Chapter 15

STATIC ELECTRICITY

Electricity has an important place in our life. Without it we cannot even imagine the existence of the modern world. Bulbs, fans, radios, televisions etc. all run on electricity. The flow of charges is called electric current. To know electric current more clearly, it is necessary to know the basic nature of electric charges.

In previous classes we have studied that when a plastic comb is rubbed with dry hair and brought near small pieces of paper it attracts the paper pieces. Similarly while switching the television on or off if we bring our hand near the screen a crackling sound is produced. All these events occur because of electric charges.

Activity - 1

Materials required :- Drinking Straw, balloon, comb and paper.

Rub the straw on a sheet of paper 5 to 7 times and place it on the wall. Similarly rub an air filled balloon on a paper sheet 5 to 7 times and place it on the wall. What happens in the two situations? You will find that the straw as well as balloon stick to the wall. Combing dry hair or rubbing straw or balloon on paper makes them develop a charge.

15.1 Charged and neutral objects

The objects around us do not show the presence of charge in normal conditions. Some of them get charged when rubbed with paper or any other matter. Let us do an activity to understand this.

Activity - 2

Materials required :- Scales made of plastic and wood, pen, comb, balloon, iron nails, cotton cloth, candle and a polythene bag.

Rub each object with the polythene bag and bring them near the small pieces of paper one by one. Make Table 15.1 in your notebook and categorize objects on the basis of your observations.

Table - 15.1

S. No.	Objects that attract the paper pieces (charged objects)	Objects that do not attract the paper pieces (Neutral objects)
1.	Plastic scale	Wooden scale
2.	.....	.....
3.	.....	.....
4.	.....	.....

Some objects develop charge on being rubbed with some other specific materials. The objects, carrying charge, are called charged objects.

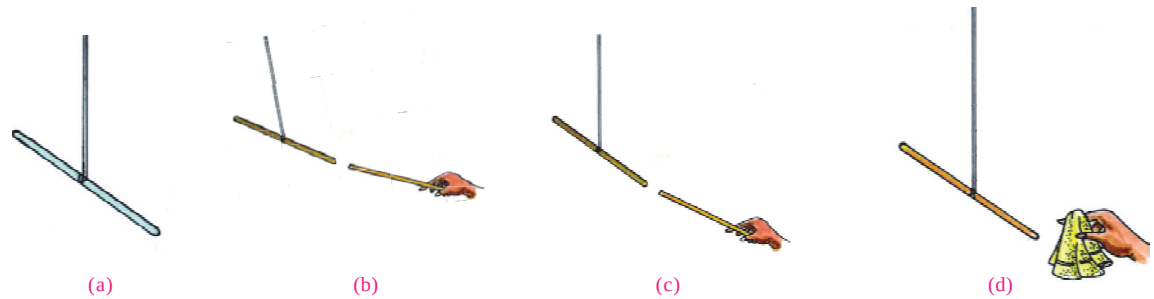
15.2 Nature of charges

We saw in the above activity that charged objects attract small pieces of paper. Now we will see what happens when two charged objects are brought close to each other?

Activity - 3

Materials required :- Two straws, thread, glass rod, silk cloth.

Rub straw with your dry hair. Now hang the straw with a thread (fig. 15.1 (a)). Take another straw, rub it with dry hair. Bring it near the hanging straw. What do you see (fig. 15.1 (b))



(a) Hanging charged straw

(b) On bringing the charged straw close to the charged straw

(c) On bringing the charged glass rod close to the charged straw

(d) On bringing the charged slik cloth close to the charged straw

Fig. 15.1

"When two objects with similar charges are brought close to each other, they repel each other." Now rub a glass rod with the silk cloth and take the glass rod and silk cloth near the hanging charged straw, turn by turn. (fig. 15.1 (c), 15.1 (d)) what do you see? You would see that in one situation there is attraction and in the other situation, there is repulsion. That means opposite charges/develop on the two objects (glass rod and silk) when they are rubbed with each other.

"When two objects with opposite charges are brought near each other they attract each other."

It was on the basis of experiments of this type that the scientists concluded :

Charges are of two kinds – positive charges (+) and negative charges (-).

We must remember that it is only a convention to represent one kind of charge with a positive sign and the other kind of charge with a negative sign.

The charge developed on the straw when it is rubbed with paper is assumed to be negative. Similarly the charge developed on the glass rod when rubbed with silk is assumed to be positive, while the silk becomes negatively charged.

Activity - 4

Materials required :- Two straws, a glass rod, paper, a piece of silk cloth and cotton thread.

1. Hang a straw with the help of the cotton thread. Rub the straw with paper.
2. Take a glass rod and rub it with the silk cloth.

3. Bring the glass rod and silk near the hanging charged straw one by one. You will see that straw is attracted towards the glass rod and is repelled by silk.

4. Rub another straw with paper and bring this straw and the paper near the hanging straw one by one. Both straws repel each other and there is attraction between the paper and the hanging straw.

5. Since it is assumed that when we rub the straw with paper, then the straw gets negatively charged, therefore the glass rod would have a positive charge. Similarly identify the charge on the other objects on the basis of whether they attract or repel the hanging straw and write it in table 15.2.

Like charges repel each other and unlike charges attract each other.

"Repulsion between two objects can prove that both objects are charged."

Table - 15.2

On rubbing the glass rod with silk cloth		On rubbing the straw with paper	
Charge on glass rod	Charge on silk	Charge on straw	Charge on paper
Positive (+)	……	Negative (-)	……

15.3 Properties of charged objects

The properties of charged objects are given below –

1. Each charged object attracts the neutral object towards itself.
2. Like charges repel each other.
3. Un-like charges attract each other.

Electric tester

Electric tester is used to know the presence of current in an electric circuit. It contains a metallic rod whose central portion is covered with a plastic or rubber tube. At one end of the metallic rod a carbon resistance is attached.

A neon bulb, a spring and a brass cap are attached to the other end of the resistor.

The open end of the metallic rod of the tester is connected to the electric circuit and the brass cap is connected to the hand. In this situation electric charge flows to the Earth after passing through the metallic rod, the resistance, the bulb, the spring and then our body. In the situation when charge flows through the instrument the neon bulb inside, starts glowing and shows the presence of current in the circuit.

Fig. 15.2 a
(Electric tester)

The price of a electric tester is between Rs. 5 to 10. Request your teacher or guardian to show you the flow of current using a tester and observe it.

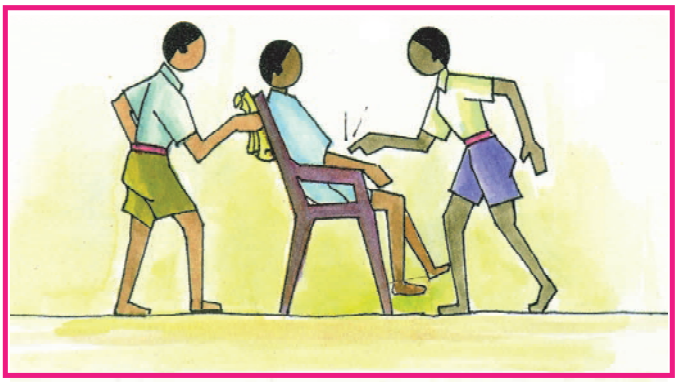
15.4 Different methods of charging objects

(1) Charging by friction -

We have learnt to charge different objects by rubbing them with each other. We know that when two objects are rubbed together, then both objects get charged. This method is called charging by friction.

Activity - 5

Materials required :- One plastic chair, woollen sweater or shawl or cotton cloth electric tester.



The boy sitting on the chair with charge on him (charging by friction)

Fig. – 15.2 b

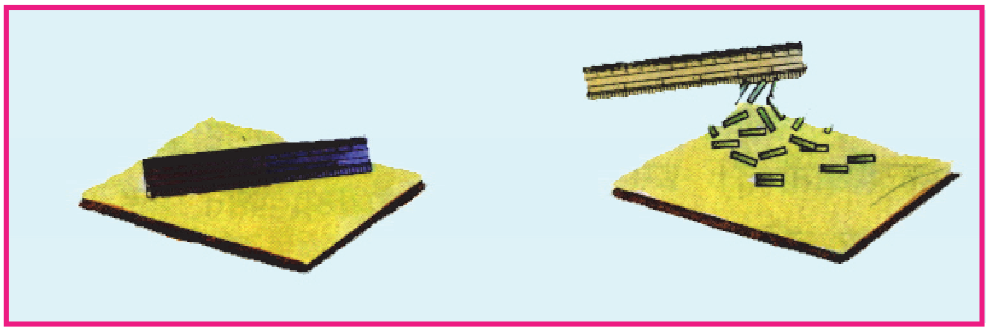
In dry atmosphere make a boy sit on a plastic chair. Ensure that the feet of the boy do not touch the ground. Rub the back of the chair with a woollen sweater or a shawl or cotton cloth eight to ten times. Now touch the tester on the body of the boy sitting on the chair (fig. 15.2). What do you see?

On touching the boy sitting on the chair we get an electric shock. The reason is that charge is generated by rubbing the plastic chair with the woollen sweater or the shawl or cotton cloth.

(2) Charging by contact -

Activity - 6

Materials required :- Two plastic scales.



a b

Fig. – 15.3 **Charging by contact**

Rub one plastic scale with paper 5 to 6 times (fig. – 15.3 a). Touch this scale with the other plastic scale. Now place the other scale near small pieces of paper (fig. -15.3 b). See what happens?

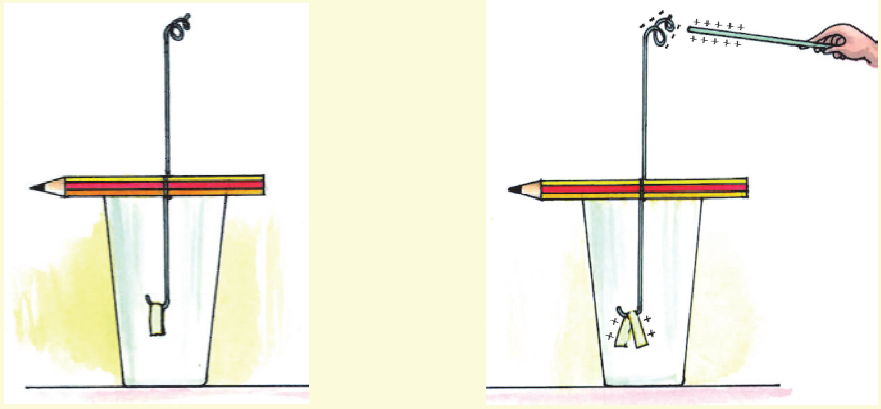
Any object, on being touched with an object having charge, gets charged. This is called charging by contact. If an object is charged by contact then it develops a charge of the same kind as is possessed by the object with which it is touched. It is difficult to charge the objects made up of metals because the charge developed in them flows to the Earth through the human body. If a metal piece is placed on an insulated stand and then charged by friction then the charge developed is maintained.

(3) Charging by induction -

Activity - 7

Materials required :- A glass tumbler, thick copper wire, a glass rod, silver foil used on sweets (2 cm long and 1/2 cm wide), silk cloth and pencil.

Remove the insulator coating of the copper wire, Take a 5 inch long piece of this wire. Roll this over the pencil in such a way that one end of the wire becomes perpendicular and points in the upward direction while the other end points downward, in line with the first end. Fold the lower end of the wire to be inside the tumbler and make a hook. Now fold the silver foil from its mid point and place it over the hook such that it hang on the hook. (fig. 15.4a)



a. hanging neutral foil b. Leaves of foil spread out due to the effect of induction

Fig. – 15.4 Electroscope

Keep this arrangement inside the glass tumbler such that the foil does not touch the walls.

Now rub the glass rod with the silk cloth and bring it close to the upper end of this apparatus without touching it. See what happens? You will find that on bringing the charged rod close to this apparatus, the upper end of the wire becomes negatively charged and the other end gets positively charged. Because of this both leaves of the silver foil move away from each other. Since the silver foil and the copper wire are in contact, when a charged object comes close to the copper wire the silver foil receives charge developed due to induction. Both leaves move away from each other because they have the same charges and are spreadout (fig. 15.4 b). This is called charging by induction.

Answer these

1. How can we check whether an object is charged?
2. How many types of charges are there? Write their names.
3. How many ways can be used to charge an object?

15.5 Gold leaf electroscope

Gold leaf electroscope is a sensitive instrument. With its help the presence of charge in any object can be detected. The electroscope generally contains a metallic rod placed in a glass jar. One end of the rod is connected to a metal coil above the mouth of the jar. The other end of the metallic rod has a golden foil with two leaves placed on it. These leaves are inside the jar (fig. 15.5).

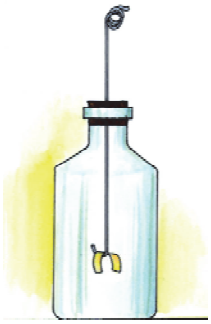


Fig. – 15.5
Golden leaf Electroscope

When a charged object is brought close to the upper end of the gold leaf electroscope, its gold leaves move away from each other. This is because the foil get charged due to induction. On removing the charged object, the leaves collapse and come close to each other. It would be appropriate to perform the above experiment in a dry atmosphere.

15.6 Charge in the atmosphere -

Thundering clouds and lightening are known to people since the primitive ages. Around 250 years ago Benjamin Franklin proved that lightening is a natural event occurring due to charged particles.

Through some experiments it has been observed that the tiny drops of water in the clouds develop positive charge. Bigger and heavier drops have negative charge. Positively charged tiny drops, due to their light weight move towards the upper part of the cloud with air and the negatively charged drops move towards the lower part.

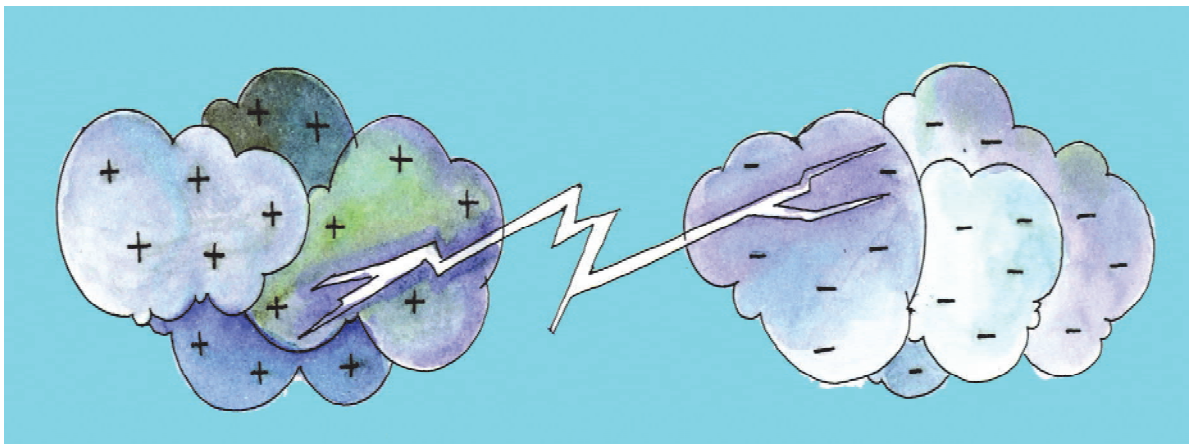


Fig. – 15.6 Electric discharge between clouds with opposite charge

A large force of attractions exists between the opposite charges on the clouds. But the air between clouds prevents the charges from coming closer and neutralize each other. When the amount of charge is very large, the electric insulation can break. In such a situation electric charge can flow through air. When this happens the air gets heated to a very high temperature due to the electrical energy and starts luminescencing (fig. – 15.6). This process is called electrical discharge. We see the luminescence of air in the form of lightning in the sky. This sustains for a very short duration. The cracking sound produced by the lightning discarge can be very intense and we hear it as the thundering cloud.

Sometimes at the time of the lightening, the discharge flows to the ground through tall trees, buildings or other structures and damages them (fig. – 15.7). When this happens, we say that lightning has struck. Lightning can hurt human beings and animals. Sometimes it even causes their death. In mountainous regions lightening is more common than in plains.

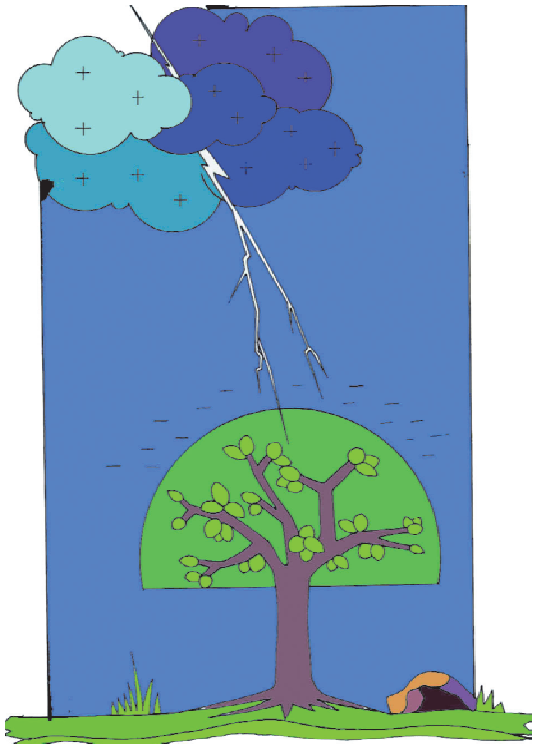


Fig. – 15.7
Lightning between a tree and charged clouds

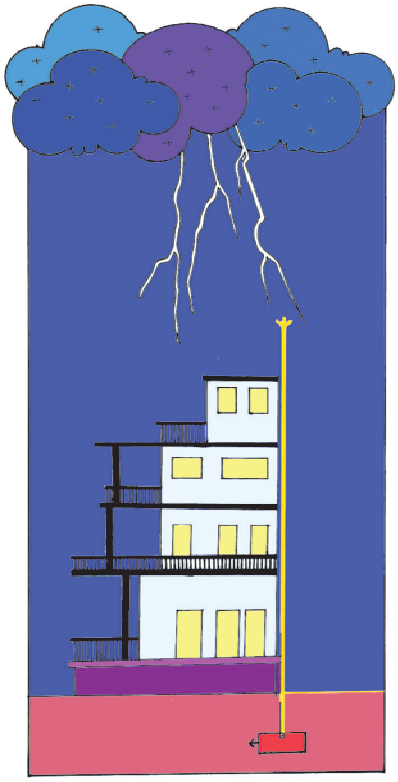


Fig. – 15.8 Lightning Conductor

Advantages of lightening –

Many natural events occur at the time of lightning. Out of these, some are useful.

1. The intense heat generated in lightening helps in the formation of oxides of nitrogen from oxygen and nitrogen. These oxides dissolve in water to make very dilute solution. These solutions provide our Earth with nitrogen compounds, necessary for the growth of plants.

2. During lightning, oxygen gas gets converted to ozone gas. The layer of ozone gas prevents the ultraviolet radiations from the Sun to reach the Earth's surface.

Lightning Conductor

It is not that electric discharges can occur only between clouds having opposite charge. Sometimes the discharge also occurs between charged clouds and the Earth. For example if a charged cloud comes close to the Earth and passes over some tall building or tree, then an opposite charge is induced in them. Consequently an electric discharge occurs between the cloud and that building. This discharge can damage the building.

To prevent tall buildings from getting struck by lightning, lightning conductors are used. These conductors consist of a thick and flat metallic rod with the upper end shaped like a trident. This conductor is fixed at the highest point of the building and the lower end of the rod is connected with a copper plate buried deep inside the ground (fig.–15.8).

When charged clouds pass over the building, then a large opposite charge is produced in the upper part of the conductor by induction. At this time an electric discharge takes place between the cloud and the lightning conductor. The whole charge goes to the ground through the rod and there is no damage to the building.

Benjamin Franklin (1706 - 1790)

In the year 1752 Franklin together with his son William did his experiment of flying kites, and showed that lightning is a natural event. He made his kite with a silk cloth and sticks of Devdar tree. A thin metal wire was connected to a wooden stick in such a way that one of its ends pointed to the upper part of the kite and the other end remained connected to the thread of the kite. When Franklin flew his kite on a stormy day with repeated lightening and thunder. The kite began to fly in the sky, then they observed that due to the transfer of charge from the clouds to the kite, its thread became taut. They connected the metallic wire, which was touching the clouds, to the ground, this grounded the charge on the thread. This produced a spark. Their observation showed lightning is electric in nature.

बैंजामिन फ्रेंकलिन (1706-1790)

Answer these

1. What is a lightening conductor?
2. On what principle does the electroscope work?

We have learnt

- An object can be charged by rubbing it with another object. This is called charging by friction.
- Charged objects attract small pieces of paper.
- It is difficult to charge objects made of metals.
- There are two kinds of charges in nature: (+) positive charges and (-) negative charges.
- Like charges repel each other and unlike charges attract each other.
- Objects can be charged by friction, by contact and by induction.
- With the help of an electroscope we can test whether an object is charged or not.
- Lightning is due to the electric discharge of charges from the clouds.
- Lightning conductor helps in protecting life and property of human beings.

Questions for practice

1. Choose the correct answer –

1. **On rubbing two objects (a) and (b) if (a) attains negative (-) charge then (b) will have–**
   (a) negative charge (b) negative and positive charges both
   (c) positive charge (d) none of these
2. **Out of the following, which one can not be easily charged by friction?**
   (a) glass rod (b) ball of wool
   (c) copper rod (d) balloon filled with air

3. Human body for electric current is –

(a) an insulator (b) sometimes a conductor / sometimes an insulator
(c) a conductor (d) none of these

4. When two objects are rubbed together, then they develop –

(a) opposite charge (b) same charge
(c) No charges (d) some times opposite some times same charge

5. Lightning conductors are made –

(a) of metal (b) of non-metal
(c) by painting the walls (d) of wood

2. Fill in the blanks –

(a) The materials that allow electric current to pass through them are called …….. of electric current.
(b) Like charges……each other, while unlike charges ……. each other.
(c) The mechanism used to protect the buildings from lightning is called ……..
(d) When two objects are rubbed with each the nature of the charges produced on them is ……

3. Write the names of two conductors and two insulators for electricity.

4. Why does the charge on an object vanish when the object comes in contact with our body?

5. What precautions should we take to protect ourselves from lightning?

6. Give reasons –

(a) It is unsafe to stand under trees while it is raining and lightning.
(b) The feather of a peacock stretches on being rubbed between two papers.
(c) When the television is switched on or off, a crackling sound is produced if a hand is placed on the screen of the television.

Do these also

1. Take two empty boxes of camera reels, wrap them in silver foil and hang them close to each other with the help of silk thread as shown in fig. – 15.9. Touch these boxes with a polythene bag after rubbing it with dry hair for one minute. What happened? Why did it happen? Find the reason.

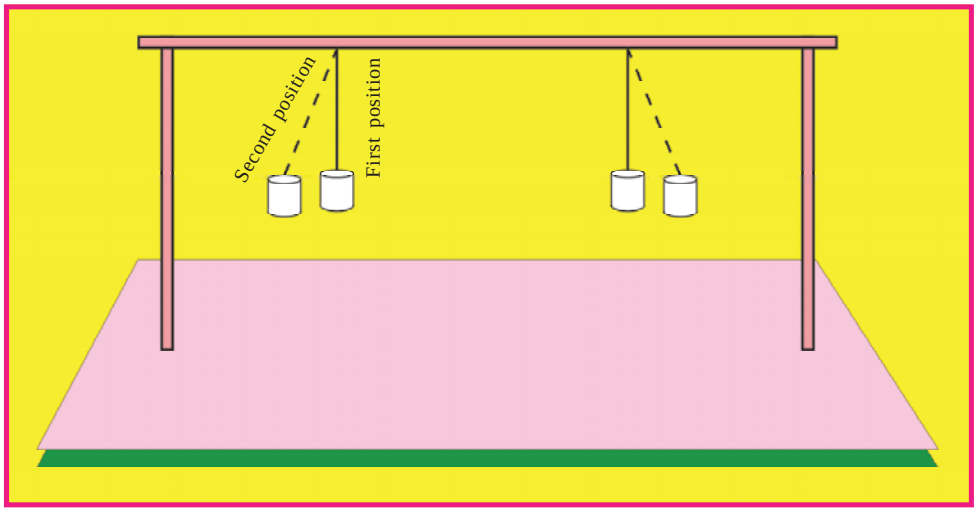


Fig. – 15.9

2. Rub mustard or seaseme seeds kept inside a polythene bag for some time, then keep them in a Plastic or paper plate. What happens? Why does this happen? Discuss it with friends in your class.