CHEMISTRY
UNIT: 2 MATTER
SLO'S. (LECTURE BY MISS AYESHA)

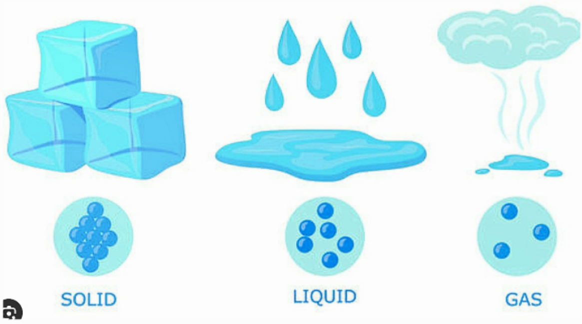
Q1: Define Phase Change

Definition:

A **phase change** is the **physical change of matter from one state to another without altering its chemical composition**.

States of Matter:

- **Solid** (e.g., ice) → **Liquid** (e.g., water) → **Gas** (e.g., water vapours)



Internal Energy and Its Types

Internal Energy:

The **total energy** possessed by a substance due to the motion and position of its particles.

🔷 **Types of Internal Energy:**

- Kinetic Energy
- Definition: Energy due to motion or temperature of particles.
- **Example:** In **boiling water**, particles move faster as temperature increases.
- Potential Energy
- Definition: Energy due to the position or arrangement of particles.
- **Example:** In **ice**, particles are closely packed with strong forces holding them, so potential energy is high.

Q: Define Types of state change :

Melting, freezing, sublimation, deposition, condensation, and evaporation.

1): Melting (Endothermic Process):

A phase transition in which a substance **changes from solid to liquid by absorbing heat**.

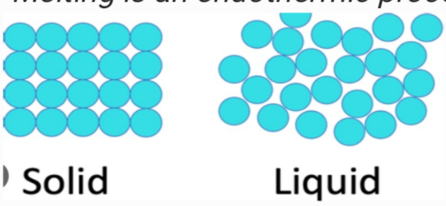
Solid State → Liquid State

Example: *Melting of ice*

Explanation / Reasoning:

- A solid (like ice) is heated.
- Its particles gain energy and vibrate faster.
- Vibrations become strong enough to break the forces holding them.
- Particles start moving freely.
- The solid turns into a liquid.

Melting is an endothermic process because it absorbs heat energy.



2): Boiling (Endothermic Process)

Definition:

Boiling is a **phase transition** in which a substance **changes from liquid to gas by the addition of heat**.
Liquid State → Gaseous State

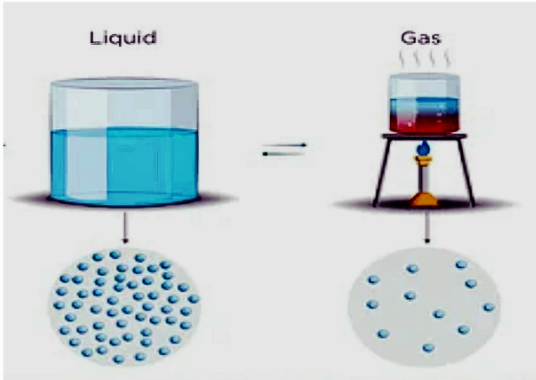
Example:

Conversion of water into steam

Explanation / Reasoning:

- The **liquid absorbs heat**.
- Heat increases **vibrational and translational motion** of particles.
- **Attractive forces** between liquid particles **break**.
- As a result, the **distance between molecules increases**, and the **liquid turns into gas**.

*Boiling is an endothermic process because it **requires heat** to occur.*



3): Freezing (Exothermic Process)

🔷 **Definition:**

Freezing is a **phase transition** in which a substance **changes from liquid to solid by losing heat**.
Liquid State → Solid State

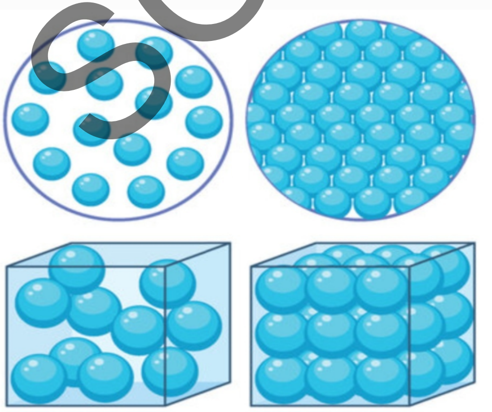
Example:

Freezing of water to form ice

Explanation / Reasoning:

- The **liquid particles lose energy** and **slow down**.
- Particles come **closer to each other**.
- The **force of attraction increases** between the particles.
- The **liquid is converted into a solid state**.

*Freezing is an **exothermic** process because it **releases heat** during the change.*



4): Condensation (Exothermic Process)

Definition:

Condensation is a **phase change** in which a **gas changes into liquid** by **losing heat**.
Gas → Liquid

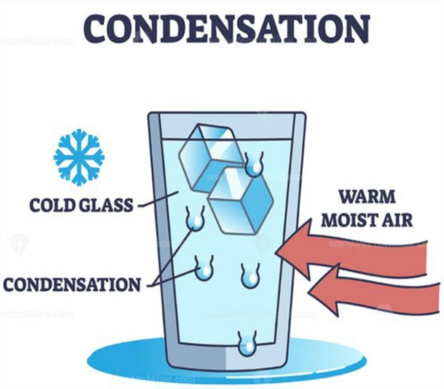
Example:

Formation of dew drops on the surface of grass in the early morning.

Explanation / Reasoning

- **Gas particles lose energy.**
- Particles **slow down**.
- Particles **come closer** to each other.
- Gas changes into **liquid**.

Condensation is **exothermic** because it **releases heat** to the surroundings.



5): Sublimation (Endothermic Process)

🔷 Definition:

Sublimation is a **process in which a solid changes directly into gas** without passing through the **liquid state**.
Solid State → Gaseous State

Examples:

- **Dry ice** (solid CO_2)
- **Iodine crystals**
- **Camphor**

Reason:

These substances have **weak intermolecular forces (IMF)**.

Explanation / Reasoning:

- Solid particles **gain energy**.
- The energy **breaks attractive forces** between particles.
- This energy is enough to **convert solid directly into gas**.

*Sublimation is an **endothermic process** because it absorbs heat.*

Deposition / Desublimation (Exothermic Process)

🔷 **Definition**:

Deposition is a **process in which a gas changes directly into solid** without passing through the liquid state.

Gas → Solid

🔷 **Examples:**

- **Frost formation** (water vapor → ice crystals)
- **Snowflakes**
- **Soot deposition** on chimneys (smoke → solid particles)

Explanation / Reasoning:

- Gas particles **lose energy**.
- Motion of particles **slows down**.
- **Attractive forces increase** and pull particles together.
- Gas is **converted into solid** directly.
- **Energy is released**, and **potential energy decreases**.

Deposition is an **exothermic process** because **heat is released** to the surroundings.


Q: Define heating curve.?

Heating Curve:

A **heating curve** typically shows **temperature change over time** as a **substance is heated**.
It represents how the **temperature increases or stays constant** during **phase changes** (solid → liquid → gas).

● Solid Phase (A to B):

In the **solid phase**, from point **A to B**:

- **Temperature increases** as the **solid absorbs heat**.
- According to the **Kinetic Molecular Theory (KMT)**, **kinetic energy (K.E)** of particles increases.
- Particles **vibrate more vigorously** due to increase in energy.

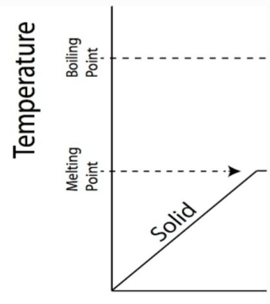
Heat → K.E ↑ → Temp ↑ → Vibration ↑

Formula:

$$\mathrm{K.E} \propto T$$

Phase Symbols:

- **S** → Solid
- **L** → Liquid
- **G** → Gas



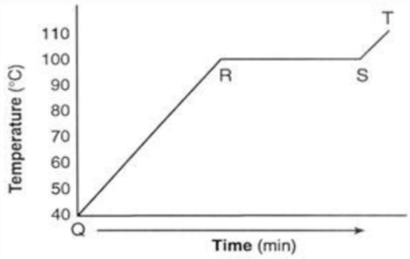
● Melting (B to C):

Melting is the change from solid to liquid.

- Temperature stays constant
- Heat is used to break intermolecular forces
- So solid start melting point

Changes During Melting (B → C):

- Temperature: Constant
- Kinetic Energy (K.E): Constant
- Potential Energy (P.E): Increases
- Distance between particles: Increases
- Heat energy: Used to overcome intermolecular forces (IMF)



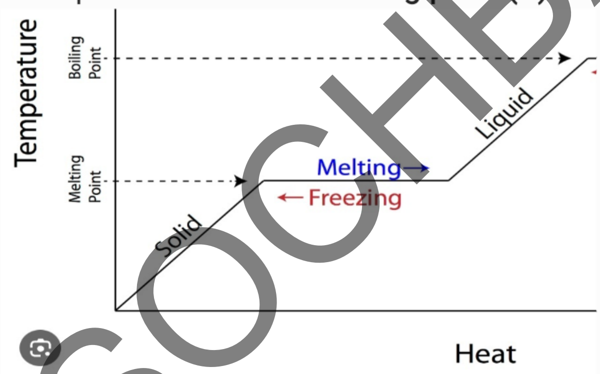
●Liquid Phase (C to D)

- As heat is absorbed, **temperature increases**.
- This increases the **kinetic energy (K.E)** of particles.
- Particles move **faster** but remain close together.
- **Potential energy (P.E)** remains **constant**.

Summary:

- **Heat absorbed → Temp ↑ → K.E ↑**
- **P.E = Constant**

Particles move more rapidly as the liquid gets hotter.
This phase ends at the **boiling point (D)**.



● Boiling Phase (D to E)

Key Points (D → E):

- Temperature remains constant
- Heat is absorbed, but it's used to overcome intermolecular forces (IMF)
- Kinetic Energy (K.E) stays constant
- Potential Energy (P.E) increases

Latent Heat of Vaporization:

- It is the energy needed to change a substance from liquid to gas at its boiling point without changing temperature.

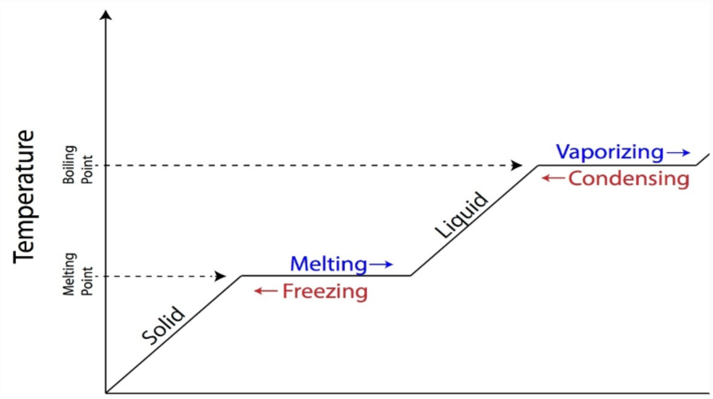
Formula:

$$Q = m \times L_v$$

- Q= heat absorbed
- m= mass of substance
- L= latent heat of vaporization
- Unit: J/kg

Summary:

- Temp = Constant
- K.E = Constant
- P.E ↑
- Heat → breaks IMF → liquid → gas



Gas Phase (E onward)

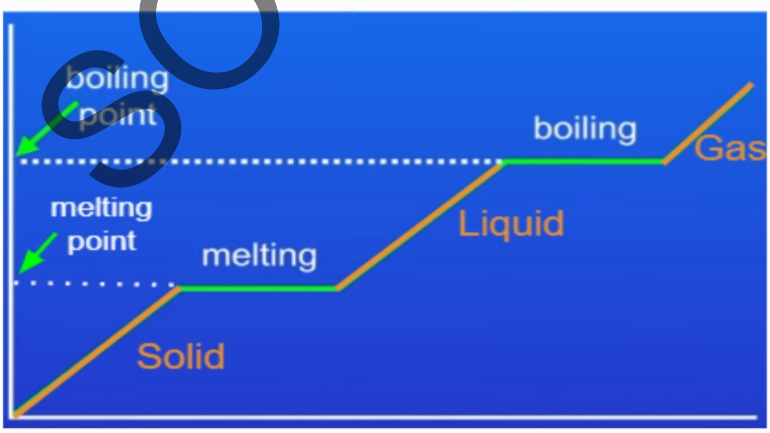
Key Points:

- **Temperature increases**
- **Kinetic Energy (K.E)** increases
- **Potential Energy (P.E)** remains **constant**
- Gas absorbs heat, causing particles to move **very rapidly**

Summary (E onward):

- **Heat absorbed → Temp ↑ → K.E ↑**
- **P.E = Constant**
- Gas particles move **faster** and become **more energetic**

This is the final stage in the **heating curve**, where the substance is fully in the **gaseous state**.



Q: Define cooling curve ?

Cooling Curve (Gas Phase) – (high to E)

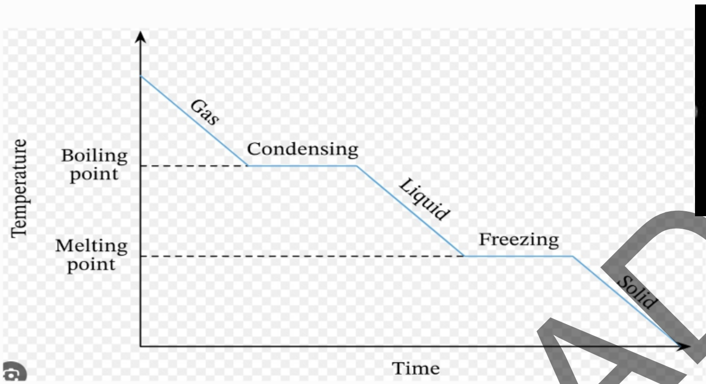
A **cooling curve** shows the **reverse process** as a substance is **cooled** from **gas to liquid to solid**.

1: Gas Phase:

- The gas has **high temperature and energy**.
- As it **loses heat**, the **temperature decreases**.
- The **kinetic energy (K.E.)** of molecules decreases, so they **move slower**.

2: Condensation Point (Gas → Liquid): (E TO D)

- **Condensation** is the phase change from **gas to liquid**.
- **Temperature remains constant**.
- The **heat is released** as the gas cools.
- **Intermolecular attractive forces (IMF)** increase.
- Gas particles are **brought closer together**.
- **Kinetic energy remains constant**, but **potential energy decreases**.
- As a result, **gas is converted into liquid**.



3. Liquid Phase (D to C):

- The **temperature decreases** as the liquid is **cooled**.
- **Kinetic energy** decreases.
- Molecules move **more slowly**.

4. Freezing Phase (C to B):

- Liquid **freezes into solid**.
- **Temperature and kinetic energy stay constant**.
- **Potential energy decreases** as heat is released.
- **Attractive forces (IMF)** between particles **increase**.
- This heat is called **latent heat of fusion**.

These changes are shown in the cooling curve from **C to B** where phase change happens without temperature change.

Q: Define Cooling curve and Heating curve

Cooling Curve:

A cooling curve shows how the **temperature of a substance drops over time** as it cools.

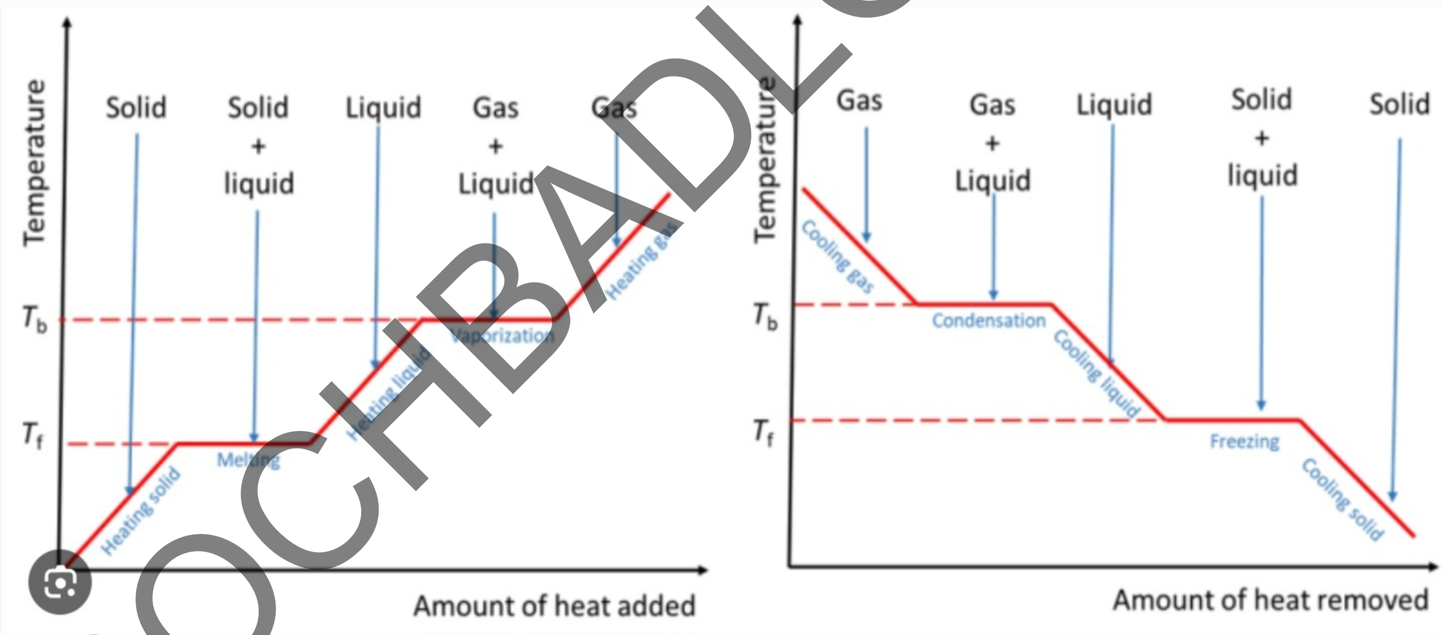
- **Flat parts**: Condensation and freezing occur, **temperature stays constant**.
- **Sloping parts**: Temperature **decreases**, kinetic energy drops, and particles **move more slowly**.
- It shows the process: **Gas → Liquid → Solid**.

Heating Curve:

- A heating curve shows how the **temperature of a substance changes** as heat is added over time.
- **During flat parts** (melting and boiling), temperature stays **constant**.
- **During sloped parts**, temperature **increases** as particles gain **kinetic energy** and move faster.
- It shows changes from **solid → liquid → gas**.

Example: Ice melts to water (flat line), then water heats up (rising line), then boils into steam (flat line), and steam gets hotter (rising line).

- **Heating Curve**: Solid → Liquid → Gas
- **Cooling Curve**: Gas → Liquid → Solid



Q: Define Evaporation

Definition:
Evaporation is the process in which molecules at the surface of a liquid gain enough kinetic energy to escape into the gaseous phase.

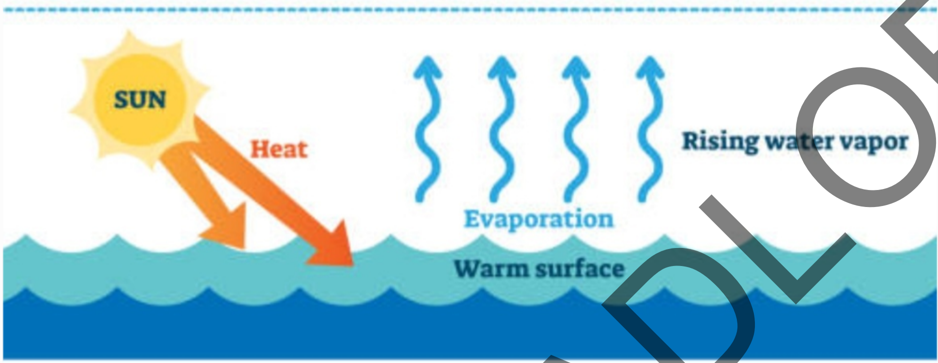
Reason/Cause:

- Only surface molecules with enough energy can break intermolecular forces (IMF) and become gas.
- It is an endothermic process – it absorbs heat.
- Heat increases kinetic energy, helping molecules overcome attraction and escape.

Explanation:
1. Happens only at the surface of the liquid.
2. Can happen at any temperature, not just boiling point.
3. High-energy particles escape into air.
4. Causes co

Example:

- Drying of clothes under the sun.
- Sweat evaporating from skin cools the body.
- Evaporation from lakes and oceans helps in the **water cycle**.



Factors Affecting Evaporation

- **Temperature**: More heat = faster evaporation.
- **Surface Area**: Bigger surface = more evaporation.
- **Wind**: Wind blows away vapor = more evaporation.
- **IMF (Intermolecular Forces)**: Weaker forces = easier evaporation.
- **Air Pressure**: Low pressure = faster evaporation.
- **Humidity**: More humidity = slower evaporation.

1. Why does water boil at a lower temperature on mountains?
At high altitudes like mountains, atmospheric pressure is lower, so vapor pressure equals it at a lower temperature, causing water to boil before 100°C.

2. How does a pressure cooker affect the boiling point of water?
A pressure cooker increases the pressure inside, which raises the boiling point of water, allowing food to cook faster at higher temperatures.

3. Why does adding salt increase the boiling point of water?
Adding salt raises the boiling point because it increases the number of particles in water, requiring more heat for vapor pressure to match external pressure.
Let me know if you want this in table or image form.

Q: Differentiate between Evaporation and boiling

Feature	Evaporation	Boiling
Temperature	Happens at **any temperature** below boiling point	Happens at **boiling point only**
Place in Liquid	Occurs **only at surface** of liquid	Occurs **throughout** the liquid
Effect	Causes **cooling** (e.g. sweat cools the body)	No cooling; heat forms **bubbles of gas**
Example	Water **evaporating** from wet clothes	Water **boiling** in a kettle

Q: DEFINE THE BOILING PROCESS

Boiling (Definition):

Boiling is the process in which a liquid changes into vapor **when it is heated to its boiling point**.

Explanation:

When a liquid is heated enough, vapor bubbles form inside the liquid and rise to the surface. This shows that boiling happens throughout the liquid, not just at the surface.

Key Points:

- Boiling occurs at a fixed temperature (boiling point).
- It happens throughout the liquid, not only at the surface.
- Vapor pressure becomes equal to the atmospheric pressure.
- Temperature remains constant during boiling.

Boiling Point

Boiling point is the temperature at which the vapor pressure of a liquid becomes equal to the external pressure (atmospheric pressure).

At this point, the liquid starts to boil and changes into vapor throughout the liquid, not just at the surface.

Example: Water boils at 100°C at sea level.

Factors Affecting Boiling:

- Atmospheric Pressure:
- Low pressure → Boiling point decreases
- High pressure → Boiling point increases
- Impurities or Salt:
- Increases boiling point (e.g. salt in water)
- Intermolecular Forces (Attractive Forces):
- Stronger forces → Higher boiling point

Example:

- **Water boils at 100°C**
- **Ethanol boils at 78.5°C**

Q: What is Evaporation and Boiling?

Evaporation:

Evaporation is the process where surface molecules of a liquid turn into gas at **any temperature**.

- **Reason**: Fast-moving particles escape the surface.
- **Example**: Sweat drying on skin.
- **Effect**: Causes **cooling**.

Boiling:

Boiling is when a liquid turns into gas at its **boiling point** throughout the liquid.

- **Reason**: Heat forms vapor bubbles that rise and burst.
- **Example**: Water boiling in a pot.

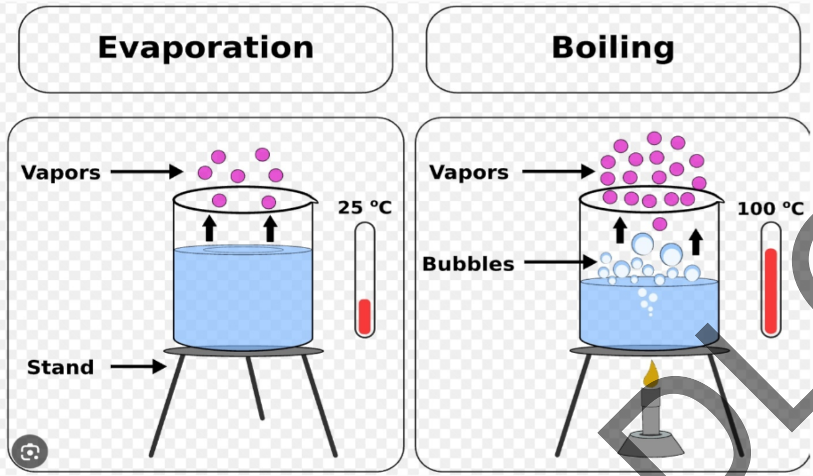
Effect of Pressure on Evaporation and Boiling:

Lower Pressure:

- Evaporation and boiling happen **faster** (e.g., on mountains).

Higher Pressure:

- Evaporation and boiling happen **slower** (e.g., in a pressure cooker).



Q: What is the effect of pressure on evaporation and boiling?

EVAPORATION

🔸 **Effect of Lower Pressure on Evaporation:**

- **Definition**: Evaporation increases at lower pressure.
- **Reason**: Lower pressure means weaker force on the liquid surface, so particles escape easily.
- **Example**: Water evaporates faster at high altitudes.

🔸 **Effect of Higher Pressure on Evaporation**:

- **Definition**: Evaporation decreases at higher pressure.
- **Reason**: Stronger external pressure holds particles, making it harder to escape.
- **Example**: In a pressure cooker, water evaporates slowly until high temperature is reached.

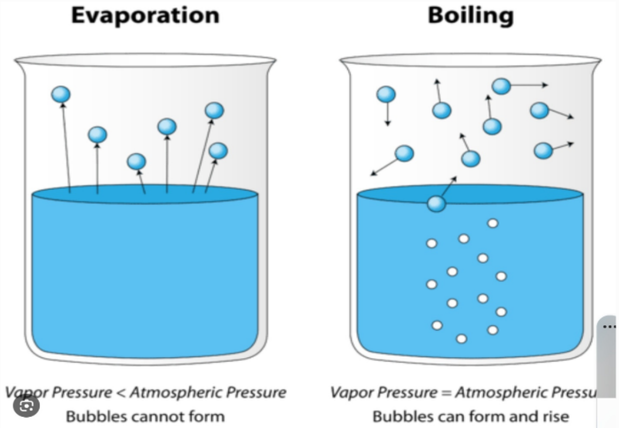
BOILING

🔸 **Effect of Lower Pressure on Boiling:**

- **Definition**: Boiling point decreases at lower pressure.
- **Reason**: Less heat is needed as gas forms more easily.
- **Example**: Water boils at a lower temperature on mountains.

🔸 **Effect of Higher Pressure on Boiling:**

- **Definition**: Boiling point increases at higher pressure.
- **Reason**: More heat is needed because particles need more energy to escape.
- **Example**: In a pressure cooker, water boils at a higher temperature, cooking food faster.



Q: Define Kinetic Particle Theory and Gas Laws

Gases are described using **four variables**:

- Number of moles (n)
- Volume (V)
- Pressure (P)
- Temperature (T)

The **kinetic particle theory** explains that gas particles are in constant motion and collide with container walls, creating pressure.

Gas laws show how two variables affect each other when the others are kept constant:

- $P \propto T$ (at constant n, V) → Direct relation
- $V \propto P$ (at constant T, n) → Inverse relation
- $V \propto T$ (at constant P, n) → Direct relation

These relationships help understand gas behavior.

Q: Define Boyle's Law of kinetic particle theory?

Statement:

It is stated that, At constant temperature, the volume of a gas is inversely proportional to its pressure.

Mathematical Equation:

$P \propto 1/V$ or $PV = k$

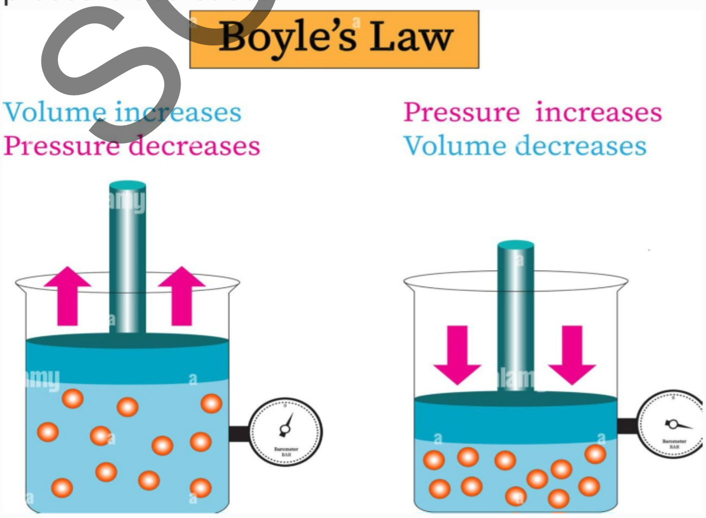
$P_1V_1 = P_2V_2$

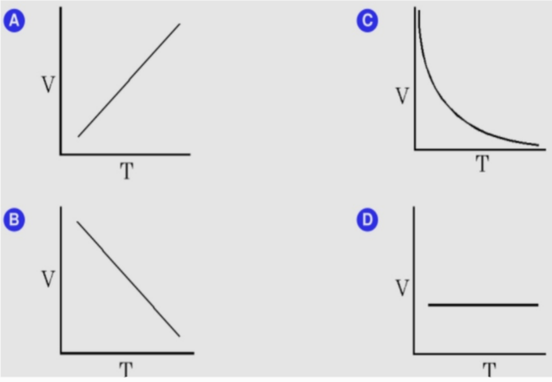
Explanation

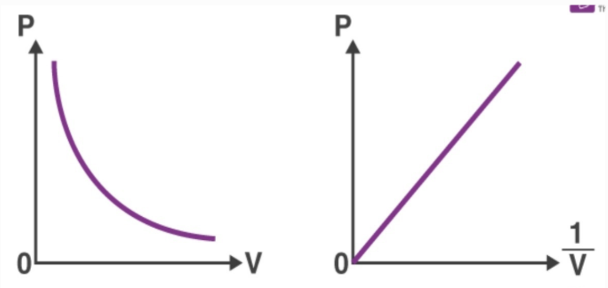
- If volume increases, pressure decreases.
- If volume decreases, pressure increases.
- Because gas particles collide more in less space, causing more pressure.

Example

Syringe: When you push it, volume decreases → pressure increases.When you pull it, volume increases → pressure decreases.







(a) Graph of P against V (a) Graph of P against $\frac{1}{V}$

Charles's Law – According to the Given Picture (Final Answer):

Statement:

For a fixed amount of gas at constant pressure, the volume of a gas is directly proportional to its absolute temperature (in Kelvin).

Mathematical Equation:

$V \propto T$

$V = k \times T$

$V_1/T_1 = V_2/T_2$

Absolute Temperature:

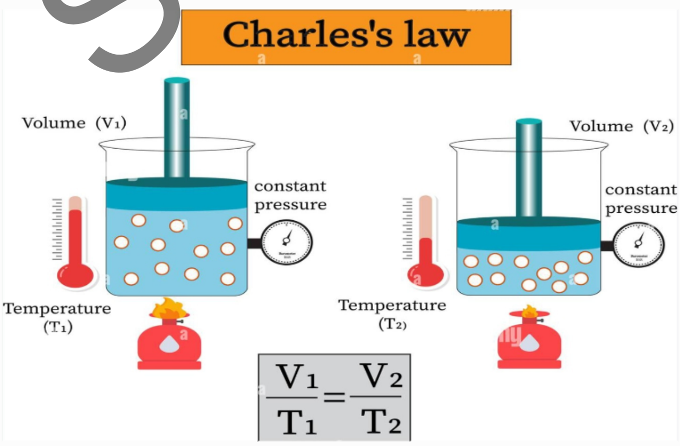
- Measured in Kelvin (K)
- 0°C = 273 K
- 0 K = -273°C (absolute zero)

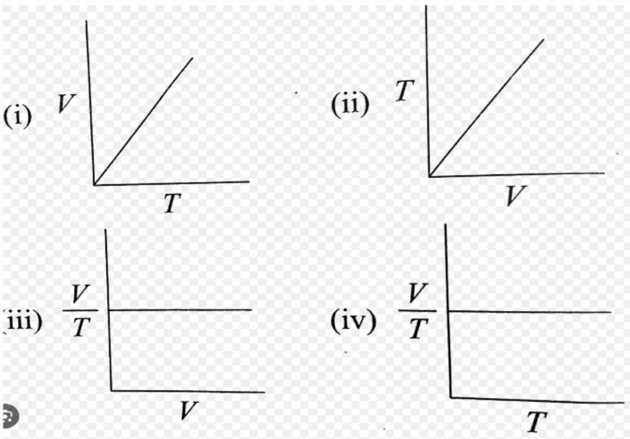
Explanation:

When temperature increases, volume increases.
When temperature decreases, volume decreases.

🎈 **Example – Hot Air Balloon:**

In a hot air balloon, the air inside is heated using a burner. As the air heats up, it expands and takes up more space. Since the pressure stays nearly constant, the volume of the balloon increases, lifting it into the air.





Q: Define Avogadro's Law – Kinetic Particle Theory ?

Statement:

At constant temperature and pressure, the volume of a gas is directly proportional to the number of moles (n) of the gas.

Mathematical Equation:

$V \propto n$

$V = k \times n$

$V_1/n_1 = V_2/n_2$

Explanation:

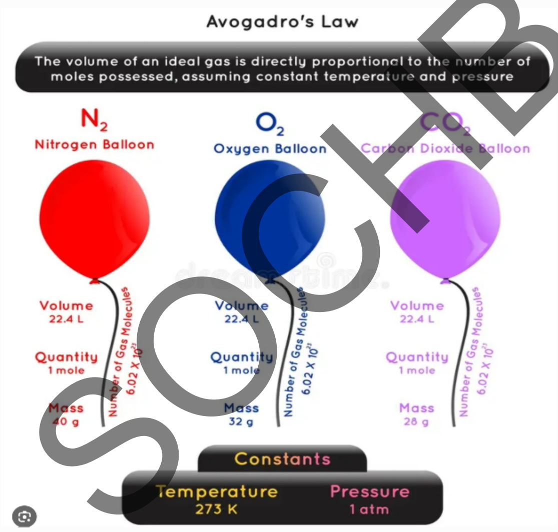
• More gas particles (moles) → more collisions → more space needed → more volume

• Fewer gas particles → fewer collisions → less volume

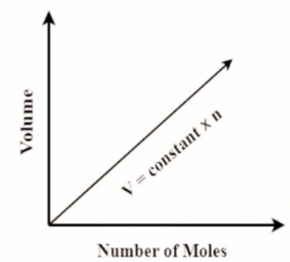
(Pressure and temperature stay constant)

🎈 **Example**:

If you fill two balloons with different gases (like helium and oxygen), but keep them at the same temperature and pressure, and each contains 2 moles of gas, then both balloons will have the same volume.



Avogadro's Law Graph



Q : Define Kinetic Particle Theory Interpretation .

- When the number of gas particles (moles) increases, more particles collide with the container walls.
- To keep pressure constant, the volume must increase to give particles more space.
- This maintains the same number of collisions per unit area.

Example:

- If you add more air to a balloon (increase moles) while keeping temperature and pressure constant, the balloon expands to make space for the extra particles.

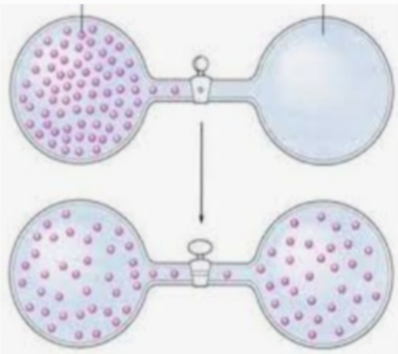
Q: Define diffusion

Definition:

Diffusion is the continuous movement of gas molecules from a region of high concentration to a region of low concentration.

Examples:

1. Smell of perfume spreading in a room
2. Gas leak through a pipe
3. Gas leaking from a balloon



Q: What are the Factors Affecting Diffusion ?

Graham's Law: the rate of diffusion of a gas is inversely proportional to the square root of its molar mass (molecular weight).

This means lighter gases diffuse faster than heavier gases.

FORMULA:

$$\text{Rate of diffusion} \propto \frac{1}{\sqrt{M}}$$

$$\frac{\text{Rate}_1}{\text{Rate}_2} = \sqrt{\frac{M_2}{M_1}}$$

- r = diffusion rate
- M = molar mass

Molecular Mass:

Higher mass → slower diffusion.

Lighter particles diffuse faster.

Temperature:

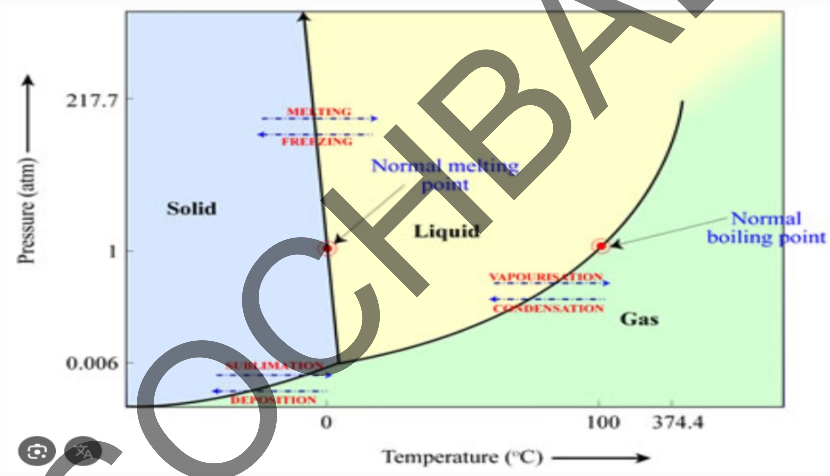
Higher temperature → faster diffusion.

Particles move quickly.

Pressure:
Higher pressure → faster diffusion.
More collisions push particles to spread.
Medium of Diffusion:
Diffusion is faster in gases than in liquids because gas particles move more freely.

Q: Define Sublimation
Definition:
Sublimation is the process in which a substance changes **directly from solid to gas** without passing through the liquid state.
Change:
Solid → Gas (Sublimation)
Gas → Solid (Deposition)
Conditions:
- Low atmospheric pressure
- High heat at a certain temperature

Reason:
These substances have **weak intermolecular forces**, so they change directly into gas.
Examples:
- Dry ice (solid CO_2)
- Camphor
- Naphthalene balls
- Iodine crystals
- Solid room freshener



Application of Sublimation in Daily Life
- Used in solid air fresheners to spread fragrance.
- Used in 3D textile printing like T-shirts and mugs.
- Used in freeze-drying food for preservation.

Simple Examples of Deposition in Daily Life:
- **Snow** forms from water vapour.
- **Black soot** in vehicle exhaust.
- **Dry ice** made using carbon dioxide.

Q: Define the Importance of Diffusion Rate in Medicine

Answer:

Diffusion rate is important because it determines how quickly a drug spreads from the injection site into the bloodstream and reaches the target area in the body.

Reason:

Faster diffusion means the medicine acts quickly, especially in painkillers or emergency drugs.

Example: Fast-acting drugs need to dissolve and diffuse quickly to give **immediate relief.**

1. Multiple Choice Questions (MCQs)

i. What happens to the internal energy of a substance during melting?

a) It decreases

b) It stays the same

✅ **c) It increases**

d) It fluctuates

ii. Which process involves a solid turning directly into a gas?

a) Melting

b) Freezing

✅ **c) Sublimation**

d) Condensation

iii. Boiling occurs at:

a) Any temperature

✅ **b) A fixed temperature**

c) Only at room temperature

d) Any pressure

iv. During condensation, the particles in a gas:

a) Gain energy and move faster

b) Lose energy and move slower

c) Gain energy and move slower

✅ **d) Lose energy and move slower**

v. Which law states that the volume of a gas is directly proportional to its temperature at constant pressure?

a) Boyle's Law

✅ **b) Charles's Law**

c) Avogadro's Law

d) Dalton's Law

vi. Evaporation differs from boiling because:

✅ a) Evaporation occurs at the surface of a liquid at any temperature

b) Boiling occurs only at the surface

c) Evaporation requires a fixed temperature

d) Boiling occurs at any temperature

vii. According to kinetic particle theory, the pressure of a gas increases when:

a) The volume increases

b) The temperature decreases

c) The number of particles decreases

✅ d) The temperature increases

viii. Which factor affects the rate of diffusion of gases?

a) Molecular mass

b) Temperature

✅ c) Both a and b

d) Neither a nor b

ix. Solid air fresheners use the process of:

a) Condensation

✅ c) Sublimation

b) Deposition

d) Freezing

x. The diffusion of medicine in the body is important because:

a) It controls the temperature of the medicine

✅ b) It ensures the medicine reaches all parts of the body

c) It keeps the medicine in one place

d) It increases the molecular mass of the medicine

UNIT:2. MATTER

EXERCISE SHORT QUESTIONS ANSWERS

Q1: Why does the temperature remain constant during the phase change from ice to water?

- During melting, heat energy is used to break the forces holding the solid particles together.
- The energy increases the potential energy, not the temperature.
- So, the temperature stays constant until all the ice changes into water.

Q2: What is the name given to the phase change when a solid is converted directly to gas?

- The phase change from solid to gas is called sublimation.
- It happens without passing through the liquid state.
- Examples include dry ice, camphor, and naphthalene.

Q3: Differentiate between evaporation and boiling?

Feature	Evaporation	Boiling
1. Temperature	Happens at **any temperature** below boiling point.	Happens at a **fixed boiling point**.
2. Location in Liquid	Occurs only at the **surface** of the liquid.	Happens **throughout the entire liquid**.
3. Speed of Process	**Slow** and gradual process.	**Fast** and vigorous process.
4. Cooling Effect	Causes **cooling** (e.g., sweating).	**Does not cause cooling**; heat is continuously added.

Q4: Interpret a heating curve for water by identifying key phase changes.

- On a heating curve, increases when water is heated.
- The flat parts of the curve show phase changes:
- Melting (ice to water)
- Boiling (water to steam)
- During phase changes, temperature stays constant while heat is used to break bonds.

Q5: What is the effect of increasing temperature on the pressure of a gas in a sealed container?

- When temperature increases, gas particles move faster.
- They hit the walls of the container more often and with more force.
- This causes the pressure to increase inside the sealed container.

Q6: How does increasing the external pressure affect the boiling point of a liquid?

- When external pressure increases, the liquid needs more heat to boil.
- This causes the boiling point to rise.
- Example: In a pressure cooker, food boils at a higher temperature and cooks faster.

Q7: describe how moleculer mass influences the rate of diffusion

- Lighter molecules move faster and diffuse more quickly.
- Heavier molecules move slower and diffuse more slowly.
- Diffusion rate is inversely related to molecular mass.
- Example: Hydrogen gas diffuses faster than oxygen gas because it has a lower mass.

Q8: Give an example of sublimation and explain its particle application.

- Example: Dry ice (solid carbon dioxide) is a common example of sublimation.
- In sublimation, a solid changes directly into gas without becoming liquid.
- Particles in the solid gain energy quickly and break free into gas form.
- This process is used in fog machines, air fresheners, and freeze-drying of food.

Q9: Why is the diffusion of gas faster at higher temperatures?

- At higher temperatures, gas particles gain more energy.
- They move faster and collide more often.
- This makes the rate of diffusion increase.
- Particles spread out quickly, filling the space faster.

Q10: How does Avogadro's Law relate to the volume and number of moles of gas?

- Avogadro's Law says that **more gas particles (moles)** mean **more volume**, if pressure and temperature stay the same.
- Volume is directly proportional to the number of moles.
- So, if the number of moles doubles, the volume also doubles.