212en26

26

AIR AND WATER

You have already learnt that air is a mixture of gases and is one of the main abiotic components of the environment. Air is an extremely important natural resource, as living organisms breathe in air. A human being breathes about 22,000 times in a day and, takes about 16 kg of air into the body during this process.

Like air, water is another abiotic component of the environment, which is also essential for all living beings. Water is the most abundant and **renewable** natural resource. It covers about three quarters of earth's surface. Water occurs in nature in the free state as well **as in the combined state**. The different properties of water make it useful and essential in our daily life. We shall learn about air and water in this lesson.

OBJECTIVES

After completing this lesson, you will be able to:

- *tabulate various components of air and their amount;*
- *explain the importance and utility of various components (O_2, N_2, CO_2) of air and give a brief account of air pressure and its use to us;*
- *list various pollutants of air, its consequences and means of control of these pollutants in air;*
- *identify different sources of water and state its properties;*
- *distinguish between potable and non-potable water and describe simple methods for making water potable;*
- *state various sources of water pollution, its consequences and means of control of water pollution;*
- *recognize the urgency of water conservation and rain water harvesting.*

26.1 COMPOSITION OF AIR

Ancient philosophers considered air as a most vital element. **Mayow** in 1674 proved that air is not an element but is a mixture of two substances, one of which is active and the other is non-active. Lavoisier in 1789 named the active element as oxygen and said that it is 1/5th of the total volume of air. The non-active element in air is nitrogen and it is about 4/5th of the total volume of air. The ratio of oxygen and nitrogen in the air is about 1:4 by volume.

Air is a mixture of gases. The composition of dry air at sea level is given in table 26.1.

Table 26.1: Composition of air

Gas	Composition (% by volume)
Nitrogen (N_2)	78.03
Oxygen (O_2)	20.09
Argon (Ar)	0.94
Carbon dioxide (CO_2)	0.033
Inert gases (Neon, Helium, Crypton, Xenon: Ne, He, Kr, Xe)	0.0020

Water is excluded from this table because its concentration in air varies drastically from location to location.

Which of the gases mentioned above is important for the following:

(a) Photosynthesis (b) Breathing

Yes, you are right: (a) carbon dioxide (b) oxygen

ACTIVITY 26.1

Let us perform a simple activity to study the presence of carbon dioxide in air.

Aim : To show the presence of carbon dioxide in air

What is required? A test tube/glass tumbler, freshly prepared lime water, a cork/ thermocol with two holes, two glass tubes/straw pipes bent at right angles;

What to do?

- Take about 4 ml freshly- prepared lime water in a test tube/glass tumbler.

- Fix a cork/thermocol (having two holes) in the mouth of the test tube/glass tumbler so that it is air tight. You may use vaseline.
- Fix the two tubes in two holes in such a way that only one is dipped in lime water while the other remains above the lime water as shown in figure. 26.1.

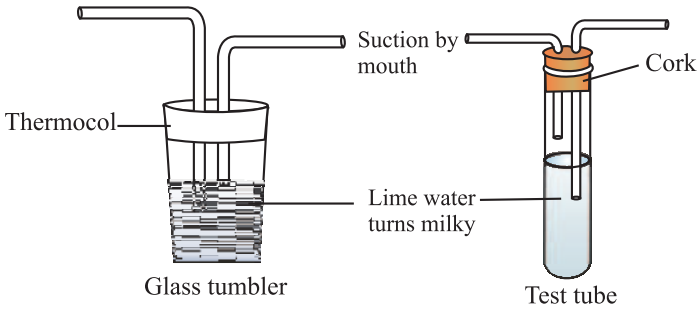

***Fig. 26.1** To show that air contains carbon dioxide*

- Suck the air through the tube, which is not dipping in limewater.

Note: Fresh lime water can be made by soaking lime (Chuna) in water overnight. The supernatant is the lime water.

What do you observe?

Due to suction the air pressure within the test tube falls. To compensate this fall in pressure, the air from outside enters into the tube dipping in limewater and bubbles through it.

You will see that after a minute the limewater turns milky. Can you explain why? Yes you are right. Carbon dioxide can turn limewater milky. What does this prove? It shows the presence of carbon dioxide in the air. Will the small concentration of CO_2 in air be able to turn lime water milky? Please check from your elders/books.

INTEXT QUESTIONS 26.1

1. A chemical substance may occur as an element, mixture or compound. To which category does air belong?

   _____

2. Name the major constituents of air. Which constituents are inevitable for survival of plants and animals?

   _____

3. If you were to compare the relative amounts of nitrogen and oxygen in the atmosphere. Which will be four times the other?

   _____

Notes

4. Air also contains water vapour. But is its percentage in air the same at all places?

_____

26.2 IMPORTANCE OF VARIOUS COMPONENTS OF AIR

Oxygen, nitrogen and carbon dioxide are directly or indirectly useful for human beings, other animals and plants. Without oxygen and nitrogen it is impossible for living beings to survive. Water vapour also plays a very important role in our life.

26.2.1 Oxygen

We live on the surface of the earth, and we are surrounded by air, which contains oxygen. Oxygen is one of the major components of air and life is not possible without oxygen. The importance and utility of oxygen is given below:

(a) General uses

- Oxygen is necessary for respiration in almost all living beings.
- It is the supporter of combustion and therefore materials burn easily in the presence of oxygen.
- Liquid O_2 called as LOX (Liquid oxidant) is used as oxidant in rockets to burn the fuel.
- Oxygen from air gets dissolved in water which keeps the water and aquatic life fresh.
- Oxygen cylinders are carried by climbers, during high altitude climbing, by aviators during high altitude flying and firemen during fire fighting.
- Rusting of iron takes place in the presence of oxygen and water.

(b) Medical uses

- Oxygen is given to the patients suffering from asthma or gas poisoning and for artificial respiration in hospitals.
- A mixture of oxygen and nitrous oxide is used as anesthesia in surgical operations.

(c) Industrial use

- **In steel industry:** Impurities present in iron are removed by burning in presence of oxygen.
- **For cutting and welding purposes:** Oxygen is mixed with hydrogen (hydrogen torch) or acetylene (oxyacetylene torch). These mixtures are

burnt to produce very high temperatures and are used for cutting metals and for welding.

- Oxygen is also used for the manufacture of sulphuric acid from sulphur and nitric acid from ammonia (NH_3).

Harmful effects of Oxygen

- Corrosion means deterioration of metals by an **electrochemical process**. The most common example of corrosion is the rusting of iron. Oxygen gas and water must be present for iron to rust. Similarly, articles made of other metals like aluminum and copper also corrode slowly in the presence of oxygen. Can you list any two rusted items that you have seen. Write them in the space provided 1. _____ 2. _____
- Oxygen combines with almost all elements to form oxides

26.2.2 Nitrogen

Nitrogen is the main constituent of proteins. A number of amino acids containing nitrogen join together to form a protein. Proteins build the body. Enzymes which act as catalyst in biochemical reactions occurring in the body are mostly proteins. Main uses of nitrogen are as follows:

- Nitrogen subdues the activity of oxygen. If concentration of oxygen in air is increased, processes like metabolism, combustion and corrosion are speeded up and this shall have a harmful effect. Hence, due to the presence of nitrogen, oxidation of food and combustion of fuel occur at a moderate rate.
- The compounds of nitrogen are of vital importance to plants as they help them to manufacture proteins. Animals and humans obtain proteins from plants. Recollect the functions of proteins and name one protein deficiency disorder in growing children.

26.2.3 Carbon dioxide

The percentage of carbon dioxide in air varies from place to place. Which two human activities are responsible for increase in atmospheric carbon dioxide.

_____

_____

Main uses or carbon dioxide are:

- During photosynthesis, plants absorb carbon dioxide and water vapour from atmosphere and convert into carbohydrates (Sugars) in the presence of chlorophyll and sunlight.

- Carbon dioxide dissolves in water to form carbonic acid H_2CO_3 which reacts with rocks that contain calcium carbonate ($CaCO_3$) or magnesium carbonate ($MgCO_3$ to form $Ca(HCO_3)_2$ and $Mg(HCO_3)_2$ salts. These salts give the taste of natural water and also supply Ca_2+ and Mg_2+ ions to the plants which are necessary for their growth.
- It is also used in food preservation. When stored in an atmosphere of CO_2, the grains are prevented from being destroyed by insects. Can you give a reason?
- Solid CO_2 which is known as dry ice, is used as refrigerant.
- Dissolved in water, CO_2 is used in the preparation of soft drinks. The effervescence that comes out when we open a soft drink bottle is carbon dioxide.
- CO_2 is used in fire extinguishers.

Harmful effects of CO_2

CO_2 is a greenhouse gas. It traps infrared radiation which raises the atmospheric temperature and results in global warming. You will read about global warming in more details in lesson-30, section 30.8)

26.2.4 Water vapour

We know that air contains water vapour. Its amount in the air is not the same everywhere. It is the maximum in low latitudes and over oceans and is low in the atmosphere over polar regions. It is also more in summers than in winters.

Though water vapour comprises a very small part of the atmosphere, it plays an important role in heating and cooling of the atmosphere and in the day to day change in weather. In fact clouds, rain, snow, fog, frost and dew that we experience, all result from water vapour present in the atmosphere.

But how does water vapour come into the atmosphere? It comes into the atmosphere through a process called **evaporation**. Evaporation is a process in which water from any source change into vapour state 'due to heat'. Water evaporates from water bodies due to heat of the sun forms clouds and then falls as rain upon condensation.

Cloud formation

Condensation of water vapour in the atmosphere leads to the formation of clouds. Clouds are formed when moist air rises upwards. When dew point is reached, condensation of water vapour occurs resulting in the formation of very tiny droplets of water. They cling to the dust particles in the air. These millions of very minute water droplets or tiny ice crystals almost hang in the air rather than fall.

They are blown as clouds by the wind. Clouds are of different types according to their shapes and height. You can observe the different types of clouds, if you watch the sky carefully.

Dew point : the temprature at which the water vapour begins to change into water drops.

Rain

When clouds rise up, they are cooled when blown into cooler regions of the atmosphere. The small droplets of water in them become still cooler and they, come closer to each other. A number of small droplets combine to form a big drop of water. These drops are so big that they can no longer float in the air and they fall down on the earth as rain. As they fall, they pickup more and more small drops of water on their way down. The falling of these big drops of water from the clouds is known as **rain** and the process is called **precipitation.**

The instrument used to measure rainfall is called **rain gauge.** Rainfall is measured in centimeters.

Do you know

The maximum rainfall occurs in the countries- near equatorial regions and South-East Asia. In these regions, annual rainfall is 200 cm or even more. The lowest rainfall occurs in Tundra, central Asia and hot deserts, where it is less than 25 cm. The medium rainfall (between 25 cm to 200 cm) occurs in west European countries, Taiga regions and China.

26.2.5 Relative humidity

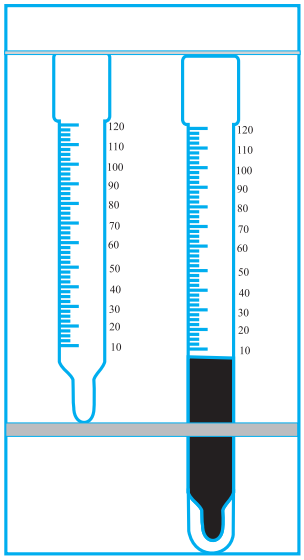

Fig. 26.2 Hygrometer

The presence of water vapour in the atmosphere is known as humidity. Humidity of the air is related to its temperature. For example, during summer, you must have experienced days when both the temperature and humidity are high.

Relative humidity is the ratio of the mass of water vapour actually present in a certain volume of air at room temperature to the mass of water vapour required to saturate the same volume of air at that temperature.

While mentioning the relative humidity, it is necessary to mention the temperature. The instrument used to measure relative humidity is called hygrometer. (figure 26.2)

INTEXT QUESTIONS 26.2

1. Why is oxygen essential for life? What would happen if there is no oxygen in air?

2. Carbon dioxide acts as food for plants. Name the process in which it is utilized for making food.

3. What is dry ice and what is it used for?

4. If you were to analyse all proteins, you would find a particular element common to all. Which one is it?

26.2.6 The air and its pressure

We know that air is a mixture of gases and molecules of these gases have weight due to gravity. Anything that has weight, pushes and presses against other objects. The envelop of air that surrounds earth (atmosphere) exerts a force which acts downwards on the surface of the earth.

The force of air column acting per unit area of a surface results in a pressure exerted by atmosphere. This pressure is called **atmospheric pressure**. The atmospheric pressure is about 1 kg cm^2 or 10 ton m^2

ACTIVITY 26.2

Aim: To show that air exerts pressure

What is required?

An empty polythene bottle of mineral water and some hot water.

What to do?

- Take an empty bottle of mineral water.
- Take some hot water in it and tightly screw its cap in order to make it airtight.
- Pour cold water on the bottle.

What do you observe?

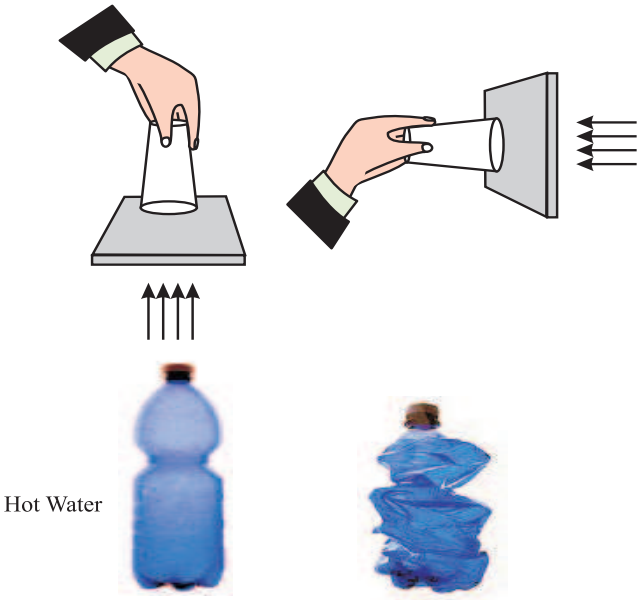

Fig. 26.3 Air exerts pressure

You will find that bottle collapses and becomes misshapen when the water vapor inside cools and condenses into water.

Why is it so?

When hot water is taken in the empty bottle, air present in it becomes hot and expands. Also some air comes out of it. On cooling, the air inside the closed bottle contracts. This creates a partial vacuum inside the bottle. The atmospheric pressure acts from outside, presses the bottle and causes the bottle to collapse. This shows that air exerts pressure.

In our everyday life, atmospheric pressure plays an important role in the working of many things, for example, working of a straw, working of a syringe or ink dropper, working of a water pump etc. Think and try to explain how atmospheric pressure helps in the working of these above mentioned devices?

26.2.7 Variation of air pressure with height

The atoms and molecules of the gases in the atmosphere like those of all other matter are subject to earth's gravitational pull. As a consequence, the atmosphere is much denser near the surface of earth than at higher altitudes. In fact, the density of air decreases very rapidly with increasing distance from earth. Therefore, atmospheric pressure also decreases with altitude. Often at higher altitudes, people find their nose bleeding because blood pressure of the body is much more than the pressure outside (i.e. atmospheric pressure).

Air pressure is measured by the instrument known as barometer.

26.2.8 Atmosphere

The region of air around earth is called atmosphere. Atmosphere protects us and all living organism from harmful radiations of the sun like ultraviolet rays etc. We can divide the atmosphere into different layers according to temperature, pressure variation and composition. The main layers of the atmosphere (figure 26.4) from the surface of earth upward are troposphere (0-10 km), stratosphere (10-50 km), mesosphere (50-85 km) and thermosphere (85-500 km).

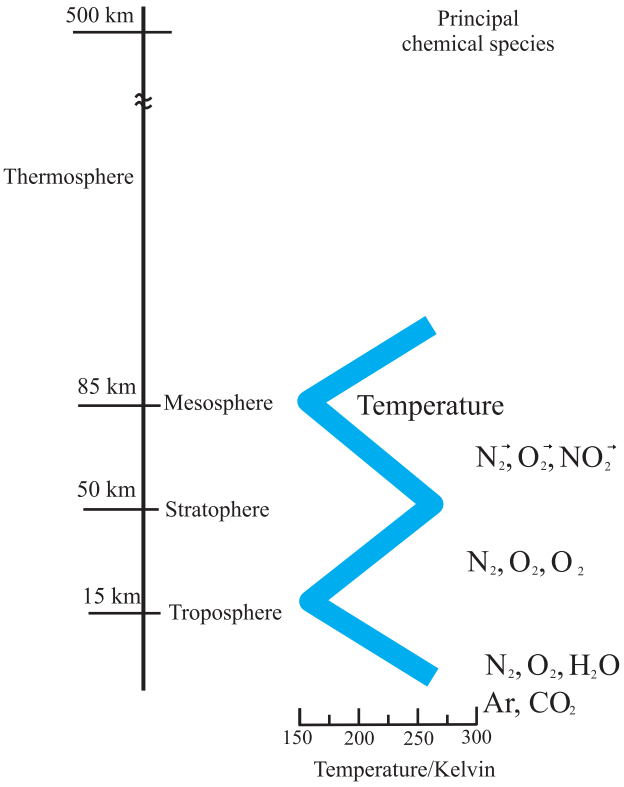

Fig. 26.4 Layers of the atmosphere

The most active region of the atmosphere is the troposphere, the layer of the atmosphere, which contains about 18% of the total mass of air and practically all the atmosphere's water vapour. It is the thinnest layer of atmosphere and all the dramatic events of weather (such as rain) occur here

26.3 AIR POLLUTION

You must have observed the black soot deposition on the plants growing in areas with heavy vehicular traffic. Have you wondered why? It is because of pollutants present in the air. These pollutants are one of the causes of air pollution. Air pollution is the introduction of harmful chemicals, biological wastes, and particulate matter into the atmosphere. Pollution has harmful effects on humans as well as on all other living beings.

Pollutants can be classified into two main categories:

A. **Primary pollutants** which are directly emitted into the atmosphere such as carbon monoxide from exhaust of a motor vehicle

B. **Secondary pollutants** which are not emitted directly into atmosphere but are formed in air when primary pollutants interact.

Notes

Major Primary pollutants include:

Carbon monoxide (CO) is produced by incomplete combustion of fuels like petrol, natural gas, coal or wood. It is a colourless and odourless gas but very poisonous in nature.

Carbon dioxide (CO_2) is produced by complete combustion of fuels in motor vehicles and various industries. It is a colourless, odourless and non-toxic gas. (A person dies in atmosphere of carbon dioxide due to lack of oxygen and not due to its toxic nature). (Read details in lesson 30, section 30.8.2)

Sulphur oxides (SOx) (mainly sulphur dioxide, SO_2) are produced by combustion of coal and petroleum and also produced in volcanoes. It is also produced in various industrial processes. Oxidation of sulphur dioxide (SO_2) to sulphur trioxide (SO_3) results in formation of sulphuric acid (H_2SO_4) which causes **acid rain.** (See Lesson-30, Section 30.8.4)

Nitrogen oxides (NOx) especially nitrogen dioxide, NO_2 is a reddish brown gas with pungent smell. It catalyses the oxidation of SO_2 to SO_3 and indirectly causes acid rain.

Volatile organic compounds (VOCs) include methane, benzene, toluene and xylene. While methane is a major green house gas, others are suspected to be carcinogens (cancer inducing).

Particulate matter consists of tiny particles of solids or liquids suspended in air. These are also called 'suspended particulate matter (SPM)'. The major sources for these include volcanoes, dust storms and burning of fuels. These can cause heart and lung diseases and breathing disorders.

Chloro-fluorocarbons (CFCs) are used as refrigerants in air conditioners and refrigerators and are harmful to the ozone layer which protect us from harmful ultraviolet rays. You shall read about the ozone hole in Lesson30, Section 30.8.1)

Major secondary pollutants include :

Photochemical smog (smoke + fog) formed by the action of ultraviolet light from the sun on particulate matter or formed due to burning of coal and petrol in an atmosphere containing SO_2. It prevents dissipation of pollutants and causes breathing disorders. Read in detail from Lesson-30, Section 30.8.3

Ground level ozone (O_3) is formed from NOx and VOCs. It is a constituent of smog. Normally ozone occurs in stratosphere and prevents UV radiations from reaching earth's surface. At ground level, when inhaled, it is harmful for health of humans and animals.

INTEXT QUESTIONS 26.3

1. What happens to atmospheric pressure as we climb a mountain?

2. At high altitude the people find their nose bleeding. Why?

3. Which layer of atmosphere is the closest to the earth's surface and which is the farthest from earth's surface?

4. In which layer of atmosphere is ozone layer present?

5. Name (i) a green house gas (ii) gas responsible for acid rain (ii) chemicals causing ozone hole

26.4 WATER - ITS SOURCES AND PROPERTIES

Next to air, water is the most important substance needed for survival of living beings. Living beings cannot live long without water. Water is available in plenty on earth. More than three-fourth of the earth's surface is covered with water in the form of seas, rivers and lakes. It is also found inside the earth's crust Most of the water that we get from the wells comes from this source.

26.4.1 Sources of water

The natural sources of water are rain, springs, wells, rivers and seas.

(a) Rain water: Rain water is considered to be the purest form of natural water (distilled water) free from impurities. Water from sea and rivers get evaporated into water vapour by the heat of sun. During this process of evaporation, impurities are left behind. When the water vapours go high up in the air they condense to form clouds. The water drops come down as rain.

(b) Spring water: Springs are formed by percolation of rain water into soil. Springs supply water to wells and lakes.

(c) Well water: The rain water seeps through the soil and goes down and is stored over rocks or hard earth crust. On digging the well this underground water

becomes available to us. This is known as well water. This water may not be pure and may contain impurities such as suspended particles, bacteria and other microorganisms.

(d) River water: Rivers are formed by melting of snow on the mountain, and also sometimes from the rain water. River water is also not pure and is not fit for drinking.

(e) Sea water: Out of all the sources, sea water is the largest natural source of water. However, it is also the source of common salt and other important chemicals. It is the most impure form of water. All the impurities dissolved in river water are carried into the sea. As such, sea water cannot be used for drinking purpose because of high salinity and impurities.

26.4.2 Potable and Non-potable water

Potable water means water which is fit for drinking by humans and other animals. It can be consumed with low risk of immediate or long term harm. Non-potable water is that which is not safe for drinking. It may carry disease causing microbes, and high levels of dissolved salts and minerals, heavy metals and suspended solids. Drinking or using such water for cooking leads to illnesses and may even cause death.

Contaminated or non-potable water can be treated to turn it into potable or drinking water. Let us learn about simple methods of purifying water.

26.4.3 Purification of water to make it suitable for drinking

- **By decantation,** insoluble impurities can be removed. Decantation is the-process of separation of solid from the liquid by allowing the former to settle down and pouring off the latter. Water is kept in a vessel for some time. The suspended insoluble impurities settle down at the bottom. Clean water can now be carefully poured into another clean vessel without disturbing the settled impurities which are left behind. But, this water has to be made fit for drinking through further treatment.
- **By filtration** also, the insoluble impurities can be removed. It is a more effective method than decantation and can remove even very fine particles of insoluble impurities. A piece of clean and very fine cloth can be used as a cheap and easily available filter. When water is poured through it, the insoluble impurities are stopped by the filter and clean water passes through it.

Commercially available water filters use 'candles' made of porous material (figure 26.5). Pure water passes through it leaving the impurities on its outer surface. These candles must be cleaned and washed periodically to maintain their effectiveness.

- **By boiling,** bacteria and other germs in the water get killed. When boiled water is allowed to cool, heavy impurities collect at the bottom and dissolved salts form a thin layer on the surface called scum. Now if we filter the water, it becomes safe for drinking.
- **By chlorine treatment** small living organisms and bacteria are killed. If required, treated water may be filtered to remove insoluble impurities.

Fig. 26.5 Candles

26.4.4 Properties of water

Water, is a common *ordinary substance of* everyday use. However it is its unusual and unique properties which make its use important and essential in our daily life.

26.4.4a Water acts as universal solvent

Water is certainly one of the best and most useful solvents that we have. It has a unique property of dissolving a large number of substances starting from solids such as common salt, sugar, to gases like oxygen, carbon dioxide etc. Indeed, as so many substances dissolve in water, it is called a **universal solvent**.-This property of water is useful for plants to take their food materials and minerals from the soil. It helps us to absorb food that we eat. Many chemical reactions also take place only in aqueous solution.

26.4.4b Hard water and Soft water

Water forms lather with soap which is used for cleaning purposes. It is called **soft water**. Sometimes water from some sources like rivers or hand pumps does not produce any lather with soap. It is called **hard water**.

Water, which we get from taps, contain lesser amounts of dissolved salts in it than water that we get from hand pumps. The dissolved salts are usually bicarbonates, sulphates and chlorides of calcium and magnesium. Their presence prevents formation of soap lather. But why?

Soap is a sodium salt called sodium stearate. It is soluble in water. When soap is added to hard water, which contains calcium and magnesium ions, a precipitate of Ca or Mg stearate is formed. These calcium and magnesium steartes are insoluble in water and appears as a greasy scum. The formation of scum in place of lather makes it more difficult to clean things.

Sodium stearate + Calcium sulphate ⟶ Calcium stearate + Sodium sulphate
(Soap) (Scum)

Accordingly, we can say that,

- Water which forms lather with soap is called **soft water.**
- Water which does not form lather is called **hard water.**
- The hardness of water is due to the presence of salts of magnesium and calcium in water.

26.5.4c Conversion of hard water into soft water

Hard water does not form lather with soap. Can this hard water be converted into soft water? Yes, hard water can be converted into soft water, by removal of Ca and Mg ions which are responsible for hardness. This is called softening of water.

Hardness of water is of two types :

- Temporary hardness
- Permanent hardness

a) Temporary hardness

Temporary hardness of water is due to the presence of soluble bicarbonates of calcium and magnesium. It is also called **carbonate hardness.** It can be removed by boiling and by soda lime process.

(i) By boiling: Upon boiling hard water, calcium or magnesium bicarbonate present in it are decomposed to give magnesium or calcium carbonate. These carbonate salts are insoluble in water. They settle down easily and water can be decanted.

$$\underset{\text{Calcium bicarbonate (Soluble)}}{Ca(HCO_3)_2} \xrightarrow{\text{Heat}} \underset{\text{Calcium Carbonate (Insoluble)}}{CaCO_3} + H_2O + CO_2$$

$$\underset{\text{Magnesium bicarbonate (Soluble)}}{Mg(HCO_3)_2} \xrightarrow{\text{Heat}} \underset{\text{Magnesium Carbonate (Insoluble)}}{MgCO_3} + H_2O + CO_2$$

(ii) By soda lime process (Clark's method): When a calculated amount of lime is added to hard water, then the soluble bicarbonates are converted to insoluble carbonates as follows:

$$Ca(HCO_3)_2 + \underset{\text{Lime}}{Ca(OH)_2} \xrightarrow{\text{Heat}} \underset{\text{(Insoluble)}}{CaCO_3} + 2H_2O$$

$$Mg(HCO_3)_2 + \underset{\text{Lime}}{Ca(OH)_2} \xrightarrow{\text{Heat}} \underset{\text{(Insoluble)}}{2MgCO_3} + CaCO_3 + 2H_2O$$

b) Permanent hardness

Permanent hardness of water is due to the presence of soluble chlorides and sulphates of calcium and magnesium. It is also known as **non-carbonate hardness.**

It can be removed by addition of washing soda or by the ion exchange method.

(i) By addition of washing soda: The hard water is treated with the 'calculated' quantity of washing soda (sodium carbonate). Washing soda reacts with chloride and sulphate of calcium and magnesium to form precipitate of calcium and magnesium carbonate.

The reactions are as follows.

$$\underset{\text{Calcium chloride}}{CaCl_2} + \underset{\text{Sodium carbonate}}{Na_2CO_3} \xrightarrow{\text{Heat}} \underset{\text{Calcium carbonate (Insoluble)}}{CaCO_3} + \underset{\text{Sodium chloride}}{2NaCl}$$

$$\underset{\text{Magnesium sulphate}}{MgSO_4} + \underset{\text{Sodium carbonate}}{Na_2CO_3} \xrightarrow{\text{Heat}} \underset{\text{Magnesium carbonate (Insoluble)}}{MgCO_3} + \underset{\text{Sodium sulphate}}{Na_2SO_4}$$

The precipitate settles down and can be removed by decantation.

(ii) By ion. exchange method: Two types of ion exchangers can be used, namely, inorganic ion exchanger and organic ion exchanger. In **inorganic ion exchange** process, complex compounds known as Zeolite are used to soften the hard water. The salts causing hardness of water are precipitated as insoluble zeolite of calcium and magnesium and are replaced by soluble sodium salts. On the large scale, this process is carried out in tanks as shown in figure 26.6. After using it for sometime the zeolite is regenerated by soaking it in 10% solution of NaCl (brine) and then washing away chlorides. The washings are removed and are replaced by soluble sodium salts.

By using organic ion exchanger, water obtained is free from cations and anions and is known as **deionized water or demineralized water.**

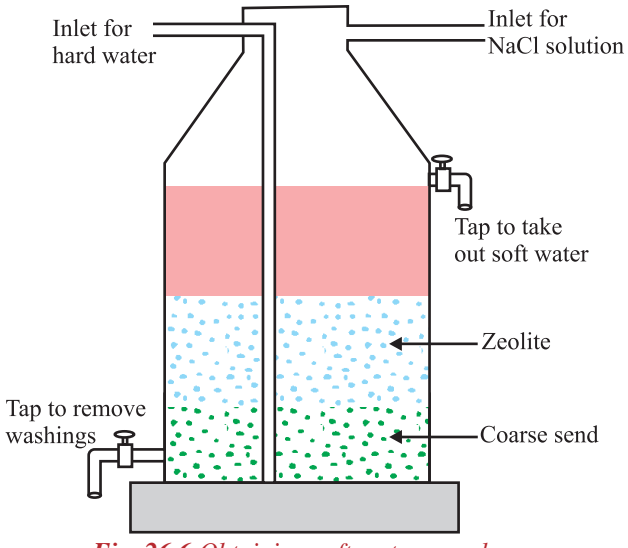

Fig. 26.6 Obtaining soft water on a large scale using tanks

26.5.4d Polar nature of water

Water is a very effective solvent for ionic compounds. Although water is an electrically neutral molecule, it has a small positive charge (on the H atoms) and a negative charge (on the O atom), Therefore, it is polar in nature and can dissolve ionic compounds.

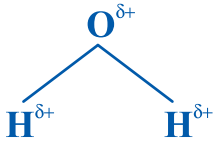

Fig 26.7 Structure of water

Let us perform an activity, which proves the polar nature of water

ACTIVITY 26.3

Aim: To study the polar nature of water

What is required? Burette, water, ebonite rod (negatively charged), glass rod (positively charge) and burette stand.

What to do?

- Take a burette or a bottle with a fine opening and fill it with water.
- Fix the burette vertically in a burette stand/hold the put a clip a little above the fine opening to regulate the water flow bottle in a suitable stand.
- Open the stopcock of the burette/clip of the bottle and allow the water to flow.
- Take an ebonite rod/ordinary straw (negatively charged by rubbing one end with fur) near the water

What to observe?

You will see that the stream of water is attracted towards negatively charged rod (figure 26.8a). Why? Because one end of water molecule has positive charge.

Similarly, now we take a glass rod/glass tumbler rubbed with fur near water, which is positively charged. You will see the rod again attracts the stream of water. This indicates that one end of water molecule also has negative charge (figure 26.8b). This proves the polar nature of water.

26.4.4e Surface tension

Surface tension is the property of all the liquids. Due to this tension water drops try to occupy a minimum surface area. Hence, water droplets always tend to take the shape of a sphere.

The tension exerted by molecules of water present on the surface layer is called **surface tension.**

To understand this let us perform an activity.

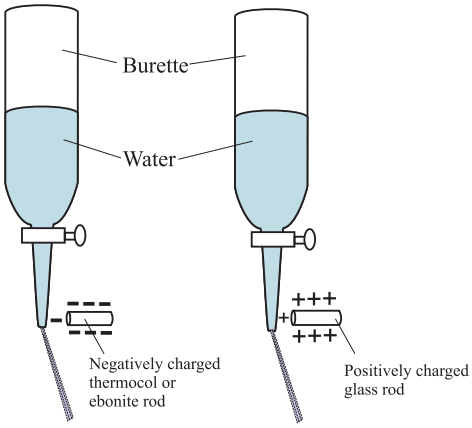

*Fig. 26.8 **a** and **b** To show that water is polar in nature*

ACTIVITY 26.4

Aim: To study surface tension

What is required? Glass and razor blade.

What to do?

Take a glass full of water. Put a safety razor blade (having a coating of very thin layer of wax), gently on the surface of water

What to observe?

You will find that the blade remains on the surface of water though it is heavier than water.

Why is it so?

The upper layer of water acts like a tight sheet and holds the blade. Why is the sheet tight? Due to intermolecular forces i.e. attractive forces between the molecules on water surface and there is a tension or force acting on the surface of the thin film of the liquid which behaves like a tight sheet.

26.4.4f Capillarity - Rise of water

When a capillary tube with a fine bore is dipped in water, water rises in the capillary. The extent to which water rises depends on the diameter of the capillary. The smaller the diameter of the capillary, the higher will be the rise of water in the capillary tube.

This property of rise of water inside a capillary is called **capillarity** or **capillary action.**

This is the property, by which water from the soil enters the leaves and branches of the plants through the stems.

When a piece of cloth or blotting paper is placed in water, it soaks the water by this process of capillary action. The thread strands in the cloth and cellulose of the blotting paper serves like very fine capillaries for the water to rise.

26.4.4g Density of water

Water behaves in an unusual way when it is heated from 0°C. As the temperature rises from 0°C to 4°C it actually contracts. However, from 4°C upwards it expands like any other liquid. This means that water takes up the least space at 4°C. It has the highest density at this temperature and will sink through warmer or colder water around it. The density of water at 4°c is $1g/m^3$

Because of this property of water, we can explain why it takes months for a lake to freeze while a small bucket of water can freeze overnight on a bitterly cold day. The surface water cools down to 4°C and sinks to the bottom of the lake due to its high density and hotter water comes up to the surface. Gradually the whole water cools down to 4°C. Further cooling decreases the temperature of surface water which finally freezes. Ice being lighter than water keeps floating on the surface. It acts as an insulator and slows down the cooling and freezing of the lower layers of water. This explains why aquatic animals living in water bodies of very cold regions do not die in severe winter.

26.5 WATER POLLUTION

Water pollution is the contamination of water bodies like lakes, rivers, ground water and oceans. It occurs due to the discharge of untreated pollutants into water bodies. It not only affects plants and organisms living near the location of discharge but also travels to other locations through transportation of polluted water.

Various sources of water pollution

Various sources of water pollution are:

- Factories and industries which release various toxins, untreated effluents and heavy metals and industrial solvents into natural water bodies.
- Agricultural farms releases fertilizers and pesticides which leads to eutrophication and biomagnification. (See lesson 30- Section 30.6 .3 b and 30.6.3c for details)
- Mining exposes heavy metals and sulphur which were buried deep in the earth into water bodies.

- Sewage pipe and storm water drains release various pathogens, disinfectants and detergents
- Air pollution releases pollutants like sulphur dioxide, oxides of nitrogen etc. which are washed down by rains.
- Food processing units and their waste includes fats and greases.

Based on their origin, sources of water pollution are generally grouped into two categories:

- **Point source pollution** refers to contaminants that enter a water body from a single identifiable source such as a pipe or a ditch.
- **Non-point source pollution** refers to diffused contamination that does not originate from a single discrete source but is the cumulative effect of contaminants gathered from a large area such as leaching of fertilizers and pesticides from agricultural land.

INTEXT QUESTIONS 26.4

1. It is said that more of earth is water than land. How much of the earth's surface is covered by water?

2. Name any two sources of water.

3. Is rainwater pure or impure? Give one reason to support your answer.

4. What does chlorination do to water in order to purify it?

5. I could not form lather with soap while washing my hands, which type of water was it?

6. Name the type of hardness caused to water due to presence of bicarbonates of Ca_2+ or Mg_2+.

7. Name the type of hardness caused to due to presence-of chloride or sulphate of Ca_2+ or Mg_2+.

8. Which type of hardness is removed by the following:
   (i) boiling _____
   (ii) ion exchange method. _____

9. Is water a polar or a non polar solvent? Why do you think so?

_____

10. At what temperature does water take up least space?

_____

26.6 UTILITY OF WATER

Water is used for many purposes, including growing crops, metallurgical operations to obtain metals such as copper, generating electricity, watering lawns, cleaning; drinking and recreation. We can say that water is essential for our life and for all living beings. Without water, plants and animal cells cannot function and they ultimately die. Let us discuss the role of water for domestic use, agricultural use, industrial use and for the generation of electricity.

26.6.1 Domestic uses of water

Water plays an important role in our domestic life. For example: it is used for cooking food, to wash utensils and clothes and clean the floor of houses. It is also used for white washing. It is used to take bath. Water provides a good medium for extracting the body waste such as urine, stool or perspiration. The salts and the nutrients of the food dissolve in water. Therefore these nutrients are easily absorbed by our body. Thus, water helps in assimilation of many nutrients present in food. Please recall the role of water as universal solvent. (Section 26.5.4a)

26.6.2 Agricultural uses of water

In agriculture sector, water is used for the irrigation of crops. It helps in the germination of seeds and growth of plants. The nutrients provided by fertilizers to the soil are soluble in water. These dissolved nutrients/fertilizers are easily absorbed by the plants. Water is also required (along with carbon dioxide) for preparation of food by plants (photosynthesis). It also acts as medium for the transportation of nutrients and minerals from one part of the plant to other. Water provides home for aquatic plants and animals.

26.6.3 Industrial uses of water

Water is used as a coolant in automobiles as well as in industries. It is also used in production of ice. It is used for the production of steam in industrial boilers and

Notes

in steam engines. It is used as solvent in many industrial processes. Water is used to prepare many chemical compounds, for example H2SO4 is prepared by dissolving SO3 in water and HNO3 is prepared by dissolving NO2 in water. Water is also used to prepare fuels like hydrogen gas and water gas.

26.6.4 Uses of water to generate electricity

There are many different ways to harness the energy from water. The most common way of capturing this energy is hydroelectric power. Electricity is generated by using the water falling from a height to rotate the turbines.

Water is used in thermal and nuclear power stations to produce steam for the generation of electricity.

26.7 CONSERVATION OF WATER AND RAIN WATER HARVESTING

Over the years, the ever increasing population, growth in industrialization and expanding agricultural needs have pushed up the demand for water. On other hand, water resources like ground water and river water are fast drying up. Wise conservation of water has become the need for our survival and attempts are being made in many different directions such as collection of water by making dams and reservoirs, creating ground water structures such as wells, recycling of used water and desalination of water. **Recharging of ground water has become necessary**. This is being done through **rain water harvesting.**

Rainwater harvesting essentially means collecting rain water on the roofs of building and storing it underground. Not only does this recharging arrest the underground depletion of water but also raises the declining water level.

While many people may not realize it, but a few centimeters of annual rainfall is a valuable resource. Harvesting rainwater not only helps reduce the possibility of flooding, but it also decreases the community's dependence on ground water for domestic uses. Rain water is perfectly suited for landscape irrigation growing vegetables and flowers, use in room coolers, washing and many other applications. Being soft water, rain water is used for washing purposes. While using rain water, hardness deposits do not accumulate and there is no problem of soap scum. Harvested water may also be used for personal consumption, but it must be filtered and treated prior to use. By reducing runoff of the rain water that falls on your house or field, you can put a valuable water resource to work around your house.

The benefits of harvesting rain water can be summarized as follows.

- Conserves valuable ground water.

- Reduces local flooding and drainage problems.
- Decreases landscaping and property maintenance needs. .
- Provides excellent quality water for many household uses.
- It can be used for domestic purposes such as for growing vegetables, flowers, trees and shrubs and seedling in a green house etc.

INTEXT QUESTIONS 26.5

1. State any two uses of harvesting rain water?

   _____

2. How would industries and agriculture suffer in the event of acute scarcity of water?

   _____

3. What does rainwater do to ground water?

   _____

4. Why does rain water prove to be suitable for washing with soap?

   _____

WHAT YOU HAVE LEARNT

- The major components of air are nitrogen and oxygen. Air also contains argon, carbon dioxide and some trace gases like neon, helium, krypton and xenon. It also contains water vapour.
- The weight of air column acting per unit area results in a pressure exerted by atmosphere called the atmospheric pressure.
- Atmospheric pressure plays an important role in our everyday life-in-the working of common devices like ink dropper, to water pumps, etc.
- The state of atmosphere in relation to the amount of water vapour present in it is known as **humidity**.
- Next to air, water is the most abundant substance available to us. The natural sources of water are rain, spring, wells, rivers and sea. Sea water is a rich source of several minerals.

- The following properties of water make it suitable for use in our everyday life:
  i. ability to dissolve many things i.e. to behave as a universal solvent.
  ii. lather formation.
  iii. surface tension.
  iv. capillarity.
  v. Density of water at 4°C being 1 g/ cm3.
- Water resources in a country is managed for proper and judicious use by constructing dams, canals, reservoir; wells and tube wells. Water collected in dams is not only used for irrigation but also to generate electricity.
- Water pollution and air pollution are due to human activities.
- Rain water can be conserved by recharging it to ground or using it for various other purposes. This is known as **rainwater harvesting**.

TERMINAL EXERCISES

1. Multiple choice type questions.

   i. Air is
      a) compound
      b) element
      c) mixture
      d) non of these

   ii. Major components of air are
      a) CO_2 and H_2O
      b) N_2 and O_2
      c) CO_2 and He
      d) H_2O and Xe

   iii. The instrument used to measure humidity is
      a) barometer
      b) hygrometer
      c) lactometer
      d) thermometer

   iv. Water has maximum density at
      a) 0°C
      b) 10 °C

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c) 5°C

d) 4 °C

2. List the utility of oxygen and nitrogen in our lives.
3. What is atmospheric pressure?
4. How does the atmospheric pressure depend on altitude?
5. Give an activity, which proves that air exerts pressure.
6. What is relative humidity?
7. What is the different source of water? Mention any two.
8. Why is water called as universal solvent?
9. What are the different ways to purify drinking water? What is the role of chlorination?
10. What do you mean by hard and soft water? Explain the types of hardness in water.
11. How are the temporary and permanent hardness removed from water?
12. Explain the following properties of water
13. (i) Surface tension

    (ii) Density
14. What is rainwater harvesting? How is it beneficial for everyday life?
15. Why is the presence of carbon dioxide in atmosphere essential? Give two reasons.
16. Give any two medical uses of oxygen.
17. What are primary and secondary air pollutants? Give one example of each.
18. What are the sources of the following pollutants : (i) Chlorofluorocarbons (ii) Nitrogen oxides (iii) Particulate matter
19. Why are the following substances considered air pollutants: (i) Carbon monoxide (ii) Carbon dioxide (iii) Sulphur oxides (iv) Volatile organic compounds
20. What are (i) photochemical smog and (ii) ground level ozone.
21. What are (i) point source pollution and (ii) non-point source pollution? Give one example of each.

22. Dive any two of water for each of the following purposes (i) domestic (ii0 industrial and (iii) agricultural

23. What do you mean by conservation of water? How is it useful?

24. You are incharge of the residents welfare association./ prepare two slogans to make residents aware of need for conservation of water.

25. The atmospheric envelop around living beings is the provider of the gases essential for their survival which are these gases, what is their proportion in air and how are they responsible for survival?

26. How does rain water pollute water bodies with the air pollutants/

27. Recall five properties of water and write a paragraph justifying that water is an indispensible resource.

28. How does boiling of hard water convert it such that it can be used for washing clothes?

ANSWERS TO INTEXT QUESTIONS

26.1

1. Mixture
2. Nitrogen and oxygen; oxygen
3. Nitrogen
4. It varies from place to place.

26.2

1. Needed for respiration by plants and animals; animals would die.
2. Photosynthesis
3. Solid CO_2 , used as a refrigerant
4. Nitrogen

26.3

1. it decreases with altitude
2. It is because the blood pressure in blood vessels of the body is much more than the air pressure at high altitude, so the capillaries burst and bleeding occurs.

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3. i) Troposphere (ii) Thermosphere
4. Stratosphere
5. (i) Methane (ii) Sulphur oxide (SOx) (iii) Chloro fluoro carbons (CFCs)

26.4

1. Three fourth
2. Rain and sea (or any other)
3. Pure/ Distilled
4. Kill microorganisms
5. Hard water
6. Temporary hardness
7. Permanent hardness
8. (i) Temporary, (ii) permanent
9. Polar—reasons to be given
10. 4^0C

26.5

1. i. It conserves valuable ground water. ii. It reduces local flooding and drainage problems, iii. It decreases landscaping and property maintenance needs iv. It provides quality water for many household needs; v. It can be used for domestic purposes (Any two)
2. Industries: coolant purpose, production of steam, use as solvent for many chemical would be affected

   Agriculture: irrigation of crops, germination of seeds and growth of plants would be affected.
3. Raises the declined water level.
4. Because rain water is in the form of soft water.