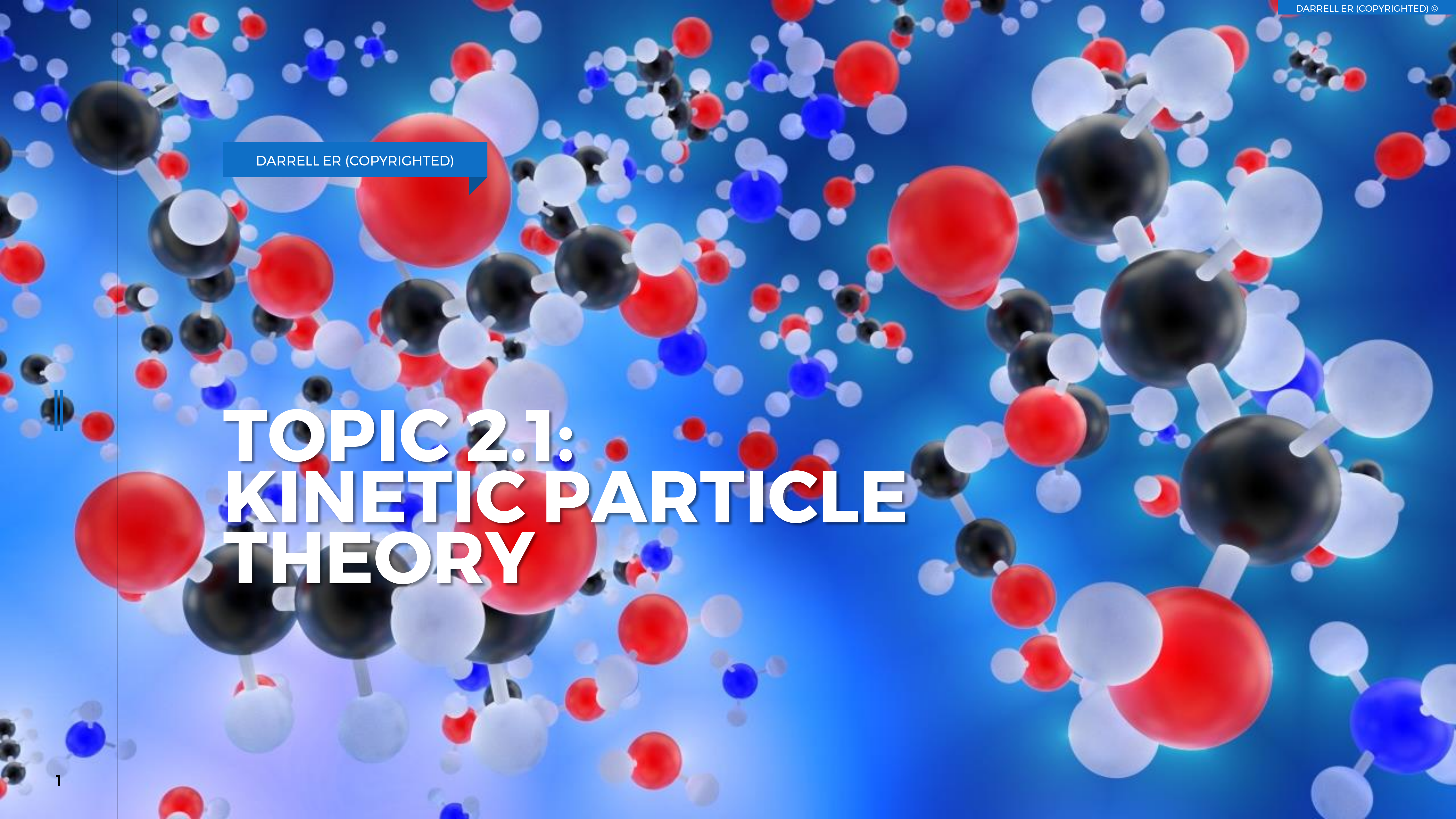


TOPIC 2.1: KINETIC PARTICLE THEORY

THE ABOUT

CHAPTER ANALYSIS

TIME

- Straight forward chapter
- 2 **key** concepts
- 1 **advanced** concepts

EXAM

- Usually tested in MCQs
  - 2009 (2), 2010(1), 2011 (2), 2012 (1), 2014 (1), 2016 (1), 2017 (1)
- Structured
  - 2010 (6 marks)

WEIGHTAGE

- Light overall weightage
- Constitute to **2.5%** of marks for past 5 year papers
- Less commonly tested in recent years

MUST KNOW

BASICS

Solid	Liquid	Gas
• Fixed volume • Fixed shape • Cannot be compressed • Does not flow	• Fixed volume • No fixed shape • Cannot be compressed • Flows easily	• No fixed volume • No fixed shape • Can be compressed easily • Flows in all direction

MUST KNOW

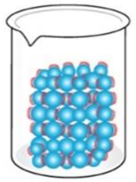
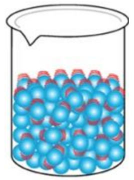
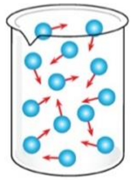
KINETIC PARTICLE THEORY OF MATTER

The theory states that:

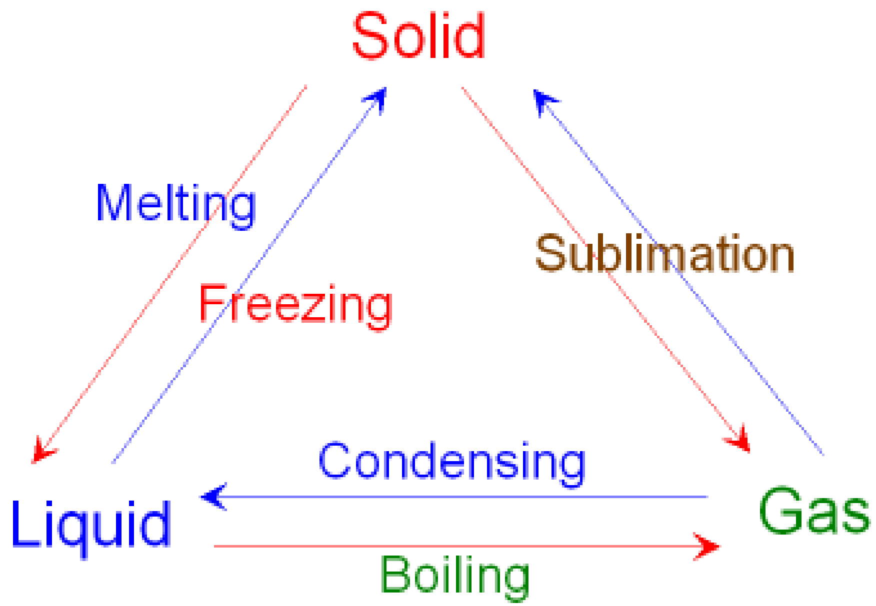
- all matter consist of **particles** that are too small to be directly visible,
- the particles are always in a constant state of **random motion** at varying speeds.

KEY CONCEPT

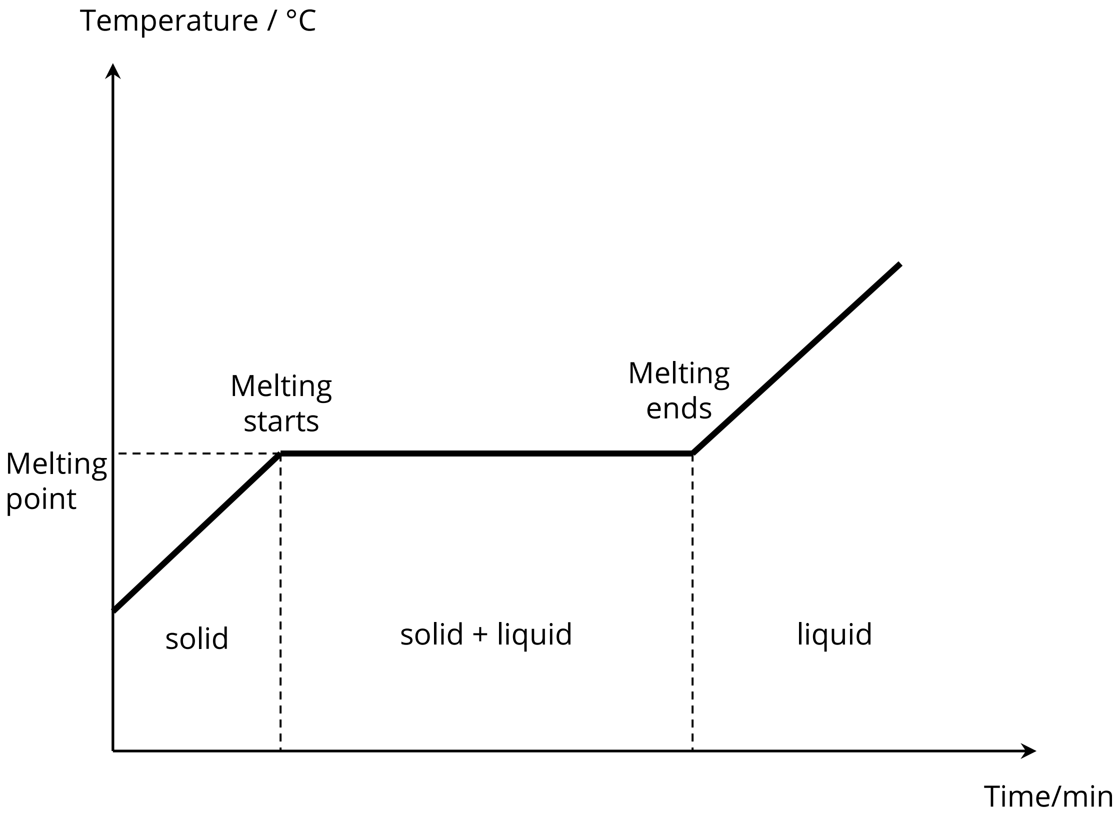
KINETIC PARTICLE THEORY OF MATTER

Physical Properties	Solid	Liquid	Gas
Particulate model of matter			
Arrangement	Closely packed in an orderly arrangement	Loosely packed in a disorderly arrangement	Far apart & random arrangement
Forces of attraction	Very strong attractive force	Strong attractive force	Weak attractive force
Density	Very high density	High density	Low density
Movement	Vibrate about its fixed position	Particles sliding over one another freely	Move about at high speeds randomly
Energy		Increasing energy →	

CHANGE IN STATE



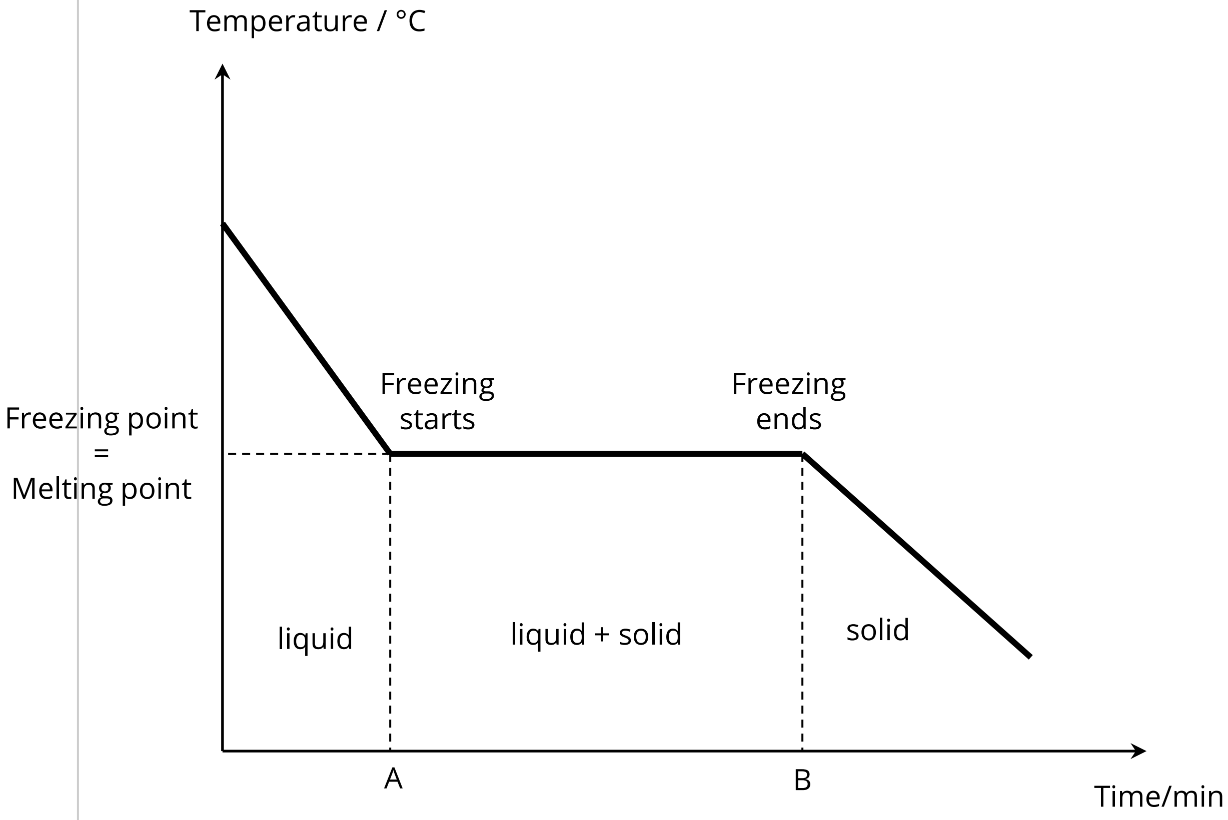
MELTING (SOLID TO LIQUID)



- During melting, the particles gain energy from the surroundings and vibrate vigorously about their fixed positions until they have sufficient energy to overcome and **break free from the attractive forces**.
- The **temperature remains constant** during the melting process as the heat energy absorbed is used to overcome the forces of attraction.
- A **mixture of solid and liquid** is present during this stage.

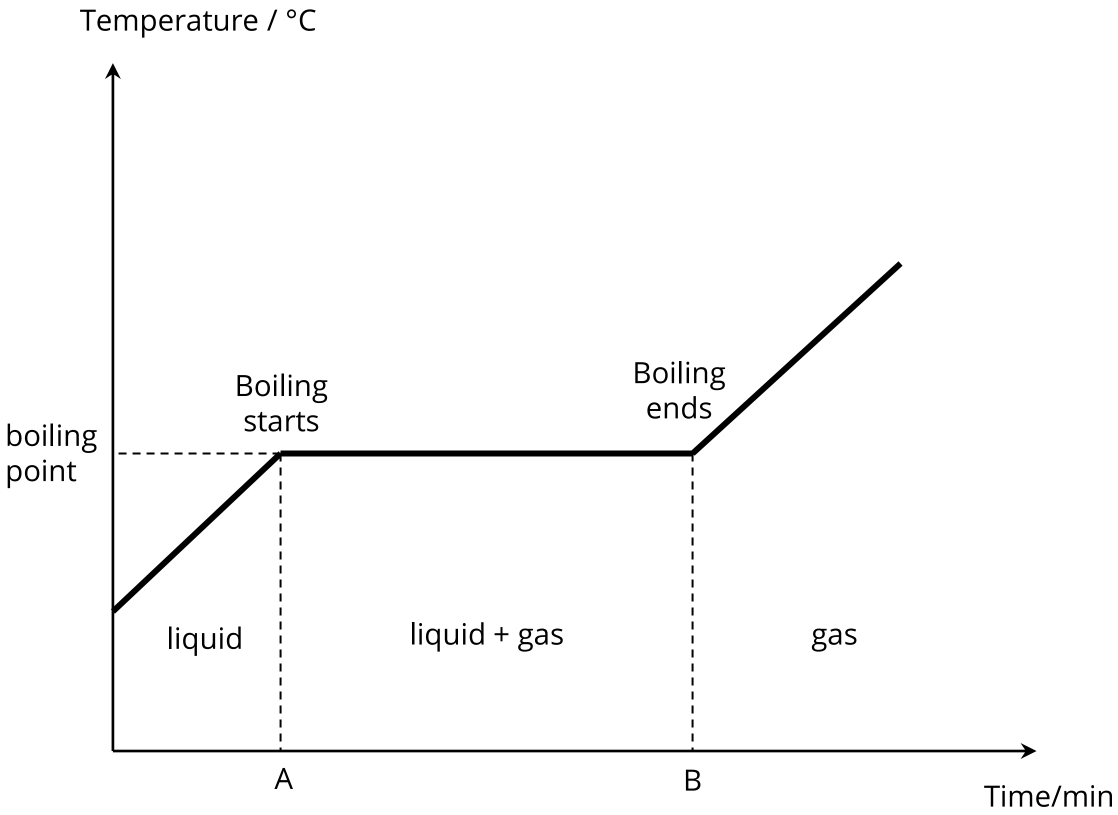
The temperature of the matter (solid) is a measure of the average kinetic energy the matter possesses.

FREEZING (LIQUID TO SOLID)



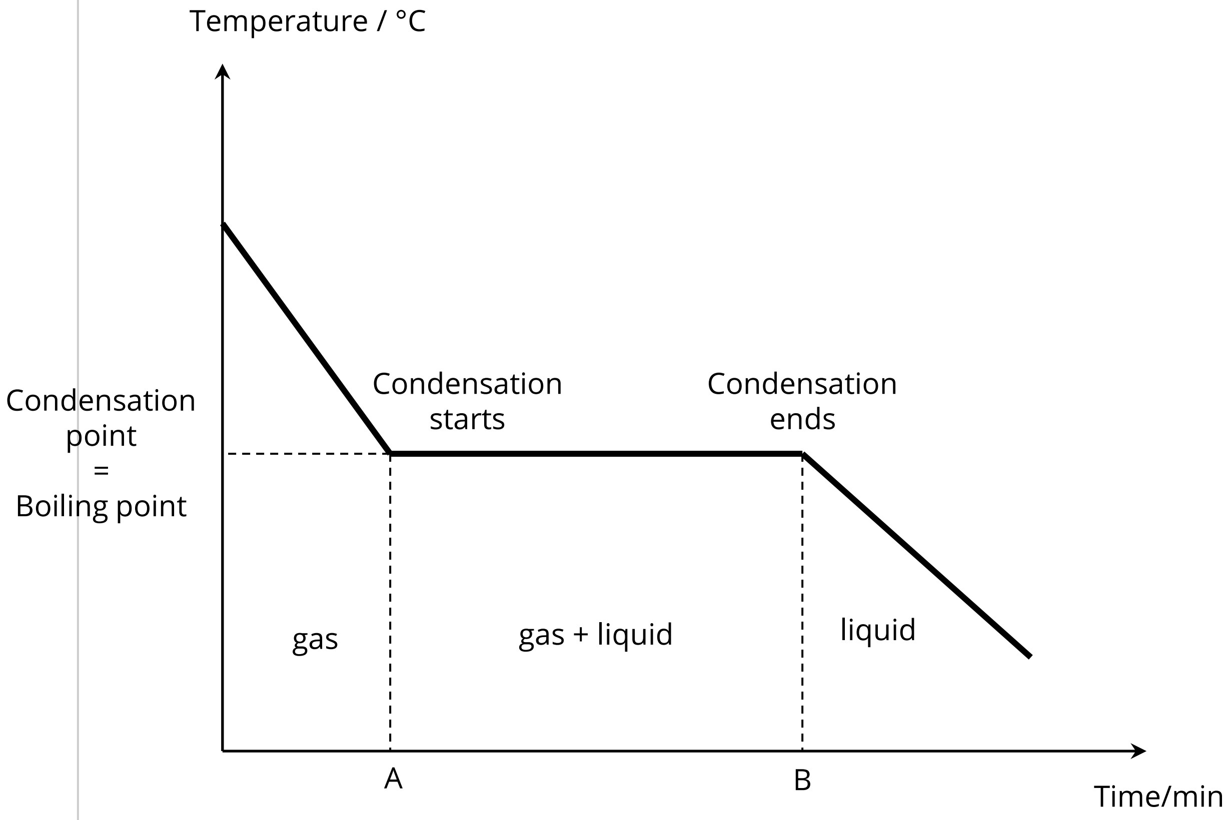
- At A, the particles have lost enough kinetic energy and freezing starts.
- The particles after losing most of their kinetic energy, **no longer have enough energy to overcome the forces of attraction** between themselves and would **return to their fixed position.**
- Between A and B, the freezing process is ongoing. The **temperature remains constant** because **heat energy is being released to the surroundings.** The release of heat energy negates the cooling effect resulting in the temperature remaining is constant.
- A mixture of solid and liquid is present during this stage.

BOILING (LIQUID TO GAS)



- At A, sufficient heat energy has been absorbed to reach its boiling point.
- During boiling, the particles have **gains the required amount of energy to overcome the forces of attraction** between them to move even further apart.
- Between A and B, the boiling process is ongoing. The **temperature remains constant** as heat energy gained was used to overcome the forces of attraction between particles rather than used to increase the particles' kinetic energy/temperature.
- A mixture of gas and liquid is present at this stage.

CONDENSATION (GAS TO LIQUID)



- At A, the particles lost much of its kinetic energy and condensation starts.
- During condensation, the particles **loses most of its energy to that was used to overcome the forces of attraction** between themselves resulting in them coming closer together.
- **Heat energy is released** to the surroundings as particles slow down and become more closely packed. The **release of heat energy negates the cooling effect** resulting in the **temperature remaining constant.**
- A mixture of gas and liquid is present during this stage.

ADVANCED

SOLID TO GAS
SUBLIMATION
DEPOSITION

ADVANCED

SUBLIMATION & DEPOSITION

Common Substances

Iodine is a dark purple solid at room temperature. When low heat is applied, it undergoes sublimation and becomes a violet gas.

Dry ice is frequently used as a cooling agent to keep temperatures low. It is used instead of normal ice as it sublimes to form gaseous carbon dioxide, rather than water.

KEY CONCEPT

GAS/LIQUID PARTICLES
DIFFUSION
MOVEMENT OF MOLECULES

MUST KNOW

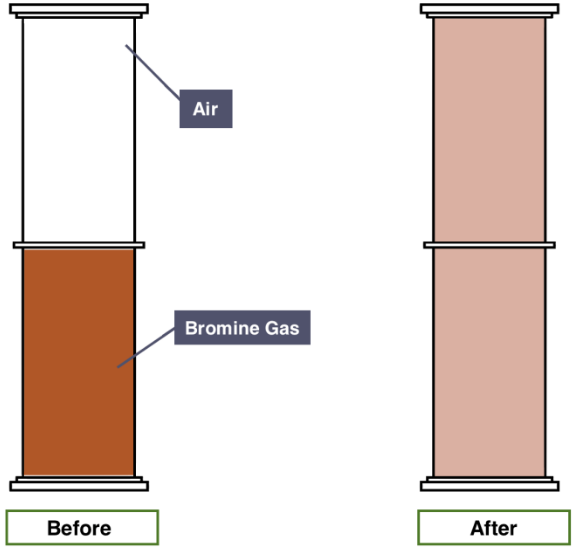
DIFFUSION

Diffusion is **the movement of molecules from a region of higher concentration to a region of lower concentration**.

During diffusion, gas or liquid particles would move to available spaces in a container through random motion, mixing thoroughly in the process.

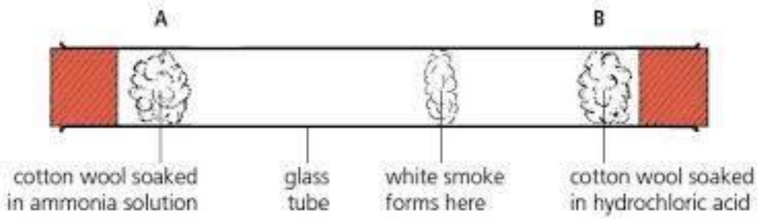
Diffusion in liquid

Diffusion in gas



KEY CONCEPT

things to note



Heavier molecules moves slower. Hence, white precipitate forms nearer to the hydrochloric acid side.

Higher temperature, faster rate of diffusion

With more kinetic energy, particles vibrate and move quicker at higher temperatures. **The higher the temperature**, the greater the average kinetic energy, hence the the particles move faster.
This leads to **a faster rate of diffusion**.

Mass of particles

The lower the mass of the particles (M_r), the **faster the rate of diffusion**.

State of matter

As the particles in a liquid are packed closer together than in a gas, the same particles has a slower rate of diffusion in a liquid as compared to a gaseous state.

Particles in gaseous state has a faster rate of diffusion than liquid state.

Concentration gradient

The greater the difference between concentration levels, it leads to a **steeper concentration gradient, which has a faster the rate of diffusion.**

Try it yourself! (TYS Question)

5. Under the same conditions, which gas diffuses at the same rate as nitrogen gas?

(N2018/P1/Q1)

A carbon dioxide
B carbon monoxide
C neon
D sulfur dioxide

( )

Answer:

5. **B**

gas	molecular mass
N_2	$2 \times 14 = 28$
CO_2	$12 + 2 \times 16 = 44$
CO	$12 + 16 = 28$
Ne	20
SO_2	$32 + 2 \times 16 = 64$

At the same room temperature and pressure, N_2 and CO will diffuse at the same rate as they have the same molecular mass.

Try it yourself! (TYS Question)

6. The rate of diffusion of two gases is measured at different temperatures but at constant pressure.
Which would diffuse most quickly? (N2020/P1/Q5)

A	argon at 15°C	**B**	argon at 40°C
C	carbon dioxide at 15°C	**D**	carbon dioxide at 40°C

( )

Answer:

6. **B**
The rate of diffusion can be determined by the relative molecular mass and temperature. The lower the relative molecular mass, the higher the rate of diffusion. The higher the temperature, the higher the rate of diffusion.

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