8 Electricity

SYLLABUS

1. (a) Sources of electricity – cell/battery/mains.
   (b) Effects of electricity – provides heat, light, movement, can make electromagnets, electroplating.
2. Simple electric circuits – electricity can flow only in a complete circuit starting at one terminal and ending at the other – conductors and insulators – the entire circuit must be made up of conductors – switches.
3. Circuit diagrams – using symbols for a cell, a bulb, a switch, etc. (Note : arrow in direction of conventional current).
4. Electricity at home – meters determine consumption and we have to pay for it – fuses/miniature circuit breakers protect the house from electrical fires by breaking a circuit – parallel circuits allow us to use different parts of the household separately (to be explained with a model/simple circuit diagram).
5. Construction of a simple dry cell – simple cross-section drawing of the same – other types of cells which are commonly available (no construction details required).
6. Simple rules for the safe use of electricity at home.
7. Need to conserve electricity.

Caution : Warn students never to conduct any experiments using mains supply. For their experiments, they only need a fresh dry cell, insulation tape, wires and a variety of insulators and conductors.

- A simple improvised circuit with a switch and a torch bulb – to be used for checking the conditions under which electricity will flow (see 2 above) and also finding out about conductors and insulators (E).
- Locating the meters in a building, watching them at work – learning to read an electric meter (E).
- Looking at fuses/MCBs; parallel circuit – set-up on a board (D).
- Survey of electrical usage in their houses – for a set period of time daily – listing examples of wastage and identifying possibilities for conservation (E).

IMPORTANCE OF ELECTRICITY

We are well familiar with the word **"Electricity"**. We cannot think of modern life without electricity. It is one of the most useful form of energy available to us. Electricity is brought to our homes, offices, factories and other places with the help of wires from electric power plants. It is used in different ways. We light our homes and other places of work with electricity. It is used to run electric fans, televisions, geysers, electric irons, room heaters, refrigerators, music systems, etc. We use electricity on a large scale to light up streets, to run machines in factories, to run trains, metro rails, etc. Some of the common electrical appliances which we use in our day-to-day life are shown in Fig. 8.1.

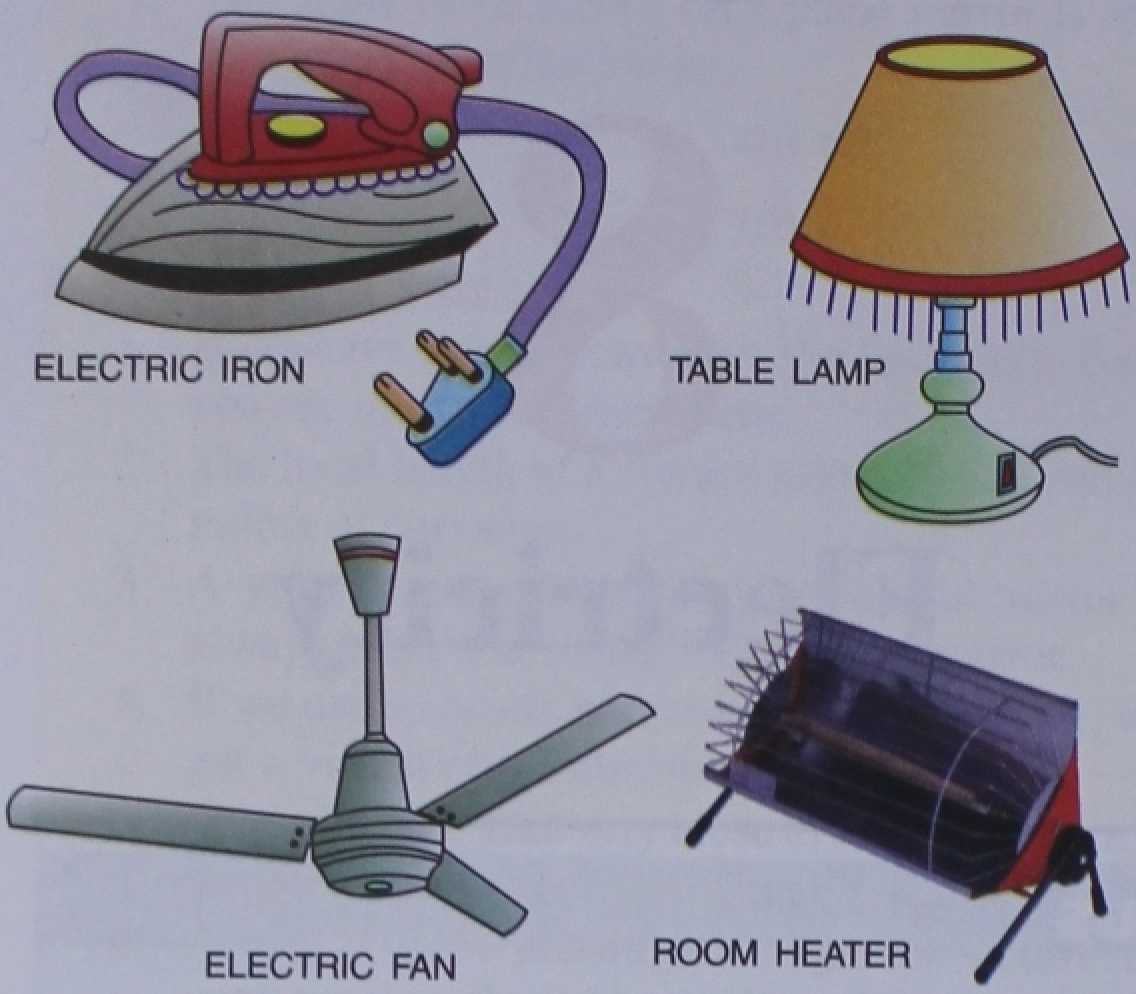


Fig. 8.1 Common electrical appliances

ELECTRICITY — AN INTRODUCTION

We often observe that when two different types of substances are rubbed together, the free electrons of one substance gets transferred to the other substance. The substance that loses electrons becomes positively charged (anode) and the one which gains electrons becomes negatively charged (cathode). In this way, both the substances become oppositely charged.

Example : Rub a glass rod with a piece of silk. The glass rod loses electrons and becomes positively charged whereas the piece of silk gains electrons and becomes negatively charged.

If both these substances are connected with the help of a metal wire an electric current flows from the glass rod to the silk, in other words, free electrons flow from the silk to the glass rod.

> The rate of flow of free electrons through a conductor is known as electric current.

You know that every atom contains one or more electrons. You also know that electrons have a negative charge. Most substances have electrons that can be detached from their atoms and they can move around freely. These loosely bound electrons are called **free electrons**. When these free electrons are forced to flow in a particular direction under certain conditions, they constitute an **electric current.**

ELECTRICITY GENERATION

There are *three* types of power plants which are used for generating electricity on a large scale.

1. Hydroelectric power plants (or hydel power plants) — Hydroelectric power plants use kinetic energy of the moving water.
2. Thermal power plants —These are based on coal, diesel or natural gas.
3. Atomic power plants — These are based on the nuclear fission of Uranium-235.

The electric currents supplied to our homes by the electricity supply companies are alternating currents (AC).

Do You Know ?

Electricity is only a means of transferring energy and not a source of energy. Hence, it is a secondary source, the primary sources being water, air, oil, coal, gas, etc.

SOURCES OF ELECTRICITY

The main sources from where we get **electricity** are : (i) the dry cell and battery, (ii) the mains provided by the electricity department, (iii) the electric generator, and (iv) a solar cell.

CONSTRUCTION AND WORKING OF A DRY CELL

In a cell, a chemical reaction takes place, due to which chemical energy changes into electrical energy. Thus, the cell becomes a source of electricity. The most commonly used cell is a **dry cell**. This cell cannot be recharged. It is also called a primary cell.

A dry cell essentially consists of a zinc container, its base acting as the negative electrode. It has a carbon rod placed at the centre with a brass cap. The carbon rod acts as the positive electrode and is surrounded by a mixture of manganese dioxide (MnO_2) and charcoal (C) in a muslin bag. The electrolyte used is a moist paste of ammonium chloride (NH_4Cl), plaster of Paris, flour, etc. The outer body (except for the base) of a zinc container is insulated with a thick cardboard or plastic material (Fig. 8.2).

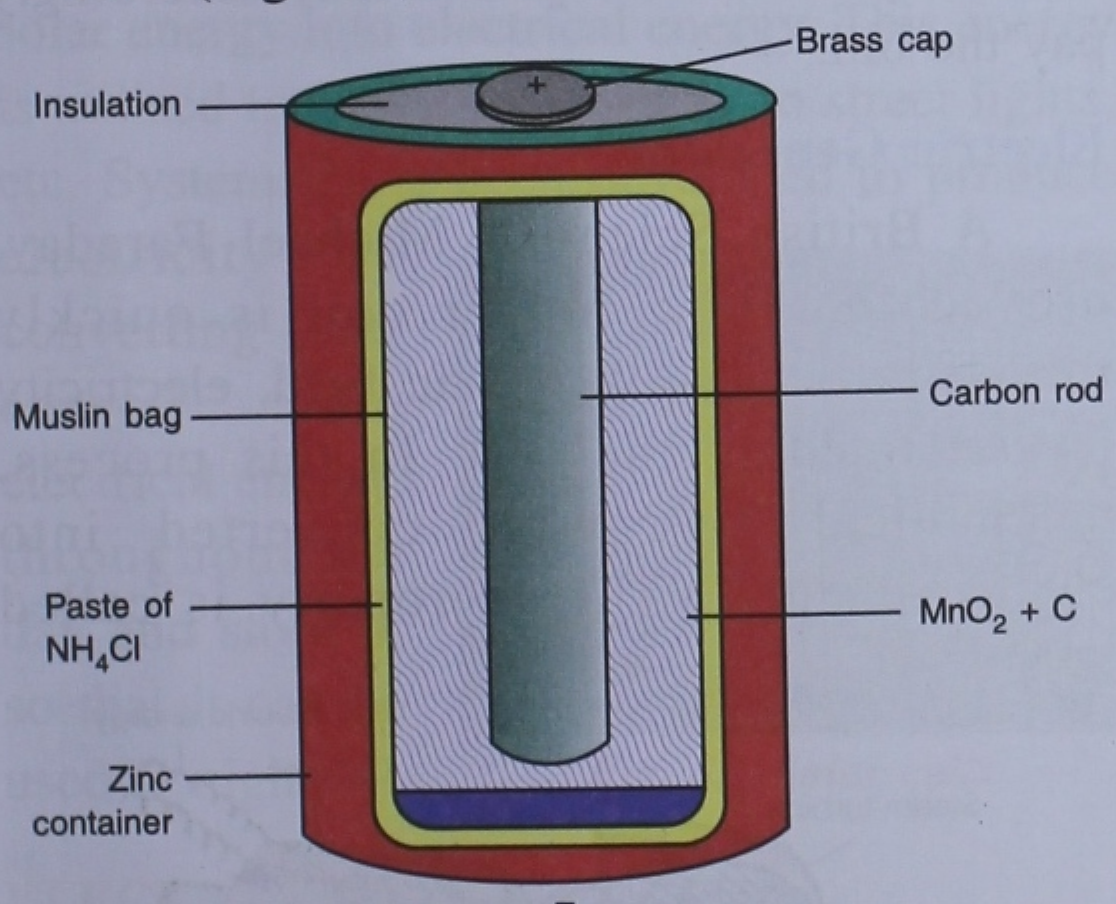


Fig. 8.2 A dry cell

When the cell is connected to a bulb, the slow ongoing chemical reaction inside the cell becomes fast and a current starts flowing through the bulb. Hence the bulb glows. These dry cells are small source of electricity.

> Cells and batteries are mostly used in portable devices.

Advantages of a dry cell—

1. Dry cells are light in weight and small in size.
2. Dry cells can be transported from one place to another very easily.
3. There is no fear of leakage/spillage in dry cells.

Knowledge Bank

Dry cells are actually not dry. In fact, a dry cell works only as long as the paste inside it remains moist. The presence of water (or moisture) helps in the movement of the ions within the cell from one electrode to the other. If the cell has not been used for a long time, the chemicals present in it are spent and it stops producing electricity, such a cell is called a dead cell.

These cells are used in a number of household gadgets like a radio, a transistor, a tape-recorder, a calculator, a wrist watch, the remote of a T.V., torch, toys, *etc*. The working of dry cells in a common gadget like a torch is described in Fig. 8.3.

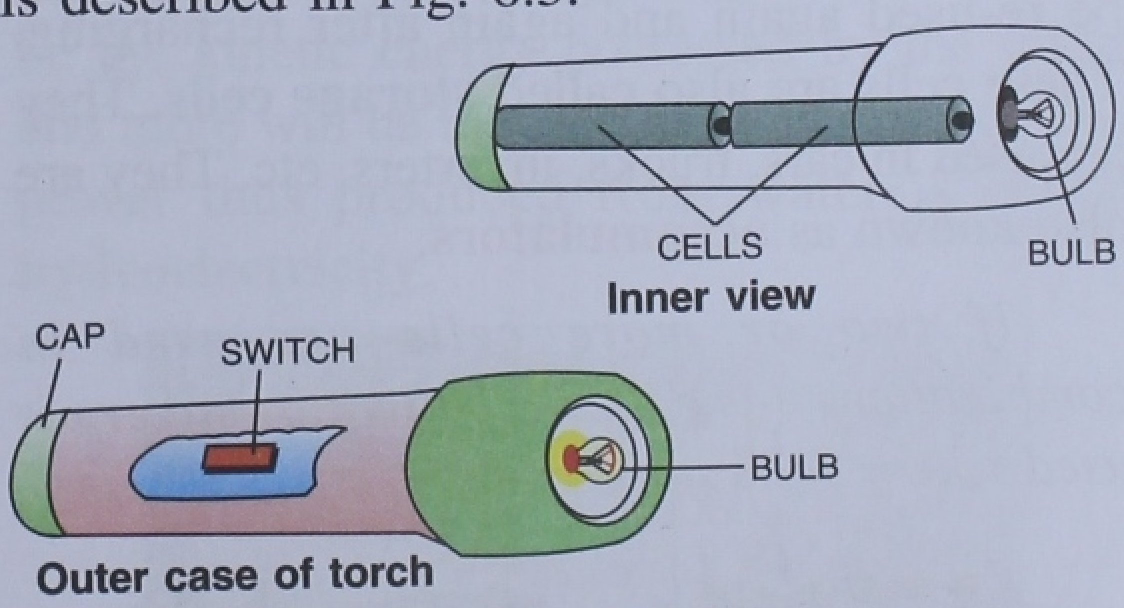


Fig. 8.3

The torch shown in Fig. 8.3 contains two cells. The cells are connected to each other in such a way that the brass cap (anode) of one cell is in contact with the container (cathode) of the other cell. When we press the switch on, the path for flow of current gets completed and the torch lights up. If we take out the cells from the torch, it will not give any light because the source of electricity is removed. Thus, the cells provide electricity to the torch.

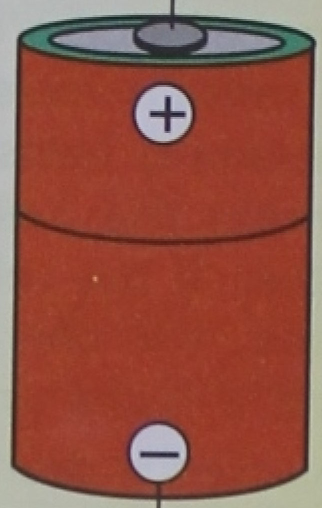
ACTIVITY 1

To locate the two terminals of a cell.

Material required : A battery cell.

Procedure : Take a dry cell and observe it carefully. Do you find the signs of positive (+) and negative (–) on it. If yes where?

In a battery cell :



- There are two terminals labelled as (+) and (–). The positive (+) terminal is at its top, whereas the negative (–) terminal is at its bottom.
- All types of cells have two terminals. In some cases, however both the terminals may be on the same side.

The other examples of primary cells are those of simple voltaic cell, Leclanche cell, Daniel cell, *etc*.

The **secondary cells** are the cells which can be re-used again and again after recharging. These cells are also called **storage cells**. They are used in cars, trucks, inverters, etc. They are also known as **accumulators**.

If two or more cells are used in combination, it is called a ***battery****. A battery is used when we require more electricity.*

The mains

It is another common source of electricity.

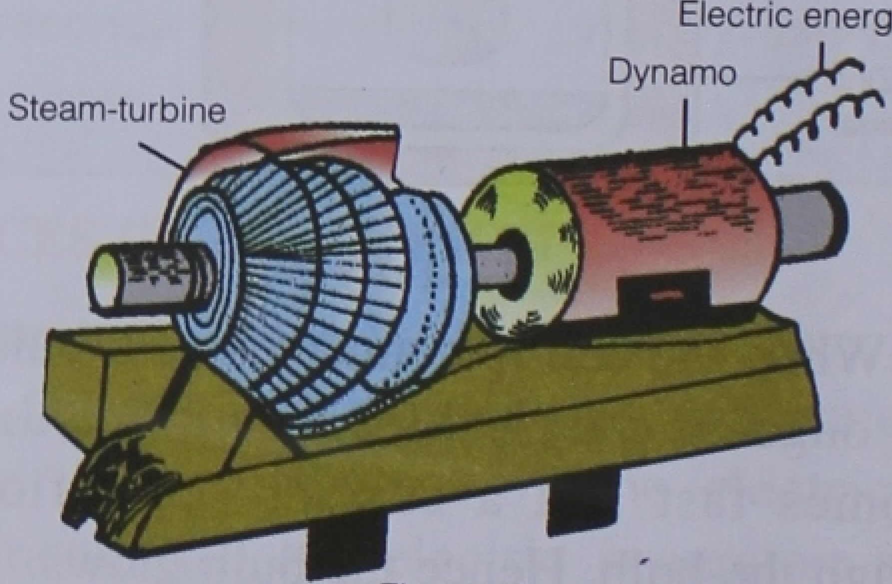
The electricity which is produced in a power station is carried through wires to different city sub-stations. From these city sub-stations it is carried to the electric poles fixed in various localities through the transformers. Then, from these poles, electricity reaches the mains board fixed in our houses from where it gets distributed through the wires fixed in all parts of our houses.

All the electrical gadgets in your house like fans, an A.C., a geyser, a TV, an electric iron, bulbs, tubelights, etc., work using this electricity supplied from the mains.

Every residential place or a commercial complex has the mains where meters are fixed to determine the consumption of electricity so that the person may accordingly pay the bill.

Electric Generator

A British Scientist, Michael Faraday, proved that if a copper coil is quickly rotated in a strong magnetic field, electricity is generated in the coil. In this process, mechanical energy is converted into electrical energy. This property is called



Electric Generator

electromagnetic induction. The property of electromagnetic induction is used to generate electricity and the device is called a **generator** or **dynamo.**

Solar Cells

The advancement of science has made possible for us to store **solar energy** in the form of electrical energy. The device used to convert solar energy into electrical energy is called the **solar cell**. This electrical energy thus generated is then stored in storage cells or accumulators.

Solar cells are used in wristwatches and calculators. Solar cell panels are used for producing electricity for use in space stations and artificial satellites. Solar cell is a non-conventional source of electricity.

Sunlight is collected on solar panels consisting of solar cells. The panel converts solar energy into electrical energy. This energy is utilised to provide electricity to street lights, etc. Systems have been developed to produce electricity by converting solar energy into electrical energy, throughout the day and store it, so that it can be used at night.

Fig. 8.4 Solar cells

ELECTRICITY FROM WIND

The kinetic energy possessed by strong winds can rotate the blades of windmills which can be used to generate electricity. The amount of electricity produced depends upon the speed of the wind. The more the speed of the wind, the more will be its kinetic energy and thus more electricity will be generated. It is a cheap and renewable source of producing electricity.

Fig. 8.5 Windmill generates electrical energy

ELECTRICITY FROM WATER

Water collected in dams is made to flow at a great speed through special channels. At this stage the potential energy possessed by water is converted into kinetic energy. More the flow of water, more will be the kinetic energy possessed by the water. This kinetic energy is made to fall on the blades of turbines which convert it into electrical energy. Similarly, more the height of a dam, more will be the kinetic energy possessed by the water and more will be the electricity generated. The power thus produced from water is called **hydroelectricity**.

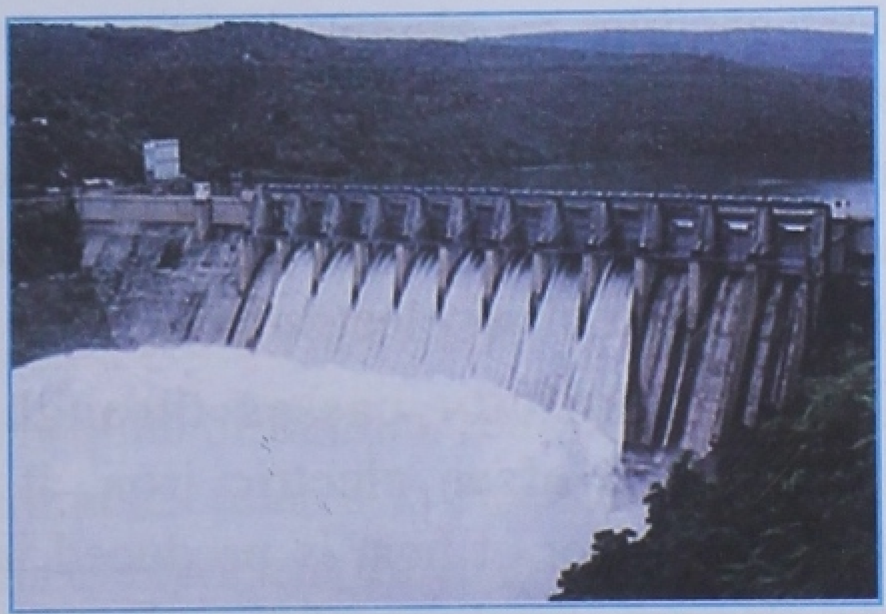


Fig. 8.6 Electricity generated by a water dam

Intext Questions

1. What is the importance of electricity in our life ?
2. Name *two* sources of electricity.
3. Who was Michael Faraday ?
4. What are primary and secondary cells.

EFFECTS OF ELECTRICITY

Under different conditions, electrical current flowing through a conductor converts into various forms of energies like heat energy, light energy, magnetic energy, chemical energy, etc. This change of electrical energy from one form to another is called the **effect of electric current.**

There are *six* main effects of electric current.

- Heating effect
- Magnetic effect
- Visual effect
- Chemical effect
- Mechanical effect
- Audio effect

Heating Effect of Current

Whenever electric current is passed through a conductor, it gets heated up. This means that electrical energy gets converted into heat energy and this effect is known as **heating effect** of electric current.

Uses of Heating Effect

Devices like an electric iron, an electric heater, an electric kettle, an immersion rod, an electric bulb, a microwave oven etc. all work on the heating effect of electric current. Let us take an example of an electric iron.

When electricity passes through the heating element of an electric iron, it gets heated. When a lot of heat is produced in the heating element, the base of the electric iron also gets heated up. We can then iron our clothes. Thus, electricity provides us heat.

Electrical circuits

The circuit in which electric current flows from one terminal of a cell or battery to the other is called a **closed circuit**. In a closed circuit, current flows from the positive terminal of a cell to its negative terminal through the external circuit.

The circuit in which electrical contact at any point is broken is called an **open circuit. No current flows in an open circuit.**

Why does a fused bulb not glow

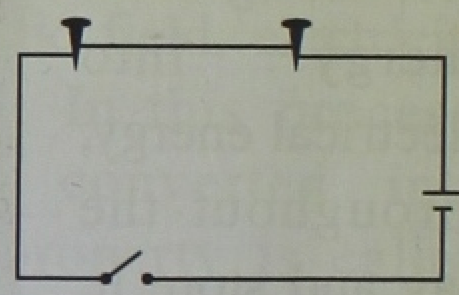
Bulb has a small filament inside it. A bulb glows as long as current passes through the filament.

A bulb is said to be fused when its filament is broken.

The broken filament cannot complete the circuit. As a result, current cannot flow through the filament and the fused bulb does not glow.

ACTIVITY 3

Make a circuit as shown in Fig. given alongside. Take about 10 cm long piece of nichrome wire and tie it between the nails. Now switch on the current in the circuit by moving the switch to the 'ON' position. After a few seconds touch the wire. (Do not hold it for a long time). Now switch off the current. Touch the wire again after a few minutes. The wire gets hot when an electric current passes through it. This is the heating effect of the electric current.



Nichrome is an alloy of nickel, iron and chromium.

In the appliances like heaters, electric iron, *etc.*, nichrome is used in the element as it offers large resistance and gets heated up when current flows through it.

Magnetic Effect of Current

The magnetic effect of an electric current is used to make magnets. When a coil of insulated wire is widely wrapped around a soft iron bar and electric current is allowed to flow through it, the iron bar behaves like a magnet. This can be detected by placing a magnetic compass near the soft iron bar. On placing a magnetic compass near the soft iron bar wrapped with current carrying coil, its needle gets deflected. This effect of electric current is called magnetic effect (Fig. 8.10). Such magnets are called temporary magnets, because they behave as a magnet as long as electricity flows through them. This method is used to make electro-magnets. The electromagnets are used in devices like electric bells, electric motors (to run machines like fans), in electric cranes, *etc*.

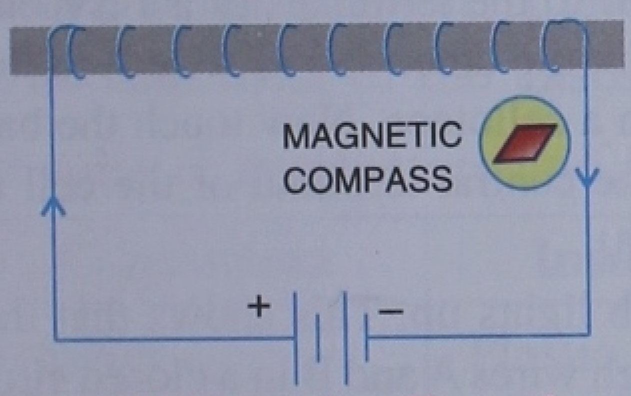


Fig. 8.10 Magnetic effect of current

Chemical Effect of Current

The phenomenon of causing chemical changes by passing electric current through a conducting solution or electrolyte is called chemical effect of electric current.

The chemical effect of current involve transformation of electrical energy into chemical energy.

When an electric current is allowed to flow through a solution of chemicals like copper sulphate, silver nitrate, *etc*., a chemical reaction occurs. The chemicals in the solution break into smaller components. These smaller components are known as ions. The most common use of chemical effect of current is *electroplating*. Ions are charged particles which allow the current to pass through the liquid. The process by which certain chemicals, in the molten state or in aquas solution break up into ions due to passage of electric current through them is called **electrolysis**. Electroplating is generally used for decorative purposes like polishing of artificial jewellery, protecting iron utensils from rusting, *etc*.

Fig. 8.11 below shows a simple experiment to electroplate an iron spoon with silver by immersing it into a solution of a salt of silver.

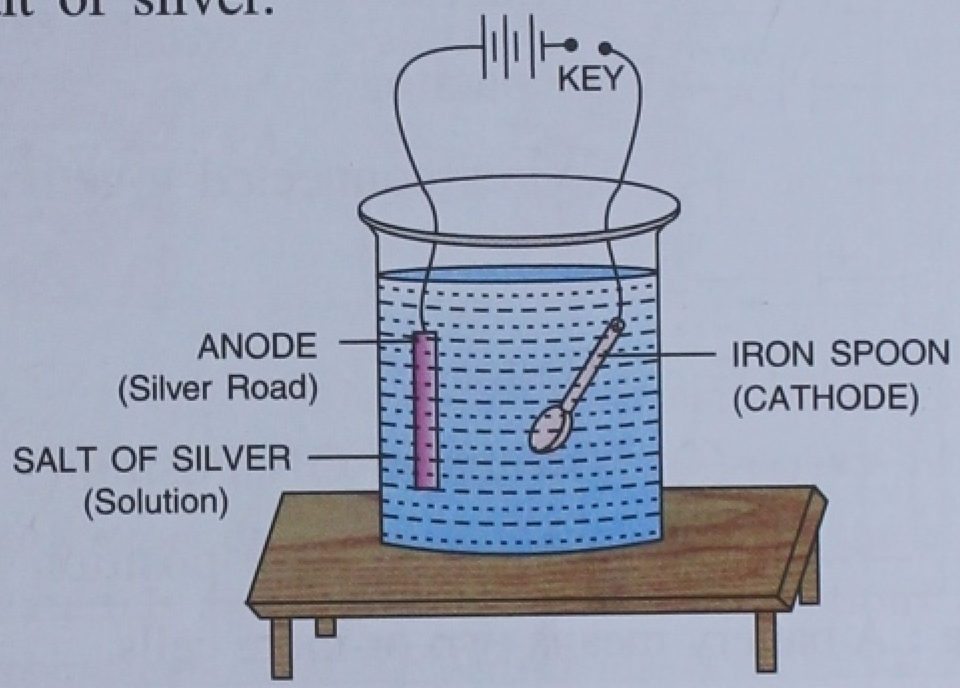


Fig. 8.11 Electroplating an iron spoon with silver

Mechanical Effect of Current

When an electric current is allowed to flow through a coil, free to rotate between the poles of a magnet, the coil rotates. During this process, electricity produces motion. This is called mechanical effect of current. It is mainly used in fans, electric toys, trains and in electric motors to lift water.

ELECTRICAL SYMBOLS

It is quite difficult to draw a correct picture of instruments related to electricity. So, we use symbols to represent the instruments, and some of these symbols are shown below:

	Symbol	Component
1.		Bulb
2.	—(·)—	Key or closed switch
3.		Open switch
4.	——	Connecting wire
5.	+ —(A)— −	Ammeter
6.	+ —(V)— −	Voltmeter
7.	—(G)—	Galvanometer
8.	—ww—	Resistance
9.		Rheostat
10.	—[RB]—	Resistance box
11.		Inductor
12.	—| |—	Capacitor
13.	+ or ⊤	Wires connected together
14.	+ −	Cell
15.		Battery
16.	or —(·)—	Switch in ON Position
17.	or —( )—	Switch in OFF position

Note : A battery means two or more cells.

ELECTRIC CIRCUIT DIAGRAM

A closed path in which the current flows is known as an *electric circuit*. It is not possible to draw a picture of actual instruments, so we make a simple figure using symbols which is known as a circuit diagram. Look at Fig. 8.7 and 8.8 given below :

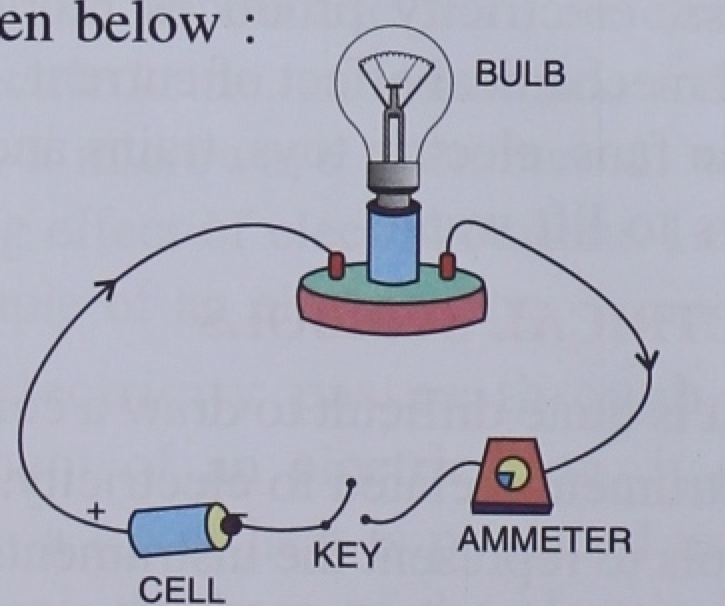


Fig. 8.7 An electric circuit with actual instruments

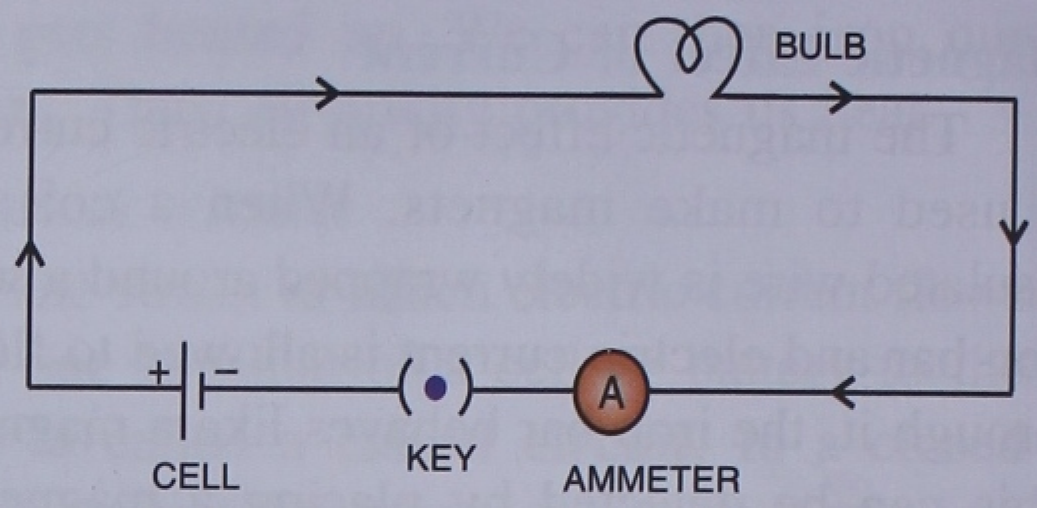


Fig. 8.8 A circuit diagram for general representation

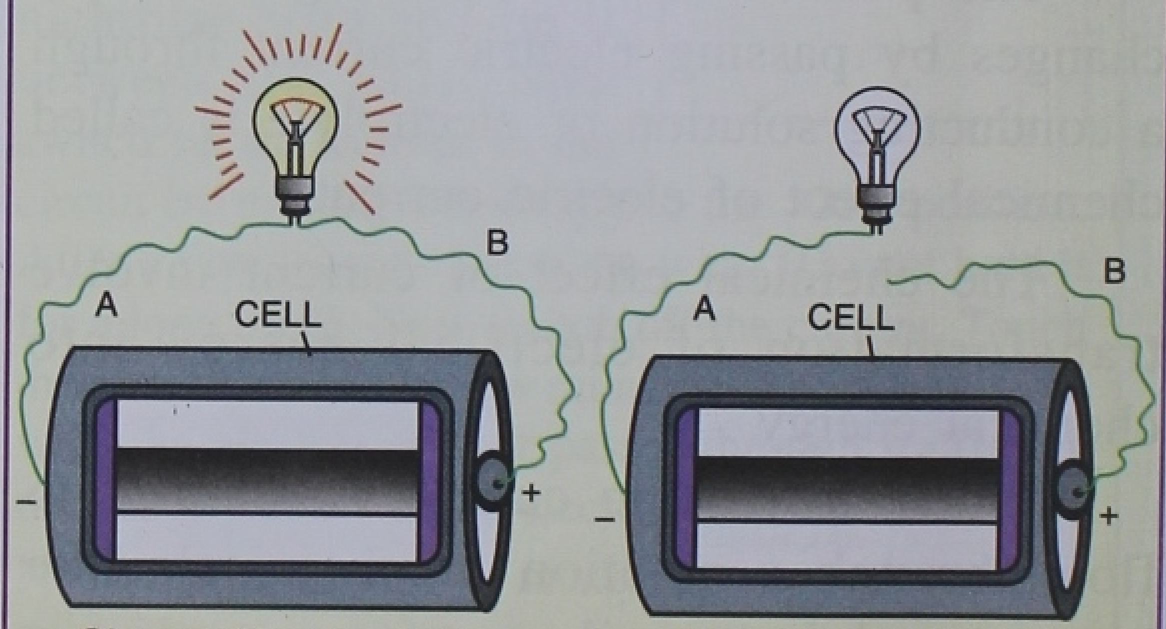
Flow of Electricity through a Circuit

The flow of electricity along a path is called a circuit. The electricity will flow only through a complete circuit and not through a broken circuit. This can be proved by the following simple activity.

ACTIVITY 2

Take about one metre long electrical wire and cut it into two parts. Remove the plastic coverings at the tips of each wire. Now fix one end of each wire A and B to the terminals of a 1·5V bulb with a cellotape. Fix the other end of wire A to the base of the cell with a cellotape. Now touch the bare end of wire B to the central terminal of the cell as shown in Fig. 8.9(a).

The bulb lights up. This shows that the current flows through wires A and B in a closed circuit. Now remove wire B from the central terminal or from the bulb (see Fig. 8.9b). The bulb will not glow since the circuit is broken.



Closed Circuit – bulb glows (a)

Open Circuit – bulb does not glow (b)

Fig. 8.9

CONDUCTORS AND INSULATORS

All electrical circuits are made of metallic wires because metals allow electric current to flow. All metals are good conductors of electricity such as copper, aluminium, iron, silver, gold, etc. Generally, non-metals do not conduct electricity but some non-metals like tap water, salt solutions, graphite, etc. are good conductors of electricity. The human body is also a good conductor of electricity.

Any material that allows the electric current to flow through it is called a **conductor**.

The materials which do not allow an electric current to flow through them are called **insulators**. A few examples of insulators are mica, rubber, plastic, glass, wood, dry air and most of the gases.

Some examples of conductors and insulators

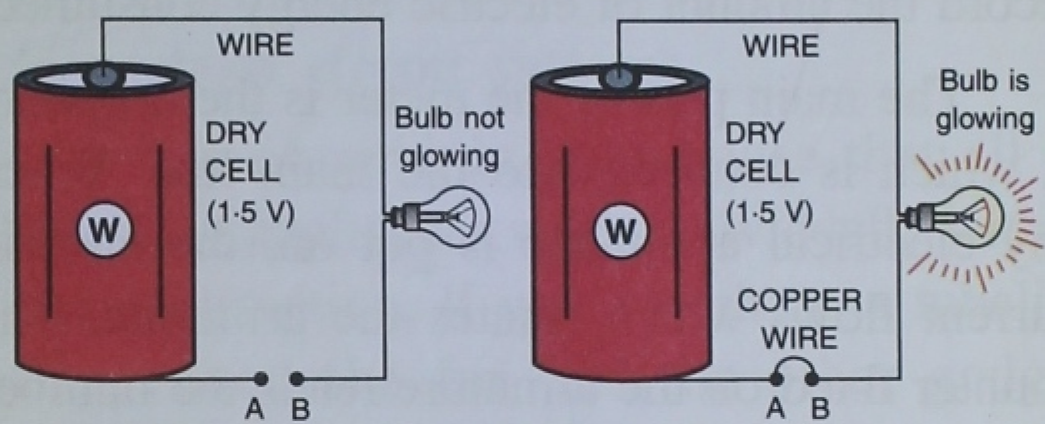
S.No.	Conductors	Insulators
1.	Silver	Plastic
2.	Copper	Glass
3.	Aluminium	Bakelite
4.	Lead	Cotton
5.	Tap water	Wood
6.	Gold	Cork
7.	Human body	Silk
8.	Living plant	Pure water
9.	Brass	Rubber
10.	Tin	Leather
11.	Iron	Ebonite
12.	Steel	Nylon

ACTIVITY 4

To find out whether the given material is a conductor or an insulator.

Material required : A small piece of each of the following materials – plastic, copper, rubber, wood, graphite (pencil lead).

Procedure : Connect a circuit as shown below. Leave a gap AB between the two ends of the wire. In this situation, the bulb does not glow, *i.e.* no current flows through the circuit. Now, place a piece of copper wire in the gap touching the points A and B. The bulb starts glowing. This shows that copper is a good conductor of electricity.



Electrical circuit to test materials for their electrical nature.

Now repeat the same experiment with the other materials and note down your observations and conclusions in the table given ahead.

Results and conclusions :

Test material	State of the bulb	conductor or insulator
Plastic	Does not glow	Insulator
Copper	....	....
Eraser (Rubber)	....	....
Matchstick (wood)	....	....
Pencil lead (graphite)	....	....

How Electricity Reaches our Homes

The wires, fixed at the poles, supply electricity to our homes. First of all, these wires are attached to the mains board or the distribution board where a device called kilo-watt-hour (kWh) meter (Fig. 8.11) is fitted. The wires coming from the pole enters the energy meter (kWh) and connections are then made to the main switch and main fuse on the distribution board. From here, the electric wires are connected to different parts of the house. Figure 8.11 shows a kWh meter used to record the amount of electric energy consumed.

Fig. 8.11 kWh meter

The main part of the meter is the armature A which is connected to the main line. When any electrical appliance is put on, the electric current flows which rotates the armature. The counter fixed on the armature reads the number of rotations. We can see five dials on the counter to read electricity consumption directly in kWh units (Fig. 8.12). These five dials are in unit, tens, hundreds, thousands and ten thousands respectively. In Fig. 8.11, the reading on the meter is 49180 kWh.

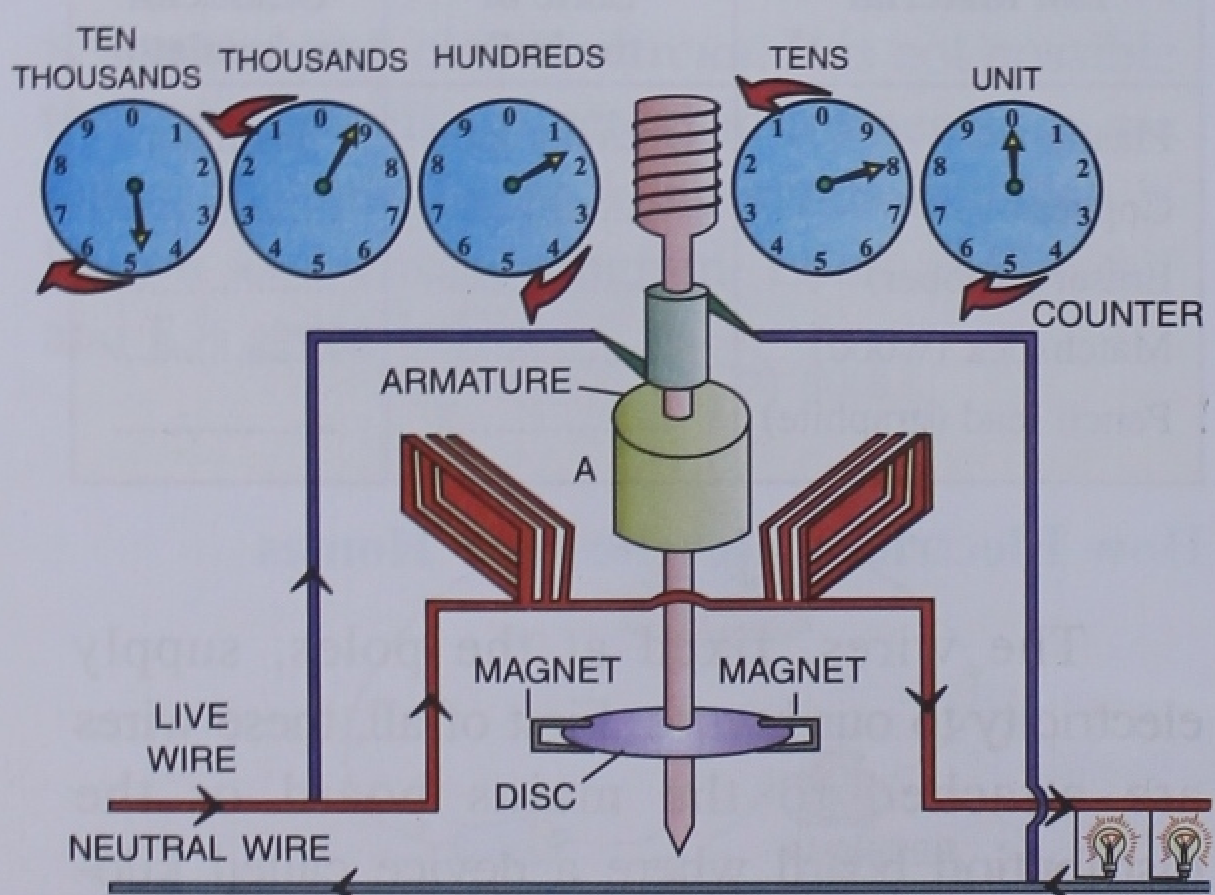


Fig. 8.12 Working of a household meter

Figure 8.13(a) shows the initial reading on the 1st day of the month and Fig. 8.13(b) shows the final reading on the last day of the month. The initial reading is 49180 kWh and the final reading is 50625 kWh, then the total consumption of electricity in that particular month is 50625 – 49180 = 1445 kWh. So the electricity consumed is 1445 units. If the rate of electricity per unit is Rs 2·60, then your bill will be 1445 × ₹ 2·60 = ₹ 3757.00 only.

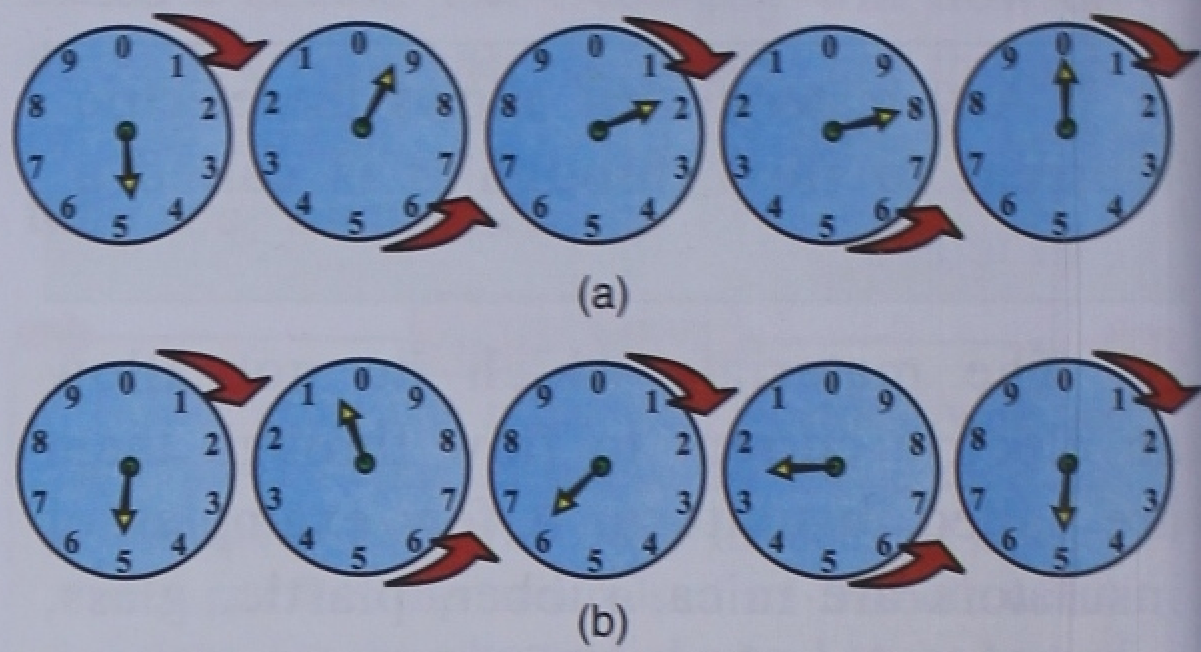


Fig. 8.13 (a) Initial reading in kWh meter
(b) Final reading in kWh meter

Nowadays, the old meters are being replaced by electronic digital meters which are totally different from the meters shown above.

Commercial unit of energy : Electrical energy is generally measured in a unit called **B.O.T.** (Board of Trade) unit or **kWh** ***i.e.*** **kilowatt hour.**

1 kilowatt hour can be defined as the *amount of energy consumed when an electrical appliance of 1 kilowatt (1000 watt) is used for 1 hour*. Our household meter measures the energy consumed in kWh. It is given by

$$E \text{ (in kWh)} = \frac{P \text{ (in W)} \times t \text{ (in hours)}}{1000}$$

$$E \text{ (kWh)} = \frac{V \text{ (in volt)} \times I \text{ (in amp)} \times t \text{ (in hour)}}{1000}$$

where E represents the amount of electricity consumed, P means the power to consume electricity of an appliance and t is the time.

Further,

$$1\ \text{kWh} = 1\ \text{kW} \times 1\ \text{hour} = 1000\ \text{W} \times 60 \times 60\ \text{s} = 1000\ \text{J/s} \times 60 \times 60\ \text{s} = 3600000\ \text{J} = 3{\cdot}6 \times 10^6\ \text{J}$$

Example 1 : An electric heater is rated at 1500 watt. What would be the electrical energy consumed by it in 2 hours.

Solution : $E = 1500\ \text{watt} \times 2\ \text{h} = 3000\ \text{Wh} = \frac{3000}{1000}\ \text{kWh or 3kWh}$

Example 2 : An electric bulb of 100 watt, an electric iron of 750 watt and a television of 100 watt are used for 3 hours a day. Calculate the energy consumed per day.

Solution : Total power $= (100 + 750 + 100) = 950\ \text{watt}$

$$\therefore \quad E = 950\ \text{watt} \times 3\ \text{h} = 2850\ \text{watt-h} = \frac{2850}{1000}\ \text{kWh} = 2{\cdot}85\ \text{kWh}$$

CIRCUIT SYSTEM

For a smooth flow of electric current, a complete circuit is needed. We have two types of circuit systems,

(i) circuit in series and

(ii) circuit in parallel.

When a circuit is in series, the appliances work simultaneously when the switch is closed. Conversely, all appliances stop working when the switch is open. Also, when a circuit is in series, if any of the appliances goes out of order, the other appliances also stop working because the circuit stands open at the point where the appliance (which has gone out of order) is installed. Thus, in a series circuit, the appliances in use are dependent upon each other.

When the circuit is in parallel, the appliances work independently. This is the reason that in our household wiring system, all the circuits are in parallel. Every appliance when put on, works on its own without the interruption of the other appliance. We describe below in detail the circuits in series and in parallel along with circuit diagrams.

Household circuit systems

You observe in your house that all the electrical appliances work individually without any interruption. If you switch on a tubelight in a room, the fan and the other gadgets installed there are not disturbed (they need not be switched on). Now we shall study the working of appliances when they are connected in series and in parallel in a circuit.

Circuit in Series

Two torch bulbs A and B are connected to a cell through a switch as shown in Fig. 8.14. The bulbs are said to be in series. When the switch is closed (*i.e.*, the circuit is complete), both the bulbs glow.

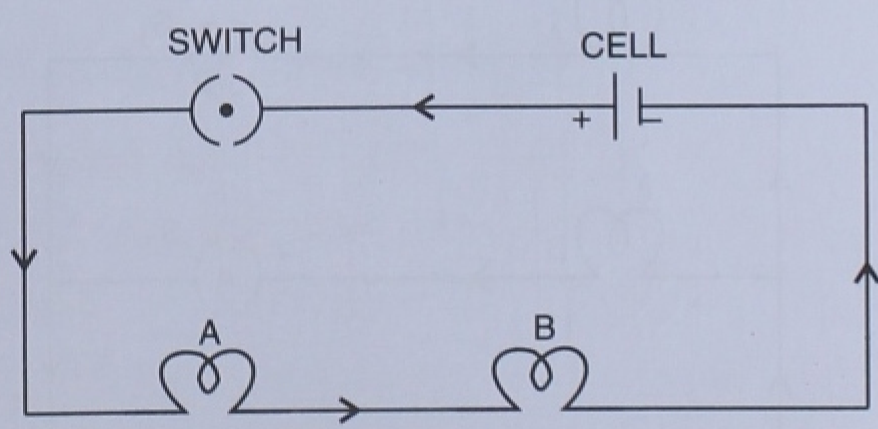


Fig. 8.14

Now let us take out the connection of bulb B as shown in Fig. 8.15. When the switch is closed, the bulb A does not glow, because the circuit is now incomplete.

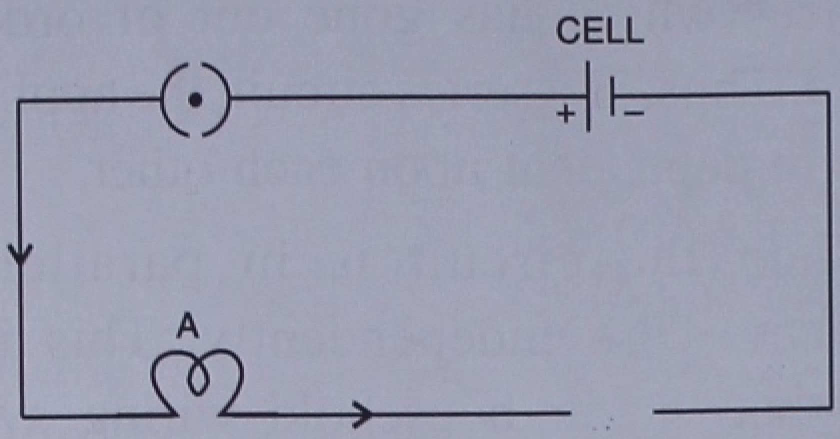


Fig. 8.15

When we replace bulb B by a fused bulb and close the switch, bulb A does not glow (Fig. 8.16). This is because the circuit is again incomplete.

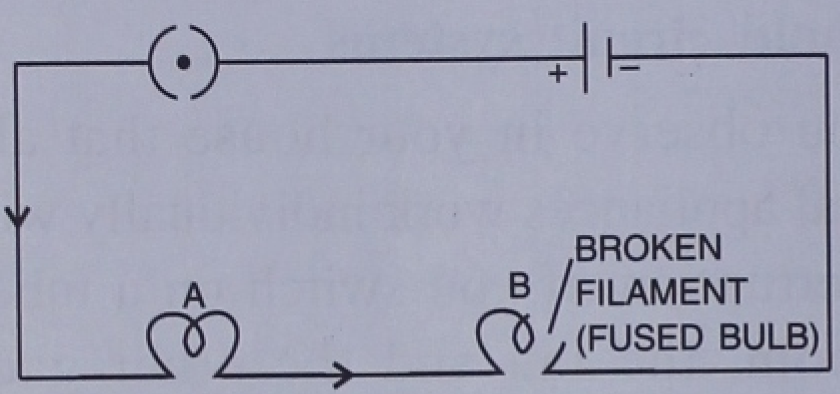


Fig. 8.16

Therefore, when the connections are in series, the appliances are dependent on each other.

Circuit in Parallel

Two bulbs A and B are connected through switches S_1 and S_2 in parallel as shown in Fig. 8.17. When both the switches are closed, we see that both the bulbs glow.

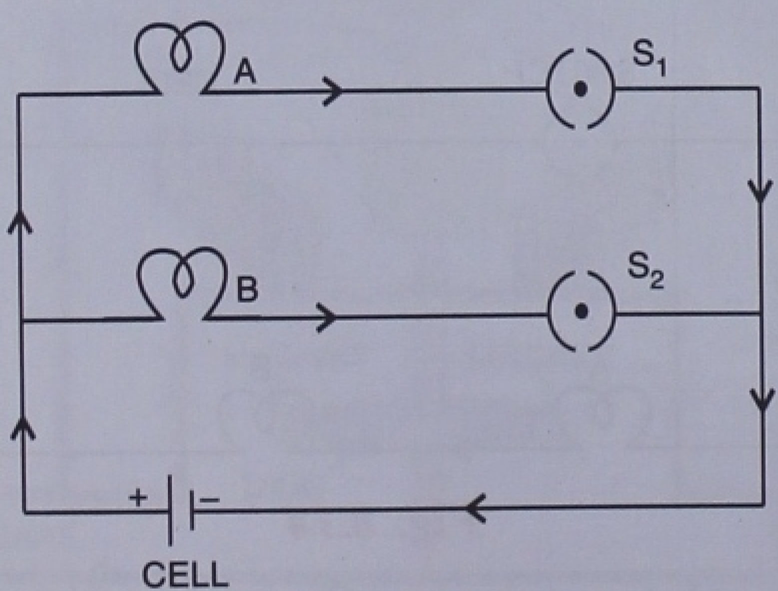


Fig. 8.17

When switch S_1 is closed and S_2 is open, only bulb A will glow, but the bulb B will not glow (Fig. 8.18).

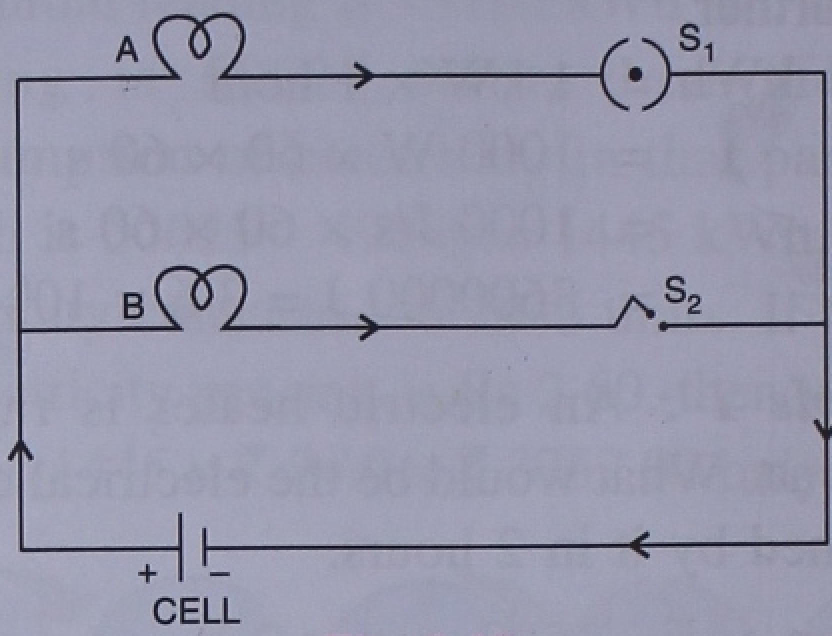


Fig. 8.18

When switch S_1 is open and S_2 is closed, only bulb B will glow and bulb A will not glow (Fig. 8.19).

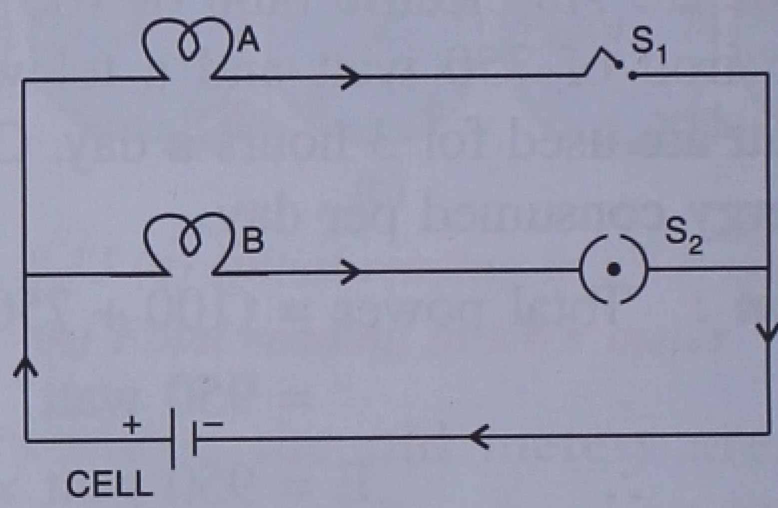


Fig. 8.19

When bulb B is replaced by a fused bulb, and both the switches are closed, we find that only bulb A will glow and the fused bulb B does not glow (Fig. 8.20) but it also does not affect bulb A.

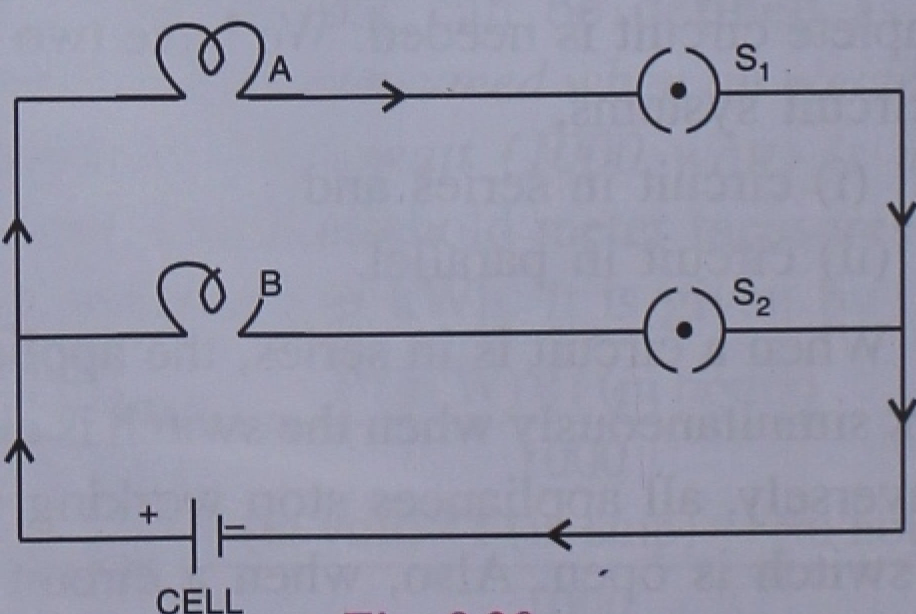


Fig. 8.20

Therefore, we conclude from these experiments that when circuits are in series, each electrical appliance is dependent upon the other. When the circuits are connected in parallel, they work on their own individual path.

This is the reason that all the electrical appliances in houses, offices, schools, factories, etc., are connected in parallel.

Electricity consumption is dependent upon the power of electrical appliances and the time for which they are used. For your convenience, the power of some of the electrical appliances commonly used is presented in Table 8.1.

Table 8.1 Electric power of some appliances

Electric appliance	Power
Light bulbs	60 W, 100 W
CFL bulbs	5 W, 22 W
Tubelight	40 W
Television	100 W
Refrigerator	150 W
Video recorder	20 W
Iron	1 kW
Immersion heater	3 kW
Kettle	2 kW
Fan	40 watts

SAFETY MEASURES FOR HOUSEHOLD CIRCUIT SYSTEMS

Generally, the following safety measures must be adopted before connecting electric supply to the main switch.

Electric Fuse

When the electrical wire is brought to the house, it is first connected to the energy meter. From the energy meter, it is then connected to the main switch, a fuse and then it is connected to other appliances.

Fuse wire is used at the beginning of our household circuit to prevent the entire household wiring from getting damaged if a particular appliance draws an excess amount of current. When a large amount of current flows through the circuit, the fuse wire gets heated up and melts away, thereby breaking the circuit and hence preventing any damage to the circuit or appliance. Thus, *electric fuse is a device which is used to control the current in an electric circuit*.

Characteristics of a fuse

1. It has a short length wire with a low melting point. The fuse wire is made of an alloy containing equal amounts of lead and tin. It melts at about 200°C.
2. Fuse wire is connected in series with the live wire and its temperature rises much faster than the connecting copper wire in case of overload.

Overload

Overload in an electric circuit, is a condition when it draws more current than it is designed for. Short circuit occurs when a naked live wire and a neutral wire come in contact or the live wire and the earth wire come in contact.

Use of gadgets in Household Wiring

In our day to day life, we use various electrical appliances such as a room heater, an electric iron, a grinder mixer, a television set, a refrigerator, etc. Each appliance is fitted with a wire having a plug at its one end.

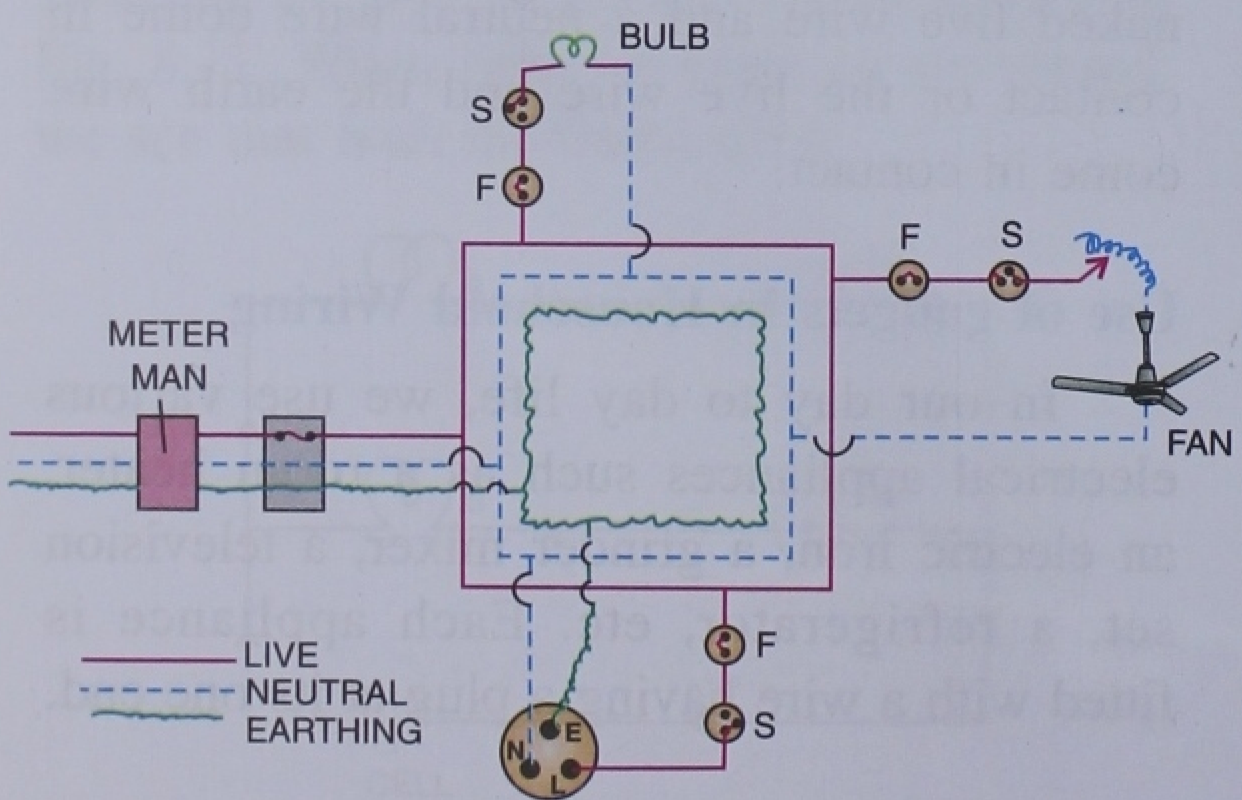
Do You Know ?

* Currents of approximately 0·2A are potentially fatal, because they can make the heart fibrillate, or beat in an uncontrolled manner.
* Silver offers least electrical resistance but is not used to make conducting wires as it is too expensive.

Household Wiring

The electrical wires used in homes should be thick and well insulated. Only ISI marked wires should be used.

The electrical circuit consists of three wires, a live wire (red or brown colour), a neutral wire (black or blue colour) and an earth wire (green or yellow colour). The live wire and the neutral wire are the main wires through which an electric current flows. In domestic supply, the earth wire has an important role to play. This wire is introduced for safety. One end of the earth wire is connected to the body of the appliance and the other end goes deep inside the ground through a metal plate. Any leakage of current in the appliance flows



Ring system of house hold wiring.

harmlessly to the earth and we do not get an electric shock due to the earthing. Now, we shall study more about the other components used in the flow of electric current.

Plugs : We generally use a three-pin plug as shown in Fig. 8.21. The two lower pins are called the terminal pins and the third pin which is on the top and is longer and thicker is called the earth pin. Of the two terminal pins, one is connected to the live wire and the second pin is connected to the neutral wire. The plug is inserted in the socket on the electricity board fixed to the wall. The plug should well fit in the socket and it should be tight otherwise there will be sparking and burning of the socket.

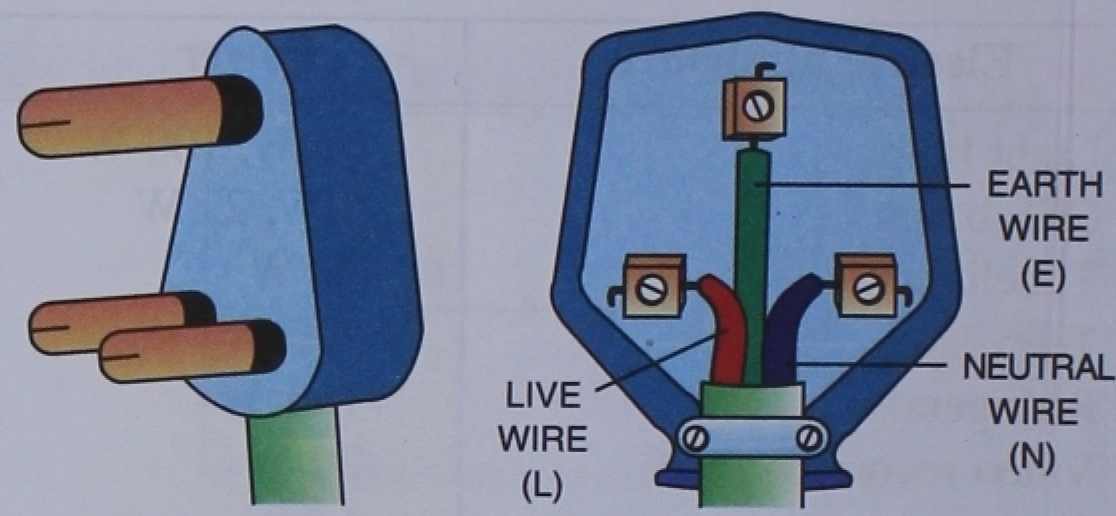


Fig. 8.21 A plug and its internal parts

ACTIVITY 5

To make a simple switch and show its use in a circuit.

Material required : Thermocol or soft wood sheet (10 cm × 15 cm), drawing pins (2), paper clip, connecting wires.

Procedure : Fix two pieces of connecting wire and a paper clip on a piece of thermocol with the help of drawing pins.

Your simple switch is ready.

Now connect the 'switch' in a circuit containing a torch bulb and a cell.

Move the clip to touch the other drawing pin. Move the clip up and down repeatedly.

What do you observe ?

- When the paper clip touches both the drawing pins, the bulb lights up.
- When the paper clip touches only one of the drawing pins, the bulb does not light up.

Socket : A socket has three holes. The lower two holes are the terminals and the third hole which is bigger in size is meant for the earth connection as shown in Fig. 8.22.

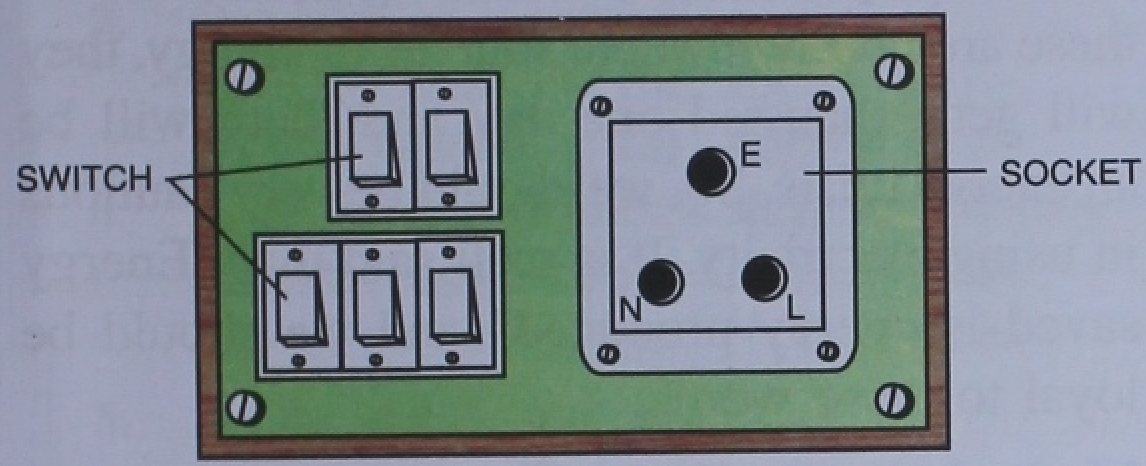


Fig. 8.22

Switch : There are a number of switches on an electric board. A switch is a kind of key or an on-off device which carries electricity in a circuit or in the gadget. The outer part of a switch is always made of an insulator (*i.e.*, a poor conductor of electricity) such as ebonite or Bakelite (Fig. 8.22). The switch should always be connected to the live wire and not to the neutral or earth wire. Figure 8.22 shows some simple switches. To be sure that we get a proper supply of electricity in our house, the household wiring should be done by using good quality wires with proper thickness and insulation.

A device that makes and breaks a circuit is called the switch

1. When the switch is in the 'off' position, the circuit is open and the current does not flow through the circuit.
2. When the switch is in the 'on' position, the circuit is closed and the current flows through the circuit.

Precaution : The electrical appliances should not be touched with wet hands. As you know that water and water vapours are good conductors of electricity. They will pass electricity to your body and you may get a shock which can even prove to be fatal.

Miniature Circuit Breaker (MCB)

Miniature circuit breakers are the automatic switches that are nowadays used to protect the household wiring from the excessive flow of electric current. When the current flow is in excess, the MCB automatically cuts the electric supply. It is reset after the fault is rectified.

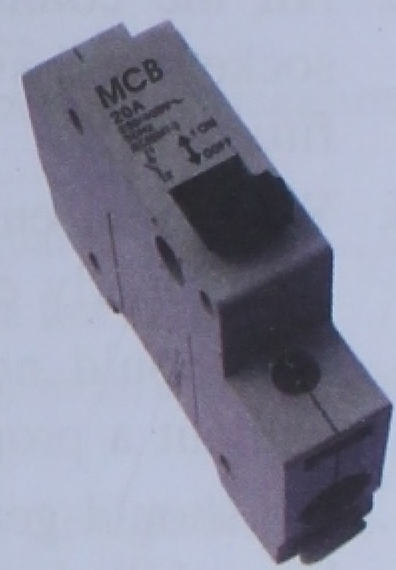


Fig. 8.23 MCB

Hazards of Electricity

Apart from the uses of electricity, there are a number of its hazards too which are given below :

When you use a number of electrical gadgets connected in a circuit at the same time, there is a large flow of current through the connecting wires. In other words, you have overloaded your house circuit. There will be overheating of the electric wires which may cause short circuiting and even electric fires.

Sometimes, due to faulty wiring in the house or at a working place, the live wires touch the neutral wire. This brings down the resistance of the circuit to zero and the flow of current will be in excess. This excess flow will damage electrical appliances such as a T.V., a refrigerator, tubelights, bulbs, *etc*. Even the wires can catch fire and there can be a mishappening.

If a person comes into contact with a live wire, he can get an electric shock. If it is a huge shock, it can cause an untime death.

PRECAUTIONS TO BE TAKEN WHILE USING ELECTRICITY

1. We should not touch switches with wet hands.
2. All the connecting wires to the plugs, sockets and switches should have a tight fitting.
3. We should ensure that all the appliances are properly earthed.
4. We should not try to repair appliances without a proper technical knowledge.
5. We should get all electrical fittings done by a skilled person.
6. We should check the safety fuse and other appliances used by us.
7. We must ensure that MCB and fuses of correct strength have been used in the circuit.

Do You Know ?

The most innocent looking appliance like a light switch, a hair dryer or a lawn mower (a revolving blade to cut grass in the lawn) has the potential to kill you if not handled properly. The cheapest and valuable safety device against electricity is to be **CAUTIOUS** while using any appliance.

NEED TO CONSERVE ELECTRICITY

The consumption of electricity is increasing day by day due to many reasons. Some of the reasons are listed below :

1. Since the population is increasing at a tremendous speed, the demand for electricity is also increasing.
2. With the advancement in the technology and the invention of newer gadgets and techniques in various fields, the use of electricity is increasing.
3. The high standard of living as well as the comforts of life has put in more pressure on the use of electricity, which needs to be cut down.

Electricity is produced from fossil fuels like coal, petroleum, natural gas, *etc*. Since these are non-renewable sources of energy, they will get exhausted one day and there will be an energy crisis. So, we should be very cautious in using electricity. It is well said that "Energy saved is energy produced" and we should be loyal to these words.

Methods to Conserve Electricity

1. Electrical fans, fluorescent tubes and bulbs should be switched off when not in use.
2. All electrical appliances like the radio, television, heater, geyser, etc., should be switched off immediately after use.
3. Tubelights should be used in place of electric bulbs to save electricity.
4. Electrical appliances that require less power must be used. They should be used not only to save electricity but also to reduce huge electricity bills.
5. CFL (compact fluorescent lamp) and LED (light emitting diode) can be used in place of normal bulbs to reduce the wastage of electrical energy.

Intext Questions

1. What is the commercial unit of electric energy ?
2. What happens when a person gets electric shock ?
3. What type of wiring (circuit) is done in your house ?

TEST YOURSELF

A. Tick the most appropriate answer :

1. Electric current is the flow of
   (a) Protons (b) Electrons
   (c) Neutrons (d) None of these
2. Fuse wire is an alloy of
   (a) Tin-lead (b) Copper and lead
   (c) Tin-copper (d) Lead-silver
3. One kilowatt is equal to
   (a) 100 watts (b) 1000 watts
   (c) 10 watts (d) None of these
4. A person gets an electric shock on touching
   (a) An earth wire (b) A neutral wire
   (c) A live wire (d) None of these
5. A fuse wire should have
   (a) A low melting point
   (b) High melting point
   (c) Very high melting point
   (d) None of these
6. Current is measured in
   (a) Joules (b) Watts
   (c) Volts (d) Amperes
7. Pick out the conductors and insulators from the following items
   (a) Mica (b) Air
   (c) Silver (d) Brass
   (e) Lead (f) Human body
   (g) Plastic
8. A bulb of 100 watts means it will consume electrical energy at the rate of
   (a) 100 joules per second
   (b) 100 kJ per second
   (c) 100 joules per hour
   (d) 100 joules per minute
9. The source of electricity in a torch is
   (a) Switch (b) Bulb
   (c) Mains (d) Cell
10. All wires used in electric circuits should be covered with
    (a) A colouring material
    (b) A conducting material
    (c) An insulating material
    (d) None of these

B. Fill in the blanks

1. When a short-circuit takes place, the fuse wire .... and breaks the ....
2. If a person touches the .... wire, he gets a severe ....
3. An electric meter in our house measures electrical energy in ....
4. One kilowatt hour is equal to .... or ....
5. A fuse wire should have low ....
6. A combination of two or more cells is called a ....
7. .... pass electricity through them.
8. Energy saved is energy ....
9. The cheapest safety device against electricity is to be ....

C. Write *true* or *false*. Rewrite the false statement correctly.

1. A fuse wire has a high melting point.
2. Flow of protons constitutes electric current.
3. Silver is an insulator of electricty.
4. S.I. unit and commercial unit of electrical energy have no connection between them.
5. Overloading of electric current circuits can lead to short circuiting.
6. Our body is a conductor of electricity.
7. All metals are insulators of electricity.
8. For a circuit to be complete, every part of it must be made up of conductors.
9. The earth connection does not protect us from an electric shock.
10. A switch can be touched with wet hands.

D. Answer the following :

1. Name four electrical gadgets which work with electricity.
2. Name three sources of electricity.
3. State the four effects of electricity.
4. Name four appliances based on heating effect of current.

5. What do you understand by the mechanical effect of current ? Name two devices based on this effect.
6. What is meant by the magnetic effect of electricity ? Name a device in which this effect is used.
7. Explain the meaning of the chemical effect of electricity.
8. What is an electric circuit ?
9. Draw a neat and labelled diagram of a plug and a socket.
10. What is a switch. Of what material it is made of ?
11. Distinguish between conductors and insulators of electricity. Give three examples of each.
12. State *four* precautions you must take while handling an electrical appliance at home.
13. What is meant by a series combination ? Illustrate this by giving a suitable diagram.
14. Differentiate between a cell and a battery.
15. State three methods to consume electricity.

E. Solve the following :

1. If the electric consumption per day of your house is 10 kWh and the rate of electricity is ₹ 1.60 per unit, find how much cost you have to pay for power consumption in 30 days ?

   1 unit = 1kWh **₹ 480**
2. Five bulbs of 60 watts each and 2 fans of 100 watts each are used for 8 hours a day. Calculate the monthly bill if 1 kWh is costing ₹ 1.50. **₹ 180**
3. Calculate the cost of operating five bulbs of 100 watt each for 8 hrs and an iron of 1·5 kw for 2 hrs at the rate of ₹ 5.40 per unit. **[₹ 37·80]**
4. Two bulbs of 60 watt each, three tube lights of 40 watt each and two fans of 80 watt each are used for 8 hrs per day.

   Calcualte :

   (i) the total amount of electrical energy consumed in 30 days. **[96 kWh]**

   (ii) cost of electricity used in 30 days at the rate of ₹ 3.60 per unit. **[₹ 345.60]**

RECAPITULATION

- Electricity has brought lots of comforts in our lives. Electricity is used to light our homes, offices, factories, schools *etc.*; all the household electrical apliances like the refrigerator, fan, bulb, tubelight, geyser, machines installed at factories, *etc.* are run by electricity.
- Cell is a primary source of electricity. A combination of two or more cells is called a battery.
- Some of the other sources of electricity are the mains, generator and solar cells.
- The path along which an electric current flows is called a circuit.
- Electricity has the following six effects : heating, magnetic, chemical and mechanical effect, audio effect and visual effect.
- When electricity flows through a coil wound around a soft iron rod, it (the coil alongwith soft iron rod) becomes an electromagnet. This method is used in electric bells, electric toys, electric motors, electric cranes, *etc*. It is the magnetic effect of electric current.
- An electrical circuit which is complete or is not broken is called a closed circuit and the circuit with a break is called an open circuit.
- Switch is a device to close or open an electric circuit.
- The substances which allow the electricity to flow through them are called conductors. The examples are metals, human body, impure water, *etc*.
- The substances which do not allow electricity to flow through them are called insulators. The examples are ebonite, plastic, wood, paper, glass, *etc*.
- An electric appliance will only work if the electric circuit is made of conductors and also if the circuit is complete.
- The electric supply from the poles first comes to an energy meter installed in the house. The consumption of electricity is calculated from this meter in kWh.
- Electric fuse is a device which limits the current in an electric circuit. It is a short and thin wire made of an alloy of lead and tin. The fuse wire is always connected with a live wire.
- All electrical appliances are connected in parallel in household circuits. Hence, every gadget has a separate switch connected with its live wire. The wires used for wiring are of three different colours. The red or brown wire is the live wire, the black or blue wire is the neutral wire and the green or yellow wire is the earth wire.
- It has become necessary to conserve electricity and avoid its wastage because with the increase of population, the consumption of electricity has also increased. So, we need to be cautious in using electricity.
- Some precautions need to be taken before working on an electrical gadget or circuit to avoid getting electric shocks.