5 Separation of Substances

Learning Outcomes

- Mixture
- Types of mixtures
- Need for separation
- Pure substances
- Methods of separation
- Separation of solid-solid mixtures
- Separation of solid-liquid mixtures
- Sedimentation and decantation
  - Filtration
  - Condensation
  - Evaporation
  - Distillation
- Separation of liquid-liquid mixtures
  - Separation of immiscible liquids
  - Separation of miscible liquids
- Separation of a mixture by using more than one method
- Saturated solution

Ponder and Proceed

- We have all enjoyed a cool glass of lemonade on a hot summer day. We know that lemonade is made of sugar, salt, lemon juice and water. But can you separate these ingredients from lemonade?

Can you think of situations which require us to separate one substance from other substances? Here are a few such examples:

- Tea leaves from tea using a strainer.
- Separating nuts from their shells by peeling.

These are examples of separation of substances. Before we learn about separation in detail, let us first understand mixtures.

Fig. 5.1: Straining tea leaves

Mixture

A mixture is composed of two or more substances mixed together, with each component retaining its unique property. Lemonade is a mixture of lemon juice, salt, sugar and water. The air we breathe is a mixture of gases, such as nitrogen, carbon dioxide, oxygen, traces of neon, helium, methane, krypton, hydrogen and water vapour.

Types of Mixtures

Lemonade is a mixture of some soluble substances mixed in water. This kind of a mixture is called a solution. The substances, such as salt, sugar, lemon juice are called solutes which are dissolved in a substance of larger quantity (water), the solvent.

Lemonade has a uniform composition which means that you cannot see separate ingredients once they are mixed together. Such a mixture is called a **homogeneous mixture**. In other words, a substance is homogeneous when all parts of the solution are evenly mixed. Orange juice, tea, vinegar and blood are homogeneous mixtures as they have a uniform appearance.

Fig. 5.2: Homogenous mixture

Fig. 5.3: Heterogeneous mixture

We know that when we mix sand in water, the two substances do not mix. Such a mixture, with a non-uniform composition, is called a **heterogeneous mixture**. Oil in water, muddy water and a mixture of husk and rice are heterogeneous mixtures.

Nectar

Milk is a heterogeneous mixture because particulates of milk fat are suspended in water. The fat gets separated from water when the milk splits.

Table 5.1: Different kinds of mixtures with examples

Mixtures	Example
solid-solid mixture	a mixture of beans and rice
solid-liquid mixture	sugar and water
liquid-liquid mixture	milk is a mixture of tiny droplets of fatty oil in water
liquid-gas mixture	fog (water droplets suspended in air)
gas-gas mixture	air (mixture of gases, such as nitrogen, oxygen, carbon dioxide and water vapour)
solid-gas mixture	dust (fine sand particles suspended in air)

Check Your Memory

Give an example for each of the following.

1. Liquid-liquid mixture .....
2. Liquid-gas mixture .....
3. Solid-solid mixture .....
4. Homogenous mixture .....
5. Heterogenous mixture .....

Need for Separation

Almost everything around us exists in the form of mixtures – soil, air, water of the oceans etc. The composition of the ocean water is shown below in the chart.

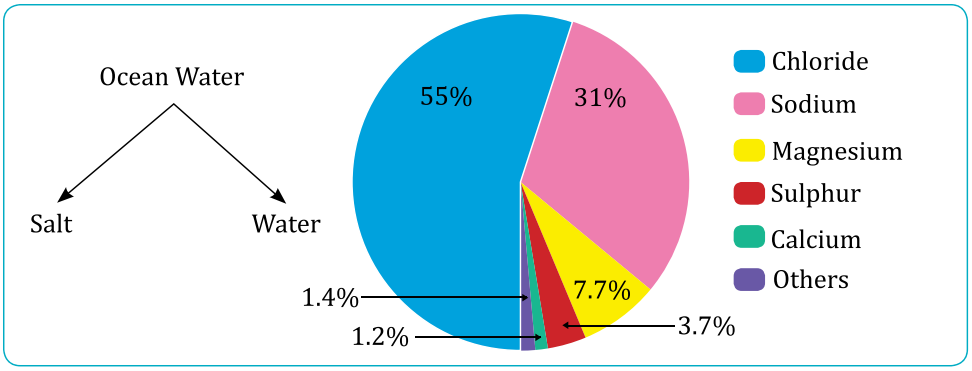


Fig. 5.4: Composition of ocean water

Nectar

The Municipal Corporation filters water from various sources before it is supplied to our homes.

We cannot drink ocean water because it is highly saline and impure, containing harmful bacteria and other impurities. We need to separate the impurities and bacteria from the water to make it fit for drinking. So, separation of mixtures is done to remove impurities or substances. In cases, such as the ocean water, separation is done in order to obtain two different useful components – salt and water.

To summarise, mixtures are separated in order to:

- remove undesirable components, such as pebbles or grit from pulses and rice and mud from muddy water.
- obtain useful components, such as petrol and diesel from crude oil and tea brew from a mixture of water, tea leaves, milk and sugar.
- obtain pure substance, such as butter from milk by churning.

Fig. 5.5: Churning of milk to obtain butter

Activity 1

All readymade food items are a mixture of many ingredients. Arrange three packs of ready to eat food items. Read the list of ingredients on each pack and list them in the table below.

	Name of the food item	Ingredients
1.		
2.		
3.		

Pure Substances

The water that we drink regularly is not pure as it contains minerals and some impurities. But distilled water, which has medicinal and industrial usage, contains only water molecules and nothing else. Such substances which contain only one type of molecules are called pure substances.

Distilled water

Fig. 5.6: Pure substances

Properties of Pure Substances

A pure substance has the following properties:

- It contains only one kind of particles or molecules.
- It is perfectly homogeneous.
- Its composition is definite and does not vary with time.
- The properties of a pure substance, such as melting point, boiling point and density do not change.

Nectar

Metallurgy is a branch of science that deals with the extraction and separations of pure metals from their impure forms, called ores.

Activity 2

Your mother went shopping to a nearby grocery store. On her way back, a packet of salt and a packet of dal got torn and the contents got mixed up. Help your mother to separate both the substances. Describe the method you would use to separate the two components.

Check Your Memory

Fill in the blanks.

1. Milk is a ..... (pure substance/mixture).
2. The composition of a pure substance is ..... (definite/indefinite) and does not vary with time.
3. Substances which contain only one type of molecules are called ..... (mixtures/pure substances).
4. Pure substances are ..... (homogeneous/heterogeneous).

Methods of Separation

Separation is carried out in different ways under dry and wet conditions:

1. **Separation under dry conditions**: In this method, no liquid is used while separating the substances. Some separation techniques used in dry conditions are handpicking, threshing, winnowing and sieving.
2. **Separation under wet conditions**: In this method, substances are separated from liquid mixtures or some kind of liquid is added during the separation procedure. Separation techniques used under this condition are sedimentation, distillation and decantation.

Fig. 5.7: Straining

The size, solubility, weight and density of materials are taken into consideration while separating the mixtures. The materials separated can be solids, liquids or gases.

Separation of Solid-Solid Mixtures

Handpicking

Different types of candies mixed-up in a box can be separated simply by hand. **Handpicking** is the simplest method used for the separation of substances.

Fig. 5.8: Handpicking

Handpicking can only be used when the unwanted materials are present in small quantities and the shape, size, or colour of the unwanted materials is different from that of the useful materials. For example, rotten grains, pebbles and insects in rice, wheat and pulses can be easily separated by this process.

Threshing

You must have seen bundles of wheat stalks lying on the fields while travelling through the countryside. These bundles are left in the field after harvesting. The grains are separated from the stalks or chaffs by the process of **threshing**. In this process, stalks are beaten to separate the grains.

Fig. 5.9: Manual threshing

When the quantity is less, threshing is done manually. Small quantities of the harvested stalks are beaten on a hard surface. The grains get separated from the stalks as the dried stalks hit the hard surface.

Fig. 5.10: Threshing by animals

Traditionally, for larger quantities, threshing was done using animals. Stalks were spread around a pole and several bullocks were made to walk over the harvested stalks. As the animals walked over the stalks, the grains got separated.

Nowadays, machines are used for this purpose. They can be powered either by a diesel engine or an electric motor. It helps to save time and labour. During threshing, the stalks are converted into very small pieces called 'hay'. This leftover material is used as fodder for cattle.

Winnowing

When a mixture consists of heavier and lighter particles, the lighter particles are separated using wind or by blowing air. This process is called **winnowing**.

Fig. 5.11: Winnowing

This method is commonly used by farmers to separate husk from grains. As husk is lighter in weight, it is carried away by wind and only the heavier grain particles are left behind. Farmers drop the mixture of rice seeds and husk from a height so that the husk is blown by the wind and forms a heap, a little distance away. The wheat grains, being heavier, fall down in a separate heap.

Nectar

In ancient China, the method of winnowing was improved by the development of the rotary winnowing fan which produced an airstream to blow away lighter impurities.

Sieving

Fresh wheat flour from the mill is not used directly for making *chapatis* because it contains some remains of husk or other impurities. These impurities are separated using a sieve plate that lets the fine flour particles pass through while the bigger impurities are left behind. This method of separating fine particles from bigger particles with the help of a sieve plate is called **sieving**.

Fig. 5.12: Separation of flour from bran using a sieve

A sieve is a shallow vessel with a fine metal wire mesh which has small to very small holes. In flour mills, this process is used to remove pieces of stones, stalk and husk from wheat and other grains. This process is also used to separate pebbles and stones from sand at construction sites.

Magnetic Separation

Magnetic separation is a method of separating magnetic particles, such as iron from non-magnetic particles, such as sand with the help of a magnet. Rag pickers use this technique to pick iron pieces from the roadside with the help of a magnet attached to a rod. In industries, magnetic separation is used to remove iron particles from mixtures using strong magnets.

Nectar

Sieving of wheat flour is not considered a healthy practice because wheat bran, which is removed during sieving, is a rich source of fibre.

Experiment 1

Aim: To separate a mixture of different solids.

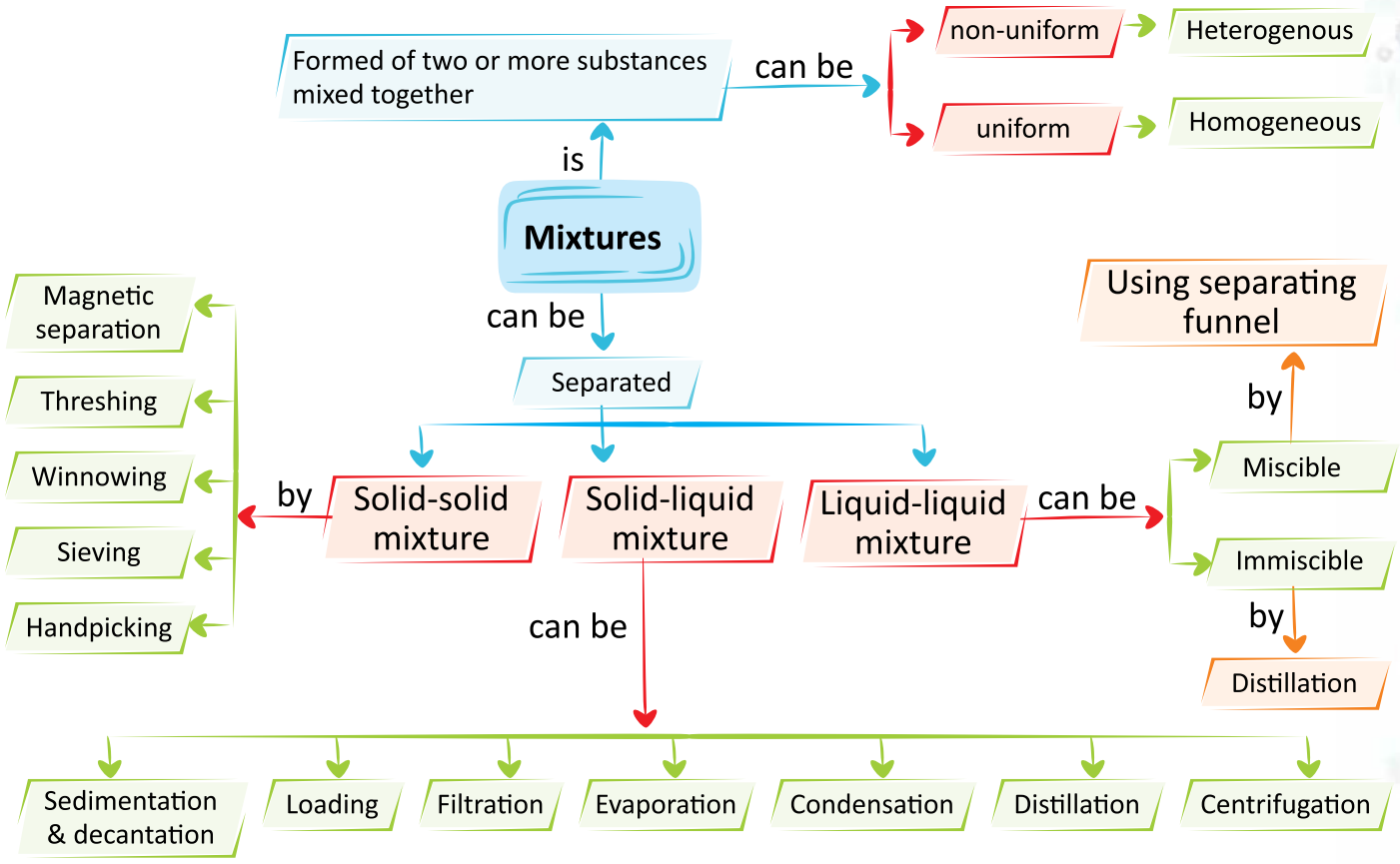
Requirements: A mixture containing dry rice husk, pebbles and sand.

Procedure:

- Keep the mixture on a flat plate. Pick out the dry hyck and keep separately.
- Put a small amount of the mixture in a sieve and shake. Repeat until all the mixture passes through the sieve. Collect the pebbles that remain on the sieve.
- The material that has passed through the sieve contains sand and rice husk. Place a table fan on the floor, five to six feet away from the wall. Drop the remaining mixture slowly in front of the running fan, from a height of about two feet.

Observations:

The sand will fall straight to the ground while the rice husk will be blown away and collected at a distance. Thus, pebbles, sand and rice husk are separated. Can you name the processes that are used in steps 1, 2 and 3?



EXERCISE

A. Tick (✓) the correct answer.

1. Z is a separation technique based on the difference in weights of the solids in a solid-solid mixture. What is Z?

   (a) Sieving ☐ (b) Handpicking ☐

   (c) Threshing ☐ (d) Winnowing ☐

2. How are grains removed from their stalks?

   (a) Sieving ☐ (b) Winnowing ☐

   (c) Threshing ☐ (d) All of these ☐

3. A solution of salt and water is a ..... .

   (a) heterogeneous mixture ☐ (b) homogeneous mixture ☐

   (c) both of these ☐ (d) none of these ☐

4. A mixture of oil and water is an example of ..... .

   (a) miscible liquids ☐ (b) homogenous mixture ☐

   (c) immiscible liquids ☐ (d) pure substance ☐

5. Animals are used for ..... to separate grains from stalk.

(a) handpicking ☐ (b) sieving ☐

(c) winnowing ☐ (d) threshing ☐

6. Cooking oil floats on water because ..... .

(a) oil is heavier than water ☐ (b) oil is lighter than water ☐

(c) oil is a good solvent ☐ (d) oil is not a good solvent ☐

7. Which of the following mixtures would you be able to separate using the method of filtration?

(a) Oil in water ☐ (b) Cornflakes in milk ☐

(c) Salt in water ☐ (d) Sugar in milk ☐

8. Four mixtures are given below.

(i) Kidney beans and chick peas ☐ (ii) Pulses and rice ☐

(iii) Rice flakes and corn ☐ (iv) Potato wafers and biscuits ☐

Which of these can be separated by the method of winnowing?

(a) (i) and (ii) ☐ (b) (ii) and (iii) ☐

(c) (i) and (iii) ☐ (d) (iii) and (iv) ☐

9. While preparing chapatis, Tanya found that the flour to be used was mixed with wheat grains. Which out of the following is the most suitable method to separate the grains from the flour?

(a) Threshing ☐ (b) Sieving ☐

(c) Winnowing ☐ (d) Filtration ☐

10. You might have observed the preparation of ghee from butter and cream at home. Which method(s) can be used to separate ghee from the residue?

(i) Evaporation ☐ (ii) Decantation ☐

(iii) Filtration ☐ (iv) Churning ☐

Which of the following combination is the correct answer?

(a) (i) and (ii) ☐ (b) (ii) and (iii) ☐

(c) (ii) and (iv) ☐ (d) (iv) only ☐

11. In an activity, a teacher dissolved a small amount of solid copper sulphate in a tumbler half filled with water. Which method would you use to get back solid copper sulphate from the solution?

(a) Decantation ☐ (b) Evaporation ☐

(c) Sedimentation ☐ (d) Condensation ☐

B. Fill in the blanks.

1. We can remove small stones from pulses before cooking by ..... .
2. The technique used to separate a liquid from an insoluble solid in a mixture by carefully pouring out the liquid is called ..... .
3. Water drops seen under a plate that has been used to cover a vessel containing boiled milk is due to ..... .
4. In a solution, the substance which is in larger quantity is called a .....
5. A mixture of oil and water can be separated by ..... and ..... .
6. Liquid mixtures can be ..... and ..... .
7. Rag pickers use the method of ..... to pick iron pieces from the roadside with the help of a magnet attached to a rod.
8. ..... is used to load the suspended particles to make them heavy and increase their sedimentation speed.

C. State whether the following statements are true (T) or false (F).

1. The property used for separating a mixture of two solids by winnowing is the difference in their weights. ☐
2. When no more salt can be dissolved in the given amount of water at a particular temperature, the solution is said to be unsaturated. ☐
3. Grain and husk can be separated by the process of decantation. ☐
4. Handpicking can be used to separate cashewnuts from a mixture of almonds and cashewnuts. ☐
5. Lemonade is a mixture that has a uniform composition. ☐
6. There are a number of useful minerals present in the seawater. ☐
7. The water that we drink regularly is completely pure as it contains minerals and some impurities. ☐
8. When a mixture consists of heavier and lighter particles, the lighter particles are separated using wind or by blowing air. ☐

D. Very-short answer questions.

1. What is a mixture?
2. How is a solution prepared?
3. One method of separation is sometimes not enough. Comment.
4. Which among the following is a separation technique used to separate a solid-solid mixture: filtration, decantation, handpicking? Give examples.
5. Differentiate between pure and impure substances.

6. If salt is completely dissolved in water, is it possible to separate salt from water by filtration? Why or why not?
7. Differentiate between homogeneous and heterogeneous mixtures.
8. What is supernatant?

E. Short-answer questions.

1. Which type of separation technique is used in tea leaves factory?
2. What method is used to separate salt from seawater?
3. Handpicking can be used only when quantity of impurities is NOT very large. Explain.
4. Which of the following is NOT a method of separation of substances?
   Threshing, filtration, saturated solution, sedimentation
5. What happens when steam comes in contact with the cool plate?
6. Which method is used to separate magnetic particles from iron? Describe.
7. Name and define the process which is the opposite of condensation.
8. Explain the process of separating oil and water.

F. Match the following.

	Column A		Column
1	A mixture of chalk and water	(a)	A gaseous mixture
2	A glucose solution	(b)	A heterogeneous solid-liquid mixture
3	Solute	(c)	A homogeneous solid-liquid mixture
4	Solvent	(d)	Salt
5	Air	(e)	Water

G. Long-answer questions.

1. Describe two methods of separation of solid-solid substances.
2. How has the method of threshing evolved over the years?
3. In a mixture of salt, sand and water, how will you separate the different substances?
4. What is a saturated solution? How will you prepare such a solution?
5. What is distillation? How is sea water converted into distilled water?
6. What is the effect of temperature on the solubility of substances?
7. Name and describe briefly a method which can be helpful in separating a mixture of husk from grains. What is the principle of this method?

HOTS

1. Samaira and Tisha were asked to make a sugar solution. Samaira was given a teaspoonful of sugar and half a glass of water, whereas Tisha was given fifteen teaspoonful of sugar and half a glass of water.
   (a) Who would be able to prepare a saturated solution?
   (b) How will both of them make sugar solution?

2. Find out ways of recycling water that is discharged in reverse osmosis process during purification and filtration.

Value-based Questions

Deepak was reading about the famous Salt March by Gandhiji in his history book. Mahatma Gandhi walked 385 kilometres from his ashram in Sabermati, near Ahmadabad, to the town of Dandi, near Surat, on the Arabian Sea coast in March-April 1930. This march was a peaceful nonviolent protest action against the British government's tax on salt. The British government prohibited Indians to make their own salt and all Indians were forced to buy the expensive salt from them.

On 6 April, accompanied by his followers, Gandhiji reached the shores of the Arabian Sea and picked up handfuls of salt, thus breaking the law. For many months thereafter, people continued to make their own salt revolting against the unjust laws of the British.

Deepak bowed his head in respect to the Father of the nation. He too vowed to stand up for his rights and be strong-willed.

1. Why did Gandhiji go to the seashore to get salt?
2. What is the process of making salt from seawater?
3. What value was shown by Deepak?

Assertion and Reasoning

The questions given below consist of two statements marked as Assertion and Reason. Use the following key to choose the appropriate answer.

a. If both the assertion and the reason are CORRECT and the reason is the CORRECT explanation of the assertion.
b. If both the assertion and the reason are CORRECT but the reason is NOT THE CORRECT explanation of the assertion.
c. If the assertion is CORRECT but the reason is INCORRECT.
d. If the assertion is INCORRECT but the reason is CORRECT.
e. If both the assertion and the reason are INCORRECT.

1. **Assertion**: We cannot drink ocean water.
   Reason: Ocean water is highly saline and impure, containing harmful bacteria and other impurities.
2. **Assertion**: The properties of a pure substance, such as melting point, boiling point, and density do not change.
   Reason: The composition of pure substances is definite and does not vary with time.