

17 Lightning Accidents



Recall what you have learnt about the accidents caused by lightning in grade 7. Pay your attention to the newspaper headlines on loss of lives and property caused by bolts of lightning.

Female elephant and the baby elephants caught in lightning

Central Anurdhapura Specialist, Gamini jayasinghe
A female elephant with her three baby elephants were suspected to be dead with lightning. The dead bodies were found in Mahawilachchiya police area to

2016.04.09 - Daily News Page 04.

Lankadeepa 10.03.2005 Page 2
Heard a burst with a big sound.
My son Wipula was found dead near the doorway.
Death of a 12 year old student in Thissamaharamaya mother witness.

Island 29.04.2005 Page 4
Rupavahini
Transmission stucked due to lightning at Piduruthalaggala.

28th of Wednesday, April 2005 Page 4
A loss of Rs. 20 lakhs to Rupavahini

Lankadeepa 17.10.2003 page 9
Lightning came along the trip switch.

Fig. 17.1 - Some newspaper reports on accidents caused by lightning

Lightning causes loss of human, animal and plant life. Only a small part of the accidents brought about by lightning are reported by mass media.

Lightning claims loss of lives and property not only in Sri Lanka but also in other countries.

In United States of America, it is reported that 100 deaths and nearly 500 get injured within one year by lightning accidents. It has been observed that many lives were lost due to negligence of the precautions for preventing lightning accidents.

Therefore, it is important to have an understanding about lightning.

There are seasons in which the lightning accidents are more frequent. To investigate into it do the assignment 17.1.



Assignment 17.1

Collect information regarding lightning and thunder occurred in this year. Note down the months in which the lightning activity is highest.

According to the above newspaper reports (figure 17.1), it has been observed that the lightning activity is at its peak in the months of March-April and October-November. Meteorologists call those two periods **inter-monsoons**.

In these inter-monsoon periods the temperature of the atmosphere close to the Earth is high. Blowing of wind is low. This increases the amount of water vapour in the atmosphere. This water vapour rises up and also gets cooled forming **clouds**. Cumulonimbus is the type of cloud that contributes most to lightning. Generally, these are located at a height of about 15 000 m from the ground level.

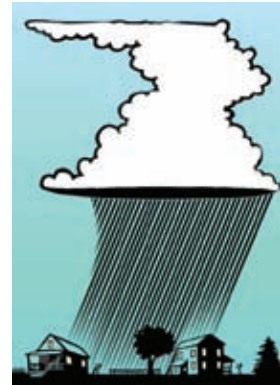


Figure 17.2 -
Cumulonimbus cloud



Assignment 17.2

Observe continuously the changes taking place in a cumulonimbus cloud formed in the afternoon during the inter-monsoonal period and Observe the following.

- General increase in height
- Flattening of the top
- Getting darker from the bottom to top.

17.1 How lightning occurs

Clouds contain crystals of snow and tiny droplets of water. Inside the clouds, wind blows fast from the bottom to the top. This makes crystals and water droplets rub each other. Because of this rubbing **electrostatic charges** are formed in the crystals and water droplets.

Recall what you have learnt about the electrostatic charges in grade 7. There are two types of electrostatic charges as positive and negative. It has been discovered that in a cumulonimbus cloud positive charges accumulate in the upper region whereas negative charges get collected in the lower region.



Figure 17.3 - How charges are distributed in a cumulonimbus cloud

The air in a cloud is an insulator. Hence electrical charges do not flow easily through air. Therefore, a large amount of electrical charges accumulate in the upper and lower regions of a cloud. When, very large amounts of charges are developed like this, a moment will arise where electricity can flow even through air. Then a jump of electrical charges or an electric discharge occurs. This phenomenon is known as lightning.

Types of lightning

Depending on the sites between which the charges jump, lightnings are classified into three types.

- Cloud to cloud lightning
- Cloud to air lightning
- Cloud to ground lightning

Photographs illustrating the above three types of clouds are given below.



Cloud to cloud lightning



Cloud to air lightning



Cloud to ground lightning

Figure 17.4



Figure 17.5 - Induction of positive charges on ground due to negative charges in the cloud

A jump of charges either between two regions of a charged cloud or between two clouds with different charges is referred to as a **cloud to cloud lightning**. Sometimes a discharge of charges accumulated in a cloud occurs to surrounding air. It is a **cloud to air lightning**.

The most dangerous type is the **cloud to ground lightning**. Let us find out how it occurs.

When a charged cloud positions itself above a certain point on the Earth, positive charges are induced on the ground due to the influence of the negative charges accumulated in the lower part of the cloud. When the amounts of charges in the cloud and on Earth increase, at a certain moment negative charges from the cloud, jump to Earth. This is called a cloud to ground lightning.

Lightning and thunder

The voltage of a cloud to ground lightning is about 10 million volts. In such a lightning a current of nearly 25 000 amperes flows. The voltage of an LED lamp used in houses is 230 volts while the current flowing through it is less than even 0.1 amperes. Hence, you will be able to understand how high is the voltage and current of a lightning.

When such a large current flows through air in a very short time (about 10 milliseconds), air is heated up to a very high temperature. This temperature is about 30 000 °C. It is five times the temperature of the sun's surface.

Due to the high air temperature, around the lightning current expands instantaneously (same thing happens when a cracker explodes). When air expands at once like this, first a wave is generated followed by a sound wave. The result of the sound wave is the thunder.

In lightning, both light and sound are born simultaneously. But, light is seen first and sound is heard afterwards. The reason for this is that the speed of light is very high whereas the speed of sound is much less than the speed of light. Since the speed of light is very high, light travel from the place where lightning occurs to us is negligibly small. Sound takes more time to reach us. That is why sound reaches us later.



For extra knowledge

The speed of light is $300\,000\,000\text{ m s}^{-1}$ ($3 \times 10^8\text{ m s}^{-1}$) and the speed of sound is 330 m s^{-1} .

During a lightning, if time is measured from the moment of observing light to the moment at which the sound is heard, the distance to the point at which the lightning occurred can be calculated approximately.



For extra knowledge

As the speed of sound is 330 m s^{-1} , it takes about three seconds to travel a distance of 1km (1000 m). So, if the time between the observation of light and hearing of sound (in seconds) is divided by three, we get the distance to the point of lightning in kilometers.

e.g. Let us assume that the sound was heard 12 seconds after the lightning. Then, the distance to the place of lightning is $12/3 = 4\text{ km}$.

Let us do the activity 17.2 to produce an electric spark (a teacher demonstration).



Activity 17.2

- Produce an electric spark using the induction coil available in the laboratory.
- Observe the production of light and sound while doing it.
- If an induction coil is not available in the school, a spark plug in a motorcycle can be removed from the engine and the way a spark is produced in it can be observed.



Figure 17.7 - Sparking in a spark plug



Figure 17.6 - Producing sparks by the induction coil

Caution

Here, the participation of the teacher or an adult is essential.

In the above activity you would have observed an electric spark. You could have also observed the production of light and sound. The length of that spark is only a few millimetres or centimetres. But, the length of the spark produced in a lightning bolt would be several kilometres. Accordingly, you may understand that the thunder accompanying is also intense.

How lightnings get earthed

There are four ways by which lightnings get earthed harming humans and animals and damaging buildings.

- Direct strikes
- Side flashes
- Contact voltages
- Step potentials

Direct strikes

A strike of a lightning on a solitary man, tree or a building standing on a flat land is known as a **direct strike**.

If a human is struck by a direct lightning, it would seriously affect the person because the lightning current flows to the Earth through his/her body.



Figure 17.8 - A direct strike

Side flashes

A bolt of lightning hitting a tall building or a tree passes into the Earth through it and during its passage may side-step from it and get earthed through the body of a man standing near by. The reason for this is that the flow of the lightning current through a human body is easier than its flow through a building or a tree.

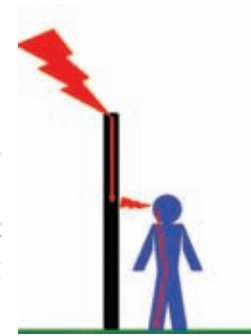


Figure 17.9 - Side flashes



Figure 17.10 - A contact voltage

Contact voltages

Being struck by a lightning at a time of its production because of touching domestic electrical appliances or using cellular phones is known as a **contact voltage**.

Besides, a person in contact with a tree at a time of the occurrence of a lightning may also fall prey to it when it hits the tree. This is also a contact voltage.



Figure 17.11 - Step potential

Step potentials

When a lightning strikes a building, a tree or the ground the lightning current spreads in every direction from that place. Suppose a person or an animal is standing within such a spread area. The lightning current that enters the body of that man or the animal from one leg will pass through the other leg. This phenomenon is called **step potential**.

The longer the distance between the two feet, the higher is the potential difference and hence the intensity of the current too. That is the reason why it is safer to keep the two feet closer at a time of lightning.

An ox is hurt more than a human by a step potential. This is because the distance between the fore limb and hind limb of an ox is greater than that between the two feet of a human. This increases the potential difference and hence the current flow through the body of the ox. Consequently the damage caused is also greater.

According to the newspaper reports shown to you at the beginning of this lesson, it would be clear to you that a lot of damage is caused on human, animals and property by lightning. Though a systematic calculation has not been carried out, the loss of property due to lightning per year in Sri Lanka may amount to billions of rupees.

Therefore, measures should be taken to minimize the losses caused by lightning.

17.2 Prevention of lightning accidents

Some precautions that can be taken to prevent accidents caused by lightning are given below.

- Fixing lightning conductors for tall buildings and maintaining them properly.
- Installing earth wires properly in domestic electrical circuits
- Disconnecting all electrical appliances from the circuit and keeping them away from sockets in situations in which lightning is likely
- Disconnecting television antennas from the television set and keeping them outside the house when there is likelihood of lightning.
- Identifying safe sites in advance when planning outdoor activities.

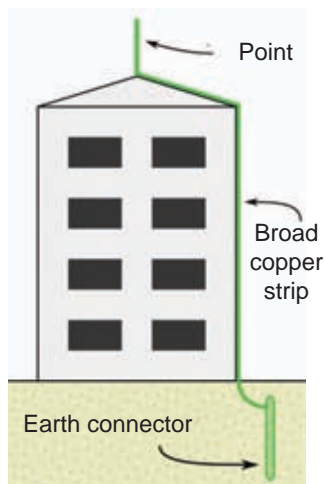


Figure 17.12 - A lightning conductor

Ensuring safety from lightning accidents

Following precautions can be taken to minimize the accidents caused by lightning.



For extra knowledge

The lightning conductor was invented by Benjamin Franklin.

Benjamin Franklin



- Not staying in open areas such as playgrounds, tea plantations and paddy fields
- Refraining from using equipment such as mamaty and crowbars
- If it is required to stay in an open area keeping feet closer and being in squatting position
- Wearing dry shoes or standing on insulator materials
- Not staying on trees or high lands
- Keeping away from the foliage if it is required to stay near a tree
- Staying away from flag posts, wire meshes, wire fences etc.
- Staying seated or reclined lessening the height above the ground
- Being seated if it is required to stay in an open boat
- Limiting the use of landline phones as much as possible
- Refraining from using electric irons, refrigerators, electric ovens etc.

A fully-enclosed vehicle is very safe place to be in, when lightning occurs. Be sure not to touch interior metallic parts in the vehicle.

Lightning victims do not carry an electrical charge and are safe to handle.



Figure 17.13 - Not staying in an open areas when lightning



Figure 17.14 - Avoid the use of landline phones when lightning

First aid for a person struck by lightning

- If the limbs are benumbed bring them back to normal by massaging
- If respiration has stopped, give artificial respirations
- If the heart beat has stopped, massage the heart

It is very important to have a practice in artificial respiration and heart massaging. It is useful for you in day to day life.

- Take the patient to the hospital as soon as possible. Give first aid while taking the patient to the hospital



Summary

- Lightning is a natural disaster affecting Sri Lanka. It causes loss of human lives, animal lives and property.
- Lightning occurs mainly due to the accumulation of electrostatic charges in cumulonimbus clouds.
- When the clouds heavily laden with electric charges they get discharged.
- Lightnings are classified according to the way of discharge.
- Cloud of ground lightnings are the most harmful. They are further classified according to how they get earthed.
- In a lightning bolt, flow of a high current occurs instantaneously due to the high potential difference created between the clouds and the Earth.
- Thunder is the result of sudden expansion of air due to intense heat generated in an electric discharge.
- In a lightning through both light and thunder are produced simultaneously, an observer at a distance sees light first and hears the sound afterwards.
- The damage caused by lightning can be minimized by suitable precautions and following safety measures in the occasions of lightning.

Exercises

(01) State whether the following statements are true (✓) or false (×).

- i. Exact predictions cannot be made about the lightning strikes. ()
- ii. Only water vapour can be seen in clouds. ()
- iii. It is not suitable to be on a tall tree in an occasion where there is a risk of lightning. ()
- iv. Even a person inside a house can be hurt by a lightning. ()
- v. In a lightning bolt, both light and sound are produced at the same time. ()

(02) Match the pairs correctly.

- i. Direct strike a. Hurting a person staying near a building when a lightning hits that building
- ii. Contact voltage b. A man standing under a tree being struck by part of a lightning that hits the tree
- iii. Side flash c. A lightning hitting a person staying alone in a flat land
- iv. Step potential d. A lightning hitting a man leaning against a tree or a person using a cellular phone

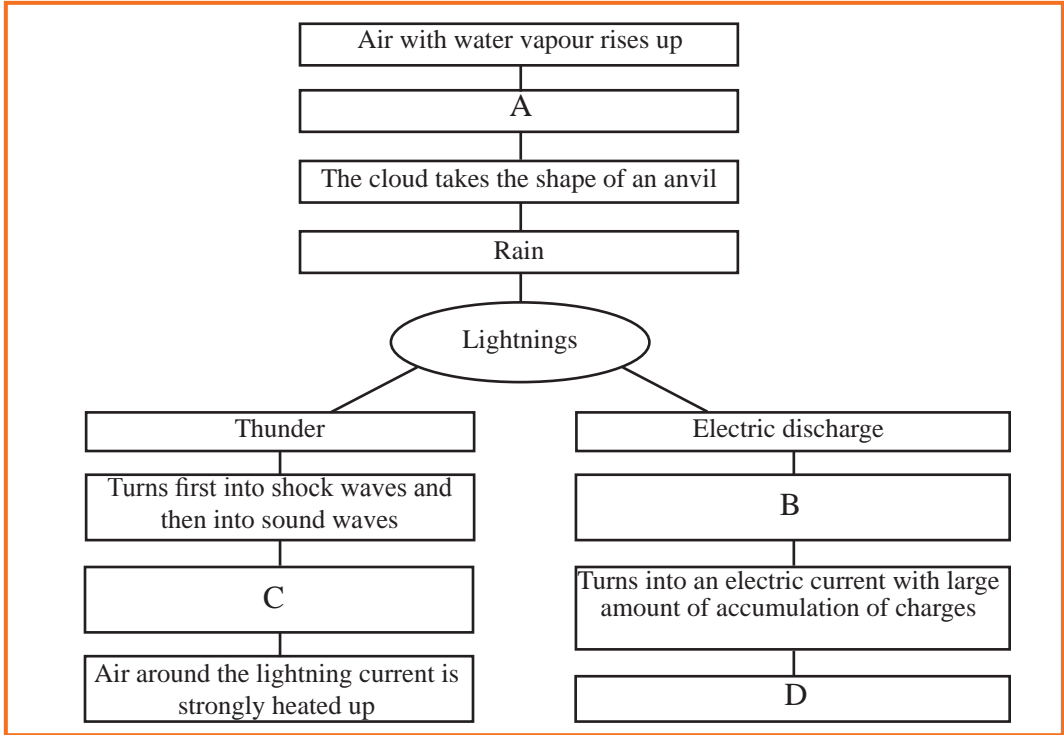
(03) Fill in the blanks of the sentences given using the following words.

(cloud to air, cloud to ground, cloud to cloud, large, greater)

- i. A lightning comes from a cloud to Earth.
- ii. lightnings are produced between clouds.
- iii. The lightnings occurring between clouds and air are.....
- iv. The temperature of a lightning is than the temperature of the sun's surface.
- v. A amount of heat is generated by a lightning.

(04) Match the following sentences with the blank spaces A,B,C and D in the concept map given as approximate.

- i. Air gets heated up and expands suddenly ()
- ii. Charges jump within a cloud, between cloud or from a cloud to ground. ()
- iii. Electrical charges accumulate in a cloud. ()
- iv. Air with water vapour moving up gets cooled to form clouds. ()



Technical Terms

Discharge	- විසර්ජනය	- மின்னிறக்கம்
Lightning	- அகுவன	- மின்னல்
Thunder	- குரூரூம	- இடிமுழக்கம்
Inter monsoon	- அன்னர் மூர்சூ	- பருவக் காற்று காலப்பகுதி
Cumulo nimbus clouds	- காரூ வூகூ வலூகூலூ	- தூரூள் முகூல்
Snow crystals	- கூமூ சூலூவூகூ	- பனூப் பனூங்கூகூள்
Static electric charges	- சூலூவூகூ வூடூயூன் அூரூர்லூனூ	- நூலூ மூன்னூறூறூங்கூள்
Cloud to cloud lightning	- வலூ அகுவூனூ	- முகூல் மூன்னல்
Cloud to ground lightning	- லூலூவூ அகுவூனூ	- ஡ுவூ மூன்னல்
Cloud to air lightning	- வூ - அகுவூனூ	- படிமுறூ மூன்னல்
Induction coil	- ஡ூர்லூனூ ஡ூரூரூ	- தூண்டூறூ கூரூள்
Lightning rod	- அகுவூனூ ஂன்னூயகூ	- மூன்னூறூ கடூத்தூ
Direct strike	- ஂளூ அகுவூனூ	- நூரூடித் தூக்கு
Side flash	- ஂரூலூவூகூ அகுவூனூ	- பக்கப் பாய்ச்சல்
Step potential	- ஂயூவூரூ அகுவூனூ	- படிமுறூ அழுத்தம்
Contact voltage	- ஂபூர்லூகூ அகுவூனூ	- தூாடுகூ வூலூற்றூளவூ
Shock wave	- கூலூபனூ கரூரூ	- அதூர்வலூ