MATTER

Learning outcomes

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

- define matter and classify it as solid, liquid or gas
- demonstrate the properties of solids, liquids and gases
- define intermolecular force and intermolecular space
- explain the effect of heat on matter
- explain how change of state of matter occurs
- differentiate between physical and chemical change

Warm-up

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

GUIDELINES TO TEACH

Introduction

Ask Students:

Can you list all the things that you see in the classroom?

- Students call out names of various things (books, bags, board, lights, water bottles, lunch bags, pencil boxes and so on.)
- Take an empty bowl and ask students to lift it. Now, fill the bowl with small stones and ask students to lift it.
- Ask students which bowl was heavier. Record their answer.

Ask students:

Why was the bowl with the stones heavier? (stones have weight).

- Help students recall what matter, mass and volume are.
- Give examples for these from daily life situations.
- Elicit the definitions for matter, mass and volume.

Classification of matter: solids, liquids and gases

- Encourage students to do the activity, given in the coursebook.
- Use the objects available in the class to help students list the common properties of the three states of matter and classify the objects into solids, liquids and gases.
- Show a steaming glass of hot water to students.

- Compare and contrast solids, liquids, and gases based on the physical properties of each of these states of matter (solid → glass; liquid → hot water; gas → steam).
- Elicit more examples of solids, liquids and gases from students.
- Do the activities, given in the coursebook, that show that
  - liquids have a fixed volume but not a fixed shape
  - solids and liquids have mass
  - solids and liquids occupy space
  - air has mass and occupies space.
  - Use **Stop and check** for a quick recap. 

What is matter made of?

Characteristics and arrangements of molecules in the three states of matter:

Physical properties of solids, liquids and gases

Tell students:

Matter is made up of very tiny particles called atoms and that most atoms join with other atoms to form molecules. These molecules are always in a state of random motion.

These molecules are held together by a force of attraction.

The three states of matter depend on the arrangement and movement of the molecules.

- With the help of the activity, given in the coursebook, explain intermolecular spaces.
- Tell students how the intermolecular forces between molecules determine the state of a substance.
- Explain what **cohesive force** is—intermolecular force of attraction between molecules of the same kind (Spotlight).
- Explain **Brownian motion**—the random movement of liquid and gas molecules (Spotlight).

Ask students:

What are the smallest particles that make up matter?

Which state of matter has the strongest intermolecular force and which state has the weakest?

- Draw the attention of students to the table, *Comparison of solids liquids and gases*, given in the coursebook.
- Discuss the three states of matter with their characteristic properties as given in the coursebook.

Diffusion

- Bring a bunch agarbattis to the class. Light them and allow the smoke to fill the air in the classroom.

Ask students:

Can you smell the fragrance of the agarbattis?

I'm holding them in my hands. How do you smell them? (They may say through smoke or air. Accept any logical answer.)

- Explain the phenomenon of diffusion using the above-mentioned activity.

- Elicit other examples of diffusion from students' daily life situations.

Discuss:

How diffusion happens

Why it happens more easily in liquids and gases than in solids

Ask students:

Why do solids not diffuse with one another?

- Use **Stop and Check** for a quick recap. 

Effect of heat on solids, liquids and gases

(i) physical changes, like expansion and change of state

(ii) chemical changes

(iii) increase in temperature

Expansion or contraction

Tell students:

All the three states of matter expand (increase in size or volume) when heated. They contract (decrease in size or volume) when cooled.

When substances expand, their **particles do not expand, they stay the same size**. It is the volume that increases.

When a substance is heated, the moving molecules gain more energy and they move further. This causes an increase in volume.

The molecules in a solid become more energetic and vibrate more when strongly heated. The molecules move apart slightly and take up more space. Solids expand a little because of strong intermolecular force.

Liquids too expand on heating, but they expand more than solids because the molecules in a liquid are packed loosely than in a solid. The intermolecular force is weaker in liquids than in solids.

Gases too expand readily on heating due to extremely weak intermolecular force. Heat causes the energised molecules to move faster and further.

The volume of a gas increases more than the volume of a solid or liquid when all the three states of matter are heated.

On cooling, molecules lose energy, and come closer. The intermolecular forces hold the molecules in their fixed position. This leads to contraction.

- Do the activities, given in the coursebook, to show
  - solids expand on heating
  - liquids expand on heating
  - gases expand on heating
  - air exerts pressure

Ask students:

Note: Give time for students to answer these questions as they need time to think before answering them.

Have you noticed a gap in the railway tracks between two pieces of metal rails? *Is it essential*? *What is its purpose*? (Gaps are made in the tracks to provide space for the rails to expand.)

Which substance expands the most when heated—solids, *liquids* or *gases*?

Change of state

- Tell students: All matter exists as solids, liquids or gases. Matter can change from one state to another on heating or cooling.
- Using the figure, given in the coursebook, explain how water changes its state (when the arrangement of molecules is changed).
- Also, draw the attention of students to the definitions of freezing point, melting point and boiling point.
- Explain the processes of sublimation and deposition.
- Use the example of camphor to demonstrate sublimation.
- Point out the difference between sublimation and evaporation.
- Share the information from 'SciTech'.

Ask students:

What is the difference between vaporisation and sublimation?

Chemical change

- Explain that heat can cause chemical changes in matter.
- With the help of examples such as burning of paper, wood or candle and cooking food explain that chemical changes lead to the formation of new substances.
- Point out that this type of change is permanent and irreversible.
- Use **Stop and check** for a quick recap. 

Matter changes

Types of change

- Explain physical changes.
- Explain about reversible physical changes with examples, given in the coursebook.

Ask students:

Can we change water to ice?

Can we change the cut wooden pieces into a log?

What change occurs when you drop a glass / tear a paper?

Can you get the glass/paper back from the pieces?

Does the change cause any difference in the properties?

Discuss:

The reversible and irreversible physical changes with examples.

Ask students:

How does your mother make curd?

Can you change curd back to milk?

- Using the above example, explain chemical change.
- Tell them that in a chemical change neither appearance nor properties are preserved.
- Help students distinguish if a change is physical or chemical based on the conditions mentioned in the coursebook.
- Explain further with the help of the examples given in the coursebook.
- Draw the attention of students to the table that lists the difference between the physical and chemical changes.

Ask students:

How will you know if a chemical change has happened?

- Help students analyse the case of a burning candle and explain the physical and chemical changes (Activity).

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

Activity:

Make a poster on physical and chemical changes with suitable illustrations.

Your poster should include:

(i) A caption/title

(ii) Three illustrations of each type of change (other than the ones given in the textbook)

(iii) Labels of the illustrations

(iv) Two to three sentences on description of the examples given

MATTER

Stop and check

1. Matter has mass and occupies space.
2. Solid, liquid and gas are the three different states of matter.
3.

	Solids	**Liquids**
Similarity	Both have a definite volume.	
Difference	Have a definite shape	Take the shape of their container
	Liquids	**Gases**
Similarity	Both can flow and are together called fluids.	
Difference	Have a definite volume	Spread easily to fill the space available and so do not have a definite volume

Stop and check

1. i. stone > milk ii. air < water iii. honey < salt iv. sugar > water
2. Intermolecular space is greater in
   i. milk ii. air iii. honey iv. water
3. i. stone, salt [X] ii. oxygen, air [1] iii. honey, water [2] iv. water, oil [X]

Stop and check

1. A substance can be changed from one state to another either by heating or by cooling.
2. i. Melting ii. Evaporation iii. Freezing iv. Condensation v. Sublimation vi. Deposition
3. i. burning of paper and ii. frying of an egg are chemical changes

Checkpoint

A. 1. c, ice, iron, iodine and salt are solids.
2. d, it has no fixed shape but has a definite volume and cannot be compressed.
3. a, cohesive forces
4. b, lighting a match

B. 1. matter 2. solids, liquids and gases 3. expand 4. Melting 5. chemical

C. 1. iii. 2. v. 3. iv. 4. ii. 5. i.

D. 1. True 2. True 3. False 4. False 5. False 6. True

E. 1.

	Solids	Liquids	Gases
Shape	definite	take the shape of the container	no shape
Volume	fixed	fixed	not fixed
Intermolecular force	very strong	weaker than in solids	very weak
Intermolecular space	very small	larger than in solids	very large
Fluidity	cannot flow	can flow	can flow
Compressibility	hardly compressible	hardly compressible	compressible

2.

Intermolecular force	Intermolecular space
It is the force of attraction between molecules. It keeps molecules together.	It is the space between the molecules of a substance.
It is strongest in solids and weakest in gases.	It is the largest in gases and smallest in solids.

3.

Physical change	Chemical change
No new substance is formed.	One or more new substances are formed.
Only physical properties change.	Both physical and chemical properties change.
Most physical changes are temporary and reversible	Most chemical changes are permanent and cannot be reversed.
Example: melting of ice	Example: rusting of iron

F. 1. Matter is made up of atoms or molecules.

2. Diagram: refer to coursebook

3. Matter exists in three states, namely, solid, liquid and gas. When a substance in one state changes into another, without the formation of a new substance, it is called change of state. Heating or cooling a substance can bring about a change of state. Melting of ice to form liquid water or boiling of liquid water to form steam are examples of change of state.

4. Sublimation is a change of state where a substance in the solid state changes to the gaseous state directly without passing through the liquid state.

5. Under certain conditions, such as heating or adding other substances, a substance undergoes a chemical change. In a chemical change, one or more new substances can be formed. The properties of the new substance or substances formed are very different from those of the starting materials. A chemical change is often not reversible.

   Example: When iron rusts, a red coating is formed on it. The red substance is iron oxide and its properties are completely different from iron. It is also not possible to transform the rusted parts back to iron.

G. 1. When the intermolecular forces are strong, the molecules are attracted to one another. They are held close together because of which the intermolecular space is less. This is the case in solids. When intermolecular forces are slightly weaker, the molecules are not held very close together. Because of this, the intermolecular spaces are larger. The molecules are able to slide over one another. This is the case in liquids. Very weak intermolecular forces cannot hold the molecules together. They move about freely and the intermolecular spaces are very large. This is the case in gases. Thus, a substance with high intermolecular force and low intermolecular space must be in the solid state, slightly weaker intermolecular force and slightly larger intermolecular space must be in the liquid state and very weak intermolecular force and very large intermolecular space must be in the gaseous state.

2. The following activity can be conducted to show that solids and liquids occupy space and have mass.

   - Place an empty beaker on a digital weighing scale. The scale will show a reading which is the mass of the beaker. Now pour water into the beaker. The reading on the weighing scale increases. This proves that solids and liquids have mass.
   - Fill a jar up to the brim with water and place it over a basin. Immerse a stone suspended from a thread slowly into the water. Water flows out of the jar into the basin. If the stone is removed, the water level in the jar is lower than the brim. If the water in the basin is poured back into the jar, it again fills to the brim. This shows that solids and liquids occupy volume.

3. The following activity can be conducted to show that gases have mass.

   Suspend a meter scale with two identical inflated balloons tied to its two ends by a thread. Prick one of the balloons. The scale will go down on the side with the filled balloon because it is heavier. This proves that gases have mass.

4. Diffusion is the movement of a substance from an area of high concentration to one of low concentration. When a stick of incense or a fragrant candle is lit in one corner of the room, the fragrance spreads everywhere. The concentration of the fragrance is at first strongest where the incense stick or candle is lit. The fragrance slowly spreads to other parts of the room where the concentration is lower. Similarly, when a spoonful of milk is added to a glass of water, it spreads and mixes with the water to make the concentration of milk in water uniform.

   Diffusion occurs because of the intermolecular spaces in substances. During diffusion, smaller molecules can fill these spaces. Since intermolecular spaces are different in the different stats of matter, the degree of diffusion also varies. Gases diffuse rapidly due to their large intermolecular spaces. Some liquids diffuse depending on their intermolecular spaces. The intermolecular spaces in solids are very low and they do not undergo diffusion.

5. When a solid is heated, two kinds of changes can happen

   Physical change: The solid can undergo a change in state or expand. It returns to its original state when the heating is stopped. No new substances are formed during these changes. Only the physical properties change.

   Example:

   - When a thin wire is heated, it expands and its length increases. When the heating is stopped, the wire comes back to its original length.
   - When wax is heated, it melts. It becomes solid again on cooling.

   Chemical change: If a new substance with different physical and chemical properties is formed on

heating, a chemical change has taken place. The original solid cannot be got back by simply cooling.

Example:

- Cooking food is an example of a chemical change. When rice, lentils or vegetables are cooked, a new substance is formed. It has properties different from the original substance. The change cannot be reversed by cooling.
- When wood is burned, ash is formed. Ash is a new substance and wood cannot be got back from it.

Think and answer

1. An inflated balloon is filled with air. When the balloon is compressed, the air gets compressed as gases are highly compressible. When it is released the air molecules spread to completely fill the available space. This is because the molecules in the gaseous state can move about freely within the volume of the balloon. Because of this, the balloon returns to its original shape.
2. Mercury being a metal is a good conductor of heat and expands on heating. In a thermometer, a small quantity of mercury is sealed inside a capillary tube enclosed by a glass tube with markings to denote the temperature. When you place a thermometer in your mouth (or on a hot object), heat from your mouth causes the mercury to expand and rise up the capillary tube. The extent to which the mercury level rises depends on the temperature in your mouth. Higher temperatures will cause more expansion and a greater increase in the mercury level. Markings are made on the thermometer such that the height to which the mercury column rises shows the temperature of the body.

   A thermometer is calibrated to read temperatures between two limiting point such as freezing point of ice and boiling point of water. The distance between the two points is divided into several divisions to read various temperatures within the limiting points.
3. The volume of the mixture of marble and sand will be less than 100 ml. There will be a lot of empty space in the jar surrounding each marble because marbles are rigid and non-compressible. Sand particles are much smaller than the spaces around the marbles. When sand is poured into the jar, the sand particles quickly fill up these empty spaces. Only after all these spaces have been filled up will the remaining sand rise above the marbles. Hence the total volume of the mixture will be less than 100 ml.
4. The piece of iron will occupy the least volume because it is a solid and its molecules are arranged very close to one another such that intermolecular space is least due to the strong intermolecular forces. Intermolecular space is more in liquids and largest in gases. Hence for a given mass, the volume will be least for a solid.

MATTER

Answer the questions.

1. What are fluids? Give two examples.

   Ans: Anything that can flow is a fluid. Examples are water and air.

2. Define cohesive force.

   Ans: The force that binds particles of the same substance is called cohesive force.

3. Name two materials that undergo sublimation.

   Ans: Camphor and naphthalene are two materials that undergo sublimation.

4. Name two physical changes that cannot be reversed.

   Ans: Tearing of paper and breaking of glass are two physical changes that cannot be reversed.

5. Is cooking a physical or chemical change? Justify your answer.

   Ans: Cooking is a chemical process. In the presence of heat the food items undergo permanent chemical changes and become new substances. This process cannot be reversed.

6. Explain why digestion is a chemical change?

   Ans: The food we eat is acted upon by chemicals in our digestive tract and broken down into new substances that the body can absorb. This is a process which cannot be reversed. Hence digestion is a chemical change.

7. Is there a relation between intermolecular forces and intermolecular spaces? Justify your answer.

   Ans: Intermolecular forces and intermolecular distances are related. When the intermolecular forces are strong, the particles are attracted strongly to one another and they come closer. This reduces intermolecular spaces. When the forces are weaker, the particles are only weakly attracted to each other. This increases the intermolecular spaces.

8. Can intermolecular forces be repulsive? Explain.

   Ans: Since matter occupies space, each particle occupies a definite volume which cannot be simultaneously occupied by another particle. Because of this, if two particles come very close to each other, the force between them becomes repulsive. So, intermolecular forces are attractive at normal distance and repulsive when the particles are very close to each other.

9. Why does a small mass of liquid have a spherical shape?

   Ans: For a small quantity of liquid, the distance between the particles is small, and the cohesive force is sufficient in keeping the molecules together in a spherical drop. As the size of the drop increases, the distance between the particles increases and the intermolecular forces between the particles become weaker. Hence the cohesive force can no longer keep all the particles tightly bound together.

10. Explain why diffusion does not happen in solids.

    Ans: Intermolecular forces are strongest in a solid. So the molecules are strongly bounded together. They cannot move freely, but can only vibrate about their mean position. Because of this reason diffusion does not happen in solids. Intermolecular spaces in solids are also very small and this does not allow diffusion to happen.

11. Why does diffusion happen easily in gases?

    Ans: The intermolecular spaces in gases are large as their intermolecular forces are the weakest. The molecules are capable of random motion. The intermolecular spaces are large enough for other smaller molecules to occupy. Because of this, diffusion happens readily in gases.

12. How does heat affect the state of matter?

Ans: Adding heat to a solid provides more energy to the molecules. Hence the molecules overcome the strong attractive intermolecular forces to become liquid. Further heating provides even more energy to the molecules. When the energy is sufficient to overcome the intermolecular forces in a liquid, it will become a gas. In a gas, the molecules are free to move around randomly. Conversely, if a gas is cooled, the molecules lose energy and become a liquid, which on further cooling lose more energy and become a solid.

13. Compare the freedom of motion of particles in the three states of matter.

Ans: In the solid state, there is very little freedom of motion due to the high intermolecular attractive forces. The particles move about their fixed position. In the liquid state, the molecules have more freedom of motion due to the weaker intermolecular forces. They can slide over each other. Because of this, they are able to flow. Freedom of motion is the maximum for the molecules of a gas in which. the intermolecular forces are the weakest. Hence the molecules undergo random motion.

14. Distinguish between freezing point and melting point.

Ans:

Freezing point	Melting point
It is the temperature at which a liquid changes state to a solid.	It is the temperature at which a solid changes state to a liquid.
For a particular substance, the freezing point and the melting point are the same.	

15. Distinguish between evaporation and boiling.

Ans:

Evaporation	Boiling
It is the escaping of liquid molecules from the surface of a liquid.	It is the vaporisation of liquid molecules when they are heated; takes place throughout the liquid.
slow process	fast process
takes place at all temperatures	takes place at a fixed temperature (boiling point)
results in cooling	does not result in cooling

16. Distinguish between sublimation and deposition.

Ans:

Sublimation	Deposition
It is the process by which a substance in the solid state changes directly to the gaseous state without going through the liquid state.	It is the process by which a substance in the gaseous state changes directly to the solid state without going through the liquid state.

MATTER

1. Mark ✓ for true and × for false sentences.

a. Air is not matter.

b. Liquids can flow because the molecules in liquids are not tightly packed.

c. Gases have no shape but have definite volume.

d. Brownian motion is absent in liquids.

e. Molecules become closer to each other when they lose energy.

f. The freezing point of water is 0°C.

g. Water starts to boil at 0°C.

h. When a gas turns directly into a solid on cooling, the process is called sublimation.

i. Solids can diffuse into each other.

j. Melting of butter is an example of chemical change.

k. Hot air sinks.

l. All changes require heat.

WORKSHEET

2. Answer the questions.

a. On heating an iron rod its temperature rises, is it a chemical or physical change? Give reason.

b. Why are gaps given between sections of rail in a railway track?

ANSWER KEY FOR THE WORKSHEET

MATTER

1. a. × b. ✓ c. × d. × e. ✓ f. ✓ g. × h. × i. ×
j. × k. × l. ×

2. a. When a rod is heated, its temperature rises. Since no new substance is formed it is a physical change. Also when the source of heat is removed, the temperature of the rod comes back to normal. Thus this is a reversible physical change.

b. Gaps are given between sections of rail on a railway track to provide space for the rails to expand without bending.