2

MATTER IN OUR SURROUNDINGS

You have learnt about units of measurement in the previous lesson. What we eat, drink or breathe is the matter. Hence all of us are surrounded by matter. *Anything which occupies space and has mass is matter*. In order to understand the world better it is necessary to understand the *nature of matter*.

In this section you shall learn about matter and shall utilise the concepts of measurement in understanding the properties of matter.

OBJECTIVES

After completing this lesson you will be able to:

- *describe what is matter and explain its particulate nature;*
- *clarify and differentiate the three states of matter – solid, liquid and gas;*
- *describe the effect of pressure and temperature on states of matter;*
- *illustrate the inter-conversion of these states with the help of suitable examples;*
- *classify the given matter as an element, a compound or a mixture;*
- *distinguish between homogeneous and heterogeneous mixtures;*
- *define the terms solution, solvent and solute;*
- *calculate the percentage composition of a solution;*
- *describe the properties and uses of suspension, and*
- *describe the common methods used for separation of mixtures or purification of a substance.*

2.1 WHAT IS MATTER?

Matter is any thing which has mass and occupies space. All solids, liquids and gases around us are made of matter. Scientist believe that matter is made of tiny particles that clump together. You cannot see these particles but you can see the matter, for example, a book, a car, a letter, a hand set, a piece of wood, tree, a bag etc. Think and add a few more exmaples from your day to day life.

When we say matter has mass it means matter has weight: the heavier an object, the more mass it has. Matter occupies space it means matter has volume.

A substance is a pure kind of matter having only one kind of constituent particle (atom or molecule). Water, iron, gold, copper, aluminum and oxygen are examples of substances. **All substances are matter but all forms of matter are not substances.** You must be wondering how this is possible. Well, a substance is a pure form of matter, that is, it is the same throughout. Let us take the examples of soft drinks and soil. In what category you would put them. They are not single substance but they are mixture of substances. Now you will find out what is the nature of matter?

2.2 PARTICULATE NATURE OF MATTER

Human beings have been questioning the nature of matter. In ancient times there were two different views about it. One school of thought believed that if we take a piece of matter (for example stone) and break it into smaller pieces and break these smaller pieces into still smaller pieces, the process can be repeated any number of times. This would happen because matter is continuous and its piece of any size can be broken or subdivided into smaller pieces. Greek philosophers Plato and Aristotle belong to this school of thought.

The second school of thought believed that process of subdivision of matter can be repeated only for limited number of times. A stage would be reached when the tiny particles of matter so obtained cannot be further subdivided. They believed that all matter is composed of very tiny particles. In other words, the matter has particulate nature. The smallest indivisible particles of matter were given the name "atom" from the Greek word "atomos" for " indivisible" .

Indian philosopher Kanada and Greek philosophers Leucippus and Democritus belong to this school of thought. The term "atom" was coined by Democritus. Today the idea of atom has changed since it was first proposed. The modern idea of atom originated with John Dalton in 1803. Today we talk of two types of constituent particles-atoms and molecules. Atoms is a basic unit of matter and all chemical

properties of matter can be explained on its basis. Molecules are important in explaining physical properties of matter. Details about atoms and molecules will be undertaken in the Lesson No. 3. Let us learn about how to classify matter.

INTEXT QUESTIONS 2.1

1. What is matter?
2. Which of the following is not a pure substance?

   (a) Iron (b) Water (c) Soil
3. Who coined the term "atom" and what does it mean?

2.3 STATES OF MATTER

Matter can be classified in many ways. However, the following are the two main ways of classifying the matter:

(i) by the physical state of matter as a solid, liquid, or gas, and

(ii) by the chemical composition of matter as an element, compound or mixture.

We shall discuss these classifications in the next section.

Let us discuss about the classification of matter based on physical states. Matter can ordinarily exist in three states – solid, liquid and gas. These three states of matter have different properties. Water exists in all the three states namely steam or water vapour (gas), water at room temperature (liquid) and ice (solid). This is the only substance which exists naturally in all the three states.

The characteristic properties of different states of matter depend on intermolecular forces. **The forces holding molecules together are called intermolecular forces.** Intermolecular forces (i.e. forces between the constituent molecules) try to keep molecules together but thermal energy always tries to keep them far apart. It is the competition between molecular interaction energy and thermal energy that decides whether a given substance under given conditions will be a solid, liquid or gas. Thermal or heat energy can convert one state of matter into another state. Thus a particular state of a matter depends on both : intermolecular force and the thermal energy which basically depends upon temperature.

Each state of matter has some characteristic properties. Now you shall learn about these properties.

2.3.1 Solids

We are surrounded by innumerable solid objects. A piece of wood, a stone, a pencil, a pen, and a computer all are examples of solids. **A solid has definite size and shape which do not change on their own** (see **Fig.2.1).** However, by using external forces you can change the shape of a solid. For example you can cut a piece of metal into two and you can use hammer to change its shape. Can you think of any other way to change the shape of solids? Yes, you can. Beat it into sheets or pull it into strings.

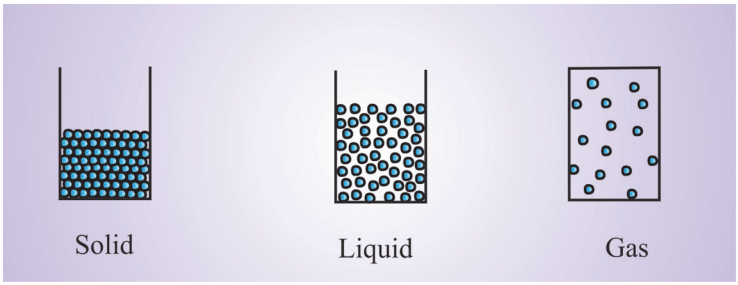


Fig. 2.1: *Shapes of different states of matter*

In solids the constituent particles are present very close to each other and the intermolecular forces operating between the constituent particles are very strong and they are capable of keeping the molecules in fixed positions. This is the reason why solids are rigid and hard. Also, solids cannot be compressed. The attractive intermolecular forces become repulsive when atoms or molecules are forced to come further closer. When a solid is heated there is an increase in thermal energy of the particles which results in conversion of solid into liquid. The temperature at which this happens is the **melting point** of the solid.

2.3.2 Liquids

Water is a liquid. Mustard oil and kerosene oil are other examples of liquids. Can you think of some more examples? **A liquid has a definite volume**. However, a liquid does not have a definite shape. It takes the shape of its container. A liquid can flow. You can pour a liquid or spill it. Can you spill a solid?

Liquids have properties intermediate between solids and gases. The intermolecular forces in liquids are weaker than solids but stronger than gases. In liquids the constituent particles do not occupy fixed position as in solids, but they have freedom of movement as in gases. In liquids intermolecular forces are stronger than those of gases.The constituent particles (atoms and molecules) in a liquid can break away from each other and get attracted while approaching the other molecules. Like in solids,

the intermolecular forces become repulsive when an attempt is made to bring the molecules closer by applying pressure. This is the reason why pressure does not have much effect on volume of liquids.

2.3.3 Gases

We cannot see gases but they are all around us. We can feel the presence of air when the wind blows. **The wind is moving air and is a mixture of many gases like oxygen, nitrogen, argon, carbon dioxide and others.** A gas occupies the entire volume of the container irrespective of its size (see Figure 2.1). In gases, molecules move freely because the intermolecular forces are very weak and are unable to keep the gas molecules together in bulk. The molecules remain far apart from each other due to weak molecular interactions. Since molecules are far away from each other in gases, they can be brought closer when pressure is applied. This is the reason why-gases are highly compressible. We can compress a gas only up to a certain limit. Beyond this limit repulsion between gas molecules becomes very high. Temperature also affects the volume of the gases. When temperature increases, volume of the gas also increases. For example when a closed container is heated it blasts due to rapid increase in volume.

We are lucky that a gas can be compressed easily. If this was not the case then we could not have obtained CNG (Compressed Natural Gas). As you might be aware that CNG is used as a clean fuel for vehicles and you might have noticed that at the back of several Autorikshas and buses, CNG is written. We also have our cooking gas cylinders in kitchen because gas (LPG) is compressible. There are many other examples of uses based on compressibility of gases. Can you think some more examples? Oxygen cylinder in hospital is another example.

The distribution of molecules in solid, liquid and gas is shown in Fig 2.2.

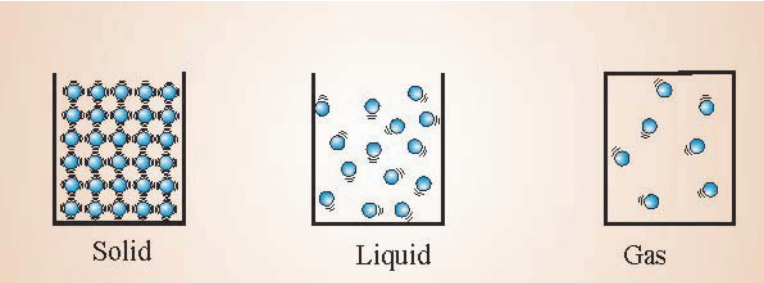


Fig. 2.2: *Schematic representation of distribution of molecules in solid, liquid and gas*

Do you know

Three basic states of matter, described above, are dominant on Earth but they become less relevant in other parts of the universe. You will be surprised to know that 99% of the matter in the entire universe is not a solid, a liquid or a gas. The form of matter that is more dominant is called 'plasma'. The Sun consists of plasma as most of the other stars do. You will learn about "plasma" in your higher classes.

Different characteristics of the three states of matter have been summarized in Table.2.1.

Table 2.1 Different characteristics of the three states of matter

State of matter	Volume	Density	Shape	Fluidity	Compressibility
Solid	Has fixed volume	High	Has definite shape	Does not flow	Negligible
Liquid	Has fixed volume	Lower as compared to solid	Has no definite shape. It takes the shape of container.	Flows smoothly	Very small
Gas	Has no fixed volume	Low	Has no definite shape.	Flows smoothly	Highly compressible

INTEXT QUESTIONS 2.2

1. Which of the three states of matter has no definite volume? Give one reason for your answer.
   (a) Solid, (b) liquid, (c) gas
2. Why do solids have definite shape?
3. Name a substance which exists naturally in all the three states.

Do you know

There are two basic concepts in the physical world around which you can organize everything. These two basic concepts are matter and energy. Both matter and energy are related to each other by the formula $E = mc^2$. Here E is energy, m is mass and c is velocity of light. One of the greatest scientists of all times, Albert Einstein showed that matter can be transformed into energy, and energy can be transformed into matter. No doubt, transforming matter into energy is easy whereas transforming energy into matter is difficult.

2.4 EFFECT OF TEMPERATURE AND PRESSURE ON STATES OF MATTER

Have you ever thought what happens if a solid substance is heated? When heat is supplied to a solid, it expands. This expansion is very small. In fact after receiving thermal energy, particles (atom/molecules) vibrate more rapidly in their position and take up more space. If particles become more energetic on further heating they leave their fixed positions and the solid melts. Once a solid becomes liquid it can be poured into a container. As you learned earlier, a liquid takes the shape of the container in which it is poured. Particles in the liquid state are free to move.

Now let us see what happens when a liquid is heated. On receiving heat (thermal energy) a liquid is converted into a gas. This happens because the kinetic energy of the particles becomes so high that they can overcome the intermolecular force within the liquid. Therefore liquid is converted into gas (vapour).

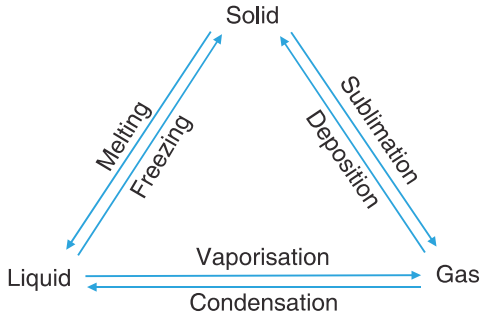


Fig. 2.3: *Interconversion of states of matter*

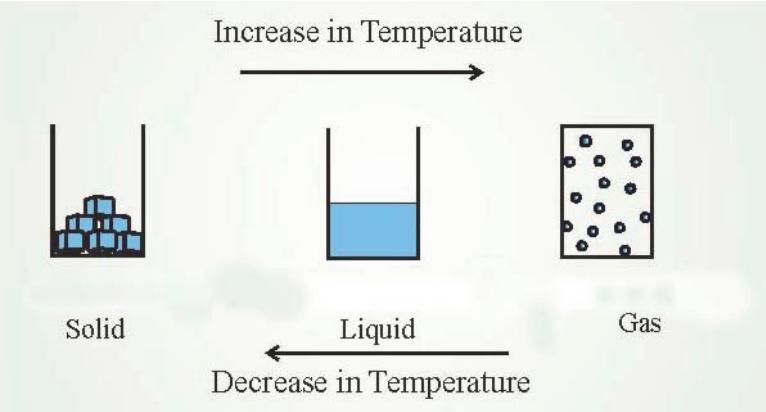


Fig. 2.4: *Inter-conversion of states: from solid to liquid, liquid to gas and vice versa with variation of temperature*

When a gas is heated, kinetic energy of the particles increases. They move more freely and at much higher speed. Intermolecular distance also increases and the volume of the gas increases if pressure is kept constant. Do you know what happens when a balloon filled with air is brought near fire?

A pure solid turns to liquid at a fixed temperature or in other words conversion of pure substance from solid to liquid takes place at one particular temperature. This particular temperature is called **melting point** of that particular solid substance. Similarly when the liquid cools down, it converts into solid at a particular temperature. This temperature is called **freezing point** of that particular liquid substance. The temperature at which a liquid boils and is converted into a gas is **boiling point** of the liquid.

ACTIVITY 2.1

Demonstrating the inter-conversion of the three states of matter

Materials required: Ice, container, gas burner or any other heating device.

How to do it:

Put the ice in the container and gradually heat it. First it will melt into water and if you continue heating it will turn into vapour.

You should remember that the three different states of matter respond differently with changes of temperature and pressure. All the three states expand or show an increase in volume when the temperature is increased. They contract or show a decrease in volume when the temperature is lowered. However, the effect of pressure on solid and liquid is negligible. A gas can be compressed easily by applying pressure.

ACTIVITY 2.2

You can observe the effect of pressure on gases and liquids by performing the following experiment.

Take a syringe and close its nozzle by inserting it in a rubber cork. Remove the piston so that the entire space inside the syringe is filled with air. Now, insert the piston carefully back in the syringe and try to compress the air by pushing the piston. What do you observe? You will find that the piston can be pushed easily. Of course beyond a point you will not be able to push the piston. This shows that air is compressible easily. Now you repeat the experiment with liquid. Can you push the piston as easily as you could push with air? If you try, you will find that it is not possible. This is because the molecules in liquids are much close to each other as compared to gases.

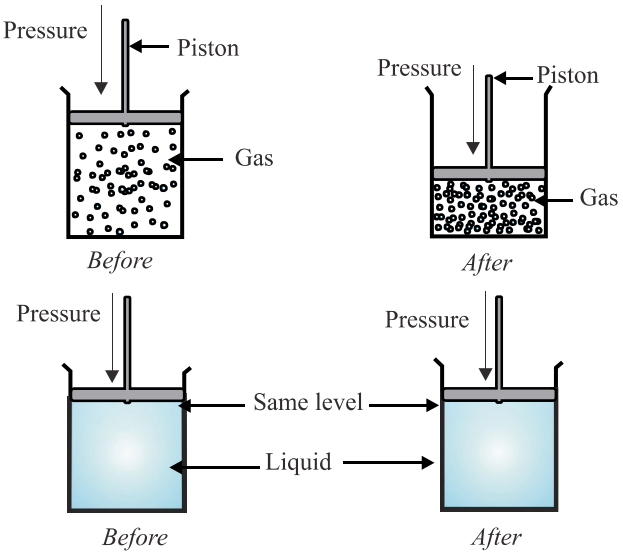


Fig. 2.5 : *Effect of pressure on gas and liquid*

INTEXT QUESTIONS 2.3

1. Why gases are more compressible as compared to solids?
2. How can you change water into ice?

2.5 ELEMENTS, COMPOUNDS AND MIXTURES

2.5.1 Elements

All substances are made up of chemical elements. A chemical element is a basic form of matter that cannot be chemically broken down into simpler substances. **A chemical element is a pure substance and it consists of one type of atom distinguished by its atomic number.** Examples of some elements are : helium, carbon, iron, gold, silver, copper, aluminum, hydrogen, oxygen, nitrogen, sulphur, copper, chlorine, iodine, uranium, and plutonium.

Elements are the building blocks of the Universe. In total, 114 elements have been listed so far. Out of the total 114 known elements, about 90 occur naturally on Earth and the remaining have been synthesized artificially by nuclear reactions. Only two elements namely hydrogen (92%) and helium (7%) make up about 99% of the total mass of the Universe. The remaining elements contribute only 1% to the total mass of the Universe.

Out of about 90 elements found naturally on Earth, two elements silicon and oxygen together make up almost three-quarters of the Earth's crust. Our body is also composed of elements but the composition of elements in human body is very much different from that of the Earth's crust, as it can be seen from Table 2.2.

Table 2.2: Elements in Earth's crust and human body

Elements	% by mass	
	Earth's Crust	Human Body
1. Aluminium	6.5	very little
2. Calcium	3.6	1.5
3. Carbon	0.03	18.5
4. Hydrogen	0.14	9.5
5. Iron	5.0	very little
6. Magnesium	2.1	0.1
7. Oxygen	46.6	65.0
8. Silicon	27.7	very little
9. Sodium	2.8	0.2
10. Sulphur	0.03	0.3

Although human beings and Earth share elements in their composition, human being have several advantages like being able to think, feel etc. Don't you think that it is our responsibility to take care of Earth?

2.5.2 Compounds

A compound is a substance formed when two or more than two elements are chemically combined. **A compound can be defined as a pure substance made from two or more elements chemically combined together in a definite proportion by mass.** When elements join to form compounds they lose their individual properties. Compounds have different properties from the elements they are made of. For example, water (a compound) is made up of elements – hydrogen and oxygen but properties of water are different from those of hydrogen and oxygen .The world of compounds is really fascinating because compounds show a great variety in forms and properties.

Some examples of compounds are given below:

Glucose	Glycerol	Calcium oxide
Sodium chloride	Sulphuric acid	Carbon dioxide
Hydrochloric acid	Chloroform	Acetic acid
Sodium carbonate	Ethanol	Carbon monoxide
Phenol	Citric acid	Methane

A pictorial representation of element compound and mixture is shown in Fig. 2.6

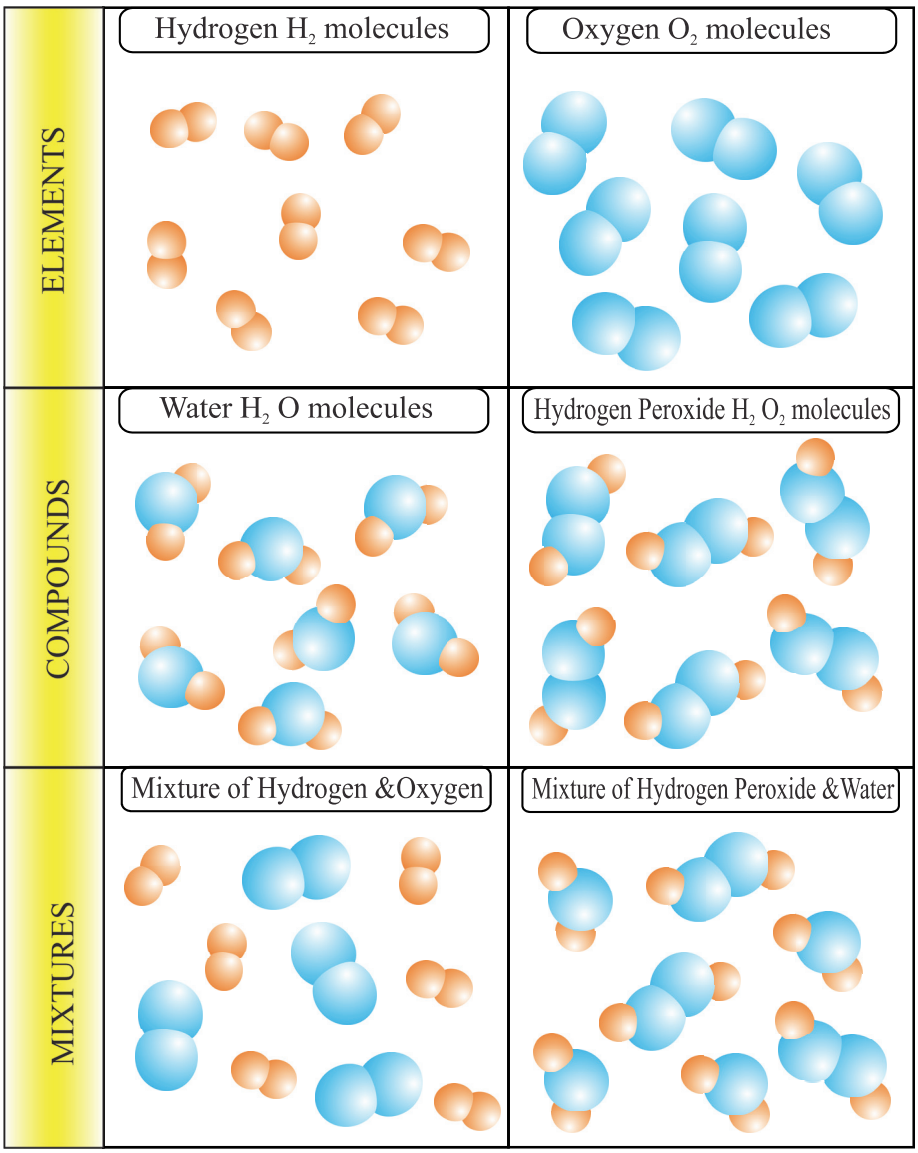


Fig. 2.6: *A Pictorial representation of elements, compounds and mixtures. From the figure we can see that elements combine to form compounds but in the mixture the elements and compounds maintain their separate identities*

2.5.3 Mixture

In our everyday life we deal with a large number of substances but majority of them are not pure substances (elements or compounds). They are mixtures of two or more pure substances. In the next section we shall see that there are two types of mixture depending on whether the parts of the mixtures completely mix or not

The relationship among elements, compounds and other categories of matter are summarized in Fig. 2.7.

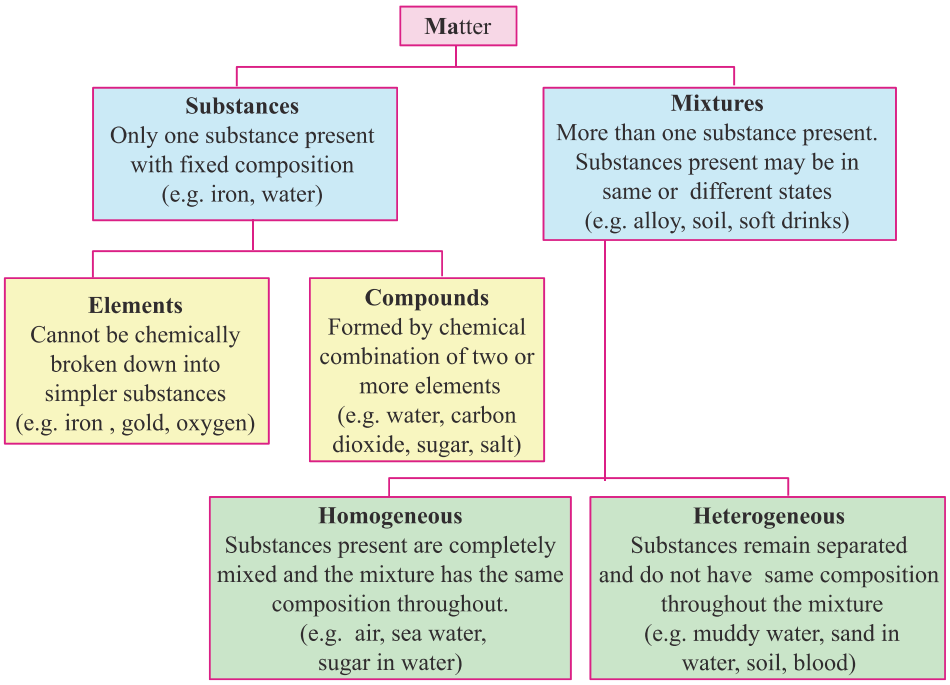


Fig. 2.7: *Classification of matter*

INTEXT QUESTIONS 2.4

1. Classify the following into element, compound and mixture:
   aluminum, carbon, granite, water, silicon, carbon dioxide, air and sugar.
2. How does an element differ from a compound?
3. Which is the most abundant element in the universe?

2.6 HOMOGENEOUS AND HETEROGENEOUS MIXTURES

Mixtures are broadly divided in two major groups – (i) homogeneous mixtures and (ii) heterogeneous mixtures.

2.6.1 Homogeneous Mixture

You have seen that people having loose motion take ORS. What is ORS? You can yourself prepare ORS by putting little amounts of salt and sugar in water. ORS is an example of a homogeneous mixture or solution. So let us learn about homogeneous mixtures.

In some mixtures, constituents are completely mixed in such a way that the entire mixture has the same composition throughout. Such mixtures which have uniform composition are called **homogeneous mixtures**. For example when you prepare *sharbat* by mixing sugar and water in a jug, the entire mixture has the uniform

sweetness. Technically such homogeneous mixtures are called **solutions**. For example common salt, which is solid when dissolved in water, forms a liquid mixture or a salt solution. The salt is totally dispersed into water uniformly and one cannot see it (Fig. 2.8). Two-thirds of the Earth's surface is covered by sea water which is nothing but a homogeneous mixture (solution) of various salts in water. Sea water also contains dissolved gases like oxygen and carbon dioxide. The air we breathe is a homogenous mixture of different gases. Two liquids can also form homogeneous mixture for example water mixes with ethyl alcohol in all proportions. In other words water is miscible with ethyl alcohol or vice versa. Many alloys are also homogeneous mixtures of two or more than two metals. Gold and copper form homogeneous solid *solution*. Do you know a goldsmith can judge the purity of gold by testing any part of it.

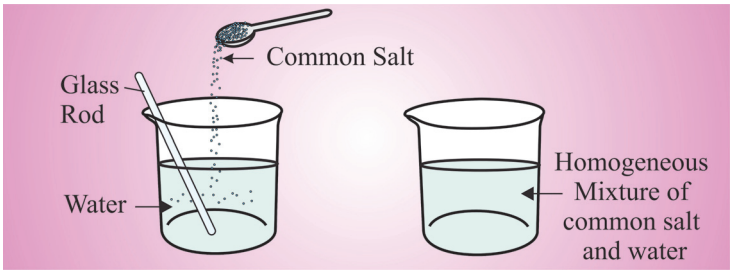


Fig. 2.8 Mixing of common salt into water

A homogeneous mixture is a mixture where the substances are completely mixed together and have uniform composition throughout.

Different types of homogeneous mixtures that may result by mixing different substances have been summarized in **Table 2.3**.

Table 2.3: Different types of homogeneous mixtures

Type of mixture	Description	Examples	Can you think another example(s)?
Solid + liquid	solid dissolves in liquid to form transparent solution	sugar in water or salt in water, iodine in ethyl alcohol (tincture iodine)	
Liquid + liquid	forms a single transparent mixture	Mixture of water and ethyl alcohol.	
Gas + liquid	Gas completely dissolves in a liquid to form a transparent solution	Soda water and any other common soft drink	
Gas + gas	mixture of two or more gases	Air	
Solid + solid	some metallic alloys	Brass, bronze	

You can discuss with your friends and others while carrying out the above exercise.

2.6.2 Heterogeneous Mixture

Have you ever brought a 'mixture' from market? If yes, then you must have noticed that such a mixture contains different constituents and each of these constituents is visible.

Such mixtures where the constituents do not completely mix with each other, and remain separate, are called *heterogeneous mixtures* (Fig. 2.9). In such mixtures one substance is spread throughout the other in the form of small particles, droplets or bubbles.

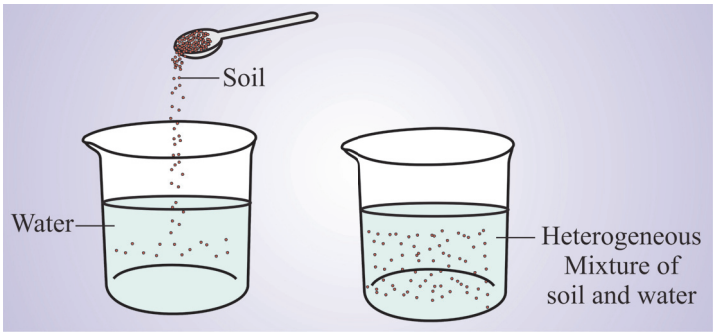


Fig. 2.9 Mixing of soil into water to form heterogeneous solution

A heterogeneous mixture is a mixture where the substances (parts or phases) remain separate and composition is not uniform.

Different types of heterogeneous mixtures that may result by mixing different substances have been summarized in **Table 2.4**.

Table 2.4: Different types of heterogeneous mixtures

Type of mixture	Description	Examples	Can you think of another example(s)?
Suspension	solid + liquid	flour in water, river water carrying mud	
Gel	liquid trapped in solid	fruit jelly, agar gel	
Emulsion	mixture of tiny droplets of one liquid suspended in another	milk	
Aerosol	small droplets of liquid or particles of solid dispersed in a gas	clouds (liquid in gas) smoke (solid in gas)	
Foam	Gas in liquid: small bubbles of gas trapped in liquid	shaving foam	
	Gas in solid: small bubbles of gas trapped in solid	polystyrene foam (Thermocoal)	

You may like to discuss with your mother to know whether any of the above types of mixtures are used in your home.

ACTIVITY 2.3

Collect at least 10 different things from your homes and surroundings and classify them based on their composition and place in the following table:

S.No.	Name of the things/ objects/ material	Element	Compound	Mixture	not known
				Homogeneous or Heterogeneous	
1.	Water				
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					

INTEXT QUESTIONS 2.5

1. Say whether ethyl alcohol and water form a homogeneous mixture or heterogeneous mixture.
2. Give an example of homogeneous mixture obtained by mixing two solids.

2.7 SOLUTION AND ITS CONCENTRATION

A solution (a homogeneous mixture) is formed when one or more substances (the **solute**) are completely dissolved in another substance (the **solvent**). When we think about solutions, the most common examples that come to our mind are the solutions that are obtained by dissolving solids in water. Sugar or common salt dissolved in

water gives this type of solution. Do you know that two-third of the Earth's surface is covered by a solution? You may be able to guess this solution present in oceans. The sea-water is a solution of water and soluble minerals. It also contains gases like oxygen, nitrogen and carbon dioxide. Such dissolved gases are very important for aquatic life to survive in oceans.

There are some solutions of two or more than two liquids. As you know that ethyl alcohol mixes with water in all proportions to form a solution. Iodine (solid) dissolved in ethyl alcohol gives tincture of iodine which has antiseptic properties.

A solution made of solid dissolved in a liquid has two parts:

- the solid that dissolves is called the **solute**,
- the liquid, in which the solid is dissolved, is called the **solvent.** Fig. 2.10.

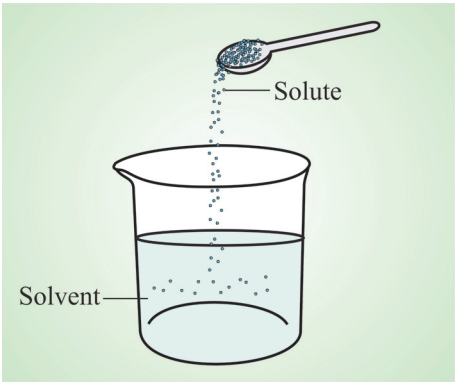


Fig. 2.10 Mixing of NaCl into water

You have just seen that solutions are not confined to only solids dissolved in liquids. There are other types of solutions as described earlier. In each case the **substance which is present in bigger quantity is normally taken as solvent and substance which is present in smaller quantity is normally taken as solute.**

When a substance dissolves in a solvent it is said that that particular solute is **soluble** in that particular solvent. If it does not dissolve then it is **insoluble**. Water is a commonly used solvent as it dissolves a large number of substances. Because of this property water is called a **universal solvent**. Different types of substances dissolve in water. Because of this unique property of water, plants can take minerals from the soil? Being a good solvent, water is used in many ways. However, there are some disadvantages also which result from this unique property of water. Water becomes easily contaminated. Therefore, purifying water for drinking and other uses is a major challenge.

There are other important solvents, for examples organic liquids. The **organic solvents** are important because, unlike water, they dissolve organic substances. Ethyl alcohol and benzene are examples of such organic solvents.

2.7.1 Concentration of a Solution

The term "concentration" is most often used when we talk about solutions. Concentration of a solution is expressed in terms of the amount of solute present in a given mass or in a given volume of a solvent. Usually **concentration** of a solution is defined as the mass of solute present in a definite volume of a **solution** (which is usually taken as 1 litre). Concentration of a solution may also be expressed in terms of per cent by mass of solute (in gram). This gives the mass of solute per 100 mass units (grams) of solution as shown below:

$$\% \text{ of solute} = (\text{mass of solute/mass of solution}) \times 100.$$

A solution of 10% glucose by mass means that 100 grams of the solution contains 10 gram of glucose. This means 10 grams of glucose is dissolved in 90 grams of water.

When we try to dissolve a particular substance say sugar in water, the solution becomes more concentrated as we add more and more sugar. A concentrated solution contains a high proportion of the solute. A dilute solution contains a small proportion of solute.

If we keep on adding solute to a solvent, keeping the temperature constant we reach a point where no more solute will be dissolved. At this point we say that the solution has become **saturated** with respect to solute. However, if we increase the temperature, more solute will get dissolved. **The concentration of a solute in a saturated solution at a definite temperature is called solubility of that solute in that particular solvent.**

ACTIVITY 2.4

Make a solution of sodium chloride in water with a known concentration of 10g/litre by mass.

1. Take a graduated flask and fill approximately half with distilled water (the solvent).
2. Weigh out 10 g of sodium chloride (the solute).
3. Carefully add the sodium chloride to the water in the container.
4. Gently shake the container to dissolve all the sodium chloride.
5. Add more distilled water to make up the volume of the solution to exactly the 1000 mL (1.0 dm^3) mark on the neck of the graduated flask. Finally shake the flask carefully to make the solution uniform.

INTEXT QUESTIONS 2.6

1. To make one kilogram of 40% sugar solution by mass, how much sugar and water will you need?

   sugar .....

   water .....

2. What is the name given to a liquid which dissolves a solid to make a solution?
3. To make a given solution more concentrated, what will you add?

2.8 SUSPENSIONS

In winter, the fog is a common experience in both urban and rural areas. What is fog? Fog forms when tiny water droplets are suspended in air. So fog is nothing but a type of a suspension. There are large numbers of substances which do not mix with each other. There are some solids that do not dissolve in water or other liquid solvents and there are liquids that do not mix with each other. The mixing of such substances results into heterogeneous mixtures. Depending on the size of the particles suspended, or dispersed in the surrounding medium, heterogeneous mixtures can be divided into colloids and suspension. You will study about colloids in higher classes. Here we shall briefly describe suspension. Materials of smaller particle size, insoluble in a solvent but visible to naked eyes, form suspension.

Unlike a colloid, which contains smaller particles ranging in size from 1 to 1000 nanometres, a suspension contains relatively larger particles. The size of particles in suspension is over 1000 nanometres. When flour is added to water it does not dissolve but forms a slurry, which we call a suspension. However, if less amount of water is added in the flour (200 g of flour and 100 mL of water) we get dough to make chapatti etc. Muddy water is an example of suspension. When a suspension is allowed to stand undisturbed, the dispersed particles settle down (Fig. 2.11).

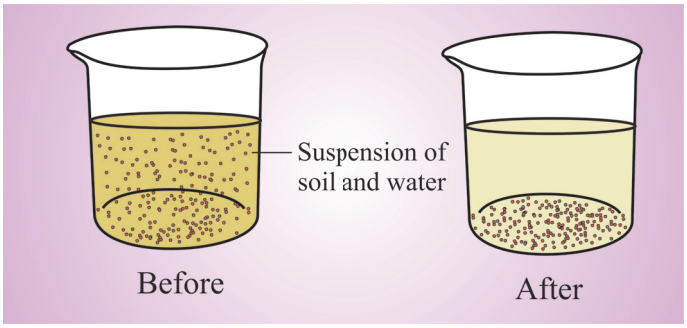


Fig. 2.11 *Settling of suspension when it is allowed to stand undisturbed*

Suspensions are very useful in medical sciences. For example barium sulphate (whose solubility is very low when dispersed in water) is an opaque medium. It is used for diagnostic X-rays (barium meal test). Many medicines, which are insoluble in water, are given in the form of suspension, for example, pencillin and amoxycilin. Please check a few bottles of medicine. Do you find the word suspension written on a bottle.

ACTIVITY 2.5

Prepare a suspension using materials available in your home.

Materials required**:** Wheat flour (1 cup approximate 200g), water, a glass (250 mL), and a spoon.

How to do it

Pour water into a glass and add wheat flour to water. Stir the water with the help of the spoon. Keep the mixture undisturbed for some time . Write your observation and identify whether you have prepared a suspension or a solution. Give at least one reason for your answer..

2.9 SEPARATION OF MIXTURES

Have you seen someone removing unwanted materials from rice or wheat? If so then you have seen separation of heterogeneous mixture into pure components by physical means. Have you eaten *mishri*, the bigger crystal of sugar? Preparation of *mishri* involves separation of sugar from homogeneous mixture of sugar and water. Both in our households and in industries we need to separate mixtures, both homogeneous and heterogeneous, for various purposes. Fortunately we can recover sugar or salt from its water solution by evaporating the water or even sometimes by heating. To separate different components of a mixture variety of physical techniques are available. ***All these separation techniques are based on difference in the physical properties of the components present in the mixture***. The following two factors decide the best possible technique to be adopted for separation:

(i) the type of mixture,

(ii) the component which you want to collect.

Here we shall describe some of the common techniques of separation.

2.9.1 Separation by using Separating Funnels

The mixture of two immiscible liquids (i.e, the liquids that do not mix , as oil and water) can be separated by using a **separating funnel**. The mixture is placed in

separating funnel and allowed to stand for some times. When the two layers of liquids are separated, the denser liquid which is in the lower part, is first collected by opening the stop-cock. (See Fig. 2.12) This method is very useful in industries.

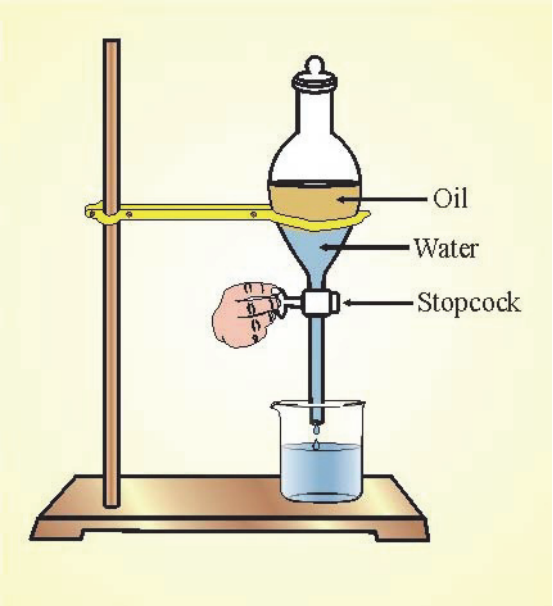


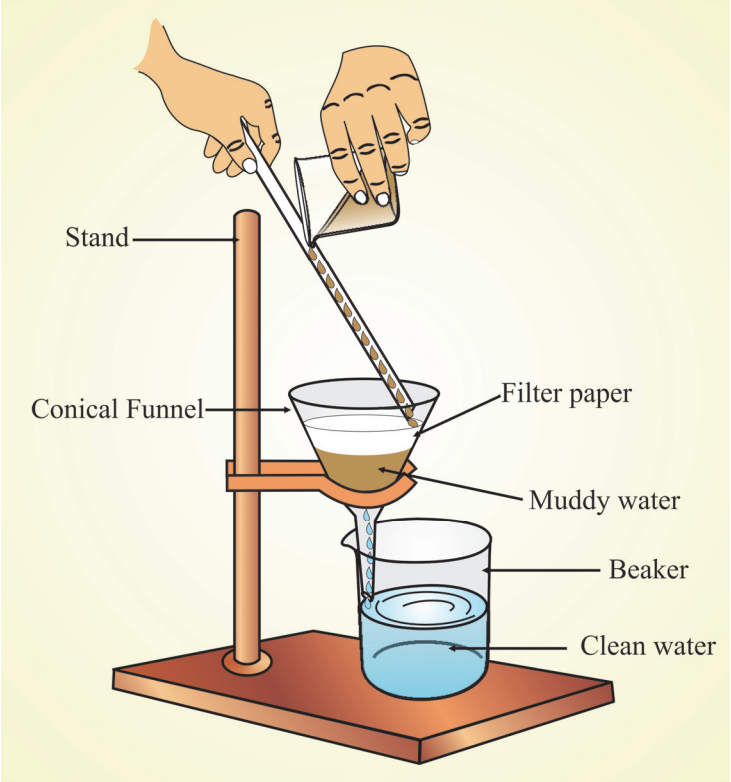
Fig. 2.12: *Separation of oil and water using separating funnel*

2.9.2 Separation by Evaporation

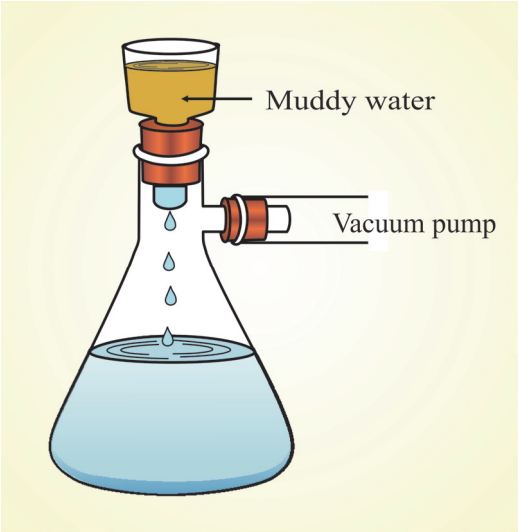
The separation of liquid (solvent) and solid (solute) from a solution is done by removing the liquid (solvent) by heating or by solar evaporation. By evaporation you can recover the solute component only in solid or powder form. If the solvent is inflammable you cannot use flame for heating instead you can use an electrical heating system and an oil or water bath. You might have heard that salt is obtained from sea water by the process of evaporation in shallow beds near the sea shore.

2.9.3 Separation by Filtration

Filtration is a better method for separating solids from liquids in heterogeneous mixtures. In filtration the solid material is collected as a residue on filter paper and the liquid phase is obtained as filtrate. The method of filtration is used on a large scale in industries Fig. 2.13.



(*a*)



(*b*)

Fig. 2.13: *Filtration (a) simple filtration (b) vacuum filtration*

2.9.4 Separation by Crystallization

Crystallization is a process of formation of solid crystals from a solution. The method of crystallization for separating solid from liquid begins by evaporating the liquid.

However, in crystallization, the evaporation is stopped when the solution is concentrated enough. The concentrated solution thus produced, is allowed to cool slowly to form crystals which can be separated by filtration. *Mishri (sugar crystals)* is produced by crystallization from concentrated sugar solution.

2.9.5 Separation by Distillation

The method of distillation is used to separate a liquid from a solution of a homogeneous mixture. The distillation is a process in which a liquid or mixture of liquids is boiled in a distillation flask. The vapour is condensed by passing through a water-cooled tube called **condenser** and collected as liquid called **distillate** Fig. 2.14. In case of a solution of two miscible liquids (the liquids which can be mixed completely) the **separation is based on the fact that the liquids will have different boiling points** and there is a wide difference between the boiling points of the two liquids.

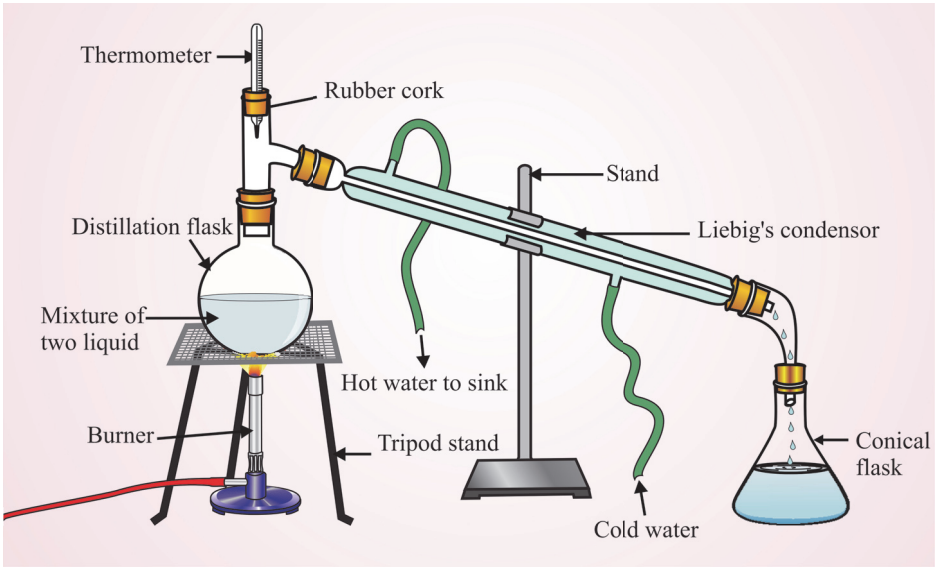


Fig. 2.14 : *The Distillation apparatus*

2.9.6 Separation based on Magnetic Properties

How would you separate a mixture of magnetic and non-magnetic substance? In a mixture of magnetic and non-magnetic substances, the magnetic substance can be separated by using a magnet. For example you will be able to separate iron granules, which are magnetic, from non-magnetic substances like sand, sugar, saw dust etc. (Fig. 2.15). In industry this method is used to separate iron materials from non-magnetic materials by using large electromagnets. e.g. of iron ore.

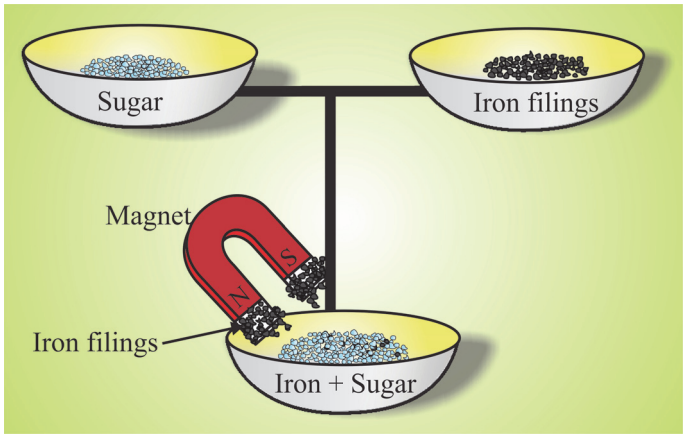


Fig. 2.15 : *Magnetic Separation of a mixture*

ACTIVITY 2.6

Separate iron granules from the mixture-iron granule and sugar.

Materials

Sugar, iron granules and a magnet.

How to do it

Mix the sugar crystals and iron granules and spread a thin layer of the mixture over a piece of paper. Hold the magnet closely over the mixture. The iron granules will be attracted to the magnet. Remove the iron granules from the magnet and repeat the process till no more iron granules remain in the mixture.

ACTIVITY 2.7

Separate water from muddy water by the process of distillation using solar energy

Materials

Large dish pan, a glass container shorter in length than the pan, plastic wrap, 9-10 clean marbles or small pieces of stone, plastic membrane, and (2 litre) muddy water.

How to do it

1. Take muddy water in a large pan and put a glass in the centre of the pan as shown in Fig. 2.16. Put a few small marbles at the bottoms of the glass in order to make it stable in the water.

2. Cover the pan with a plastic wrap in such a way that it doesn't become too tight. The cello tape can be used to keep the plastic wrap in place.
3. Put marble or a small piece of stone in the centre of the plastic wrap to create a slight dip in the plastic over the glass for collecting water. The plastic should not touch glass.
4. Keep the pan in direct sunlight for several hours and you will see water vapour condense on the plastic and drip into the small glass container.

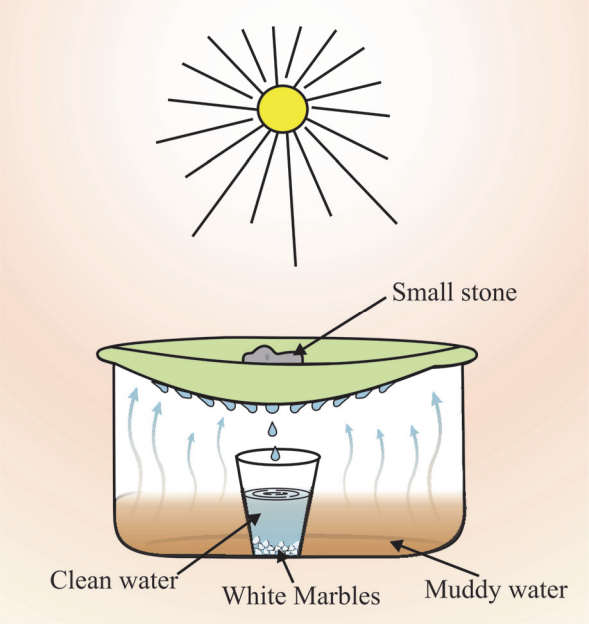


Fig. 2.16: *Solar still for purifying water*

The device prepared by following the steps mentioned above is called a **solar still (see Fig. 2.16.)**, which uses the natural process of evaporation and condensation to purify muddy water. The muddy water kept in the pan gets heated by the sun. The water is turned into vapour, and the mud remains in the bottom of the pan. The vapour on touching the plastic sheet covering the pan gets condensed as the plastic sheet is relatively cool because of the cooler air outside the container. The water collected in the small container is clean water (but not very fit for drinking).

INTEXT QUESTIONS 2.7

1. Which physical property is used to separate iron granules from dust particles?
   (a) Magnetic, (b) Electric, (c) Density
2. The separation of sugar in the form of *Mishree* is called
   (a) evaporation (b) crystallization (c) distillation

WHAT YOU HAVE LEARNT

- Anything that has mass and occupies space is matter. Matter can be detected and measured.
- There are three different physical states of matter in which a substance can exist namely solid, liquid and gas.
- A particular state of matter can be changed into other states by changing the temperature and/or pressure.
- A solid has a definite size and shape which do not change on their own.
- A liquid has a definite size or volume and it takes shape of the container in which the liquid is kept.
- A gas has no shape or size of its own. It occupies entire volume of the container in which it is kept.
- Matter can be classified on the basis of its composition as element, compound or mixture.
- An element is a basic form of matter that cannot be chemically broken down into simpler substances.
- A compound is a pure substance made from two or more than two elements chemically combined together in a definite proportion by mass.
- Pressure and temperature affect states of matter.
- A wide varieties of mixture are possible between substances depending on their nature.
- A homogeneous mixture is a mixture where the substances are completely mixed together and are indistinguishable. A homogeneous mixture is called a solution.
- A heterogeneous mixture is a mixture where the substances remain separate and the composition is not uniform.
- A suspension is a heterogeneous mixture where the dispersed particles are large enough to settle out eventually.
- There are a number of methods available to purify and separate substances from a mixture. Some of the methods are filtration, crystallization and distillation.

TERMINAL EXERCISE

1. Indicate whether each of the following statements is true or false.

   (i) A liquid has a definite shape true/false

   (ii) An element cannot be broken into simpler substances by chemical means. true/false

(iii) A solid cannot be converted into liquid even by increasing temperature. true/false

(iv) A liquid can be converted into solid by lowering temperature true/false

2. Indicate the normal state (i.e. state at room temperature) of each of the following?

(i)	iron	(ii)	water	(iii)	nitrogen
(iv)	carbon	(v)	gold	(vi)	oxygen

3. In the table given below, a list of substances has been provided. Identify whether each of them is an element, compoind, mixture or soluton.

(i)	Milk	(ii)	Sugar	(iii)	Silver
(iv)	Air	(v)	Water	(vi)	Sea water
(vii)	Iron	(viii)	Sugar	(ix)	Carbon dioxide

4. Why is it important to store cooking gas cylinder away from heat and flame?

5. Identify the most appropriate method to separate the following:

Substances	Method of Separation
1. Separate water from yogurt	
2. Separate clean water from muddy water	
3. Separate oil from oil water mixture	
4. Separate iron nails from saw dust	
5. Separate sugar from saturated sugar solution	

ANSWERS OF THE INTEXT QUESTIONS

2.1

1. Matter is anything that has mass and occupies space
2. Soil
3. Democritus. The word atom means indivisible.

2.2

1. Gases. A gas has no definite volume because intermolecular forces in gas are so weak that the molecules are far apart and in constant motion. They can fill container of any size.
2. The molecules in solids have fixed positions and strong intermolecular forces are acting between them. Therefore, it solids hae a definite shape.
3. Water

2.3

1. Molecules in solids are closely packed and any attempt to bring them closer results in strong repulsive forces and so solids cannot be compressed. In gases there are large spaces between their molecules and can be brought closer by applying pressure.
2. Water can be converted into ice by lowering the temperature.

2.4

1.

Element	Compound	Mixture
Aluminium	Water	air
Carbon	Carbon dioxide	granite
Silicon	Sugar	

2. An element consists of one type of atom but a compound contains two or more types of atom.
3. Hydrogen

2.5

1. The mixture of ethyl alcohol and water is a homogeneous mixture
2. Alloys eg. brass

2.6

1. 400 g sugar and 600 g water
2. Solvent
3. Solute

2.7

1. Magnetic
2. Crystallisation