4 SOME NATURAL PHENOMENA

4.1 INTRODUCTION

We can say nature as the power which governs so many activities in our atmosphere and also on our earths surface. There are large number of activities being controlled by nature and we as a human being don't have much control over them but, upto some extent we can predict them.

Storms, cyclones, Earthquake, lightning, rainfall, snowfall are the examples of naturals activities. In our perspective some of them are useful and some of them are destructive in nature but, all of them are happening and governed by the nature to create a balance on earth.

In this chapter we will go through two very important occurrences of nature –

(i) Lightning

(ii) Earthquake

You have learnt about winds, storms and cyclones in Class VII. You know that such phenomena are highly destructive and cause a lot of damage to property and suffering to the human and animal life.

In this chapter, we shall study two more destructive phenomena, i.e., lightning and Earthquake. We shall also consider ways to reduce or minimize their destructive effect.

To start with, we shall consider lightning, which is a kind of huge electric discharge passing between the two clouds or a cloud and the earth. However, before discussing how lightning is caused, let us learn something about electric charges.

Knowledge Based Questions :

Q.1 Which one is the destructive natural phenomena ?
(A) Day and Night (B) Seasons (C) Earthquake (D) Rain

Q.2 Storms and cyclones are destructive natural phenomena.
(A) Yes (B) No (C) Do not know (D) May be.

Q.3 How many types of charges are there?
(A) One (B) Two (C) Three (D) Four

Q.4 If two positive or two negative charges are kept very close to each other, what will happen between them.
(A) No effect (B) They will attract each other
(C) Repel each other (D) No Idea.

Q.5 Name the scientist who studied first time electric charge in clouds.
(A) Benjamin (B) Coulomb (C) Newton (D) Einstein

Q.6 When a comb rub through hair, it attracts pieces of paper.
(A) Due to electrostatic force of attraction (B) Due to gravitational force of attraction
(C) Due to magnetic force of attraction (D) None

Q.7 When a balloon is rubbed with hair, in sticks to wall, due to
(A) Electrostatic force (B) Gravitational force (C) Magnetic force (D) All

Q.8 When we are taking off a shirt, some times a cracking sound is heard or sparks are seen.
(A) Due to charge developed (B) Due to heat developed
(C) Due to tearing of cloth (D) None

4.2 WHAT ARE ELECTRIC CHARGES AND ELECTRICITY?

Electricity is one of the most convenient forms of energy available to us. Can you imagine life without fans, radio, tape-recorders, refrigerators, computers, television and electric lamps? It would be very difficult to live for even a day without some of these benefits of electricity.

Electricity is brought to our houses, factories and other places with the help of wires from electric power plants. Electric current is actually nothing but electric charges in motion. In this article, we shall study **some properties of electric charges at rest, which are also known as static electric charges.**

Amber (known as ***Electron*** in Greek language) is a kind of fossil gum having a straw yellow colour. The ancient Greek philosopher, Thales, found out that when amber is rubbed with the wool, it develops a strange property of attracting tiny bits of dry paper, dry straw, dry pieces of leaves, etc., towards itself. Later, some time in the seventeenth century, *Dr. Gilbert*, reconstructed the experiment of Thales. He showed that not only the amber and wool combination, but many other combinations like ***ebonite rod and cat's skin, glass rod and silk, sealing wax and wool, etc.***, also develop similar properties when rubbed against each other.

The substances which acquire this strange property of attraction were said to be ***charged with electricity or electrified*** (from the Greek word, ***Electron***).

"The phenomenon due to which a suitable combination of bodies, on rubbing, get electrified is called *charging or electrification".*

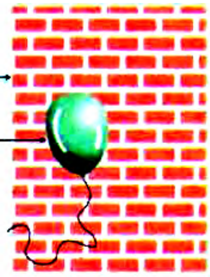
PRACTICAL LEARNING

ACTIVITY - 1

To show that an electrically charged body is attracted by an uncharged body.

Materials required :
- An inflated balloon
- A woolen pullover or any other woolen material.

Method : Take an inflated rubber balloon. Rub it against your pullover or any other woolen material for sometime. Now take the balloon near a wall. What do you observe? You will notice that the balloon sticks to the wall. Why? **This activity show that balloon gets electrically charged on rubbing.**



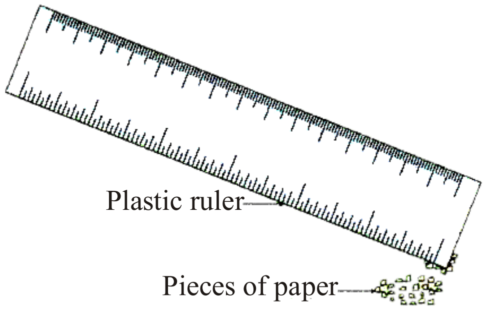
A charged balloon sticks to a wall

ACTIVITY - 2

To prove that a charged body attracts tiny bits of paper towards itself.

Materials required:

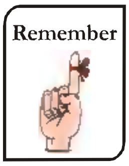
- A plastic ruler
- Some woolen material or your own dry hair
- Small bits of paper or thermocol.



Charged plastic ruler attract tiny bits of paper

Method : Rub the plastic ruler against your dry hair or some woolen material for sometime. Bring this ruler near tiny bits of paper as shown in figure. You will notice that bits of paper cling to the plastic ruler.

Thus, the activity clearly proves that a charged body attracts bits of paper.



- The electric charges make the sparks fly off our body, when we take off our clothes (made from synthetic fibres such as nylon, terylene, etc.) in darkness.
- When you comb your dry hair in darkness with a plastic comb, the electric sparks fly off from your hair. It is because the hair and comb get electrically charged on rubbing.
- It is the electric charge which makes the cuffs and collar of your shirt very dirty. It is because the collar or cuffs get charged by friction and hence they attract dirt particles from the air.

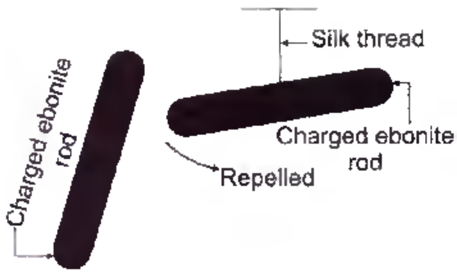
4.3 TWO KINDS OF ELECTRIC CHARGES

Having found that a number of bodies can be charged by rubbing with a suitable material, **Dr. Gilbert** and **Coulomb** set out to find the nature of electric charge on the bodies. They took **a glass rod and silk as one combination and cat's skin and ebonite rod as another combination.**

PRACTICAL LEARNING

ACTIVITY - 3

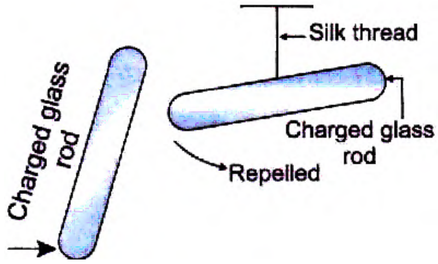
Take an ebonite rod and rub it with a cat's skin. Suspend it freely by a silk thread from some support. Bring near this suspended rod another ebonite rod, which has also been rubbed with a cat's skin.



It is observed that the suspended ebonite rod is repelled as shown in figure.

ACTIVITY - 4

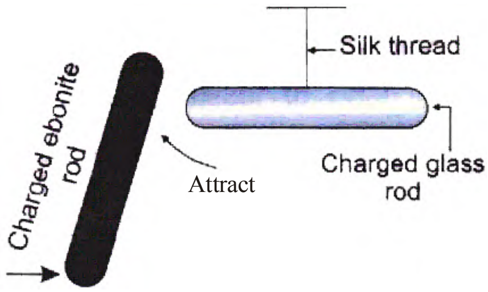
Take a glass rod, rub it with silk and suspend it freely from a silk thread. Bring near this suspended charged glass rod, another glass rod which is rubbed with silk.



It is observed that the suspended glass rod is repelled.

ACTIVITY - 5

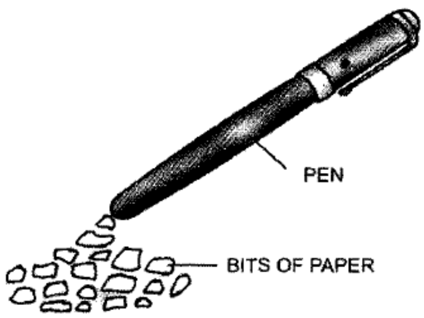
Take a glass rod and rub it with silk and suspend it freely by a silk thread. Bring near it an ebonite rod which is rubbed with cat's skin.



It is observed that the glass rod is attracted by the ebonite rod.

ACTIVITY - 6

Charging by Rubbing : Take a plastic pen, or plastic ruler and rub it on the sleeve of your woollen coat or jersey. Bring it near small bits of paper. What do you observe?



A charged pen attracts bits of paper

The pieces of paper will jump up and stick to the pen, or ruler.

Conclusion : All these activities shows that there is two type of charges one is positive and other is negative. Some charges repel each other and opposite charges attracted each other.

4.3.1 Development of charge on a body

A process of developing charge on a body is called electrification. There are many ways of developing charge on a body.

A. Charging by Rubbing or Charging by Friction

You already know that when a plastic comb is rubbed with dry hair, it acquires a small charge, due to which it may attract pieces of paper or a balloon after rubbing with hair may stick to the wall. These objects are called charged objects.

B. Charging by Conduction

If a charged body is brought in contact with a neutral body the charges may be distributed uniformly on both bodies and hence the neutral body will also be called a charged body.

C. Charging by Induction

When a charged body is brought near to a neutral body the same polarity charge of neutral body will go away from that end and accumulate on the other end, where as the opposite polarity charge will come closer to that end, the other body will behave like charged body.

D. Charging by Ionization

The dissociation of an ionic compound into charged entities(ions) is called ionization

$$NH_4Cl \rightarrow NH_4^+ + Cl^-$$

Remember

TYPES OF CHARGES

There are two types of charges. Positive and Negative. In fact, whenever any one of the process is adopted to develop charge on a body, it is the transfer of electron only, electron is the smallest particle of negative nature possessing a charge of -1.6×10^{-19} Coulomb, where Coulomb is the unit of the charge.

It means, when a body gains electrons, it becomes negatively charged body, if it looses electrons it becomes positively charged body.

→ Gain of electrons : - body called negative charged body

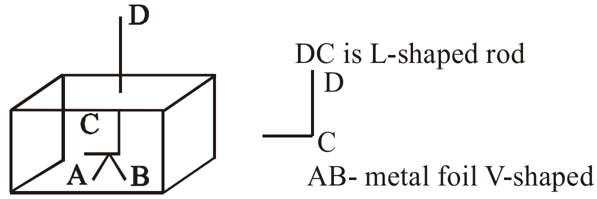
→ Loss of electrons : - body called positive charged body.

1. If we take two bodies of same charge i.e. positive or negative they will repel each other and if they are of opposite nature then they will attract each other.
2. The electrical charges generated by any one of the method are static. They do not move by themselves.
3. The rate of flow of charge is called electric current. The current in a circuit which makes a bulb glows, or the current that makes a wire hot, is nothing but motion of charges.

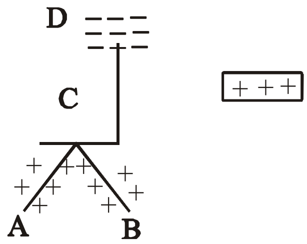
4.3.2 Electroscope

It is a device which is used to detect the presence of charges on a body.

It consists of a glass called cubical box having a conducting rod placed at the center of box in such a way that it is partially inside and partially outside the box.



A metal foil in V- shape is hanging on the lower portion of conducting rod.
When a charged body is brought near its upper end, due to electrostatic repulsion positive charges will move down where as negative charges will accumulate to the upper end.



When positive charges will accumulate at the lower end (AB) where from they will be equally distributed on the metal leaf AB.
Due to repulsion, the divergence in leaf will be seen.
If we touch the foil leaf the divergence vanishes, because the charges are drained to the earth through our body.

Remember

Transfer of Charge : On touching an uncharged body with a charged body, charge is transferred from the charged body to the uncharged body. Again, on touching a charged body with our bare hands, the charge from the charged body is transferred to the earth through our body. **"This transfer of charge from a charged body to the earth is called earthing. The body from which the charge has been earthed loses the charge on it. Such a body on losing the charge on it is called discharged".**

PRACTICAL LEARNING

ACTIVITY - 7

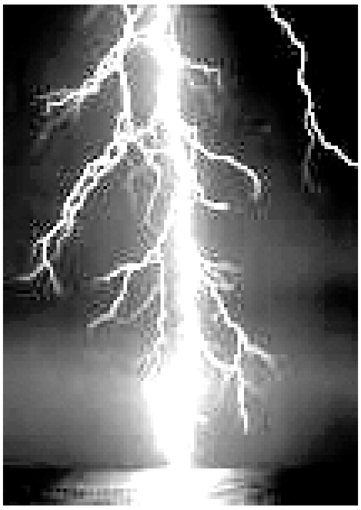
1. Bring a rubbed ebonite rod with fur and touch the metal rod of the electroscope with it. The negative charge from the ebonite rod gets transferred to the gold leaves. The gold leaves diverge (open up) showing that both are bearing the same charge. They repel each other.
2. Touch the rod of the electroscope with bare hands. The gold leaves fold and come to lie parallel to each other. The charge from the electroscope and its gold leaves it 'earthed' on touching them with hands.
3. Again, charge the electroscope with negative charge from a rubbed ebonite rod. The gold leaves diverge. Now, bring a positively charged glass rod rubbed with silk and touch the disc with it. The gold leaves fold back, showing that there is no charge on them. This time, the negative charge from ebonite rod has been neutralised with positive charge from the glass rod.

Conclusion : Charge gets transferred from one body to another.

4.4 CHARGES IN ATMOSPHERE OR ATMOSPHERIC ELECTRICITY

Lightning is a dazzling bluish white light produced in the clouds. It is followed by a loud noise called thunder: Till 1752, nobody really knew about the cause of lightning. Benjamin Franklin, by a brilliant experiment, proved that it was caused by static electric charges in the clouds.

We know that sometimes during rain, thunder and lightning also takes place. **"During rain over the sky flashes of light are also observe. This natural phenomenon is called lightning".** During lightning strike, ten to twenty thousand amperes of electric current flows. The air in the path of lightning heats up and gets hotter than the surface of the sun (about **30,000ºC**). This causes the flash of lightning.



Lightning

The thunder that we hear during rain is due to the wave of vibrations (shock wave) which occur due to enormous amount of heat produced and make the air expand suddenly.

Therefore, a lightning is a high-energy electric discharge accompanied by a large amount of heat and light. This can happen between a charged cloud and the ground, between two charged clouds or even between two oppositely charged portions of the same cloud.

4.4.1 How do Clouds Get Electrically Charged?

Due to the heat of the sun, the warm air and water vapour rise up. Similarly, the cold air from above sinks down. When the air molecules rub against water molecules or the cold currents of air rub against the hot currents of the air, due to friction the electrons of air get transferred to water molecules or vice versa. All this depends upon atmospheric conditions.

When condensation takes place and clouds are formed, these clouds have a huge amount of static electric charges. It has been found that positive charge accumulates near the upper part of cloud and negative charge near the lower part of cloud.

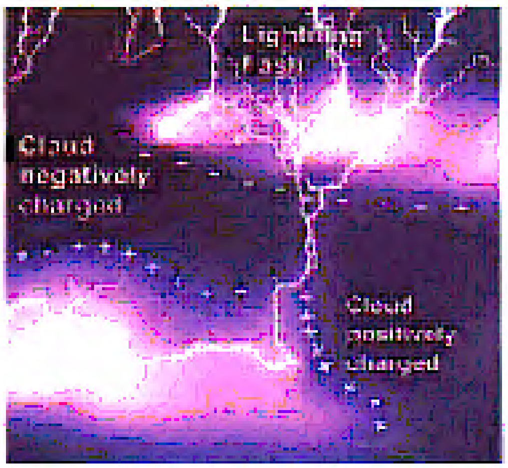
4.4.2 How does Lightning Take Place between the Clouds?

Normally air is a bad conductor of electricity. However, when two clouds at different heights having a huge amount of positive and negative static charges approach each other, the air becomes a good conductor of electricity. This phenomenon is called electric discharge.

The spark due to electric lighter used to ignite cooking gas in the kitchen is another example of electric discharge through the air.

Thus, electrons from the negatively charged cloud push their way through air so as to reach the positively charged cloud at different heights. In doing so, the air gets white hot and hence a dazzling bluish white streak of light is formed which is called lightning.

Because of this intense heat produced, the air suddenly expands and sends out huge pressure waves. These waves produce claps of thunder:



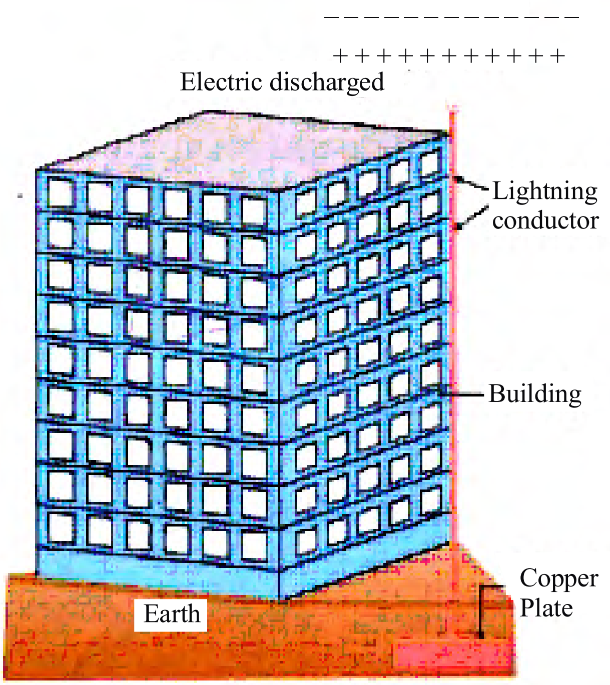
4.4.3 How does Lightning Strike a building?

Imagine a cloud negatively charged at its base passing over a high rise building. This cloud induces positive charges on the top of building and negative charges at its base due to electric induction.

As the positive charges attract negative charges, therefore, the free electrons from the cloud start pushing their way through the moist air. This forms a sort of conducting path. When these electrons reach the building, suddenly all the charges in the cloud flow into the building. Thus. the lightning strikes with a devastating effect and sets the building on fire.

4.4.4 How to Protect Buildings from Lightning

The best method of defence is offence. Thus, we invite the lightning to strike a building but take care that it does not damage the building. This is done by installing a lightning conductor. The idea of using lightning conductors was first given by Benjamin Franklin about 250 years ago.



A good lightning conductor is made of a copper rod, at one end of which are provided sharp copper points. It is installed on the highest point of the building. Its lower end is connected to a thick copper strip which runs along the height of the building. The lower end of this copper strip is attached to a flat copper plate buried deep inside the earth.
When the lightning strikes, it strikes on the sharp points of the lightning conductor. As copper is a very good conductor of electricity, all the electric discharge from the cloud flows into the earth without damaging the building. However, extreme caution must be exercised to ensure that the contact between the conductor and the earth is very good. If it is not so, both lightning conductor and the building which it is supposed to protect, may get damaged by lightning.

4.4.5 Lightning Safety

During lightning and thunderstorm no open place is safe. Hearing of thunder is an alert to rush to a safer place. A house or a building is a safe place, if it is provided with a lightning conductor.
If you are travelling in a car or a bus, you are safe inside, provided the doors and windows of the vehicle are shut.

Remember

IMPORTANT NOTE:

(a) Lightning & Thunder:

During a thunderstorm, thunder and lighting occur together. But we see a flash of lightning first and hear the thunder after few seconds. The time difference that we sense is due to the speed at which sound and light travel. Light travels so quickly (about 300,000 kilometres in one second) that we see a bright flash of lightning instantly. Sound, on the other hand, travels much more slowly than light at about 340 m/s through air. Therefore, we can see light in an instant, but it takes a while to hear thunder.

During a storm, wait until we see a flash of lightning, then start to count slowly. For every count of three, the storm is roughly one kilometer away. If we see lightning and hear thunder at just about the same moment, watch out. The storm could be right above us, only a few hundred feet away.

(b) **Electric spark :** An electric spark is an electric discharge (i.e. flow of electric charges) through air, vacuum or any other gas. We would have seen these sparks at electric switches. Switch off all the lights at night and then observe the switch closely when we switch off the fan switch. We will most likely see a small flash or light. This is an electric spark. This is due to the charges jumping across the small gap formed when the switch is being turned off. Lightning is one example of a huge electric spark in the atmosphere. The flash of light that we see is due to the air molecules being heated up to very high temperatures.

(c) **Rain :** Water from the water bodies on the surface of the earth get converted into water vapour by evaporation goes into the atmosphere and then rises up in the air. The water vapour then condenses on dust particles to form tiny water droplets, which float in the air in the form of clouds. These water droplets by colliding against each other and stick together to form bigger water droplets. When these water droplets become too heavy to float, they come down as rain.

NOTE : The saying that lightning never strikes the same place twice is wrong. Once the step leader forms the conducting path, charges flow through this path many times, in rapid succession. So lightning strikes again and again at the same place, with intervals of a few tens of a millisecond. It has even struck more than 40 times at the same spot. It is so quick that it is difficult for the eye to detect, but if we observe the lightning very closely, we will notice a brightening and dimming. This is called the 'strobe effect'. Somewhat like the lights at a disco.

4.5 DO'S AND DON'TS DURING THUNDER AND LIGHTNING STORM

(a) Outside

Only closed vehicles are safe from lightning. Open vehicles, such as scooters, motorbikes, open cars, tractors, trailors carrying machinery, are not safe. Get out of these vehicles immediately. Open fields, tall trees, shelters in parks, bridges, etc. do not protect us from lightning. Carrying an open umbrella also invites lightning.

It is better to take shelter under a small tree. It is better to crouch in open as shown in Fig.

This way minimum part of your body is exposed to lightning strike. Do not lie flat on the ground, because you expose more surface area to lightning.

(b) Inside a House

Lightning can strike the exposed metal pipes, telephone wires, TV antennas, and electric wires. Avoid contact with these during lightning storm. Use only mobile phone and please make sure that you are contacting the person who also has a mobile phone. Do not call through a landline, as in doing so you may endanger his life. It is better to unplug appliances like computers, TVs, landline telephone, etc. Do not take bath as you can receive lightning shock through metallic water pipes.

4.5.1 Some Useful Effects of Lightning

1. It is believed that lightning played an important role in the evolution of life on the earth.
2. When the lightning passes through the air, the nitrogen and oxygen in the air combine to form nitric oxide gas. The nitric oxide gas reacts with more oxygen to form nitrogen dioxide gas. The nitrogen dioxide gas then dissolves in water droplets in the clouds to form traces of nitric acid. When it rains, the nitric acid in a very dilute form reaches the earth. The nitric acid then reacts with soil carbonate [such as calcium carbonate and magnesium carbonate] to form soil nitrates. The soil nitrates are excellent fertilisers and help in the growth of plants.
3. A part of oxygen changes to ozone when the lightning discharge passes through air. The ozone so formed then protects us from the harmful radiations coming from the Sun.

Remember

Cause of Lightning

During the development of a thunder storm, the air current move upward, while the water drop move downward, due to friction the positive charges collect near the upper edges of the clouds and the negative charges accumulate near the lower edge if the charges are too much, so that air no longer remain bad conductor of electricity or flow of charge.
Hence positive and negative charge meet, producing streaks of bright light and sound.
We see streaks as lightning.

DID You KNOW?

It is not wise to take shelter under a tall tree or a high building during lightning storm. It is because each leaf of a tall tree acts as a lightning conductor. Furthermore, being higher, It is nearer to the clouds. This in way is perfect condition for the lightning to strike. Similarly, a tall building without lightning conductor will invite a lightning bolt.

Illustrations

Illustration 1

What are Lightening conductors and where they are used ?

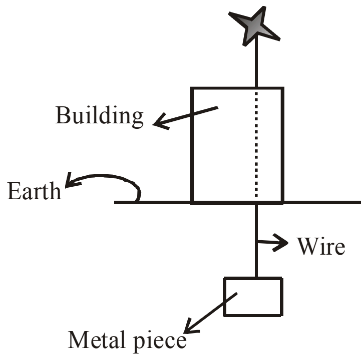
Solution

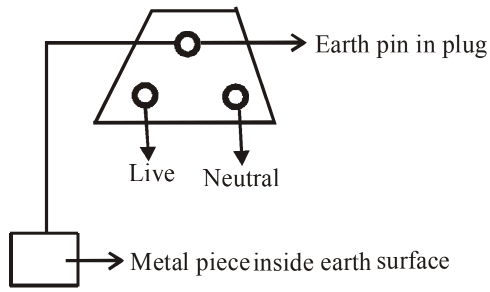
Lightning conductors are metal wires that runs from the top of the building or any structure to the base deep inside the earth surface. Commonly copper rod/strip wire is used for this purpose. They are used to provide safety to the person and equipments inside buildings and tall structures.

Knowledge Enhancer

Earthing

In simple terms we can say our earth is the sink for all the electric current. Due to its large size earth is able to behave like a sink to any amount of electric charge flowing.
You must have seen some long metal pole or rod on top of the buildings or you always see a third pin in the plugs we use in our homes.
The rod on the top and also the third pin in our plug is connected to the earth to provide safety to our building and equipment.



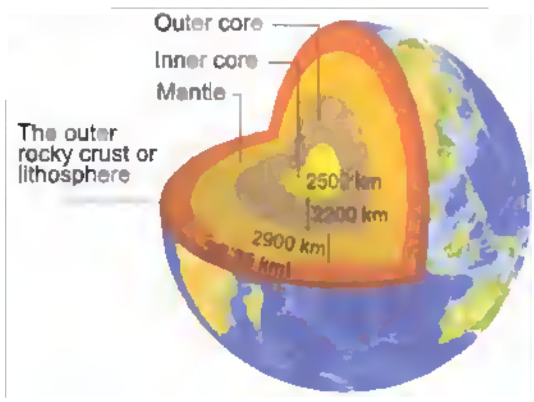


When ever lightning strikes a building, the high current due to that is directly transferred to the ground with the help of the metal rod on top which prevents the damage to the electrical equipments inside the building. So, basically earthing is provided for the safety of people and structures.

So, earthing means connecting all the equipments, metal parts and building to the ground with the help of wires so that any high current due to any reason should flow to the ground (earth) to provide protection to the people and property.

4.6 INTERNAL STRUCTURE OF EARTH

The planet earth as a whole is called Geosphere. The outer rocky part of the earth is called lithosphere or crust. On the lithosphere [crust] live plants and animals which together form the biosphere. The depressions in the lithosphere [crust] are filled with vast oceans. The watery part is called hydrosphere.



Basically, Internal structure of earth divided into four parts :

(a) **Crust :** It is the outer layer of earth on which our continents and ocean basins rest. It is thickest in the continental regions where it has an average thickness of **40 kilometres** and thinnest in the oceans where it may have maximum thickness of **10 km approx.**

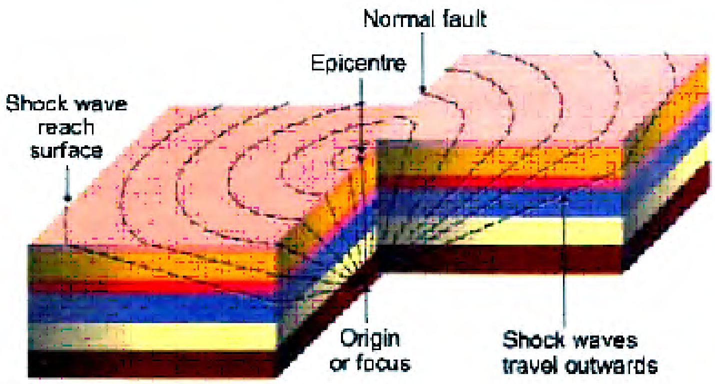
(b) **Mantle :** The layer beneath the earth's crust is called the mantle. Mantle is important because it accounts for nearly half of the radius of the earth **(2900 km)**. The dynamic processes which determine the movements of the crust plates are powered by the mantle. The mantle is a shell of red hot rock and separates the earth's metallic and partly melted rock (both the inner and the outer rocks) from the cooler rocks of the earth's crust. It consists of silicate minerals rich in magnesium and iron. The density of mantle increases with depth from about **3.5 grams** per cubic centimetre to around **5.5 grams** per cubic centimetre, near the outer core.

(c) **Outer Core :** The outer core is around **2300 km** thick. The outer core appear to be in molten state. It contains iron and nickel in molten state. It also contains sulphur.

(d) **Inner Core:** The inner core is about **1300 km** thick and is surrounded by outer core. It is a solid ball and is composed of iron.

4.7 EARTHQUAKE

"Any sudden vibration or movement of a part of the earth's crust caused by natural or man made forces, resulting in the shaking or trembling is called earthquake".



Definitions:

(a) A shock or a series of shocks due to the sudden movement of the crustal rocks is called earthquake.

(b) The point within the crust or the mantle, where a sudden shift of rocks takes place, is called seismic origin or seismic focus or hypocentre.

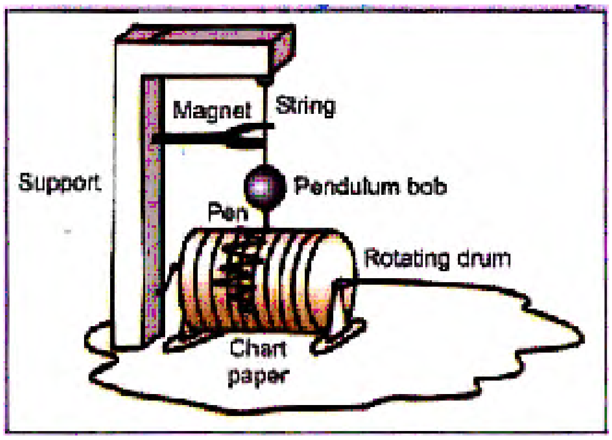
(c) The waves generated in the lithosphere due to the sudden shifting of crustal rocks are called shockwaves or seismic waves.

(d) The point directly above the seismic focus of an earthquake, where the shock wave reaches above the earth crust is called epicentre.

(e) The instrument which detects and then records the intensity of seismic waves generated by an earthquake is called seismograph.

(f) The branch of science which deals with the study of earthquake is known as seismology.

Seismograph :

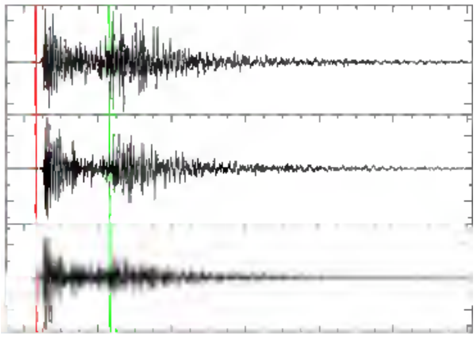


The seismic waves produced during an earthquake are recorded by an instrument called seismograph.

This instrument is simply a vibrating rod or a pendulum, which starts moving as soon as the earthquake occurs. A pen is attached to the vibrating pendulum, under which is fixed a roller with a chart paper The pen draws the pattern of waves produced on the chart paper. By studying these waves the seismologists can construct a complete map of the earthquake and can estimate its power of destruction.

SEISMOGRAM

The graphical record of the intensity of seismic waves is called seismogram .



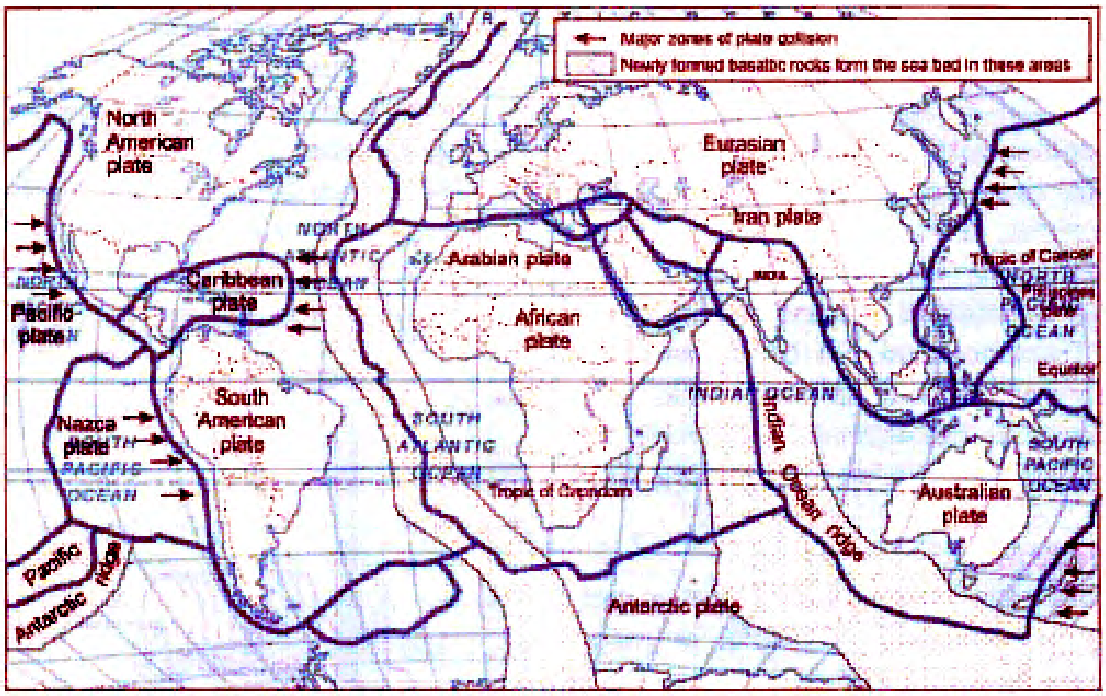
4.7.1 Causes of Earthquake

Following are the main causes of earthquake:

1. Volcanic Eruptions 2. Plate Tectonics 3. Folding and Faulting 4. Anthrapogenic Factors.

1. Volcanic Eruptions

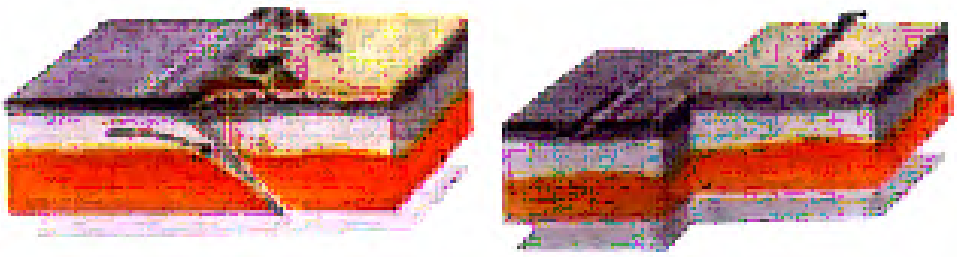
Volcanic eruption is one of the main causes of earthquake. Volcanic earthquake are caused by gas explosions. Such earthquake occur either simultaneously with the eruption or more commonly in the period preceding an eruption. They are generally of shallow origin and their area of disturbance is relatively small and rarely exceeds a few hundred square kilometres. Their intensity, however, may be quite high near the volcanoes. The violent eruption of Krakatoa volcano [between Sumatra and Java islands] caused such a severe earthquake that its impact was experienced at Cape Home [12,800 km away]. The Krakatoa earthquake generated 30 to 40 metres high tsunamis (sea waves) which killed over 36,000 people in the coastal area of Java and Sumatra. The ash cloud reaches the mesosphere, and sound of blast was heard in central Australia, Philippines and even 4,800 km away in the Indian Ocean. Such volcanic eruptions always result in severe Earthquake of hazardous nature



2. Plate Tectonics

It is believed that lithosphere of the earth is not one solid shell surrounding the mantle, but is broken into a number of plates which float over the molten magma in the mantle.

At the margins of these plates there is a considerable geological activity, such as spreading of sea floor, volcanic eruptions, mountain building and continental drift, due to the continuous outflow of magma at various points. The plate boundaries are the primary location of volcanic activity throughout the world.



When these plates brush past one another, or when one plate goes under another plate, they cause disturbance in the earth's crust. It is this disturbance which manifests itself in the form of an earthquake.

3. Folding and Faulting

A fracture in a rock along which there has been an observable amount of displacement is known as fault. **Earthquake occur when movement of the earth takes place along a line of fracture called a fault.** Faults can be found in rocks of all ages, but the likelihood of movement occurring is minimal unless the fault is located in an active area of plate motion i.e. in a zone where one plate moved against another. Such zones are known as **seismic zones or fault zones**.

In India such zones are in Kashmir, Western and Central Himalayas, the whole North-East, Rann of Kutch, Rajasthan and Indo-Gangetic plains. Some areas of South India also lie in seismic zones.

4. Anthropogenic Factors

Human interaction with nature is also one of the main causes of the occurrence of many of the Earthquake. The extraction of minerals, deep underground mining, blasting of rocks by dynamite for construction of roads, dams and reservoirs, nuclear explosion etc. might lead to the occurrence of Earthquake of various intensity and magnitudes. Many of the Earthquake of the world in the present century are the result of construction of dams and reservoirs. The earthquake of 1931 in Greece has been attributed to Marathon dam constructed in 1929. The Koyna earthquake of 1967 in Satara district of Maharashtra [India] was due to the Koyna reservoir constructed in 1962.

4.7.2 Magnitude of Earthquake

The power of earthquake is expressed in terms of magnitude on a scale called Richter scale, which was devised by an eminent seismologist Charles F. Richter in 1935 and then modified in 1965 by Richter and his colleague, Beno Gutenberg. This scale can be related to the energy released at the earthquake's centre and thus can be used as an estimate of the severity of a particular earthquake. The scale has neither a fixed maximum nor a minimum, but Earthquake rated as high as 8.4 on the Richter scale have been measured thus far. Earthquake of magnitude 2 are the smallest that may not be normally detected by human senses. Like many other scales, such as scale for measuring, length, mass or time, the Richter scale is not linear. The above statement implies that an earthquake of magnitude 6 on the Ritcher scale does not have 1.5 times destructive energy as compared to an earthquake of magnitude 4 on the Richter scale.

In fact, an increase of magnitude 2 means 1000 times more destructive energy. For example, an earthquake of magnitude 4 is 1000 times more powerful than an earthquake of magnitude 2. Similarly, an earthquake of magnitude 6 is 1000 times more powerful than an earthquake of magnitude 4.

4.7.3 Intensity of Earthquake

The intensity or destructive power of an earthquake is an evaluation of the severity of ground motion at a given location. It is measured in relation to the effects of the earthquake on human life. Generally, destruction is described in terms of damage caused to buildings, dams, bridges and other structures as reported by witnesses. An intensity scale commonly used and a description of some of the criteria have been presented below for Richter scale from 1 to 10.

4.7.4 Scale of Earthquake Intensity

Richter Scale	Description
1.	Not felt, except under special conditions. mostly through movement in the instruments.
2.	Felt by a few people, specially those on upper floors of the buildings. Suspended objects may swing.
3.	Felt no disabling doors. Stationary automobiles may rock slightly.
4.	Felt by nearly everyone . Some dishes and windows are broken. Unstable objects are overturned.
5.	Felt by everyone. Many people become frightened and run outdoors. Some heavy furniture may move. Some plaster falls of the walls.
6.	Most people are alarmed and run outside. Damage is negligible in constructed buildings.
7.	Damage is slight in specially designed structures, considerable in ordinary buildings, more in poorly built structures. Heavy furniture is overturned.
8.	Damage is considerable in specially designed structures. Buildings shift from their foundations and partly collapse. Undergo round pipes are broken.
9.	Some well built wooden structures are destroyed. Most masonry structures are destroyed. The ground is badly cracked. Considerable landslides occur on steep slopes.
10.	Few, if any masonry structures remain standing. Rails are bent. Broad fissures appear in the ground .

S.No.	Date	Area	Death Toll	Magnitude
1	16 June, 1819	Kutch (Gujarat)	2000	8.0
2	10 Jan., 1869	Cachar (Assam)	-	7.5
3	30 May, 1885	Sopore (J & K)	-	7.0
4	12 June, 1897	Shillong (Meghalaya)	1542	7.5
5	4 Apr., 1905	Kangra (HP)	19500	8.7
6	8 July, 1918	Shri Mangal (Assam)	NA	8.0
7	2 July, 1930	Dhubri (Assam)	NA	7.6
8	15 Jan., 1934	Bihar-Nepal Border	10700	7.1
9	26 June, 1941	Andaman Islands	NA	8.3
10	23 Oct., 1943	Assam	NA	8.1
11	15 Aug., 1950	Arunachal Pradesh-China border	1526	7.2
12	21 July, 1956	Anjar (Gujarat)	113	8.5
13	10 Dec., 1967	Koyna Maharashtra	177	7.0
14	19 Jan., 1975	Kinnaur (HP)	NA	6.5
15	6 Aug., 1988	Manipur-Myanmar border	NA	6.2
16	21 Aug., 1988	Bihar-NepaL border	900	6.6
17	20 Oct., 1991	Uttarkashi (UP-Uttarakhand)	2000	6.4
18	30 Sept., 1993	Latur-Osmanabad (Maharashtral)	9748	6.3
19	22 May, '1997	Jabalpur (MP)	-	6.0
20	29 Mar:, 1999	Chamoli (Uttarakhand)	-	6.8
21	26 Jan., 2001	Bhuj (Gujarat)	30000	8.1
22	8 Oct., 2005	Kashmir	70000	8.1

4.7.5 Consequences of Earthquake

1. **Building Collapse :** People can be trapped in collapsed buildings or under rubble that collapses into the street. This is the type of damage that leads to the worst casualties. The worst thing to do is to rush out into the street during the quake. The danger from being hit by falling glass and debris is many times greater in front of the building than inside. In the 1989 Lama Prieta quake the streets of San Francisco's financial district were covered by broken glass and people were buried under the facade of a brick building that fell forward into the street. Likewise, in the 1964 Alaska quake, a huge concrete facade fell off of a department store onto the pedestrians passing by.

2. **Buildings Knocked off Their Foundations :** Building that can otherwise withstand the quake can be knocked off their foundations and severely damaged. This type of damage can be largely prevented by bolting the frame securely to the foundation, so that it remains in place.

3. **Landslides :** Buildings can be damaged when the ground gives way beneath them . This can be in the form of a landslide down a hill, or liquefaction of soils that can cause severe settling of the ground. Ground movement can change the whole landscape, as in the New Madrid quake that changed the course of the Mississippi river. A landslide into a lake or reservoir can cause flooding downstream. This kind of damage is not unique to Earthquake, but can be triggered by a quake.

   In the young-fold mountains like Andes, Rockies, Alps and the Himalayas, Earthquake result into landslides which damage the human settlements and disturb the transport system.

4. **Fire :** Fires often break out following the Earthquake. The fire can be caused by the inflammable materials being thrown into a cooking or heating fire or broken gas lines. Fires can easily get out of control since the earthquake may have broken water mains or blocked roads fire-fighters need to use. There are many demands made on the emergency response systems that slow down response to fires. In the 1906 San Francisco earthquake, for example the fire that followed the quake caused more damage than the earthquake itself.

   At the occurrence of Earthquake, short circuit of Live electric wire and damage to blast furnaces in factories and other fire-related appliances cause devastating fires. Consequently, more damage to life and property occurs from these fires.

5. **Loss of Human's Property :** Earthquake inflict great damage to buildings, roads, railways, dams, bridges, etc. The Earthquake of Gokuk [Turkey] on August 17, 1999 killed about 40,000 people and damaged property worth billions of dollars. The disastrous earthquake of Mexico City of 1985 caused a total collapse of about 400 buildings and damage to 6000 buildings. Moreover, the water supply system was seriously damaged as a result of which the water and power supplies were disrupted. The Bihar earthquake of 1934 [measuring 7.1 at Richter scale] resulted in over 10,700 human deaths while the Darbhanga earthquake [1988] damaged over 25,000 houses. The Gujarat earthquake [January 26, 2001] not only killed over 30,000 people, but also damaged property worth more than Rs. 2000 crores. The Kashmir earthquake [October 8, 2005] killed over 70,000 people and caused extensive damage to houses, roads and bridges.

6. **Loss of Human Lives :** It has been estimated that, on an average, about 15,000 people are killed every year by Earthquake. There have been Earthquake of great magnitudes in the densely populated areas of the world in which over one lakh [0.1 million] people lost their lives.

Table : Most Hazardous Earthquake and Human Casualty

Year	Place	Country	Deaths
1556	Shenshi	China	830,000
1737	Calcutta (Now Kolkata)	India	300,000
1923	Tokya	Japan	143,000
1976	Tangshan	China	250,000

7. **Flash Floods**

Many a time, under the impact of severe Earthquake, the dams and embankments develop fissures which become the cause of flash floods.

8. **Tsunamis (Seismic Seawaves)**

The seismic waves, travelling through the ocean and seawater, result into high seawaves which are known as tsunamis. 'Tsunami' is a Japanese term which has been universally adopted to describe a large seismically generated seawave. These waves are capable of causing considerable destruction in certain coastal areas, specially where submarine Earthquake occur.

Once a tsunami is generated, its steepness [ratio of height to length] is extremely low. This lack of steepness, combined with waves for very long period [5 to 20 minutes] enables it to pass unnoticed beneath ships at sea. As the seismic seawave crest approaches the shore, however, the situation changes rapidly and often dramatically. The period of the wave remains constant, velocity drops, and wave height greatly increases. As the crest arrives at the coast, to the observers seawater appears surging ashore in the manner of a very high, fast tide . In confined coastal waters relatively close to their points of origin, tsunamis can reach a height of over 30 metres [100 feet]. These seismic waves [tsunamis] occur more frequently in the Pacific Ocean.

The greatest recent tsunami was associated with a massive earthquake along the Indonesian coast on December 26, 2004. The earthquake and associated tsunami killed more than 1 million people in India, Srilanka, Indonesia, Burma and Thailand.

Knowledge Enhancer

Tsunami Waves

A sudden slump in the ocean bed during an earthquake forms a trough in the water surface subsequently followed by a crest and smaller waves. A more marked change of level in the sea bed can form a crest, the start of a tsunami which travels up to 60 km/h with waves up to 60 m high. Seismographic detectors continuously record earthquake shocks and warn of the tsunami which may follow it.

9. **Rise and Subsidence of Ground Surface**

Under the impact of several Earthquake, the land rises or subsides into the weaker zone. For example, the Assam earthquake of 1897 caused a subsidence measuring over 10 metres wide and about 20 km long. The Indus river delta was deformed in the earthquake of 1819. Subsidence of land and fissures in the ground around the city of Bhuj have been reported as a result of the earthquake of January 26, 2001.

Since 1948, an International Tsunami Warning Network has been in operation around the Pacific Ocean to alert coastal residents of possible danger. Alarm must be issued rapidly because the speed of these waves are fairly high through water. Telephone directories in coastal Hawaiian towns contain maps and evacuation instructions for use when the warning siren sounds.

Throughout history, Earthquake have done great damage to both human lives and property. The major consequences of Earthquake are:

(a) Deformation of ground surface.

(b) Damage and destruction of human establishments and structures such as buildings, railway lines, Roads, bridges, dams, towns and cities.

(c) Loss of human and cattle lives.

(d) Devastating fires, floods, Landslides and disturbances in the underground levels.

4.7.6 Protection Against Earthquake

We know that Earthquake cannot be predicted. They just strike at will and are highly destructive. It is, therefore, necessary to take precautions to protect ourselves from the Earthquake all the time. The major loss to life is caused by the collapse of buildings. So, the building in the quake prone zone should be made in such a way that they can withstand strong tremors. Present-day building technology is capable of protecting buildings. So, followings steps should be taken before constructing buildings and then their upkeep.

(i) Consult qualified architects and structural engineers regarding your plan of the construction of buildings.

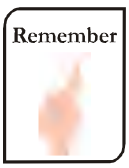
(ii) In highly seismic zones do not construct multistoryed concrete houses. Instead, use mud and-timber as construction material. Keep the roofs as light as possible. This is done so that during earthquake, if the debris fall, they cause minimum damage.

(iii) The cupboard and shelves should be fixed in the walls. This will protect them from falling on human beings during Earthquake.

(iv) The wall clocks, photoframes, water heaters and other articles, should be hung from the walls at such places, so that during earthquake they do not fall on people.

(v) As we use LPG gas for cooking purposes, there is a chance of the pipe bursting and causing fire. So, all the buildings must have fire fighting arrangement.

Note : San Andreas Fault : This is one of the world's most famous faults and is in California. It is about 1,000 km long and is about 9 m deep. The San Andreas Fault marks a boundary between the Pacific Plate and the North American Plate. This fault is known for producing large and devastating Earthquake.



POINTS TO REMEMBER DURING AN EARTHQUAKE

[A] When you are inside home

(i) Take shelter under a big table (such as dining table) and stay there, till the tremors stops.

(ii) Stay away from the heavy object hung on the walls as they may fall on you

(iii) In case you are in the bed, do not get up and start running. Continue lying on the bed and protect your head with a pillow.

[B] If you are outdoors

(i) Find a spot, away from buildings, big trees, overhead power lines, etc., and lie flat on the ground.

(ii) If you are in a car or bus or any other mode of transportation, do not stop and come out. Instead, drive slowly so that you come to an open spot away from big trees, bridges, overhead wires.

Illustration 2

How earthquake occurs, explain ?

Solution

Basically, Earthquake occur due to movement of plates. These plates are known as tectonic plates. When two plates rub against each other then tremors are produced and felt on the earth surface as Earthquake. Volcanic eruptions and nuclear explosions also cause Earthquake but they affect small areas.

LET US RECAPITULATE

- Some objects can be charged by rubbing with other objects.
- **Static Electricity:** The electrical charge generated by rubbing is called static electricity because these charges do not transmit.
- There are two types of charges-positive charge and negative charge.
- **Positive Charge:** When the charge of an object is due to loss of electrons, it is called positive charge.
- **Negative Charge:** When the charge of an object is due to excess of electrons, it is called negative charge.
- When we rub two objects made of different substances together the charge they acquire are opposite to each other.
- **Electroscope:** Electroscope is a device used to test whether an object is carrying charge or not.
- **Electric Current:** When charges move through conductor, they constitute an electric current.
- **Electric discharge:** Negative charges from the clouds and positive charges on the ground when meet a huge amount of energy is produced as bright light and sound, what we see as lightning. The process is called electric discharge.
- **Lightning:** The process of electric discharge between clouds and the earth or between different clouds causes lightning.
- **Thunder:** The loud noise which accompanies lightning.
- **Thunder storm:** A storm accompanied by thunder and lightning.
- **Transfer of Charge:** Electrical charge can be transferred from a charged object to another through a metal conductor.
- **Earthing:** The process of transfer of charges from a charged object to the earth is called earthing.
- Earthing is provided in electrical wiring in building to protect us from electrical shocks, in case of any leakage of electrical current.
- **Lightning Conductor:** Lightning rod is a device used to secure tall buildings from the effect of lightning conductor. A metallic rod taller than the height of the building to installed in the walls of the building during its construction to protect from the effect of lighting.
- Lightning strike could destroy life and property.
- **Crust:** Crust is the uppermost layer of earth.
- **Earth's Plates:** The outermost layer of the earth is not in one piece. It is fragmented. Each fragment is called a plate.
- **Tremors:** Trembling or shaking of the earth.
- **Earthquake:** An earthquake is a sudden shaking or trembling of the earth. It is caused by a disturbance i.e., deep inside the earth's crust (i.e., by the movement of earth's plates).
- Earthquakes tend to occur at the boundaries of earth's plates. These boundaries are known as fault zones.
- **Richter Scale:** The power of an earthquake is expressed in terms of magnitudes on a scale called Richter Scale. The earthquake measuring 7 or more on Richter scale can cause severe damage to life and property.
- **Seismograph:** The seismic waves are recorded by an instrument in the form of graph called the seismograph.
- It is not possible to predict the occurrence of an earthquake.
- **Tsunami:** Tsunami are the huge sea waves due to an under water earthquake, resulting huge losses in costal areas.