Some Natural Phenomena

Electrical Charge

Why is it advised to stay away from an electric plug, fitted loosely in the socket?

This is because a loosely fitted electric plug can produce sparks. These sparks can harm the human body, if it comes in contact with it.

Electric sparks can be found in nature too. They are present on a large scale and are more harmful. Lightning is a natural phenomenon. However, it is destructive as it is a result of electric sparks.

The sparks produced by lighting can be dangerous, since they are caused due to an accumulation of a huge amount of charges. Also, the sparks produced are widespread.

If you take off your woollen sweater inside a dark room, you will be able to see sparks. These sparks occur due to the presence of electric charges.

Rubbing induces electrical charge

Comb dry hair with a plastic comb and bring it near small pieces of paper. **What do you observe?**

You will observe that the pieces of paper get attracted towards the comb.

What is the reason for this?

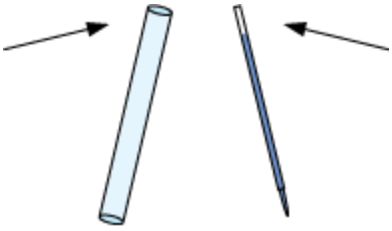
A small amount of electrical charge is acquired by the comb on rubbing it with dry hair. Thus, the comb becomes charged and attracts small pieces of paper.

Rub various objects (such as a glass rod, plastic scale, and rubber tube) with different types of clothes (such as cotton, woollen, and silk). Now, bring these objects close to small pieces of paper. **Can you tell which objects are charged and which are not?**

Interaction between Charges

You know that a charged plastic comb attracts small pieces of paper. Similarly, when we rub a refill with a polythene bag and bring it close to the pieces of paper, we will see that the refill attracts the pieces of paper. Thus, we can say that both the comb and the refill acquire charge.

Bring two charged refills close to each other. **What do you observe?** You will observe that the refills repel each other.



Rub a glass rod with silk cloth. The glass rod will also get charged. **What do you observe when you bring the glass rod close to the charged refill?** You will observe that the rod and the refill attract each other.

Can you explain these observations? These observations can be explained on the basis of **like** and **unlike** charges.

There are two kinds of charges existing in nature: **positive** charges and **negative** charges. As a convention, the charge carried by a plastic refill rubbed against a polythene bag is taken as negative. And the charge carried by a glass rod rubbed with silk is taken as positive. Different types of charges interact with each other according to the following rule:

Like charges repel and unlike charges attract.

Thus, the two refills carrying negative charges repel each other. Now, the refill and the glass rod carry opposite charges. Therefore, they are attracted towards each other.

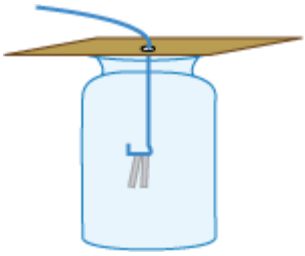
Bring different charged objects near a charged glass rod and observe the interaction between them. **Can you identify the type of charge on an object by observing its interaction with the glass rod?** Now, bring each of these objects near a charged refill. **Are you able to guess correctly the type of interaction of these objects with the refill?**

Charges produced by rubbing do not move by themselves. Therefore, they are known as **static charges**.

Construction and Working of an Electroscope

You know that objects can be charged by rubbing. **Is it possible to detect whether an object is carrying a charge?**

Electroscope is an instrument that is used to detect electrical charge on a body.



How can you construct an electroscope?

It is a pretty simple device. Take an empty glass bottle and cover its mouth with a piece of cardboard. Pierce a hole at the centre of the cardboard and insert a thick metal wire curved at the end. Hang two small strips of aluminium foil of the same size on the curved end of the metal wire (as shown in the figure). This is an electroscope.

Therefore, you see that an electroscope is used to detect whether an object is carrying a charge or not. However, it cannot detect the type of charge (positive or negative) carried by an object.

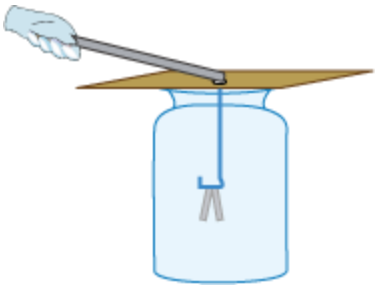
The pith-ball electroscope and the gold-leaf electroscope are two classical types of electroscopes.

Charging by Conduction

In an electroscope, the charge carried by a charged object is transferred to the aluminium strips through a metal wire. Thus, we can say that charge can be transferred from one charged body to another.

However, charge can only be transferred through a good conductor of electricity. In the case of an electroscope, charge is transferred to the aluminum strips through a metal wire. Metal wires are good conductors of electricity. Thus, charge can pass through them.

Let us see if charge can be transferred through the human body. It is extremely dangerous to touch an object carrying a heavy charge. In order to test whether a charge can be transferred through the human body or not, let us perform a simple activity.



Touch a charged glass rod with the metal strip of an electroscope. You will observe that the aluminum strips are repelled by each other. Also, you will observe that they remain in that position even after removing the glass rod. Now, touch the metal strip with your hand. **What do you observe?**

You will observe that the aluminum strips collapse to their original position as soon as you touch the metal wire.

Why does this happen? The charge carried by the aluminum strips is transferred to our body, which in turn is transferred to the ground, i.e., the charge carried by the aluminum strips is transferred to the Earth through our body. Thus, you see that the human body is a good conductor of electricity.

The transfer of charge to the Earth is known as Earthing or grounding.
Removing a charge from a charged body is known as discharging.

Buildings are provided with earthing so that in case of leakage of an electrical charge, people inside the building are not affected, and the charge is transferred to the ground safely.

When electrically charged, the charges on a conductor, whether solid or hollow, reside on the outer surface of the conductor.

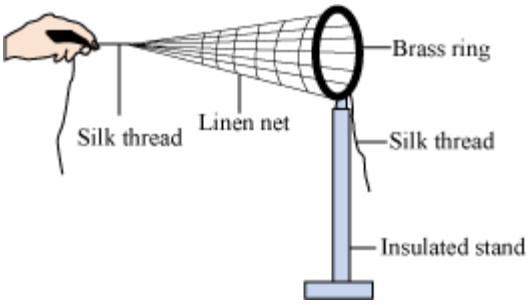
Let us perform few experiments to see how charges are distributed on a conductor.

Biot's Experiment

A is a spherical conductor and **B** and **C** are two hemispherical conductors with handles such that **B** and **C** can just fit on sphere **A**. When **A** is electrically charged, we cover it up with **B** and **C**. After some time, we detach **B** and **C** from **A**. Now, if we test all of them, then we will observe that the hemispheres **B** and **C** are charged, but sphere **A** is neutral. Why does this happen?

When **B** and **C** are attached to **A**, the whole system acts similar to a single conductor. As electric charges only reside on the outer surface of a conductor, all the charges from **A** get transferred to the outer surfaces of **B** and **C**. Therefore, on detaching from **A,** only the hemispheres **B** and **C** contain charges whereas **A** becomes neutral.

Faraday's Butterfly-Net Experiment



Apparatus

- Butterfly net made of linen
- Brass ring mounted on the butterfly net
- Insulated stand supporting the brass ring
- Silk thread fixed on the pointed side of the net such that it extends on both sides

Working

First the net is charged by a glass rod. Then, the presence of the charges is tested on the inner as well as on the outer surface of the net with the help of a proof plane and gold leaf electroscope. It is observed that no charge is present on the inner surface of the net. All the charges are present on the outer surface only. Then the thread is pulled, hence making the inner surface outer and the outer surface inner. The same experiment is repeated. Again, it is observed that the charges are present on the new outer surface.

Charges on a conductor are present only on the outer surface of the conductor. Therefore, charges are always found on the outer surface of the net and not in the inner surface.

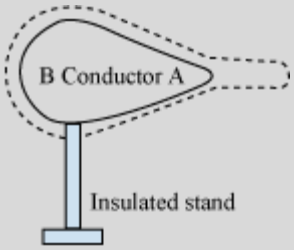
How Charges are Distributed on a Conductor

Do you think that charges are always evenly distributed on a conductor?

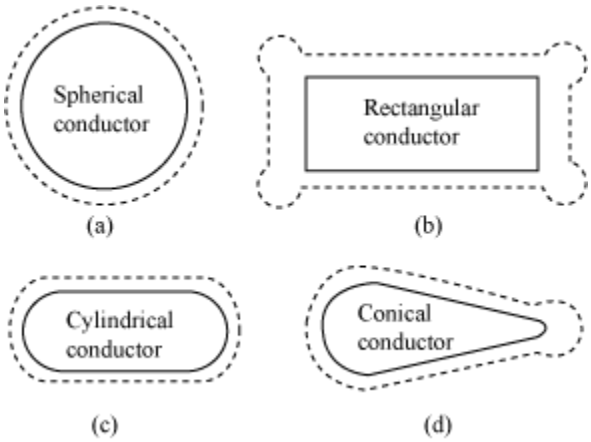
The answer is simple NO. Distribution of charges on a surface depends upon the shape of the conductor. It is observed that charges are densely packed on the pointed areas of a conducting surface or we can say that the density of charges is more on the pointed edges.

The charges present on a unit surface area of a substanceare called the **surface density of charges**.

Take an egg-shaped conductor. Charge it and test the amount of charges at different points on it by using a proof plane or electroscope. It is observed that surface charge density is the maximum at A and the least at B.



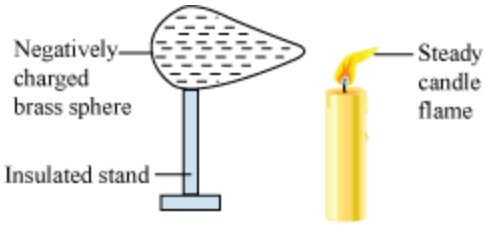
The distributions of charges on conductors of different shapes are shown in the following figures.



Leakage of Charge

Mount a conical conductor on an insulated stand. Charge the conductor with negative charges. Now, bring a candle near the pointed end of the conical conductor. You will observe that the flame of the candle bends away from the conductor. Why is it so?

It is so because the surface charge density of the pointed edge is very high. Hence, when the air molecules come in contact with the pointed end, they take away some electrons from the conductor and become negatively charged. This is called the **leakage of charges.** These air molecules then lose the electrons to the neighbouring air molecules. The air molecules then repel each other, thus forming an electric wind, which bends the flame of the candle away from the pointed edge.

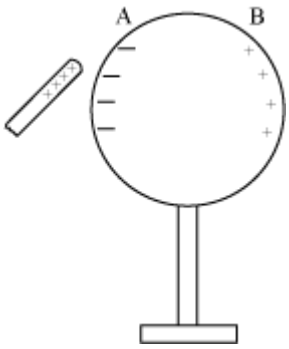


Charging by Induction

It is another method to charge a conductor. In this method the conductor to be charged is not touched with the charge body, but is kept near the it.

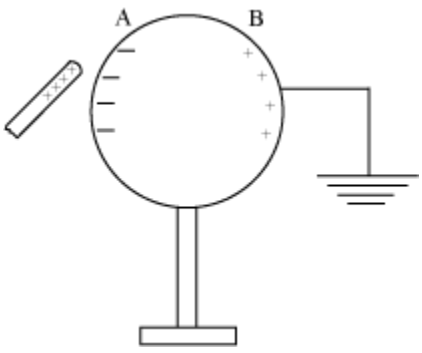
A conductor may be charged permanently by induction in the following steps.

Step I



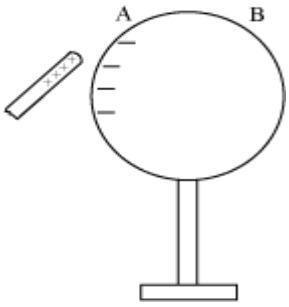
To charge a conductor AB negatively by induction, bring a positively charged glass rod close to it. The end A of the conductor becomes negatively charged while the far end B becomes positively charged. It happens so because when positively charged glass rod is brought near the conductor AB, it attracts the free electrons present in the conductor towards it. As a result, the electron accumulates at the near end A and therefore, this end becomes negatively charged and end B becomes deficient of electrons and acquires positive charge.

Step II



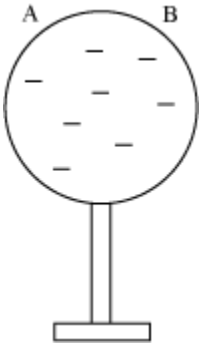
The conductor is now connected to the earth. The positive charges induced will disappear. The negative induced charge on end A of the conductor remains bound to it due to the attractive forces exerted by the positive glass rod.

Step III



The conductor is disconnected from the earth keeping the glass rod still in its position. End A of the conductor continues to hold the negative induced charge.

Step IV



Finally, when the glass rod is removed, the negative induced charge on the near end spreads uniformly over the whole conductor.

Lightening

You know that lightning is a large electrical spark in nature. Lightning usually occurs during thunderstorms. You can see bright streaks of light in the sky known as **lightning**.

Some key points you should remember:

- In general, air is a poor conductor of electricity.
- Lightning only occurs when accumulation of charges becomes so high that air cannot resist the flow of charges.

The electrical discharge that causes lightning may take place between two clouds or between a cloud and the Earth.

Lightning Conductor

Projecting objects such as trees, poles and tall buildings are more likely to be striked by lightning. A lightning conductor is an instrument which is used to protect tall buildings from being striked by the lightning.
It is a long metal rod that runs from the top to bottom along the outer wall of the building. The lower end of the conductoris connected to a metal plate which is burried deep under the ground. If the lightning strikes, the conductor provides the path for the charge to pass directly to the ground without harming the building.

Safety measures during lightning strikes

Following are some safety measures to be followed during a thunderstorm when lightning strikes.

If outdoor:
1. Avoid taking shelter under trees.
2. Avoid being near to any kind of metal objects which may include metal wires, fences, machinery and power appliances.
3. Take shelter inside a fully enclosed car with all the windows shut.

If indoor:
1. Turn off all the electrical appliances such as television and refrigerator.

Earthquakes

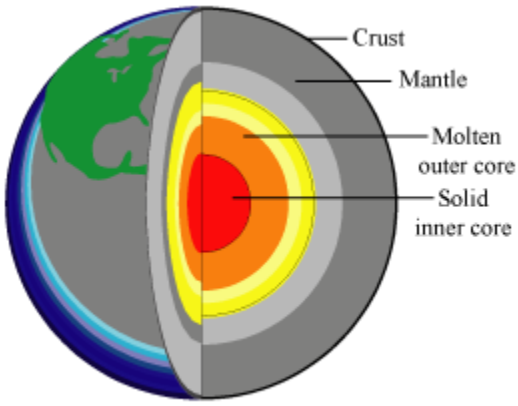
Many natural phenomena such as lightning, cyclones, and thunderstorms can be predicted well in advance. However, there is one natural phenomenon that cannot be predicted. This natural phenomenon is the **earthquake**. Earthquakes can produce large scale destruction. You must have heard about the earthquake, which lead to large scale destruction in the Bhuj district of Gujarat.

An earthquake is a vibration or tremor produced in the Earth's crust. It is caused by the disturbances originating deep inside the Earth's crust. Generally, the period for which the effect of an earthquake is felt is very small.

Earthquakes vary extremely in magnitude. Sometimes, earthquakes are so mild that we don't even feel them. Earthquakes of large magnitudes are not very frequent, but they can produce large scale damage to houses, buildings, and roads.

The earthquake in Bhuj took lives of as many as 15000 people. Recently in China, approximately 8600 people lost their lives due to an earthquake.

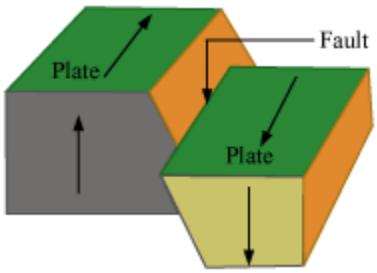
Earthquakes can also produce floods, landslides, and tsunamis. In 2004, a tsunami occurred in the Indian Ocean. It is the second largest earthquake ever recorded and countries like India, Sri Lanka, Indonesia, and Thailand were severely hit by its impact**.**



Structure of the earth

What causes an earthquake?

We know that tremors are produced by the disturbances taking place deep down in the uppermost layer of the Earth known as the **crust**.



This exterior portion of the Earth is not continuous, and is broken into many pieces known as **plates**. These plates move constantly. They can each other because of slide past one another, or move into the collisions taking place between them.

When this happens, disturbances are produced in the earth's crust, which lead to an earthquake on the surface of the Earth. However, this is not the only reason which can give rise to an earthquake.

Earthquakes can also be caused by the following:

- Volcanic eruption
- Meteors falling on the Earth's surface
- Underground explosions. For example, underground nuclear tests.
- Collapsing structures such as mines etc.

We know that earthquakes are caused by the movement of the plates. Hence, boundaries of these plates are weak zones as earthquakes are more likely to originate from here. These weak zones are also known as **seismic zones or fault zones**. In India, some places that come under seismic zones are Guwahati, Srinagar, New Delhi, Patna, Lucknow, Indore, Chennai, and Coimbatore.

The disasterous effects which an earthquake brings along with are:

- Loss of life and property
- Direction of river flows and streams changes
- Change in level of water-table
- Earthquake below oceanic bed can cause tsunami which leads to vast destruction of coastal regions
- Imbalance in ecosystem due to loss of biodiversity

Richter Scale

Earthquakes can be of different magnitudes. The magnitude of an earthquake is measured with the help of a scale known as the **Richter scale**. The Richter scale was developed in 1935 by **Charles F. Richter** of California Institute of Technology.

The magnitude of an earthquake on the Richter scale can range from 0 to 10. Earthquakes that cause massive destruction have magnitude higher than 7 on the Richter scale.

The Richter scale is not a linear scale. This means that an earthquake of magnitude 6 does not have twice as destructive power as the earthquake of magnitude 3. Actually, an earthquake with magnitude 5 is ten times more destructive than an earthquake of magnitude 4. The Richter scale is a logarithmic scale.

The classification of earthquakes on the basis of its magnitude in the Richter scale is given in the following table.

Richter Magnitudes	**Description**	**Earthquake Effects**
0 – 2.0	Micro	Micro-earthquakes. They are not even felt.
2.0 – 2.9	Minor	These earthquakes are generally not felt, but can be recorded.
3.0 – 3.9	Minor	These earthquakes are often felt, but rarely cause damage.

4.0 – 4.9	Light	Noticeable shaking of indoor items and rattling noises are produced during these earthquakes. However, the probability of significant damage is very low.
5.0 – 5.9	Moderate	These earthquakes can cause major damage to poorly constructed buildings in small regions.
6.0 – 6.9	Strong	These earthquakes can be destructive across large populated areas.
7.0 – 7.9	Major	These earthquakes cause serious damage over large areas.
8.0 – 8.9	Great	These earthquakes can cause serious damage in areas several hundred kilometers across.
9.0 – 9.9	Great	These earthquakes can be devastating in areas several thousand kilometers across.
10.0	Epic	An earthquake with a magnitude of 10 in the Richter scale has never been recorded.

Do You Know:

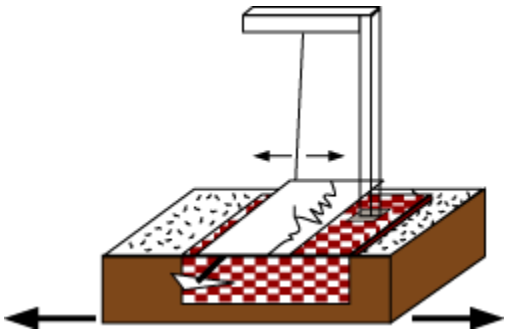
The magnitude of the earthquake which recently hit China was 8 on the Richter scale.
Tsunami, which hit the Indian Ocean on 26th December in 2004, had a magnitude of 9 on the Richter scale. Its duration being as long as 10 minutes.
The earthquake that hit the bhuj area had a magnitude more than 7.5.

Other scales that are used to measure the intensity of Earthquakes are the Mercalli intensity scale, the Rossi-Forel scale, the Medvedev-Sponheuer-Karnik scale, body wave magnitude, the European Macroseismic Scale, the Japan Meteorological Agency seismic intensity scale, the moment magnitude scale, and the surface wave magnitude.

Of all these scales, the Richter scale and the Mercalli intensity scale are widely used. They are universally accepted scales for measuring the magnitude of Earthquakes.

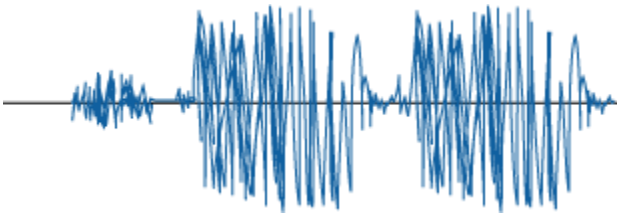
Seismograph

The vibrations produced by an earthquake give rise to waves that travel on the surface of the Earth.



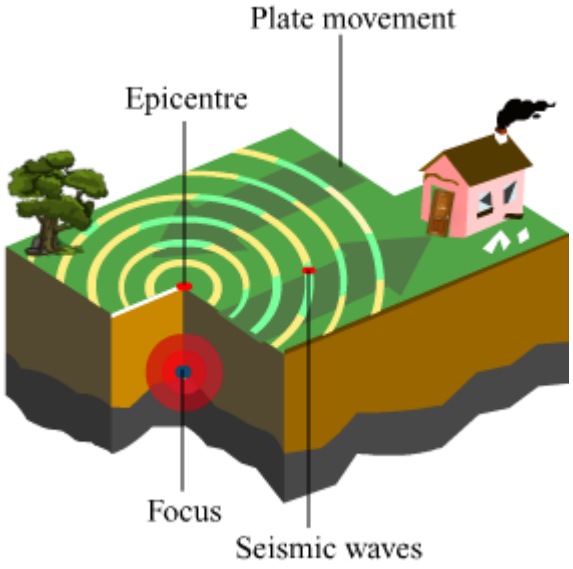
These waves can be recorded by a vibrating instrument known as a **seismograph**.

The seismograph consists of a vibrating rod or pendulum, which starts to vibrate as soon as an earthquake occurs.



This vibrating rod is attached to a pen, which moves with the vibrations that are produced and records the seismic waves on the graph paper. By observing the pattern of these vibrations, scientists can determine the nature of an earthquake and its magnitude. A complete map of the earthquake can be constructed using the observations made by a seismograph.

A complete map of an earthquake includes information about the epicenter, focus of the earthquake, and its intensity on the Richter scale.



The focus of an earthquake is the point in the Earth's crust from where the shock waves of the earthquake originate.
Epicenter is the point on the surface of the Earth directly above the focus.

Precautions During Earthquakes

Earthquakes can be extremely destructive. Also, the occurrence of an earthquake cannot be predicted. Thus, earthquakes can cause extreme destruction to life and property.

Some modern instruments, like laser ranging very long baseline, geiger counter, creep meter, strain meter, tide gauge, tilt meter, volumetric strain gauge etc., help us to get some prior information about earthquake.

It is very important to take appropriate precautions to minimize the destruction caused by an earthquake. Since seismic zones are more prone to earthquakes, people living in these zones have to be extra careful.

Buildings constructed in seismic zones should be strong enough to withstand earthquakes of high magnitudes.
Specialist engineers and architects should be consulted to make quality buildings in these areas.
Roofs of houses must be made as light as possible, so that if they fall the damages incurred are not huge.
Heavy objects such as wall clocks, photo frames, decoration pieces etc. must be hanged in such a way that that they do not fall on anyone during an earthquake.
Buildings can catch fire during earthquakes. Hence, fire fighting equipment must be installed properly in the buildings.

During an earthquake, the following precautions must be followed:

1. If caught indoors:

1.

- Protect yourself by taking shelter under a bed, table, chair etc.
- Do not stand below heavy objects such as wall clocks, decoration pieces, photo frames etc.

2. If caught outdoors:

- Try to find an open area away from buildings, trees, and electric wires.
- If you are inside a closed vehicle, then stay inside it. Do not try to move out.

Do you know?
There are buildings which do not get affected or damaged due to earthquake to a certain extent. These buildings are known as earthquake resistant buildings.

The tall buildings are constructed following the code of conduct for constructions of buildings given by 'Indian Standard Institute'. Buildings are constructed according to IS 456 but the earthquake resistant constructions are done as per IS 1893 and IS 13920 using advanced technologies.