7 Particulate Nature of Matter

Class 8 · Science (Curiosity) · Handwritten Revision Notes

"You can pile up sand, but not water. Water takes the shape of folded hands, yet slips away when released. Even invisible air adds weight to a balloon! All of this happens because matter is made of tiny particles – too small to see – and how they are packed and held together decides everything."

7.1 What Is Matter Composed Of?

Activity 7.1: Break a stick of chalk into pieces, keep breaking till it's too hard to break further, then grind it with a mortar & pestle and view the fine powder under a magnifying glass.

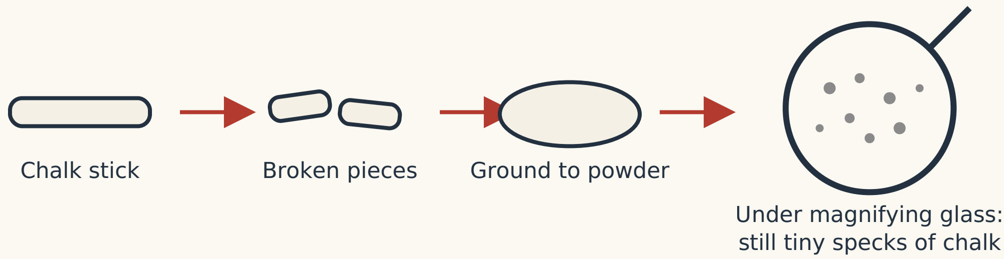


Fig 1: Breaking & grinding chalk – each tiny speck is still chalk (physical change)

***Constituent particle:** The basic unit that makes up a larger piece of a substance or material – obtained when breaking/grinding is imagined to continue until no further division is possible.*

Remember!

Grinding chalk is a **physical change** – only the size of each speck reduces; chalk does not turn into a new substance. Sand and clay grains are also not the smallest units of rocks – they too are made of many constituent particles.

Activity 7.2: *Add 2 tsp sugar to a glass of water without stirring – taste the top layer (not sweet). Now stir until sugar dissolves completely – taste again (sweet!), yet no sugar grains are visible.*

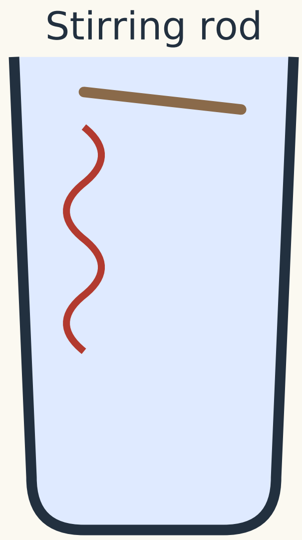


Fig 2: Dissolving sugar in water – stirred water tastes sweet with no visible grains

*Sugar particles can no longer be seen, but their presence is **sensed by taste** – each tiny sugar grain is made of millions of constituent particles that spread into the water.*

> ***Interparticle spaces:*** ***The empty spaces between the particles of matter. Dissolved sugar particles occupy the interparticle spaces between water particles.***

7.2 What Decides Different States of Matter?

> ***Interparticle attractions: The attractive forces that hold the constituent particles of matter together. Their strength depends on the nature of the substance and the interparticle distance – even a slight increase in distance sharply weakens them. These forces decide the physical state of a substance.***

Our Scientific Heritage

Acharya Kanad*, an ancient Indian philosopher, first proposed the idea of Parmanu (atom) – tiny, indivisible, eternal particles that make up matter. This was written in his work Vaisheshika Sutras.*

7.2.1 Solid State

Activity 7.3: Collect solids (iron nail, rock salt, stone, wood, key, aluminium) – observe shape/size & try hammering them.

> **Solids have a definite shape and volume – particles are tightly packed with very strong interparticle attractions, holding them in fixed positions (they can only vibrate/oscillate in place, not move past each other).**

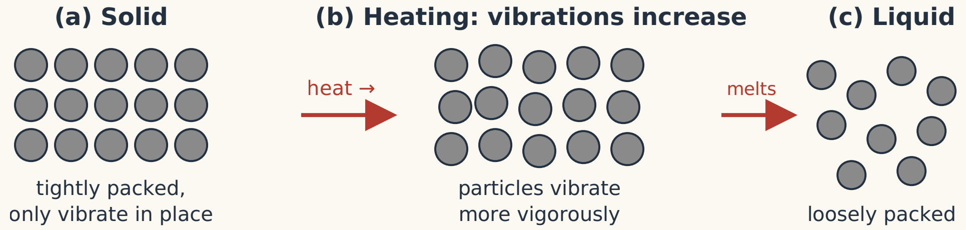


Fig 3: Melting of a solid – particles vibrate more until they break free (melting point)

> **Melting point: The minimum temperature at which a solid melts into a liquid at atmospheric pressure.**

Material	Melting Point
Ice	0 °C
Urea	133 °C
Iron	1538 °C

Weak interparticle forces → low melting point; strong forces → high melting point. (Note: liquid particles are usually farther apart than in solids – **ice is an exception**, its particles are farther apart than in water!)

7.2.2 Liquid State

Activity 7.4: Fill container A with water up to a 200 mL mark; pour into containers B, then C of different shapes.

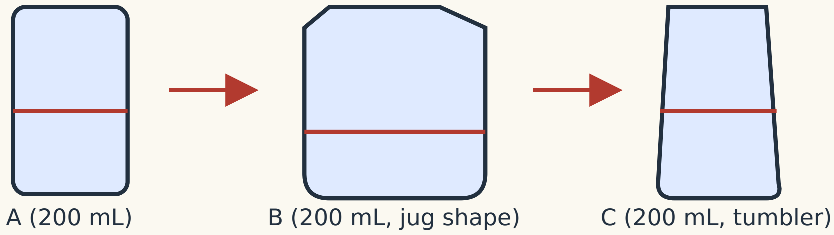


Fig 4: Same 200 mL water takes the shape of each container, but the volume stays the same

> **Liquids have no fixed shape (take the shape of their container) but have a definite (fixed) volume – particles are free to move but only within a limited space, and interparticle attractions are slightly weaker than in solids (you can move your finger through water, unlike a solid).**

Try this (Fig 7.6 in NCERT): Move your finger through water in a shallow vessel – this confirms liquid particles are loosely held, close but not rigidly fixed – water temporarily displaces and then restores its position (unlike a solid, which you cannot pass your finger through).

> **Boiling point: The temperature at which a liquid boils and turns into vapour at atmospheric pressure. At this point, particles move so vigorously that they escape the liquid, forming bubbles both at the surface and within the liquid.**

Remember!

Evaporation happens slowly, only at the surface, at ALL temperatures (even below boiling point) – that's why spilled water disappears eventually, even without heating!

7.2.3 Gaseous State

Activity 7.5: Trap incense smoke in Gas Jar A, cover with a glass plate, place Gas Jar B over it, then remove the plate.

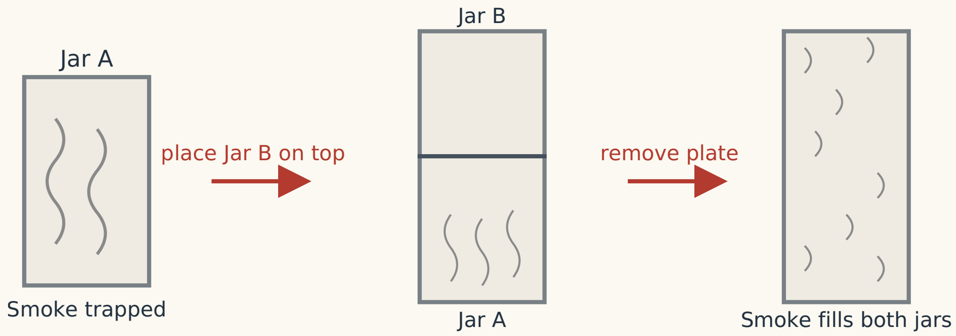


Fig 5: Smoke (representing a gas) spreads to fill all available space

> **Gases have no fixed shape and no fixed volume – they occupy the entire available space. Particles move freely in all directions and interparticle attractions are negligible.**

Remember!

Iodine vapour (from heating solid iodine) can also be used instead of smoke to show this. Both **liquids and gases flow** and don't retain a fixed shape – together they are classified as **fluids.**

7.3 Interparticle Spacing in the Three States

Activity 7.6: Pull a syringe's plunger out, block the open end with your thumb, and push the plunger in.

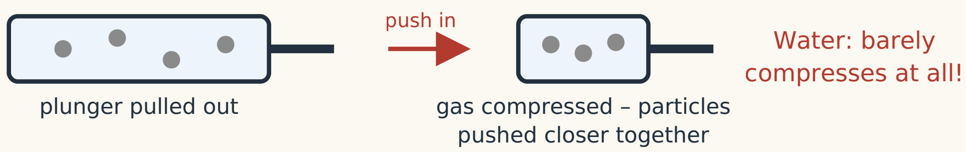


Fig 6: Gas particles have lots of space between them – easily compressed; liquids are not

Activity 7.7: Mark water level A, add sugar (level rises to B), stir to dissolve (level settles at C, slightly below B) – showing sugar particles fit into the **interparticle spaces** of water. (Sand, being insoluble, instead settles at the bottom and increases the total volume.)

Fig 7 – Interparticle Spacing Compared

Solid	Liquid	Gas
Spacing: minimum	Spacing: little more than solid	Spacing: maximum
Closely packed	A little loosely packed	Particles free, far apart

The space between particles contains **nothing at all** (not even air) – it is empty space, not a gas-filled gap.

Remember!

Suspended Particulate Matter (SPM) (used in air-pollution contexts) refers to tiny dust particles in air – not the same as the ultra-tiny constituent particles (atoms/molecules) of matter.

7.4 How Particles Move in Different States

Activity 7.8: Drop a few grains of potassium permanganate ($KMnO_4$) into water without stirring.

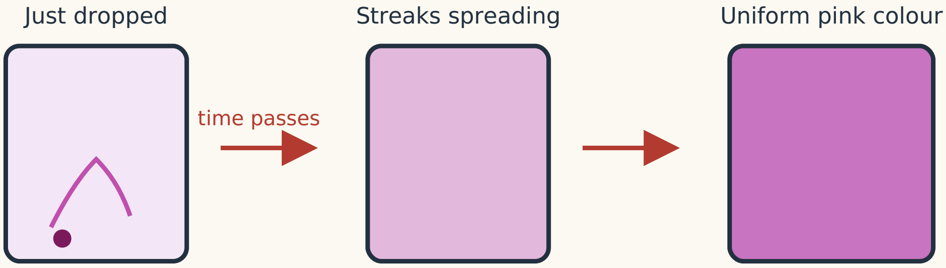


Fig 8: Diffusion – moving water particles pull out & spread $KMnO_4$ particles

> **Diffusion: The spreading of particles of one substance throughout another, caused by the constant motion of particles – happens in liquids ($KMnO_4$ in water) and gases (incense fragrance filling a room).**

Think Like a Scientist – Effect of Temperature

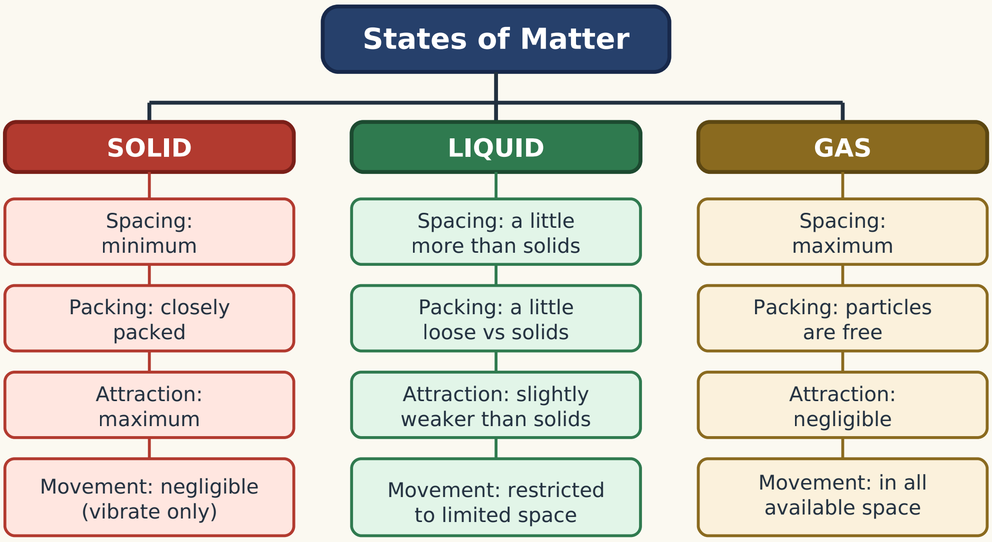
$KMnO_4$ dropped into **hot**, room-temperature, and **ice-cold** water spreads **fastest in hot water** and **slowest in ice-cold water.** → Heat increases particle motion, which speeds up diffusion.

Activity 7.9: Light an incense stick in one corner of a room – the fragrance is felt only nearby at first, then spreads to fill the whole room, because **air particles are in constant motion** and carry fragrance particles along.

Remember!

Real-life example: **soap cleaning** – one end of a soap particle attaches to oil on fabric, the other end mixes with water, lifting the oil off and washing it away.

Flowchart – States of Matter at a Glance



Key idea: it is the THERMAL ENERGY of particles that decides which physical state matter is in.

Low thermal energy → strong attraction → SOLID
More thermal energy → weaker attraction → LIQUID → GAS

Fig 9: Flowchart summarising particle behaviour in the three states of matter

Key Terms & Quick Revision

Term	Meaning
Constituent particle	Basic unit that makes up a larger piece of a substance
Interparticle spaces	Empty spaces between particles of matter
Interparticle attraction	Attractive forces holding particles of matter together
Melting point	Temperature at which a solid turns into a liquid (atm. pressure)
Boiling point	Temperature at which a liquid turns into vapour (atm. pressure)
Evaporation	Slow vapour formation at the surface, at any temperature
Diffusion	Spreading of particles of one substance into another due to particle motion
Fluids	Substances that flow and have no fixed shape – liquids & gases

Snapshot – Quick Recap

- Matter is made of extremely small **constituent particles**, held by **interparticle attractions.**
- Attraction strength: **Solid > Liquid > Gas.** Interparticle spacing: **Gas > Liquid > Solid.**
- Solids: fixed shape & volume. Liquids: fixed volume, no fixed shape. Gases: no fixed shape or volume.
- Heating increases particle motion → solid → liquid (melting) → gas (boiling/evaporation).
- **Diffusion** ($KMnO_4$ in water, incense fragrance in air) proves particles are always moving – faster when heated.
- The space between particles is truly **empty** – not filled with air.

Remember!

Exam tip: Practice drawing the 3-state particle diagrams (dots showing spacing/packing) and labelling them – diagram-based and "explain why" questions are common for this chapter.

Topic-wise Questions & Answers

A. Matter & Constituent Particles

Q1. What is a constituent particle?

Ans: *The basic unit that makes up a larger piece of a substance or material – obtained when breaking/grinding is imagined to continue until no further division is possible.*

Q2. Is grinding a piece of chalk a physical or a chemical change? Why?

Ans: *It is a physical change – the chalk does not turn into a new substance; only the size of each speck is reduced.*

Q3. If we could remove all the constituent particles from a chair, what would happen – (i) nothing changes, (ii) it weighs less, or (iii) nothing of the chair remains?

Ans: *(iii) Nothing of the chair would remain, since the chair itself is entirely made up of these constituent particles – removing all of them removes the chair completely.*

Q4. Why can't we see the constituent particles of matter, even under an ordinary microscope?

Ans: *They are extremely small – far smaller than what an ordinary (optical) microscope can resolve.*

Q5. Name one other everyday example (besides grinding chalk) of a physical change where only particle size reduces.

Ans: *Grinding wheat into flour, or crushing sugar crystals into powdered sugar – the substance stays the same, only the particle size changes.*

B. Solid State

Q1. Why do solids have a fixed shape and volume?

Ans: *Their particles are tightly packed with very strong interparticle attractions that hold them in fixed positions, allowing only vibration – not free movement.*

Q2. What is the melting point of a solid, and why do ice and iron have such different melting points (0°C vs 1538°C)?

Ans: *Melting point is the minimum temperature at which a solid turns into a liquid at atmospheric pressure. Ice has weak interparticle forces (low melting point), while iron's particles are held by very strong forces (much higher melting point).*

Q3. Represent diagrammatically the change in particle arrangement as ice melts and then turns into water vapour.

Ans: *Solid (ice): particles tightly packed in a regular grid, only vibrating → Liquid (water): particles a little farther apart, loosely packed, free to move within a limited space → Gas (vapour): particles far apart, moving freely in all directions with negligible attraction.*

Q4. Arrange ice, urea, and iron in increasing order of interparticle force of attraction.

Ans: *Ice < Urea < Iron (increasing melting point reflects increasing strength of interparticle attraction).*

C. Liquid State

Q1. Why do liquids take the shape of their container but still have a fixed volume?

Ans: *Liquid particles are free to move but only within a limited space – this lets them flow into any container shape while the total amount (volume) of particles stays the same.*

Q2. When spilled on a table, milk flows and spreads out, but the glass tumbler it was in stays in the same shape. Justify this statement.

Ans: *Milk is a liquid – its particles are loosely packed and free to move, so it has no fixed shape and flows/spreads. The tumbler is a solid – its particles are rigidly held in fixed positions by strong attractions, so it keeps its shape.*

Q3. Distinguish between evaporation and boiling.

Ans: *Evaporation is slow vapour formation only at the liquid's surface, occurring at all temperatures. Boiling is fast vapour formation at a fixed temperature (the boiling point), happening both at the surface and within the liquid (seen as bubbles).*

Q4. Why does hot water evaporate/diffuse a dissolved substance faster than cold water?

Ans: *Heat increases the thermal energy and speed of particle motion, so particles move apart and spread out faster in hot water than in cold water.*

D. Gaseous State

Q1. Why do gases not have a fixed shape or volume?

Ans: *Gas particles move freely in all directions and the interparticle attraction between them is negligible, so they spread out and occupy all the available space.*

Q2. Why do gases mix easily, while solids do not?

Ans: *Gas particles are far apart, move freely, and have negligible interparticle attraction, so different gases mix completely and quickly. Solid particles are rigidly fixed in place with strong attraction, so they cannot move into one another to mix.*

Q3. Why does an inflated balloon feel heavier than an empty (deflated) one, even though we cannot see air?

Ans: *Air is matter – it is made of particles that have mass. Blowing air into the balloon adds more air particles inside it, adding to its total weight, even though the particles themselves are invisible.*

Q4. Draw/describe the arrangement of particles present in methane gas.

Ans: *A few particles scattered far apart inside the container, each moving freely and randomly in all directions, with large empty (interparticle) spaces between them and no fixed pattern.*

E. Interparticle Spacing & Compressibility

Q1. Why can a gas be compressed easily (e.g. in a syringe), but water can barely be compressed at all?

Ans: Gas particles have large interparticle spaces between them, so pushing them closer together is easy. Liquid particles are already closely packed with very little empty space, so there's almost no room left to compress.

Q2. Why does sugar dissolve in water, but sand does not?

Ans: Sugar's constituent particles are pulled apart by water particles and fit into the interparticle spaces of water. Sand's particles are held together by forces too strong for water particles to break apart, so sand remains undissolved and simply settles down.

Q3. When sugar is dissolved in water, why is the final volume of the solution less than the sum of the volumes of water and sugar taken separately?

Ans: The dissolved sugar particles do not add on top of the water – they occupy the empty interparticle spaces that already exist between the water particles, so the total volume increases by less than expected.

Q4. Is the space between particles filled with air?

Ans: No – the interparticle space contains nothing at all; it is genuinely empty space, not air or any other gas.

F. Movement of Particles & Diffusion

Q1. Why can the fragrance of an incense stick lit in one corner of a room be smelt throughout the room after some time?

Ans: Air particles are in constant, random motion. They collide with and carry the fragrance particles, helping them spread and diffuse throughout the entire room.

Q2. Why does a crystal of potassium permanganate colour water faster in hot water than in cold water?

Ans: Heat gives particles more thermal energy, so they move faster in hot water. This speeds up the pulling apart and spreading (diffusion) of the permanganate particles compared to cold water, where particles move more slowly.

Q3. Why does a drop of ink spread through a glass of water even without stirring?

Ans: Water particles are constantly moving; they collide with the ink particles and carry them outward in all directions, so the ink diffuses through the water over time.

Q4. Why does ocean water taste salty even though the dissolved salt cannot be seen?

Ans: The salt has dissolved – its constituent particles have broken away from the visible crystal and spread into the interparticle spaces of the water. Though invisible, their presence can still be sensed by taste.

G. Higher-Order & Mixed Questions

Q1. The primary difference between the constituent particles of solids and liquids is that the particles are: (i) closely packed in solids, stationary in liquids (ii) far apart in solids, fixed position in liquids (iii) always moving in solids, fixed in liquids (iv) closely packed in solids and move past each other in liquids — which is correct?

Ans: None of the four options is fully accurate as commonly framed, but the closest correct idea is: particles are closely packed with fixed positions in solids, while in liquids they are a little more loosely packed and can move past one another (slide) within a limited space — this sliding/moving-past ability is what liquids have that solids do not.

Q2. State True or False, correcting any false statement: (i) Melting ice into water is an example of a solid changing into a liquid. (ii) Melting involves a decrease in interparticle attraction. (iii) Solids have a fixed shape and fixed volume. (iv) Interparticle interactions in solids are very strong and interparticle spaces are very small. (v) Heating camphor in one corner lets its fragrance reach every corner of a room. (vi) On heating, we add energy to camphor, released as smell.

Ans: (i) True. (ii) True. (iii) True. (iv) True. (v) True (this is diffusion of camphor vapour). (vi) False — heating adds energy that helps camphor particles escape as vapour (sublimation/evaporation) and diffuse as smell; the smell is not "released energy" but the spreading of camphor's own particles.

Q3. Grains of rice and rice flour both take the shape of the container they are placed in. Are they solids or liquids? Explain.

Ans: Both are still solids. Each individual grain (or fine powder particle) keeps its own fixed shape and volume — it is only the loose collection of many separate solid grains that rearranges and appears to "take the container's shape," unlike a true liquid whose individual particles themselves flow and move past each other.

Q4. A candle that has just been extinguished shows wax in more than one form — solid wax, a pool of melted (liquid) wax, and some wax vapour near the wick. Match each to its particle arrangement.

Ans: Solid wax (the unmelted candle body): particles tightly packed in a fixed pattern. Melted wax pool: particles loosely packed, free to move within the pool. Wax vapour/smoke near the wick: particles scattered far apart, moving freely in the air.

Q5. If an inflated balloon is left out in strong sunlight, it may burst after some time. Why?

Ans: Heat from the sun increases the thermal energy of the air particles inside, making them move faster and hit the balloon's walls harder and more often, increasing the pressure until the balloon can no longer hold and it bursts.

Q6. Two identical containers hold the same volume of iron nails and cotton wool respectively. Why does the container of iron nails feel much heavier?

Ans: Iron's constituent particles are packed much more closely together and are individually more massive than the particles making up cotton fibres, so a given volume of iron contains far more matter (and hence more mass/weight) than the same volume of cotton.

Discover, Design & Debate (from the chapter)

- Fix a balloon over a bottle's neck and place the bottle in hot water — observe & explain what happens to the balloon.
- Model solid, liquid, and gas particle spacing using clay balls or beads.
- Debate: "Gases can spread and fill all available space" — is this beneficial or harmful?

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