CHAPTER 15

Humidity

Syllabus

Humidity — meaning and difference between relative and absolute humidity.

Condensation — forms (clouds, dew, frost, fog and mist).

Precipitation — forms (rain, snow, and hail).

Types of rainfall — relief/orographic, convectional, cyclonic/frontal with examples from the different parts of the world.

Moisture continuously enters and leaves the atmosphere. When present in air, it gives air a different character. *The process by which water vapour enters the atmosphere on heating is known as* ***evaporation.*** *The process by which water vapour forms water droplets on cooling is known as* ***condensation.*** *The process by which the droplets fall to ground in liquid, solid or frozen form is known as* ***precipitation.*** *The amount of water vapour present in air is known as the* ***humidity.***

The total volume of water in the oceans and seas is constant. This is because all the water that evaporates from the earth's water bodies is eventually returned to it directly by the process of condensation and precipitation; and indirectly by stream and overflow from land surfaces.

Vapour is the gaseous state of water. A certain amount of energy is required to change water into water vapour. Heating of water over oceans, lakes and rivers causes water to evaporate. Generally 600 calories of heat is required to change one gram of liquid water into its vaporous state. Heat loss occurs during evaporation. The heat passes into water vapour in a hidden form. It is known as *latent heat.* When condensation occurs, this latent heat is released back into atmosphere causing a slight rise in temperature. That is why during the rainy season, one feels more heat than when the skies are clear. In low latitudes owing to a relatively higher temperature, evaporation is greater. However in Equatorial regions, the sky often remains overcast with clouds and evaporation is relatively low. In tropical deserts, surrounded by seas, evaporation is maximum because of high temperatures and clear skies. Thus, it is clear that the factors favouring evaporation are as follows.

(i) ***Humidity:*** Dry air promotes greater evaporation. This is because dry air has more capacity to hold water vapour than humid air.

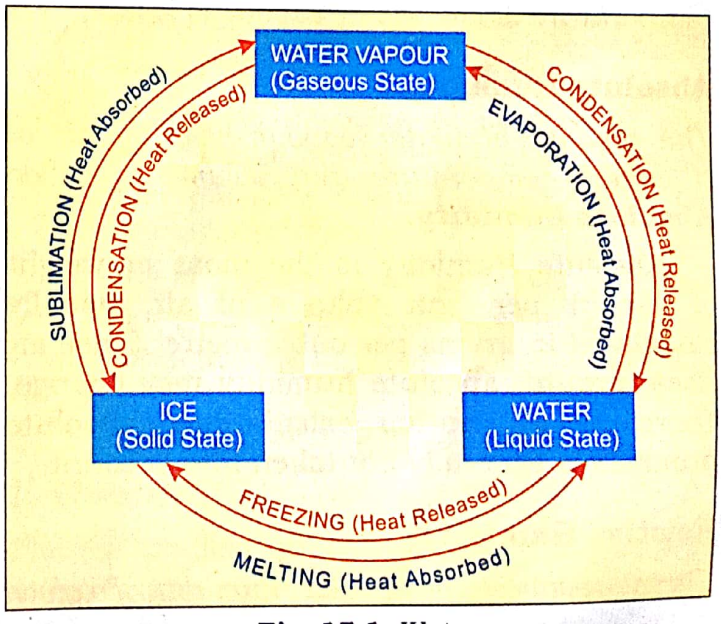

Fig. 15.1. Water

Difference between Absolute Humidity and Relative Humidity

Absolute Humidity	Relative Humidity
It is the measure of the actual amount of water vapour in the air, regardless of temperature.	It measures water vapour in air but relative to the maximum vapour that the air can hold at that temperature.
It is expressed as grams of moisture per cubic meter of air (g/m^3).	It is expressed as the ratio (percentage value) between the absolute humidity of a given mass of air and the maximum amount of water vapour that it can hold at the same temperature.
The higher the amount of water vapour, the higher is the absolute humidity.	Warm air possesses more water vapour than cold air, so with the same amount of absolute humidity, air will have a different relative humidity depending on temperature.
In weather calculations, absolute humidity is generally not taken into account.	It is the essential characteristic of weather forecasts, which indicates the likelihood of precipitation, dew or fog.

(ii) ***Supply of heat:*** The greater the heat of the water surface and air above it, the greater will be the rate of evaporation.

(iii) ***Winds:*** Strong winds promote evaporation. Wet clothes dry more quickly on a windy day than when it is calm.

HUMIDITY

Water is added to the atmosphere by the process of evaporation. It changes from liquid to gaseous form. *The water vapour in air is called* ***humidity.*** Humidity is related to temperature higher the temperature, the more is the water vapour present in it. When the atmospheric temperature is low, water vapour is less.

Absolute Humidity

The amount of water vapour held by air at a certain temperature and volume is called ***Absolute Humidity.***

Absolute Humidity is the mass or weight of vapour per unit volume of air, usually calculated in grams per cubic metre. Since air rises upward, absolute humidity may change. Therefore, in weather calculations, absolute humidity is generally not taken into account.

Relative Humidity

The ratio between the absolute humidity of a given mass of air and the maximum amount of water vapour that it can hold at the same temperature is called the ***relative humidity.*** Relative humidity is generally expressed in percentage.

$$\text{Relative Humidity (RH)} = \frac{\text{Actual amount}}{\text{Water holding Capacity}} \times 100$$

If the temperature of an air mass is 25°C and if its relative humidity is 60%, then it can still add 40% more water vapour at the same temperature before it becomes saturated or Relative humidity reaches 100%.

If a sample of air holds 20 gm/cu.m at 25°C but has the capacity to hold 25 gm/cu.m at this temperature; the Relative Humidity would be:

$$\text{R.H} = \frac{20}{25} \times 100 = 80 \text{ or } 80\%$$

Thus the RH of air is 80% at 25°C temperature.

Relative Humidity increases with more water vapour in atmosphere but decreases with reduction in the vapour content. When the air is fully *saturated,* Relative Humidity is 100%. Saturated air will not hold any more vapour at that temperature. ***Dew point*** *is the temperature at which air gets fully saturated.*

Relative humidity is the most essential characteristic of climate. It generally helps to

determine the amount of precipitation. Above all, human comfort depends on humidity. Highly humid air is more oppressive. The human body dissipates heat through perspiration and its evaporation. Under conditions of high relative humidity, the rate of evaporation of sweat from the skin decreases and the human being feels warm and uncomfortable.

MEASUREMENT OF HUMIDITY

The humidity of the atmosphere is measured with the help of a *Hygrometer*, also known as *Dry and Wet Bulb Thermometer*. In the Dry and Wet Bulb Thermometer, a piece of wet cloth is tied around one bulb, the other end of the cloth dips into a small container of water. The rate of evaporation of water vapour from the wet bulb keeps the temperature of this bulb lower than the dry bulb. A difference in temperature between the two thermometers indicates the relative humidity. Saturated air will not allow evaporation and in that case the temperature reading on both the dry and wet thermometers will be the same. This would mean that Relative Humidity is 100%.

CONDENSATION

Condensation is the reverse process of evaporation. In condensation, water vapour in the atmosphere get converted into water droplets or ice. During condensation, the latent heat locked in water vapour is released back into the atmosphere. Condensation can take place only when water vapour is added to saturated air or when the temperature falls below the temperature at which air becomes saturated. For example at 25°C temperature, air can hold 30 gm of water vapour per cubic metre. If the temperature falls to 20°C, it can hold only 24 gm of water vapour. The remaining 6 gm of water vapour will get condensed.

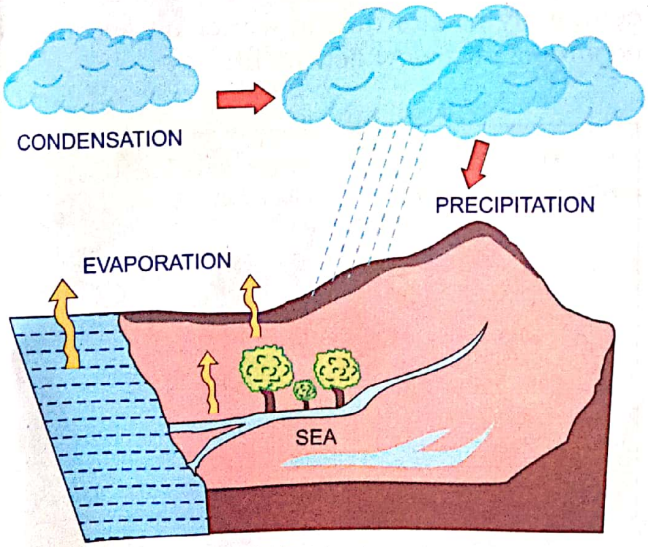

Fig. 15.2. Precipitation

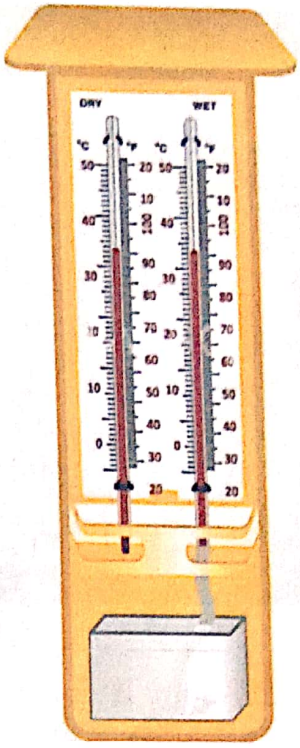

Fig. 15.3. Hygrometer

Condensation takes place when the following atmospheric conditions exist:

(i) There should be a high amount of water vapour present in atmosphere.

(ii) Minuscule particles of dust, salt, and even smoke act as condensation nuclei (i.e., particles around which the water vapour condenses).

(iii) The temperature of air must be below dew point temperature so as to encourage condensation.

FORMS OF CONDENSATION

1. Clouds

Clouds are formed when minute droplets of water vapour condense on a nuclei and remain suspended in air.

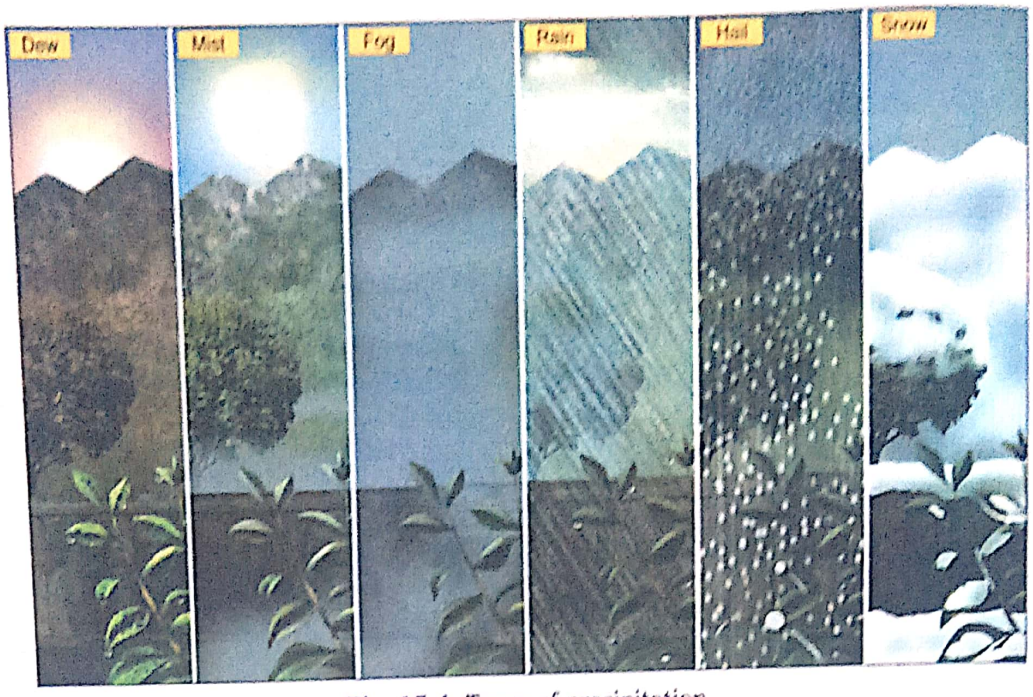

Fig. 15.4. Types of precipitation

When a cloud is fully saturated and relative humidity reaches 100%, precipitation occurs. Warm moist air near the ground rises into the sky. Since temperature decreases with height, the ascent causes reduction in temperature below dew point. Moving air on colliding with dust particles in air, sheds the extra moisture. This leads to condensation in the form of tiny droplets of water. It is important to remember that condensation occurs only around tiny solid particles like dust or carbon dioxide in smoke.

These impurities in air are known as *condensation nuclei. Without condensation nuclei condensation does not take place. Without condensation, clouds do not form and without clouds, precipitation cannot occur.* The products of condensation are so tiny that they remain in suspension and do not fall to the ground. Clouds then rise. As more and more droplets are added, the cloud slowly grows in size. When it cannot hold any more moisture, or when the air is fully saturated with Relative Humidity 100%, the moisture comes down as rain.

Classification of Clouds: When clouds rise, they take on different shapes but not all clouds cause precipitation. Clouds may be grouped according to their formation in the atmosphere and their shape.

Clouds can be of three types mainly—

(i) **Cirrus** clouds are fleecy like wo generally at high altitude.

(ii) **Cumulus** have a cauliflower-like shape.

(iii) **Stratus** clouds have a layered structure

The base of cumulus clouds is horizonta but they have a vertical structure and their to is dome-shaped. They are generally termed a rain-bearing clouds.

2. Dew

When water vapour condenses on the surface it forms tiny droplets of water called dew. Dew commonly occurs during winter on account o cooling of air below dew point.

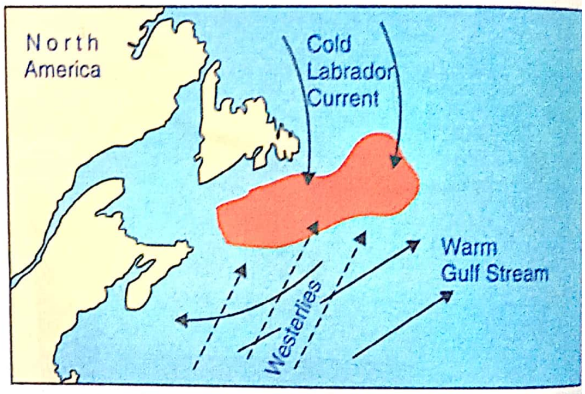

Fig. 15.5. The meeting of warm and cold currents gives rise to fog

3. Frost

In very low temperature, when condensation occurs at zero metre or ground level, water vapour freezes into minute crystals of ice on objects near the ground such as blades of grass, leaves and tiny rock particles. Frost is harmful to plants.

4. Fog and Mist

Fog and Mist are two related terms. Droplets of water suspended in the atmosphere close to the surface of the earth are termed as fog. On long winter nights, the ground cools more rapidly than the air above. Such cooling reduces temperature at the surface to below dew point. Water vapour at lower levels get condensed around minute solid particles to form fog.

Mist is less dense than fog and the visibility is relatively better. Visibility during fog extends to less than one kilometre but under conditions of mist, it may go up to two kilometres.

PRECIPITATION

The process by which products of condensation, *viz* water droplets, ice crystals, sleet, etc., fall to ground is known as *precipitation*. Rainfall, snowfall, drizzle, sleet and hail are the chief forms of precipitation. Precipitation takes place only when tiny particles of water join together to form large sized particles which become too heavy to remain in suspension in the clouds.

- ***Rain:*** It is the most common form of precipitation. Raindrops of smaller size and less intensity are known as drizzle.
- ***Snow:*** Water droplets which rise higher and freeze on account of drop in temperature. Snowfall usually occurs in winter in cold climates or on high mountains.

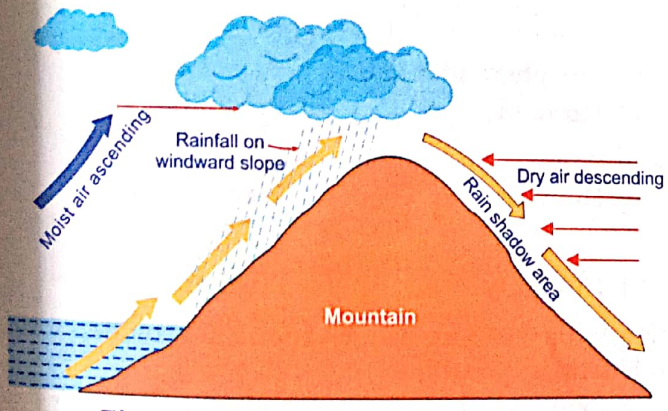

Fig. 15.6. Orographic or Relief rainfall

- ***Hail:*** Sometimes, vertical air currents may push water droplets or ice particles higher. They form into solid ice and fall as hail. Hailstones cause great damage to crops.

Types of Rainfall

Deposition of moisture from the atmosphere on the earth's surface is called precipitation. One of the forms of precipitation is rainfall. The three types of cooling of air produce three different types of rainfall known as *Convectional Rainfall, Orographic Rainfall* and *Cyclonic Rainfall.*

1. Relief Rainfall

Relief Rainfall is also known as *Orographic Rainfall.* It occurs from the cooling of warm moist air which ascends above the mountain barrier lying in the direction of the prevailing winds. The presence of mountains causes humid air to rise. The sudden ascent causes cooling of air, leading to condensation and precipitation. Since it is caused by the relief of the land, it is called *relief rain.* On descending the leeward slope, a decrease in altitude increases both the pressure and the temperature, leading the air to get compressed and warm. Consequently, the relative humidity drops and there is evaporation and little no precipitation in the rain shadow area.

For example, the monsoon winds, while ascending the Western Ghats cause heavy rainfall on the windward side. In the North-East, the Himalayan barrier makes the winds to shed their moisture on the windward side on the slopes facing south.

Similarly, other regions receiving orographic rainfall include Eastern Brazil, East China, South Eastern United States. Orographic rainfall is especially heavy in the hot and humid areas bounded by tropical oceans. In all these regions, there are regions of heavy rainfall (200 cm and above), moderate rainfall (100-200 cm) and very low rainfall (less than 25 cm).

2. Convectional Rainfall

There is Convectional Rainfall in the Equatorial regions. The high temperature leads to the rapid heating of air. Such heated air rises in convectional currents, leading to development

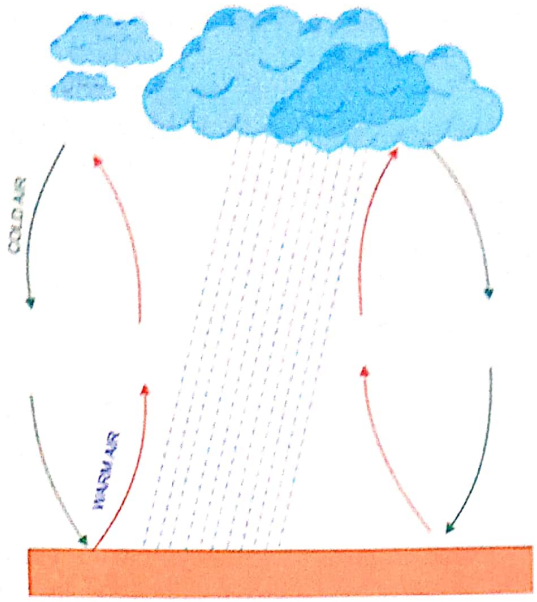

Fig. 15.7. Convectional rainfall

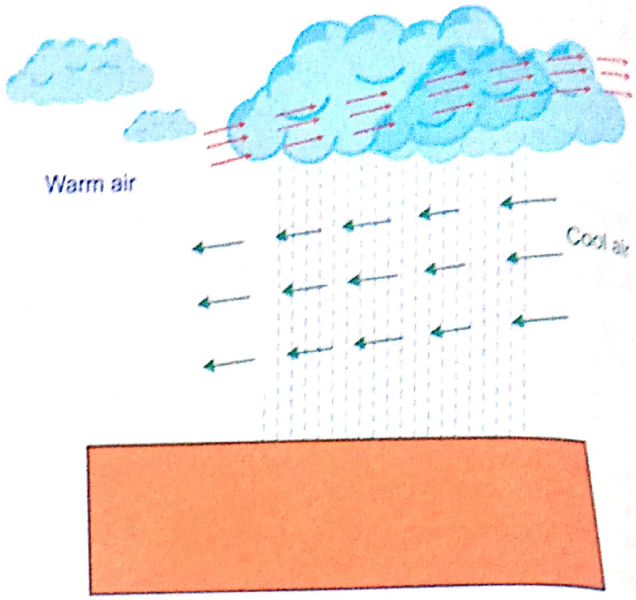

Fig. 15.8. Cyclonic or frontal rainfall

of clouds at about 10 km height. Ascending currents of hot and humid air causes condensation of the clouds, resulting in heavy rainfall. This type of rainfall occurs in the afternoon at about 4 O'clock and is known as '4 O'clock Shower.'

Such rainfall is also accompanied by thunder and lightning. Convectional rainfall occurs daily in the Equatorial regions. They receive an annual rainfall of more than 200 cm.

3. Cyclonic or Frontal Rainfall

This type of rainfall is due to cyclones (in Tropical Latitudes) and depressions (in Temperate Latitudes or the mid-latitudes), irrespective of relief or convection. It is caused by convergence (meeting) of two different air masses with different temperatures and other physical properties. When warm and cold air masses confront each other, the warmer (lighter) air generally climbs above the colder (heavier) air. The boundary zones of these air masses are called the *fronts*. The rising air is cooled while undergoing a frontal lift. This causes precipitation. Such precipitation or rainfall is called *Cyclonic or Frontal Rainfall* and it is very heavy in tropical cyclones. It lasts for only a few hours. In temperate depressions, such as those of Western Europe, the rainfall is much lighter though it lasts for several days. There, it falls in the form of a continuous drizzle.

EXERCISES

I. Choose the correct option:

1. The process by which water vapour enters the atmosphere on heating:
   (a) Water Vapour (b) Evaporation (c) Humidity (d) Precipitation
2. The process by which water vapour forms water droplets on cooling:
   (a) Condensation (b) Evaporation (c) Humidity (d) Precipitation
3. The amount of water vapour present in air:
   (a) Condensation (b) Evaporation (c) Humidity (d) Precipitation
4. Name the heat that is lost during evaporation and passes into water vapour in a hidden form and is released in the atmosphere during condensation.
   (a) Condensed heat (b) Humidity (c) Latent heat (d) Relative Humidity

5. Which, amongst the following, is NOT one of the factors favouring evaporation?
(a) Humidity (b) Supply of heat (c) Winds (d) Precipitation

6. The ratio between the absolute humidity of a given mass of air and the maximum amount of water vapour that it can hold at the same temperature:
(a) Humidity (b) Dew Point (c) Relative humidity (d) Latent heat

7. The temperature at which air gets fully saturated:
(a) Humidity (b) Dew Point (c) Relative humidity (d) Latent heat

8. The measure of the actual amount of water vapour in the air, regardless of temperature:
(a) Absolute Humidity (b) Humidity
(c) Dew Point (d) Relative Humidity

9. The process by which products of condensation, viz water droplets, ice crystals, sleet etc. fall to the ground:
(a) Evaporation (b) Humidation (c) Precipitation (d) Condensation

10. Which of the following is not a type of a cloud:
(a) Cirrus (b) Cumulus (c) Strata (d) Stratus

11. Which of the following type of cloud has a cauliflower-like shape?
(a) Cirrus (b) Cumulus (c) Strata (d) None of the above

12. Condensation nuclei are
(a) impurities that support condensation.
(b) water particles that help in precipitation.
(c) droplets formed as a result of condensation.
(d) droplets that fall to the ground.

13. Which of the following is NOT correct
(a) Frontal rainfall : cyclones (b) Convectional rainfall : 4 o'clock showers
(c) Cyclonic rainfall : mountains (d) Relief rainfall : mountain barriers

14. In the month of August after many rainy days there was a clear Sunday. We went for a picnic to a park. We felt so hot and uncomfortable that we changed plans and went to watch a movie instead. What caused us this discomfort?
(a) Latent heat released as a result of condensation raised the temperature.
(b) High humidity due to the rains of the previous day.
(c) Heat released from the surface of the earth raised the temperature.
(d) None of the above.

15. Jyoti and her family had gone to the Little Andaman Island for a holiday. It was a clear day when the sky became dark with clouds and there was heavy rain late in the afternoon. This was the case every day that they spent there. What type of rainfall is this?
(a) Relief (b) Convectional (c) Cyclonic (d) Frontal

II. Short Answer Questions

1. What determines the amount of water vapour in the air?
2. How is relative humidity determined?
3. Name four chief forms of condensation.
4. Mention the different forms of precipitation.
5. Give one difference between fog and mist.
6. What do you understand by 'condensation nuclei'?

7. State the three types of rainfall.
8. Why is orographic rainfall also called relief rainfall?
9. What is cyclonic rainfall? What are fronts?

III. Explain the following terms:

(a) Precipitation (b) Evaporation
(c) Condensation (d) Humidity

IV. Structured Questions

1. (a) What is 'humidity'? How is humidity measured?
   (b) Distinguish between Absolute Humidity and Relative Humidity.
   (c) Give a geographical reason for each of the following:
      (i) The total volume of water in the oceans and seas remains constant.
      (ii) In Equatorial regions the sky often remains overcast with clouds.
      (iii) Human comfort depends on humidity.
   (d) Draw a well labelled diagram showing orographic rainfall.

2. (a) What is condensation? Explain briefly the process of condensation.
   (b) Explain the atmospheric conditions that favour condensation.
   (c) Give a geographical reason for each of the following:
      (i) Condensation is the reverse process of evaporation.
      (ii) Coasts receive more rainfall than the interior of the continents.
      (iii) The windward sides of mountains receive more rainfall than the leeward sides.
   (d) Draw a well labelled diagram showing convectional rainfall.

3. (a) How is dew formed? What is the difference between fog and mist?
   (b) Describe briefly the orographic and convectional rainfall.
   (c) Give a geographical reason for each of the following:
      (i) A rain shadow area is generally dry.
      (ii) Frontal rain is common in mid-latitudes.
      (iii) Convectional rainfall is called 4 o'clock rainfall.
   (d) Define precipitation. Explain briefly the three forms of precipitation.

V. Thinking Skills

1. Condensation is regarded as the reverse process of evaporation. Imagine if this reverse process does not happen, what would be its consequences on climate and human beings? Also state the conditions under which this reversal may not happen.
2. Name two physical objects in your home which are affected by humidity. Also state the reason for such an affect.
3. List two places which receive two types of rainfall. Give reasons to support your answer.

VI. Project Work/Map Work

List the forms of precipitation that occur in your city along with the time of year when they occur.

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