14 Electric Current and its Effects

Lesson at a Glance

- Electricity is one of the most convenient sources of energy. Electricity has very important place in the modern society. Now, we cannot imagine life without making use of electricity.

  Electric charges at rest, present on the surface of a conductor, constitute *static electricity*. When these charges flow, they constitute *current electricity*.
- **Electric charge (Q):** The charge on a body is discussed in terms of electrons. A negatively charged body has excess electrons and a positively charged body has deficiency of electrons.
- **Electric current:** The rate of flow of charge through a conductor, i.e., the electric charge flowing per second is called *electric current*. Symbol used for electric current is I. The unit used to measure current is *ampere (A)*.

  Electric current = electric charge/time

  i.e., $I = Q/t$

  where, I = electric current,

  Q = electric charge flowing and

  t = time in second (s)
- **Ampere (A):** When a charge of 1 coulomb flows through a conductor in 1 second, the current is said to be *1 ampere,*

  1 ampere = 1 coulomb/1second

  Ammeter is used to measure current. Small quantities of current are expressed in milliampere (1 mA = 10^{-3} A) or in microampere (1 μA = 10^{-3} A).
- **Quantity of electricity (Q)** is the amount of charge flowing through a conductor. The quantity of electricity is measured in *coulomb,* denoted by the symbol *C*. 1 coulomb is the charge contained in nearly 6.65×10^{18} electrons.
- **Dry cells:** Electric cells which we use for torches, transistors, and other devices do not have any liquid. They

are portable form of Leclanche cell. Such a cell consists of an outer container made of zinc. The zinc container acts as anode (+ve electrode). A carbon rod having a brass cap is placed at the centre of the zinc container. This carbon rod acts as cathode (–ve electrode).

The carbon rod is surrounded by a mixture of manganese dioxide and powdered charcoal. The remaining space in the container is then filled with a thick paste of ammonium chloride. The cell is sealed from the top with pitch. The outer side of the zinc container is covered with cardboard cover.

- **Battery:** A battery consists of two or more electric cells connected with each other. There is usually a thick wire or a metal strip connecting the positive terminal of one cell to the negative terminal of the next.

  To place the cells correctly in a battery compartment '+' and '–' symbols are usually printed there on the dry cell or storage battery.

- **Storage Batteries:** Dry cell supplies small electric current for a relatively short interval of time as the chemicals are used up due to chemical reaction in it. When higher electric current for long duration is required, we use another type of battery called storage batteries.

  Storage batteries are advantageous to use as they can be charged again and again and the battery is not to be replaced by a new one very frequently.

  Storage batteries are generally used as a source of electric current in motor cars, railway carriges for lighting the head lamps. Such batteries are also used for starting the engines of cars and buses, etc.

- When two bodies with different states of electrification are connected through a metal wire, the electrons flow through the wire till the two bodies attain same state of electrification. This flow of electrons constitutes electric current.

  In a conductor (metal wire), flow of electrons constitutes an electric current.

  According to conventions, the direction of flow of electric current in a conducting wire is taken opposite to the direction of flow of electrons.

- **Electric circuit:** An *electric circuit* is an arrangement for obtaining electric current in a conductor by connecting it to a source of electric current.

  Basically all electrical circuits consist of four main components:

  1. ***A Source of Electric Current:*** It supplies electric current to the electric circuit.
  2. ***A Load:*** It is a component for which an electric circuit is constructed. The load may be an electric lamp, electric bell, electric iron, television or many other electric appliances. When current flows through the load it performs some specific work.
  3. ***Metal Wires:*** These are used to connect source of electric current to the load. In electric circuits we generally use copper or aluminium wires.
  4. ***A Switch:*** It is used for switching on (start) and switching off (stop) the flow of electric current in the circuit. We use many types of switches.

  Electric circuit is an arrangement of various components in which the path of current is continuous and is in the form of a closed loop.

- **Electric conductor and insulator:** Most of the materials can be broadly classified into two categories: conductors and insulators.

  (*i*) **Conductors:** *Conductors* are the substances through which electric charges can flow easily. For example, the electrons of the outer shells of metallic atoms are loosely bound to the nucleus. These electrons are quite free to move. So metals have high electrical conductivity.

  (*ii*) **Insulators:** *Insulators* are the substances through which electric charges cannot move freely. In insulators, the electrons are tightly bound to the nucleus and cannot move away from it. As the electric charges cannot move freely in insulators, so they are poor conductors of electricity.

- **Effects of Electric Current:** When an electric current is passed through an electric circuit, it may produce the following effects:

  (*i*) Heating effect (*ii*) Magnetic effect

(i) Heating Effect of Electric Current: When electric current flows throw a conductor, some heat is produced (due to resistance of the conductor). This effect of current is known as *heating effect of electric current.*

Heat produced in a conductor by an electric current depends on:

(*i*) Length of the conductor

(*ii*) Thickness of the conductor

(*iii*) Nature of the material of the conductor.

In our daily life, there are many applications of heating effect of electric current. The working of electric bulb, electric iron, electric heater, room heater and many other electrical appliances is based on the heating effect of electric current.

(ii) Magnetic Effect of Current: An electromagnet is a temporary magnet, which behaves like a magnet only when electric current is passed through it. It consists of an insulated wire wound around a magnetic material like iron. Both ends of the wires behave like both poles of the magnet.

Electromagnets are used in many devices such as electric bell, cranes etc.

- **Electric Fuses:** Wires made from special materials that melt quickly and break when large electric currents are passed through them. These wires are used for making *electric fuse.* A fuse is a safety device which prevents damages to electrical circuits and possible fire. This is because, if by accident the current exceeds the safe limit, the fuse wire melts or blows off and breaks the circuit. This prevents damage to electric circuit and possible damage to the electric appliances.
- **CFLs:** The wastage of electricity can be reduced by using fluorescent tube lights in place of the bulbs. *Compact fluorescent lamps* (CFLs) also reduce wastage and can be fixed in the ordinary bulb holders.
- **MCBs:** MCBs stands for *Miniature circuit breakers.* They are being used in place of fuses. These are switches which automatically turn off when current in a circuit exceeds the safe limit.

TEXTBOOK QUESTIONS SOLVED

Q.1. *Draw in your notebook the symbols to represent the following components of electrical circuits: connecting wires, switch in the 'OFF' position, bulb, cell, switch in the 'ON' position and battery.*

Ans. Connecting wires

Switch in 'on' position

Bulb

Cell

Switch in 'off' position

Battery

Q.2. *Draw the circuit diagram to represent the circuit shown in fig. 14.1.*

Fig. 14.1

Ans.

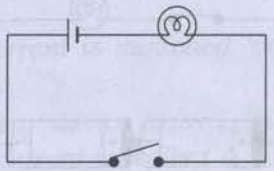

Fig. 14.2

Q.3. *Fig. 14.3 shows four cells fixed on a board. Draw lines to indicate how you will connect their terminals with wires to make a battery of four cells.*

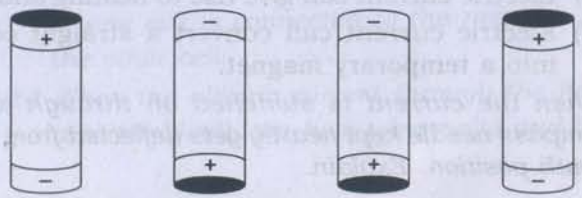

Fig. 14.3

Ans.

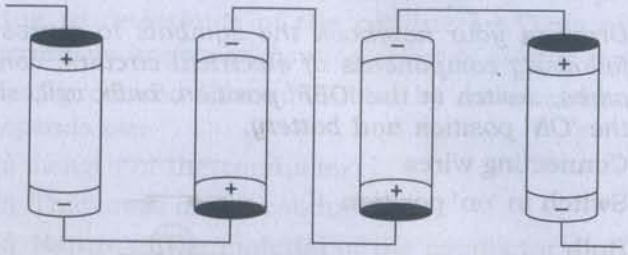

Fig. 14.4

Q.4. *The bulb in the circuit shown in fig. 14.5 does not glow. Can you identify the problem? Make necessary changes in the circuit to make the bulb glow.*

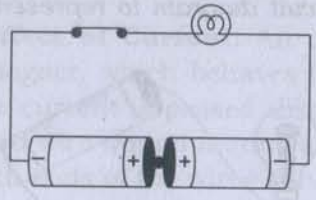

Fig. 14.5

Ans. Problem in this circuit is the combination of two cells. In the circuit positive terminal of one cell should be connected with negative terminal of other to make the bulb glow.

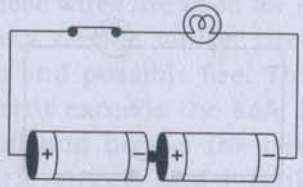

Fig. 14.6

Q.5. *Name any two effects of electric current.*

Ans. Electric current has the following effect :

(*i*) Electric current can give rise to heating and lighting.

(*ii*) Electric current can convert a straight conductor into a temporary magnet.

Q.6. *When the current is switched on through a wire, a compass needle kept nearby gets deflected from its north-south position. Explain.*

Ans. When current is passed through the wire, it deflects the compass near it from its north-south position like a magnet. This is called magnetic effect of the current. As we know that needle of the compass is made up of a thin magnet. When this needle comes in contact with another magnet then the like poles of the magnet repel each other and opposite poles attract each other. So the deflection is seen in the needle. In this case the wire behaves like a magnet and causes deflection in needle of the compass.

Q.7. *Will the compass needle show deflection when the switch in the circuit shown by fig. 14.7 is closed?*

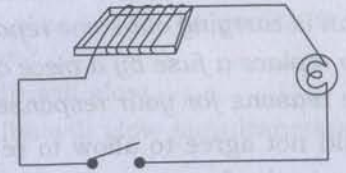

Fig. 14.7

Ans. No, because there is no source of electric current in this circuit, i.e., there is no battery.

Q.8. *Fill in the blanks:*

(*a*) *Longer line in the symbol for a cell represents its _____ terminal.*

(*b*) *The combination of two or more cells is called a _____ .*

(*c*) *When current is switched 'on' in a room heater, it _____ .*

(*d*) *The safety device based on the heating effect of electric current is called a _____ .*

Ans. (*a*) positive (*b*) battery (*c*) becomes red hot and emits heat (*d*) fuse.

Q.9. *Mark 'T' if the statement is true and 'F' it is a false:*

(*a*) *To make a battery of two cells, the negative terminal of one cell is connected to the negative terminal of the other cell.* (*T/F*)

(*b*) *When the electric current through the fuse exceeds a certain limit, the fuse wire melts and breaks.* (*T/F*)

(c) *An electromagnet does not attract a piece of iron.* (T/F)

(d) *An electric bell has an electromagnet.* (T/F)

Ans. (a) F (b) T (c) F (d) T

Q.10. *Do you think an electromagnet can be used for separating plastic bags from a garbage heap? Explain.*

Ans. No, the plastic bags do not get attracted by the magnet, so they cannot be separated by an electromagnet. Plastic bags are not magnetic materials, only magnetic materials like iron can be attracted by the magnet.

Q.11. *An electrician is carrying out some repairs in your house. He wants to replace a fuse by a piece of wire. Would you agree? Give reasons for your response.*

Ans. No, we would not agree to allow to replace the fuse by a wire. Wires in the fuses are of specific melting points. So we should always use ISI marked fuses in our houses to prevent short circuits.

Q.12. *Zubeda made an electric circuit using a cell holder shown in fig. 14.8, a switch and a bulb. When she put the switch in the 'ON' position, the bulb did not glow. Help Zubeda in identifying the possible defects in the circuit.*

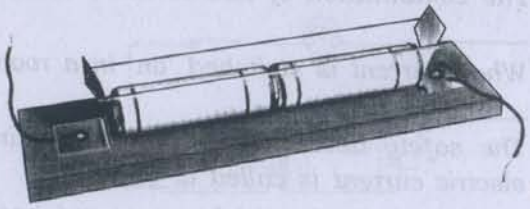

Fig. 14.8 A cell holder.

Ans. It is important to put the cells in right series. The positive terminal of the first cell should be connected with negative terminal of the second cell. The switch should be closed properly and bulb should not be fused. If Zubeda will check these then the bulb will certainly glow.

Q.13. *In the circuit shown in fig. 14.9.*

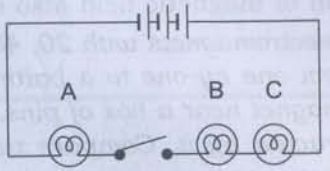

Fig. 14.9

(i) *Would any of the bulb glow when the switch is in the 'OFF' position?*

(ii) *What will be the order in which the bulbs A, B and C will glow when the switch is moved to the 'ON' position?*

Ans. (i) No bulb will glow.

(ii) All bulbs will glow simultaneously.

EXTENDED LEARNING — ACTIVITIES AND PROJECTS

Q.1. *Set up the circuit shown in Fig. 14.10 of NCERT again. Move the key to 'ON' position and watch carefully in which direction the compass needle gets deflected. Switch 'OFF' the current. Now keeping rest of the circuit intact, reverse the connections at the terminal of the cell. Again switch 'on' the current. Note the direction in which the needle gets deflected. Think of an explanation.*

Ans.

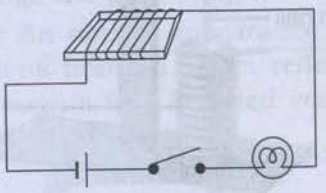

Fig. 14.10

We observe that when key is on position then the compass needle gets deflected in one direction. The needle comes its original position when current is switched off. When we change the direction of current the direction of deflection of compass needle also changed. This activity shows:

(i) Electricity shows magnetic effect.

(*ii*) If the direction of current is changed then the direction of magnetic field also changes.

Q.2. *Make four electromagnets with 20, 40, 60 and 80 turns. Connect them one by one to a battery of 2 cells. Bring the electromagnet near a box of pins. Count the number of pins attracted by it. Compare the strengths of the electromagnets.*

Ans. Students count the pins themselves. If we compare the strength of different electromagnets having 20, 40, 60 and 80 turns the electromagnet having 80 turns has largest strength. This activity shows that:

Strength of magnet $\propto$ Number of turns

Q.3. *Using an electromagnet, you can make a working model of a railway signal as shown in Fig. 14.11.*

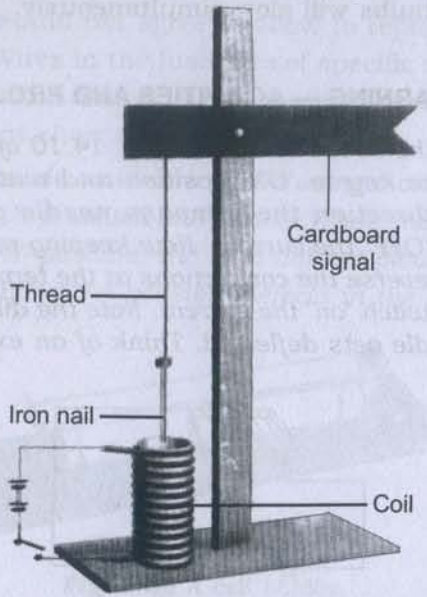

Fig. 14.11 A working model of a railway signal.

Ans. Do it yourself according to fig.

Q.4. *Visit an electric shop. Request a mechanic to show you the various types of fuses and MCB and to explain how they work.*

Ans. The fuses and MCB both work on the basis of heating effect of current. They set up at particular amount of current. If amount of current increases beyond a limit, they cut off the circuits.