ELEMENTS, COMPOUNDS AND MIXTURES

Learning outcomes

By the end of this theme, students will be able to:

- identify substances as elements, compounds or mixtures
- differentiate between compounds and mixtures
- provide examples of elements, compounds and mixtures from daily life
- discuss different techniques for the separation of components of mixtures
- justify the reason for the use of a particular technique in the separation of a mixture
- explain chromatography and its importance

Warm-up

Encourage students to complete the *Get going* section given at the beginning of the chapter.

GUIDELINES TO TEACH

- Show the class a gold ring and a mixture of sand and pebble and ask them to identify the pure one from the impure one.

Ask students:

What do you drink in the morning? (Probable answers: water, milk, coffee, tea)

Is water pure? What about milk, coffee / tea?

What would your mother do if there are stones in the dal?

Why do we use a water filter? What does it do?

Can we drink tea without straining it first?

Introduction

Ask students:

What are substances made of?

How can matter be classified on the basis of state?

How can matter be classified on the basis of their constituents?

- Explain what pure and impure substances are.
- Discuss the information given in 'Spotlight'.

ELEMENTS AND COMPOUNDS

- Explain what elements and atoms are.
- Give examples of elements. Mention how many of these are natural and synthetic.

Periodic table

- Display the periodic table in class.

Ask students:

Take a close look at this chart. Do you think the elements are arranged randomly?

Do you notice anything about their order and grouping? (Guide students to notice the order of atomic numbers.)

Why do you think the elements have been grouped this way? (Guide students to notice the coloured grouping.)

- Explain the different ways by which elements can be denoted by symbols. Write examples for each on the board.
- Revise the symbols of elements by calling out the element, element in the language of origin or symbol and ask students to give the corresponding element, element in the language of origin or symbol.

Classification of elements

Ask students:

Look at the periodic table. How many classes have the elements been divided into?

- Explain what metals, non-metals, metalloids and inert gases are.

Ask students:

Name the following*:*

Elements that are good conductors of heat and electricity

The number of non-metals

Elements that are used as semiconductors

Inert gases

- With the help of the table '*Some common elements and their uses*', given in the coursebook, discuss the uses of hydrogen, carbon, nitrogen, oxygen, neon, sodium and magnesium.
- Discuss the information given in 'Know more.
- Use '**Stop and check'** for a quick recap. 

Give the following instruction to students/Write on the board.

Activity: Give an oral presentation in class on the uses of three non-reactive gases.

Compounds

- Write the formula of water, H_2O, on the board.

Ask students:

Are compounds made up of one kind of atom?

How are compounds formed?

Are the properties of a compound different from that of the elements from which it is made? (Write the reaction for the formation of water on the board.)

Does energy transfer take place during the formation of a compound?

- Encourage students to do the activity, given in the coursebook. 

Chemical formulae

- Explain the terms 'molecule' and 'chemical formula'.Differentiate between molecules of elements and molecules of compounds.

- With the help of the table, *Some common compounds and their constituent*, given in the coursebook, discuss the formula of some common compounds.

MIXTURES

- Explain what mixtures are, with examples.

Ask students:

Do the components of a mixture undergo any change?

Does a chemical reaction take place?

Why are mixtures 'impure substances'?

Homogeneous and heterogeneous mixtures

- Explain what homogeneous and heterogeneous mixtures are. Give examples.
- Demonstrate the activity '*To prepare homogeneous and heterogeneous mixtures*', given in the coursebook.

Ask students: (Questions based on homogeneous and heterogeneous mixtures.)

Which mixture has a uniform appearance?

In which mixture can the components be seen apart?

- With the help of the table, given in the coursebook, differentiate between homogeneous and heterogeneous mixtures.

Characteristics of mixtures

Ask students:

Can you tell what are the characteristics of mixtures?

- Consolidate the points on the board.

- Discuss the information given in 'Spotlight'.
- Demonstrate the activities '*To show that a solution of salt in water is a mixture*' and '*To compare the properties of compounds and mixtures*', given in the coursebook.
- Consolidate the understanding of compounds and mixtures by reviewing the points mentioned in Table 3.6 (Differences between compounds and mixtures).

Types of mixtures based on physical states of the components

Ask students:

Do you think there can be one standard procedure to separate all mixtures?

Why do you say so?

Come up with an example each for solid–solid, solid–liquid, solid–gas, liquid–liquid, liquid–gas, gas–gas mixtures.

- Use **'Stop and check'** for a quick recap. 

Separation of the components of mixtures

Need for separating the components of mixtures

- Discuss why it is necessary to separate the components of a mixture, as given in the coursebook.

Methods of separation

Solid–solid mixtures

- Explain how solid–solid mixtures can be separated by handpicking, sieving, magnetic separation, sublimation, threshing, winnowing, gravitational method and solvent extraction.

Ask students:

What method can be followed to remove the impurities in dal?

When can we use the method of sieving?

How can a mixture of iron filings and sulphur be separated?

How can a mixture of grain and husk be separated?

How can a mixture of sand and sawdust be separated?

Solid–liquid mixtures

- Explain how solid–liquid mixtures can be separated by sedimentation, decantation, filtration, evaporation, crystallisation and centrifugation.

Ask students:

What does the supernatant refer to?

What does the filtrate refer to?

How can a mixture of sand and water be separated?

If a liquid mixture is allowed to evaporate, can both the solute and solvent be recovered?

How can you get copper sulphate crystals from copper sulphate solution?

What happens when cream is churned vigorously?

- Share the 'SciTech' information on the methods of separation we come across in our daily lives.

Give the following instruction to students/Write on the board.

Activity: Add lemon juice to lukewarm milk. Write a short report on your findings and present it in class.

Liquid–liquid mixtures

- Explain how liquid–liquid mixtures can be separated using a separating funnel and by distillation, fractional distillation and chromatography.
- Demonstrate the activity '*To separate components of ink using chromatography*' given in the coursebook.

Ask students:

Which substance will be left behind when you distil seawater?

How can a mixture of alcohol and water be separated?

How can crude oil be separated into its components?

What technique can be used to separate components that are close to each other in physical and chemical properties?

Combinations of methods

Ask students:

How do you think clean drinking water can be obtained from muddy water?

- Tell students that in some cases, more than one method has to be used to separate mixtures.
- Guide students to read the 'Career watch' section in the coursebook.

ELEMENTS AND COMPOUNDS

Stop and check

1. An element is a pure substance that cannot be converted into a simpler substance by any physical or chemical process.
2. Mendeleev classified all the elements known at that time in the form of a table based on their properties. This form is known as the periodic table.
3. Each element is represented by a symbol or chemical symbol. The symbol is a kind of abbreviation, and is derived from the name of the element.
4. The elements are broadly divided into four classes based on their properties. They are metals, non-metals, metalloids and inert or noble gases.
5. F: fluorine Si: silicon Ne: neon Li: lithium P: phosphorus Al: aluminum
6. Chlorine: Cl Calcium: Ca Beryllium: Be Nickel: Ni Helium: He Oxygen: O

Checkpoint

A. 1. a, metals 2. a, sulphur 3. d, germanium 4. c, i and ii

B. 1. elements and compounds 2. periodic table 3. atom 4. argentum 5. elements
6. sodium, potassium 7. iron oxide

C. 1. True 2. False 3. False 4. True 5. False

D. 1. metalloid 2. solid 3. F

E. 1. element 2. compound

F. 1. An element is a pure substance that cannot be converted into a simpler substance by any physical or chemical process. Hydrogen, carbon and nitrogen.

2. i. hydrogen (H), boron (B)
   ii. lithium (Li), beryllium (Be)
   iii. sodium (natrium, Na), potassium (kalium, K)
3. chalk: $CaCO_3$; salt: NaCl; sugar: $C_6H_{12}O_6$
4. SiO_2: compound H_2: element H_2O: compound NaCl: compound O_2: element

F. 1. i. Mendeleev classified all the elements known at that time in the form of a table based on their properties. This table is known as the periodic table.
   ii. He classified elements as metal, non-metal, metalloid and noble gas.
   iii. *Examples of metals*: aluminum, iron, copper. *Examples of non-metals*: sulphur, chlorine and phosphorus. *Examples of metalloids*: silicon, germanium, arsenic. *Examples of noble gases*: helium, neon, argon.

2. i. For ease of writing, each element is represented by a symbol or chemical symbol.
   ii. The symbol is a kind of abbreviation, and is derived from the name of the element. The abbreviation/short form is used to refer to an element.
   iii. Symbols help in distinguishing one element from the rest of the elements.
   iv. Symbols are helpful in representing chemical reactions.

3. i. A compound is a chemical made up of two or more elements that have combined chemically in a fixed proportion.
   ii. Compounds are formed through chemical reactions.
   iii. The properties of a compound are different from those of the elements that make it up.
   iv. Energy is absorbed or released during the formation of a compound.

4.

Elements	Componds
Elements are made up of one kind of atoms.	Compounds are made up of two or more kinds of atoms.
Elements cannot be broken down into simpler substances by any physical or chemical method	Compounds can be broken down into simpler substances by chemical methods.
Examples: hydrogen, oxygen	Examples: water, sodium chloride

MIXTURES

Stop and check

1. i. Heterogeneous mixture ii. Homogeneous mixture

2.

Pure water	Salt water
Made up of identical particles. It is a compound.	Made up of different types of particles. Hence, it is not a pure substance; it is a mixture.
It can be represented by a formula.	It cannot be represented by a formula.
It does have a fixed boiling point.	It does not have a fixed boiling point.

3. i. solid–solid mixture: homogeneous (alloys: bronze); heterogeneous (spice powders)
   ii. solid–liquid mixture: homogeneous (sugar and water); heterogeneous (salt and oil)
   iii. liquid–liquid mixture: homogeneous mixture (ink and water); heterogeneous mixture (oil and water)

Checkpoint

A. 1. d, solution 2. c, sieving 3. b, supernatant 4. c, immiscible liquids

B. 1. True 2. False 3. False

C. 1.

Homogeneous mixture	Heterogeneous mixture
Uniform in appearance and properties	Not uniform in appearance or properties
Components cannot be seen as separate entities	Generally components can be seen as separate entities
Examples: mixtures of water and vinegar, and sugar and water.	Examples: mixtures of salt and pepper, and sand and water.

2.

Compound	Mixture
It is a pure substance that is homogeneous.	It is an impure substance that can be homogeneous or heterogeneous.
It is a result of a chemical reaction between elements or compounds or both.	It is a result of elements or compounds or both being added without any chemical reaction.
The components are taken in a fixed proportion.	The components are taken in any proportion.
It has a definite formula.	It cannot be represented by a formula.
It is made up of identical molecules. Each molecule is made up of atoms of two or more elements.	It does not contain identical molecules but those of the substances mixed together.
Its properties are different from those of its components.	The properties of the components are retained.
It has fixed characteristics such as boiling and melting points.	The characteristics depend on those of the components.

D. 1. i. A mixture is an impure substance.
ii. The appearance of a mixture can be homogeneous or heterogeneous.
iii. The components of a mixture can be added together in any proportion.
iv. A mixture cannot be represented by a formula.
v. A mixture has the characteristics of all the components.
vi. A mixture does not have fixed characteristics such as boiling or melting points. (*Any three*)

2. The methods of separation used to separate the components of a mixture depend on the: kinds of components used; the physical state of the components and their physical properties.

3. i. sand and pebbles: sieving
ii. sulphur and iodine: sublimation
iii. soil and water: sedimentation and decantation
iv. kerosene, salt and water: separating funnel, distillation
v. petrol and kerosene-fractional distillation

4. i. *raw rice and lentils*: by difference in sizes / colour of particles
ii. *sulphur and iron filings*: by difference in magnetic nature, iron filings are attracted to a magnet
iii. *sand and sawdust*: this method is used when one of the components is lighter than water and the other is heavier than water.
iv. *oil and water*: liquids of different densities, the lighter liquid forms the upper layer and heavier liquid forms the lower layer.
v. *camphor, salt and sand*: a component that sublimes (camphor sublimes); solubility (salt is soluble in water while sand is not).

5. The advantage of distillation over evaporation is that the desired liquid can be recovered and not lost in evaporation. Also distillation can be used to separate two or more miscible liquids with different boiling points while evaporation cannot.

6. The two phases in chromatography are:
   i. The stationary phase is the medium onto which the components of the mixture are adsorbed. ii. The mobile phase is the solvent in which the components of the mixture dissolve, and which carries these components.

7. The principle behind chromatography is the capacity of a chemical to be adsorbed on a medium. The rates of adsorption of different chemicals on a medium vary.

E. 1. This method is used to recover both the dissolved solid and the solvent from their mixture.

A pure liquid is separated from a mixture by evaporating the liquid first and then condensing its vapours. At its boiling point, the water is completely converted to vapour, while the salt remains behind.

The vapours of water rise, flow through the condenser and get collected as distillate, which is pure water. The salt remains in the flask.

Diagram: Refer to the coursebook.

2. A mixture of alcohol and water can be separated based on the fact that each liquid boils at a definite and fixed temperature.

Alcohol boils at 78.5°C while water boils at 100°C. Thus, when the mixture is heated, alcohol boils first and changes to vapour. The vapours of alcohol rise, flow through the condenser and get collected as distillate. The distillate is distilled repeatedly till a mixture of 95% alcohol with 5% water is obtained Water, with the higher boiling point, remains in the flask.
Water boils later.

3. **Aim:** To separate components of ink using chromatography

Materials required: Whatman no. 1 filter paper (stationary phase), water (mobile phase), beaker, marker pen, clip, pencil

Method:

1. Mark a line near the lower end of the filter paper strip.
2. Place a dot on the line with the marker pen.
3. Take water in the beaker.
4. Suspend the filter paper strip such that the line with the dot is just above the level of the water.

Observations and conclusions: Water starts rising up the filter paper. As it crosses the ink drop, it dissolves the substances in the ink and continues to rise. The different colours in the ink soon separate on the filter paper. This is because different substances move at different rates on the filter paper. The component with the highest rate of adsorption will be adsorbed first and form the lowest layer, while that with the lowest rate of adsorption will be adsorbed last and form the layer farthest from the line.

4. i. *To remove harmful or undesirable substances:* For example, contaminants are removed from water to make it drinkable. Food grains, salt, sugar and spices are cleaned to remove harmful substances such as mud, stones, fertilizers and pesticides.

ELEMENTS, COMPOUNDS AND MIXTURES

Answer the questions.

1. Write the molecular formulae of the following compounds:
   Plaster of Paris, potassium iodide, sodium chloride, glucose

   Ans: plaster of Paris: $CaSO_4$
   potassium iodide: KI
   sodium chloride: NaCl
   glucose: $C_6H_{12}O_6$

2. Distinguish between elements and compounds.

   Ans:

Elements	Compounds
Elements are simple substances that cannot be broken down to simpler substances.	When two or more elements combine chemically in a fixed ratio, they form compounds.
Elements are represented using symbols.	Compounds are represented using formulae.
Oxygen, hydrogen, carbom, iron, gold, lead, silver and calcium are some examples of elements.	Water, salt, sugar, carbon dioxide, zinc oxide and hydrogen chloride are some examples of compounds.

3. Explain the difference between winnowing and threshing.

   Ans: Threshing is the method by which grains are separated from the stalks by beating bundles of wheat or paddy stalks against a surface. Threshing also loosens the husks or seed coats covering the grains. Winnowing is done to separate the grains from the husks by allowing the grain–husk mixture to fall slowly. The lighter husks are blown away by the wind, while the heavier grains fall to the ground.

4. Describe the choice of methods (with reason) to separate solid substances in solid–liquid mixtures.

   Ans: The choice of methods to be used to separate the components in solid–liquid mixtures depends on whether the solid is soluble or insoluble in a liquid. Sedimentation, decantation and filtration are used to separate heavier, insoluble solids in a solid–liquid mixture.

   Evaporation is the method used to separate soluble solid particles from its solution.

5. Describe the method used to separate immiscible liquids.

   Ans: Two immiscible liquids, like oil and water, can be separated using a separating funnel. The mixture of oil and water is poured slowly into the separating funnel and allowed to stand for a few minutes. Water, which is the heavier liquid, settles down and can be collected in a beaker by opening the stopcock. Oil remains in the funnel.

ELEMENTS, COMPOUNDS AND MIXTURES

1. Circle the odd one out. Give reasons.

a. a mixture of ink and water, a mixture of sugar and water, a mixture of oil and water, a mixture of water and vinegar

_____

b. hydrogen, rust, carbon, beryllium

_____

c. hydrogen, carbon, nitrogen, oxygen

_____

d. hydrogen, helium, neon, argon

_____

2. Say if the statements are true or false.

a. Potassium is derived from the Latin name plumbum.

b. Elements are pure substances while compounds are impure substances.

c. Lead is a non-metal.

d. Magnesium is used to make firecrackers.

e. Energy is absorbed or released during the formation of a mixture.

3. What is the method of separation shown in this picture? What is the principle behind this technique?

_____

_____

_____

ANSWER KEY FOR THE WORKSHEET

ELEMENTS, COMPOUNDS AND MIXTURES

1. a. a mixture of oil and water (A mixture of oil and water is heterogeneous while the others are homogeneous mixtures.)

b. rust (Rust is a compound while the others are elements.)

c. carbon (Carbon is a solid while the others are gases.)

d. hydrogen (Hydrogen participates in chemical reactions readily while the others are extremely unreactive.)

2. a. False b. False c. False d. True e. False

3. Chromatography

The principle behind chromatography is the capacity of a chemical to be adsorbed on a medium. The rates of adsorption of different chemicals on a medium vary.