11 Humidity in Atmosphere

Water in the atmosphere exists in three physical forms. It is seen as snow particles in the cloud in Troposphere. The water drops in the clouds at medium or low altitudes is its liquid form, and the water vapour in the air near the earths surface is its gaseous form.

Water vapour is devoid of colour, taste and smell. The volume of other gases except water vapour is uniform in the atmosphere. The humidity fluctuates according to place, season, time and temperature. Humidity decreases as we go up in the atmosphere. There is hardly any humidity beyond the altitude of 10 to 12 km from the surface.

Seas and oceans, spread over 71 % of the earths surface, are major source regions for humidity. Besides, wet lands, rivers, lakes etc. are also supplementary sources. Constant evaporation from these water bodies adds water vapour in the atmosphere. This water vapour rises high due to winds and air currents. Due to cold, condensation takes place and the water vapour turns into clouds, and finally returns to earth in the form of rain. This is how the water cycle works constantly between the earth and the atmosphere. Hygrometer is used to know the amount of humidity in the air.

Importance of Humidity

Water vapour comprises only two per cent of the atmosphere, yet plays an important role in deciding the weather and climate on earth. Humidity contributes decisively to warm up and to cool down the atmosphere. Humidity absorbs solar heat and restrains the heat on earth. It also works as a driving force for the atmosphere. The **latent heat** in the water vapour is released when condensation takes place, so air temperature rises and creates disturbances in the atmosphere. Humidity is responsible for the formation of the atmospheric disturbances, cyclones etc.

Atmosphere absorbs the humidity from the surface of the earth, stores and returns under proper conditions. We know them as dew, mist, cloud, rainfall, hails etc. Humidity in the atmosphere is also important for entire biotic world which gets its required amount of water due to the condensation of humidity and precipitation.

Evaporation

The process in which the water turns into vapour due to solar heat is known as **'Evaporation'**. The evaporation becomes faster with increasing temperature and more vapour is added to atmosphere. The humidity mixes with the atmosphere till the air has the capacity to hold moisture. So the evaporation process continues till the air becomes saturated.

Intensity of evaporation depends on temperature, aridity of the air and wind velocity. Hot and dry air has more capacity to hold more moisture, so it intensifies the evaporation. Winds blowing over the upper surface of water masses peak up moisture and move ahead. Thus, wind also intensifies evaporation. The evaporation exceeds in summer than in winter. Maximum evaporation takes place in equatorial region while polar regions experience least evaporation.

Absolute Humidity and Relative Humidity

In a given volume of air at any given time, the actual amount of humidity present in the atmosphere is known as **Absolute Humidity**. It changes with place and time. It is maximum over equator and minimum over poles.

Relative Humidity

Relative Humidity is the proportion of amount of humidity present in a given volume of air at a specific temperature with its saturation capacity. Relative Humidity is measured in percentage (%) and can be found by the formula given below :

$$\text{Relative Humidity} = \frac{\text{Moisture present in specific volume of air at specific temperature}}{\text{Saturation capacity of the same volume of air at the same temperature}} \times 100$$

With the fluctuations in temperature, the relative humidity also fluctuates. Temperature is low at night and during early morning so the relative humidity is more. At noon, it is less due to increased temperature. Relative humidity in the air is more over the seas than on the land mass and more over forests compared to open land.

Condensation and its forms

(1) Dew : When water vapour near the surface of the earth condenses in the form of a drop over the cold area on the surface, it is called **Dew**. Land area cools faster at night, so the air in its contact also cools. If the temperature of the cooled air drops below freezing point, the additional vapour condenses in the form of drops over the solid substance on earths surface.

Sufficient water vapour, clear sky, calm weather and longer winter night etc. are ideal conditions for dew formation. Dew is seen over the tree leaves, grass and over the buildings in the early morning in winter. Dew is useful for Rabi crops like wheat, grams and vegetables.

(2) Frost : Conditions for the formation of dew and frost are identical. When some substance on the surface becomes extremely cold, the temperature of the air in its contact falls below freezing point. So the additional vapour condenses into snow crystals instead of dew. This is called **Frost**.

In countries like India, when frost occurs during winter, crops like cumin seed, isabgul, fennel seed, tobacco, cotton etc. are heavily damaged.

(3) Fog : Fog is a form of condensation near the surface of the earth. It is stationed mostly over one area. When the temperature of the air near the surface of the earth falls below freezing point, the vapour condenses. It forms very minute water particles or snow particles which float in the air for a longer time and creates a cloud like shape. This is called **Fog**.

Just like dew, the favourable conditions for the formation of fog are sufficient humidity in the air, clear sky, calm weather, longer winter nights and minute dust particles.

The atmosphere looks smoky due to fog. Visibility of the air is also reduced. In some countries of the world, fog becomes obstacle for transportation. Flights cannot take off due to dense fog. In December 1952, thousand of passengers at Hithrowair port at London were stranded for four days continuously due to dense fog.

(4) Clouds : The fog at a higher altitude can be called a cloud. As the light moist air rises, it becomes cooler and the vapour within it condenses. When the temperature of the rising air falls below freezing point, the excess vapour condenses and many water drops are formed over the dust particles. If the temperature falls below 1^0 c, then snow particles are formed over the dust particles. These snow crystals float in the air because these are light weighted.

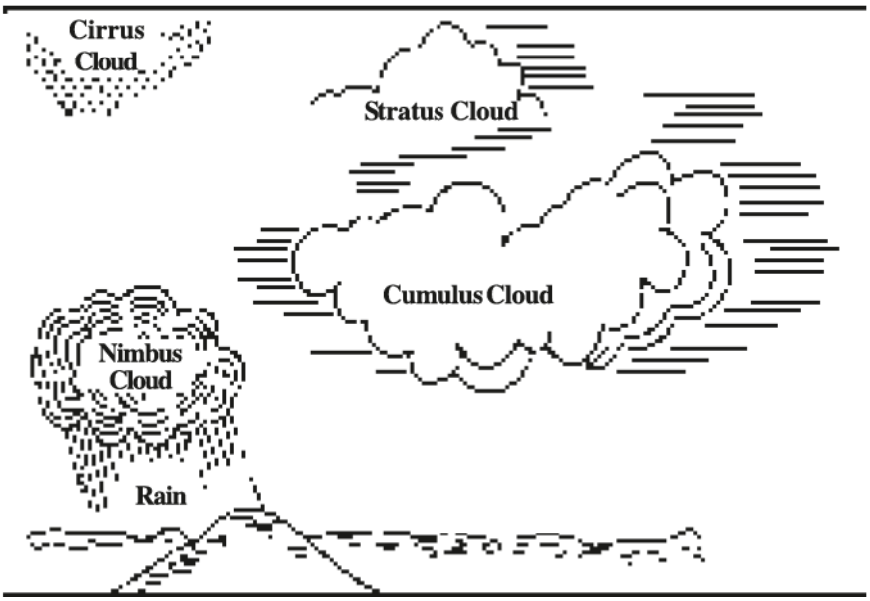
So a group of many water drops or snow particles which are very close to each other is called Cloud. According to height and the form, clouds are divided into four types :

(1) Cirrus Cloud (2) Stratus Cloud (3) Cumulus Cloud (4) Nimbus Cloud

(1) Cirrus Cloud : Cirrus clouds are seen at an altitude of about 10 km or more. These clouds are made up of minute icy crystals so they appear as white silver in sunlight and coloured at sunset.

When Cirrus clouds are spread like scattered feather, they indicate good weather, but if these are arranged in regular belts it suggests bad weather or approaching cyclonic condition. These clouds do not give any rain.

(2) Stratus Clouds : These clouds are seen within an altitude of 10 km from the surface. There are layers in this cloud just as the layered salted biscuits. Due to this peculiar appearance where the layers are seen over one another, these clouds are known as Stratus Clouds. In the upper layers of the air, if the warm and cool air come from opposite directions over each other, they form the shape of a stratus cloud. These clouds forecast the atmospheric disturbances. Low lying stratus clouds give slow drizzle, but the high altitude stratus clouds which are spread like a bed sheet in the sky do not give any rain.



11.1 Types of Cloud

(3) Cumulus Clouds : These clouds are seen between 500 metres from the surface up to an altitude of 10 to 12 km. They appear like a cotton heap so these are known as Cumulus Clouds. Its broad base is seen towards the earth and narrow apex towards the sky. The distance between its base to apex may be hundreds of metres. These cumulus clouds expand during day time due to convectional thermal currents but disappear at night.

When very large cumulus clouds turn into Nimbus clouds, they give heavy showers with thunders.

(4) Nimbus Clouds : These clouds are seen up to a maximum altitude of 2 km from the surface. Compared to other types, these are lowest clouds. These clouds give heavy rains with thunders. They are very close to each other and are dark coloured. During rainy season, the sky becomes overcast sometimes with such clouds. Viewing the stark black clouds makes us feel about the rainy season.

Precipitation

Due to evaporation of the water on the surface of the earth, the moisture mixes with the air. This vapour is condensed and returns back on the surface of the earth in various forms. These forms are called as Precipitation.

Generally the precipitation is recorded in inches, centimetres or millimetres. (1inch = 2.54 cm = 25 millimetres.). Various instruments are used to record precipitation.

There are four major types of precipitation received by the earth :

(1) Snowfall (2) Hails Stones (3) Slit Pallets (4) Rainfall. (Water rain)

(1) Snowfall : When the air temperature falls below 0^{o} c the vapour condenses. The vapour is transformed into small snow particles or snow pallets. When these snow particles or snow pallets grow larger, they precipitate on the surface which is called **snowfall**. Snowfall is very common over Canada, Greenland and polar regions. Heavy snowfall also occurs over the high peaks in Himalayas, Andies, Rockys and Alps.

Snowfall cools down the temperature of respective places and the cold is spread towards the remote areas. When there is heavy snowfall over Himalayan region, a severe cold wave spreads over entire North India, Rajasthan and upto Gujarat.

(2) Hail Stones : Water drops coming down from the clouds are pushed back in the colder upper air due to convectional air currents. They condense and transform into snow particles. When these snow particles come down, more vapour condenses over them and the snow particles become larger. Sometimes, before the snow particles fall down, they are sent up and down many times by the convectional current. This enlarges their size and finally fall on the earth in the form of a small piece of ice. This is called **Hail Stones**. Sometimes, such hail stones damage agricultural crops and other living organisms.

(3) Sleet Pallets : Sleet Pallets may be called half frozen rain. Water drops get frozen while passing through very cold winds in between before they fall on the surface. They fall in the form of snow pallets, which is called **Sleet Rains**.

In sleet rains the snow particles falling down are very soft or half frozen, and also have water particles. Sleet rain takes place when cold air from polar region gushes towards middle latitudes. Whenever there is sleet rain in few areas of the world, road accidents increase.

(4) Water Rain : When the water vapour from the clouds fall on the ground in the form of small water particles it is called **water rain**.

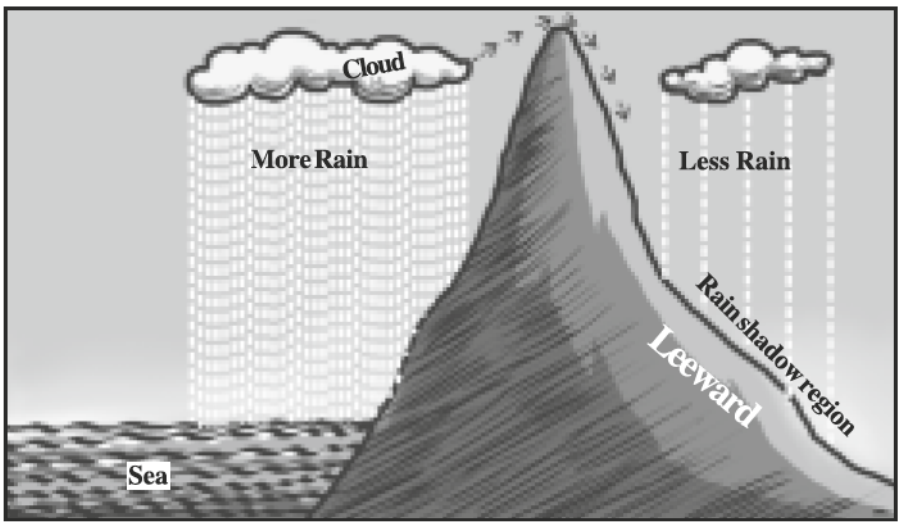
About 5 to 10 lakh minute water particles from the cloud mingle with one another, then a water drop is formed capable to fall down. These water drops are smaller than 5 millimetres or less.

Types of Water Rain

All precipitation falling on the earth is formed when the rising air becomes cool. On the basis of the cooling process, there are three types of rain.

(1) Orographic (Relief) Rain (2) Convectional Rain (3) Cyclonic Rain

(1) Orographic (Relief) Rain : If there is any obstruction like a mountain or a high land in the direction of the humid winds coming from over sea, these winds dash against the windward side of the mountain and rise. The rising air becomes cool and clouds are formed from the vapour, which cool and give rain on windward side. This is called Orographic or relief Rain.



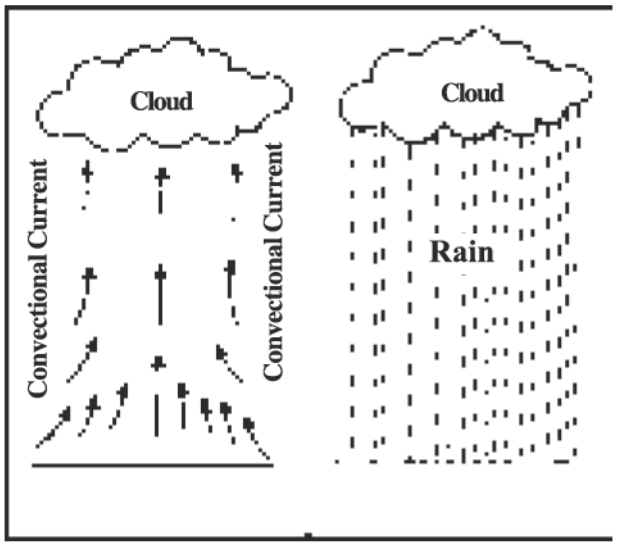
11.2 Orographic Relief Rain

After showering some rain these winds become less humid. They cross the mountain and descend on the leeward side of the mountain. Air pressure increases of the descending winds and they become warmer. As a result, these winds give less rainfall on the other side of the mountains. This area on the leeward side is called **Rain shadow** area. Konkan and Malabar coast on the western side of Western Ghats are windward regions so there is more rainfall, while the Deccan Plateau on the eastern side of Western Ghats is a rain shadow area so there is less rainfall.

On the windward side of Western Ghats, Mumbai gets about 200 cm rainfall annually, while there is hardly 80 cm of rain in Pune which is on the Leeward side of the Western Ghats.

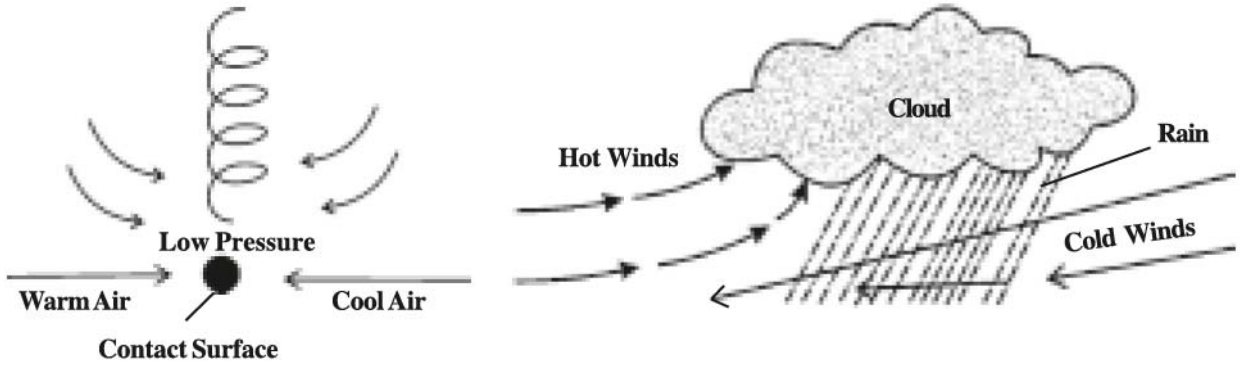
(2) Convectional Rain : Hot, humid and light air on the surface rises high due to convectional current. Due to the cold at higher altitude the water vapour condenses, forms clouds and gives heavy rain with thunders. This is called Convectional Rain.

As this rainfall occurs in heavy downpour, it causes heavy soil erosion. There is more surface runoff than the leaching and so it is less useful for agriculture.



11.3 Convectional Rain

(3) Cyclonic Rain : Cyclone develops at the confluence of cold and warm air masses. There is low pressure at the centre of the cyclone. So the air from high pressure in all sides gushes towards the centre of the cyclone with much velocity. These winds rise in circular motion due to the coriolis force. The water vapour cools due to lower temperature at higher places and then condenses. Finally, it gives much rain at the centre of cyclone and nearby places. This is known as Cyclonic Rain.



11.4 Cyclonic Rain

In middle latitudes, most of the rain during winter is cyclonic rain. In North India also such rain occurs during winter.

Besides these types, man to-day experiments for **artificial rain** by scientific means.

When crops are dried up due to shortage of water even during rainy season, the sky is overcast by rainy clouds and yet there is no rain, then scientific means are implemented to get rainfall. This is known as **Artificial Rain**.

Indian Institution of Tropical Meteorology and other private agencies work on artificial rainfall. In these experiments a mixture of sodium chloride and soft stone in the proportion of 9:1 is sprinkled on the rainy clouds from air plane or a helicopter from 2 to 3 kilometres height. Sometimes a fume of silver iodide is also used.

Before sprinkling the chemicals, the humidity and the density of clouds are examined. With artificial rain, the drying crops can be saved for some time. The experiment of artificial rain is very much successful in western countries. In 1978-79 the experiments of artificial rain had yielded 3 to 10 cm of rain in Bhavnagar district.

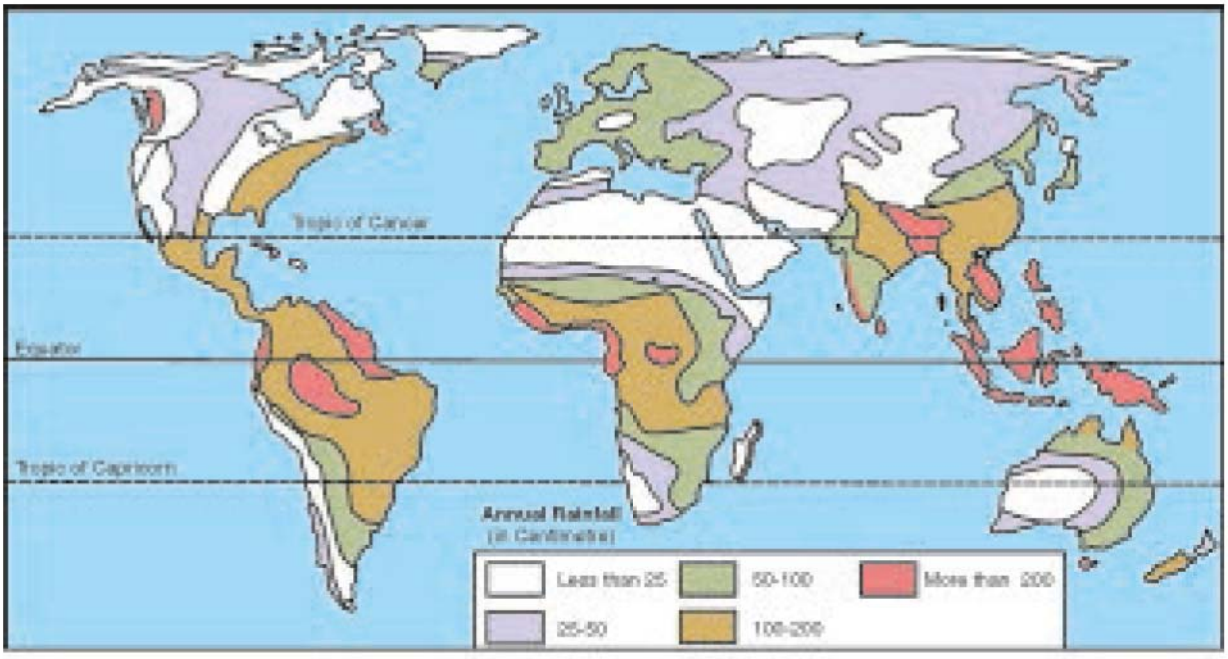
Distribution of Rainfall

Distribution of rainfall differs from place to place in the world. Latitude distance from sea, relief, winds, ocean currents, amount of forests etc. affect the volume and the distribution of rainfall.

Maximum rainfall occurs in the belt between 10^0 to 20^0 latitudes near equator. As per one estimate, about 150 to 300 cm rainfall occurs here annually. Rainfall decreases towards north in both the hemispheres. High pressure belts exist between 25^0 to 35^0 in both hemispheres, so there is less rainfall there. In Tropical High Pressure belt an average of 80 to 90 cm rain falls. In the deserts here, the rainfall is less than 10 cm. In polar regions, no evaporation takes place due to cold, so less than 10 to 30 cm rainfall occurs there. In the middle latitudes between 40^0 to 60^0 latitudes in both hemispheres, an average rainfall occurs between 100 to 200 cm.

Oceans and continents affect the distribution and amount of rainfall. As per one estimate, out of the total rain falling on the surface of the earth, 22 % rain falls over landmass and 78 % rain falls over oceans. Rainfall decreases with increasing distance from sea. Monsoon winds give more rain over either coasts of India. The same winds loose moisture and give less rain in the interior parts. Moisture bearing winds coming from Bay of Bengal give heavy showers over Meghalaya and nearby mountainous regions. Cherrapunji, located in Khasi Hills of Meghalaya receives about 1200 cm rainfall which is maximum in the world. Viewing from the volume of annual rain, the equatorial regions, coastal area of monsoon

regions, torrid zone and some mountainous areas of temperate zone receive more than 200 cm rainfall. These are regions of maximum rainfall. The nearby regions of less rainfall, such as the interior parts in Torrid zone and hot temperate coastal areas get 100 cm to 200 cm rainfall.



11.5 World : Annual Rainfall

Besides this, rainfall is negligible in leeward areas of mountains, western parts of tropical landmass and in interior parts of temperate zone. Sahara (Africa), Sonoran (North America), Kachchh-Rajasthan (India), Saudi Arabian Desert (West Asia), Atacama (South America), kalahari (Africa), West Australian Desert (Australia), Gobi Desert (Mongolia), Colorado desert (North America) etc. are regions which receive much less rainfall.

The area between 5^0 latitudes around equator receive convectional rain throughout the year. Some regions get summer rain while some get rainfall during winter. Most of the monsoon regions and some parts of torrid and temperate zones also get summer rain. These are the regions of summer rainfall.

Mediterranean regions, located on the western side of the continents between 30^0 to 40^0 latitudes in both hemispheres receive rain during winter season. Moreover, the North-East Monsoon Winds coming from Bay of Bengal shower rain over Tamil Nadu and Sri Lanka in winter. Thus, the types of wind and their direction affect the distribution of rainfall.

EXERCISE

1. Answer the following questions in details :

(1) What is meant by condensation ? State the forms of condensation and explain any two of them.

(2) What is a cloud ? Explain various types of clouds with figures.

(3) State the types of precipitation and explain orographic rain in details.

2. Write short notes on :

(1) Importance of humidity (2) Artificial Rain (3) Convectional Rain

3. Give geographical reasons :

(1) Evaporation is faster in summer.

(2) The distance between Mumbai and Pune is less, however Mumbai gets more rainfall.

(3) A cold wave sometimes grips Gujarat and Rajasthan during winter.

4. Answer the following questions in brief :

(1) Which factors affect the distribution of precipitation ?

(2) Write the formula to find Relative Humidity.

(3) Which substances are used in artificial rain ?

(4) What are the forms of condensation ?

(5) State the favourable conditions for dew formation.

(6) Where does the maximum rain fall in the world ?

(7) What is meant by Rain Shadow region ?

(8) Which crops are damaged due to snowfall in winter in India ?

5. Select the correct option from the following options and write the answer :

(1) What is the fog at higher altitude called as ?

(a) Cloud (b) Dew (c) Snow (d) Precipitation

(2) By which of the following names is the instrument to record amount of humidity known as ?

(a) Thermometer (b) Pyrenometer (c) Hygrometer (d) Barometer

(3) In which Indian State does the rain occur in winter ?

(a) Gujarat (b) Madhya Pradesh (c) Uttar Pradesh (d) Tamil Nadu

(4) In which season does the Mediterranean region get its rain ?

(a) Winter (b) Summer (c) Rainy (d) None of them

(5) In which state is Cherrapunji situated ?

(a) Assam (b) Meghalaya (c) Arunachal Pradesh (d) Nagaland

(6) After how many km of altitude there is almost no humidity in the atmosphere ?

(a) 10 to 12 (b) 11 to 22 (c) 21 to 32 (d) None of these