5 Water

Next to air, water is the most essential substance for our survival, and indeed for life on earth. It makes up seven-tenths of our body.

In ancient times, it was considered an element, but now it is established that water is a compound of hydrogen and oxygen (combined in the mass ratio 1 : 8).

Sources of Water

1. Large water bodies Water bodies like rivers, lakes, oceans and the polar ice caps constitute large reservoirs of water, the oceans being the largest. In fact, water covers three-fourths of the earth's surface.

2. Groundwater Groundwater is also an important source of water, and is pumped out when required.

3. Clouds Clouds are yet another source of water.

4. Fruits and vegetables Water makes up about 80–90% of fruits and vegetables.

An Essential Part of All Livings Things

A large part of the body weight of all living beings is made up of water. All chemical reactions in living organisms take place in the presence of water. Water either takes part in a reaction of this kind or acts as a medium for it. This will be clear from the following examples.

1. Photosynthesis requires water as a reactant.

$$\underset{\text{carbon dioxide}}{6CO_2} + \underset{\text{water}}{6H_2O} \xrightarrow[\text{chlorophyll}]{\text{(sunlight)}} \underset{\text{glucose}}{C_6H_{12}O_6} + \underset{\text{oxygen}}{6O_2}$$

2. Complex molecules like proteins and vitamins are also synthesised in plants in the presence of water.
3. The digestion of food inside our body requires water as a medium.
4. The transport of some essential substances, like blood in animals or sap in plants, requires water as a medium.
5. Some organisms live in water. In fact, the earliest life-forms were probably simple organisms living in water.

Table 5.1 **Some important uses of water**

Type of use	Purpose
Agricultural	Irrigation
Industrial	1. As a reactant as well as a solvent in chemical industries
	2. The production of electricity
	3. The extraction of metals
	4. The production of water gas—an important fuel
	5. The disposal of wastes
	6. Cooling
Household	1. Drinking
	2. Bathing
	3. Washing
	4. Cooling

The Balance of Water on Earth

Water is required in large quantities for agricultural, industrial and household purposes. Yet the total amount of water on our planet remains constant. Let us see how.

Large volumes of water evaporate from water bodies like rivers, lakes and seas into the atmosphere. The water vapours condense on dust particles and form clouds. The clouds drift from one place to another and finally precipitate in the form of rain or snow. A part of the rainwater seeps through the soil and the rest flows into rivers. On melting, some of the snow also seeps through the soil, while the rest flows into rivers.

The water vapours of the atmosphere also form snow over high mountains. And on melting, the mountain snow finds its way into rivers, which finally merge with seas or oceans.

In this way, water changes from one form to another continuously, but the total amount of water remains constant. This is called the water cycle.

Potable Water

Water used for drinking must be clean, i.e., free from the following substances.

1. Suspended particles like mud and sand (so the water must be transparent)
2. Excess of soluble salts
3. Pesticides and fertilisers that find their way to water bodies from farms
4. Any harmful chemicals disposed of by industrial units
5. Harmful microorganisms that cause water-borne diseases like typhoid, cholera and dysentery

Fresh groundwater is generally fit for drinking, but water directly taken from a river, lake or sea is not. You will learn later that the water of a river or a lake contains disease-causing substances. And sea water is salty, and hence not fit for drinking.

Water fit for drinking is called potable water. (In Latin, *pot* means drink.)

How the Need for Potable Water is Met

With the growing population of the world, the need for potable water is also increasing every day.

A part of the need is met by groundwater. But groundwater is not available in plenty at a reasonably small depth in every area. Moreover, when too much of it is pumped up, its level (called the water table) goes down. When this happens, no more water can be drawn from that source. Hence, water is mostly drawn from rivers and lakes and purified to make it potable.

Purification of water on a large scale

Water is purified on a large scale in establishments that are known as waterworks. Usually, the following steps are taken (Figure 5.1) to purify water.

1. Pumping Water is pumped from the source to large tanks in the waterworks.

2. Sedimentation Water is allowed to stand in large tanks, called settling tanks, for a few hours. Mud, sand and other suspended particles settle down. The addition of a small quantity of potash alum ($K_2SO_4 \cdot Al_2(SO_4)_3 \cdot 24H_2O$) helps the suspended particles to settle down quickly. The solid that settles at the bottom of the tank is called sediment. That is why these tanks are also called sedimentation tanks.

3. Filtration The water from the sedimentation tank is filtered through layers of sand and gravel. Filtration is also done through activated charcoal, which affords better-quality water. Activated charcoal is a special type of charcoal made by heating ordinary charcoal in vacuum. This charcoal holds the impurities strongly.

4. Chlorination The filtered water is now treated with chlorine gas. Chlorine kills germs—harmful bacteria—and destroys many other harmful substances present in water.

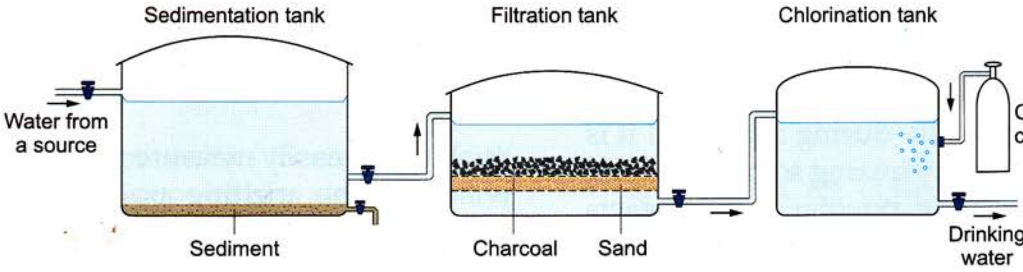

Fig. 5.1 Operations at waterworks

5. Supply Finally, the water is pumped into the supply system.

Remember that water is not supplied only for drinking, but for all household purposes.

EXPERIMENT

You can see for yourself that alum helps the particles suspended in water to settle down quickly. Take two similar glasses containing equal volumes of muddy water and label them A and B. (You can prepare muddy water by mixing a teaspoonful of mud from your garden with the water in the glass.) Crush a small crystal of alum (which you can obtain from a store) between the folds of a paper and add it to A. Stir the water in the two glasses and allow them to stand side by side. Within a short while, you will find that the mud has settled down with clear water above it in glass A, but the water is still not clear in glass B.

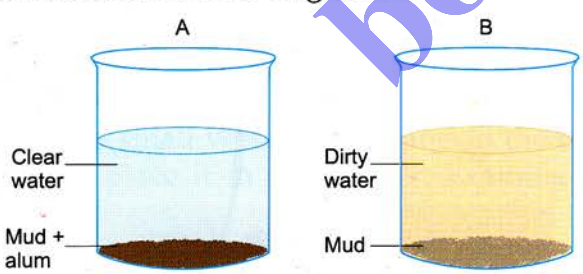

Fig. 5.2 Action of alum on muddy water

Purification of water at home

It is advisable that water meant for drinking be purified at home also. This is done by the following processes.

1. Boiling and filtering Water is boiled to kill the microorganisms and allowed to stand for some time. Some solid may also settle down. The clear water is decanted off and filtered through ceramic candles. Ceramic candles have fine pores which allow only the water to pass through, but not the suspended particles.

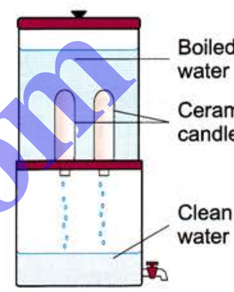

Fig. 5.3 Filtering through ceramic candles

2. Radiating water with ultraviolet rays Ultraviolet lamps radiate high-energy rays which kill germs.

Nowadays, domestic water purifiers are available, which purify water in three stages. Water from the tap enters the purifier, where it gets filtered first through a candle and then through activated charcoal (carbon). The filtered water is finally irradiated by ultraviolet radiation to render it free from germs. This water is safe to drink.

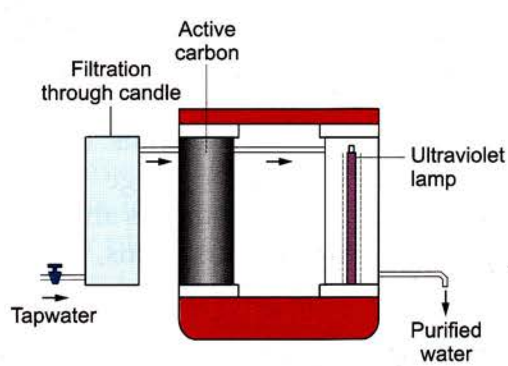

Fig. 5.4 A domestic water purifier

3. Using bleaching powder or potassium permanganate

In rural and backward areas, water is lifted in buckets from wells. Well water gets contaminated, especially during rains, and it is generally disinfected by mixing some bleaching powder. The bleaching powder slowly reacts with water to give chlorine, which kills the germs.

$$\underset{\text{bleaching powder}}{CaOCl_2} + \underset{\text{water}}{H_2O} \rightarrow \underset{\text{calcium hydroxide}}{Ca(OH)_2} + \underset{\text{chlorine}}{Cl_2 \uparrow}$$

Well water is also disinfected by using potassium permanganate ($KMnO_4$). The reaction is complicated.

Even after treating it with bleaching powder, the water should be boiled to make it potable.

Properties of Water

Water makes life possible on earth, creating conditions that suit our survival. This is due to some of the properties of water. Let us discuss these and some other properties of water.

1. Pure water is tasteless and colourless.

2. Water is a good solvent

A liquid that dissolves other substances is called a solvent. Water is a very good solvent. It dissolves most salts, a large number of acids and bases, and many organic compounds.

Thus, water dissolves minerals from the soil, and the solution gets into plants as sap. Water transports all sorts of chemical substances from one part to the other in a living organism.

The liquid wastes from industries are also discharged into rivers as solutions. In their long journey, rivers dissolve a large number of inorganic and organic substances and discharge them into lakes and oceans. Thus, large water bodies are vast stores of chemicals.

3. It remains a liquid over a long range of temperature (0°C to 100°C).

Freezing point Water freezes at 0°C and ice also melts at the same temperature. The effect of pressure on the freezing point of water is negligible.

You can easily measure the freezing point of water or the melting point of ice. Hang a thermometer into a beaker and pack the beaker with crushed ice so that the bulb of the thermometer is fully covered with ice. Within a short time, the temperature falls to a minimum and remains constant at 0°C. This is the temperature at which water freezes or ice melts.

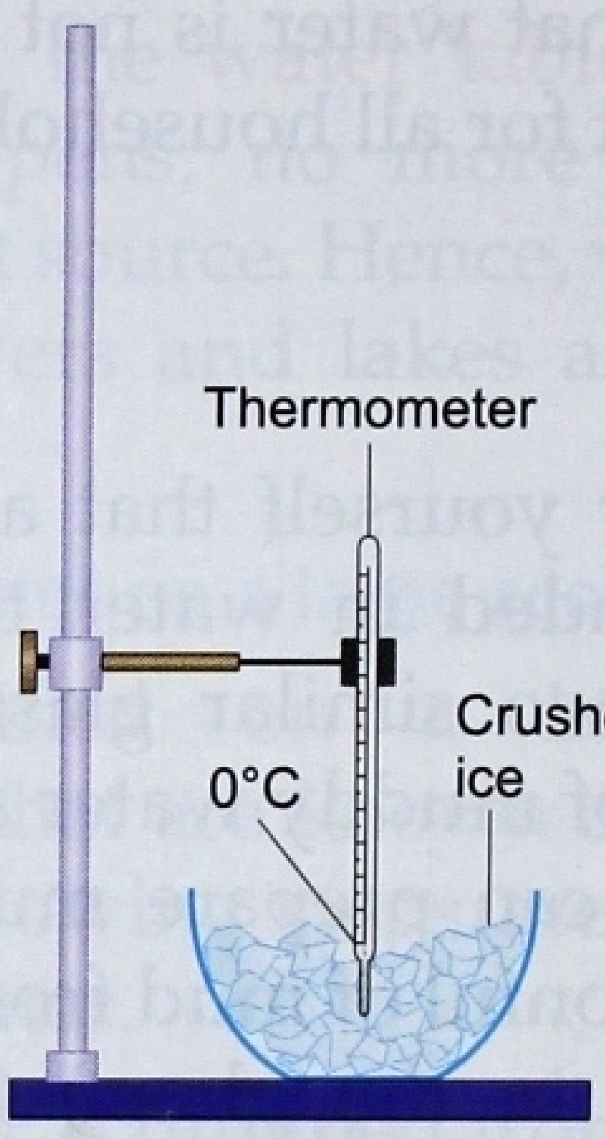

Fig. 5.5 Determining the melting point of ice, i.e., the freezing point of water

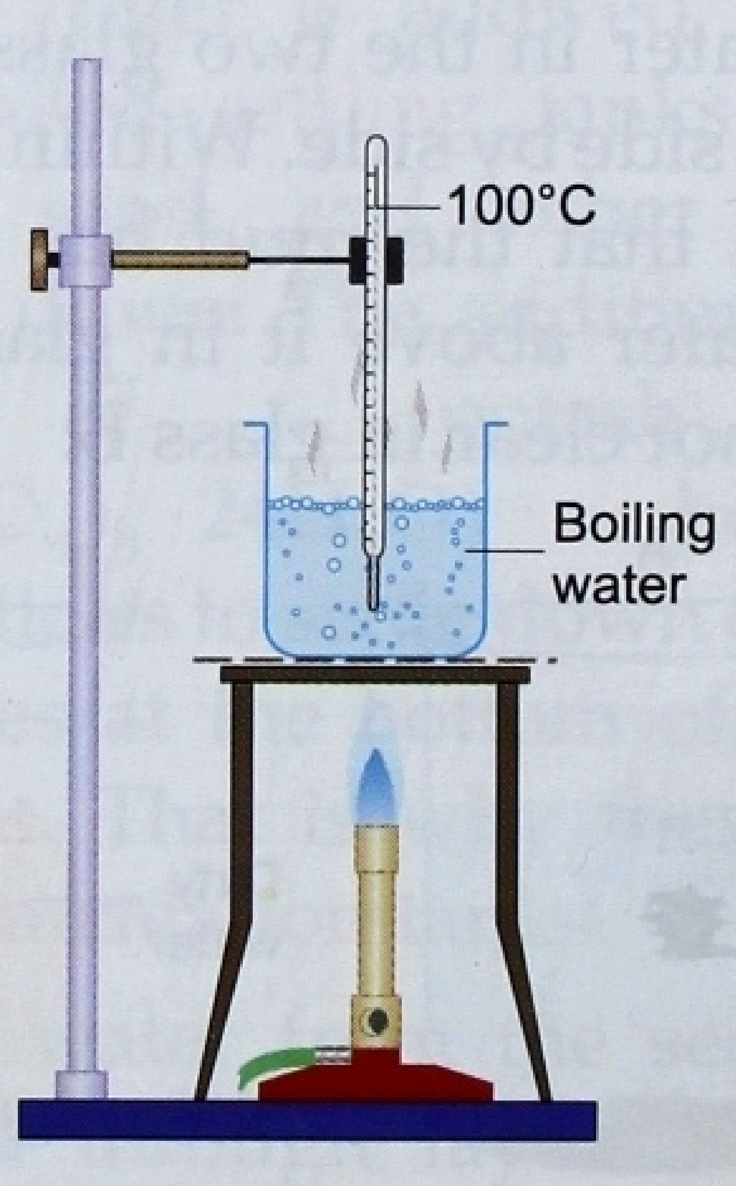

Fig. 5.6 Determining the boiling point of water

Boiling point Water boils at 100°C at 1 atm (i.e., 760 mmHg) pressure.

A thermometer immersed in boiling water records a temperature of about 100°C (Figure 5.6).

The boiling point of water is appreciably affected by pressure.

The higher the pressure, the higher is the boiling point. And the lower the pressure, the lower is the boiling point.

Atmospheric pressure decreases with altitude. So the boiling point of water is lowered as we go up. You will be surprised to know that *water boils at about 70°C at Mount Everest.*

How is a meal so well cooked in a pressure cooker? When the contents of the cooker start steaming, we close the outlet of the vapours by placing the 'weight' over the nozzle. Thereby, the pressure inside the cooker increases and the water boils at a higher temperature, cooking the food well in no time.

4. The anomalous expansion of water You know that things usually expand on being heated and contract on being cooled. Water also does so, but only above 4°C. Below 4°C, water expands on being cooled and contracts on being heated. Water has the maximum density of 1 g/cc at 4°C. The density decreases as the temperature is raised or lowered from 4°C. Thus, ice—the solid form of water—is lighter than water. This is contrary to the general observation that a substance in the solid state is heavier than in the liquid state.

The behaviour of a substance that is contrary to the general trend is called anomalous behaviour. Thus the expansion of water below 4°C is called anomalous expansion.

EXPERIMENT

1. Fill a small vessel with water to the brim and place it in the freezer. Examine the vessel when ice has been formed. The ice will occupy more volume than the water did. It means that water has expanded at 0°C.

Fig. 5.7 Water expands on freezing.

2. Place an ice cube in a glass containing water. It floats, showing that ice is lighter than water.

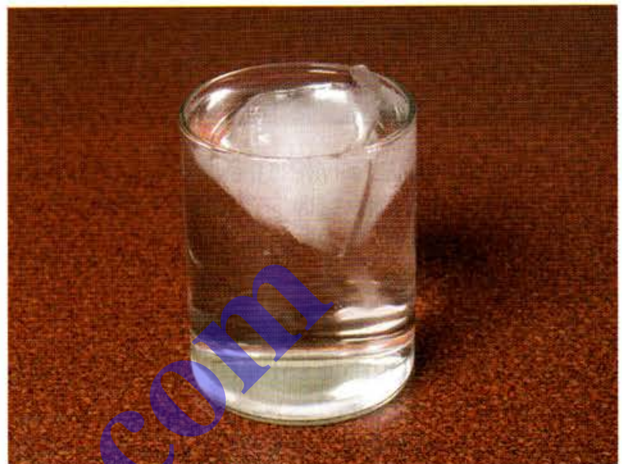

Fig. 5.8 Ice floating on water

3. Place some water in a vessel and keep it in the freezer. Examine it from time to time. You will find that water starts freezing from the top rather than the bottom. This is again because ice is lighter than water.

How useful is the anomalous expansion of water? The anomalous expansion of water is a very useful property. In the colder parts of the world, rivers, lakes and seas start freezing from the top. When a thick layer of ice is formed, it protects the water beneath from the cold air above. Thus, the warmth of the water below the ice layer is preserved and not dissipated to the atmosphere. Aquatic animals, like fish, survive in the water below the layer of ice (Figure 5.9).

Hard Water and Soft Water

You may have noticed that the water of some places forms lather easily with soap whereas that of other places does not lather easily.

Water that lathers easily with soap is called soft water.

Water that does not lather easily with soap is called hard water.

Fig. 5.9 Aquatic animals survive in the water below the frozen surface of a water body.

What Makes Water Hard?

The presence of soluble salts (like bicarbonates, sulphates or chlorides) of calcium and magnesium in a sample of water makes it hard.

Soap contains sodium salts of fatty acids. (Fatty acids are organic acids containing a large number of carbon atoms.) These salts produce lather with water. However, the calcium and magnesium salts of these fatty acids are insoluble. So, when a soap is treated with hard water, the calcium and magnesium salts of the fatty acids precipitate in the form of a scum. As a result, the soap is consumed but no lather is produced.

$$\underset{\text{sodium salt of the fatty acid}}{2Na(Ft)} + \underset{\text{calcium bicarbonate}}{Ca(HCO_3)_2} \rightarrow \underset{\text{sodium bicarbonate}}{2NaHCO_3} + \underset{\text{calcium salt of the fatty acid}}{Ca(Ft)_2} \downarrow$$

Precipitation over clothes leaves dirty stains and that over your body causes irritation of the skin.

It is obvious that hardness of water increases with the amount of dissolved calcium and magnesium salts. But remember that *dissolved sodium or potassium salts (e.g.,* NaCl, K_2SO_4, *etc.) do not make water hard*. This is because the sodium and potassium salts of fatty acids do not precipitate. And water containing sodium and potassium salts does lather with soap.

Temporarily and Permanently Hard Water

The hardness of some water samples can be removed by boiling, but not of all. On this basis, hard water is classified into two types.

> When the hardness of a water sample can be removed by boiling, it is called temporarily hard water.
>
> When the hardness of a water sample cannot be removed by boiling, it is called permanently hard water.

Temporary hardness is caused by the dissolved bicarbonates of calcium and magnesium. Permanent hardness is caused by the dissolved sulphates and chlorides of calcium and magnesium.

Softening of Water

If the hardness of water is removed, soft water is produced and the process is called softening of water.

The following methods are used to soften water.

1. Boiling Temporarily hard water can be softened by boiling it. When such water is heated, the bicarbonates of calcium and magnesium are decomposed to the carbonates. Being insoluble, the carbonates precipitate out.

$$\underset{\text{calcium bicarbonate}}{Ca(HCO_3)_2} \rightarrow \underset{\text{calcium carbonate}}{CaCO_3}\downarrow + CO_2\uparrow + H_2O$$

2. Treating with washing soda Permanent hardness of water is removed by treating with washing soda ($Na_2CO_3 \cdot 10H_2O$). A solution of washing soda is added to the water, and the carbonates of calcium and magnesium are precipitated.

$$\underset{\text{calcium sulphate}}{CaSO_4} + \underset{\text{sodium carbonate}}{Na_2CO_3} \rightarrow \underset{\text{calcium carbonate}}{CaCO_3}\downarrow + \underset{\text{sodium sulphate (in solution)}}{Na_2SO_4}$$

$$\underset{\text{calcium chloride}}{CaCl_2} + \underset{\text{sodium carbonate}}{Na_2CO_3} \rightarrow \underset{\text{calcium carbonate}}{CaCO_3}\downarrow + \underset{\text{sodium chloride (in solution)}}{2NaCl}$$

We know that the sodium sulphate and

sodium chloride formed will not make the water hard.

Why is it necessary to soften water?

It is necessary to soften water because hard water is unfit for most domestic and industrial purposes.

1. Hard water is unfit for laundries as it
   (a) consumes too much soap, and
   (b) leaves dirty stains of calcium and magnesium salts of fatty acids on cloth.
2. Hard water is not very suitable for bathing. The precipitates of calcium and magnesium salts of fatty acids, formed on reaction with soap, cause irritation of the skin.
3. It is not possible to properly cook hard foodstuff, like pulses, in hard water.
4. Though not injurious to health, hard water does not have an agreeable taste.
5. When used for industrial purposes (mainly in boilers), hard water produces white deposits of insoluble substances, called scales. The scales consist mainly of $CaCO_3$, $MgCO_3$ and $CaSO_4$. They deposit on the walls of the boiler and do not allow proper conduction of heat. They also block the pipes, which may cause serious accidents.

Pollution of Water

Pure water does not harm living things. Dissolved air and a few mineral salts are useful rather than injurious to living organisms.

> However, sometimes substances harmful to living things are present in water, in which case the water is said to be polluted.

Indicators of Water Pollution

A given sample of water is polluted if

(i) it tastes bad,
(ii) it smells bad,
(iii) oil or grease is floating over it,
(iv) there has been a decrease in the population of fish in the water body from which it has been taken, or
(v) there has been an unchecked growth of weeds in the water body from which it has been taken.

Such water is unfit for human consumption.

Types of Water Pollution

Water pollution can be broadly classified into two types—chemical and thermal.

Chemical pollution

> Chemical pollution of water is caused by the discharge of unwanted chemical substances into water bodies.

The pollutants may be organic or inorganic substances.

Chemical pollutants

Organic	Inorganic
Examples	*Examples*
(i) Oxygen-demanding wastes	(i) Mineral acids
(ii) Plant nutrients	(ii) Metals and their compounds
(iii) Synthetic organic chemicals	(iii) Phosphates from detergents
(iv) Oils and grease	
(v) Disease-causing microorganisms	

Oxygen-demanding wastes Many organic substances break up into simpler substances by taking up dissolved oxygen in the presence of some bacteria. As they consume the dissolved oxygen, the oxygen runs short for aquatic life, which is then badly affected. Moreover, many harmful products are formed.

Such oxygen-demanding substances are

(i) sewage,

(ii) wastes from food-processing industries, tanneries, etc.,

(iii) dead bodies thrown into water,

(iv) wastes from hospitals, and

(v) run-off from agricultural land.

Plant nutrients Sewage and run-off from agricultural land are natural plant nutrients. They help the aquatic weeds to grow fast. The unchecked growth of weeds makes the water body extremely deficient in dissolved oxygen, badly affecting aquatic life. This process is called eutrophication and this leads to the depletion of dissolved oxygen in a water body.

Man-made organic chemicals Man-made organic chemicals are in great demand these days. They are used in the manufacture of plastics, synthetic fibres, paints, dyes, drugs, pesticides, food additives, etc. Their production has increased manifold in recent years. The disposal of these chemicals into water bodies has caused a great increase in water pollution. Some of them are extremely harmful to living things, more so because they persist for a long time, i.e., they are not destroyed quickly.

Water from farms carries pesticides and fertilisers to water bodies. Among other things, pesticides can affect the nervous system.

Oils and grease Oil tankers carry petroleum by sea from one country to another. Oil spills out in tanker accidents or otherwise. The film of oil that floats over the water badly affects the transmission of light through the water body. This affects the process of photosynthesis in aquatic plants. Moreover, petroleum produces many chemicals that are extremely harmful to marine animals. Some of these chemicals cause cancer too.

Grease comes out of ships and ferries and pollutes water in much the same way as oil does.

Disease-causing microorganisms Water is the carrier of several microorganisms that cause common water-borne diseases. The common water-borne diseases are typhoid, dysentery, cholera and hepatitis. The microorganisms responsible for these diseases multiply fast in water. They are present in the excreta of infected persons. As the excreta are discharged into a water body, the water body becomes a source of infection and the disease spreads, often taking the form of an epidemic.

Table 5.2 Water-borne diseases

Disease	Microorganism responsible for the disease
Dysentery	Certain protozoa, bacteria and viruses
Cholera	Bacteria *Vibrio cholerae*
Typhoid	Bacteria *Salmonella typhi*
Hepatitis	Hepatitis virus

Inorganic pollutants Mineral acids, metals and their compounds, and phosphates are common inorganic pollutants.

Mineral acids enter water bodies from mineral acid plants and abandoned coal mines, besides acid rain. They render the water unfit for aquatic life.

Metals and their compounds enter water bodies from metallurgical units. Some metals, like mercury, arsenic, antimony, bismuth, lead and copper, are highly toxic.

The phosphate radical comes from detergents. It promotes the growth of aquatic weeds to such an extent that the water body gets choked, and the amount of dissolved oxygen decreases (eutrophication).

Thermal pollution

Several industrial units, especially power plants, use water as a coolant. They draw water from a water body like a river or a lake and return it to the water body after use. The temperature of the discharged water is about 10°C higher than that of the water drawn in. This difference in temperature is harmful to aquatic life and the pollution caused thereby is called thermal pollution.

Thermal pollution causes a decrease in dissolved oxygen too. This is because gases are less soluble at higher temperatures.

Steps to Curb Water Pollution

The following steps can help us curb water pollution.

1. Sewage should not be discharged directly into water bodies. It should be treated properly in sewage treatment plants.
2. Oil spills should be avoided as far as possible.
3. Synthetic organic chemicals should not be discharged into water bodies. They should be converted into other useful substances.
4. Pesticides should be used only to a limited extent.
5. Industrial wastes should be properly treated (to remove harmful substances) before disposal.
6. Thermal pollution may be avoided by allowing the hot water to dissipate the heat to the atmosphere rather than to the water body.

Steps to Avoid Water-borne Diseases

The following steps should be taken to avoid water-borne diseases.

1. Water must be properly cleaned and disinfected (say, by chlorination) before supply to the city.
2. Drinking water should be boiled and filtered before use.
3. Domestic water purifiers using ultraviolet radiation may be used for purifying drinking water.
4. If someone in the house is suffering from an infectious disease, the following steps should be taken.
   (a) The clothes of the patient must be washed with soap/detergent in hot water, treated with a disinfectant and ironed every day. This should be done so that the germs do not multiply and infect others.
   (b) The bathroom must be disinfected after each use.

Points to Remember

- Water is a compound of hydrogen and oxygen (combined in the mass ratio 1:8).
- Water is an essential constituent of all living things.
- The balance of water on earth is maintained due to the water cycle.
- Water fit for drinking is called potable water.
- The purification of water on a large scale comprises sedimentation, filtration and chlorination.
- Water should be purified for drinking at home by boiling and filtering, or filtering and radiating it with ultraviolet rays.
- Well water is purified by chlorinating it using bleaching powder or potassium permanganate.
- Pure water is tasteless and odourless.
- Water is a very good solvent.
- Water freezes at 0°C, and boils at 100°C at a pressure of 1 atm.
- The higher the pressure, the higher is the boiling point. Conversely, the lower the pressure, the lower is the boiling point.
- Water has the maximum density (1 g/cc) at 4°C.
- Water expands (i.e., its density decreases) as its temperature is lowered below 4°C. This is called the *anomalous expansion of water*.

- Ice is lighter than water.
- Water that lathers easily is called soft water. Water that does not lather easily is called hard water.
- Temporary hardness of water is caused by the dissolved bicarbonates of calcium and magnesium.
- Permanent hardness of water is caused by the dissolved sulphates and chlorides of calcium and magnesium.
- If the hardness of water is removed, soft water is produced, and the process is called softening of water.
- Temporarily hard water can be softened by boiling it.
- Permanently hard water can be softened by treating it with washing soda.
- If substances harmful to living things are present in water, the water is said to be polluted.
- Chemical pollution of water is caused by the discharge of unwanted chemical substances into water bodies.
- The chemical pollutants of water may be organic or inorganic.
- Thermal pollution of water is caused by the discharge of hot water into water bodies.
- Steps must be taken to curb water pollution as also to avoid water-borne diseases.

Exercise

Short-Answer Questions

1. What fraction of your body is made up of water?
2. What fraction of the earth's surface is covered by water?
3. What fraction of fruits and vegetables are made up of water?
4. What do you mean by potable water?
5. Name a chemical that helps suspended particles in water to settle.
6. Why is water chlorinated to make it potable?
7. Why should you boil water to make it fit for drinking?
8. Which property of water is shown by the fact that sea water is too salty?
9. How does soap behave with
   (i) soft water, and (ii) hard water?
10. What will you observe if temporarily hard water is boiled?
11. What will you observe if permanently hard water is treated with washing soda?
12. What do you mean by pollution of water?
13. Name three chemical pollutants of water.
14. Name three water-borne diseases along with the microorganisms causing them.
15. Name a chemical that can be used to disinfect well water when a water-borne disease takes the form of an epidemic.

Long-Answer Questions

1. Discuss three points to show that water is an essential constituent of all living things.
2. What are the substances that water used for drinking must be free from?
3. Describe an experiment to show the anomalous expansion of water. How does this phenomenon help aquatic life to survive even when a river, lake or sea freezes?
4. Describe three steps to curb water pollution.
5. Discuss three steps to avoid water-borne diseases.

Objective Questions

Choose the correct options.

1. The boiling point of water at a pressure of 1 atm is
   (a) 0°C (b) 50°C (c) 70°C (d) 100°C
2. Water boils at Mount Everest at about
   (a) 0°C (b) 50°C (c) 70°C (d) 100°C
3. The boiling point of water in a pressure cooker is
   (a) 100°C (b) >100°C (c) <100°C
4. At which of the following temperatures is the density of water maximum?
   (a) 0°C (b) 4°C (c) 100°C (d) 120°C
5. Which of the following substances will cause temporary hardness of water?
   (a) Calcium chloride (b) Magnesium chloride
   (c) Magnesium bicarbonate (d) Magnesium sulphate
6. Which of the following substances will not cause hardness of water?
   (a) $Ca(HCO_3)_2$ (b) $CaCl_2$ (c) $MgSO_4$ (d) NaCl
7. Which of the following processes removes temporary hardness of water and, at the same time, kills the microorganisms present in it?
   (a) Filtering (b) Treatment with alum
   (c) Chlorinating (d) Boiling

Fill in the blanks.

1. Groundwater is ...... suitable than surface water for drinking. (more/less)
2. Pure water is ...... and odourless. (sweet/tasteless)
3. The boiling point of water ...... with altitude. (decreases/rises)
4. The anomalous expansion of water takes place ...... 4°C. (above/below)
5. The disposal of sewage into a water body ...... the dissolved oxygen of the water body. (increases/reduces)
6. An oil spill ...... the light transmitted through a water body. (increases/reduces)
7. When water is used as a coolant in an industrial plant, the waste water causes ...... pollution (chemical/thermal)
8. Thermal pollution leads to a/an ...... in the dissolved oxygen of the water body. (increase/decrease)
9. Complete the following equations.

   (a) $Ca(HCO_3)_2 \xrightarrow{\text{boil}} \ldots\ldots + CO_2\uparrow + H_2O$

   (b) $CaSO_4 + \ldots\ldots \rightarrow CaCO_3\downarrow + Na_2SO_4$

   (c) $6CO_2 + \ldots\ldots \xrightarrow[\text{chlorophyll}]{\text{sunlight}} C_6H_{12}O_6 + 6O_2$

   (d) $CaOCl_2 + H_2O \rightarrow Ca(OH)_2 + \ldots\ldots$

Match the items of column A with those of column B.

A	B
(a) Oil spill	(i) $K_2SO_4 \cdot Al_2(SO_4)_3 \cdot 24H_2O$
(b) Ceramic candles	(ii) a water-borne disease
(c) Alum	(iii) reduces the transmission of light into water
(d) Bleaching powder	(iv) water filter
(e) Typhoid	(v) $CaOCl_2$

Indicate which of the following statements are true and which are false.

1. Hard water is injurious to health.
2. Sea water is not potable.
3. Oil spills can cause cancer.
4. Hepatitis is a water-borne disease.

Rainwater Harvesting

Areas where the population is dense generally face acute water shortage. One reason is that people pump most of the groundwater out to meet their needs, and the level of the water below the ground, called the water table, becomes low. Another reason is the lack of water in lakes and rivers due to intense heat and low rainfall. The problem of water shortage can be solved at least partially if we could store whatever little rainwater there is. Using rainwater for our daily needs is called *rainwater harvesting*, for which the following methods are commonly used.

1. Pits or tanks are dug in low-lying areas to collect rainwater. This water can be filtered, disinfected and supplied for consumption. Sometimes, the collected water (after being filtered) is fed into dried-up borewells to replenish the groundwater reservoir.
2. Rooftop rainwater harvesting is also useful. The rainwater from the roof of a house is collected through pipes in tanks on the ground. How much water do we get this way?

   Let us suppose the roof area of a house is 100 m^2, the annual rainfall is 100 cm (= 1 m), and also that we are able to catch only 70% of the rainwater. Then the volume of water collected in a year is $100\,m^2 \times 1\,m \times (70/100) = 70\,m^3 = 70{,}000$ L. For a family of four, requiring 400 L of water a day, the harvested water will run for 175 days, i.e., about 6 months.

Fig. 5.10 Rooftop rainwater harvesting

3. In a hilly area, where there are hills on three sides, a reservoir is made by raising a dam on the fourth side. The harvested rainwater is supplied to areas nearby.

Fig. 5.11 Rainwater harvesting in hilly areas

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