

CHAPTER 1

Matter in Our Surroundings

CBSE Class 9 · Science · Chapter 1

CBSE · Science · Class 9

WHAT THIS CHAPTER DOES



Describe matter using the particle model and its five characteristics.



Compare solids, liquids and gases by property AND by particle arrangement.

Boards prep that builds confidence, not anxiety.

TODAY'S MISSION

Today's mission

- 1 Describe matter using the particle model and its five characteristics.
- 2 Compare solids, liquids and gases by property AND by particle arrangement.
- 3 Explain change of state, latent heat, and why temperature stays constant during it.
- 4 Explain why evaporation causes cooling — and score the 3-mark reasoning questions.

WHY THIS MATTERS

Why this chapter matters

- 1 Your **FIRST** Chemistry chapter — the particle model here underlies every chemistry chapter that follows (atoms, mixtures, reactions).
- 2 4-6 marks of reliable, reasoning-based questions in every Class 9 Science test cycle.
- 3 Bridges straight to daily life: sweating, clay-pot cooling, steam burns, mothballs vanishing, ice cubes melting.

TOPIC

A

What IS matter? — the particle model

TOPIC

Physical nature of matter - particles & their 5 characteristics

MATTER IS PARTICULATE

Matter is anything that occupies space and has mass — air, water, a stone, even smells you cannot see. The key idea of this chapter is that all matter is made of extremely tiny particles. The dissolving-of-potassium-permanganate demonstration proves this: a few crystals colour an entire bucket of water

SPACE BETWEEN PARTICLES

Particles of matter have empty space between them. When you dissolve sugar or salt in a full glass of water without overflowing, the dissolved particles fit into the spaces between the water particles. This characteristic also explains why gases are highly compressible —

CONTINUOUS MOTION + DIFFUSION

Particles of matter are continuously moving — they possess kinetic energy. This is shown by diffusion: the intermixing of particles of two substances on their own. The smell of incense or food spreading across a room, a drop of ink colouring still water, and copper-sulphate-and-

FORCE OF ATTRACTION

Particles of matter attract each other. This force of attraction holds the particles together, and its strength differs across the three states. The attraction is **STRONGEST** in solids — which is why solids have a fixed shape and resist being pulled apart. It is weaker in liquids, letting the particles slide over

THEOREM · LOAD-BEARING RESULT

The Particle (Kinetic) Model of Matter



All matter is made of tiny particles that (1) have empty space between them, (2) are continuously moving with kinetic energy, and (3) attract one another. Heating increases the particles' kinetic energy and the spacing between them.

STATEMENT

The state, properties, and changes of any sample of matter follow from just three particle properties — spacing, motion (kinetic energy), and mutual attraction. Change the balance of attraction versus

WHY THIS MATTERS

- This single model explains rigidity, fluidity, compressibility, diffusion, change of state, latent heat AND evaporation
- Learn the model once and most answers follow.

WATCH OUT FOR

NOTE Particles do NOT change size on heating or compression — only the SPACING between them changes. Saying 'the particles expand' is a marked error.

TOPIC

B

The three states of matter

TOPIC

Solid · Liquid · Gas — properties from the particle model

SOLID STATE

Solids have a definite shape, distinct boundaries and a fixed volume, and are almost incompressible. Their particles are packed very closely in a regular, fixed arrangement with strong forces of attraction, so the particles can only vibrate about fixed positions and cannot move freely. This rigidity

LIQUID STATE

Liquids have NO fixed shape — they take the shape of the container — but they DO have a definite (fixed) volume. They are only slightly compressible and they flow, so they are called fluids. Their particles are loosely packed with weaker forces of attraction than in solids, allowing the particles to

GASEOUS STATE

Gases have neither a fixed shape nor a fixed volume — they fill the entire container they are put in. They are highly compressible because their particles have very large empty spaces between them. The particles are far apart, have negligible force of attraction, and move randomly at high speed

QUICK COMPARISON

Use this exam-ready ranking. **SHAPE:** solid fixed, liquid & gas take container shape. **VOLUME:** solid & liquid fixed, gas not fixed. **COMPRESSIBILITY:** gas high, liquid very low, solid negligible. **FLUIDITY (flow):** gases and liquids flow, solids do not. **PARTICLE SPACING & SPEED:** smallest spacing/

TRY IT · SOLVE BEFORE YOU PEEK

Why can a gas be compressed easily into a small cylinder, but a liquid cannot?

SOLUTION

ANSWER Gas particles have LARGE empty spaces between them, which can be squeezed out — so gases are highly compressible. Liquid particles are already close together with little space, so liquids are nearly incompressible. This is why LPG and oxygen are stored as compressed gas in small cylinders.

TOPIC

C

**Change of state
— melting,
boiling, freezing**

TOPIC

How matter changes from one state to another

MELTING (FUSION)

Melting, also called fusion, is the change of a solid into a liquid on heating. The fixed temperature at which a solid melts at atmospheric pressure is its MELTING POINT — for ice this is $0\text{ }^{\circ}\text{C}$ (273 K). On heating a solid, its particles gain kinetic energy and vibrate more vigorously until they

BOILING (VAPORISATION)

Boiling, or vaporisation, is the change of a liquid into a gas. At a fixed temperature called the BOILING POINT ($100\text{ }^{\circ}\text{C}$ / 373 K for water at 1 atm), the liquid changes to vapour throughout its bulk, not just at the surface. On heating, liquid particles gain enough kinetic energy to overcome the remaining

FREEZING & CONDENSATION

These are the reverse changes, releasing heat instead of absorbing it. FREEZING (solidification) is liquid \rightarrow solid: as a liquid cools, its particles lose kinetic energy until the forces of attraction lock them into fixed positions. Water freezes at $0\text{ }^{\circ}\text{C}$ — the same temperature as ice melts.

EFFECT OF PRESSURE

Pressure (along with temperature) determines the state of matter. Applying high pressure and reducing temperature can liquefy a gas — this is how gases are stored as liquids (e.g. liquefied CO_2 , LPG). Solid carbon dioxide (dry ice) is stored under high pressure; when the pressure is

THEOREM · LOAD-BEARING RESULT

Latent Heat — the hidden heat of state change



Latent heat is the heat energy absorbed (or released) during a change of state at constant temperature. It does NOT change the temperature — it changes the STATE by overcoming the forces of attraction between particles.

STATEMENT

Latent heat of FUSION = the heat required to change 1 kg of a solid into liquid at its melting point without any change in temperature. Latent heat of VAPORISATION = the heat required to change 1 kg

WHY THIS MATTERS

- It explains why temperature stays constant during melting and boiling, why steam at 100 °C scalds far worse than water at 100 °C (steam carries extra latent heat of vaporisation), and why ice at 0 °C cools a drink better than water at 0 °C.

WATCH OUT FOR

NOTE The heat is NOT lost or wasted during the plateau — it is stored in the particles as the energy that pulled them apart. It is released again on freezing/condensation.

WORKED EXAMPLE

Why does steam at 100°C burn worse than water at 100°C ?

- 1 Both steam and boiling water are at the same temperature, 100°C — so temperature alone cannot be the reason.
- 2 To form steam, each gram of water at 100°C absorbed the latent heat of vaporisation (about $22.5 \times 10^5 \text{ J/kg}$) WITHOUT any rise in temperature.
- 3 When steam touches your skin and condenses back to water at 100°C , it RELEASES that stored latent heat of vaporisation into your skin — in addition to cooling from 100°C .
- 4 So steam delivers much more total heat than the same mass of boiling water → steam causes far more severe burns. This is a direct exam-favourite application of latent heat of vaporisation.

TOPIC

Sublimation - solid straight to gas

WHAT SUBLIMATION IS

Sublimation is the change of a solid DIRECTLY into vapour (gas) on heating, without first passing through the liquid state. The reverse process — gas changing directly into solid on cooling — is called deposition. Sublimation happens because some solids have particles that gain enough kinetic energy to escape directly into the gaseous state. The classic NCERT demonstration heats ammonium chloride in an inverted funnel: the solid

EVERYDAY EXAMPLES

Camphor (kapoor) used in poojas leaves no liquid residue — it sublimates straight to vapour, which is why a camphor tablet shrinks and vanishes over days. Naphthalene balls (mothballs) placed among clothes slowly disappear by sublimation, releasing vapour that repels moths. Dry ice (solid carbon dioxide) sublimates at atmospheric pressure, producing the dramatic 'smoke' used in stage shows. Iodine crystals sublime on gentle heating to

TOPIC

D

Evaporation & the cooling effect

TOPIC

Evaporation — a surface phenomenon at all temperatures

WHAT EVAPORATION IS

Evaporation is the change of a liquid into vapour at ANY temperature below its boiling point. It is a SURFACE phenomenon: only the particles at the surface of the liquid that happen to have enough kinetic energy escape into the air. This is the key difference from boiling, which occurs at a

FACTORS AFFECTING RATE

Four factors control how fast a liquid evaporates. (1) SURFACE AREA: a larger exposed surface means more surface particles can escape — wet clothes are spread out, not bundled, to dry faster. (2) TEMPERATURE: higher temperature gives more particles enough kinetic energy to escape, so

WHY EVAPORATION COOLS

Evaporation produces a cooling effect. To change from liquid to vapour, the escaping particles must absorb energy (the latent heat of vaporisation). The fastest, highest-energy particles leave first, so the average kinetic energy — and thus the temperature — of the remaining liquid falls. The needed energy is drawn

EVERYDAY APPLICATIONS

The cooling effect of evaporation is used everywhere. We sweat in summer because the evaporation of sweat absorbs body heat and cools us — this is the body's natural air-conditioning. People sprinkle water on rooftops or in courtyards on hot evenings so its evaporation cools the

THEOREM · LOAD-BEARING RESULT

The Kelvin (SI) Temperature Scale



The SI unit of temperature is the kelvin (K). To convert: $K = ^\circ C + 273$ and $^\circ C = K - 273$. The Kelvin scale starts from absolute zero ($0\text{ K} = -273\text{ }^\circ\text{C}$), the lowest possible temperature, where particle motion is minimum.

STATEMENT

Melting point of ice = $0\text{ }^\circ\text{C} = 273\text{ K}$. Boiling point of water = $100\text{ }^\circ\text{C} = 373\text{ K}$ (at 1 atm).
The Kelvin scale has no negative values; a temperature difference of $1\text{ }^\circ\text{C}$ equals a difference of 1 K .

WHY THIS MATTERS

- Scientists use the Kelvin scale because it has no negative numbers and starts at the true zero of thermal energy, making it the natural scale for the kinetic energy of particles.

WATCH OUT FOR

NOTE 0 K is NOT $0\text{ }^\circ\text{C}$. $0\text{ }^\circ\text{C} = 273\text{ K}$. The single most common slip is forgetting to add (or subtract) 273. Practise: $25\text{ }^\circ\text{C} = 298\text{ K}$; $37\text{ }^\circ\text{C} = 310\text{ K}$; $100\text{ }^\circ\text{C} = 373\text{ K}$.

WORKED EXAMPLE

Convert temperatures between °C and K

- 1 Rule: $K = ^\circ\text{C} + 273$ and $^\circ\text{C} = K - 273$.
- 2 Convert 25 °C to kelvin: $25 + 273 = 298$ K.
- 3 Convert 373 K to Celsius: $373 - 273 = 100$ °C (the boiling point of water).
- 4 Convert -273 °C to kelvin: $-273 + 273 = 0$ K (absolute zero — the lowest possible temperature).

TRY IT · SOLVE BEFORE YOU PEEK

Why do we feel cool after sweating on a hot day?

SOLUTION

ANSWER Sweat (water) evaporates from the skin. To evaporate, the sweat particles absorb the latent heat of vaporisation FROM our body. As our body loses this heat to the evaporating sweat, our skin cools down — that is the cooling effect of evaporation.

TOPIC

Latent heat

TRAP → TRUTH

- × **MISTAKE** The heat supplied during melting or boiling raises the temperature of the substance.
- ✓ **CORRECT** During a change of state the temperature stays **CONSTANT**. The heat supplied (latent heat) is used to overcome the forces of attraction between particles and to change the state — **NOT** to raise temperature. The thermometer reads the same value throughout melting at 0 °C and boiling at 100 °C until the change is complete.

TOPIC

Evaporation

TRAP → TRUTH

× **MISTAKE** Evaporation happens only at the boiling point of a liquid.

✓ **CORRECT** Evaporation is a SURFACE phenomenon that occurs at ALL temperatures, not just at the boiling point. Some surface particles always have enough kinetic energy to escape into the air. Boiling, by contrast, occurs at one fixed temperature and throughout the bulk of the liquid.

TOPIC

Nature of gases

TRAP → TRUTH

× **MISTAKE** Gases have no mass / weigh nothing.

✓ **CORRECT** Gases ARE matter and DO have mass — a balloon filled with air weighs slightly more than an empty one, and an inflated football is heavier than a deflated one. Gas particles are far apart, so a gas has low density, but density is not the same as zero mass.

TOPIC

Compressibility

TRAP → TRUTH

× **MISTAKE** Liquids can be compressed as easily as gases because both flow.

✓ **CORRECT** Liquids are almost INCOMPRESSIBLE — their particles are already close together. Gases are highly compressible because their particles have large empty spaces between them. The ability to flow (fluidity) is shared by liquids and gases, but compressibility is NOT.

TOPIC

Sublimation

TRAP → TRUTH

× **MISTAKE** Every solid melts into a liquid first before becoming a gas.

✓ **CORRECT** Some solids change DIRECTLY into vapour without passing through the liquid state — this is sublimation. Camphor, naphthalene balls, dry ice (solid CO_2), ammonium chloride and iodine all sublime. The reverse (gas → solid directly) is deposition.

TOPIC

Temperature scale

TRAP → TRUTH

× **MISTAKE** 0 Kelvin is the same as 0 °C.

✓ **CORRECT** 0 °C corresponds to 273 K (the melting point of ice), not 0 K. The conversion is $K = ^\circ\text{C} + 273$. Absolute zero (0 K) equals $-273\text{ }^\circ\text{C}$, the lowest theoretical temperature, where particle motion is minimum. The Kelvin scale has no negative values.

TOPIC

Particle spacing vs heat

TRAP → TRUTH

× **MISTAKE** When water boils, the water particles themselves expand and become bigger.

✓ **CORRECT** Particles do NOT change size. On heating, the particles gain kinetic energy and move farther apart and faster — the SPACING between particles increases, the particles themselves stay the same. This is why a gas occupies far more volume than the same mass of liquid.

TOPPER TEMPLATE · MARK-BY-MARK

2-3 mark question: 'Why does the temperature of a substance remain constant during melting

- 1 STATE WHAT IS OBSERVED**
1 m
'When ice is heated, its temperature rises to 0 °C and then stays at 0 °C until ALL the ice has melted, even though heat is still being supplied.'
- 2 EXPLAIN USING LATENT HEAT**
1 m
'The supplied heat is used not to raise the temperature but to overcome the forces of attraction between the particles and change the state from solid to liquid. This heat is the latent heat of fusion.' The key phrase examiners reward is 'used to change state, not to raise temperature'.
- 3 CONCLUDE (ENERGY STORED, NOT LOST)**
1 m
'This latent heat is stored in the particles as their potential energy / increased separation. Once the whole substance has melted, further heating again raises the temperature.' Linking the constant temperature to a definite molecular cause secures the final mark.

TOPPER TEMPLATE · MARK-BY-MARK

2-3 mark question: 'Explain why evaporation causes cooling. Give one everyday example.'

- 1 STATE THE ENERGY IDEA**
1 m
'During evaporation, the particles at the surface of the liquid with the highest kinetic energy escape into the air. To do so they absorb energy (latent heat of vaporisation) from the surroundings.'
- 2 LINK ENERGY LOSS TO COOLING**
1 m
'Because this energy is taken FROM the surroundings (the remaining liquid, the skin, the surface), the surroundings lose heat and their temperature falls — that is the cooling effect.'
- 3 GIVE A CONCRETE EXAMPLE**
1 m
Any ONE with the chemistry stated: 'We feel cool after sweating because sweat evaporates absorbing heat from our body'; OR 'Water kept in an earthen pot (matka) stays cool because water evaporating through the pores absorbs heat'; OR 'Acetone/nail-polish on the palm feels cold as it evaporates fast.'

TOPPER TEMPLATE · MARK-BY-MARK

3-5 mark question: 'Compare the three states of matter (solid, liquid, gas) and explain the

1 **TABULATE SHAPE, VOLUME, COMPRESSIBILITY, FLUIDITY**

2 m

Draw a clean 3-column table: Solid (definite shape, definite volume, negligible compressibility, does not flow); Liquid (no fixed shape — takes shape of container, definite volume, very slightly compressible, flows); Gas (no fixed shape, no fixed volume, highly compressible, flows and fills the container). A table earns more than prose here.

2 **EXPLAIN WITH PARTICLE ARRANGEMENT**

2 m

'In solids the particles are tightly packed in a fixed regular arrangement with strong forces of attraction, so they only vibrate about fixed positions. In liquids the particles are loosely packed with weaker attraction, so they can slide past each other. In gases the particles are far apart with negligible attraction and move randomly at high speed.'

3 **CONNECT TO A PROPERTY EXPLICITLY**

1 m

Tie one property to the model for the final mark: 'Gases are highly compressible because of the LARGE empty spaces between particles, while solids are nearly incompressible because the particles are already close.'

PYQ PATTERNS

Top PYQ patterns to drill

#1

Why does evaporation cause cooling? Explain with an everyday example. (2-3 marks)

Almost every cycle (SQP 2019, 2021, 2022, 2023)

#2

Compare the three states of matter on the basis of shape, volume, compressibility and particle arrangement. (3-5 marks)

Annual exam staple (2020, 2021, 2023)

#3

Why does the temperature remain constant during melting / boiling even though heat is supplied? (latent heat) (2-3 marks)

SQP 2021, 2022, 2024

#4

State two factors that affect the rate of evaporation and explain how each affects it. (2-3 marks)

2019, 2022, 2023

#5








Convert 25 °C / 100 °C to Kelvin (and vice versa). / Define latent heat of vaporisation. (1-2 marks)

Recurrent 1-mark and 2-mark item

MARKS DISTRIBUTION

10-year marks distribution

10-YEAR PYQ MARKS DISTRIBUTION

Three states of matter — properties + comparison + particle explanation		30%
Change of state (melting, boiling, freezing) + temperature-constant reasoning		22%
Latent heat of fusion & vaporisation		14%
Evaporation — factors affecting + cooling effect		20%
Characteristics of particles (diffusion, space, attraction, motion)		16%
Sublimation + effect of pressure		10%
Temperature scale conversion ($^{\circ}\text{C} \leftrightarrow \text{K}$)		8%

RECAP · MEMORISE THESE

5-line revision

1 Particle model — All matter is tiny particles with space between them, in constant motion, attracting each other. One model explains everything.

2 Three states — Solid (fixed shape + volume), liquid (fixed volume, no shape, flows), gas (no shape/volume, highly compressible). Decided by attraction vs kinetic energy.

3 State change & latent heat — Melting/boiling absorb latent heat at **CONSTANT** temperature; sublimation is solid → gas direct. $K = ^\circ\text{C} + 273$.

4 Evaporation — Surface phenomenon

WHAT'S NEXT

What's next

- Chapter 2 — Is Matter Around Us Pure? (mixtures, solutions, separation — builds on the particle idea you just learnt).
- Sit the 15-MCQ Quick Drill (companion PDF) — under 20 minutes, target $\geq 12/15$.
- Then the full annual-pattern paper — 30 marks, 60 minutes, real CBSE Class 9 internal pattern.

You've cracked the particle model.

Now prove it. Take the drill, sit the paper, beat the chapter.

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