Atmosphere and Its Importance

Our earth is surrounded by a huge blanket of air called the atmosphere. All living beings on this earth depend on the atmosphere for their survival. It provides us with the air we breathe and protects us from the harmful effects of the sun's rays. Without this blanket of protection, we would be baked alive by the heat of the sun during the day and get frozen during night. So it is this mass of air that has made the temperature on the earth liveable.

Composition of the Atmosphere

The air we breathe is a mixture of many gases. Nitrogen and oxygen make up the bulk of the atmosphere. Carbon dioxide, helium, ozone, argon, and hydrogen are found in lesser quantities. Tiny dust particles are also present in the air.

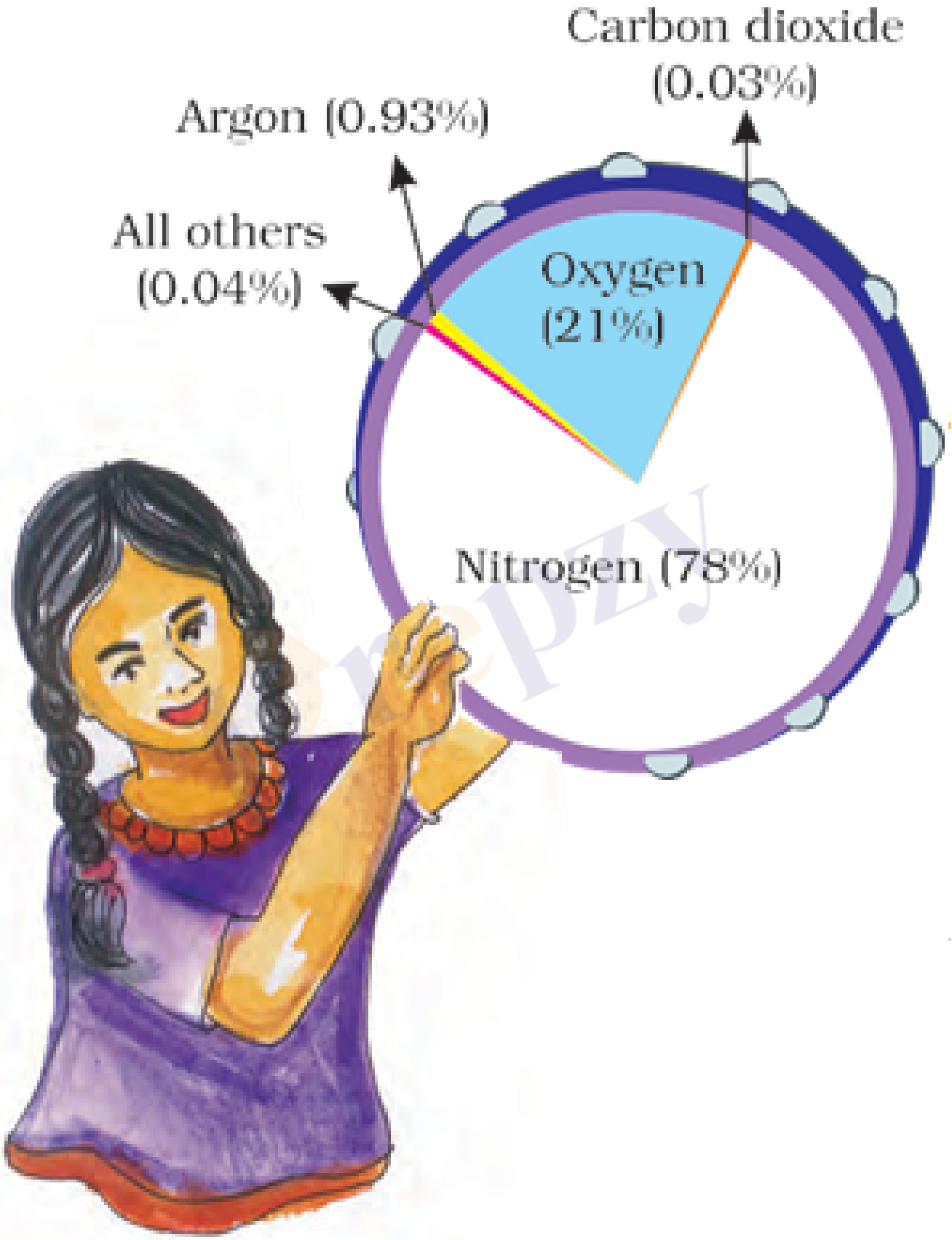


Fig.4.1:ConstituentsofAir

The major components of air are:

- **Nitrogen (78%)**: The largest part of air, inert gas, dilutes oxygen and prevents rapid burning.
- **Oxygen (21%)**: Essential for respiration and combustion.
- **Argon (0.93%)**: Noble gas, chemically inert, used in industrial processes.
- **Carbon dioxide (0.03%)**: Used by plants in photosynthesis, exhaled by humans and animals, important in carbon cycle and climate.
- **Other gases (0.04%)**: Includes neon, helium, methane, krypton, hydrogen, etc.

Nitrogen is taken in and exhaled by humans but plants cannot use it directly. Soil bacteria convert nitrogen into usable forms for plants. Oxygen is produced by green plants during photosynthesis, maintaining balance. Carbon dioxide is balanced between what humans and animals release and what plants use, but burning fossil fuels increases CO_2 levels, affecting climate.

Exam Question

Q: Why is nitrogen important for plants even though they cannot use it directly from the air?

A: Nitrogen is converted into usable forms by bacteria in the soil and roots of some plants, which plants then absorb for their survival.

Global Warming and Greenhouse Effect

Carbon dioxide released in the atmosphere traps heat radiated from the earth, creating a greenhouse effect. Without it, the earth would be too cold to live in. However, increased CO_2 from burning fuels causes excess heat retention, leading to global warming.

Global warming causes melting of snow in cold regions, rising sea levels, floods in coastal areas, and drastic climate changes that may lead to extinction of some plants and animals.

Exam Question

Q: What causes the greenhouse effect and how does it lead to global warming?

A: Carbon dioxide traps heat radiated from the earth, creating the greenhouse effect. Increased CO_2 from human activities causes more heat to be trapped, leading to global warming.

Structure of the Atmosphere

The atmosphere is divided into five layers starting from the earth's surface: Troposphere, Stratosphere, Mesosphere, Thermosphere, and Exosphere.

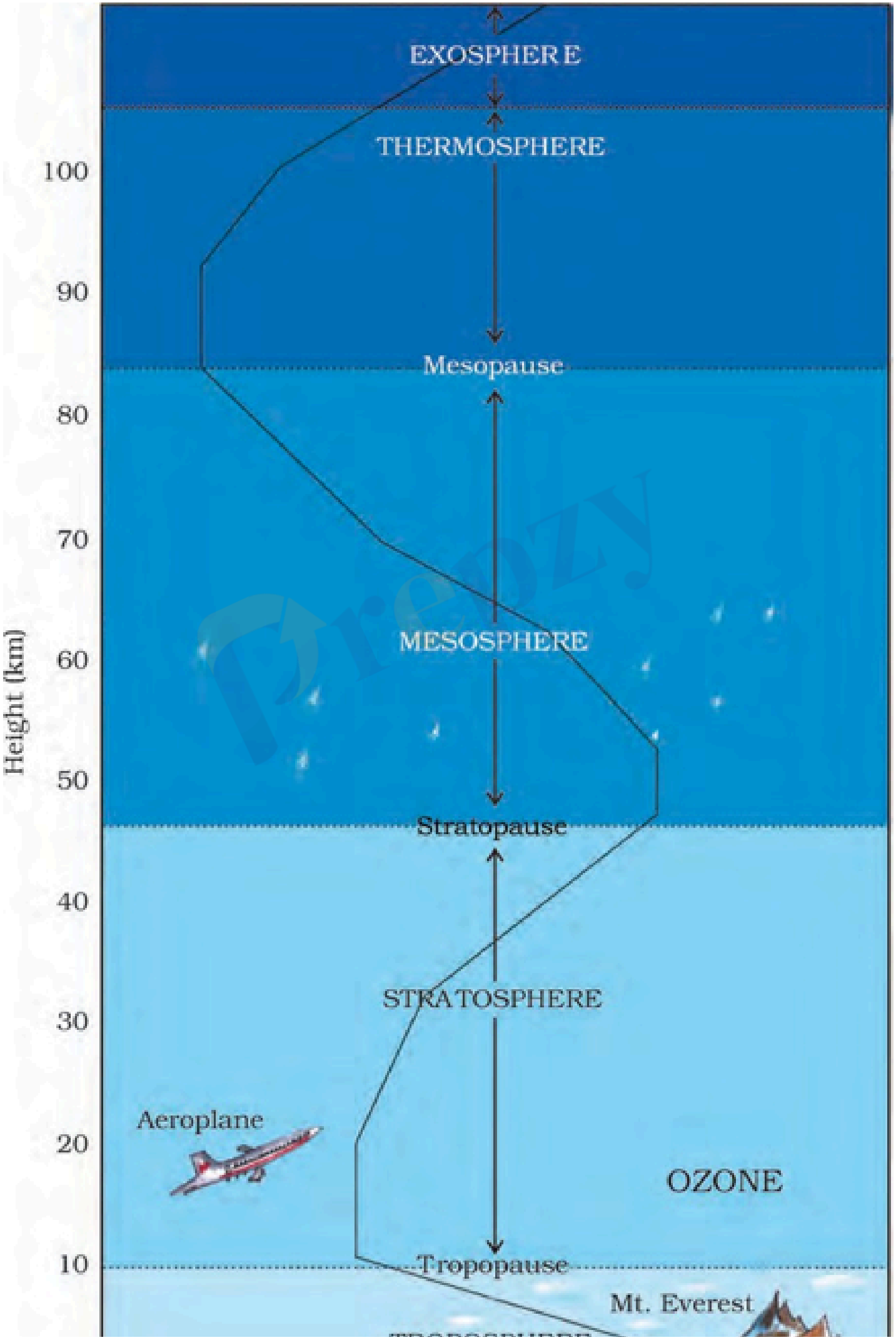

EXOSPHERE
THERMOSPHERE
100
90
Mesopause
80
70
MESOSPHERE
60
50
Stratopause
40
STRATOSPHERE
30
Aeroplane
20
OZONE
10
Tropopause
Mt. Everest
Height (km)

Fig. 4.2: Layers of the Atmosphere

- **Troposphere (0-10 km):** Contains most of the atmosphere's mass, weather phenomena occur here, temperature decreases with height.
- **Stratosphere (10-50 km):** Contains ozone layer that absorbs UV radiation, temperature increases with height, ideal for flying airplanes.
- **Mesosphere (50-85 km):** Coldest layer, meteors burn up here, temperature decreases with height.
- **Thermosphere (85-600 km):** Temperature rises rapidly, auroras occur, satellites orbit here.
- **Exosphere (600+ km):** Outermost layer, very thin air, transition to outer space.

Exam Question

Q: Which layer of the atmosphere contains the ozone layer and why is it important?

A: The ozone layer is in the stratosphere. It absorbs harmful ultraviolet rays from the sun, protecting living beings on earth.

Weather and Climate

Weather is the hour-to-hour, day-to-day condition of the atmosphere, such as rain or sunshine. Climate is the average weather condition of a place over a longer period.

Temperature is the degree of hotness or coldness of the air. It varies between day and night and across seasons. Insolation, the incoming solar energy, decreases from the equator to the poles, causing temperature to decrease similarly.

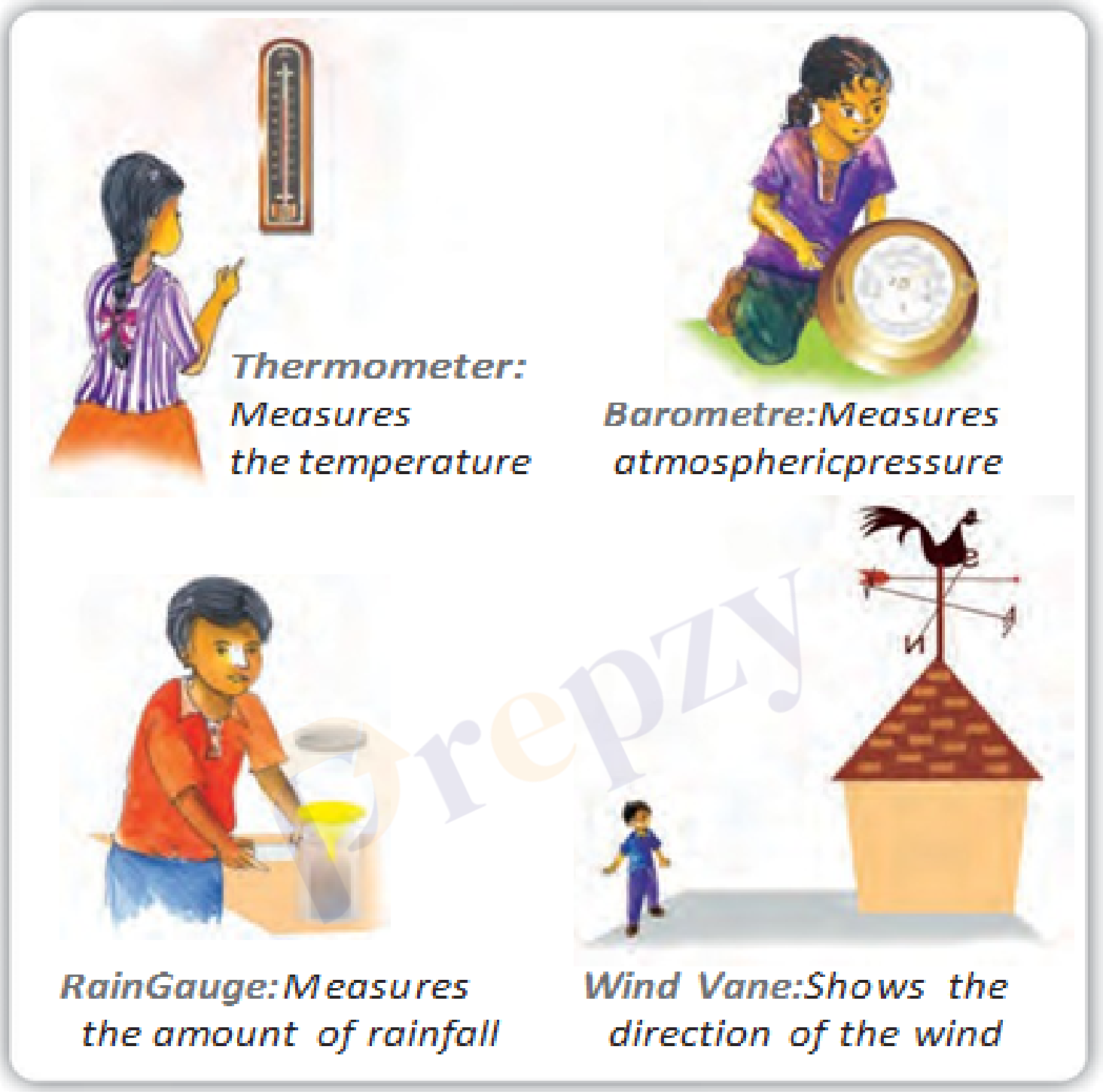


Fig.4.3:Weather Instruments

Weather instruments include:

- **Thermometer:** Measures temperature.
- **Barometer:** Measures atmospheric pressure.
- **Rain Gauge:** Measures rainfall amount.
- **Wind Vane:** Shows wind direction.

Exam Question

Q: What is the difference between weather and climate?

A: Weather is the short-term condition of the atmosphere, while climate is the average weather over a long period.

Air Pressure

Air exerts pressure on the earth's surface due to its weight. Air pressure is highest at sea level and decreases with height. Warm air rises creating low pressure, associated with cloudy and wet weather. Cold air sinks creating high pressure, associated with clear and sunny weather. Air moves from high to low pressure areas, causing wind.

Exam Question

Q: Why does air pressure decrease with height?

A: Because the weight of the air above decreases as we go higher, resulting in lower air pressure.

Wind

Wind is the movement of air from high pressure areas to low pressure areas. Winds can be permanent (trade winds, westerlies, easterlies), seasonal (monsoons), or local (land and sea breezes).

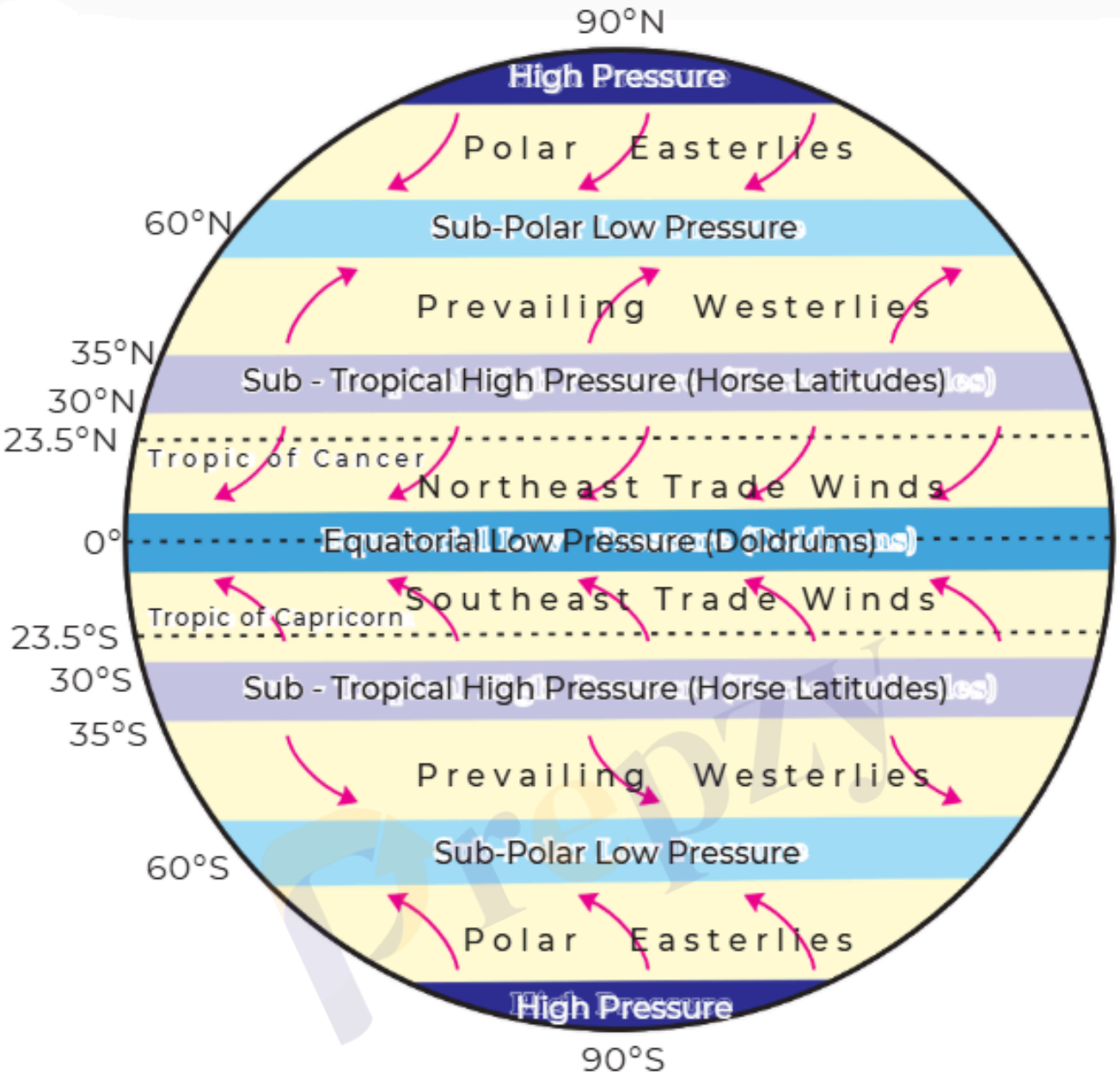


Fig. 4.4: Major Pressure Belts and Wind System

Major pressure belts and wind systems include:

- High pressure at poles (90°N and 90°S)
- Polar Easterlies (60°-90°)
- Sub-Polar Low Pressure Belts (around 60°)
- Prevailing Westerlies (35°-60°)
- Sub-Tropical High Pressure (Horse Latitudes, around 30°)
- Trade Winds (0°-30°)
- Equatorial Low Pressure (Doldrums, 0°)

Exam Question

Q: What causes wind to blow?

A: Wind blows due to air moving from high pressure areas to low pressure areas.

Cyclone – Nature's Fury

Cyclones are powerful storms with strong rotating winds that form over warm ocean waters. Odisha is prone to cyclones originating in the Bay of Bengal. The supercyclone of October 1999 caused massive destruction due to high wind velocity, heavy rain, and tidal surge.

Destruction caused by a cyclone

Cyclones uproot trees, damage houses, cause flooding, and affect agriculture and forests. Understanding cyclones helps in preparation and reducing damage.

Exam Question

Q: What are the main causes of damage during a cyclone?

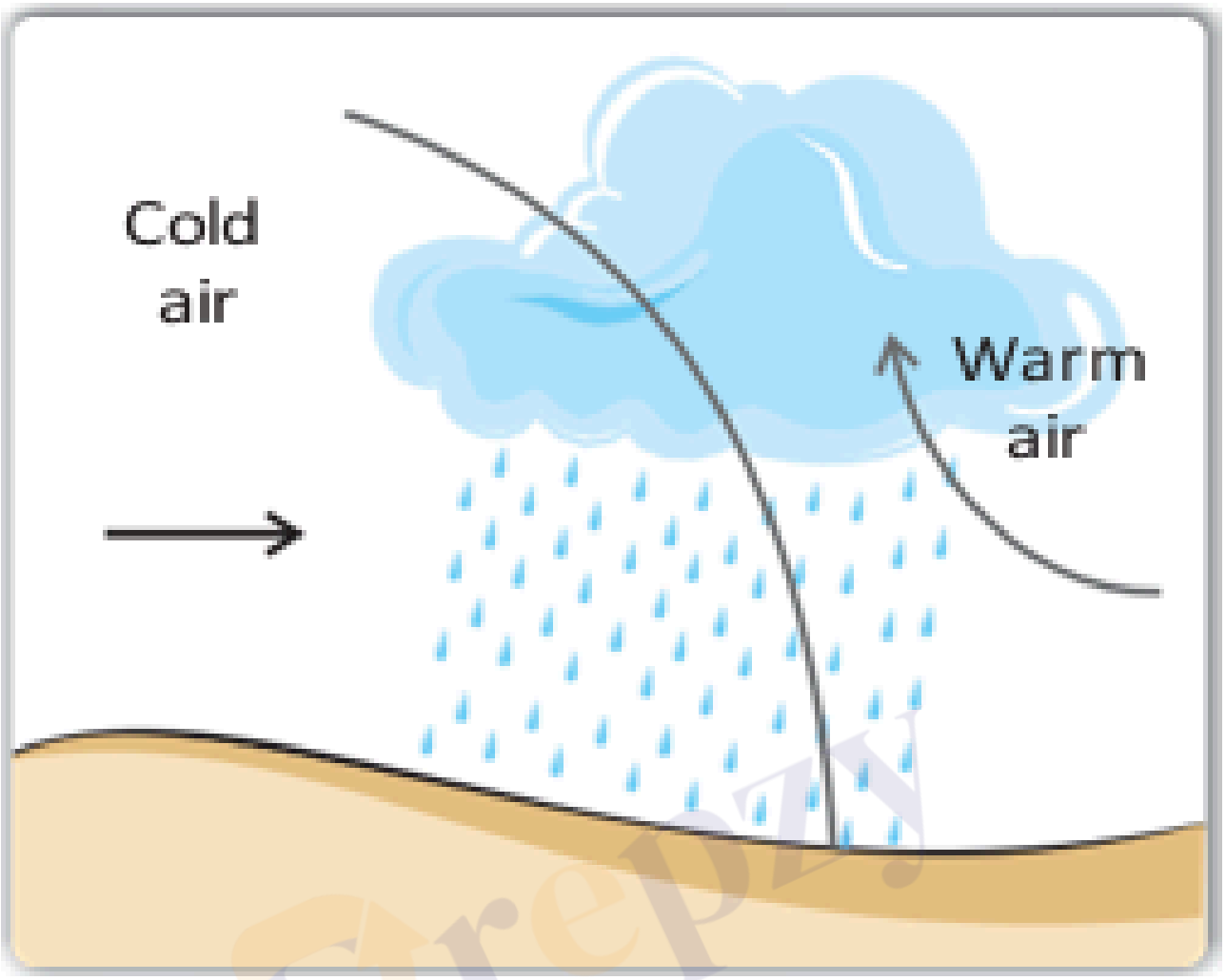
A: Wind velocity, heavy rain, and tidal surge are the main causes of damage during a cyclone.

Moisture and Rainfall

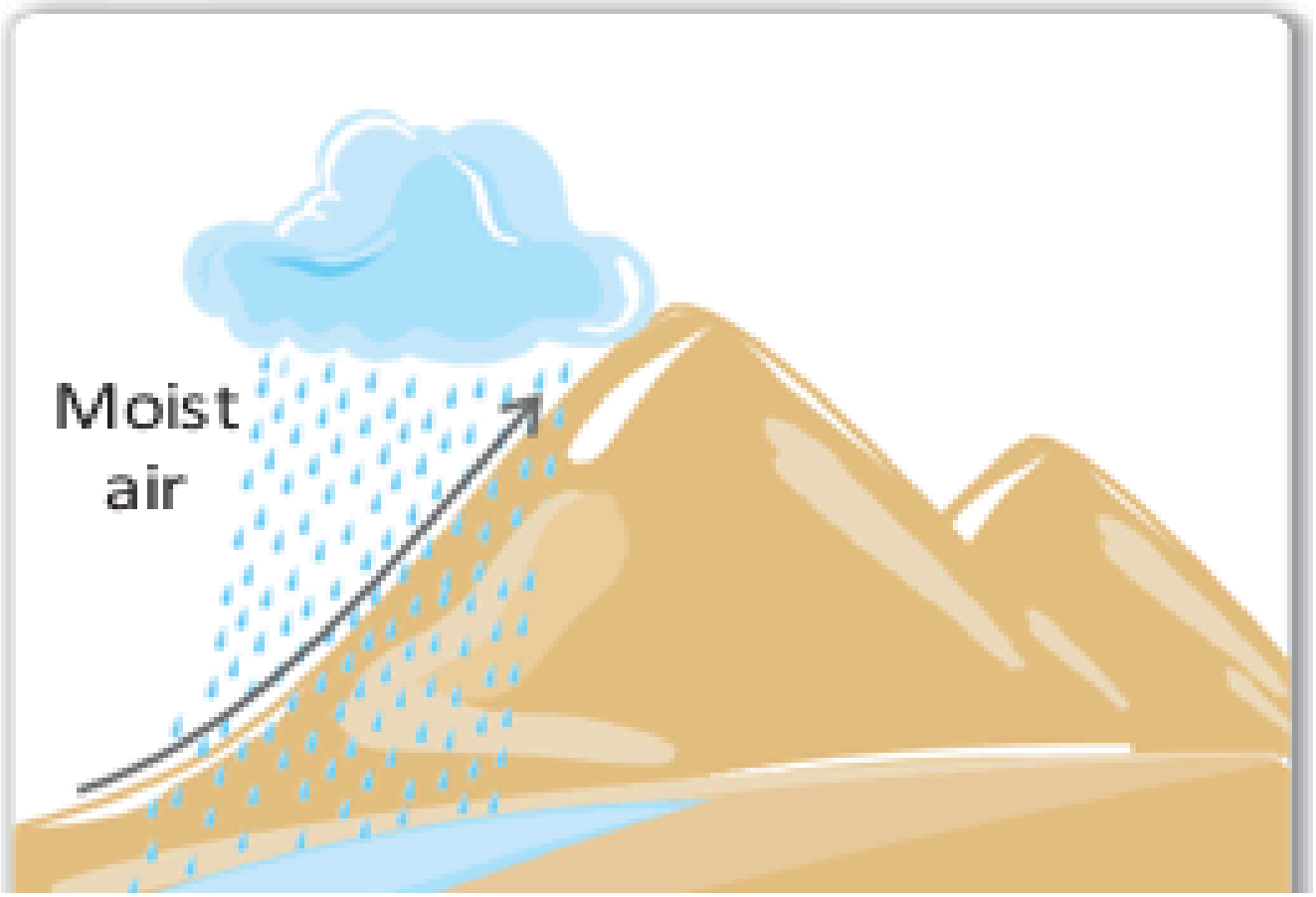
Water evaporates from land and water bodies to form water vapour, which is moisture in the air. Humidity is the amount of moisture present. When moist air rises and cools, water vapour condenses to form clouds and precipitation.

Rainfall is important for plants and animals. Insufficient rainfall causes drought, while excess causes floods.

There are three types of rainfall:



Cyclonic Rainfall



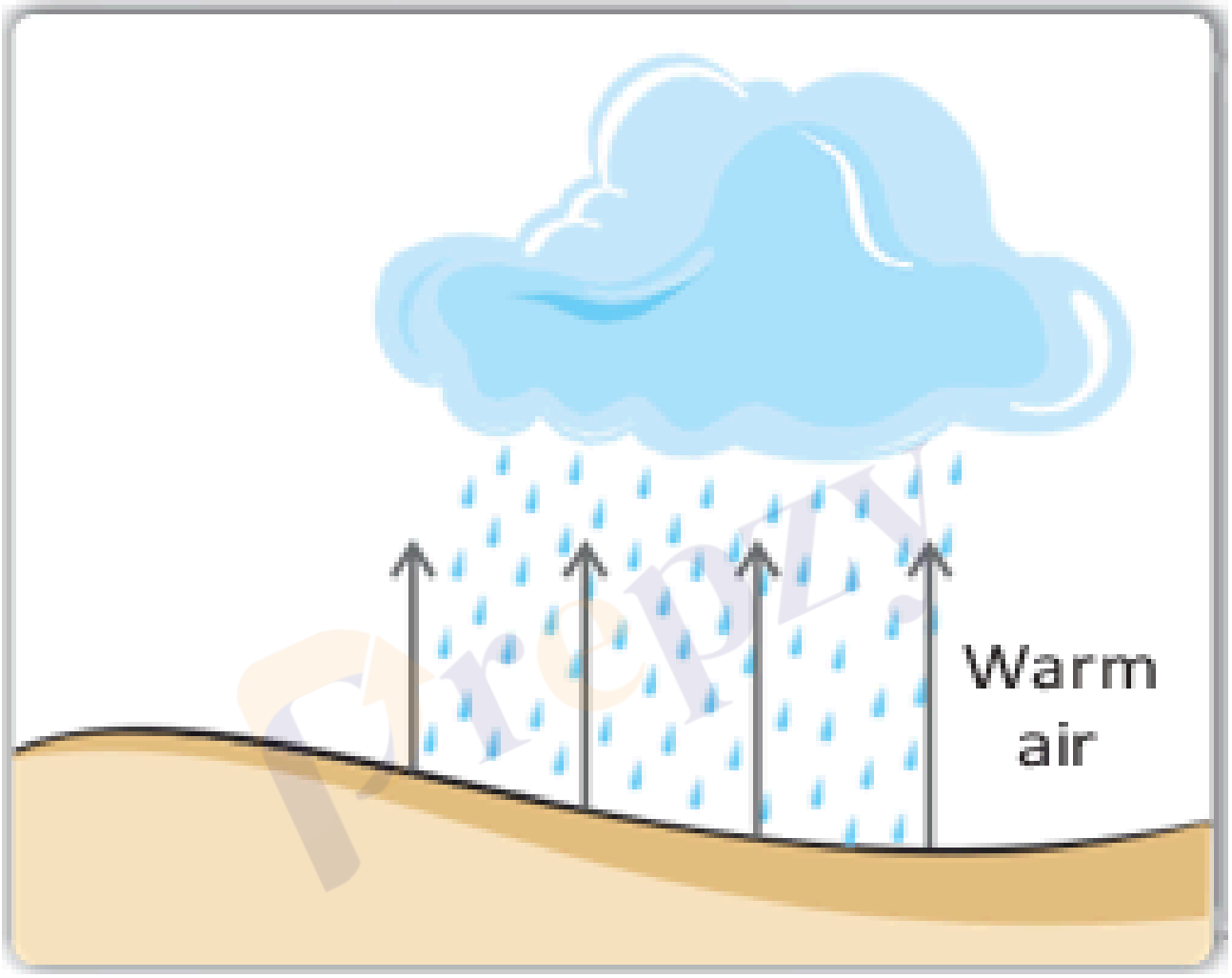


Fig. 4.5: Types of Rainfall

- **Cyclonic Rainfall:** Occurs when warm air meets cold air, warm air rises, cools, and rains.
- **Relief (Orographic) Rainfall:** Occurs when moist air is forced to rise over mountains, cooling and raining on windward side.
- **Convectional Rainfall:** Occurs when the sun heats the ground, warm air rises, cools, and rains.

Exam Question

Q: Name the three types of rainfall and briefly explain one.

A: The three types are cyclonic, relief (orographic), and convectional rainfall. Cyclonic rainfall occurs when warm air rises over cold air, cools, and causes rain.

Solved Examples

1. **Example:** Why is the stratosphere important for life on earth?
   Answer: The stratosphere contains the ozone layer which absorbs harmful ultraviolet rays from the sun, protecting living beings on earth.
2. **Example:** What causes wind to blow?
   Answer: Wind blows due to air moving from high pressure areas to low pressure areas caused by differences in air pressure.

Practice Set

Easy

1. What is the main gas present in the atmosphere?
2. Define weather and climate.

Moderate

1. Explain the greenhouse effect and its impact on earth.
2. Describe the structure of the atmosphere.

Challenging

1. Discuss the causes and effects of cyclones with an example.
2. Explain the different types of rainfall and their formation.

Answer Key

1. Nitrogen
2. Weather is the short-term atmospheric condition; climate is the average weather over a long period.
3. Greenhouse effect is caused by gases like carbon dioxide trapping heat, leading to global warming.
4. The atmosphere has five layers: Troposphere, Stratosphere, Mesosphere, Thermosphere, and Exosphere.
5. Cyclones are caused by low pressure over warm ocean waters, bringing strong winds, rain, and tidal surges causing damage.
6. Rainfall types: Cyclonic (warm air rises over cold air), Relief (moist air rises over mountains), Convectional (warm air rises due to sun's heat).

Quick Reference

- **Atmosphere:** Blanket of air surrounding earth.
- **Major gases:** Nitrogen (78%), Oxygen (21%), Argon, Carbon dioxide.
- **Greenhouse effect:** Trapping of heat by gases like CO_2.
- **Layers of atmosphere:** Troposphere, Stratosphere, Mesosphere, Thermosphere, Exosphere.
- **Weather:** Short-term atmospheric condition.
- **Climate:** Average weather over time.
- **Wind:** Air movement from high to low pressure.
- **Cyclone:** Powerful storm with strong winds and rain.
- **Rainfall types:** Cyclonic, Relief, Convectional.

Glossary

Atmosphere
: The layer of gases surrounding the earth.

Greenhouse Effect
: The warming of earth due to trapped heat by gases like carbon dioxide.

Ozone Layer
: A layer in the stratosphere that absorbs harmful ultraviolet rays.

Troposphere
: The lowest layer of the atmosphere where weather occurs.

Humidity
: The amount of moisture in the air.

Air Pressure
: The force exerted by the weight of air on the earth's surface.

Wind
: Movement of air from high pressure to low pressure areas.

Cyclone

A violent storm with strong winds and heavy rain.

Precipitation

Water in any form falling from the atmosphere, such as rain or snow.

Chronology of Major Atmospheric Events

Time Period / Year	Event / Change	Importance
Prehistoric times	Formation of atmosphere	Supports life on earth
Industrial Revolution	Increase in CO_2 due to burning fossil fuels	Start of global warming concerns
1999	Supercyclone in Odisha	Highlighted cyclone damage and need for preparedness
21st Century	Rising global temperatures and CO_2 levels	Climate change and environmental challenges