MATTER IN OUR SURROUNDINGS

CBSE CLASS 9 SCIENCE (CHEMISTRY) • HIGH-YIELD QUESTION BANK & NOTES

Chapter Overview & Exam Matrix

Aspect	Details
Weightage	5–7% in Annual CBSE Examinations
Key Concepts	Diffusion, Latent Heat, Evaporation Dynamics, Sublimation, States of Matter Transitions
High Probability Map	Latent heat thresholds, kinetic evaporation factors, particulate diffusion proofs (3–5 Marks)
Medium Probability Map	Particulate characteristics, sublimation experimental verification (2–3 Marks)

SECTION A: Top 50 Most Important Questions with Answers

A. Very Short Answer Questions (1 Mark)

Q1. Name the state of matter that has a definite volume but no definite shape.

Liquid.

Q2. Convert 25°C into Kelvin.

25 + 273.15 = 298.15 K (commonly written as 298 K).

Q3. What is the SI unit of temperature?

Kelvin (K).

Q4. What is the melting point of ice?

273.15 K (or 0°C).

Q5. Why does a desert cooler cool better on a hot dry day?

High temperatures and low humidity accelerate the rate of water evaporation, absorbing thermal energy and increasing the cooling effect.

Q6. Name the phenomenon responsible for the spreading of perfume smell in a room.

Diffusion.

Q7. What is the boiling point of water at normal atmospheric pressure?

373.15 K (or 100°C).

Q8. What is the unit of latent heat?

> Joules per kilogram (J/kg).

Q9. Name two substances that undergo sublimation.

> Camphor and Ammonium Chloride (also Naphthalene and Iodine).

Q10. Why do gases exert pressure on the walls of their container?

> Gas particles move continuously and randomly at high speeds, colliding with each other and exerting force against the inner walls of the container.

Q11. What happens to the kinetic energy of particles when heat is supplied to a solid?

> The kinetic energy of the particles increases, causing them to vibrate more rapidly.

Q12. Define Brownian motion.

> The continuous, random, zig-zag motion of tiny particles suspended in a fluid (liquid or gas) caused by continuous collisions with moving molecules of the medium.

Q13. Why are solids rigid?

> Because their constituent particles are tightly packed with maximum intermolecular forces and minimal interparticle spaces.

Q14. What is the physical state of water at 373 K?

> Gaseous state (water vapour / steam).

Q15. Is evaporation a surface phenomenon or bulk phenomenon?

> Surface phenomenon.

B. Short Answer Questions (2–3 Marks)

Q1. State any three characteristics of particles of matter.

1. Particles of matter are extremely small.
2. Particles of matter have spaces between them (interparticle space).
3. Particles of matter are continuously moving and possess kinetic energy.
4. Particles of matter attract each other via intermolecular forces.

Q2. Why does diffusion become faster on heating?

Heating supplies thermal energy, which increases the kinetic energy of the particles. As a result, the particles move faster and mix together more rapidly.

Q3. Differentiate between evaporation and boiling.

Feature	Evaporation	Boiling
Temperature	Occurs at any temperature below the boiling point.	Occurs only at a specific fixed boiling point.
Mechanism	Surface phenomenon (particles escape from surface).	Bulk phenomenon (particles escape from across the liquid).
Thermal Effect	Always results in cooling of the remaining liquid.	Temperature remains constant throughout boiling.

Q4. Give reasons: (a) Sponge is a solid yet compressible. (b) We can walk through air but not through a wall.

(a) A sponge contains tiny pores trapped with air. When pressed, this air is expelled, allowing it to compress despite being a solid.
(b) Air is a gas with large interparticle spaces and very weak attractive forces, allowing our hands to move through it easily. A solid wall has tightly packed particles with strong forces, making it completely rigid.

Q5. Define latent heat of vaporisation. Why does temperature remain constant during boiling?

The latent heat of vaporisation is the amount of heat energy required to change $1 ext{ kg}$ of a liquid into a gas at its boiling point at atmospheric pressure without changing its temperature. The temperature stays constant because the added heat is fully used to break the intermolecular forces holding the liquid particles together, rather than increasing their average kinetic energy.

Q6. List three factors affecting evaporation. Explain one.

Factors: (i) Surface Area, (ii) Temperature, (iii) Humidity, (iv) Wind Speed.
Explanation (Surface Area): Evaporation is a surface phenomenon. Increasing the surface area exposes more particles to the edge, allowing more molecules to escape and boosting the evaporation rate. For example, wet clothes dry faster when spread out.

Q7. Why do we wear cotton clothes in summer?

Cotton is an excellent absorber of water. It absorbs sweat from the body and exposes it to the atmosphere, increasing the rate of evaporation. As the sweat evaporates, it absorbs latent heat of vaporisation from our body, producing a cooling effect.

Q8. How does applying pressure and reducing temperature help in liquefying gases?

Applying pressure forces gas particles closer together, reducing the interparticle spaces. Simultaneously, lowering the temperature reduces their kinetic energy, slowing them down. This combination allows intermolecular forces to pull the particles together, turning the gas into a liquid.

Q9. Give reason: Ice at 273 K is more effective for cooling than water at the same temperature.

Ice at $273 ext{ K}$ must absorb its latent heat of fusion ($3.34 imes 10^5 ext{ J/kg}$) from its surroundings to melt into liquid water. Because it absorbs this extra heat without rising in temperature, it removes more heat from the substance it touches than liquid water at $273 ext{ K}$ can.

Q10. Explain why steam at 373 K causes more severe burns than water at the same temperature.

Steam at $373 ext{ K}$ contains significantly more energy than boiling water at the same temperature because it holds extra hidden energy in the form of latent heat of vaporisation ($22.6 imes 10^5 ext{ J/kg}$). When steam hits the skin, it condenses and releases this extra heat, causing much more severe thermal burns.

Q11. Compare solids, liquids, and gases regarding shape, volume, and compressibility.

Property	Solid	Liquid	Gas
Shape	Definite shape	Indefinite shape (takes container form)	Indefinite shape
Volume	Definite volume	Definite volume	Indefinite volume
Compressibility	Negligible / Incompressible	Very slightly compressible	Highly compressible

Q12. Why are naphthalene balls kept in clothes? Explain scientifically.

Naphthalene undergoes sublimation, meaning it changes directly from a solid into a gas without melting into a liquid. The vapor released spreads throughout the clothes, repelling insects and moths to prevent damage.

Q13. Define melting point. Why does ice start melting at 0°C?

The melting point is the fixed temperature at which a solid substance turns into a liquid under standard atmospheric pressure. Ice starts melting at $0^\circ ext{C}$ because the thermal energy at this temperature is high enough to break the intermolecular forces holding the crystal lattice together.

Q14. Why does a liquid cool when it evaporates?

During evaporation, only the high-energy particles at the surface manage to overcome the liquid's attractive forces and escape as vapor. This leaves behind particles with lower average kinetic energy, which causes the temperature of the remaining liquid to drop.

Q15. Why are gases highly compressible but not liquids?

Gases have very large interparticle spaces, meaning there is plenty of empty room between molecules to force them closer together under pressure. In contrast, liquid particles are already packed relatively close together, leaving minimal empty space for further compression.

Q16. What is Brownian motion? Name the scientist who discovered it.

Brownian motion is the continuous, random, zig-zag motion of tiny particles suspended in a fluid, caused by constant collisions with the fast-moving molecules of the surrounding liquid or gas. It was discovered by botanist Robert Brown.

Q17. Distinguish between melting and freezing.

Melting is the process where a solid absorbs heat energy and transforms into a liquid. Freezing is the reverse process, where a liquid releases thermal energy and turns into a solid. For any pure substance, both transitions happen at the exact same temperature.

Q18. Why is water liquid at room temperature?

At room temperature ($25^\circ ext{C}$), water's intermolecular forces are balanced—strong enough to keep its particles gathered in a fixed volume, but fluid enough to let them slide past one another. Since room temperature lies squarely between water's melting point ($0^\circ ext{C}$) and boiling point ($100^\circ ext{C}$), it remains a liquid.

Q19. How can you demonstrate that particles of matter have spaces between them?

> Dissolve a spoonful of sugar into $100 ext{ mL}$ of water in a calibrated beaker. After stirring, the sugar disappears completely, but the overall water level does not rise. This happens because the dissolving sugar particles break apart and slip into the existing interparticle spaces between the water molecules.

Q20. Why does the smell of perfume reach every corner of the room?

> Perfume molecules evaporate quickly into high-energy gas particles. Because gases have large spaces between them and move at high speeds, the perfume particles rapidly mix and spread through the air via diffusion, quickly reaching every corner of the room.

C. Long Answer Questions (5 Marks)

Q1. Explain the characteristics of particles of matter with suitable experiments.

Characteristic	Experimental Verification	Scientific Deduction
Extremely Small Size	Dissolve 2-3 crystals of Potassium Permanganate ($ ext{KMnO}_4$) in $100 ext{ mL}$ water. Take $10 ext{ mL}$ of this solution and dilute it into $90 ext{ mL}$ of fresh water. Repeat this process 5 to 8 times.	The pink color remains visible even after high dilution. This proves a few tiny crystals contain millions of microscopic particles.
Have Interparticle Spaces	Add $50 ext{ g}$ of sugar into a beaker filled with $100 ext{ mL}$ of water. Mark the initial water level. Stir to dissolve.	The water level does not rise. This shows that the sugar particles broke apart and fit into the empty spaces between the water molecules.
Continuous Thermal Motion	Place an unlit incense stick in a corner—you must get close to smell it. Now, light the stick with a match.	The fragrance quickly spreads across the entire room. This shows that the particles move continuously, and heating increases their speed.
Mutually Attract Each Other	Try breaking an iron nail, a piece of chalk, and a rubber band by striking or stretching them.	The iron nail is hardest to break because different substances hold their particles together with different levels of intermolecular force.

Q2. Draw a labelled diagram showing the change of state of matter. Explain the role of temperature and pressure.

> Below is the phase transition mapping network for the states of matter:
>
> [Image of phase transition diagram showing melting vaporization condensation freezing sublimation and deposition]
>
> **1. The Governing Role of Temperature:** Adding heat energy increases the kinetic energy of particles, making them vibrate faster. At specific temperatures (the melting or boiling point), this energy becomes strong enough to overcome the attractive forces holding the particles together, causing a phase change. Cooling removes kinetic energy, allowing attractive forces to pull the particles back into a more structured state.
>
> **2. The Governing Role of Pressure:** Increasing pressure forces gas particles closer together, reducing interparticle spaces. If you lower the temperature at the same time to slow down the particles, the gas will condense into a liquid. For example, solid carbon dioxide ($ ext{Solid CO}_2$) is kept under high pressure; reducing the pressure back to 1 atmosphere causes it to sublime directly into a gas.

Q3. Explain the phenomenon of evaporation. Discuss any four factors affecting the rate of evaporation with examples.

> **Evaporation** is the process where a liquid changes into a gas or vapor at any temperature below its boiling point. It is a surface phenomenon. Particles at the surface gain enough kinetic energy from collisions to break away from the attractive forces of the remaining liquid and escape into the air.
>
> - **Temperature:** Higher temperatures give more particles the kinetic energy needed to escape into the vapor state. *Example:* Clothes dry much faster on a hot summer day than in winter.
> - **Surface Area:** Since evaporation happens only at the surface, increasing the exposed surface area gives more particles a chance to escape at once. *Example:* Hot tea cools down much faster when poured from a narrow cup into a wide saucer.
> - **Humidity:** Humidity measures the amount of water vapor already present in the air. The air around us can only hold a limited amount of moisture at a given temperature; if humidity is already high, it cannot easily accept more vapor, slowing down evaporation. *Example:* Wet clothes take a long time to dry on humid, rainy days.
> - **Wind Speed:** Strong winds blow away water vapor particles from the immediate area, lowering the local humidity and allowing more water to evaporate. *Example:* Clothes dry faster when hung under a moving ceiling fan.

Q4. Differentiate between solids, liquids, and gases based on five major properties.

Property Criteria	Solid State	Liquid State	Gaseous State
1. Interparticle Space	Extremely small / negligible	Intermediate / moderate	Extremely large space
2. Attractive Forces	Very strong	Moderate	Negligible / very weak
3. Kinetic Energy	Lowest (particles only vibrate)	Intermediate	Highest (free random motion)
4. Shape & Volume	Definite shape & volume	Fixed volume, indefinite shape	Indefinite shape & volume
5. Compressibility	Incompressible / rigid	Slightly compressible	Highly compressible

Q5. Describe an activity to show that the rate of diffusion increases with increase in temperature.

Aim: To prove that the rate of diffusion increases as temperature rises.

Procedure: Prepare two beakers: Fill Beaker A with $100 ext{ mL}$ of hot water and Beaker B with $100 ext{ mL}$ of ice-cold water. Drop a few crystals of Copper Sulfate ($ ext{CuSO}_4$) or Potassium Permanganate into both beakers at the exact same time. Leave the beakers completely still and watch how the color spreads.

Observation: The intense color spreads quickly throughout Beaker A (hot water) without any stirring. In Beaker B (cold water), the color settles near the bottom and spreads very slowly.

Conclusion: Higher temperatures provide more thermal energy, which increases the kinetic energy of the particles. Because the particles move faster, they mix together much more quickly, proving that diffusion speeds up with heat.

Q6. Why does temperature remain constant during melting of ice and boiling of water? Explain latent heat in detail.

When a substance changes its state, the temperature stays completely constant because the added heat energy is used as **latent heat** (hidden heat). Instead of raising the temperature, this energy is used to break the intermolecular forces holding the particles together in their current phase.

- **Latent Heat of Fusion:** The heat energy needed to convert $1 ext{ kg}$ of a solid into a liquid at its melting point under standard atmospheric pressure. For ice, this value is $3.34 imes 10^5 ext{ J/kg}$. During melting, the temperature stays at $0^\circ ext{C}$ until every bit of ice has turned into water.
- **Latent Heat of Vaporisation:** The heat energy needed to convert $1 ext{ kg}$ of a liquid into a gas at its boiling point under standard atmospheric pressure. For water, this value is $22.6 imes 10^5 ext{ J/kg}$. During boiling, the temperature stays at $100^\circ ext{C}$ until all the liquid has turned into steam.

Q7. How can matter change its state? Explain the effect of change of pressure with two examples.

> Matter can change its state through two primary methods: changing the temperature or changing the external pressure. While changing temperature alters the kinetic energy of the particles, changing pressure alters the distance between them.
>
> **Example 1 (Liquefaction of Gases):** Industrial gases are stored and transported as liquids by applying high pressure and lowering the temperature. The high pressure forces the gas molecules close together, while the cooling slows them down enough for intermolecular forces to lock them into a liquid state (such as LPG or Liquid Nitrogen).
>
> **Example 2 (Solid Carbon Dioxide / Dry Ice):** Carbon dioxide gas can be turned into a solid by drastically reducing temperature and increasing pressure. This solid $ ext{CO}_2$ is called "dry ice." It must be stored under extremely high pressure. When exposed to normal atmospheric pressure ($1 ext{ atm}$), it sublimes directly back into a gas without melting, which is why it is widely used as a deep-cooling agent.

Q8. Why is it advised to wear light coloured cotton clothes in summer and dark woollen clothes in winter? Explain using heat, evaporation, and radiation concepts.

> **Summer Clothing Strategy:** Light colors are poor absorbers but excellent reflectors of thermal radiation, helping keep solar heat away from the body. Cotton fabric has a porous weave that absorbs sweat easily. It pulls moisture away from the skin and exposes it to the air, speeding up evaporation. As the sweat turns to vapor, it absorbs its latent heat of vaporisation from our skin, producing a comfortable cooling effect.
>
> **Winter Clothing Strategy:** Dark colors absorb almost all incident thermal radiation, helping capture warmth from sunlight. Wool is a poor conductor of heat and features a highly crimped fiber structure that traps small pockets of air. Since trapped air acts as an excellent thermal insulator, it prevents body heat from escaping into the cold environment, keeping us warm.

Q9. Distinguish between latent heat of fusion and latent heat of vaporisation based on core metrics.

Metrics	Latent Heat of Fusion	Latent Heat of Vaporisation
Phase Boundary	Applies to the transition between solid and liquid phases.	Applies to the transition between liquid and gaseous phases.
Thermodynamic Point	Measured at the substance's melting point.	Measured at the substance's boiling point.
Energy Profile Value (Water)	Requires $3.34 imes 10^5 \ ext{J/kg}$ to melt ice.	Requires $22.6 imes 10^5 \ ext{J/kg}$ to vaporize water.
Structural Action	Loosens the rigid crystalline structure so particles can slide.	Completely breaks all remaining attractive forces so particles can fly freely.

Q10. Explain the concept of sublimation with two examples. How will you demonstrate sublimation in the laboratory?

> **Sublimation** is the phase change where a solid turns directly into a gas or vapor without melting into a liquid first. The reverse process, where a vapor cools directly into a solid, is called **deposition**. Common examples include Ammonium Chloride, Camphor, Iodine crystals, and Naphthalene.
>
> **Laboratory Demonstration Steps:** Crush some Ammonium Chloride ($ ext{NH}_4 ext{Cl}$) and place it in a clean china dish. Set an inverted glass funnel over the dish, and plug the narrow open stem of the funnel with a small wad of cotton. Place the dish on a tripod stand over a Bunsen burner and heat it slowly.
>
> **Observation & Conclusion:** As it heats up, the solid ammonium chloride does not melt into a liquid. Instead, it turns directly into white vapor that rises inside the funnel. When these vapors hit the cooler upper walls of the glass funnel, they cool down and deposit back as a pure solid sublimate. This experiment clearly demonstrates sublimation.

Q11. A student cools a liquid from 50°C to 10°C. Explain changes in kinetic energy and particle arrangement. What would happen if the same liquid is heated to 120°C? (Assume liquid is water)

> **Cooling Sequence (50°C → 10°C):** As the temperature drops, the liquid loses thermal energy, causing the average kinetic energy of its particles to decrease. The molecules slow down, allowing intermolecular forces to pull them tighter together. This causes a slight decrease in interparticle space, though the water remains a liquid since it stays above its freezing point ($0^\circ ext{C}$).
>
> **Heating Sequence up to 120°C:** As you heat the water from $50^\circ ext{C}$ to $100^\circ ext{C}$, the particles gain kinetic energy and move faster, causing the temperature to rise steadily. Once it hits $100^\circ ext{C}$ (its boiling point), the temperature stops rising and stays completely flat. At this plateau, all added heat is used as latent heat of vaporisation to break the intermolecular bonds and turn the liquid into steam. Once all the water has vaporized, heating it further from $100^\circ ext{C}$ to $120^\circ ext{C}$ increases the kinetic energy of the steam particles, causing the temperature of the gas to rise again.

Q12. Provide a rigorous scientific justification for the following statements: (a) A gas fills entire vessel. (b) A gas exerts pressure. (c) Gases are highly compressible. (d) Gases show maximum diffusion. (e) Solids cannot be compressed.

> **(a)** Gas particles have very high kinetic energy and almost no intermolecular attraction, allowing them to break completely free and move randomly in all directions to fill any container.
> **(b)** Gas particles move continuously at high speeds, constantly colliding with each other and striking the inner walls of the container. These rapid impacts exert a steady force per unit area, creating gas pressure.
> **(c)** Because gas molecules are spread far apart with massive interparticle spaces, applying pressure easily forces them closer together, drastically reducing the volume.
> **(d)** The combination of high kinetic energy (fast motion) and large open spaces between particles allows gas molecules to easily slide past and mix with other gases very quickly.
> **(e)** Particles in a solid are already tightly packed together with maximum attraction and almost zero interparticle space, leaving no room to force them any closer under pressure.

Q13. Explain why: (a) A sharp knife cuts vegetables easily. (b) Incense stick fragrance spreads quickly. (c) Sponge is compressible. (d) Boiling water is difficult on mountains. (e) Water droplets appear on cold glass.

> **(a)** A sharp knife has an extremely thin edge, which concentrates the applied force onto a very small surface area. This generates high pressure ($ ext{Pressure} = ext{Force}/ ext{Area}$) that easily breaks the intermolecular bonds of the vegetable tissues.
> **(b)** Burning the incense stick generates high-temperature gas particles with high kinetic energy. These fast-moving particles diffuse rapidly through the large open spaces in the air, carrying the scent across the room.
> **(c)** A sponge features a highly porous matrix containing trapped pockets of air. Pressing the sponge forces this trapped air out through the pores, allowing the solid structure to compress.
> **(d)** Atmospheric pressure drops at higher altitudes. Because the surrounding pressure is lower, water molecules can escape into vapor much more easily, causing water to boil at a temperature well below $100^\circ ext{C}$. This lower boiling temperature carries less thermal energy, making it harder to cook food thoroughly.
> **(e)** The surrounding air naturally contains invisible water vapor. When these warm vapor particles hit the cold outer surface of the glass, they lose thermal energy and condense back into visible liquid water droplets.

Q14. Describe the key regions of a temperature vs. heat graph for ice at -10°C heated to steam at 110°C.

> A heating curve for water across phases features distinct alternating rising sloped lines and flat horizontal plateaus:
>
> [Image of heating curve graph for water plotting temperature against heat showing sloped lines and phase change plateaus]
>
> - **Region AB (Sloped Line, -10°C to 0°C):** The added heat increases the kinetic energy of the ice particles, causing the temperature of the solid ice to rise steadily toward $0^\circ ext{C}$.
> - **Region BC (Horizontal Plateau at 0°C):** The temperature stops rising. This flat region represents the phase change from solid ice to liquid water, where all added energy is used as latent heat of fusion to break the crystal lattice.
> - **Region CD (Sloped Line, 0°C to 100°C):** Once all the ice has melted, the added heat increases the kinetic energy of the liquid water molecules, raising the temperature steadily up to $100^\circ ext{C}$.
> - **Region DE (Horizontal Plateau at 100°C):** The temperature levels off again. This flat region represents boiling, where the heat is used as latent heat of vaporisation to turn liquid water into gaseous steam.
> - **Region EF (Sloped Line, Above 100°C):** Once all the liquid has turned into gas, any extra heat increases the kinetic energy of the steam particles, causing the temperature of the gas to rise above $110^\circ ext{C}$.

Q15. Differentiate briefly between the following pairs: (a) Rigidity & Fluidity, (b) Fusion & Vaporisation, (c) Condensation & Freezing, (d) Evaporation & Sublimation, (e) Diffusion & Brownian motion.

> **(a) Rigidity vs. Fluidity:** Rigidity is a solid's ability to maintain its shape and resist deformation under external force. Fluidity is the ability of liquids and gases to flow and change shape easily based on their container.
> **(b) Fusion vs. Vaporisation:** Fusion is the phase transition where a solid melts into a liquid at its melting point. Vaporisation is the phase transition where a liquid boils and turns into a gas at its boiling point.
> **(c) Condensation vs. Freezing:** Condensation is the phase change where a gas cools down and turns into a liquid. Freezing is the phase change where a liquid loses heat and turns into a solid.
> **(d) Evaporation vs. Sublimation:** Evaporation is a slow surface process where a liquid changes to a gas at any temperature below its boiling point. Sublimation is a process where a solid changes directly into a gas without passing through a liquid phase.
> **(e) Diffusion vs. Brownian motion:** Diffusion is the passive mixing of different substances caused by the random motion of their particles. Brownian motion is the specific, random, zig-zag movement of tiny visible particles suspended in a fluid, caused by constant collisions with the invisible molecules around them.

SECTION B: NCERT Activity-Based Questions

Activity 1.2: Potassium Permanganate Dilution Study

Dissolve 2 crystals of $ ext{KMnO}_4$ in $100 ext{ mL}$ water, transfer $10 ext{ mL}$ into $90 ext{ mL}$ of fresh water, and repeat for multiple steps.
Core Observation & Deduction: The pink color remains visible even after being diluted many times. This proves that matter is made of incredibly tiny particles, with a single small crystal containing millions of microscopic units that spread out across the water.

Activity 1.3: Sugar Solution Evaluation

Add a spoonful of sugar or salt to a marked volume of water and mix thoroughly.
Core Observation & Deduction: The sugar disappears completely, but the overall water level does not rise. This proves that particles of matter have empty spaces between them; the dissolving sugar particles break down and slip into the gaps between the water molecules.

Activity 1.11: The Sealed Bell Jar Vacuum Check

Place an active ringing electric bell inside a sealed glass bell jar connected to a working vacuum pump.
Core Observation & Deduction: As the pump removes air from the jar, the sound of the bell grows steadily fainter until it goes completely silent, even though the mechanical hammer can still be seen striking the bell. This proves that sound is a mechanical wave that requires a material medium to travel and cannot propagate through a vacuum.

Activity 1.13: Syringe Compression Metrics

Take three identical syringes: trap a solid piece of chalk in the first, fill the second with water, and trap air in the third. Seal the nozzles and push the pistons down hard.
Core Observation & Deduction: The piston in the air syringe pushes down easily under force, while the water piston barely budges, and the chalk piston remains completely locked in place. This demonstrates that gases are highly compressible due to their large interparticle spaces, whereas liquids and solids are virtually incompressible.

SECTION C: Assertion & Reason Questions

Directions: Select **(A)** if both Assertion (A) and Reason (R) are true and R is the correct explanation of A; select **(B)** if both are true but R is not the correct explanation; select **(C)** if A is true but R is false; select **(D)** if A is false but R is true.

1. Assertion (A): Solids possess a rigid, definite shape and a fixed volume.
Reason (R): The intermolecular forces holding solid particles together are extremely strong, keeping them in fixed positions.

> **Ans: (A)** Both statements are true, and the strong forces explain why solids maintain their rigid shape.

2. Assertion (A): Ice at 0°C ($273 ext{ K}$) provides more effective cooling than liquid water at the exact same temperature.
Reason (R): Ice absorbs extra heat energy equal to its latent heat of fusion from its surroundings in order to melt.

> **Ans: (A)** Both statements are true, and the absorption of latent heat directly explains the superior cooling effect.

3. Assertion (A): Steam at 100°C causes significantly more severe thermal burns than boiling water at 100°C.
Reason (R): Steam exists at a much higher physical temperature than boiling water.

> **Ans: (C)** Assertion is true, but the Reason is false. Both steam and boiling water exist at the exact same temperature ($100^\circ ext{C}$); steam causes worse burns because it carries extra energy as latent heat of vaporisation.

4. Assertion (A): Solid naphthalene balls gradually disappear over time without leaving behind any liquid residue.
Reason (R): Naphthalene undergoes sublimation, changing directly from a solid into a vapor.

> **Ans: (A)** Both statements are true, and sublimation is the direct reason why no liquid residue is left behind.

5. Assertion (A): The rate of evaporation from an open liquid surface increases significantly when surrounding humidity rises.
Reason (R): High humidity means the air already contains a large amount of water vapor.

> **Ans: (D)** Assertion is false, but the Reason is true. Higher humidity slows down evaporation because the air is already saturated with moisture.

SECTION D: Case Study Questions

Case Study: Evaporation Factors in Action

An experimental chemistry student hangs three identical wet cotton cloths to dry under three different environmental conditions: Cloth 1 is placed outside in direct sunlight with a strong wind blowing; Cloth 2 is placed under shade with no moving air; Cloth 3 is placed inside a humid greenhouse room.

Q1. Which cloth will dry the fastest? Explain the scientific reason behind this.

> **Ans:** Cloth 1 will dry the fastest. Direct sunlight provides thermal energy that increases the kinetic energy of the water particles, while the strong wind blows away water vapor as it escapes, lowering local humidity and speeding up evaporation.

Q2. Why does Cloth 3 dry slowest inside the greenhouse room?

> **Ans:** The air inside the greenhouse is highly humid and trapped. Because the air is already filled with water vapor, it cannot easily accept more moisture, which slows evaporation to a crawl.

Q3. What kind of physical process is evaporation, and how does it affect the temperature of its surroundings?

> **Ans:** Evaporation is a surface phenomenon. As high-energy particles escape from the surface, they take latent heat with them, lowering the average kinetic energy of the remaining liquid and causing a cooling effect.

SECTION E: High-Yield Exam Blueprint Matrix

Q.No.	Most Expected Core Examination Question Targets	Weightage
1	Define latent heat of vaporisation. Why does temperature remain constant during boiling?	3 Marks
2	List four distinct factors that affect evaporation, and explain how each alters the rate.	5 Marks
3	Explain why steam at 373 K causes more severe burns than boiling water at the same temperature.	2 Marks
4	Describe a laboratory experiment to demonstrate the sublimation of ammonium chloride.	5 Marks
5	Compare solids, liquids, and gases regarding interparticle spaces, attractive forces, and kinetic energy.	5 Marks