Winds, Storms and Cyclones

Air Pressure

We have seen kites flying in the sky and the trees moving to and fro when the wind blows.

How do kites fly in the sky? What causes the trees to move back and forth when the wind blows?

The movement of kites and the swaying of trees are caused by the pressure exerted on them by air.

What is this air pressure?

Air pressure refers to the force exerted per unit area of surface by the air that is directly above that surface.

When air blows, it exerts pressure on the face of a kite and pushes the kite up in the sky. Similarly, when the wind blows, it exerts pressure on a tree and makes it bend in the direction of the blowing air.

Let us perform an activity to understand this.

Please perform the activity under adult supervision.

- Pour water into a metal can and boil over a stove keeping the can uncovered.
- After boiling for 2-3 minutes, cover the can with a lid.
- Using tongs, carefully place the can in the sink.
- Pour cold water over it.

What do you observe? When cold water is poured over the can, it causes the can to crush.

Water vapour condenses when cooled. It has more pressure. Therefore, when cooled, the vapour condenses, reducing the pressure. This compresses the metal can. Therefore, air exerts pressure.

Let us look at some more instances where we feel the air pressure.

- Cycling or rowing against the wind is difficult because of the pressure exerted by air.
- The tyres of vehicles are filled with air, thereby exerting pressure. This makes it possible for them to hold and carry weight.

Let us now explore another important property of air by performing an activity.

Place a small paper ball inside the neck of a transparent bottle as shown and forcefully blow air into it. **What do you observe?**

It is observed that it is difficult to push the small paper ball inside the bottle by blowing.

This is because the speed of the wind is higher at the mouth of the bottle, thereby resulting in reduced air pressure near the mouth of the bottle.

On the contrary, the wind inside the bottle has a low speed and therefore, a higher pressure as compared to that at the mouth of the bottle. This higher air pressure inside the bottle prevents the paper ball from entering the bottle.

Therefore, high wind speed has low pressure and low wind speed has high pressure.

Let us perform a small experiment.

Let us look at another demonstration of this property. Place a strip of paper between your lips and forcefully blow out air. You will observe that the paper strip moves upwards.

Air Expands On Heating

Have you seen people gliding in the air in a basket tied to a balloon? This is called hot air ballooning. How does the balloon move?

Situated just below the balloon and above the basket is a flame that heats up the air inside the balloon up to about 100 ºC. This hot air expands as a result of heating.

When the air expands, its density reduces. The air in the balloon thus becomes lighter and less dense than the air outside the balloon. This makes a hot air balloon rise up.

Thus we know that air expands on heating.

Let us perform an activity to understand this principle

We know that hot air expands. How does hot air make a balloon move up?

Let us perform an activity to understand this phenomenon

Using a pump, inflate a balloon with cold air and another with hot air. Hang them on a horizontal, wooden stick. Observe the motion of both the balloons.

You will find that the balloon filled with hot air rises upward more in comparison to the balloon filled with cold air. **Can you explain why this happens?**

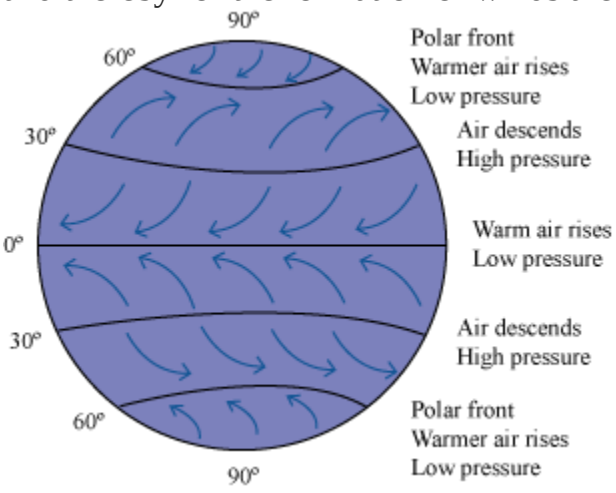
Since, air expands on heating and occupies more space, the hot air balloon becomes lighter than the cold air balloon.

We have observed that smoke from a fire moves upward. This is because fire heats the air and it causes the air to move upward. The air carries the smoke along with it, thereby making it rise up.

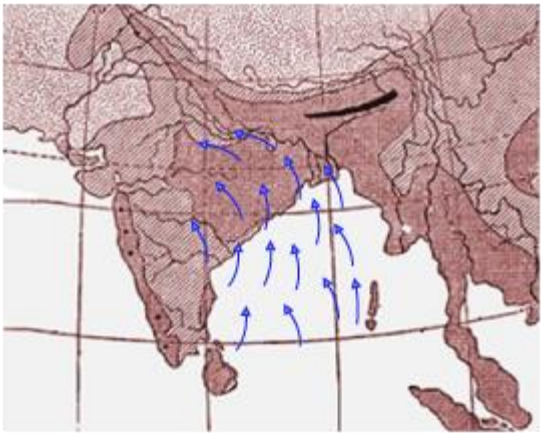
The movement of hot air creates a pressure difference over a certain region and the cold air from surrounding areas (high pressure)moves toward this region of hot air (or low pressure) to balance this difference. This results in the formation of winds.

- The movement of air is caused by the difference in the pressure of air at different places.
- Air always moves from a region of high pressure (low temperature) to a region of low pressure (high temperature).
    - Wind Formation
    - 
    - **We have all felt the gush of wind. Why is this wind sometimes fast and at other times slow? How is wind formed and what causes it to move?**

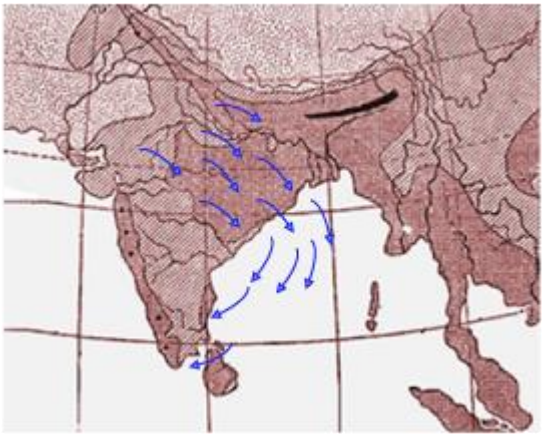
- Let us first learn a few facts about air that would help us understand wind better.
- ***Winds blow from a region of low temperature to a region of high temperature because of a difference in the atmospheric pressures.***
- ***A region with a high temperature has a low-pressure condition because of low air density. A region with a low temperature has a high-pressure condition because of high air density.***
- We understand that a pressure difference is important in the formation and movement of winds. However, **what is responsible for creating this difference in pressure?**
- The pressure differences exist because of the uneven heating of the Earth's surface.
- **What causes an uneven heating of the Earth's surface?**
- The various factors responsible for the uneven heating of the Earth's surface and thereby for the formation of winds are listed below.



- **[1] Different latitudes**
- Owing to the tilted rays of the Sun, both the poles receive a minimum amount of sunlight. This causes the air in these regions to remain relatively cold, thereby creating a high-pressure region. The air between the 30° to 60° latitude belts is warmer in comparison to the air near the poles. Hence, this warm air rises up and cold air from the Polar Regions rush in to fill the empty space. This is depicted in the above figure.
- **[2] Different heating of land and water**
- **Have you ever heard of land breeze and sea breeze?**



- During the summer months, the equatorial land absorbs heat and the temperature of the land becomes higher than that of the oceans. This makes the hot air from the land rise up and the cold air from the oceans blow towards the land. This results in the formation of the **monsoon winds**.



- During winter months, the temperature of the land becomes less than that of the oceans. As a result, winds start blowing from land to the oceans.
- **Monsoon rain**
- Monsoons are seasonal winds that change their direction with changing seasons. They blow from the oceans towards land in summer and from the land to oceans in winter. When blowing from oceans to land, these winds carry water droplets with them and are responsible for the rains in India.
- **Other factors that influence winds:**
- **The rotation of the Earth affects the direction of wind currents.**
- The rotation of the Earth on its axis causes the day and night cycle. During the day, one-half of the Earth receives sunlight and the other half is dark. Because of the rotation of the Earth, the wind currents do not flow in a straight North-South direction, but tend to flow in a curved path. The force produced by the rotation of the Earth is known as **Coriolis force**. It affects the direction of winds.

- **Summer and winter seasons affect the speed of wind currents.**
- The seasons are caused by the revolution of the Earth around the Sun. Air near the Earth's surface becomes very hot during the summer months. This hot air rises upwards and creates a region of a very low pressure. Cold air comes in very fast to fill this low-pressure space. This results in the occurrence of high-speed wind currents.
- On the other hand, during the winter months, wind current blows at very low speeds because of minimal pressure differences between the hot air and cold air regions.

Thunderstorm And Cyclone

A thunderstorm is a high-speed wind that is accompanied by heavy rain (or hail), lightning, and thunder

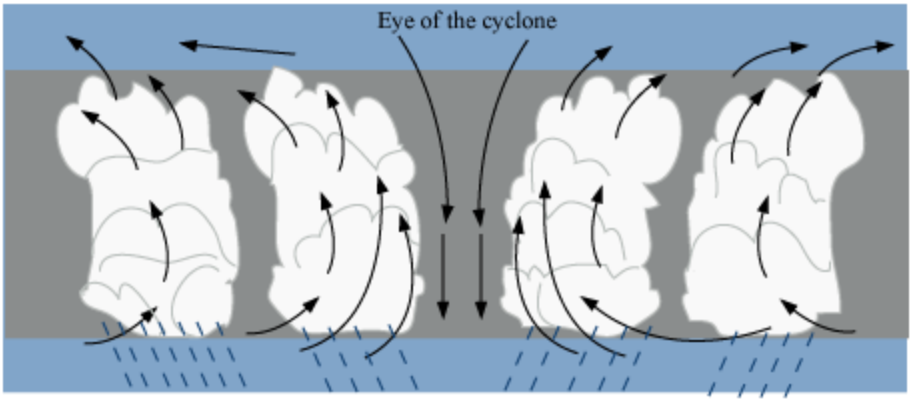
How are thunderstorms formed?

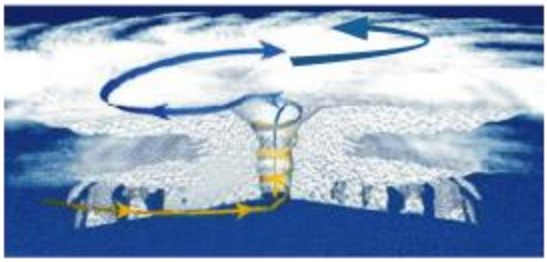
In hot, humid, tropical, and equatorial areas, the temperature of the air over the land is very high. This causes the air to move upward and forcefully carry the water vapour present in the air, to a higher altitude. At high altitudes water vapour freezes to form water drops or hail which falls on the Earth. This sudden rise and fall of hot air and cold-water droplets causes lightning and thunder, and results in what is commonly called as a thunderstorm.

Did you know that over 40,000 thunderstorms occur throughout the world each day!

What are cyclones?

Water on the surface of the Earth absorbs heat and changes to vapour. As water vapour moves up higher in the atmosphere, it carries this heat along with it. The higher regions of the atmosphere are cooler. This condenses the water vapour into water drops.





When vapour cools down, it releases the absorbed heat into the atmosphere. The heat thus released warms up the air, which once again causes it to rise up. A low-pressure area is thus formed and the air from the surrounding areas rushes in. This sequence of events is repeated continuously.

Thus, this cycle is the result of the formation of a very low-pressure system with high wind speeds revolving around it. This weather phenomenon is known as a Cyclone.

The low-pressure centre of a cyclone is known as the **eye** of the cyclone. It is very calm i.e. the centre of the storm is actually free from storm and rain!

More about cyclones

- The height of a cyclone varies from l0 km to 15 km
- Cyclone is a whirl of a large mass of air in the atmosphere
- The size of the eye of a cyclone may extend from 30 km to 65 km in diameter
- The large mass of air containing clouds in a cyclone may extend up to 150 km with wind speeds of about 150 km to 250 km per hour
- Cyclones are called **hurricanes** in the American continent and **typhoons** in Philippines and Japan.

Factors that affect the generation of cyclones

- Humidity
- Temperature

- Wind speeds
- Wind direction

Why are cyclones destructive?

The characteristic features that make cyclones destructive are

- **High wind speeds:** Wind speeds ranging from 150 km to 250 km per hour are capable of destroying houses, crops, trees, electric and communication lines.
- **Low pressure:** High wind speeds and very low pressure conditions, especially around the eye of the cyclone, cause the ocean water to rise as high as 3 to 12 meters. This rise in the ocean water submerges the low-lying areas near the shore, causing damage to life and property along the shoreline. The fertility of the soil also gets affected due to the saline water of the oceans.
- **Heavy rain:** Cyclones are accompanied by heavy rains. If rains continue for longer periods, it causes floods.

Tornadoes also are destructive winds, but are smaller in size than cyclones. Violent tornadoes can have wind speeds of over 300 km per hour.

Safety Measures During Cyclones and Tornadoes

Do you know that approximately 1, 40,000 people died in a cyclone that hit Bangladesh in 1991?

The cyclone that hit the state of Orissa in 1999 destroyed 17110 square kilometres of crop land. Approximately, 25 00 000 domestic animals died and the total loss of property was estimated to be about 4.5 billion dollars!

Thus, high speed winds are capable of causing large-scale destructions. Since their occurrence cannot be controlled therefore, knowledge of safety measures is of utmost importance.

Some of the safety measures to be followed are listed

- Pay heed to the warnings broadcasted by the authorities over the radio and television

- Floods cause damage to the roads. Therefore, all roads in flood-hit regions should be avoided
- Necessary arrangements should be made for the shifting of domestic animals, vehicles, household goods etc from cyclone hit areas to safer areas
- Emergency phone numbers of services like police, fire brigade, and medical centres should be known by all members of the family

Some precautions for cyclones include

- Floods follow cyclones. Therefore moving to a higher altitude area is recommended in order to avoid floods
- Going outside the house, particularly to the sea-shore, should be avoided during a cyclone
- Previously stored water should be used for drinking as water during cyclones may be contaminated
- Emergency supplies such as water and food, first-aid kits, etc should be stored by people living in cyclone-prone areas
- Construction of cyclone shelters in cyclone-prone areas is recommended. Construction of houses that can withstand cyclones should be encouraged, wherein plywood can be used instead of glass to make the windows.
- Broken switches and wires should not be touched during a cyclone as these can cause electric shock
- Rescue workers who provide support by supplying food, water, and medicine should be helped in their tasks
- We should help and cooperate with neighbours and friends who may need assistance during a cyclone

Some of the safety measures to be followed during tornadoes

- Constructing tornado shelters
- Shutting down of all the doors and windows
- Sitting underneath a bench or a table inside the house
- Bending on your knees and bowing down by protecting the head with your hands will help shield the body from fatal injuries

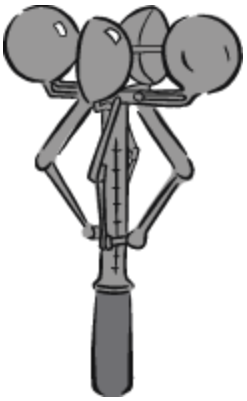
Along with the knowledge of cyclones, advancements in science and technology can help develop better prediction and warning systems. This will help to combat emergency situations.

With time, predictions about the occurrence of cyclones and tornadoes have become very accurate. With the help of satellites and radar systems, weather forecasters can warn people in advance about cyclones and tornadoes. Forecasters use watches and warning systems to help people in cyclone-hit areas.

A **cyclone watch** is a weather alert that makes a forecast about cyclones that are likely to hit a particular area

- For a **storm**, it is issued about two days in advance
- A **cyclone** warning is a weather alert that is issued 24 hours in advance
- Before **cyclones hits the shoreline** the message is broadcasted every 30 minutes

These systems are used by several national and international agencies. An instrument used to study the speed of winds is the **anemometer**



More about anemometers!

Since the low-pressure area in a cyclone results in high-speed winds, it is very important to measure the speed of the winds. It helps the meteorologists to accurately predict the nature and extent of these natural disasters. You can measure wind speeds with the help of an anemometer that can be installed at the top of your house.