in appliances to attach them to the electrical grid and provide power for them to run.

J. Switches

An electrical switch is any device used to interrupt the flow of electrons in a circuit. Switches are essentially binary devices: they are either completely on (“closed”) or completely off (“open”).

K. Connection boxes

An electrical **junction box** is an enclosure housing electrical connections, to protect the connections and provide a safety barrier.



LO 1.2 – Sketch the work

- Content/Topic 1 Drawing tools

A. Pencil

A slender tube of wood, metal, plastic, etc., containing a core or strip of graphite, a solid coloring material, or the like, used for writing or drawing.

B. Paper

Drawing paper is a paper that is specially prepared for use in drafting.

Soviet formats with multiplied shorter side (**mm × mm**)

n	(×1)	×2	×3	×4	×5	×6
A0	841×1189	1682×1189	2523×1189	3364×1189	4204×1189	5045×1189
A1	594×841	= A0	1784×841	2378×841	2973×841	3568×841
A2	420×594	= A1	1261×595	1682×595	2102×595	2523×595
A3	297×420	= A2	892×420	1189×420	1487×420	1784×420
A4	210×297	= A3	631×297	841×297	1051×297	1261×297
A5	148×210	= A4	446×210	595×210	743×210	892×210

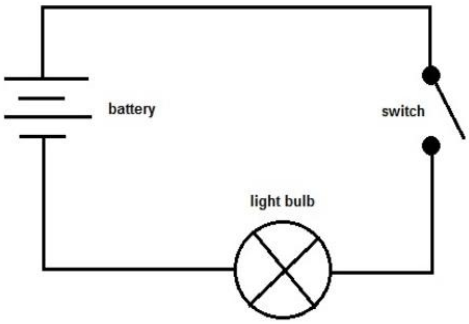
C. Rubber

An eraser made of rubber (or of a synthetic material with properties similar to rubber); commonly mounted at one end of a pencil

D. Sharpener

A device that makes something sharp.

Sketching of the electrical circuit



The main components of an electrical circuit comprise the following:

1. A source of supply, AC or DC depending on the type of circuit
2. A fuse, which is a weak link in the circuit that will break if too much current is one that is above the rating of the current.
3. A cable comprising phase and neutral or supply and return conductors.
4. A switch to enable the circuit to be switched ON or OFF. (A main switch serves as a main disconnection for the flow of electricity to a building, unit or house, whereas, a local switch is located in every final circuit.)
5. A current- using device or devices in general called a load or loads.

LO 1.3 – Dispose tools, materials and equipment

- Content/Topic 1 Arrange tools, materials and equipment in appropriate space

A. Proper Storage

Storage of all types of materials must be arranged in a logical way so that everything is easily retrievable from the storage area.

Cleaning your tools is of no use if you don't store them properly. Based on your needs, a simple toolbox will suffice. In case you own a big collection of tools or use them professionally, a great option is a metal cabinet. All tools must be sorted and organized and replaced in their stipulated storage area after use. This way you can not only access them quickly but also keep them safe.

Tool storage is, in a large part, dependent upon the available space you have. Some people store their tools in boxes or chests, on shelves, in drawers, or on a peg board. The best is probably on a peg board; each tool is there to be found at a glance and wall space can be used very efficiently in this way.

Equipment must be stored under appropriate conditions (protected from heat, humidity and direct sunlight).

Whichever storage option you choose, the most important thing is to protect your valuable tools from rust. Rust will destroy tools and make them either difficult to use or completely unusable. Keep tools in a dry place with low humidity.

Pointers to follow in storing tools, materials and equipment:

- Have a designated place for each kind of tools.
- Label the storage cabinet or place correctly for immediate finding.
- Store them near the point of use.
- Wash and dry properly before storing.
- Store knives properly when not in use with sharp edge down.




Learning Unit 2 – Perform various electrical circuits

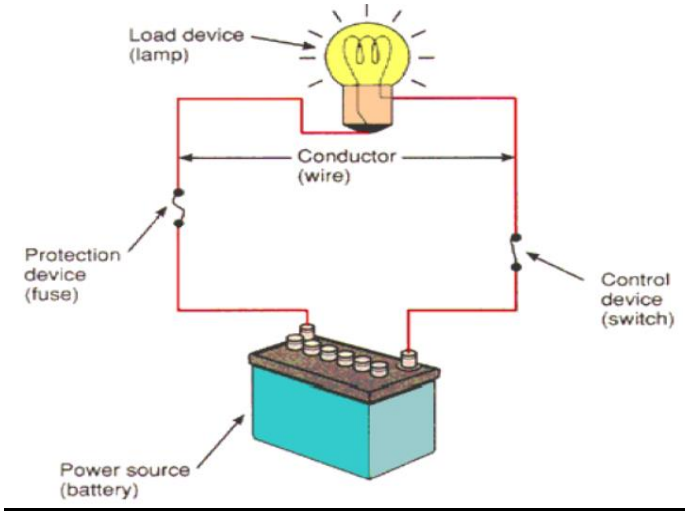
LO 2.1 – Working out of simple circuit

- Content/Topic 1 Terminology used in electricity

A. Terminology used in electricity

A.1. Circuit

A closed path in which electrons from a voltage or current source flow. Circuits can be in series, parallel, or in any combination of the two.



A.2. Current

The flow of an electric charge through a conductor. An electric current can be compared to the flow of water in a pipe. Measured in amperes.

A.3. Ammeter

An instrument for measuring the flow of electrical current in amperes. Ammeters are always connected in series with the circuit to be tested.

A.4. Frequency

The number of cycles per second. Measured in Hertz. If a current completes one cycle per second, then the frequency is 1 Hz; 60 cycles per second equals 60 Hz.

A.5. Fuse

A circuit interrupting device consisting of a strip of wire that melts and breaks an electric circuit if the current exceeds a safe level.

A.6. Ground

The reference point in an electrical circuit from which voltages are measured, a common return path for electric current, or a direct physical connection to the Earth.

A.7. Load

Anything which consumes electrical energy, such as lights, transformers, heaters and electric motors.

A.8. Ohm

Ohm (Ω) A unit of measure of resistance. One ohm is equivilant to the resistance in a circuit transmitting a current of one ampere when subjected to a potential difference of one volt.
An instrument for measuring the resistance in ohms of an electrical circuit is called Ohmmeter.

A.9. Open Circuit

An open or open circuit occurs when a circuit is broken, such as by a broken wire or open switch, interrupting the flow of current through the circuit. It is analogous to a closed valve in a water system.

A.10. Parallel Circuit

A circuit in which there are multiple paths for electricity to flow. Each load connected in a separate path receives the full circuit voltage, and the total circuit current is equal to the sum of the individual branch currents.

A.11. Polarity

A collective term applied to the positive (+) and negative (-) ends of a magnet or electrical mechanism such as a coil or battery.

A.12. Power

The rate at which electrical energy is transferred by an electric circuit. Measured in Watts.

A.13. Resistance

The opposition to the passage of an electric current. Electrical resistance can be compared to the friction experienced by water when flowing through a pipe. Measured in ohms.

A.14. Resistor

A device usually made of wire or carbon which presents a resistance to current flow.

A.15. Series-parallel circuit

A circuit in which some of the circuit components are connected in series and others are connected in parallel.

A.16. Series circuit

A circuit in which there is only one path for electricity to flow. All of the current in the circuit must flow through all of the loads.

A.17. Short circuit

When one part of an electric circuit comes in contact with another part of the same circuit, diverting the flow of current from its desired path.

A.18. Voltage

An electromotive force or "pressure" that causes electrons to flow and can be compared to water pressure which causes water to flow in a pipe. Measured in volts.

A.19. Voltmeter

An instrument for measuring the force in volts of an electrical current. This is the difference of potential (voltage) between different points in an electrical circuit. Voltmeters have a high internal resistance are connected across (parallel to) the points where voltage is to be measured.

A.20. Wattmeter

The wattmeter is an instrument for measuring the electric power (or the supply rate of electrical energy) in watts of any given circuit.

A.21. Conductor

Any material where electric current can flow freely.

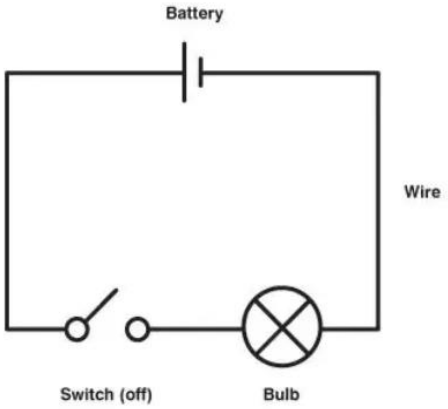
A.22. Insulator

Any material where electric current does not flow freely.

- Content/Topic 2 Perform simple circuit

A. Simple electrical circuits

A **circuit** is the path that an electric current travels on, and a simple circuit contains three components necessary to have a functioning electric circuit, namely, a source of voltage, a conductive path, and a resistor. Circuits are driven by flows.



A.1. How to make a simple electrical circuit

1. Gather the necessary materials

To build a simple circuit, you will need a power source, 2 insulated wires, a light bulb, and a light bulb holder. A power source can be any type of battery or battery pack.

2. Strip the ends of the insulated wires

In order for your circuit to work properly, the wires need to be totally exposed so you must strip the ends. Using wire strippers, remove about 1 inch (2.5 cm) of the insulation from the ends of each wire.

3. Install batteries into the battery pack

Depending on the type of batteries you are using, you may be able to skip this step. If you are using multiple batteries, you will need a power pack to hold the batteries. Push each battery in by the side taking care to put the positive and negative ends in the correct orientation.

4. Attach your wires to the battery pack

The wires will be conducting your electric current from the batteries to the light bulb. The easiest way to attach the wires is to use electrical tape. Attach the end of one wire to one side of the battery, making sure that the wire maintains contact with the metal of the battery. Repeat with the other wire on the other side of the battery.

5. Install the switch. Take the exposed metal end of one of the wires from the battery pack and bend it into a U-shape. Loosen the screw on the switch and slip the U-shape of the wire underneath. Tighten the screw making sure that the metal of the wire remains in contact with the screw.

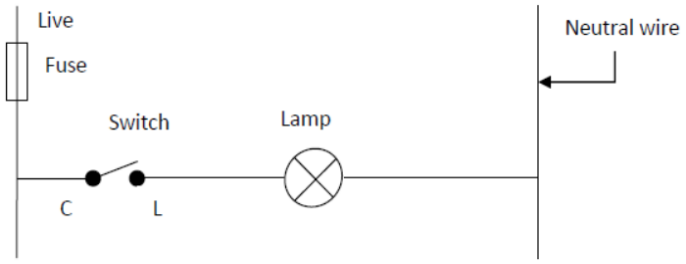
6. Fasten the other end of the wire to the metal screw of the bulb holder

Take the exposed metal end of each wire and bend it into a U-shape. Loosen each screw on the light bulb holder just enough to slip the U-shape of the wire around the screw. Each wire will be attached to its own screw. Tighten the screw, ensuring that the metal of the wires remains in contact with the screw.

7. Test your circuit

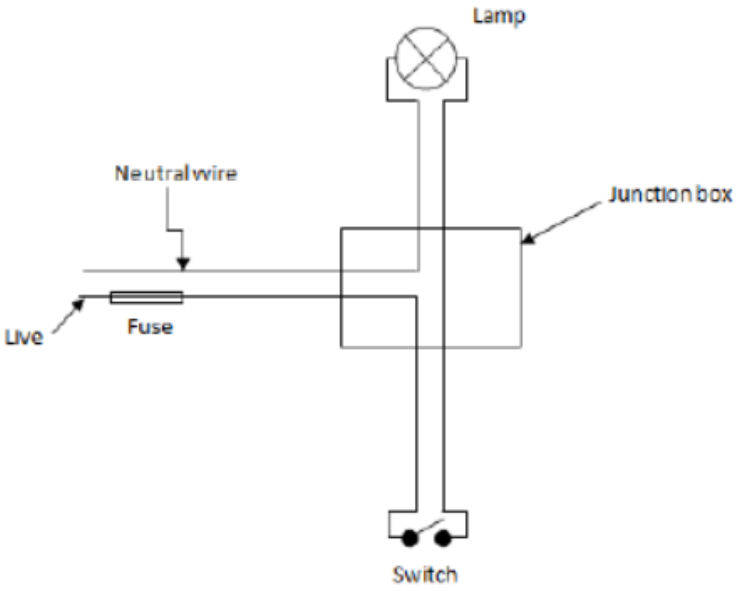
Screw the light bulb into its holder until it is tight. If your circuit is hooked up properly, the bulb should light up when fully screwed into its socket.

i) Circuit diagram



ii)Wiring diagram

When more than one lamp is required, the extra lamp or lamps should be connected in parallel.



LO 2.2 – Work out the series circuit

- Content/Topic 1 Identification of wires

A. Colour

Cable colours are used to identify different power lines in different countries and different phases within three phase power supplies.

A.1. Green, green with a yellow stripe, or bare copper

These are ground wires that keep you, your appliances, and your home safe from electrical fires. Their purpose is to provide a path for a circuit's electrical current if a device shorts out or trips a breaker.

A.2. Black

Black indicates a hot or live wire that's carrying a current and is used for power in all circuits.

These wires feed an outlet or switch and are often used as switch legs (the connection that runs from the switch to the electrical load).

A.3. Red

This will be your second hot wire when doing a 220-volt installation for large appliances such as a stove, clothes dryer, or air conditioner.

Red can also be the interconnecting electrical wire between two hardwired smoke detectors.

A.4. Blue and Yellow

These two colors are hot wires usually pulled in conduit for common plug-in electrical devices.

A.4.1. Blue

Blue wires are used as travelers, usually on three- or four-way switches (controlling a light from multiple locations) or as switch legs for things such as fans or lights.

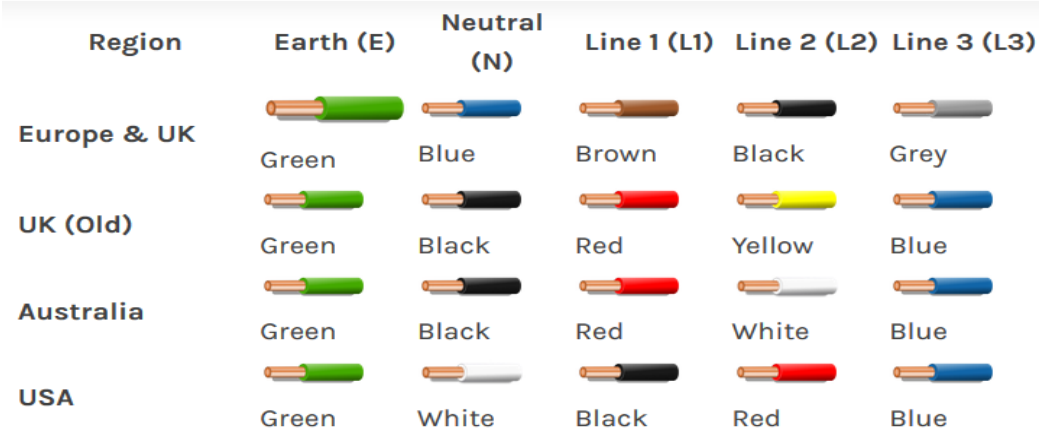
A.4.2. Yellow

Yellow wires are almost always used as switch legs for outlets, fans, or lights.

A.5. White or Gray

White or gray indicates a neutral wire, which provides the return path for the current carried by the hot wires and is grounded within the electrical panel.

Fixed wiring electricity supply requires specific wiring colour regulations to identify different power lines in different countries.



B. Size

The size of the wire refers to the diameter of the conductor itself.

There are two sizing criteria for copper conductors:

The amount of current a cable can carry depends on the cross-sectional area of its conductor. The larger the cross-sectional area, the more current it can take. It is, therefore, important to select the correct size for the job.

Cable size	Maximum current	Type of use
1.5 mm^2	10 A	Lighting circuits

2.5 mm^2	20 A	One or more 13 A for sockets wired as ring final circuit
4 mm^2	25 A	Water heaters
6 mm^2	30 A	Electric showers
10 mm^2	45 A	Large cookers
16 mm^2	60 A	Main supply to a house

C. Types

Types of electric cable by their use.

C.1. Cables for electric panels

Flexible cables for wiring electric cabinets. These electric cables are especially suitable for domestic use, for installation in public places and for internal wiring of electrical cabinets, switch boxes and small electrical appliances.

C.2. Power cables

It is common to find power cables in applications for power transmission in all types of low voltage connections, for industrial use and for variable frequency drive.

C.3. Armoured cables

Cables with aluminium or steel reinforcement for installations with risk of mechanical aggression**.**

C.4. Rubber cables

The use of extra flexible rubber cables is very varied. We can find rubber cables in fixed industrial installations as well as in mobile service**.**

C.5. Halogen-free cables

High Security Halogen Free Cables with low smoke and corrosive gas emission in case of fire are suitable for use in wiring of electrical panels and public places, installations of all kinds in public places, individual derivations, emergency circuits, public distribution networks and also for mobile service.

C.6. Fire resistant cables

These cables are specially **designed** to transmit electrical energy in the extreme conditions that occur during a prolonged fire, guaranteeing supply to emergency equipment such as signalling, smoke extractors, acoustic alarms, water pumps, etc.

C.7. Control cables

Control cables for fixed or mobile installations should be extremely flexible, as they are mainly designed for small household appliances, for the interconnection of machine parts used for manufacturing,

C.8. Instrumentation cables

These are flexible and shielded cables for the **transmission of signals between equipment in industrial installations**.

C.9. Solar cables

These cables are particularly suitable for **connecting photovoltaic panels**, and from the panels to the DC to AC inverter. Thanks to the design of their materials and their cover, which is especially resistant to solar radiation and extreme temperatures, they can be installed outdoors with full guarantees.

C.10. Special cables

There is a wide variety of **electric cables for special installations** such as: temporary light garland installations at trade fairs; connections for overhead cranes, hoists and lifts; applications in submerged pumps and drinking water areas such as aquariums, purification systems, drinking water fountains or in swimming pools for lighting, purification and cleaning systems.

C.11. Aluminium cables

Aluminium cables for power transmission are suitable for fixed installation indoors, outdoors and/or underground.

- Content/Topic 2 Types of switches

A. Switch

A switch is a device which is designed to interrupt the current flow in a circuit, in other words, it can make or break an electrical circuit.

The type of switch used in domestic installations is called a plate switch.

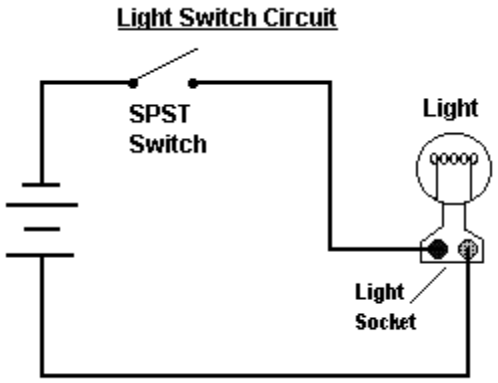
The types of switches are classified into four types namely:

- SPST (Single Pole Single throw)
- SPDT (single pole double throw)
- DPST (double pole, single throw)
- DPDT (double pole double throw)

A.1. SPST (Single Pole Single Throw)

The SPST is a basic ON/OFF switch that is used to connect or break the connection between two terminals. A simple PST switch is shown below:

When the switch is OFF or open, then the current doesn't flow through the two terminals.



Types of switches depending on the specifications

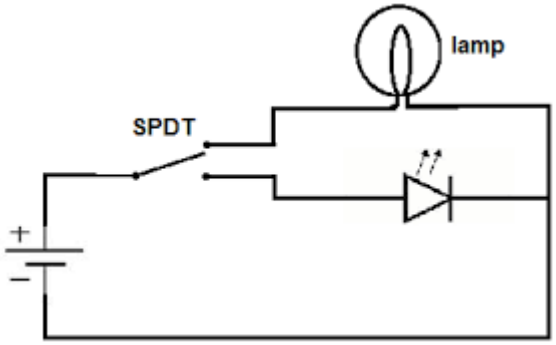
One-way or single-pole electrical switch

A one-way or single-pole electrical switch is the most common one in use. They are used to control lights, fans, or other devices from a single location. It has a simple ON and OFF marking.

A.2. SPDT (Single Pole Double Throw)

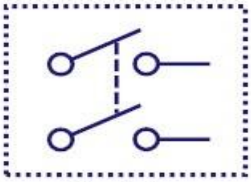
The SPDT switch is a three terminal switch, one terminal is used as input and remaining two terminals are used as outputs. It joins a mutual terminal to one or the other of two terminals.

Her two circuits will be controlled through one source or one way.



A.3. DPST (Double Pole, Single Throw)

The DPST switch consists of two poles that means it includes two identical switches located on side by side. This switch is operated by one single toggle, which means that two discrete circuits are controlled at a time through one push.

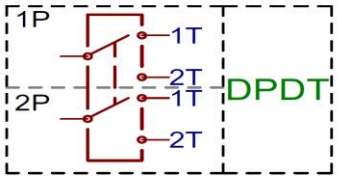


Symbol

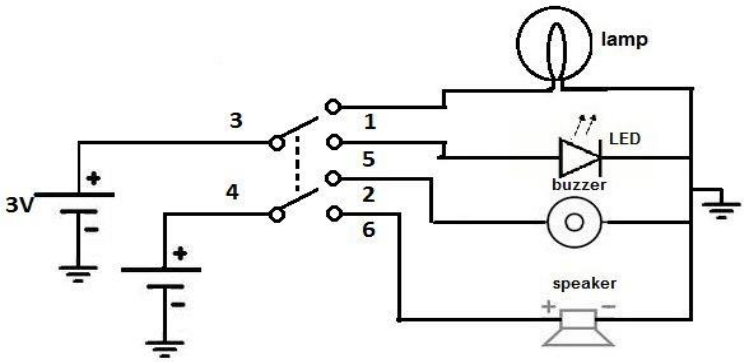
DPST Switch

DPDT (Double Pole Double Throw)

This switch is equal to two SPDT switches, it means two separate circuits, connecting two inputs of each circuit to one of two outputs. The switch position controls the number of ways and from the two contacts each contact can be routed.



When it is in ON-ON mode or ON-OFF-ON mode they work like two discrete SPDT switches worked by the similar actuator. At a time only two loads can be ON. A DPDT switch can be used in any application that needs an open & closed wiring system.



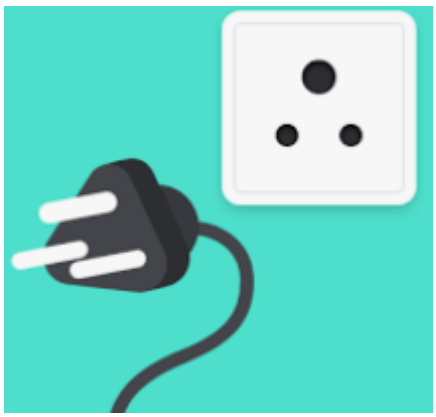
- Content/Topic 3 Identificaton of sockets

A socket is one endpoint of a two-way communication link between two programs running on the network.

Domestic AC power plugs and sockets are devices that connect the home appliances and portable light fixtures commonly used in homes to the commercial power supply so that AC electric power can flow to them.

Power plugs are male electrical connectors that fit into female electrical sockets. They have contacts that are pins or blades which connect mechanically and electrically to holes or slots in the socket. Plugs usually have a live or hot contact, a neutral contact, and an optional earth or ground contact. Many plugs make no distinction between the live and neutral contacts, and in some cases they have two live contacts.

Power sockets are female electrical connectors that have slots or holes which accept the pins or blades of power plugs inserted into them and deliver electricity to the plugs. Sockets are usually designed to reject any plug which is not built to the same electrical standard. Some sockets have one or more pins that connect to holes in the plug.




A socket outlet is the main connection point in most installations. Equipment is connected to the supply by means of a plug which ts into the three slots on the face of the socket. The slots are protected by shutters which are opened when the plug's earth pin is pushed into place.

- Content/Topic 4 Types of lamps

A. Types of lamps

The different types of lamps include:

- Incandescent Lamps
- Tungsten Halogen Lamps
- Fluorescent Lamps
- Compact Fluorescent Lamps
- Mercury Vapour Lamps
- High Pressure Sodium Vapour Lamps
- Low Pressure Sodium Vapour Lamps
- LED Lamps

A.1. Incandescent lamp

An **incandescent light bulb**, **incandescent lamp** or **incandescent light globe** is an electric light with a wire filament heated until it glows.

A.2. Tungsten Halogen Lamp

A **halogen lamp**, also known as a **tungsten halogen**, quartz-**halogen** or quartz iodine **lamp**, is an incandescent **lamp** consisting of a **tungsten** filament sealed into a compact transparent envelope that is filled with a mixture of an inert gas and a small amount of a **halogen** such as iodine or bromine.

A.3. Fluorescent Lamp

A fluorescent lamp, or fluorescent tube, is a low-pressure mercury-vapor gas-discharge lamp that uses fluorescence to produce visible light.

A.4. Compact Fluorescent Lamp

A compact fluorescent lamp (CFL), also called compact fluorescent light, energy-saving light and compact fluorescent tube, is a fluorescent lamp designed to replace an incandescent light bulb; some types fit into light fixtures designed for incandescent bulbs.

A.5 Mercury Vapour Lamp

Mercury vapor lamps are bright, long-lasting light sources that are often used to light large areas such as streets, gyms, sports arenas, banks, or stores.

A.6. High Pressure Sodium Vapour Lamp

High pressure sodium lamps are **used in** outdoor **lighting** of streets and parking lots and in indoor settings where color rendering is not critical.

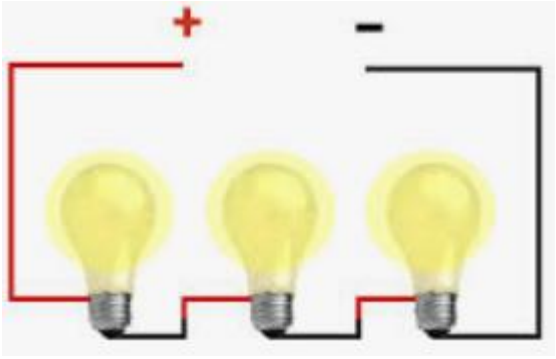
A.7. Low Pressure Sodium Vapour Lamp

A low-pressure sodium-vapour (LPS) lamp contains an inner discharge tube made of borosilicate glass that is fitted with metal electrodes and filled with neon and argon gas and a little metallic sodium.

A.8. LED Lamp

An LED lamp or LED light bulb is an electric light for use in light fixtures that produces light using one or more light-emitting diodes (LEDs). LED lamps have a lifespan many times longer than equivalent incandescent lamps, and are significantly more efficient than most fluorescent lamps.

In series circuit, the current flows through each lamp in the circuit,Lamp 1, Lamp 2 and Lamp 3.



Consider a very simple circuit consisting of four light bulbs and one 6 V battery. If a wire joins the battery to one bulb, to a second bulb, to a third bulb, then back to the battery, in one continuous loop, the bulbs are said to be in series.

The disadvantages of the series circuit are:

1. If one load or lamp fails, then all loads will lose their supply.

• Each lamp or load has to be designed to operate on a different voltage from the supply and, in turn, the voltage at one lamp will depend on the size of the other loads in the circuit.

Advantages:
1. Series circuits do not overheat easily. This makes them very useful in the case of something that might be around a potentially flammable source, like dry plants or cloth.
2. Series circuits are easy to learn and to make. Their simple design is easy to understand, and this means that it's simple to conduct repairs.
3. We can add more power devices, they have a higher output in terms of voltage.
4. The current that flows in a series circuit has to flow through every component in the circuit. Therefore, all of the components in a series connection carry the same current.

- Content/Topic 5 Different capacity of circuit breaker

A. Circuit breaker

A circuit breaker is an electrical device that opens and closes a circuit by non-automatic means and automatically opens a circuit when a predetermined current overload is reached, without damage to itself.

The standard for most household **circuits** are rated either 15 amps or 20 amps.

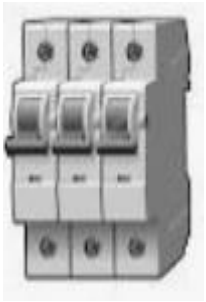
A circuit breaker is required to perform the following three duties:

1. It must be capable of opening the faulty circuit and breaking the fault current.

2. It must be capable of being closed on to a fault.

3. Must be capable of carrying fault current for a short time while another breaker is clearing the fault.

Depending on the above duties circuit breaker has three ratings breaking capacity, making capacity and short time capacity.



A.1. Breaking capacity

It is current that a circuit breaker is capable of breaking at a given recovery voltage under specified conditions.

The breaking capacity is always stated at the r.m.s value of fault current at the instant of contact separation.

A.2. Making capacity

The capacity of a breaker to make current depends up on its ability to withstand and close successfully against the effects of electromagnetic forces.

A.3. Short time rating

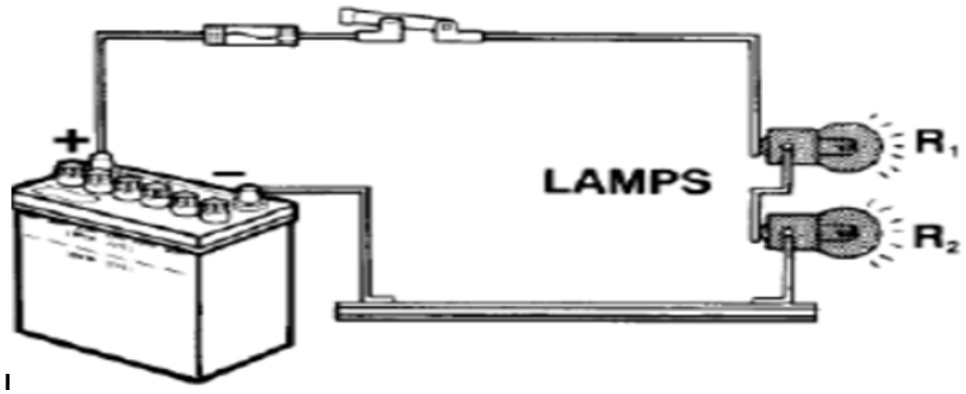
It is the period for which the circuit breaker is able to carry fault current while remaining closed.

The fault on the system of very temporary nature persists for 1 or 2 sec after which the fault will be cleared, so the breaker should not be tripped in such situations.

It depends on its ability to withstand electromagnetic force effects and temperature rise.

A.4. Series-connected resistors

In any series circuit a current *I* will flow through all parts of the circuit as a result of the potential difference supplied by a battery. Therefore, we say that in a series circuit the current is common throughout that circuit.



I

In a series circuit , the current through each of the components is the same, and the voltage across the components is the sum of the voltages across each component.

In above figure, all the two light points are connected in series. Each lamp is connected to the next one it means the **L** (Line also known as live or phase) is connected to the first lamp and other lamps are connected through middle wire and the last one wire as **N** (Neutral) connected to the supply voltage then.

LO 2.3 – Work out the parallel circuit

- Content/Topic 1 Identification of wires

A. Colour

Cable colours are used to identify different power lines in different countries and different phases within three phase power supplies.

A.1. Green, green with a yellow stripe, or bare copper

These are ground wires that keep you, your appliances, and your home safe from electrical fires. Their purpose is to provide a path for a circuit's electrical current if a device shorts out or trips a breaker.

A.2. Black

Black indicates a hot or live wire that's carrying a current and is used for power in all circuits.

These wires feed an outlet or switch and are often used as switch legs (the connection that runs from the switch to the electrical load).

A.3. Red

This will be your second hot wire when doing a 220-volt installation for large appliances such as a stove, clothes dryer, or air conditioner.

Red can also be the interconnecting electrical wire between two hardwired smoke detectors.

A.4. Blue and Yellow

These two colors are hot wires usually pulled in conduit for common plug-in electrical devices.

A.4.1. Blue

Blue wires are used as travelers, usually on three- or four-way switches (controlling a light from multiple locations) or as switch legs for things such as fans or lights.

A.4.2. Yellow

Yellow wires are almost always used as switch legs for outlets, fans, or lights.

A.5. White or Gray

White or gray indicates a neutral wire, which provides the return path for the current carried by the hot wires and is grounded within the electrical panel.

Fixed wiring electricity supply requires specific wiring colour regulations to identify different power lines in different countries.

Region	Earth (E)	Neutral (N)	Line 1 (L1)	Line 2 (L2)	Line 3 (L3)
Europe & UK	Green	Blue	Brown	Black	Grey
UK (Old)	Green	Black	Red	Yellow	Blue
Australia	Green	Black	Red	White	Blue
USA	Green	White	Black	Red	Blue

B. Size

The size of the wire refers to the diameter of the conductor itself.

There are two sizing criteria for copper conductors:

The amount of current a cable can carry depends on the cross-sectional area of its conductor. The larger the cross-sectional area, the more current it can take. It is, therefore, important to select the correct size for the job.

Cable size	Maximum current	Type of use
1.5 mm^2	10 A	Lighting circuits
2.5 mm^2	20 A	One or more 13 A for sockets wired as ring final circuit
4 mm^2	25 A	Water heaters
6 mm^2	30 A	Electric showers
10 mm^2	45 A	Large cookers
16 mm^2	60 A	Main supply to a house

C. Types

Types of electric cable and their use.

C.1. Cables for electric panels

Flexible cables for wiring electric cabinets. These electric cables are especially suitable for domestic use, for installation in public places and for internal wiring of electrical cabinets, switch boxes and small electrical appliances.

C.2. Power cables

It is common to find power cables in applications for power transmission in all types of low voltage connections, for industrial use and for variable frequency drive.

C.3. Armoured cables

Cables with aluminium or steel reinforcement for installations with risk of mechanical aggression**.**

C.4. Rubber cables

The use of extra flexible rubber cables is very varied. We can find rubber cables in fixed industrial installations as well as in mobile service**.**

C.5. Halogen-free cables

High Security Halogen Free Cables with low smoke and corrosive gas emission in case of fire are suitable for use in wiring of electrical panels and public places, installations of all kinds in public places, individual derivations, emergency circuits, public distribution networks and also for mobile service.

C.6. Fire resistant cables

These cables are specially **designed** to transmit electrical energy in the extreme conditions that occur during a prolonged fire, guaranteeing supply to emergency equipment such as signalling, smoke extractors, acoustic alarms, water pumps, etc.

C.7. Control cables

Control cables for fixed or mobile installations should be extremely flexible, as they are mainly designed for small household appliances, for the interconnection of machine parts used for manufacturing,

C.8. Instrumentation cables

These are flexible and shielded cables for the **transmission of signals between equipment in industrial installations**.

C.9. Solar cables

These cables are particularly suitable for **connecting photovoltaic panels**, and from the panels to the DC to AC inverter. Thanks to the design of their materials and their cover, which is especially resistant to solar radiation and extreme temperatures, they can be installed outdoors with full guarantees.

C.10. Special cables

There is a wide variety of **electric cables for special installations** such as: temporary light garland installations at trade fairs; connections for overhead cranes, hoists and lifts; applications in submerged pumps and drinking water areas such as aquariums, purification systems, drinking water fountains or in swimming pools for lighting, purification and cleaning systems.

C.11. Aluminium cables

Aluminium cables for power transmission are suitable for fixed installation indoors, outdoors and/or underground.

- Content/Topic 2 Types of switches

A. Switch

A switch is a device which is designed to interrupt the current flow in a circuit, in other words, it can make or break an electrical circuit.

The type of switch used in domestic installations is called a plate switch.

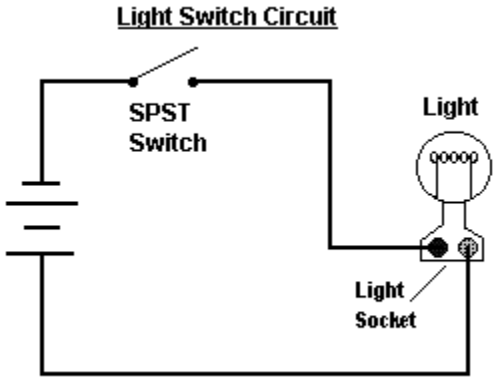
The types of switches are classified into four types namely:

- SPST (Single Pole Single throw)
- SPDT (single pole double throw)
- DPST (double pole, single throw)
- DPDT (double pole double throw)

A.1. SPST (Single Pole Single Throw)

The SPST is a basic ON/OFF switch that is used to connect or break the connection between two terminals. A simple PST switch is shown below:

When the switch is OFF or open, then the current doesn't flow through the two terminals.



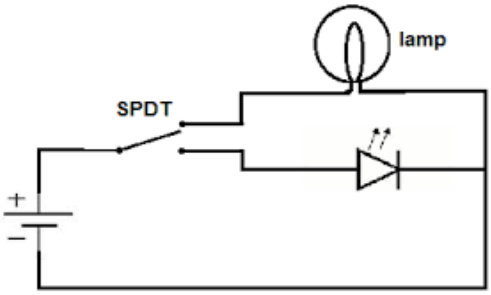
One-way or single-pole electrical switch

A one-way or single-pole electrical switch is the most common one in use. They are used to control lights, fans, or other devices from a single location. It has a simple ON and OFF marking.

A.2. SPDT (Single Pole Double Throw)

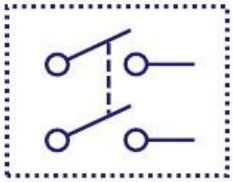
The SPDT switch is a three terminal switch, one terminal is used as input and remaining two terminals are used as outputs. It joins a mutual terminal to one or the other of two terminals.

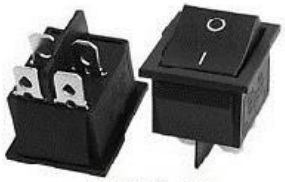
Her two circuits will be controlled through one source or one way.



A.3. DPST (Double Pole, Single Throw)

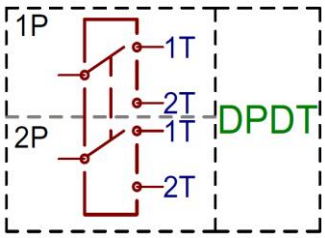
The DPST switch consists of two poles that means it includes two identical switches located on side by side. This switch is operated by one single toggle, which means that two discrete circuits are controlled at a time through one push.


Symbol

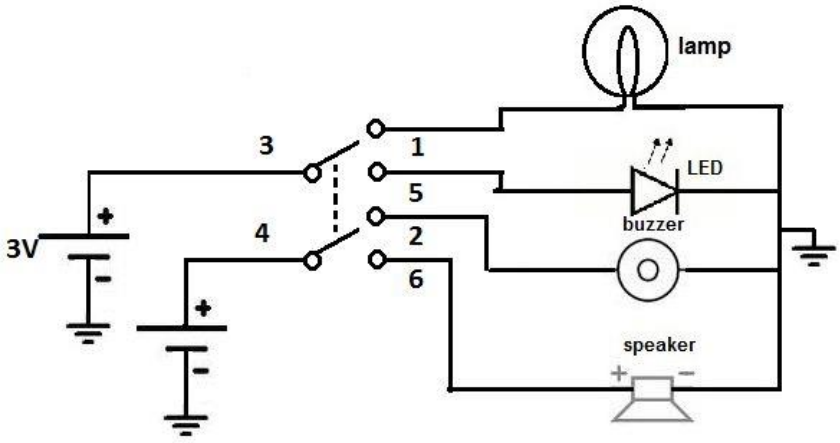

DPST Switch

DPDT (Double Pole Double Throw)

This switch is equal to two SPDT switches, it means two separate circuits, connecting two inputs of each circuit to one of two outputs. The switch position controls the number of ways and from the two contacts each contact can be routed.



When it is in ON-ON mode or ON-OFF-ON mode they work like two discrete SPDT switches worked by the similar actuator. At a time only two loads can be ON. A DPDT switch can be used in any application that needs an open a closed wiring system.



The type of switch used in domestic installations is called a plate switch.

Resistors in series and parallel
In electrical circuit resistors may be connected in series, in parallel, or in various combinations of series and parallel connections.

Surface Switch: The switches are mounted on wooden board, fixed over the surface of the wall. These switches are also known as “Tumbler switches”.

Flush/Piano type switch: The switches are used where good appearance is required. The switches are fixed in flush with the wall and do not project out.These switches are also known as “Piano Type Switches”.

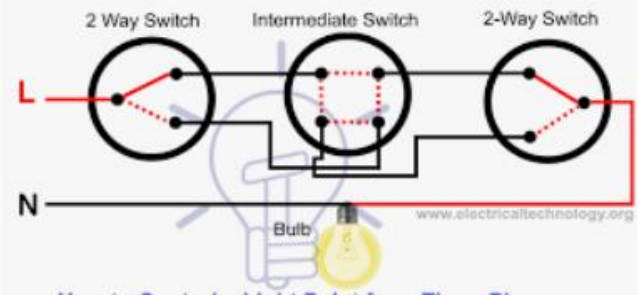
Bed switch: As the name indicates, it is used to switch “ON or OFF” the light from the place, other than switch-board or from near the bed, while going to sleep or getting up. This switch is connected through flexible wire.

Rotary switch: This switch is used to control different lamps from one places one by one or as selector switch, to select different voltage tapping of transformer in voltage stabilizer

Push Button switch: These switches are used to control the electric bell and indicating lamps etc. When the push button is pressed, the circuit is completed and the bell or lamp is switched on. The supply to bell or lamp is switched off as the push button is released.

Pull switch: These switches are operated with a single pull of the cord, for the on and off position. These are also used in bedroom and bathroom. These switches are fixed near the ceiling and hence these are also known as “Ceiling Switches”.

Intermediate switch: This switch has four terminals and four different connection position. The main function of this switch is to control a lamp from three or more different places, along with ordinary two-way switch. Generally this switch is used in double stair case wiring or corridor wiring. This switch is also known as four-way switch.



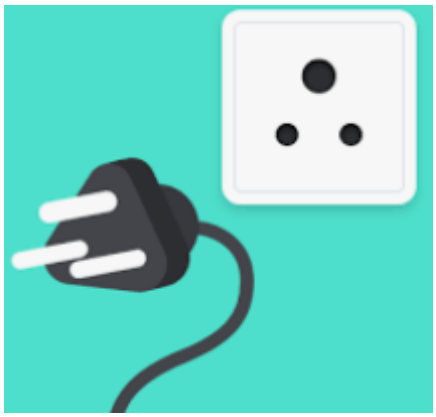
- Content/Topic 3 Identificaton of sockets

A socket is one endpoint of a two-way communication link between two programs running on the network.

Domestic AC power plugs and sockets are devices that connect the home appliances and portable light fixtures commonly used in homes to the commercial power supply so that AC electric power can flow to them.

Power plugs are male electrical connectors that fit into female electrical sockets. They have contacts that are pins or blades which connect mechanically and electrically to holes or slots in the socket. Plugs usually have a live or hot contact, a neutral contact, and an optional earth or ground contact. Many plugs make no distinction between the live and neutral contacts, and in some cases they have two live contacts.

Power sockets are female electrical connectors that have slots or holes which accept the pins or blades of power plugs inserted into them and deliver electricity to the plugs. Sockets are usually designed to reject any plug which is not built to the same electrical standard. Some sockets have one or more pins that connect to holes in the plug.




A socket outlet is the main connection point in most installations. Equipment is connected to the supply by means of a plug which ts into the three slots on the face of the socket. The slots are protected by shutters which are opened when the plug's earth pin is pushed into place.

- Content/Topic 4 Types of lamps

A. Types of lamps

The different types of lamps include:

- Incandescent Lamps

- Tungsten Halogen Lamps
- Fluorescent Lamps
- Compact Fluorescent Lamps
- Mercury Vapour Lamps
- High Pressure Sodium Vapour Lamps
- Low Pressure Sodium Vapour Lamps
- LED Lamps

A.1. Incandescent lamp

An **incandescent light bulb**, **incandescent lamp** or **incandescent light globe** is an electric light with a wire filament heated until it glows.

A.2. Tungsten Halogen Lamp

A **halogen lamp**, also known as a **tungsten halogen**, quartz-**halogen** or quartz iodine **lamp**, is an incandescent **lamp** consisting of a **tungsten** filament sealed into a compact transparent envelope that is filled with a mixture of an inert gas and a small amount of a **halogen** such as iodine or bromine.

A.3. Fluorescent Lamp

A fluorescent lamp, or fluorescent tube, is a low-pressure mercury-vapor gas-discharge lamp that uses fluorescence to produce visible light.

A.4. Compact Fluorescent Lamp

A compact fluorescent lamp (CFL), also called compact fluorescent light, energy-saving light and compact fluorescent tube, is a fluorescent lamp designed to replace an incandescent light bulb; some types fit into light fixtures designed for incandescent bulbs.

A.5 Mercury Vapour Lamp

Mercury vapor lamps are bright, long-lasting light sources that are often used to light large areas such as streets, gyms, sports arenas, banks, or stores.

A.6. High Pressure Sodium Vapour Lamp

High pressure sodium lamps are **used in** outdoor **lighting** of streets and parking lots and in indoor settings where color rendering is not critical.

A.7. Low Pressure Sodium Vapour Lamp

A low-pressure sodium-vapour (LPS) lamp contains an inner discharge tube made of borosilicate glass that is fitted with metal electrodes and filled with neon and argon gas and a little metallic sodium.

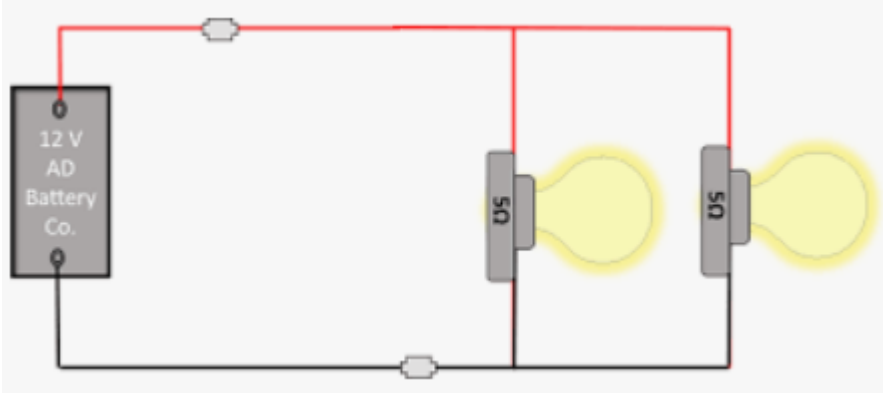
A.8. LED Lamp

An LED lamp or LED light bulb is an electric light for use in light fixtures that produces light using one or more light-emitting diodes (LEDs). LED lamps have a lifespan many times longer than equivalent incandescent lamps, and are significantly more efficient than most fluorescent lamps.

In a parallel circuit, all of the positives are connected together and the negative are connected together, each separately.

In parallel circuits, current adds and voltage stays constant.

If the light bulbs (lamps) are connected in parallel, the current flowing through the light bulbs combine to form the current flowing in the battery, while the voltage drop across each lamp and they all glow.



In a parallel circuit, if a lamp breaks or a component is disconnected from one parallel wire, the components on different branches keep working. Unlike a series circuit, the lamps stay bright if you add more lamps in parallel.

Advantages:

1. Every unit that is connected in a parallel circuit gets equal amount of voltage.
2. It becomes easy to connect or disconnect a new element without affecting the working of other elements.
3. If any fault happened to the circuit, then also the current is able to pass through the circuit through different paths.

Disadvantages:

1. It requires the use of lot of wires.
2. We cannot increase or multiply the voltage in a parallel circuit. 3. Parallel connection fails at the time when it is required to pass exactly same amount of current through the units.

- Content/Topic 5 Different capacity of circuit breaker

A. Circuit breaker

A circuit breaker is an electrical device that opens and closes a circuit by non-automatic means and automatically opens a circuit when a predetermined current overload is reached, without damage to itself.

The standard for most household **circuits** are rated either 15 amps or 20 amps.

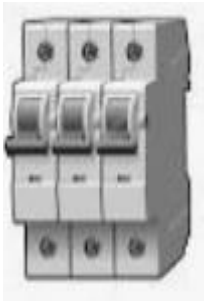
A circuit breaker is required to perform the following three duties:

1. It must be capable of opening the faulty circuit and breaking the fault current.

2. It must be capable of being closed on to a fault.

3. Must be capable of carrying fault current for a short time while another breaker is clearing the fault.

Depending on the above duties circuit breaker has three ratings breaking capacity, making capacity and short time capacity.



A.1. Breaking capacity

It is current that a circuit breaker is capable of breaking at a given recovery voltage under specified conditions.

The breaking capacity is always stated at the r.m.s value of fault current at the instant of contact separation.

A.2. Making capacity

The capacity of a breaker to make current depends up on its ability to withstand and close successfully against the effects of electromagnetic forces.

A.3. Short time rating

It is the period for which the circuit breaker is able to carry fault current while remaining closed.

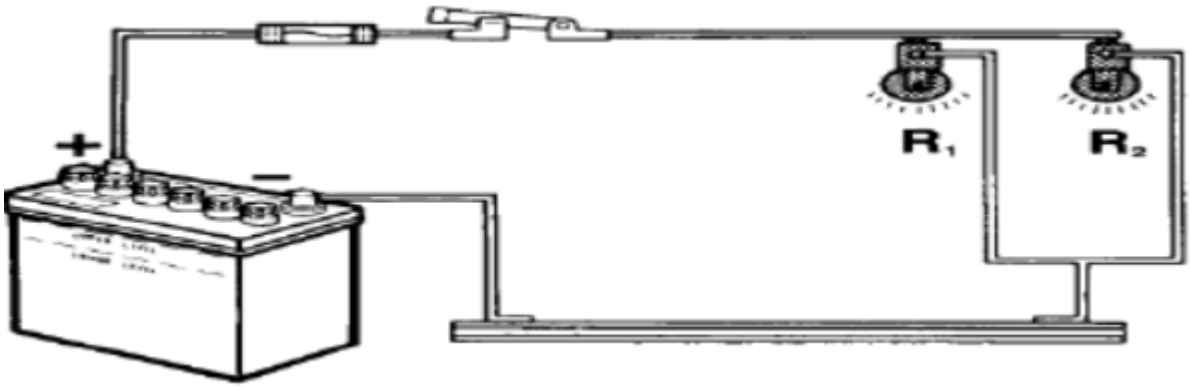
The fault on the system of very temporary nature persists for 1 or 2 sec after which the fault will be cleared, so the breaker should not be tripped in such situations.

It depends on its ability to withstand electromagnetic force effects and temperature rise.

A.4. Parallel-connected resistors

A.4.1.Current is shared

When two components are connected in parallel, the current is shared between the components. The current is shared when it reaches the branches, then adds again where the branches meet.



In a parallel circuit, different components are connected on different branches of the wire. If you follow the circuit diagram from one side of the cell to the other, you can only pass through all the different components if you follow all the branches.

Parallel circuits are useful if you want everything to work, even if one component has failed. This is why our homes are wired up with parallel circuits.

If the lamps were not identical, their resistances would be different and the current flowing through each lamp would not be the same. The greater the resistance of a lamp, the smaller the current that flows through it.

The current would still be shared between them, and it would still add where the branches meet.

LO 2.4 – Work out the series-parallel circuit

- Content/Topic 1 Identification of wires

A. Colour

Cable colours are used to identify different power lines in different countries and different phases within three phase power supplies.

A.1. Green, green with a yellow stripe, or bare copper

These are ground wires that keep you, your appliances, and your home safe from electrical fires. Their purpose is to provide a path for a circuit's electrical current if a device shorts out or trips a breaker.

A.2. Black

Black indicates a hot or live wire that's carrying a current and is used for power in all circuits.

These wires feed an outlet or switch and are often used as switch legs (the connection that runs from the switch to the electrical load).

A.3. Red

This will be your second hot wire when doing a 220-volt installation for large appliances such as a stove, clothes dryer, or air conditioner.

Red can also be the interconnecting electrical wire between two hardwired smoke detectors.

A.4. Blue and Yellow

These two colors are hot wires usually pulled in conduit for common plug-in electrical devices.

A.4.1. Blue

Blue wires are used as travelers, usually on three- or four-way switches (controlling a light from multiple locations) or as switch legs for things such as fans or lights.

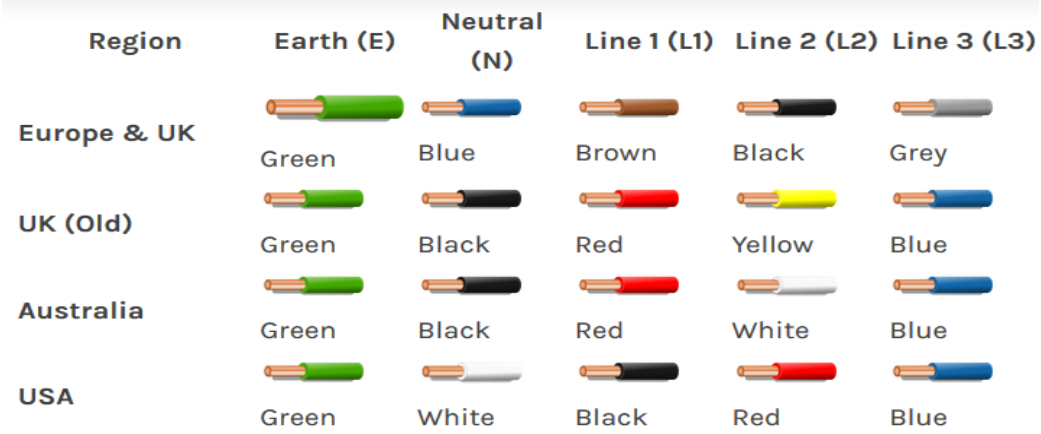
A.4.2. Yellow

Yellow wires are almost always used as switch legs for outlets, fans, or lights.

A.5. White or Gray

White or gray indicates a neutral wire, which provides the return path for the current carried by the hot wires and is grounded within the electrical panel.

Fixed wiring electricity supply requires specific wiring colour regulations to identify different power lines in different countries.



B. Size

The size of the wire refers to the diameter of the conductor itself.

There are two sizing criteria for copper conductors:

The amount of current a cable can carry depends on the cross-sectional area of its conductor. The larger the cross-sectional area, the more current it can take. It is, therefore, important to select the correct size for the job.

Cable size	Maximum current	Type of use
1.5 mm^2	10 A	Lighting circuits
2.5 mm^2	20 A	One or more 13 A for sockets wired as ring final circuit
4 mm^2	25 A	Water heaters
6 mm^2	30 A	Electric showers
10 mm^2	45 A	Large cookers
16 mm^2	60 A	Main supply to a house

C. Types

Types of electric cable by their use.

C.1. Cables for electric panels

Flexible cables for wiring electric cabinets. These electric cables are especially suitable for domestic use, for installation in public places and for internal wiring of electrical cabinets, switch boxes and small electrical appliances.

C.2. Power cables

It is common to find power cables in applications for power transmission in all types of low voltage connections, for industrial use and for variable frequency drive.

C.3. Armoured cables

Cables with aluminium or steel reinforcement for installations with risk of mechanical aggression**.**

C.4. Rubber cables

The use of extra flexible rubber cables is very varied. We can find rubber cables in fixed industrial installations as well as in mobile service**.**

C.5. Halogen-free cables

High Security Halogen Free Cables with low smoke and corrosive gas emission in case of fire are suitable for use in wiring of electrical panels and public places, installations of all kinds in public places, individual derivations, emergency circuits, public distribution networks and also for mobile service.

C.6. Fire resistant cables

These cables are specially **designed** to transmit electrical energy in the extreme conditions that occur during a prolonged fire, guaranteeing supply to emergency equipment such as signalling, smoke extractors, acoustic alarms, water pumps, etc.

C.7. Control cables

Control cables for fixed or mobile installations should be extremely flexible, as they are mainly designed for small household appliances, for the interconnection of machine parts used for manufacturing,

C.8. Instrumentation cables

These are flexible and shielded cables for the **transmission of signals between equipment in industrial installations**.

C.9. Solar cables

These cables are particularly suitable for **connecting photovoltaic panels**, and from the panels to the DC to AC inverter. Thanks to the design of their materials and their cover, which is especially resistant to solar radiation and extreme temperatures, they can be installed outdoors with full guarantees.

C.10. Special cables

There is a wide variety of **electric cables for special installations** such as: temporary light garland installations at trade fairs; connections for overhead cranes, hoists and lifts; applications in submerged pumps and drinking water areas such as aquariums, purification systems, drinking water fountains or in swimming pools for lighting, purification and cleaning systems.

C.11. Aluminium cables

Aluminium cables for power transmission are suitable for fixed installation indoors, outdoors and/or underground.

- Content/Topic 2 Types of switches

A. Switch

A switch is a device which is designed to interrupt the current flow in a circuit, in other words, it can make or break an electrical circuit.

The type of switch used in domestic installations is called a plate switch.

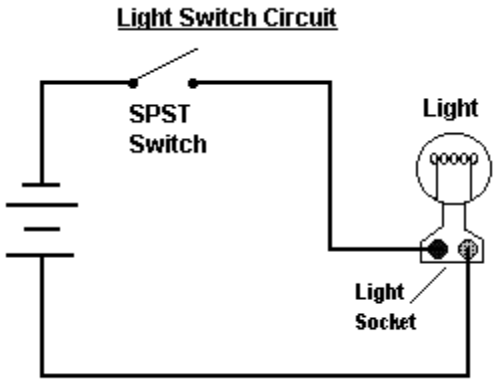
The types of switches are classified into four types namely:

- SPST (Single Pole Single throw)
- SPDT (single pole double throw)
- DPST (double pole, single throw)
- DPDT (double pole double throw)

A.1. SPST (Single Pole Single Throw)

The SPST is a basic ON/OFF switch that is used to connect or break the connection between two terminals. A simple PST switch is shown below:

When the switch is OFF or open, then the current doesn't flow through the two terminals.



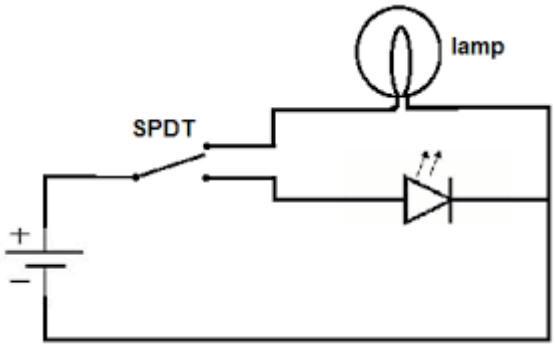
One-way or single-pole electrical switch

A one-way or single-pole electrical switch is the most common one in use. They are used to control lights, fans, or other devices from a single location. It has a simple ON and OFF marking.

A.2. SPDT (Single Pole Double Throw)

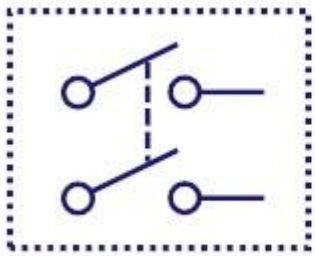
The SPDT switch is a three terminal switch, one terminal is used as input and remaining two terminals are used as outputs. It joins a mutual terminal to one or the other of two terminals.

Her two circuits will be controlled through one source or one way.

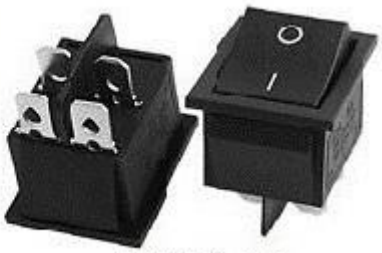


A.3. DPST (Double Pole, Single Throw)

The DPST switch consists of two poles that means it includes two identical switches located on side by side. This switch is operated by one single toggle, which means that two discrete circuits are controlled at a time through one push.



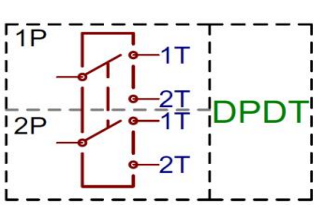
Symbol



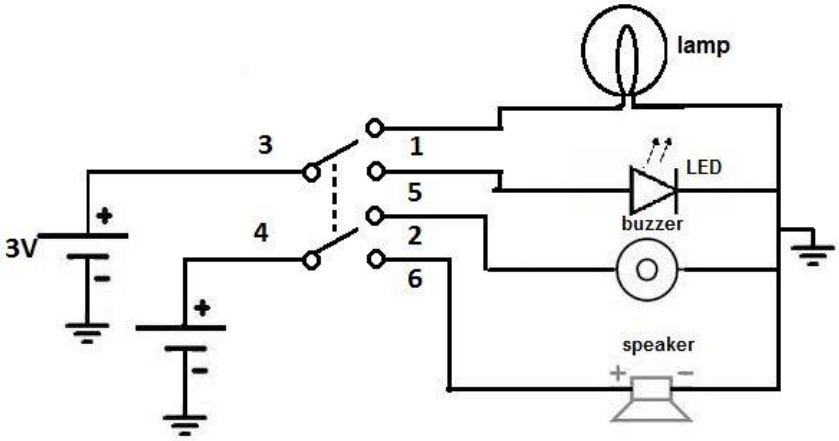
DPST Switch

DPDT (Double Pole Double Throw)

This switch is equal to two SPDT switches, it means two separate circuits, connecting two inputs of each circuit to one of two outputs. The switch position controls the number of ways and from the two contacts each contact can be routed.



When it is in ON-ON mode or ON-OFF-ON mode they work like two discrete SPDT switches worked by the similar actuator. At a time only two loads can be ON. A DPDT switch can be used in any application that needs an open a closed wiring system.



The type of switch used in domestic installations is called a plate switch.

Resistors in series and parallel
In electrical circuit resistors may be connected in series, in parallel, or in various combinations of series and parallel connections.

Surface Switch: The switches are mounted on wooden board, fixed over the surface of the wall. These switches are also known as “Tumbler switches”.
Flush/Piano type switch: The switches are used where good appearance is required. The switches are fixed in flush with the wall and do not project out.These switches are also known as “Piano Type Switches”.
Bed switch: As the name indicates, it is used to switch “ON or OFF” the light from the place, other than switch-board or from near the bed, while going to sleep or getting up. This switch is connected through flexible wire.

Rotary switch: This switch is used to control different lamps from one places one by one or as selector switch, to select different voltage tapping of transformer in voltage stabilizer

Push Button switch: These switches are used to control the electric bell and indicating lamps etc. When the push button is pressed, the circuit is completed and the bell or lamp is switched on. The supply to bell or lamp is switched off as the push button is released.

Pull switch: These switches are operated with a single pull of the cord, for the on and off position. These are also used in bedroom and bathroom. These switches are fixed near the ceiling and hence these are also known as “Ceiling Switches”.

Intermediate switch: This switch has four terminals and four different connection position. The main function of this switch is to control a lamp from three or more different places, along with ordinary two-way switch. Generally this switch is used in double stair case wiring or corridor wiring. This switch is also known as four-way switch.

- Content/Topic 3 Identificaton of sockets

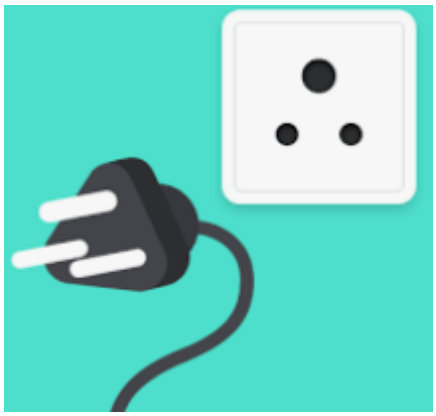
A **socket** is one endpoint of a two-way communication link between two programs running on the network.

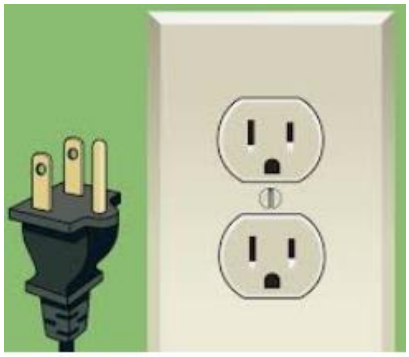
Domestic AC power plugs and sockets are devices that connect the home appliances and portable light fixtures commonly used in homes to the commercial power supply so that AC electric power can flow to them.

Power plugs are male electrical connectors that fit into female electrical sockets. They have contacts that are pins or blades which connect mechanically and electrically to holes or slots in the socket. Plugs usually have a *live* or *hot* contact, a *neutral* contact, and an optional *earth* or *ground* contact. Many plugs make no distinction between the live and neutral contacts, and in some cases they have two live contacts.

Power sockets are female electrical connectors that have slots or holes which accept the pins or blades of power plugs inserted into them and deliver electricity to the plugs. Sockets are usually designed to reject

any plug which is not built to the same electrical standard. Some sockets have one or more pins that connect to holes in the plug.



A socket outlet is the main connection point in most installations. Equipment is connected to the supply by means of a plug which ts into the three slots on the face of the socket. The slots are protected by shutters which are opened when the plug's earth pin is pushed into place.

- Content/Topic 4 Types of lamps

A. Types of lamps

The different types of lamps include:

- Incandescent Lamps
- Tungsten Halogen Lamps
- Fluorescent Lamps
- Compact Fluorescent Lamps
- Mercury Vapour Lamps
- High Pressure Sodium Vapour Lamps
- Low Pressure Sodium Vapour Lamps
- LED Lamps

A.1. Incandescent lamp

An **incandescent light bulb**, **incandescent lamp** or **incandescent light globe** is an electric light with a wire filament heated until it glows.

A.2. Tungsten Halogen Lamp

A **halogen lamp**, also known as a **tungsten halogen**, quartz-**halogen** or quartz iodine **lamp**, is an incandescent **lamp** consisting of a **tungsten** filament sealed into a compact transparent envelope that is filled with a mixture of an inert gas and a small amount of a **halogen** such as iodine or bromine.

A.3. Fluorescent Lamp

A fluorescent lamp, or fluorescent tube, is a low-pressure mercury-vapor gas-discharge lamp that uses fluorescence to produce visible light.

A.4. Compact Fluorescent Lamp

A compact fluorescent lamp (CFL), also called compact fluorescent light, energy-saving light and compact fluorescent tube, is a fluorescent lamp designed to replace an incandescent light bulb; some types fit into light fixtures designed for incandescent bulbs.

A.5 Mercury Vapour Lamp

Mercury vapor lamps are bright, long-lasting light sources that are often used to light large areas such as streets, gyms, sports arenas, banks, or stores.

A.6. High Pressure Sodium Vapour Lamp

High pressure sodium lamps are **used in** outdoor **lighting** of streets and parking lots and in indoor settings where color rendering is not critical.

A.7. Low Pressure Sodium Vapour Lamp

A low-pressure sodium-vapour (LPS) lamp contains an inner discharge tube made of borosilicate glass that is fitted with metal electrodes and filled with neon and argon gas and a little metallic sodium.

A.8. LED Lamp

An LED lamp or LED light bulb is an electric light for use in light fixtures that produces light using one or more light-emitting diodes (LEDs). LED lamps have a lifespan many times longer than equivalent incandescent lamps, and are significantly more efficient than most fluorescent lamps.

- Content/Topic 5 Different capacity of circuit breaker

A. Circuit breaker

A circuit breaker is an electrical device that opens and closes a circuit by non-automatic means and automatically opens a circuit when a predetermined current overload is reached, without damage to itself.

The standard for most household **circuits** are rated either 15 amps or 20 amps.

A circuit breaker is required to perform the following three duties:

1. It must be capable of opening the faulty circuit and breaking the fault current.

2. It must be capable of being closed on to a fault.

3. Must be capable of carrying fault current for a short time while another breaker is clearing the fault.

Depending on the above duties circuit breaker has three ratings breaking capacity, making capacity and short time capacity.

A.1. Breaking capacity

It is current that a circuit breaker is capable of breaking at a given recovery voltage under specified conditions.

The breaking capacity is always stated at the r.m.s value of fault current at the instant of contact separation.

A.2. Making capacity

The capacity of a breaker to make current depends up on its ability to withstand and close successfully against the effects of electromagnetic forces.

A.3. Short time rating

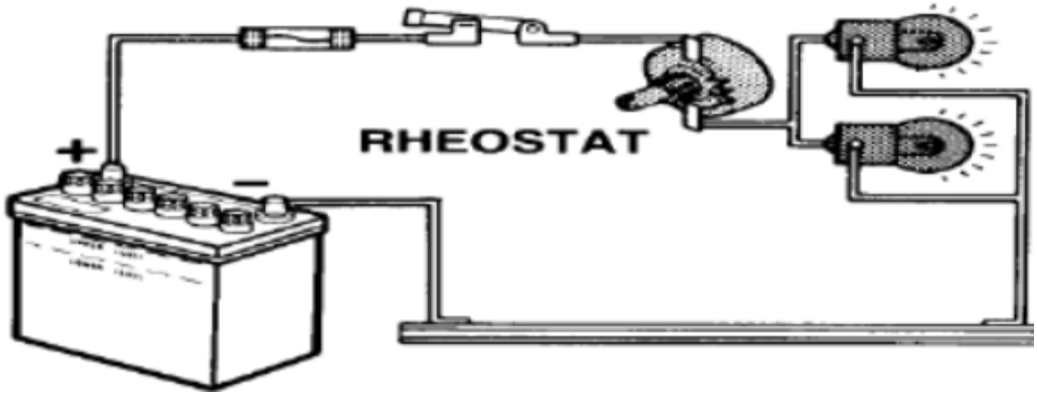
It is the period for which the circuit breaker is able to carry fault current while remaining closed.

The fault on the system of very temporary nature persists for 1 or 2 sec after which the fault will be cleared, so the breaker should not be tripped in such situations.

It depends on its ability to withstand electromagnetic force effects and temperature rise.

A.4. Series-Parallel-connected resistors

However, if circuit components are series-connected in some parts and parallel in others, we won't be able to apply a *single* set of rules to every part of that circuit. Instead, we will have to identify which parts of that circuit are series and which parts are parallel, then selectively apply series and parallel rules as necessary to determine what is happening.



In a series circuit, the output current of the first lamp flows into the input of the second lamp; therefore, the current is the same in each lamp. In a parallel circuit, all of the resistor leads on one side of the lamps are connected together and all the leads on the other side are connected together.

Learning Unit 3 – Perform measuring of circuits

LO 3.1 – Use of different testing instruments

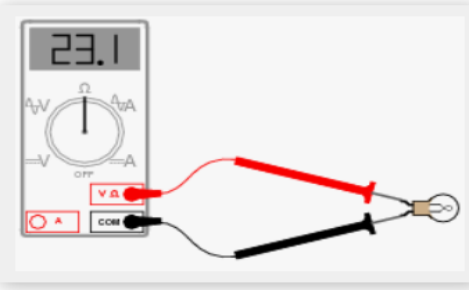
- Content/Topic 1 Identification of electrical instruments

A. Ohmmeter

An **ohmmeter** is an electrical instrument that measures electrical resistance (the opposition offered by a substance to the flow of electric current).

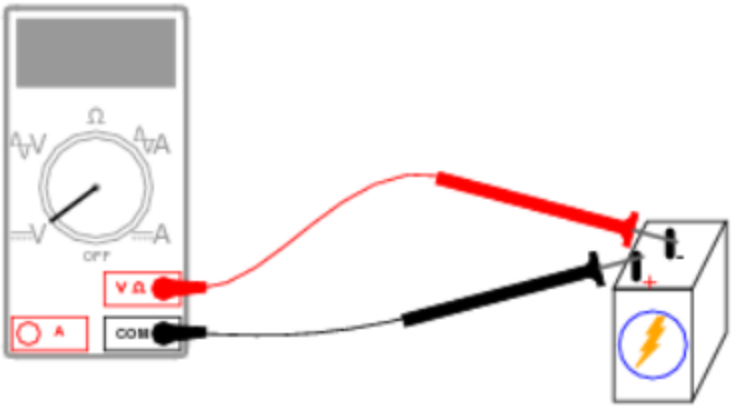
Set your **multimeter** to the highest resistance range available. The resistance function is usually denoted by the unit symbol for resistance: the Greek letter omega (Ω), or sometimes by the word "ohms." Touch the two test probes of your meter together. When you do, the meter should register 0 ohms of resistance.

In the simplest ohmmeters, the resistance to be measured may be connected to the instrument in parallel or in series. If in parallel (parallel ohmmeter), the instrument will draw more current as resistance increases. If in series (series ohmmeter), current will decrease as resistance rises.



B. Voltmeter

A **voltmeter** is an instrument used for measuring electric potential difference between two points in an electric circuit.
The main principle of **voltmeter** is that it must be connected in parallel in which we want to measure the voltage. Parallel connection is used because a **voltmeter** is constructed in such a way that it has a very high value of resistance.
The **voltmeter** is **connected** in parallel with the **circuit** to be measured. We do not want the **voltmeter** to load the **circuit**. Consequently an ideal **voltmeter** will have infinite resistance.



C. Wattmeter

The wattmeter is an instrument for measuring the electric power (or the supply rate of electrical energy) in watts of any given circuit. Electromagnetic wattmeters are used for measurement of utility frequency and audio frequency power; other types are required for radio frequency measurements.

D. Ammeter

An ammeter (from ampere meter) is a measuring instrument used to measure the current in a circuit. Electric currents are measured in amperes (A), hence the name. Instruments used to measure smaller currents, in the milliampere or microampere range, are designated as milliammeters or microammeters.

Connect a simple circuit so that the current will flow through the ammeter. Connect the positive probe of the ammeter to the positive terminal of the power supply. Connect the negative probe of the ammeter to one end of a resistor.

- Content/Topic 2 Different connections of electrical instruments

A. Range selection

A.1. Ohmmeter

It always takes the same amount of current to deflect the pointer to a certain position on the scale (midscale position for example), regardless of the multiplication factor being used. Since the multiplier resistors are of different values, it is necessary to **ALWAYS** "zero" adjust the meter for each multiplication fact or selected.

You should select the multiplication factor (range) that will result in the pointer coming to rest as near as possible to the midpoint of the scale. This enables you to read the resistance more accurately, because the scale readings are more easily interpreted at or near midpoint.

A.2. Voltmeter

The range of voltmeter can be increased by connecting a suitable high resistors in series with it. 2. The range of a voltmeter can decreased by reducing its resistace. This can be done by putting a suitable resistance in parallel with the voltmeter.

It is possible to increase or decrease the range of voltmeter.
1. The range of voltmeter can be increased by connecting a suitable high resistors in series with it.
2. The range of a voltmeter can decreased by reducing its resistace. This can be done by putting a suitable resistance in parallel with the voltmeter.

A.3. Wattmeter

A typical wattmeter in educational labs has two voltage coils (pressure coils) and a current coil. The two pressure coils can be connected in series or parallel to change the ranges of the wattmeter. The pressure coil can also be tapped to change the meter's range. If the pressure coil has range of 300 volts, the half of it can be used so that the range becomes 150 volts.

A.4. Ammeter

Part of the correct use of an ammeter is the proper use of the range selection switch. If the current to be measured is larger than the scale of the meter selected, the meter movement will have excessive current and will be damaged.

When you use an ammeter, certain precautions must be observed to prevent injury to yourself or others and to prevent damage to the ammeter or the equipment on which you are working. The following list contains the MINIMUM precautions to observe when using an ammeter.

- Ammeters must always be connected in series with the circuit under test.
- Always start with the highest range of an ammeter.
- Deenergize and discharge the circuit completely before you connect or disconnect the ammeter.

- In dc ammeters, observe the proper circuit polarity to prevent the meter from being damaged.
- Never use a dc ammeter to measure ac.
- Observe the general safety precautions of electrical and electronic devices.

B. Series

B.1. Ohmmeter

In the simplest ohmmeters, the resistance to be measured may be connected to the instrument in parallel or in series. If in series (series ohmmeter), current will decrease as resistance rises.

B.2. Ammeter

An ammeter is connected in **series** with a **device** to measure its current.

C. Parallel

C.1. Ohmmeter

In the simplest ohmmeters, the resistance to be measured may be connected to the instrument in parallel or in series. If in parallel (parallel ohmmeter), the instrument will draw more current as resistance increases.

C.2. Voltmeter

A voltmeter is connected in parallel with a **device** to measure its voltage.
The main principle of **voltmeter** is that it must be connected in parallel in which we want to measure the voltage. Parallel connection is used because a **voltmeter** is constructed in such a way that it has a very high value of resistance.

LO 3.2 – Read and interpret measuring results

- Content/Topic 1 Data interpretation

Electrical measurements are the methods, devices and calculations used to measure electrical quantities. Measurement of electrical quantities may be done to measure electrical parameters of a system.

The standard units of electrical measurement used for the expression of voltage, current and resistance are the Volt [V], Ampere [A] and Ohm [Ω] respectively.

These electrical units of measurement are based on the International (metric) System, also known as the SI System with other commonly used electrical units being derived from SI base units.

Sometimes in electrical or electronic circuits and systems it is necessary to use multiples or sub-multiples (fractions) of these standard electrical measuring units when the quantities being measured are very large or very small.

The following table gives a list of some of the standard electrical units of measure used in electrical formulas and component values.

Standard Electrical Units of Measure

Measuring instrument	**Electrical Parameter**	**Measuring Unit**	**Symbol**	**Description**
Ohmmeter	Resistance	Ohn	Ω	Unit of DC Resistance R = V ÷ I
Voltmeter	Voltage	Volt	V or E	Unit of Electrical Potential V = I × R
Wattmeter	Power	Watt	W	Unit of Power P = V × I or $I^2 \times R$
Ammeter	Current	Ampere	A	Unit of Electrical Current I = V ÷ R

Examples:

1) A current of 5A flows in the winding of an electric motor, the resistance of the winding being 100 . Determine (a) the p.d. across the winding, and (b) the power dissipated by the coil.

Solution

a) Potential difference across winding,
V = IR = 5 × 100 = **500 V**

b) Power dissipated by coil,
P = I2R = 52 × 100
= **2500 W** or **2.5 kW**

2) A 10 watt resistor has a value of 120 Ω. What is the rated current through the resistor ?
Solution

Rated power,

$$P = I^2R$$

$$I = \sqrt{\frac{P}{R}} = \sqrt{\frac{10}{120}}$$

= **0.2887 A**

3) A 100 V lamp has a hot resistance of 250 Ω. Find the current taken by the lamp and its power rating in watts. Calculate also the energy it will consume in 24 hours.

Solution

Current taken by lamp, I = V/R = 100/250 = **0.4 A**
Power rating of lamp, P = VI = 100 × 0.4 = **40 W**
Energy consumption in 24 hrs. = Power × time = 40 × 24 = **960 watt-hours**

4) An electric kettle has a resistance of 30 . What current will flow when it is connected to a 240V supply? Find also the power rating of the kettle.

Solution

Current, I = V/ R = 240/30= **8 A**
Power, P = VI = 240 × 8 = 1920 W
= **1.92 kW** = power rating of kettle

LO 3.3 – Test the electrical circuits

- Content/Topic 1 Test by using:

A. Multimeter

A multimeter or a multitester, also known as a VOM (volt-ohm-milliammeter), is an electronic measuring instrument that combines several measurement functions in one unit. A typical multimeter can measure voltage, current, and resistance.

Analog multimeters use a microammeter with a moving pointer to display readings.

A digital multimeter or DMM is a useful test instrument for measuring voltage, current and resistance, and some meters have a facility for testing transistors and capacitors.

Step 1: Testing continuity

 A continuity test tells us whether two things are electrically connected: if something is ***continuous***, an electric current can flow freely from one end to the other.

 If there's no continuity, it means there is a break somewhere in the circuit. This could indicate anything from a blown fuse or bad solder joint to an incorrectly wired circuit

Step 2:

 Plug the black probe into the **COM** port on your multimeter.

 Plug the red probe into the **V Ω mA** port

Step 3:

Switch on your multimeter, and set the dial to continuity mode (indicated by an icon that looks like a sound wave).

Step 4:

 The multimeter tests continuity by sending a little current through one probe, and checking whether the other probe receives it.

 If the probes are connected—either by a continuous circuit, or by touching each other directly—the test current flows through. The screen displays a value of zero (or near zero), and the multimeter **beeps**. Continuity!

 If the test current isn't detected, it means there's no continuity. The screen will display 1 or OL (open loop)

Step 5:

- To complete your continuity test, place one probe at each end of the circuit or component you want to test.
- As before, if your circuit is continuous, the screen displays a value of zero (or near zero), and the multimeter **beeps**.
- If the screen displays 1 or OL (open loop), there's no continuity—that is, there's no path for electric current to flow from one probe to the other.

Step 6:

- If your multimeter doesn't have a dedicated continuity test mode, you can still perform a continuity test.
- Turn the dial to the lowest setting in the resistance mode.

Step 7:

- In this mode, the multimeter sends a little current through one probe, and measures what (if anything) is received by the other probe.
  - If the probes are connected—either by a continuous circuit, or by touching each other directly—the test current flows through. The screen displays a value of zero (or near zero—in this case, 0.8). Very low resistance is another way of saying that we have continuity.
  - If no current is detected, it means there's no continuity. The screen will display 1 or OL (open loop)


Step: 8

- To complete your continuity test, place one probe at each end of the circuit or component you want to test.
- As before, if your circuit is continuous, the screen displays a value of zero (or near zero).
- If the screen displays 1 or OL (open loop), there's no continuity—that is, there's no path for electric current to flow from one probe to the other.

Step 9: Testing Voltage

- Plug the black probe into the **COM** port on your multimeter.
- Plug the red probe into the **VΩmA** port.


Step 10:

- Switch on your multimeter, and set the dial to DC voltage mode (indicated by a V with a straight line, or the symbol ⎓).
- Most multimeters are not autoranging, meaning you will need to set the correct range for the voltage you expect to measure.
  - Each setting on the dial lists the maximum voltage it can measure. So for example, if you expect to measure more than 2 volts but less than 20, use the 20 volt setting.
  - If you're not sure, start with the highest setting.


Step 11:

- Place the red probe on the positive terminal, and the black probe on the negative terminal.
  - If your range was set too high, you may not get a very accurate reading. Here the multimeter reads 9 volts. That's fine, but we can turn the dial to a lower range to get a better reading.
  - If you set the range too low, the multimeter simply reads 1 or OL, indicating that it is overloaded or out of range. This won't hurt the multimeter, but we need to set the dial to a higher range.


Step 12: Testing Resistance

- To begin, make sure no current is running through the circuit or component you want to test. Switch it off, unplug it from the wall, and remove any batteries.
  - Remember that you'll be testing the resistance of the entire circuit. If you want to test an individual component such as a resistor, test it by itself—not with it soldered in place!
- Plug the black probe into the **COM** port on your multimeter.
- Plug the red probe into the **VΩmA** port.


Step 13:

- Switch on your multimeter, and set the dial to resistance mode.
  Resistance is measured in ohms, indicated by the **Ω** symbol.
- Most multimeters are not autoranging, meaning you will need to set the correct range for the resistance you expect to measure. If you're not sure, start with the highest setting.


Step 14:

- Place one probe at each end of the circuit or component you want to test.

- If your multimeter reads close to zero, the range is set too high for a good measurement. Turn the dial to a lower setting.
- If you set the range too low, the multimeter simply reads 1 or OL, indicating that it is overloaded or out of range. This won't hurt the multimeter, but we need to set the dial to a higher range.
  - The other possibility is that the circuit or component you are testing doesn't have continuity—that is, it has infinite resistance. A non continuous circuit will always read 1 or OL on a resistance test.
  - With the multimeter set to a usable range, we get a reading.

B. Lamp tester

A test light, test lamp, voltage tester, or mains tester is a piece of electronic test equipment used to determine the presence of electricity in a piece of equipment under test.

A test light is simpler and less costly than a measuring instrument such as a multimeter, and often suffices for checking for the presence of voltage on a conductor.

Properly designed test lights include features to protect the user from accidental electric shock. Non-contact test lights can detect voltage on insulated conductors.

The test light is an electric lamp connected with one or two insulated wire.



B.1. Making sure your tester works

Always check to see if the tester is working properly before using it to check for voltage. The easiest way is to go to an outlet on a circuit that you know is live (has power). Insert the tester leads or sensor into the outlet slots. If the tester lights up, it's working fine. If it fails to light up, the tester is bad or needs new batteries.

B.2. How to test outlets for power

A typical outlet receptacle has three holes in its face. The shorter straight slot is the “hot” lead and connects to the active hot wire in the outlet box. The longer straight slot is the “neutral” lead and connects to the neutral circuit wire in the electrical box. The slot that looks like a small D-shaped hole is the ground slot, and it is connected to the circuit ground wire.

To test an outlet for power, turn off the power to the circuit at the circuit breaker. Insert the two probes of the tester into the two straight vertical slots on the receptacle. If the power is on, the tester will light. Because there is a possibility that the outlet is "split-wired"—with the top and bottom halves of the

outlet fed by different circuits—always check both halves for power before removing the receptacle to work on it.

You can also test to see if the ground system is properly connected to the receptacle. To test the ground, make sure the power to the circuit it on. Insert one tester probe into the hot (short, straight) slot and the other in the ground (D-shaped) slot. If the circuit is working and you have a good ground connection, the tester will light.

B.3. Testing wall switches

To test a switch for power, turn off the power to the circuit at the circuit breaker. Remove the switch's cover plate and flip the switch's toggle so the switch is *on.* Carefully touch one probe of the tester to one of the screws on the side of the switch. Touch the other probe to the bare copper ground wire or the ground screw on the switch (you can also touch this probe to the electrical box if it is metal, but this test works only if the metal box is properly grounded; plastic boxes are not grounded). Next, touch one probe to the other screw terminal on the switch and touch the other probe to the ground wire or screw. Flip the switch's toggle to *off* and repeat the same tests. If the tester does not light for either test, the switch is not getting power.

B.4. Testing light fixtures for power

When checking light fixture wiring for power, turn off the power to the circuit at the circuit breaker, then loosen the mounting straps holding the fixture to the ceiling box and pull the light fixture slightly away from the ceiling box for testing. Always test twice—with the fixture's wall switch *on* and with it *off*—because the fixture may get power in either position.

To test for power with a non-contact voltage tester, touch the sensor tip of the tester to each of the circuit wires. If the tester lights up when touching any of the wires, the circuit still has power.

To test a fixture for power using a probe-type tester, you need access to the fixture's screw terminals or, if the fixture has wire leads, to the ends of the wire leads. Touch one tester probe to the hot (black or red wire) screw terminal, and touch the other probe to the neutral (white wire) terminal. If the tester lights up, the fixture still has power.

Neon screwdriver test light in use. Current flows through a high ohm resistor and the lamp and the distributed capacitance and resistance of the user's body.

Neon-lamp type tester, which has no amplifier; this type requires a direct metallic contact to the circuit to be tested.

Learning Unit 4 – **Handover the work**

LO 4.1 – Clean the workplace

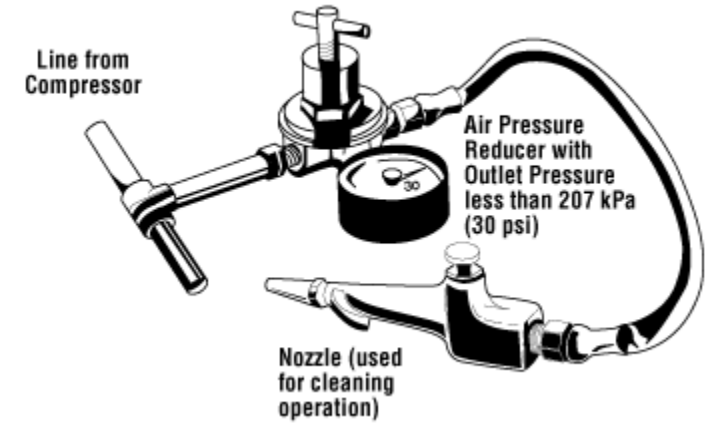
- Content/Topic 1 Methods of clean

A. Air pressure

The **air** around you has weight, and it presses against everything it touches. That **pressure** is called **atmospheric pressure**, or **air pressure**. It is the force exerted on a surface by the **air** above it as gravity pulls it to Earth.

If **you** want your computer to last as long as possible, keep it **clean**. Using **compressed air** is the best solution to remove any kind of dirt from keyboards and computers. Before **you** start **cleaning** your computer, turn it off and unplug it to remove it from the power source.

- **Cleaning with compressed air is dangerous.**
- Do not use compressed air for cleaning unless no alternate method of cleaning is available. The nozzle pressure **MUST** remain below 207 kPa (30 psi). Personal protective equipment and effective chip guarding techniques must be used.
- Two acceptable methods of meeting the "below 207 kPa (30 psi)" requirement are illustrated below.



B. Cleaning with cloth rugs

Wash colorfast **rugs** by hand with a mild detergent, using a soft brush or a sponge. Rinse thoroughly with water mixed with a small amount of white vinegar to remove residue. Roll it inside a thick **towel**, then stand on it to remove as much moisture as you can.

1. Gather your tools and supplies

Here's exactly what you'll need to have on hand to complete a successful area rug cleaning:

- Rug shampoo (or mild dish soap)
- Bucket
- Soft-bristle brush or sponge
- Water

Optional:

- Rubber gloves
- Garden hose
- Wet-dry vacuum

2. Remove dirt and debris

Thoroughly vacuum on the rug on *both* sides. You want to make sure every last bit of debris is gone. If you have pets, use the brush attachment to get any lingering stray hairs.

3. Mix your cleaner

When it comes to the actual cleaning solution, you can use a rug shampoo like this one from Bissell. Whatever shampoo you choose, follow its specific directions (found on the bottle) for mixing.

Alternatively, you can also use mild dish detergent mixed in a bucket with warm water. Do not use hot water as it can shrink the rug or cause fading.

4. Wash the Rug

Using a sponge or soft-bristle brush, work the cleaning solution into a lather on the rug. Let the cleaner sit on the rug for a five minutes before you start rinsing. Anything less than that and you'll shortchange the cleaning process. Give it those five minutes to set in and start lifting away dirt.

5. Rinse the Rug

Rinse the soap out of the rug using a garden hose or buckets of clean water. Make sure all the cleaning solution is completely removed from the area rug and the runoff water is crystal clear.

7. Remove Excess Water

At this point, you'll want to get rid of as much excess water in the rug as you can so it will dry faster. You can use a wet-dry vacuum if you have one, or use a squeegee in the direction of the nap.

8. Let the rug dry

The next-to-last step to clean an area rug is simply letting it dry. Lay the rug flat and allow the top of the rug to dry completely. Then, flip it over to let the bottom side dry. Fans can help speed up the process. Make sure the rug is fully dry before you return it to the room.

9. Vacuum or brush out the rug

During the cleaning process, threads and fibers can get compacted and squished. Revive them by running a vacuum over the now-dry rug, or brush them with a soft-bristled brush. *Now* you're finished, and can enjoy your freshly cleaned carpet. You know how to clean an area rug yourself, and you can complete the job whenever you like.

C. Soap

Wash (soap and scrub)

Use the right detergent in the right concentration with the right level of mechanical action in the right water temperature for the right contact time.

LO 4.2 – Clean and store tools and equipment

- Content/Topic 1 Rearrange

A. Arrangement of tools and equipment

All tools and equipment must be properly maintained so that workers are not endangered.

Preventive maintenance is the systematic care and protection of tools, equipment and machines in order to keep them in a safe, usable condition that limits downtime and extends productivity.

We must always be aware that maintenance tasks themselves are potentially hazardous and can result in injury.

The successful maintenance program is:

- Well organized and scheduled
- Controls hazards
- Defines operational procedures
- Trains key personnel

Clean, Inspect and Care for Tools. Make it a habit to clean tools after each use before you return them to storage.

Wipe them down with a rag or old towel and be sure they are free of dust, grease and debris before you put them into their proper places.

This is also an opportunity to look for any damage or defects.

Step 1:

Delegate a portion of your garage, shed or basement closet as a place to store tools. Clean out the junk and clutter and make a space only for tools. Figure out how much space is needed for the amount of tools you have. Sweep away cobwebs, dirt and other foreign matter. Get a shelving unit and store chemicals, liquids and paint substances out of the reach of children and pets.

Step 2

Find the parts. Locate cords, bits, nails and screws and organize them. Allocate plastic bins to store smaller household tools. If you have a large tool collection, organize by type for easy location. Keep the parts for each specific tool close by.

Step 3

Clean out dirt and debris from tools. Oil power tools to lubricate moving parts. Repair loose handles and clean out oil or other fluids used to power the tool. Sharpen blades and replace worn out parts.

Step 4

Set up racks. Mount commercially available racks along the wall of your garage or storage area to hang garden tools, cords and other equipment. Screw racks into the wall with screws recommended by the

manufacturer and a power drill. Wind long cords in a loop and hang from rack. Place tools on racks by the handle. Draw the outline of the tool with a permanent marker to identify its place, or use labels to mark the location.



- Content/Topic 2 Remove the remains, metal chips and dust from the working place

Work Practice Controls

Work practices involve the way a task is performed. OSHA has found that appropriate work practices can be a vital aid in lowering worker exposures to hazardous substances and in achieving compliance with the PEL. Some fundamental and easily implemented work practices are:

- Good housekeeping,
- Use of appropriate personal hygiene practices,
- Periodic inspection and maintenance of process and control equipment,
- Use of proper procedures to perform a task, (5) provision of supervision to ensure that the proper procedures are followed.

Proper cleaning and maintenance begins with employee training and supervision and should be considered a significant part of the facility's overall hygiene and sanitation plan.

The cleaning regime of different tools is influenced by their purpose or use. Different cleaning routines should be established for food contact and non-food contact tools. For example, a broom used in a low-risk environment probably won't be cleaned after every use. However, a tank brush that's used for cleaning the interior of a batch tank should be cleaned and sanitized before and after each use. To avoid cross-contamination, tools used on food contact surfaces must be easily identifiable and kept separate from those used on non-food contact surfaces. Color coding is often a simple solution for achieving this level of intended segregation.

Housekeeping

A rigorous housekeeping program is necessary in many jobs to keep airborne lead levels at or below permissible exposure limits.

Good housekeeping involves a regular schedule of housekeeping activities to remove accumulations of lead dust and lead-containing debris. The schedule should be adapted to exposure conditions at a particular worksite.

All workplace surfaces must be maintained as free as practicable of accumulations of lead dust. Lead dust on overhead ledges, equipment, floors, and other surfaces must be removed to prevent traffic, vibration, or random air currents from re-entraining the lead-laden dust and making it airborne again. Regularly scheduled clean-ups are important because they minimize the re-entrainment of lead dust into the air, which otherwise serves as an additional source of exposure that engineering controls are generally not designed to control.

Vacuuming is considered the most reliable method of cleaning dusty surfaces, but any effective method that minimizes the likelihood of re-entrainment may be used (for example, a wet floor scrubber). When vacuuming equipment is used, the vacuums must be equipped with high-efficiency particulate air (HEPA) filters. Blowing with compressed air is generally prohibited as a cleaning method, unless the compressed air is used in conjunction with a ventilation system that is designed to capture the airborne dust created by the compressed air (e.g. dust "blowdown" inside a negative-pressure containment structure). In addition, all persons doing the cleanup should be provided with suitable respiratory protection and personal protective clothing to prevent contact with lead.

Where feasible, lead-containing debris and contaminated items accumulated for disposal should be wet-misted before handling. Such materials must be collected and put into sealed impermeable bags or other closed impermeable containers. Bags and containers must be labeled to indicate that they contain lead-containing waste

LO 4.3 – Prepare a report

- Content/Topic 1 Writing the correct report

Make the report to the work done

Report writing is important in all areas of work and the language and layout of a report is important to ensure that the information is accurate and easily understood.

Both a report of an event and a work report will have the following layout

- Heading
- Introduction

  The **introduction** sets out what you plan to say and provides a brief summary of the problem under discussion. It should also touch briefly on your conclusions

- Main part

The **main body of the report** should be carefully structured in a way that leads the reader through the issue. You should split it into sections using numbered sub-headings relating to themes or areas for consideration. For each theme, you should aim to set out clearly and concisely the main issue under discussion and any areas of difficulty or disagreement. It may also include experimental results. All the information that you present should be related back to the brief and the precise subject under discussion.

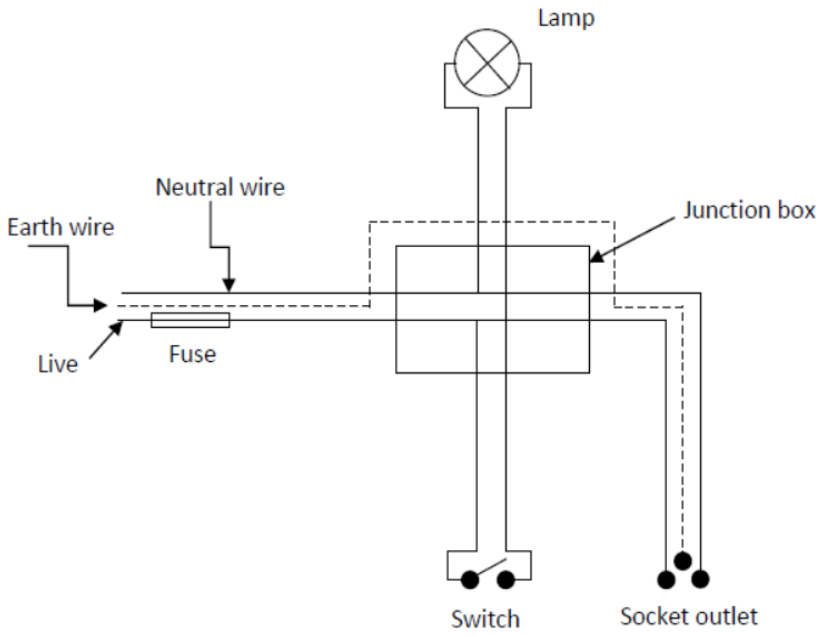
- Conclusion

The **conclusion** sets out what inferences you draw from the information, including any experimental results. It may include recommendations, or these may be included in a separate section.

A. Usable materials

- Lamps
- Wires or conductors
- Clip connecters
- Scotch
- Fastener
- Fixing
- Circuit breaker and fuse
- Lamps and socket outlets
- Sockets
- Switches
- connection boxes

A.2. Installation layout



B. Remain materials

Material remains mean physical evidence of human habitation, occupation, use, or activity, including the site, location, or context in which such evidence is situated.