10

ELECTRIC CURRENT AND MAGENETISM

Today's era is the era of communication. It is impossible to imagine this era without electricity. It seems like we have an unbreakable relationship with electricity from birth to birth. Do you know who is the creator of the electricity we all use? We are all familiar with the lightning in the sky and the roar of the clouds. What is this lightning in the sky?

Suppose the day is about to hide, clouds are roaring in the sky and suddenly the electricity of the house disappears. Your younger brother rubs the air balloon with his shirt and brings it to the wall, but today that balloon does not stick to the wall, it falls down. You take off your sweater in the dark but today neither the sound of chit-chit nor the small sparks are seen. You take out the torch to escape the darkness, but today it is also cheating, it seems its cells have stopped working. There are machines running generators in your neighbourhood factory. Bulbs are seen burning in the factory and the noise of the generator and machine is heard. You start thinking something. After studying this lesson you will be able to get answers to many of those questions that arise in your mind.

OBJECTIVES

After reading this lesson you will be able to:

- explain electric charge and electron theory;
- Why does a freely suspended magnet always stay in one direction?
- Get to know about electric current;
- explain the use of magnets; and
- Be able to differentiate between direct current and alternating current.

10.1 STATIC ELECTRIC CHARGE

If the weather is clear, try this experiment. Rub the plastic comb with your dry hair and bring it near the small pieces of paper. You will see that the pieces of paper are drawn towards the comb and stick to it. Similarly, if you rub the air filled balloon with your shirt and take it near the wall, then this balloon is pulled by your hands and sticks to the wall. Why does this happen? When we rub things, electric charge comes on them. This type of electricity is called static electricity. With this type of electricity, 2600 years ago, scientist Thales of Greece made many discoveries. Other scientists may have also studied about it, but Thales wrote down his observations, so the credit for this discovery goes to him only. After this, there was no significant discovery in this area for 2100 years. About 500 years ago, William Gilbert conducted experiments related to static electricity and first used the terms 'electric force' and 'electric attraction'.

In 1752 AD, Benjamin Franklin proved that lightning in the sky is actually due to electricity. Through his experiment, he brought the electricity produced in the clouds to the earth through a wet kite's thread. He discovered two types of electric charges - positive and negative. After Franklin's experiments, scientists kept trying to find the source of electric charge for hundreds of years. Finally, in the early twentieth century, the electron-theory that solved this question became developmental.

Electron theory

According to this theory, every object consists of extremely fine particles, which are called atoms. It was found by experiments that the atom itself is made up of two types of very fine electrical particles. Out of this, one type of particle is called a proton, which has a positive electric charge and another type of particle is called an electron, which has a negative electric charge. The negatively charged protons in the nucleus of each atom keep circulating in negative orbits around the nucleus. That is why atoms are called 'electrically neutral'. When we rub two objects together, the electrons of one object transfer to another. The object that loses the electron becomes dense. Conversely, the object on which electrons move becomes negatively charged. Thus we see that there are two types of charge - (1) positive charge and (2) negative charge. According to tradition, the charge with which the glass rod is charged when the glass rod is rubbed with silk is called positive charge. In contrast, the charge in which the scale is charged when the plastic scale is rubbed with wool is called negative charge. To know how these charges behave mutually, let's do an activity:

ACTIVITY 10.1

What you have to do: To study the interaction between charges.

What you need: Two glass sticks, plate, test tube, two plastic scales, rods, piece of silk, wool, thread, stand.

How to do: Charge a glass rod by rubbing it with silk and then hang it from the stand like in the picture. Charge another glass rod in the same way and bring it near the charged end of the first rod. What do you see? The hanging rod starts to run away from the other rod. Repeat the same experiment by rubbing both plastic scales with wool. What happens this time?

Conclusion: What do you conclude from this? It is not that homogeneous charges repel each other.

But why so?

Now rub a glass rod with silk and hang it again like before. Like before, rub the plastic scale with wool and bring it near the stand to the charged end of the hanging glass rod. What do you see this time? Now the glass rod does not run away from the plastic scale, but is attracted to it. What do you conclude from this? Obviously, heterogeneous charges attract each other.

You know that not all objects have the same structure. Observe the design of the electric wires we use on our homes. It has a rubber or plastic shell mounted on the outside of the metal wire. Watch the coil of the electric motor or the tube light coil in the choke carefully. It has enamel paint on it. Do you know why this shell or cover is mounted on metal wires? An electric charge in a metal wire flows easily, while rubber, plastic or enamel does not allow charge to flow through themselves.

Lightning in the sky and roaring of clouds

In childhood, you would be scared to hear the fierce noise of the cloud roaring along with the lightning in the sky and there would be a desire to know about them. Let's understand when lightning flashes in the sky?

The lightning in the sky is often caused by rising of hot winds in hot weather. The hot winds carry the tiny particles of water up to the clouds when they rise rapidly. When water particles and snowflakes fly at a rapid rate in the air, they become charged due to friction from the air. Small positively charged snow-crystals fly up to the top of the clouds and the negatively charged hailstone goes under the cloud bottom. When two clouds of charges of opposite nature come close to each other, their charges do not remain constant, but they move from one cloud to another at high speed through air. This makes the air conductor. Consequently, a large amount of electric charge is immersed by the conductor air for a short period of time. This electric immersion is seen in the sky in the form of a very sharp line of light (lightning), which is also known as lightening. Due to this electric immersion, high intensity compression and rarefaction occurs in the air, due to which there is a loud sound, which is called cloud roaring. With every lightning there is a thunderclap.

Although the lightning generated by the charge in the sky is visible for a very short time, it produces a large amount of light and heat. Can you guess the harm from lightning? Sometimes there is lightning between the clouds and the earth, due to which the buildings and trees are highly damaged.

The materials from which electric charge flows easily are called electric conductors. In contrast, these substances in which charge cannot flow are called insulators. All metals are electrical conductors. Our body is also an electrical conductor. Water and moisture are also electrical conductors. Rubber, plastic, dry wood, enamel paint are some examples of insulating materials. Dry air is insulated, while moist air is not insulated. This is why static electricity is used only in the dry season. If there is moisture in the weather, when glass or plastic rod are rubbed, it gets charged and gets exposed soon. Consider why this happens.

INTEXT QUESTIONS 10.1

1. Fill in the blanks:

   (i) There are two types of charge ……… and …….

   (ii) Homogeneous charges have …… and heterogeneous charges……..

   (iii) The phenomenon of excessive electric immersion between two clouds is called ……..

   (iv) When charged by friction, both objects result in .... but in nature .... take charge.

(v) The objects in which charge flows easily are called.......

(vi) The objects with which the charge does not flow are called ....

2. Choose the correct answer:

(i) Who is the electric conductor among them

(a) Chalk (b) Rubber (c) Dry air (d) Lemon juice

(iii) Who is resistant to electricity

(a) Brine (b) Copper (c) Zinc (d) Dry Air

10.2 ELECTRIC CURRENT

We read that electric charge flows through a metal wire. The flow of charge is called 'electric current'. Just think, what is the necessary condition for the flow of electric current from a conductor? To understand this, consider two utensils connected to tube AB in the picture. From which point in this tube, water will flow towards which point? How long will the flow of water in the tube remain constant? What should be done to keep the flow of water in the tube? If the pressure of water at the point A of the tube remains higher than the pressure of water at the point B, the water can flow continuously from A to B in the tube. For this, there should be constant supply of water at point A.

Similarly, to maintain the flow of electrons in a conductor AB, it is necessary that there is a continuous supply of electrons from point A to the end point B. Electric cell is one such device. In electrical cells, there can be a continuous supply of electrons at one end of the cell (minus terminal) by chemical reactions.

Volta was the first one who made an electric cell, which is called a voltaic cell. This cell has a historical significance. In practice it is not used anywhere. You can also make your own electric cell like Volta.

ACTIVITY 10.2

What you need to do: Make an electric cell from lemon.

What you need: Waste dry cell, knife, sanding paper, two wires 40 cm long electric, 1.5V torch bulb, torch bulb holder, lemon.

How do you do: Break the dry cell and remove its carbon rod. Cut the zinc of the cell into a vessel about 1cm wide. Rub this bandage thoroughly with sandpaper and clean it. Connect the two ends of the bulb holder with two electrical wires. Place the bulb in the bulb holder. Tie one of the free ends of both wires with a zinc strip and connect the other with a carbon rod like in the picture. Make two holes at some distance in the lemon. In one of the hole, zinc plate and in the other hole, be sure to sink carbon sticks. Look at the torch bulb carefully. You will see that the torch bulb is burning slowly.

But why so?

What does the burning of a bulb mean? The bulb can burn when electric current flows through it, that is, when charge flows continuously. The charge flows continuously only when electrons continuously reach the zinc strip. In fact, there is a chemical reaction between lemon juice and zinc within the lemon, due to which chemical energy is converted into electrical energy.

Dry Cell

If you leave the cell for a couple of hours late, then you will observe that the bulb stops burning. In fact these cells have many defects. These defects are removed and usable dry cells are made. To study the structure of a dry cell, take a simple dry cell used in a torch and observe its various parts according to the activity given below.

ACTIVITY 10.3

What you need to do: Study the structure of the dry cell.

What you need: Used dry cell (of a large torch), knife.

How to do it: Cut the cell carefully. Look at its parts carefully. Match the parts of the cell with the given diagram.

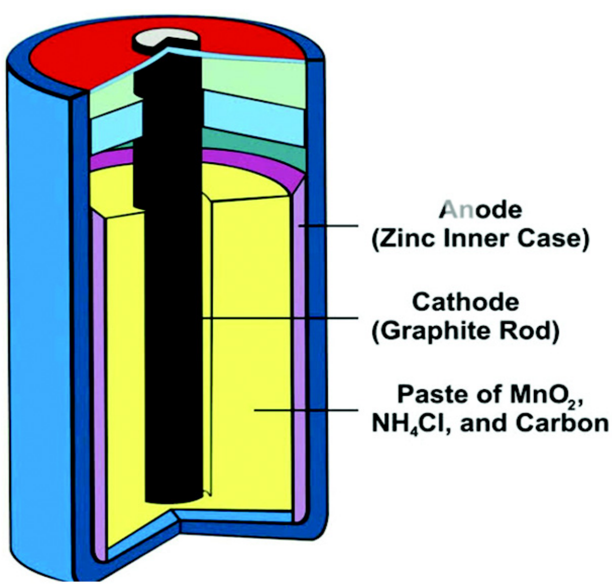

Fig. 10.1 Dry cell structure

Just think: Is it right to call this cell a dry cell? In the new dry cell, actually the material between the carbon rod and the plate in zinc happens to be wet. If this substance becomes dry due to evaporation, then the cell becomes useless without being used. This is why the cell is sealed from outside to prevent evaporation.

You must have realized that dry cells are very heavy and expensive. If more electric current is required, they become useless very soon. Due to their large size, their use is not considered practical. Hence, the search for a good source of electric current continued.

Accumulator cell

In 1860, Plante made an 'accumulator cell' from the plates of lead. We use this improved form of cell in our car, bus etc. You may be confused with the name of 'accumulator cell' and think that the storage of electricity in the accumulator cell would be exactly like that of fruits and vegetables in cold stores. It is not really right to think so.

In the structure of the accumulator cell, a vessel is filled with dilute sulfuric acid and two types of plates are places in it respectively. In charged state cells also have some plates of lead peroxide and the same number of other lead plates. Due to the different chemical composition of both the plates, this cell also provides electric current like other electric cells.

When the accumulator attains electric current by connecting the positive and negative plates of the cell to a conductor, lead sulfate is collected on both its plates. When the cells are charged again, the layer of lead sulfate is removed. And lead is collected on the negative plate and lead peroxide on the positive plate. Two precautions are very important in the use of these cells:

1. The fluid should be completely filled in these cells.
2. These cells should always be kept in charge state. Their voltage should never be less than 108V.

You must have seen electronic wrist watches. Do you know what cell is used in them? If possible, look at these cells carefully at a watch shop. These cells are button-shaped, with a voltage of 1.35V. They contain mercury oxide or silver oxide and zinc electrodes. These are used in rooms and hearing aids in addition to clocks, where low load and small size are important, but there is less demand for electric current.

INTEXT QUESTIONS 10.2

1. What is the voltage of the following cells
   (i) Dry cell (ii) Button cell
2. Name a cell that can be charged again and again?
3. What would you do to conduct current in a wire?

10.3 MAGNET

An incident took place around 2800 years ago at a place called Magnesia in the country of Greece. While grazing the sheep, a shepherd felt that a rock was pulling his iron cap studded stick towards it. He took some pieces of rock in which miraculous properties were found. In addition to pulling the iron on itself, it also had an amazing quality that it used to stop in one direction when hanging freely. Due to this property, this mineral rock was called LodeStone (meaning, which indicates direction). Due to being found in a place called Magnesia, this mineral is also called magnetite. Perhaps later it came to be called Magnet. In Hindi it is called chumbak. Magnets found in rock form are called 'natural magnets'. It is not convenient to use this magnet in practice. Magnet has become an integral part of our life. We make different types of magnets according to our needs and using them.

Find the objects in which magnets are used in our home and nearby neighborhoods. If possible, look at those magnets carefully. Most of your magnets will look like the figures given below.

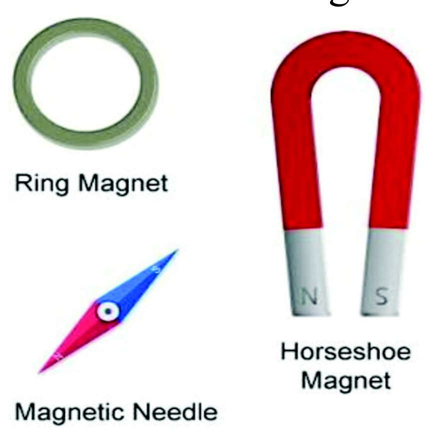

Fig. 10.6 Magnets of different shapes:

ACTIVITY 10.4

What you need to do: Study the magnetic properties of the magnet.

What you need: a rod magnet, thread, stand

How to do: You should tie a magnet to the center and hang it on a stand or peg like a picture. The stand should not be of iron and there should not be any iron items nearby. The magnet will stop in a while. Mark the direction in which the magnet rests. Now slowly position the magnet in any other direction. Observe the direction in which it stops at last.

What you saw: You will see that the magnet always stays in one direction (north-south).

Conclusions: The tip of the stagnant magnet pointing towards the north is called the north-pole and the tip pointing towards the south is called the south-pole.

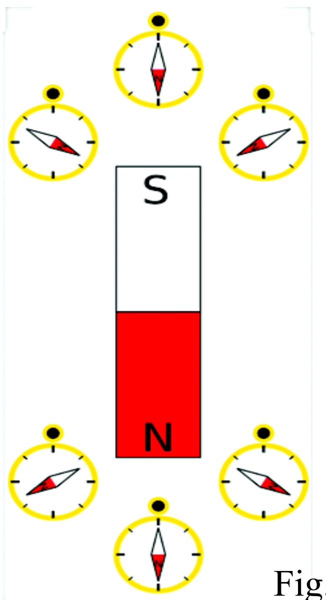

Fig. 10.7 Basic properties of magnet

ACTIVITY 10.5

What you have to do: to study the forces between the magnetic poles.

What you need: Two magnet rods, thread, stand.

How to do you: Like in previous activity, hang both magnet rods from the stand one by one and write 'N' and 'S' on their north-poles and south poles respectively. Leave one magnet hanging from the stand and hold the other magnet in your hand, like the picture, bring its north pole in close proximity to both poles of the hanging magnet, take care that both magnets should not touch each other. Note down your observations. Repeat your experiment with the south pole of the second magnet as well and observe the observations carefully.

What you saw: The north-poles of both magnets repel each other, the south-poles of both magnets repel each other. However, the north-pole of one magnet attracts the south-pole of another magnet.

In short, these conclusions can also be written as a rule that repulsion occurs in homogeneous poles and attraction in heterogeneous poles.

Compare the stated rules for the charges of this rule. What similarities do you find in them?

Perhaps you are thinking that charges and magnetic poles have the same properties of attraction and repulsion. Then why does the magnet always hang in the north-south direction while the charged rod stops in any direction? If we tell you that the earth on which we all live behaves like a giant magnet itself, you might be surprised to hear this. But this is a fact. Now you have studied the laws of attraction and repulsion between magnetic poles. If the Earth is a giant magnet, it must also have two poles. The south-pole of the Earth's magnet is near the geographical north-pole of the earth (near northern Canada) and the north-pole is near the geographical south pole of the Earth.

Uses of magnets

1. Because of the property of always staying in the north-south direction, the magnet is used to make a compass to know directions.
2. Due to its quality of attracting iron objects. Magnets are used to separate iron from litter.

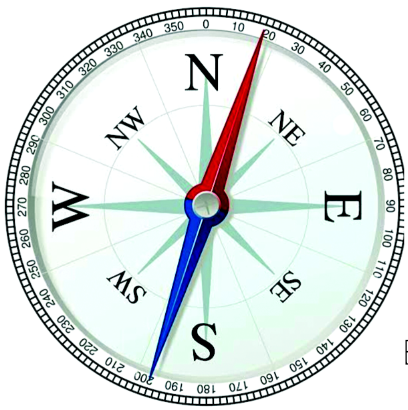

Fig. 10.9: Compass

INTEXT QUESTIONS 10.3

1. Fill in the blanks:
   (i) Free-hanging magnet always stays in the …… direction.
   (ii) In homogeneous poles ..... and heterogeneous poles.....each other.
   (iii) Earth behaves like a huge …….
   (iv) Because it tells direction the natural magnet is called......
   (v) The magnetic ……... pole of the Earth is located near its geographical north pole.
2. Why is a compass needle called a magnetic needle?
3. What is the use of a magnetic needle? Which properties of magnets does it use?

10.4 DIRECT CURRENT AND ALTERNATING CURRENT

You know that when we add an electric cell to a closed circuit, such as a dry cell, a permanent current starts flowing in the metal wires of the circuit. Such a steady flow of electric current in one direction is called 'Direction Current' or DC. But in our homes, shops and factories, direct current is not used to light bulbs or to run electric motors and other electrical appliances. We use Alternate Current or AC 220 volts in most of our works. Do you know why it is called an alternative? This current starts from zero and flows in one direction, reaching its maximum magnitude and starts decreases and reaches zero. At this point the direction of current becomes opposite and decreases to zero, reaching the maximum magnitude from zero as before. This cycle of electric current moving in one direction, decreasing to zero, then increasing to zero in the opposite direction and then decreasing to zero is repeated 50 times in one second.

This is why the frequency of alternating current used in our homes is 50 hertz. The graph shows the direct current and the alternating current as in the picture.

Generator or dynamo

About 170 years ago, England scientist Michael Faraday discovered a property of magnet that is still used in power generation all over the world. You can also do the same experiments that they did.

ACTIVITY 10.6

What you need to do: To study electromagnetic induction.

What you need: Anti-insulated copper coil ,rod magnet, galvanometer.

How to do it: Make a coil of about 25 wraps by wrapping copper wire on a cylindrical object. Remove the cylindrical object and scrape the insulated cover from both ends of the copper wire. Connect the galvanometer at both ends of the two ends as in the picture. It should be well ensured that one end of the magnet can be carried from the inside and outside the coil.

Now quickly move one end of the magnet inside the coil and watch the galvanometer needle carefully. Did the needle show any special deflection, if so in which direction? Repeat your experiment with the other end of the magnet and write your observations in the table.

What You Seen: The galvanometer undergoes a deflection while bringing the magnet back from the coil leading to the coil. The arrival of a deflection indicates that an electric current is induced in the coil at the time of the magnet's movement. When the speed of the magnet is not there, no electric current is also induced in the coil.

The same principle is used to generate electricity in generators. The picture shows the internal state of the generator. It consists of a rectangular coil moving rapidly between the poles of a powerful magnet, producing an induced electric current in the coil, sending it from both ends of the coil into circuits for use by devices. Electricity is produced on a large scale in large power stations. The generators used in these power houses are of very large size, whose horoscope is very large and heavy. Rotating these coils in a magnetic field is a very complex task. Therefore, in large generators, they keep the coil fixed and rotate the magnet.

Nowadays, all the new power plants are being built, only the alternating current is produced. The voltage of this current at the time of generation is 22000 volts or even more.

This current is sent to consumers by transmission lines. Often the voltage of the electric current is increased to 1,32,000 volts by the transformers before being sent by transmission lines. The reason for increasing the voltage is that at higher voltages, the loss of electrical energy in the power transmission is much less. You must have seen electric sub-stations on the roads near your house, where large transformers are installed. The power voltage is gradually reduced at various sub-stations before distributing power to consumers at 220 volts.

The alternating current of high voltages is very dangerous, so in communication, thick wires are placed between high towers. A red sign of danger is placed on each tower.

Household Electric Circuits

Watch the electrical wiring of your home carefully. How many wires are used in it? Observe the wire of any electrical appliance, such as electric iron, kettle, mixer, etc. Three-pin plugs are used in these. The wires of the three codes usually consist of wires of three-colored envelopes. Live wire is often red, neutral wire is black and Earth wire is green. The switch is always connected to the live wire. The ground wire is attached to the metal plate lying in the earth near the house. It is a means of protection and does not affect the power supply in any way.

Electromagnet

We know that if a magnet inside the coil of a wire moves rapidly, electric current flows in the coil. If we flow an electric current in a coil and a magnet is hanging freely near the coil, what will be the effect of the electric current on the magnet? Let's do an activity to find out.

ACTIVITY 10.7

What you need to do: Study the magnetic effect of electric current.

What you need: 8cm long iron nail, about 1 meter long enamel plated copper wire, magnetic needle, two dry cells, small nails or alpin.

How to do you: Wrap the wire tightly on the nail about 50 times. Scrape off the enamel on both open ends of the wire. Now connect these ends with dry cells like in the picture and bring the small spikes of coiled nails near the magnetic needle.

What you saw: Nail containing coil behaves like a magnet when electric current flows. Does the streamline coil also affect the magnetic needle?

Conclusion: When current flows in the coil, the nail becomes magnet. This magnet is called an electromagnet. Compare this electromagnet with a rod magnet.

Dangers and precautions from electricity

We all know that electric energy is a very important and convenient source of energy. However, it is extremely important to take precautions in its use and follow safety measures. A little carelessness can cause us 'electric shock' which can even lead to death. Do you know what causes most trauma? Touching worn metal wires, or metal parts of electrical equipment, causes electrical shock.

There are some simple ways to avoid electric shock. We should not touch any electrical device when we are barefoot or our body is wet. Electrical wires and electrical equipment should not be tampered with in the bathroom.

You are aware that fuses are used in electrical supply of homes. We should not change these fuses. They are for our protection. Fuse wires should not be thicker than required, otherwise the fuse will not be able to protect if more current flows and the wires remain vulnerable to fire.

Electrical appliances, which need to be touched while using, such as electrical irons, refrigerator, etc., must always be 'grounded' by placing 'ground wire'.

Whenever all the fuses are required to determine the cause of the blow. By eliminating that reason, if the circuit appears appropriate, then the circuit switch should be closed immediately.

INTEXT QUESTIONS 10.1

1. Fill in the blanks:

   (i) When connecting the terminals of a cell to a wire, electrons go from ………. terminal to ……. terminal.

   (ii) In a dry cell, a carbon rod acts as ……… electrode.

   (iii) The device that produces electricity by electromagnetic induction is called .... or ....

   (iv) Electrical fuse acts as a circuit ....

   (v) The wire connecting the frame of electrical equipment to the ground is called ……….

   (vi) The frequency of alternating current used in our homes is.......

WHAT HAVE YOU LEARNT

- There are two types of charge positive and negative.
- Homogeneous charges have repulsion and heterogeneous charges have attraction.
- In a normal atom, the number of positively charged protons is equal to the number of negatively charged electrons, so the atom is electrically neutral.
- When an object loses its electron due to friction, it becomes positively charged.
- The materials with which the charge flows are called 'conductors' and the materials from which charges do not flow are called 'insulators'.

- When clouds of two heterogeneous charges come close to each other, electric immersion occurs, which is called lightning.
- The cloud roars after every rain.
- The magnet has two poles, the north pole and the south pole. Homogeneous poles repel and heterogeneous poles attract each other.
- The Earth behaves like a giant magnet, whose north pole is near the geographical south pole and south pole is near the geographical north pole.
- The freely hanging magnet always points in the north-south direction.
- The flow of charge is called electric current. There are two types of currents - direct current and alternating current.
- Dry cell and accumulator cell have direct current. In these cells chemical energy is converted into electrical energy.
- When a magnet moves near a closed coil, an electric current flows in the coil due to electromagnetic induction.
- Electromagnetic induction is used in power generation by generators.
- Electrical wires should never be left naked. Bare electrical wires can cause electrical shock.
- Electrical devices that need to be touched while working must be grounded.
- A device is used for protection in electrically conductive circuits, known as 'safety fuse' or 'fuse'.

TERMINAL QUESTIONS

1. What are anti-electric? Write the names of three anti-electrical materials.
2. Why do electricians wear rubber gloves in hand?
3. Rub the glass rod with silk cloth then the glass rod is positively charged. Will there be any charge on the silk cloth? explain.
4. When we take off clothes made of nylon in the dark,the sound sparks are seen with the sound of chatter. Why does this happen?
5. Match the information given in column 'A' with the word given in column 'B' :

Column 'A'	**Column 'B'**
1. Immersion of huge charges	(a) non-conductive
2. charges flow	(b) electrostatic
3. Unable to stream flowing substance	(c) current
4. mutual repulsion of homogeneous charges	(d) lightened

6. Why the copper rod cannot be charged by holding directly in the hand.
7. Why is magnetite called lodestone?
8. When an electric current flows through a wire, why is there a deflection in a magnetic needle placed nearby?
9. What are electric cells? Explain the structure of a dry cell by diagram.
10. What is the importance of Earthing?
11. What precautions should be taken to avoid electric shock?

ANSWERS TO INTEXT QUESTIONS

10.1

1. (i) positive, negative (ii) repulsion, attraction (iii) lightning. (iv) Equal, opposite (v) Driver (vi)Insulator
2. (i)

10.2

1. (i) 1.5V (ii) 1.35V
2. Accumulator cell.
3. Connect its two ends with the bulb to both poles of a cell.

10.3

1. (i) North-South, (ii) Repel, Attract, (iii) Magnet, (iv) compass, (v) South
2. It has a small magnet.
3. The magnet always uses the properties of north-south direction to find direction.

   To know the direction, use the property of the magnet which always stays in the north-south direction.

10.4

1. (i) positive, negative, (ii) positive, (iii) generator, dynamo, (iv) security, (v) ground wire, (vi) 50 Hertz