Chapter 7: Particulate Nature of Matter

Exercises — Keep the Curiosity Alive

Q1 Choose the correct option.

The primary difference between solids and liquids is that the constituent particles are:

(i) closely packed in solids, while they are stationary in liquids.

(ii) far apart in solids and have fixed position in liquids.

(iii) always moving in solids and have fixed position in liquids.

(iv) closely packed in solids and move past each other in liquids.

SOLUTION

Evaluating each option against the particle model of matter:

(i) Incorrect — Liquid particles are NOT stationary; they move freely within the liquid's volume.

(ii) Incorrect — Solid particles are closely packed (NOT far apart). Liquid particles do not have fixed positions either.

(iii) Incorrect — Solid particles do NOT move freely; they only vibrate about fixed positions. It is the liquid particles that are always moving.

(iv) Correct — In solids, particles are tightly packed with strong interparticle attractions and can only vibrate about their fixed positions. In liquids, the interparticle attractions are slightly weaker, so particles can slide and move past each other, giving liquids no fixed shape.

Answer: Option (iv): closely packed in solids and move past each other in liquids.

Q2 Which of the following statements are true? Correct the false statements.
(i) Melting ice into water is an example of the transformation of a solid into a liquid.
(ii) Melting process involves a decrease in interparticle attractions during the transformation.
(iii) Solids have a fixed shape and a fixed volume.
(iv) The interparticle interactions in solids are very strong, and the interparticle spaces are very small.
(v) When we heat camphor in one corner of a room, the fragrance reaches all corners of the room.
(vi) On heating, we are adding energy to the camphor, and the energy is released as a smell.

SOLUTION

(i) TRUE — Ice is a solid; water is a liquid. Melting (at 0 °C) converts ice to water, which is a solid-to-liquid transformation.

(ii) TRUE — During melting, heat energy is supplied to the solid. This energy weakens (decreases) the interparticle forces of attraction, allowing particles to leave their fixed positions and flow as a liquid.

(iii) TRUE — Because solid particles are tightly packed with strong interparticle attractions and cannot move from their positions, solids maintain a definite (fixed) shape and a definite (fixed) volume.

(iv) TRUE — In solids, the interparticle forces of attraction are maximum among the three states, and particles are closely packed, leaving very little space between them (minimum interparticle spacing).

(v) TRUE — Camphor undergoes sublimation (directly converts from solid to vapour on heating). The vapour particles move and spread throughout the room by diffusion, so the fragrance reaches all corners.

(vi) FALSE — Correction: On heating camphor, energy is added to overcome the interparticle forces of attraction and convert solid camphor to vapour (sublimation). The smell (fragrance) is perceived because camphor vapour particles spread throughout the room by diffusion. The energy is NOT released as a smell; rather, the energy is used to change the state of camphor.

Answer: TRUE: (i), (ii), (iii), (iv), (v). FALSE: (vi) — Correction: heating supplies energy to overcome interparticle forces and cause sublimation; the smell is due to diffusion of camphor vapour particles, not energy released as smell.

Q3 Choose the correct answer with justification. If we could remove all the constituent particles from a chair, what would happen?
(i) Nothing will change.
(ii) The chair will weigh less due to lost particles.
(iii) Nothing of the chair will remain.

SOLUTION

Matter is defined as anything that has mass and occupies space. A chair (or any object) is made entirely of matter, which in turn is made up of constituent particles (atoms and molecules).

If ALL constituent particles are removed, there is literally nothing left — no atoms, no molecules, no mass, no volume. The chair simply ceases to exist.

(i) Incorrect — Removing all particles would destroy the chair entirely, not leave it unchanged.

(ii) Incorrect — If all particles are removed, the chair would not merely weigh less; it would have no mass or substance at all.

(iii) Correct — Since matter is composed entirely of its constituent particles, removing every particle means removing the matter itself. Nothing of the chair would remain.

Answer: Option (iii): Nothing of the chair will remain, because matter is entirely made of constituent particles — removing all of them leaves no mass, no volume, and no substance.

Q4 Why do gases mix easily, while solids do not?

SOLUTION

The ease of mixing depends on the interparticle spacing and the freedom of movement of particles in each state.

In gases:
— Interparticle attractions are negligible.
— Particles move freely and rapidly in all directions.
— There is maximum interparticle spacing between gas particles.
— When two gases are brought together, their particles move randomly and spontaneously intermingle (diffuse) into the available spaces of each other. This is why gases mix very easily and quickly.

In solids:
— Interparticle attractions are very strong.
— Particles are tightly packed with minimum interparticle spacing.
— Particles can only vibrate about their fixed positions; they cannot move past each other.
— Because solid particles have no freedom to move, they cannot intermingle with the particles of another solid under normal conditions. Hence, solids do not mix easily.

Answer: Gas particles have negligible interparticle attraction, maximum spacing, and move freely in all directions, so they diffuse and mix easily. Solid particles are tightly packed with strong interparticle attractions and can only vibrate about fixed positions, so they cannot intermingle and do not mix.

Q5 When spilled on the table, milk in a glass tumbler flows and spreads out, but the glass tumbler stays in the same shape. Justify this statement.

SOLUTION

This observation illustrates the difference in particle behaviour between liquids (milk) and solids (glass tumbler).

Milk is a liquid:
— The interparticle forces of attraction in milk are weaker than in solids.
— Milk particles are free to move past each other within the liquid.
— Because the particles can slide and flow, milk has no fixed shape — it takes the shape of whatever surface or container it occupies.
— When spilled, milk flows and spreads out over the table surface, taking the shape of that surface.

Glass tumbler is a solid:
— The interparticle forces of attraction in glass are very strong.
— The particles of glass are tightly packed and can only vibrate about their fixed positions; they cannot move past each other.
— Because the particles are held rigidly, glass has a definite, fixed shape.
— When tipped over, the glass tumbler retains its shape — it does not spread or deform.

Answer: Milk is a liquid whose particles move freely past each other (weak interparticle attractions), so it flows and takes the shape of the surface it lands on. The glass tumbler is a solid whose particles are tightly packed with strong attractions and fixed positions, so it retains its definite shape even when knocked over.

Q6 Represent diagrammatically the changes in the arrangement of particles as ice melts and transforms into water vapour.

SOLUTION

This question requires a drawn diagram. Below is a text-based description of each stage for the three particle arrangements:

Stage 1 — ICE (Solid):
Particles are represented as closely packed circles arranged in a regular, ordered pattern. They are touching or nearly touching each other. Very little space exists between particles. Particles are in fixed positions (can only vibrate). Strong interparticle forces hold them together.

Stage 2 — WATER (Liquid):
After melting, particles are shown as circles that are slightly more spread out and arranged in an irregular (disordered) pattern. Particles are close but not as tightly packed as in ice. Particles move around each other within a limited space. Interparticle forces are weaker than in ice.

Stage 3 — WATER VAPOUR (Gas):
After boiling/evaporation, particles are represented as widely separated circles scattered randomly with large spaces between them. Particles move freely in all directions. Interparticle forces are negligible.

Arrangement summary (draw as three boxes connected by arrows):
[Ice: ordered, tightly packed circles] --melting (heating)--> [Water: disordered, slightly spaced circles] --boiling/evaporation (heating)--> [Water vapour: widely spaced, randomly distributed circles]

Answer: Ice: particles tightly packed in ordered arrangement (solid). Water: particles slightly more spaced, disordered, free to move past each other (liquid). Water vapour: particles widely separated, moving freely in all directions (gas). Each stage has progressively larger interparticle spacing and weaker interparticle forces.

Q7 Draw a picture representing particles present in the following:
(i) Aluminium foil
(ii) Glycerin
(iii) Methane gas

SOLUTION

This question requires drawn diagrams. The descriptions below specify what each diagram should show:

(i) Aluminium foil — SOLID:
Draw closely packed circles arranged in a regular, ordered pattern with very little space between them. The particles are in fixed positions and touching each other. Label: strong interparticle attractions, minimum interparticle spacing, particles only vibrate.

(ii) Glycerin — LIQUID:
Draw circles arranged in a slightly irregular pattern with small but visible spaces between them. Particles are not as tightly packed as in aluminium foil and can slide past each other. Label: weaker interparticle attractions than solid, small interparticle spacing, particles move within limited space.

(iii) Methane gas — GAS:
Draw circles widely and randomly scattered throughout the box with large spaces between them. Particles are far apart and have complete freedom of movement. Label: negligible interparticle attractions, maximum interparticle spacing, particles move freely in all directions.

Answer: (i) Aluminium foil (solid): closely packed, ordered circles — minimum spacing, strong attractions. (ii) Glycerin (liquid): slightly spaced, disordered circles — small spacing, moderate attractions. (iii) Methane gas (gas): widely scattered, random circles — maximum spacing, negligible attractions.

Q8 Observe Fig. 7.16a which shows the image of a candle that was just extinguished after burning for some time. Identify the different states of wax in the figure and match them with Fig. 7.16b showing the arrangement of particles.

SOLUTION

From Fig. 7.16a — States of wax visible in the extinguished candle:

State 1 — SOLID wax: The main body/pillar of the candle. Wax here is in the solid state — it has a definite shape and volume. The interparticle attractions are

strong and particles are tightly packed.

State 2 — LIQUID wax: The pool of melted wax around and near the base of the wick (formed during burning where the heat was concentrated). Wax here is in the liquid state — it has no fixed shape (spreads into the pool) but has a definite volume. Interparticle attractions are weaker than in solid wax.

State 3 — GASEOUS wax (vapour/smoke): The wisp of smoke rising from the just-extinguished wick. Wax vapour/gas particles have escaped the liquid and are moving freely. This represents the gaseous state — no fixed shape or volume.

Matching with Fig. 7.16b (particle arrangement diagrams):
— Solid wax (candle body) → tightly packed, ordered particles (minimum spacing) = the diagram showing closely packed circles in a regular arrangement.
— Liquid wax (melted pool) → moderately spaced, disordered particles = the diagram showing circles with some space between them, irregular arrangement.
— Wax vapour (smoke/wisp) → widely spaced, randomly scattered particles = the diagram showing circles far apart in random positions.

Answer: Fig. 7.16a shows three states of wax: solid (candle body — tightly packed particles), liquid (melted pool near the wick — moderately spaced particles), and gas/vapour (smoke rising from the wick — widely spaced, freely moving particles). These match the three particle-arrangement diagrams in Fig. 7.16b: tightly packed ordered (solid), loosely packed disordered (liquid), and widely scattered (gas).

Q9 Why does the water in the ocean taste salty, even though the salt is not visible? Explain.

SOLUTION

Ocean water tastes salty because sea salt (primarily sodium chloride) is dissolved in it, forming a solution.

When salt dissolves in water, the salt breaks down into its constituent particles. These particles are too small to be seen with the naked eye or even an ordinary microscope.

The dissolved salt particles occupy the interparticle spaces between the water molecules. Because the particles are so extremely small and uniformly distributed throughout the water, we cannot see them — but their presence is detected by our taste buds, which give the sensation of saltiness.

This is the same principle as sugar dissolved in water (Activity 7.2 in the chapter): the sugar particles are invisible after dissolution, yet the water tastes sweet. Similarly, ocean salt is invisible once dissolved but the taste is unmistakable.

Key point: Matter is composed of extremely small particles. Even when a substance dissolves and its particles are no longer visible, the particles are still present in the solution — they can be detected by taste, smell, or other properties.

Answer: Salt dissolves in ocean water by breaking into extremely small constituent particles that occupy the interparticle spaces between water molecules. These particles are too small to be seen but are still present — our taste buds detect them, which is why the ocean water tastes salty even though no salt is visible.

Q10 Grains of rice and rice flour take the shape of the container when placed in different jars. Are they solids or liquids? Explain.

SOLUTION

Rice grains and rice flour are SOLIDS, not liquids.

The fact that they appear to take the shape of a container can cause confusion, but this is because they are a collection of many small individual solid particles, not because their constituent particles flow like a liquid.

Each individual grain of rice and each particle of rice flour is a solid:
— Each grain/particle has a definite, fixed shape and volume of its own.
— The particles within each grain are tightly packed with strong interparticle attractions.
— Individual grains cannot be compressed or deformed easily.

What appears as 'taking the shape of the container' is actually the collection of many separate solid pieces rearranging relative to each other (they slide over one another due to gravity), not the flowing of a continuous liquid. The particles of each grain do NOT move past each other — only the grains as a whole shift position.

In contrast, a true liquid (like water) takes the shape of the container because its individual constituent particles can slide and move past each other freely.

Key distinction: In rice grains/flour, the individual grains (or flour particles) move, but within each grain, the constituent particles remain in fixed positions — this is

the hallmark of a solid state.

Answer: Rice grains and rice flour are solids. Each individual grain or flour particle has a definite shape and volume, with tightly packed constituent particles in fixed positions. They appear to take the container's shape because the many separate solid pieces rearrange relative to each other under gravity — unlike liquids, where individual constituent particles themselves flow and move past each other.