'O' Level Chemistry
Chapter 3 – Solids, Liquids and Gases

The Three States of Matter

- Matter is anything that has mass and takes up space.
- The Three States of Matter: **Solids, Liquids** and **Gases**.

Kinetic Particle Theory of Matter

- This theory states that:

1) Particles are too small to be seen directly
2) There are spaces between particles of matter
3) Particles of matter are in **constant motion**. They move at different speeds in different states.

- **Diffusion** shows the evidence of Kinetic Particle Theory
  - The **spreading and mixing** of particles in fluids (liquids and gases)
  - For instance, particles move into the empty spaces between the particles in liquids and gases
  - Its rate is affected by:
    - ***Temperature*** - ↑ temp, ↑ rate of diffusion
    - ***Mass of particles*** - ↑ mass, ↓ rate of diffusion

Particulate Models of Matter

	Solid	Liquid	Gas
Arrangement of particles	▪ Closely packed in orderly manner ▪ Very strong forces of attraction ▪ Little empty space between them	▪ Closely packed but **not** in orderly manner ▪ Strong forces of attraction ▪ Little empty space between them *(but more space than in solid.)*	▪ Far apart ▪ Very weak forces of attraction ▪ In random arrangement
Resulting physical properties	▪ *Fixed volume* ▪ *Not compressible* ▪ *High density*	▪ *Fixed volume* ▪ *Not compressible* ▪ *High density*	▪ *No fixed volume* ▪ *Compressible* ▪ *Low density*
Motion of particles	▪ Vibrate about fixed position ▪ But cannot move about freely ▪ Low kinetic energy	▪ Not held in fixed position ▪ Slide passes each other ▪ Free to move throughout liquid ▪ Low kinetic energy	▪ Free to move anywhere in the container ▪ High kinetic energy
Resulting physical properties	▪ *Fixed shape*	▪ *No fixed shape*	▪ *No fixed shape*

Changes of State

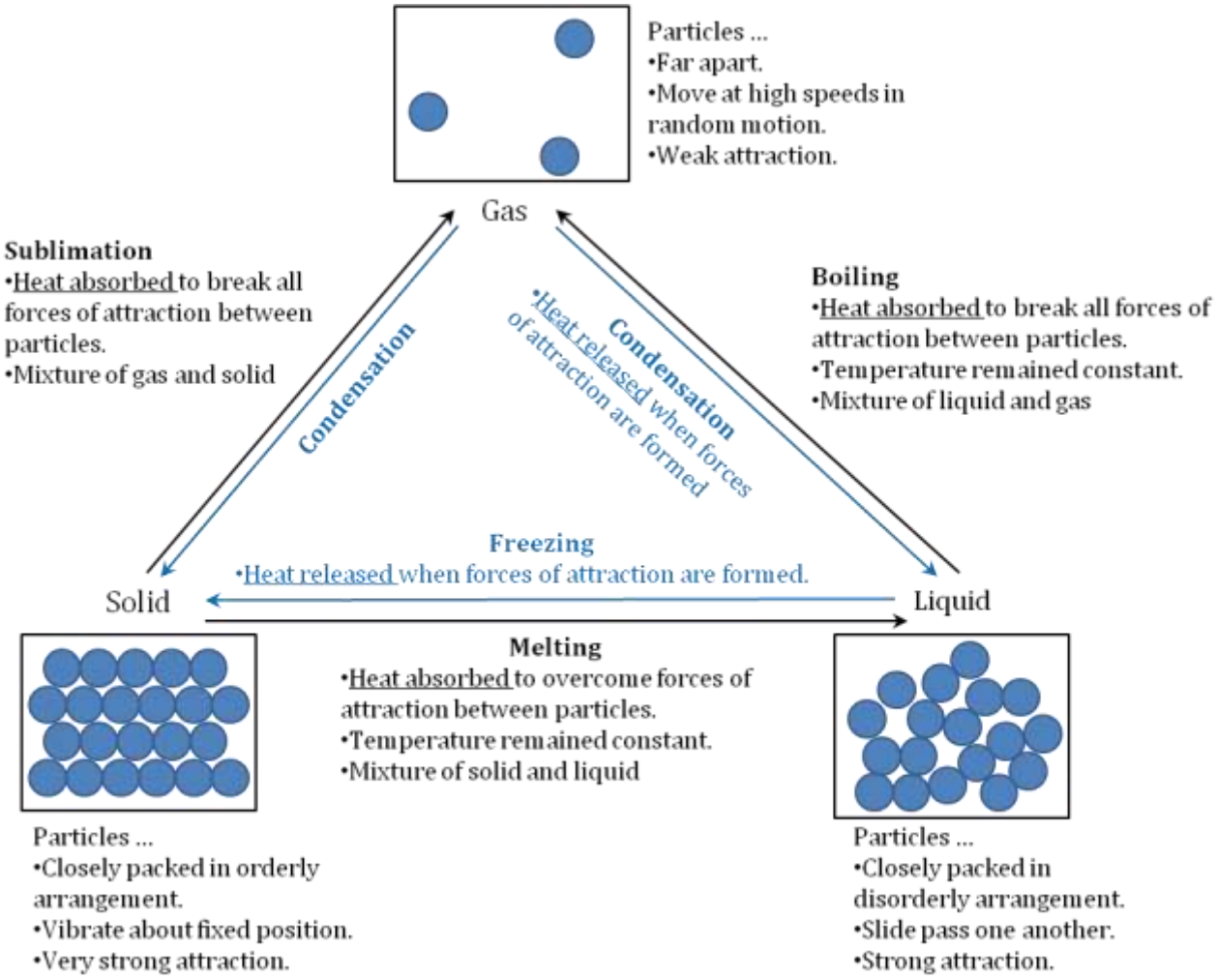


Fig. 1: Changes of states in matter

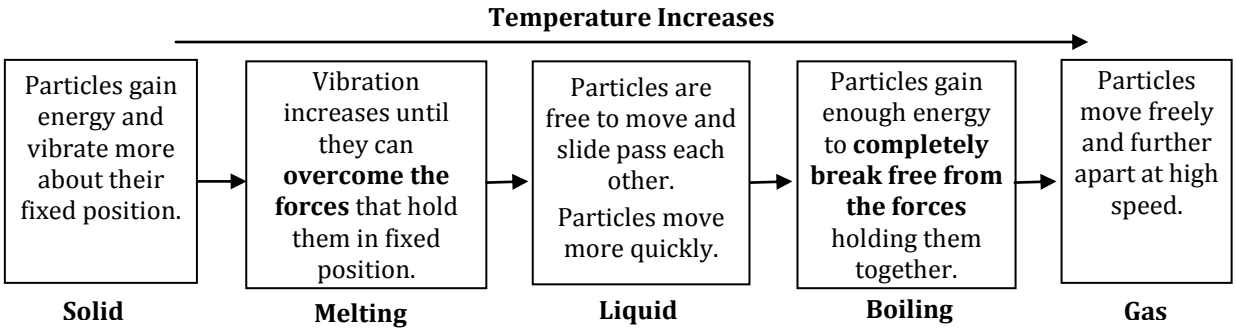


Fig. 2: Changes in particle motion and arrangement as temperature increase

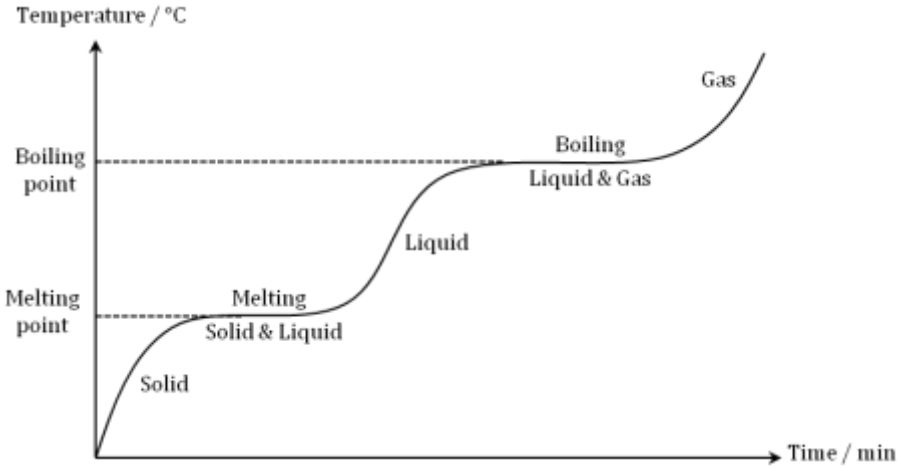


Fig. 3: The heating curve and changes in state

Evaporation and Boiling

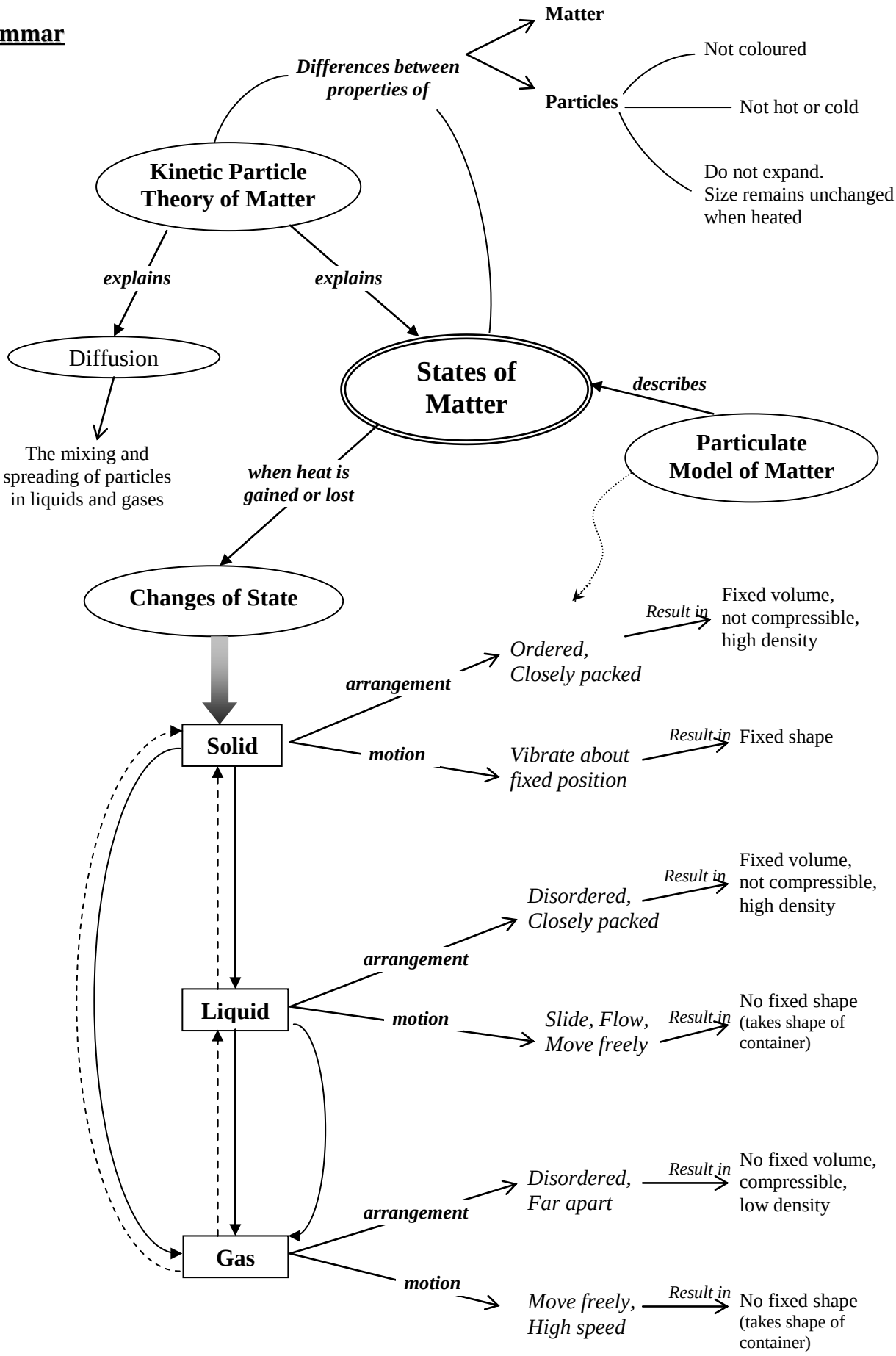
Evaporation	Boiling

• Changes from liquid to gas **without boiling**
• Occurs slowly
• Occurs at any temperature **below boiling point**
• Occurs only on the **surface of liquid**
• Particles on the surface **absorb energy** from the remaining liquid particles and escapes
  - Remaining liquid decreases in temperature.
  - Cooling effect
	• Changes from liquid to gas
	• Occurs rapidly
	• Occurs at **boiling point**
	• Occurs **throughout the liquid**.
	• Bubbles are formed when gas particles escape from the liquid.

Properties of matter and properties of particles:

- A matter can feel hot or cold but not particles.
  - The temperature of a matter is due to the **speed of movement of the particles** within it.
- Matter expands when heated but particles do not expand.
  - When a matter expands, the **distance between the particles increases**.
  - The size of particles remained unchanged when temperature changes.
- Matter may be coloured but particles of matter are not coloured.

Summary


Matter
Differences between properties of
Particles
Not coloured
Not hot or cold
Do not expand. Size remains unchanged when heated
Kinetic Particle Theory of Matter
explains
explains
Diffusion
The mixing and spreading of particles in liquids and gases
States of Matter
describes
Particulate Model of Matter
when heat is gained or lost
Changes of State
Result in
Fixed volume, not compressible, high density
arrangement
Ordered, Closely packed
Solid
motion
Vibrate about fixed position
Result in
Fixed shape
Result in
Fixed volume, not compressible, high density
Disordered, Closely packed
arrangement
Liquid
motion
Slide, Flow, Move freely
Result in
No fixed shape (takes shape of container)
Result in
No fixed volume, compressible, low density
Disordered, Far apart
arrangement
Gas
motion
Move freely, High speed
Result in
No fixed shape (takes shape of container)