

## SCIENCE

### CHAPTER 06: PRESSURE, WINDS, STORMS AND CYCLONES

(Handwritten Notes; Version 1.0)

#### ① Pressure

Force per unit area is called Pressure



$$\Rightarrow \text{Pressure} = \frac{\text{Force}}{\text{Area}} \leftarrow \text{on which the force is exerted}$$

(Scalar quantity) -

↳ Only magnitude

Pressure  $\propto$  Force (directly proportional)

Pressure  $\propto \frac{1}{\text{Area}}$  (inversely proportional)

Two factors on which the pressure depends

$\sim \propto$   
 $\uparrow$   
 nearly equal

SI unit of Pressure  $\rightarrow \text{N/m}^2$  or Pascal (Pa)

$$1 \text{ kPa} = 1000 \text{ Pa}$$

$$1 \text{ kg wt.} = 9.8 \text{ N} \sim 10 \text{ N}$$

(named after French Scientist  
 Blaise Pascal)

e.g.  $\rightarrow$

1) Why school bags have wide straps?

It is because due to the large area, the pressure exerted by the weight of the bag on the shoulders of children will become less, which will help children to easily carry it.

$$W = mg$$



Figure 21. A porter carrying a heavy load on his head.

2) Why porters keep a thick and round piece of cloth over the head while carrying luggage?

3) Why the tip of a needle is sharp?

4) Why the heavy cranes have wide tyres?

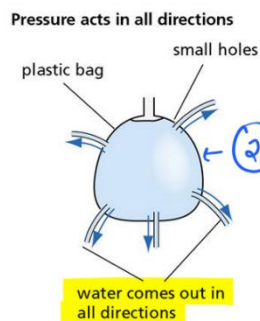
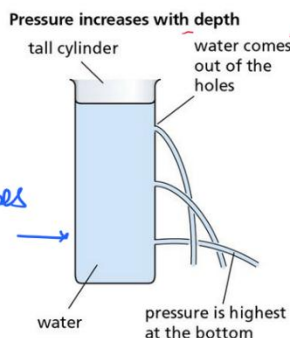


Figure 23. A tractor with very wide tyres.

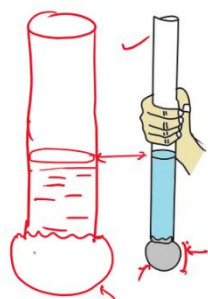
| Scenario                    | Mode of Action                   | Scientific Reason                                                                                                                             |
|-----------------------------|----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|
| <b>School Bag Straps</b>    | Broad (Megha) vs. Narrow (Pawan) | Broad straps spread weight over a larger area, reducing pressure on shoulders. Narrow straps concentrate force, increasing pressure and pain. |
| <b>Water Bucket Handles</b> | Broad vs. Narrow                 | A broad handle increases contact area with the hand, reducing the pressure exerted by the heavy water.                                        |
| <b>Carrying Loads</b>       | Round cloth on the head          | The cloth increases the contact area between the load and the head, significantly reducing the pressure from the weight.                      |

## \* Pressure exerted by liquids

① Pressure increases with depth



② Pressure exerted every point



③ Pressure remains same at every at the same depth level.

The bulge in the balloon is not dependent on the weight of the water column.



### Engineering Applications

e.g. →

• **Overhead Tanks:** Placed at high elevations to maximize water column height, ensuring strong water pressure at tap outlets.

• **Dam Construction:** Dams are constructed with a significantly broader base than the top. This structural design withstands the immense horizontal water pressure that increases proportionally with depth.

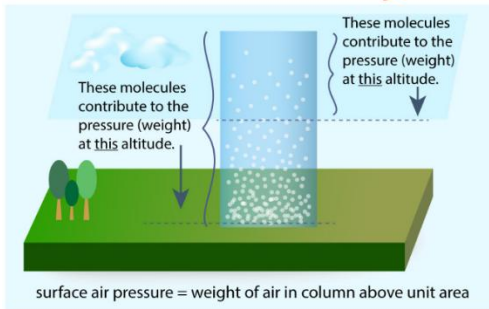


### PROBE & PONDER

**Question:** Suppose you live on the second floor of a three-story building with a water tank on the roof. Your friend lives on the first floor. Who will receive a more powerful stream of water?

**Answer:** Your friend on the **first floor**. This is because the total water column height above the first floor is greater, resulting in higher hydrostatic pressure at their taps.

\* **Atmospheric Pressure** → Pressure exerted by atmosphere  
(measured by Barometer)  
(due to the weight of air)



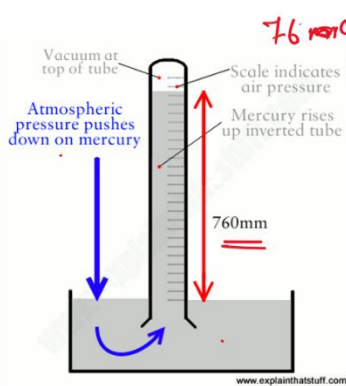
• Atm. pressure is maximum at the surface of earth and decreases as we move upwards.



← Atm. pressure over head  
(15cm x 15cm) ~ 225 N  
(or 2250 kg)

(why are we not crushed?)

Pressure inside our body balances it.



Mercury  
760mm of Hg  
760mm of Hg

← Because of the high density of Mercury, the change in the pressure is measured with reasonable change in height of the mercury.



EXTRA

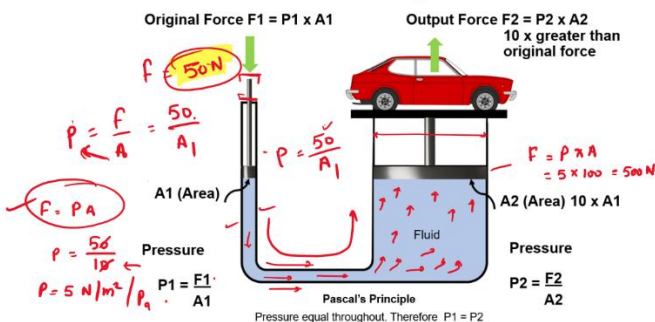
\* **Pascal's Law**

↓  
Law regarding the flow of liquid pressure



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• It states that the pressure exerted by a liquid at rest is transmitted undiminished in all directions.



Pascal's Law

Equal Forces in All Directions

Pressure = Force / Unit Area  
 $P = \frac{F}{A}$



Pascal's Law States that Pressure Applied on One Point of Liquid Transmits Equally in All Direction



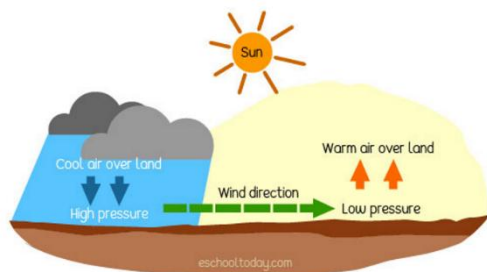
Practical applications →

- 1) Hydraulic lift
- 2) Hydraulic brakes
- 3) Hydraulic Jack

→ END OF EXTRAS →

## (\*) Wind formation and Mechanics

- Winds always blow from High Pressure area to Low Pressure area.



### Heat-Driven Wind Circulation

Wind cycles are directly driven by solar heating through the following mechanics:

1. Solar Heating  
Land/Water heats
- 
2. Expansion  
Warm air rises
- 
3. Void Created  
Low Pressure Zone
- 
4. Air Inflow  
Cool high-p air moves in

pressure

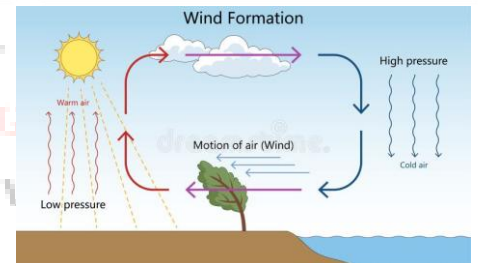
### Coastal Breezes

#### Sea Breeze (Daytime)

Land heats faster than water. Warm air over land rises, creating low pressure. Cool, dense air from the sea rushes inward toward the land.

#### Land Breeze (Nighttime)

Land cools faster than water. Water retains heat, causing warm air over the sea to rise. Cool air from the land moves outward toward the sea.



EXTRAS

## (\*) Why land heats & cools faster than water?

Specific heat of water is 5-6 times higher than that of land.

Amount of energy required to increase the temperature of an exact mass of a substance by a certain quantity.

4190 joules of energy → Required to increase the temp. of water 1°C

750-800 joules of energy → Required to increase the temp. of land by 1°C.  
(5-6 times lesser than water)

→ END OF EXTRAS →

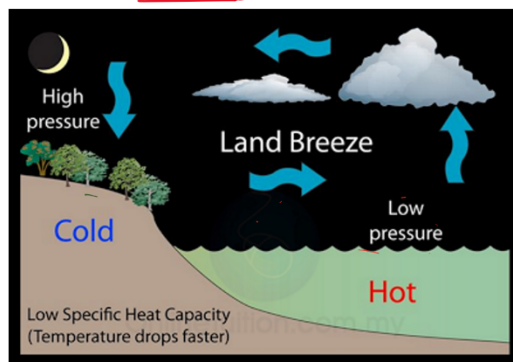
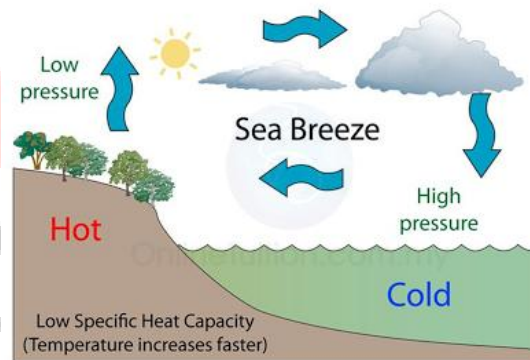
Therefore, during day time land heats up quickly results in warming the air above it.

↓ as a result

Hot air above land rises-up thereby creates Low Pressure Zone on the land while relatively colder air above sea creates High Pressure Zone on the sea

↓ as a result

Winds from sea towards land blows called as Sea Breeze or ✓ On-Shore winds



⊙ During night time, land is relatively colder than sea (due to same reason as mentioned above)

↓ as a result

High Pressure Zone created over land causes wind to blow towards Low Pressure Zone created over sea. This is called as Land Breeze or Off-Shore winds.

## \* Pressure reduction due to high-pressure winds

\* Experiments → 1) Blowing air between two balloons causes a low pressure zone between them due to which they come closer to each other.



2) Roof-tops blown off during heavy storms

↓ why?  
Strong wind outside creates a low pressure zone while pressure inside the house is static  
↓  
High pressure from inside blows off the roof.

## \* Storms, Thunderstorms and lightning

\* Storm → Atmospheric disturbance marked by strong winds accompanied by rain, hail or snow.

\* Thunderstorm → Weather event frequently occur in the warm tropical regions due to rising, warm and moist air currents.

## \* How lightning and Thunderstorm is caused?

A sudden flow of charges takes place producing a bright flash of light is called **LIGHTNING** } Definition

Lightening heats up the air around it rapidly.

result →

Air expands & produces a loud sound called **THUNDER**

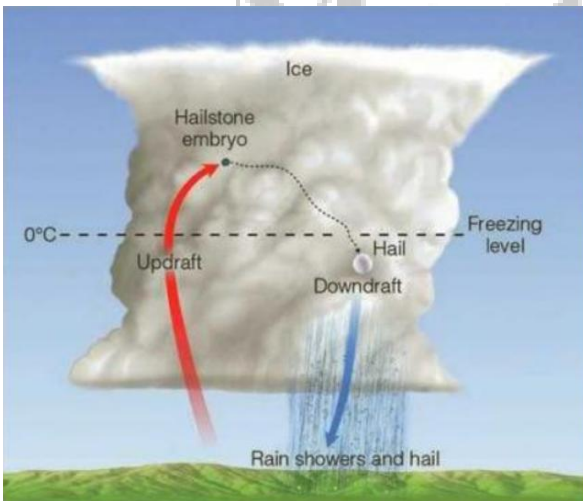
Storm accompanied by lightning and thunder is called **THUNDERSTORM**.

## ① Charge formation inside clouds →

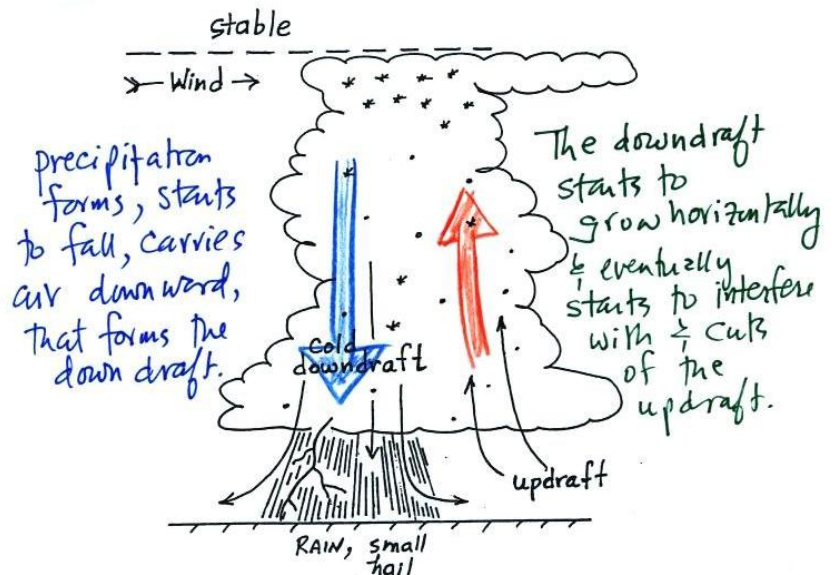
- As the warm air rises, it expands and cools
- Water vapour condenses into water droplets
- Strong winds in the upward direction (updrafts) causes these water droplets freeze into ice particles graupels

Water droplets and ice-particles collide due to strong upwards and downward winds  
(updrafts) result (downdrafts)

Charges are formed in the clouds



## II. Mature Phase





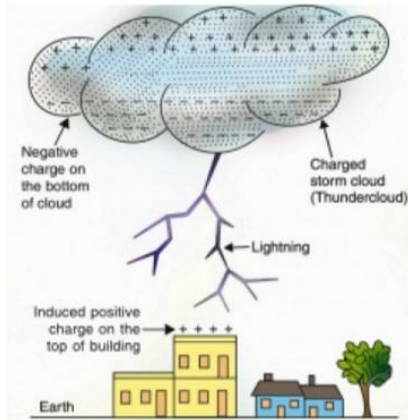
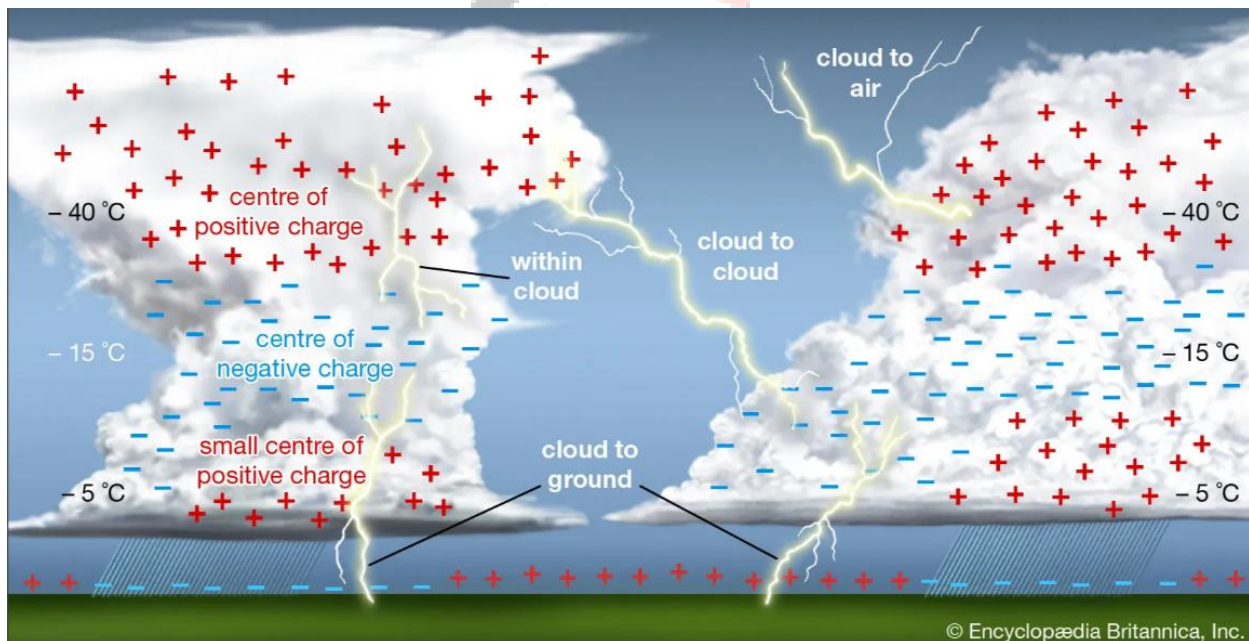


Figure 7. A view of lightning striking a building.

← Positive charge (lighter particles) are accumulated on the top of cloud while Negative charges (heavier particles) on the bottom of the cloud.

Due to electrostatic induction, positive charges accumulate over ground ( $e^-$  moves deeper into the ground)



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### DETAILED PROCESS OF LIGHTENING (WITHIN CLOUD)

1. **Charge separation in clouds:** Within a thunderstorm cloud, various ice particles, water droplets, and graupel (soft hail) collide with each other. During these collisions, electrons are transferred, leading to a separation of charges. The lighter ice particles and graupel tend to acquire a positive charge, while the heavier particles and droplets tend to acquire a negative charge.
2. **Updrafts and downdrafts:** Within a thunderstorm, there are strong updrafts and downdrafts. The updrafts carry the positively charged ice particles and graupel to the



**Topic:** Pressure, Winds, Storms and Cyclones

**Subject:** Science

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upper part of the cloud, leaving the lower part of the cloud with a net negative charge.

Meanwhile, the downdrafts bring the negatively charged precipitation (such as rain and hail) to the lower part of the cloud.

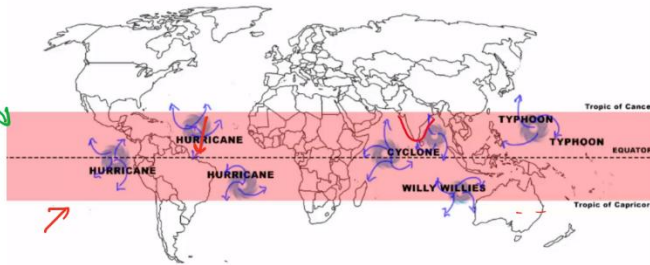
- 3. Positive charge on the ground:** Meanwhile, the positive charge on the ground is induced by the presence of the negatively charged cloud above it. This happens through a process called electrostatic induction. The positive charge is attracted to the negatively charged cloud above, creating an electric field between the cloud and the ground.
- 4. Lightning discharge:** When the electric field becomes strong enough, it can ionize the air, creating a conductive path for a lightning discharge. The discharge occurs as electrons flow from the negatively charged region in the cloud to the positively charged region on the ground.

### \* Tropical Cyclone

Rapid rotating storm originates over tropical oceans from where it draws energy to develop.

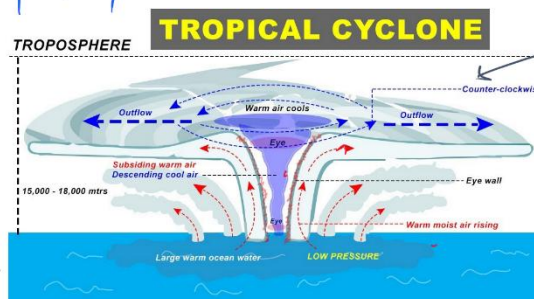
Different names in different zones.

### Tropical Cyclones



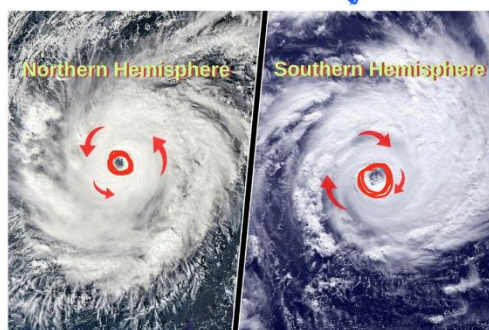
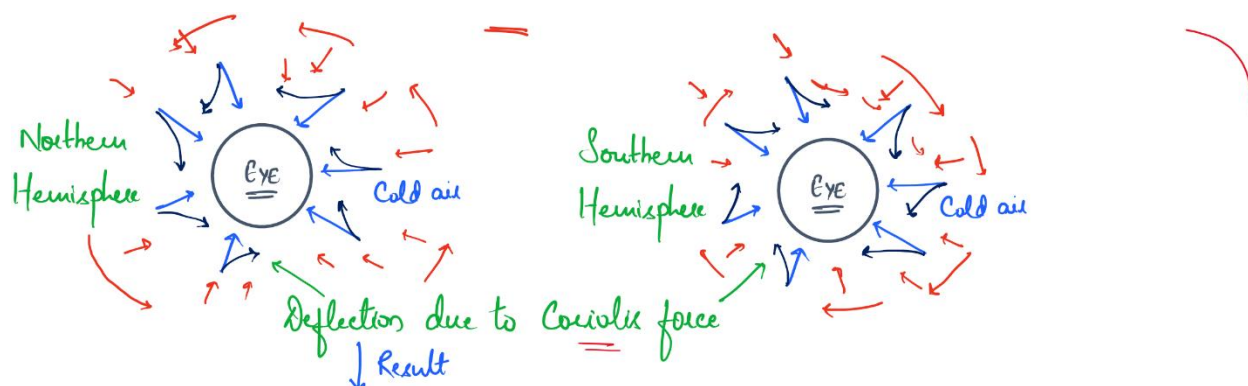
### Formation of Tropical cyclone

② Warm air rises & the cold air which takes its place also gets heated up and rises.



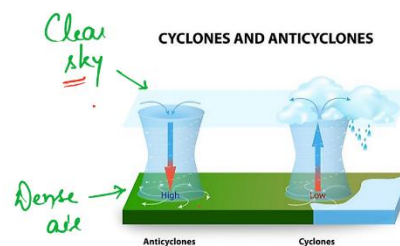
① Intense low pressure region is formed due to extensive heating of air

③ With the increase in height, temperature decreases and warm air gets cold.   
↓ as a result   
The cold air sinks and causes heavy rainfall.



NOTE: When warm air gets cold at height, it loses heat energy which also contributes to increase the temperature of "eye of the cyclone."

Anticyclone  
↑  
High pressure at the centre  
(formed at sub-tropical high pressure belts)



### How a Cyclone Forms

- (i) Ocean water heats up and moist air above it rises.
- (ii) As moist air rises, water vapour condenses to form raindrops (condensation releases heat back into the air).
- (iii) This released heat warms the air further, making it rise even more, creates a low-pressure area.
- (iv) Air from surrounding high-pressure areas rushes in to fill this low-pressure zone, and it also starts rising.
- (v) Earth's rotation makes this moving air spin.
- (vi) The cycle repeats and forms a low-pressure area with high-speed spinning winds called cyclone.

### Eye of the Cyclone

- The centre of the cyclone is called the eye — it has the lowest pressure.
- Inside the eye: winds are calm.
- Around the eye: strong winds and heavy rainfall.

**Topic:** Pressure, Winds, Storms and Cyclones

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### **Cyclone: Ocean vs Land**

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- Moving from ocean → land, cyclones get stronger (higher wind speeds than normal thunderstorms).
- Once on land, the moist air supply is cut off, so the cyclone loses strength.

### **Damage Caused by Cyclones**

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- Storm surge:** strong winds push seawater toward shore, creating a wall of water 3–12 metres high causing floods coastal (and even inland) areas.
- Heavy rain causes rivers overflow and landslides.
- Seawater intrusion contaminates drinking water, and makes soil less fertile (damages crops).
- Fallen trees/debris → block roads, delay rescue/help.
- Power outages → last for days, disrupt daily life and emergency services.
- Example: Amphan cyclone (2020) had peak wind speeds of 270 km/h.

### **Cyclone Safety / Protection**

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- Stay updated with weather reports and alerts from the India Meteorological Department (IMD).
- Weather satellites help track cyclones and predict their path.
- Keep an emergency kit ready if you live in a cyclone-prone area.
- Move quickly to the nearest cyclone shelter during a cyclone.