UNIT

7

ELECTRICITY AND MAGNETISM

In this unit, we will learn:

- Electric current
- Electrical circuit and its components
- Fuse and its importance
- Static electricity
- Electromagnets
- Earth's magnetism
- Magnetic compass

All the material objects are composed of extremely small particles called atoms. An atom consists of further smaller particles called electrons, protons, neutrons, etc. (Figure 7.1). Protons have positive charge on them and are located in the central part of an atom called nucleus. Electrons have negative charge on them and revolve around the nucleus in different paths called orbits.

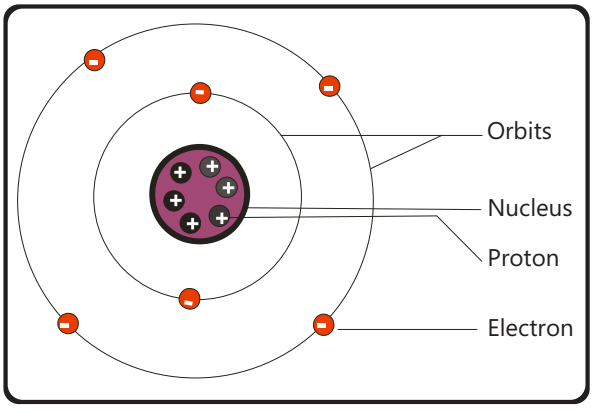


Figure 7.1 Structure of an atom

7.1 Electric Current

In some objects like copper, aluminium, silver, etc., electrons can move from one atom to another atom within the material. These electrons are called free electrons. They move freely in random directions in the material. To make these electrons flow in one direction, a force is needed, which is provided by the battery or a cell.

The flow of free electrons is called electric current.

Consider a cell as shown in Figure 7.2. If the two ends of the cell are connected by means of a metallic wire, an electric current will start flowing from positive end of the cell to its negative end through the wire. The electric current in the wire can be tested by connecting a bulb in its way. The bulb will glow due to the flow of electric current.

Electric current is measured by an instrument called ammeter (Figure 7.3).

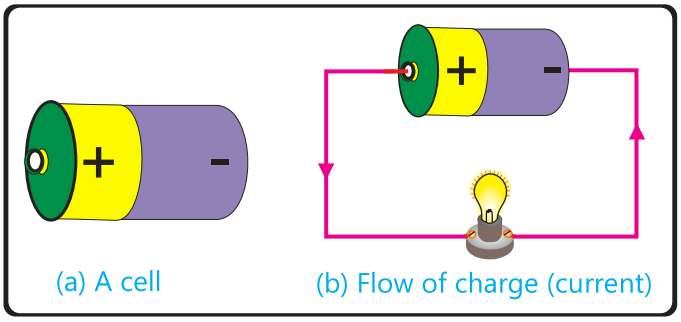


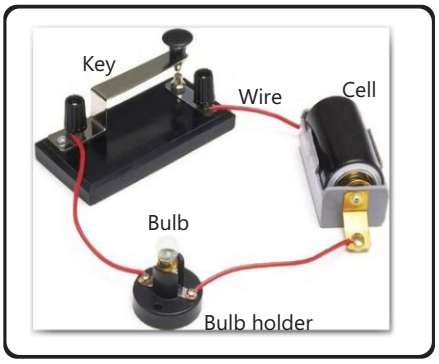
Figure 7.2

Figure 7.3

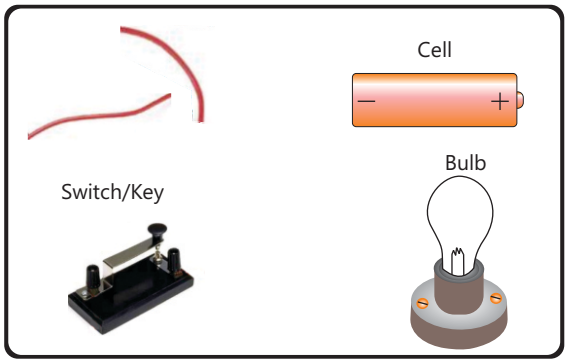
7.2 Electrical Circuit and its Components

The path along which electric current flows is called an electrical circuit (Figure 7.4). Figure 7.4 shows the flow of electric current from one end of the cell to the other end through a wire. Connecting wires, bulbs, keys or switches, battery/cell, etc., are the components of an electric circuit (Figure 7.5).

We observed that a complete or closed circuit is needed for electric current to flow. When the current passes through an electrical component such as bulb, it glows up. After passing through the bulb, the electric current enters the battery at its negative end.



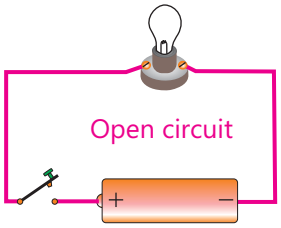
Electrical circuit
Figure 7.4

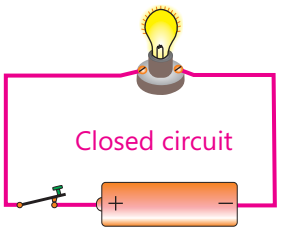


Components of an electric circuit
Figure 7.5

Activity 7.1

- Take a bulb holder and fix a bulb in it.
- Connect one end of a wire at negative terminal of the battery or cell with the help of a sticky tape.
- Connect the free end of this wire with the bulb through the bulb holder.
- Take another piece of wire and connect its one end with the second point of the bulb holder.
- Connect the free end of the other wire with positive terminal of the cell through a key.
- When the key is open, the bulb is OFF.
- Now close the key, the bulb will glow.
- When the key is open, the circuit is not complete and the bulb does not glow. Such a circuit is called open circuit.





- When the key is closed, the circuit is complete and the bulb will glow. Such a circuit is called closed circuit.

7.3 Fuse and its Uses

Fuse is a safety device connected in electrical circuits. It is a thin metal wire which allows a specific amount of current to flow through it. If the current exceeds the limit, the fuse wire melts and breaks the circuit and we say that the fuse has blown up. In this way, the fuse saves our electrical appliances from any damage.

The maximum current that a fuse allows to pass through is called its rating. Fuses of different ratings are used for different appliances. Now-a-days, circuit breakers are also used at the place of fuses. They have the same function as the fuses (Figure 7.6).

Different kinds of fuses and circuit breaker

Figure 7.6

7.4 Static Electricity

We have learnt about two types of charges, i.e., positive charge and negative charge. Positive charge appears on an object when it loses electrons. Negative charge appears on an object when it gains some extra electrons. By gaining or losing electrons, an object can be charged. This is called static electricity. The term static means at rest and electricity means charge. Static electricity thus means the charge at rest on an object. It is also interesting to know that the objects with like charges repel each other and those with unlike charges attract each other (Figure 7.7).

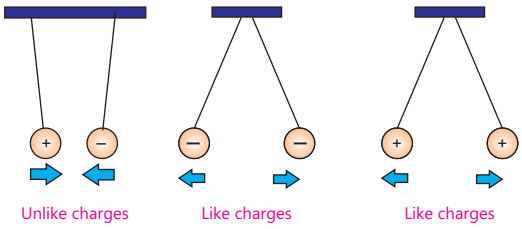


Figure 7.7

Warning!

Never touch wires or other metal parts connected to main electricity. Never touch electric switches bare footed or with wet hands.

How do static charges build up?

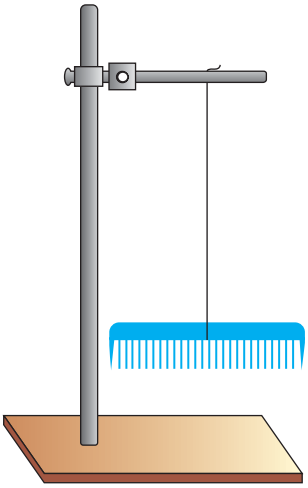
Rubbing of certain materials with one another creates imbalance of positive and negative charges on them. For example, when a plastic comb is rubbed through dry hair, electrons move from hair to the comb. Static charges are built up on the hair (positive charge) and the comb (negative charge). Hair having similar charges repel each other and stand erected separately.

When a charged object is brought close to a neutral object, it repels similar charges present on the object and attracts opposite charges on it. In this way, charges will be induced on the neutral object. Such distribution of

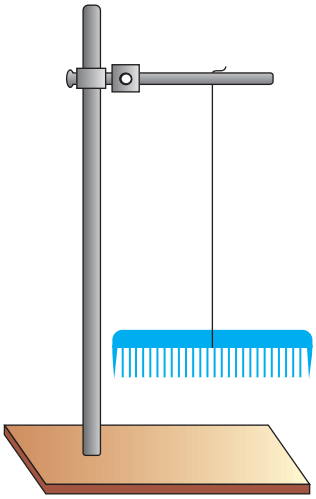
charges on the neutral object remains intact until we move the charged object away from it.

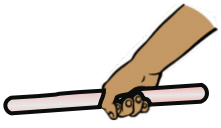
Activity 7.2

- For this activity you need the pieces of silk cloth and woolen cloth, a laboratory stand, a piece of nylon thread, two combs and one thin glass rod.
- Tie a comb with one end of the thread from its middle and hang it in such a way that it remains nearly horizontal. Rub this comb with the woolen cloth and let it hang freely. Now rub the second comb also with woolen cloth and bring it near the hanging comb. Observe what happens.



- Now take the glass rod and rub it with silk cloth. Bring it near the hanging comb and observe what happens.

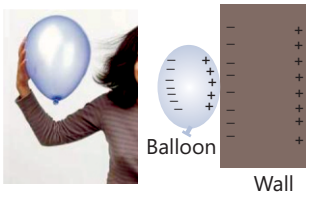




From your observations, can you guess about the nature of charge on the comb and the glass rod?

Activity 7.3

- Take a balloon filled with air. Rub it against your hair (in one direction only) and bring it near the wall.
- Your hair will be raised up and the balloon will stick with the wall.
- Why does all this happen?



Lightning

Lightning is an example of static discharge. The patches of clouds during their movement rub against each other. As a result, huge amount of static charges appear on the cloud patches. Frequent rubbing of clouds increases the amount of static charges on them. When two highly oppositely charged clouds collide, a flash of light appears and a clicking sound is produced as clap of thunder (Figure 7.8).

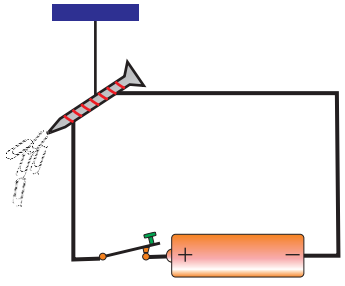
Figure 7.8 Lightning

7.5 Electromagnets

There is a close relationship between electric current and magnetism. Let us perform an activity to understand the relationship between electric current and magnetism.

Activity 7.4

- Take an iron nail and wind an insulated copper wire around it to make a coil.
- Connect the free ends of the coil to a cell or battery through a key.
- Keeping the key open, bring the iron clips near the iron nail. The iron nail will not attract the iron clips.



- Now close the key and observe what happens with the iron clips when brought near the iron nail?
- They will be attracted by the nail and cling to it as shown in the figure.
- Now open the key again and observe what happens with the iron clips?
- All the iron clips will fall from the nail. What do you conclude from this activity?

From the above activity, we observe that when an electric current passes through a wire wound around the nail, the nail starts to attract the iron clips. Thus we can conclude that:

An iron nail or a rod becomes a magnet when electric current passes through the coil wound around it . Such a magnet is called electromagnet.

An electromagnet is a temporary magnet. It remains magnet as long as the current passes through it but when the current is switched OFF it loses its magnetic effect.

Uses of Electromagnets

Electromagnets attract the objects made of iron, nickel and cobalt. They are used widely in our daily life. For example, they are used in magnetic locks, circuit breakers, and loud speakers, etc., Electromagnets are also used in magnetic cranes, electric bells, electric motors etc.

1. Electromagnetic Crane

Have you ever seen electromagnetic cranes working in a scrap yard? In electromagnetic cranes, powerful electromagnet is used for lifting heavy iron scrap (Figure 7.9). These cranes pick up metal scrap by switching the magnet ON. To release the scrap, the electromagnet is switched OFF.

Electromagnetic crane
Figure 7.9

2. Electric Bell

Electromagnet is used in the electric bell (Figure 7.10). When the switch is turned ON, a current starts flowing through the coil around an iron rod. It

becomes electromagnet and thus attracts the elastic iron strip (called armature) towards itself. The hammer which is attached to the armature strikes the gong of the bell and sound is produced. Now electric circuit breaks and the current stops flowing through the coil. The coil no longer remains electromagnet, the armature moves back and completes the circuit again.

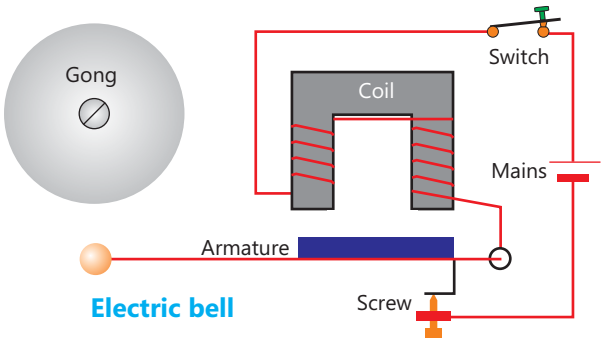


Figure 7.10

The same action is repeated and the hammer continues to strike the gong as long as the switch is kept ON.

7.6 Magnetic Compass

We know that compass is an instrument containing a freely suspended magnetic needle which always points in North-South direction. It is a navigational instrument which is used for finding directions (Figure 7.11).

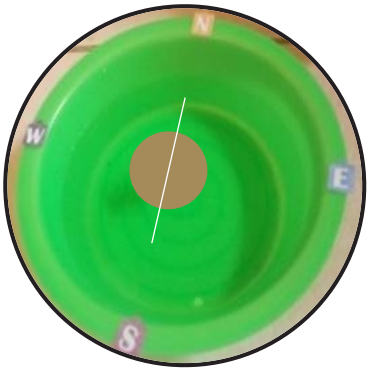

Figure 7.11 Magnetic compass

Compass is also used to locate the direction of Qibla.

Let us make a simple compass by the following activity.

Activity 7.5

- Magnetize a needle by rubbing it with North pole of a bar magnet several times in the same direction.
- Fix the needle on a cork using a sticky tape.
- Put the cork in a bowl containing water and let it float. You will see that the cork floats in water in such a way that one end of the needle points towards the north and the other towards the south.



- Change the position of the bowl in different directions and observe the movement of the needle. The needle always rotates and points in north-south direction.
- Explain what causes the magnetized needle to rotate.

Science, Technology, Society and Environment

There is a key role of electricity and magnetism in the development of modern technology and making the life comfortable. Can you imagine what would happen with technical and social activities if there was no electricity?

It is the electromagnetism on which most of our electrical appliances like fans, electric motors, etc. are based.

KEY POINTS

- Electricity is produced by the flow of electric charge within the materials.
- The path along which electric current flows is called electrical circuit.
- Fuse is a safety device connected in electric circuits. It stops the flow of excessive electric current to pass through an electric appliance and protects it from getting damaged.
- Presence of an electric charge on the surface of an object is known as static electricity.
- Static charges remain on the objects until they are neutralized or discharged.
- When the charged object is brought close to a neutral object, charges will be induced on the neutral object .
- An iron nail or a rod becomes a magnet when electric current passes through a coil around it . Such a magnet is called electromagnet.
- Our Earth itself acts as a huge magnet.

QUESTIONS

7.1 Fill in the blanks with suitable word from the word bank.

Word Bank

electrons	bulb	switch	circuit	magnet	fuse	charges

i. _____ can move in a metal wire.

ii. A _____ makes the current flow in a circuit.

iii. A _____ pulls iron pieces only.

iv. A _____ is used in the electric circuit for safety.

v. Thunder clouds have opposite _____ on them.

7.2 Encircle the correct option.

i. The opposite charges:

a. attract each other b. repel each other

c. heat up each other d. have no effect on each other

ii. Electric current is the flow of:

a. heat b. light

c. charges d. atoms

iii. To protect an appliance from damage we use:

a. switch b. fuse

c. bulb d. battery cell

iv. Which of the following is not an electromagnetic device?

a. Microphone b. Loudspeaker

c. Electric bell d. Magnetic compass

v. Which one is not an electrical component?

a. Microphone b. Telephone

c. Electric motor d. Magnet

vi. Which of the following is an example of static electricity?

a. Battery cell b. Lightning

c. Electromagnet d. Magnetic field

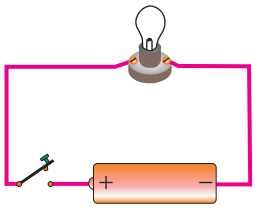
vii. The force needed for electric charge to flow in a circuit is provided by :

a. electric switch b. electric bulb

c. electric wire d. cell

viii. Which of the following is a correct figure for a closed circuit?

a.



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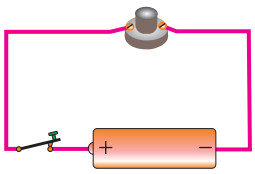

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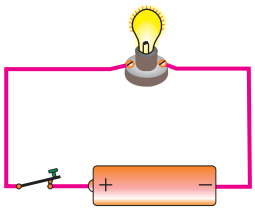

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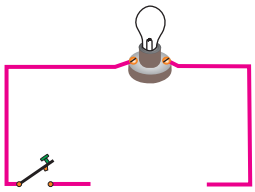

ix. Which of the following is used as a safety device in an electrical circuit?

a. Key b. Circuit breaker

c. Battery d. Ammeter

x. Which is the best material for making an electromagnet?

a. Rubber b. Glass

c. Iron d. Plastic

7.3 Name three examples of:

i. magnetic materials

ii. electromagnetic devices

7.4 Define the following:

Electric current, electrical circuit, static electricity, and electromagnet.

7.5 Explain with the help of diagram.

i. Closed circuit. ii. Open circuit.

7.6 What is a fuse? Describe its uses.

7.7 How do static charges build up?

7.8 You are given a small bulb. Name the other components you need to light it up.

7.9 When two clouds come closer to each other, lightning is produced. Why?