02 Static Electricity

2.1 Charging an object

Cut several small pieces of dry paper and place them on a table. Rub a plastic pen against your dry hair and hold the pen close to the pieces of paper. What can you observe ?
You can observe how the pieces of paper are attracted to the pen.

- Are there any other objects that can be used instead of a pen to attract pieces of paper?

Figure 2.1 ▲ How the pieces of dry paper are attracted to the pen

Do you know the reason for the attraction of light things towards an object which is rubbed against some other material ?
Let's do Activity 2.1 to find the reason.

Activity 2.1

You will need :- A glass rod, a piece of PVC pipe, an ebonite rod, a sheet of polythene, a piece of silk cloth, a piece of woolen cloth, some small pieces of paper

Method :-

Hold the objects given in Table 2.1 close to the tiny pieces of paper. Observe what happens before and after rubbing them and complete the column of the table according to your observations.

Table 2.1 ▼

Instance	Object	Observation when held close to the pieces of paper
Before rubbing	• Glass rod • PVC pipe • Ebonite rod	....
After rubbing	• Glass rod rubbed with the silk cloth • PVC pipe rubbed with the polythene sheet • Ebonite rod rubbed with the woolen cloth	....

It is observed that the objects mentioned in Table 2.1, do not attract the pieces of paper before rubbing. But they do attract them after rubbing. Accordingly, it is clear that rubbing an object can make a certain change on it.

The scientist William Gilbert (1600 AD) was the first to reveal that light things are attracted to rubbed objects.

For extra knowledge

Scientist William Gilbert observed that when a piece of solid amber is rubbed with a silk cloth, light objects like tiny pieces of paper and feathers are attracted to it

Gilbert said that electric charges are generated on the surface of objects, when they are rubbed. So, light objects are attracted to them.

- When some objects are rubbed, electric charges are generated on them.
- Electric charges generated on the surface of objects by rubbing, are called static electrical charges.

2.2 Types of static electrical charges

Let's do Activity 2.2 to study further about the static electrical charges.

Activity 2.2

You will need :- Two rods of glass, two rods of ebonite, a piece of silk cloth, a piece of woolen cloth, few pieces of thread, two stands

Method :-

- Hang one glass rod rubbed with the silk cloth, on one stand.

- Hang one ebonite rod rubbed with the woolen cloth, on the other stand.
- Rub the other glass rod with the silk cloth to charge it. Then bring the charged glass rod separately towards the rods hung.

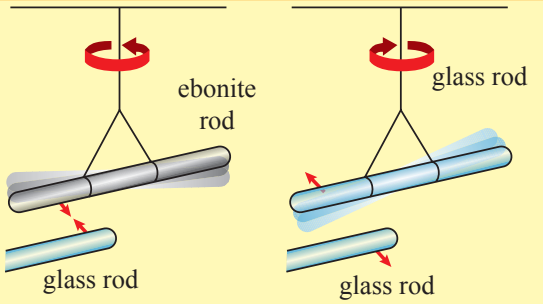


Figure 2.2 ▲ Attractions and repulsions

- Record the observations.
- Rub the other ebonite rod with the woolen cloth and charge it. Then bring it separately towards the rods hung.
- Tabulate your observations. Table 2.2 ▼

Hanging rod	Rod brought towards	Observations
Glass	Glass	Repelled
Ebonite	Glass	
Glass	Ebonite	
Ebonite	Ebonite	

Compare the observations of your group with those of the other groups. Discuss the reasons for the observations

It is observed that there are attractions as well as repulsions between charged rods.

Attractions and repulsions between charged rods are illustrated in Figure:- 2.3 and 2.4

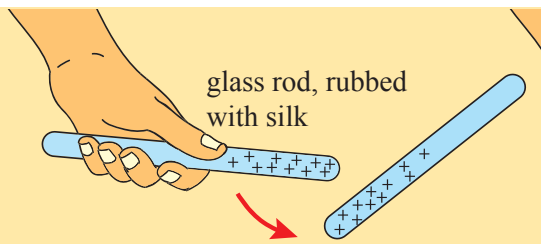


Figure 2.3 ▲ Repulsion

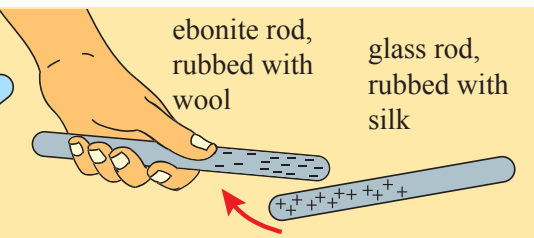


Figure 2.4 ▲ Attraction

The reason for the attraction and the repulsion between charged rods is the existence of two types of static electrical charges.

They are as follows.

1. Positive (+) static electrical charges.
2. Negative (-) static electrical charges.

- Objects with like electric charges repel each other.
- Objects with unlike electric charges attract each other.

Therefore, a glass rod rubbed with silk gains positive (+) static electric charges and ebonite rod rubbed with wool gains negative (-) static electric charges.

Exercise

A PVC rod, rubbed with a polythene sheet is hung with a thread. When a glass rod rubbed with silk is brought towards the PVC rod, it is attracted. What is the type of static electrical charge on PVC rod ?

For extra knowledge

- There are various equipments to identify static electrical charges. One of them is the gold leaf electroscope.

When a charged object is brought towards the metal plate of this electroscope, the gold leaf departs.

Let us do the Activity 2.3 to summarise what we have learnt so far.

Activity 2.3

You will need :- Clean and dry drinking straws, drawing pins, a glass, sheet of polythene

Method :-

Charge the drinking straw by rubbing it with the sheet of polythene

- Balance the charged drinking straw on an upturned glass using a drawing pin as showing in the Figure 2.5 (a)

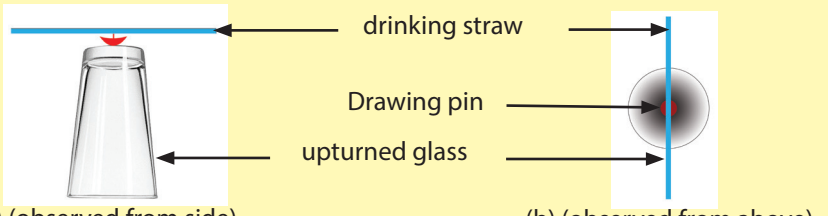


Figure 2.5

- Keep a finger near the charged drinking straw (about 1 cm away). Figure 2.5 b, shows how it in seen when observed from above
- Now, keep the polythene used to charge the drinking straw near it.
- Then, keep another charged straw near the charged straw.
- Discuss the reasons for the observations.

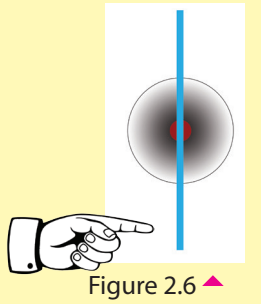


Figure 2.6

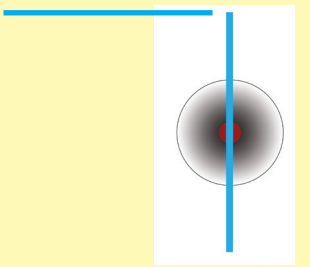


Figure 2.7

2.3 Generation of static electrical charges

The amounts of positive and negative particles are equally distributed on an object before it is rubbed. Therefore, the object does not show any net charge.

When the objects are rubbed against each other negatively charged particles (electrons) remove from one object and transfer to the other object.

The object from which negatively (-) charged particles are removed, is charged positively, and the object that gained negatively (-) charged particles is charged negatively.

The process that takes place when a pair of objects are rubbed against each other can be illustrated as follows.

1) **Before rubbing**

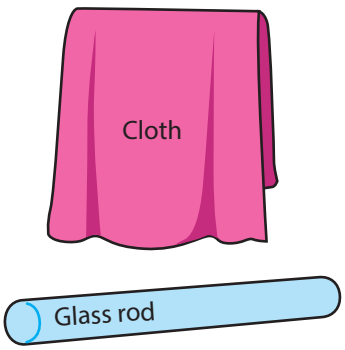


Figure 2.8

Positively (+) and negatively(-) charged particles are scattered uniformly. Therefore objects do not show any net charge.

2)While rubbing

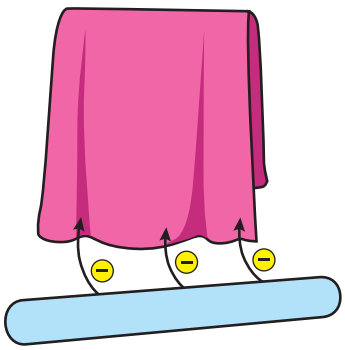


Figure 2.9

Negatively charged particles removed from one object and they are gathered on surface of the other.

3) After rubbing

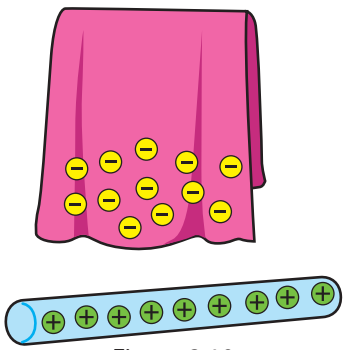


Figure 2.10

One object is negatively (-) charged, beacuse more negetively (-) charged particles are collected on it. The other object is positively (+) charged, because nagatively (-) charged particles are removed from it.

It is clear to you when two objects are rubbed with each other, one object is positively charged while the other is negatively charged.

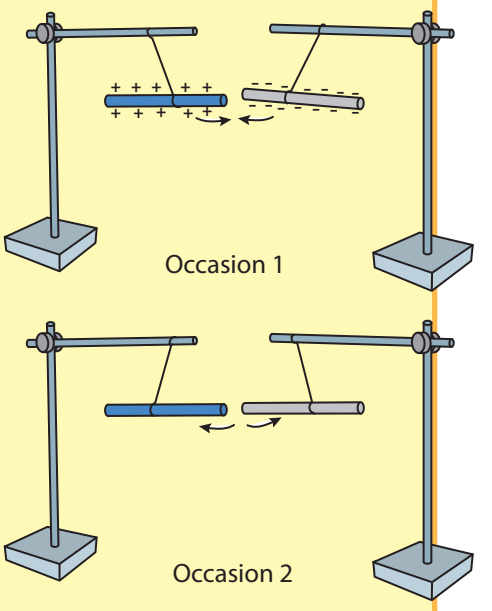
Activity 2.4

Testing the neutralization of charged objects due to the exchange of static electrical charges

You will need :- A glass rod and an ebonite rod of equal size, a piece of silk cloth, a piece of woolen cloth, two stands, pieces of thread

Method:-

- Rub the silk cloth against the glass rod and rub the woolen cloth against the ebonite rod. Hang the two rods separately on two stands with pieces of thread.
- Bring two rods close to each other slowly.
- Record the observations.
- Repeat the previous step several times and observe what happens
- Can you observe the same observation as in the previous occasion?
- Discuss the reasons for your observations.



It is observed that positively (+) and negatively (-) charged rods attract at the first time when they are brought close to each other. But they neither attract nor repel when they are brought together repeatedly.
The reason for this is that they are neutralized because of exchange of charges at the first attraction.

Assignment 2.1

Briefly explain how charges are transferred when a piece of woolen cloth is rubbed against an ebonite rod.

2.4 Phenomena associated with static electricity

There are many occasions in our day-to-day life when we experience incidents associated with static electricity. Let us consider some of them.

1. Lightning

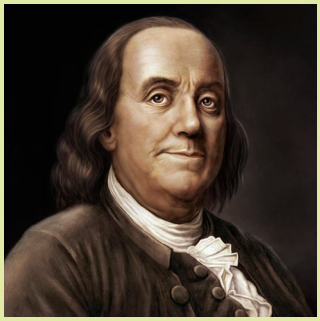
You can recall instances of lightning with or without rain. Sometimes lightning can damage property as well as lives. Lightning occurs because of the generation of static electric charges on clouds. Static electric charges occur on tiny droplets of water on clouds because of their collision with each other. Thus, static electric charges collect on the cloud and the cloud becomes charged.

Figure 2.11 ▲ Lightning

The sudden dischrage of electric charges, accumulated on a cloud, to another cloud or to the earth, as a spark is known as lightning.

For extra knowledge

The scientist Benjamin Franklin was the first to carry out experiments on lightning. Once he sent a kite upto a cloud, while there was lightning and static electrical charges in the cloud was discharged to the earth.



Benjamin Franklin

Benjamin Franklin carrying out an experiment on lightning

2. Emitting 'tic' sound when ironing clothes

Sometimes you may have observed that the hair on your arm is attracted to silk clothes giving a " tic" sound, when you iron them. The reason for this phenomenon is the generation of static electric charges, when iron comes into contact with the silk clothes.

3. Attraction of hair on the arm towards the TV screen

Sometimes you may have experienced that hair on your arm attracts to the TV screen when TV is switched off. The reason for this, is the accumulated static electric charges on the TV screen.

Some other instances associated with static electricity

Static electricity is used in the electronic circuits in equipments like photocopy machines, radio and television.

2. 5 Capacitors

Activity 2.5

You will need :- Two aluminium sheets approximately of 15 cm x 15 cm, two pieces of copper wire, a galvanometer, a polythene sheet, two dry cells, a few crocodile clips, cellotape or rubber bands.

Method :-

- Connect the two pieces of wire to each aluminium sheet, using crocodile clips.
- Place the polythene sheet between the aluminium sheets. Then hold aluminium sheets securely without letting them touch each other, using cellotape or rubber bands.
- Connect the free ends of the wires to dry cells and keep for some time.
- Remove the cells, connect the wires to the galvanometer and observe instantly.
- Discuss reasons for your observations.

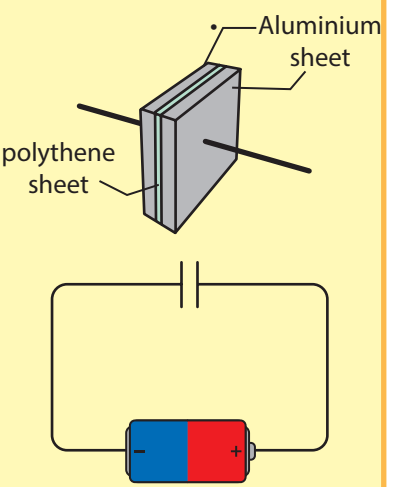


Figure 2.12 ▲ Simple capcitor and circuit with capacitors

What you made in Activity 2.5 is a simple capacitor. When connected to dry cells, static electric charges are stored in the capacitor. When it is connected to the galvanometer, releasing of charges can be observed. The appliance that can store static electric charges is known as the capacitor.

Storage of static electric charges in the capacitor is known as charging, and releasing the charges from the capacitor is known as discharging.
When discharging occurs through the galvanometer, it get deflected.
The amount of electrical charges that can be stored in a capacitor is measured in Farads (F). Microfarad (μF) is used as a subunit.

Figure 2.13 ▲ A capacitor

There are more efficient types of capacitors are made in various sizes.


Figure 2.14 ▲ Symbol of capacitor

Details like chargeable voltage, positive terminals and negative terminals, maximum capacity that can be stored are mentioned on most of them.

Assignment 2.2

Observe the electronic circuits and identify the types of capacitors in radios, televisions and CFLs.

Activity 2.6

Identification of charging and discharging of a capacitor

You will need :- 1000 μF capacitor, three dry cells, a small LED, pieces of wire
Method :-
Connect pieces of wire to the terminals of the capacitor.
Connect the other ends of the wires to dry cells correctly. After few seconds, remove the dry cells and connect the LED correctly to the capacitor and observe. Discuss the reasons for your observations.

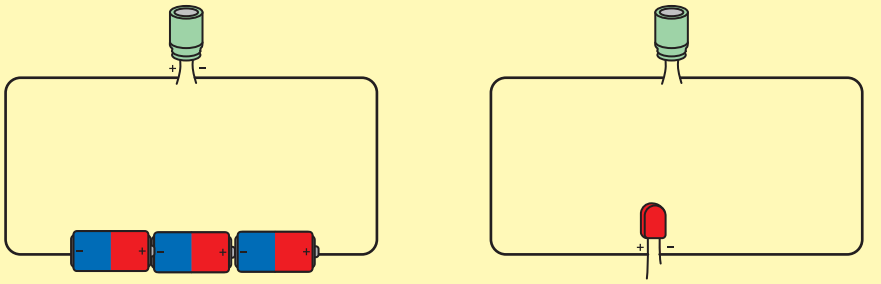


Figure 2.15 ▲ Charging and discharging of a capacitor

The reason for the lighting of the LED is the discharging of charges stored in the capacitor through LED. The capacitor can be recharged by connecting it correctly to the dry cells. Repeat the above activity several times.

Summary

- Static electricity is generated when one object is rubbed against another.
- There are two types of static electric charges, which are positive (+) and negetive (-)
- When objects are rubbed, negatively (-) charged particles in one object are removed from it and are transferred to the other.
- Repulsions occur between likely charged objects and attractions occur between unlikely charged objects.
- Lightning is a phenomenon caused by static electrical charges.
- Static electricity is used in televisions, photocopy machines etc.
- Capacitor is an appliance that can be used to store static electrical charges.

Exercise

1. Mention two instances where static electric charges are used.

2. A student hanged a PVC rod charged by rubbing with a piece of thread. He brought a glass rod rubbed with silk towards the PVC rod. The PVC rod was repelled.
 I. What is the reason for the repulsion of the PVC rod ?
II. What is the type of static electrical charges on the PVC rod ?

3. An electrical circuit prepared by a student is given in Figure 2.16. The indicator of the galvanometer moved, when terminal X is connected to point A. When X is connected to B, the indicator moved again. Clarify the above observation. Mention another observation, that can be made in this occasion.

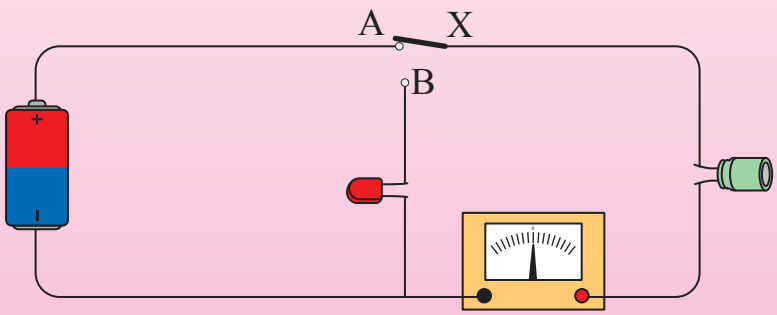


Figure 2.16

Technical Terms

Static Electricity	-	ස්ථිති විද්‍යුතය	-	நிலைமின்
Charge	-	ආරෝපණය කිරීම	-	மின்னேற்றல்
Discharge	-	විසර්ජනය කිරීම	-	மின்னிறக்கல்
Positive charges	-	ධන ආරෝපණ	-	நேரேற்றம்
Negative charges	-	ඍණ ආරෝපණ	-	மறையேற்றம்
Capacitor	-	ධාරිත්‍රකය	-	கொள்ளளவி