8. Static Electricity

Let's recall.

Do you have experience of the instances given below? What is the cause of these effects?

1. A plastic comb or ruler rubbed on dry hair attracts pieces of paper.
2. If we pass near a polyester curtain again and again, it gets attracted towards us.
3. If we rub a blanket with our hands and take it near a metal object, a spark is seen in the dark.

Do you know of other such instances?

Electric charge

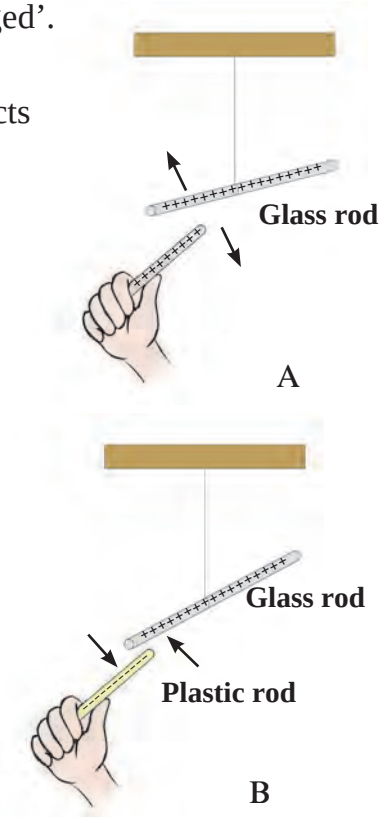
What do the above observations tell us? These examples are just a glimpse of the 'electric charge' that all objects in our surroundings hold in abundance. Electric charge is stored even in our own bodies. All substances are made of very tiny particles. Electric charge is an intrinsic property of these particles. Though, in this way, electric charge is abundantly present, it is always in a hidden state. This is because two opposite types of charges are present in equal numbers in all these substances. When the positive charge (+) and negative charge (-) on an object are balanced, the object is neutral, i.e. there is no net charge on the object. If these charges are not balanced, the object is said to be 'charged'.

Try this.

How would two charged objects interact with each other?

Rub one end of a glass rod against a silk cloth. Due to the rubbing a small charge will get transferred from one object to the other. As a result both the objects will become somewhat charged. Suspend this rod freely in air with the help of a thread. Now charge another glass rod in the same manner and bring it near the suspended rod. What do you see? The two rods push each other away. Now take a plastic rod. Rub one of its ends against a woollen cloth. Bring that end near the suspended glass rod. Now what do you see? The two rods are pulled towards each other.

What did you find in the first experiment? Two rods carrying similar charges push each other away. This is called **repulsion**. We learn from the second experiment that rods carrying opposite types of charges get pulled towards each other. This is called **attraction**.



8.1 Repulsion and attraction

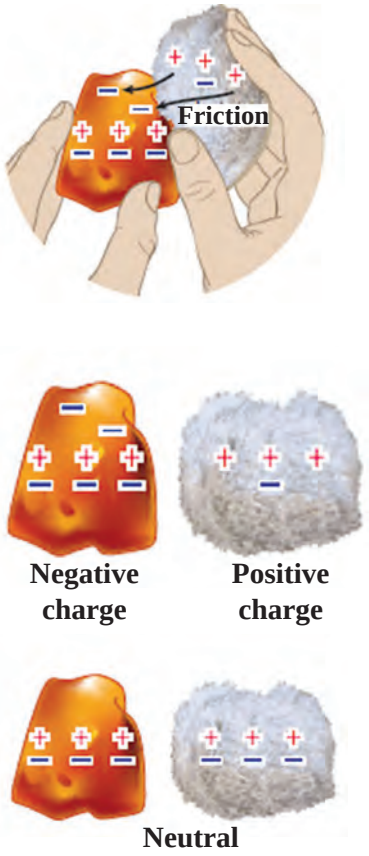
The scientist Benjamin Franklin named the electric charges positive charge (+) and negative charge (-).

What is the origin of an electric charge?

All substances are made up of particles, and these particles are ultimately made up of very tiny atoms. We shall be looking at the details of atomic structure later. At this stage, it is sufficient to know that each atom contains a stationary positive charge and moving negative charges. These two charges being perfectly balanced, an atom is electrically neutral.

All objects are made up of atoms, which means that they are electrically neutral. Then, how do objects become electrically charged?

For some reason, the balance of electrically neutral atoms gets disturbed. For example, when certain objects are rubbed against each other, the negatively charged particles on one object go to the other object. The object to which they go, becomes negatively charged due to an excess of negatively charged particles. Similarly, the object from which the negatively charged particles go away becomes positively charged due to a deficiency of negatively charged particles. It means that, of the two objects being rubbed, one becomes positively charged and the other, negatively charged.



8.2 Electric charge

Try this.

Materials : Paper, polythene, nylon cloth, cotton cloth, silk cloth, etc.

Procedure : First take the objects mentioned in the chart near some small pieces of paper and observe what happens. Then rub each of these objects in turn against one of the given materials and take it near the pieces of paper. Record your observations in the chart.

Material used for rubbing:		
Object	Whether paper pieces get attracted? Yes / No	Does the object get charged? Yes / No
1. Balloon		
2. Ball pen refill		
3. Eraser		
4. Wooden ruler		
5. Steel spoon		
6. Copper strip		

Repeat this procedure with each of the given materials.

Always remember –

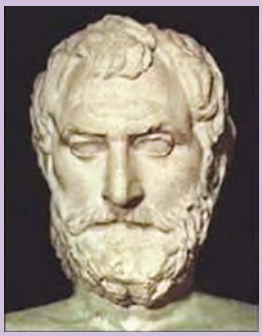
Each atom is electrically neutral. It has equal amounts of positive and negative charge. If for some reason, the negative charge decreases, the atom becomes positively charged.

Use your brain power!

Do all objects get charged by rubbing?

Do you know?

About 2500 years ago a Greek scientist named Thales found that feathers are attracted towards a rod of yellow coloured amber which had been rubbed against a woollen cloth. Amber is called 'elektron' in the Greek language. Therefore, this property of amber to attract things was named 'electricity' by Thomas Browne in 1646 A.D.



Thales

Thomas Browne

Frictional electricity

The electric charge generated by friction is called frictional electricity. This charge is produced only at the place of friction. Hence, it is called static electricity. It remains on the object for a short duration. The charges of static electricity are absorbed in moist air. That is why these experiments should be performed in dry weather, particularly in winter.

Try this.

Apparatus : A few straws, woollen cloth (socks or gloves), glass bottle.

Procedure : Place a straw on a bottle. Take another straw near it. Observe what happens. Leave the straw on the bottle as it is. Rub the other straw against a woollen cloth and take it near the straw on the bottle. Observe what happens. Now take two straws and rub them against woollen cloth at the same time. Keep one of the straws on the bottle and take the other near it. See what happens. Keep the rubbed straw on the bottle as it is. Take the woollen cloth on which it was rubbed, close to it.

8.3 Changes in the straw

Record your observations in each of the above procedures in the chart.

Procedure	Repulsion / Attraction	Inference
A charged straw is taken near the uncharged straw.		
Two straws carrying similar charges are brought near each other.		
A charged straw and the oppositely charged cloth which was used for rubbing are brought near each other.		

Electrically charged objects attract uncharged objects. There is repulsion between like electric charges. There is attraction between unlike electric charges. Hence, repulsion is used as a test for identifying an electrically charged object.

Observe and discuss.

Take thermocol balls or mustard seeds in a bottle and shake the bottle vigorously. The seeds try to move away from each other, but stick to the bottle. Why does this happen?

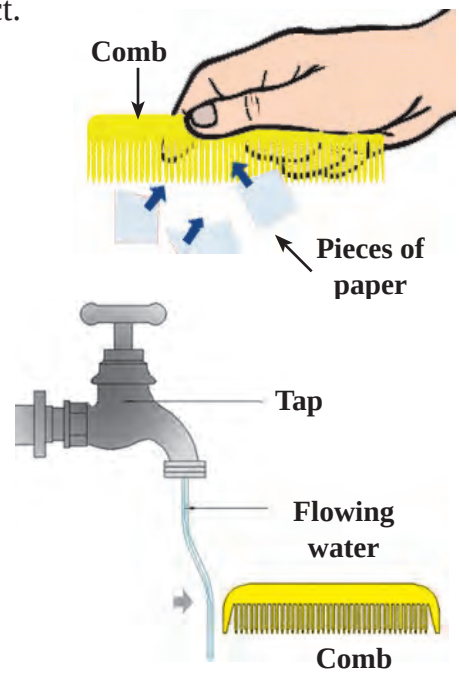
Try this.

1. To charge an object by contact.

Rub a plastic comb against paper. Touch this comb with another uncharged comb. Take the other comb near some pieces of paper. What happens?

2. To charge an object by induction.

Rub a comb or a balloon on your hair. As shown in the picture, take the comb near a thin trickle of water from a tap. See what happens. Now draw the comb away from the trickle and observe what happens.



8.4 Generation of electric charge

Mark your observation with a tick (✓) :

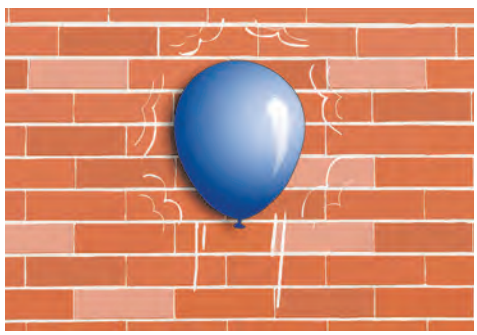
1. When the charged comb is brought close to the flowing water, water gets attracted/repelled/remains as it was.

2. When the charged comb is taken away from the flowing water, it gets attracted/repelled/remains as it was, initially.

At first, the flow of water is not charged. When a negatively charged comb comes near the flowing water, the negative particles in it nearest the comb are pushed away. That part becomes positively charged due to a deficiency of negative charge. The comb has negative, and the water has positive charge. Due to the attraction between these opposite charges, the flowing water is attracted towards the comb. When the comb is taken away, the negative particles in the flowing water come back to their original position and positive and negative charges become equal in number. As a result, the water becomes uncharged again, and stops getting attracted to the comb, as it is away from it.

Use your brain power!

Why does a charged balloon stick to a wall?



8.5 A balloon sticking to a wall

Always remember –

1. The number of positive and negative charges are equal on an uncharged or neutral object.
2. The electric charge generated by induction stays only as long as the charged object is near to it.

Try this.

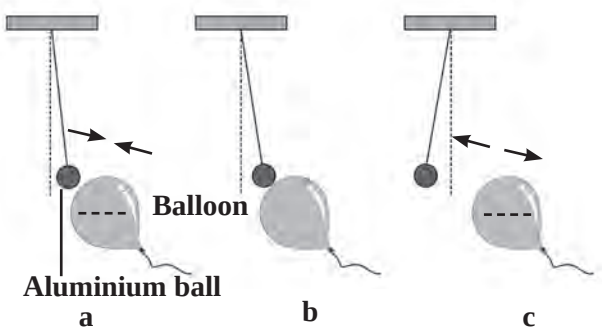
1. Keep a spent tubelight in a dark place. Rub it vigorously with a thin polythene bag. What happened ? Why ?

2. When an uncharged aluminium ball is brought near a negatively charged balloon, the following things happen.

• As shown in figure A, an opposite charge is generated in the other object by induction and both the objects get attracted to each other.

• As shown in figure B, on touching, both the objects become similarly charged.

• As seen in figure C, the like charges repel each other.



8.6 Effects of electric charge

Gold leaf electroscope

This is a simple device to detect the electric charge on an object. It consists of a copper rod which has a metal disc at the upper end and two thin gold leaves at the other end. The rod is placed in a bottle so that the disc is above the bottle. When an uncharged object is taken near the disc, the leaves remain closed. When a charged object is taken near the disc, both the leaves are charged by the same electric charge, and repel each other, i.e. move away from each other, or open up. When we touch the disc with our hand, the leaves collapse, because the charge in the leaves goes into the earth through our body, and the leaves get discharged.

Use your brain power !

Can we use leaves of some other metal instead of gold, in the electroscope? Which properties must that metal have?

Great Scientists

In the year 1752, Benjamin Franklin conducted an experiment of flying a kite with his son William. The kite was made using silk cloth, deodar wood and a metal wire. The metal wire was joined in such a way that its one end was at the top of the kite and the other end was joined to the string of the kite. There was lightning in the sky on the day they flew the kite. When the metal wire touched the clouds, the electric charge got transferred from the clouds to the kite. Then the loose string of the kite became taut and the electric charge reached the earth through the string. A spark was seen where the string touched the earth. Thus, he showed that lightning is a form of electric charge.

Atmospheric electric charge

We have experienced clouds, thunder and lightning. Sometimes we hear or read that lightning struck a tree or a building and some people or animals were killed. How does this happen? How can we prevent such injury or death?

What is it that actually happens when there is lightning in the sky and when lightning strikes the earth?

8.7 Lightning

Lightning

Where air and clouds rub against each other in the sky, the upper part of some clouds on the upper side becomes positively charged and the lower sides become negatively charged.

The science behind lightning and a lightning strike is complicated. Let us, therefore, consider a cloud in the sky with a negatively charged base above a plain ground. When this negative charge on the bottom of the cloud becomes much larger than the charge on the ground, it starts flowing towards the ground in stages. This happens very fast, in much less than a second, and heat, light and sound energy are produced along with the electric current.

A lightning strike

You probably know that, when there are electrically charged clouds in the sky electricity is attracted towards a tall building or tree. When lightning strikes, an opposite electric charge is generated on the roof of a building or on the top of a tree by induction. Due to the attraction between the opposite charges on the cloud and the building, the charge on the cloud flows towards the building. This is called a lightning strike.

Use your brain power!

1. What kind of damage is caused by a lightning strike?
2. What measures will you take to prevent the damage caused by lightning?

Do you know?

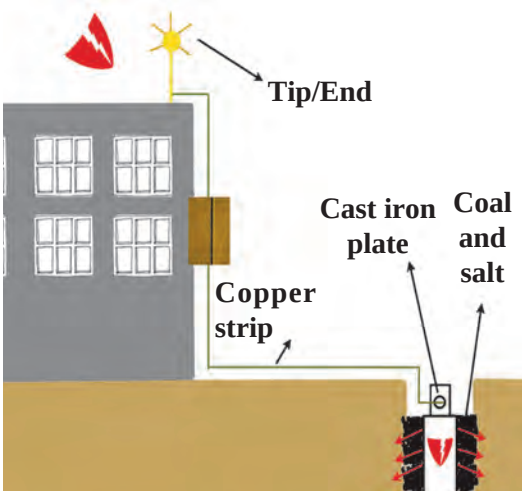
1. Due to the tremendous heat and light generated by lightning, a chemical reaction occurs between nitrogen and oxygen in the air and nitrogen oxide gas is formed. It mixes with the rain water, comes down to the earth, and supplies nitrogen to the soil thus improving its fertility.

2. Due to the energy of the lightning, the oxygen in the air is converted into ozone. This ozone gas protects us from the harmful ultra violet rays coming from the sun.

Lightning conductor

The lightning conductor is a device used for protection from a lightning strike.

It consists of a long copper strip with one end forked. This end is at the highest part of the building. The other end of the strip is connected to a plate of cast iron. A pit is dug in the ground, coal and salt are filled into the pit and the iron plate is placed upright in the pit. There is also a provision for pouring water into it. This helps to spread the electric charge quickly into the ground and prevent damage.



8.8 Lightning conductor

Whenever an electrically charged cloud passes over the building, the electric charges flowing towards the building are conducted into the ground through the copper strip, and damage to the building is prevented. When such a lightning conductor earthing is fixed on a tall building, the surrounding area is also protected from lightning. You will get more information about how to get protection from lightning in the lesson on disaster management.

Use your brain power!

1. Why is the upper end of the lightning conductor pointed?
2. Why are coal and salt added to the pit in the ground?

Exercise

1. Choose the correct option and fill in the blanks.
(always repulsion, always attraction, displacement of negative charge, displacement of positive charge, atom, molecule, steel, copper, plastic, inflated balloon, charged object, gold)

(a) There is …… between like charges.

(b) …….. is responsible for generation of electric charge in an object.

(c) A lightning conductor is made of a …….. strip.

(d) ……. does not get electrically charged easily by rubbing.

(e) There is …… when opposite electric charges come near each other.

(f) A ..... can be detected with an electroscope.

2. Explain why it is not safe to go out with an umbrella when there is heavy rain, lightning or thunder.

3. Answer in your own words.

(a) How will you protect yourself from lightning?

(b) How are charges generated?

(c) In the lightning conductor, what provision is made for spreading the electricity into the ground?

(d) Why do farmers stick an iron staff into the ground while working in the field in rainy conditions?

(e) Why is lightning not seen everyday during the rainy season?

4. What are the characteristics of a static electric charge?

5. What is the damage caused by lightning? How will you create awareness to prevent it?

Project : Make an electroscope yourself by using a thin aluminium foil and check which substances become electrically charged.