CHEMCEPTUAL

IGCSE / O Level Chemistry (0620 / 5070) • Crash Course Notes

TOPIC 1

1. States of Matter

Comprehensive theoretical summary covering kinetic particle theory, state changes, diffusion, and molecular mass effects.

1. The Kinetic Particle Theory

All matter consists of tiny moving particles (atoms, molecules, or ions). Their arrangement, movement, and energy determine the physical state of a substance.

Property	Solid	Liquid	Gas
Arrangement	Tightly packed in a regular, fixed lattice.	Closely packed but randomly arranged.	Far apart, completely random arrangement.
Movement	Vibrate about fixed positions.	Slide past one another freely.	Move rapidly & continuously in all directions.
Intermolecular Forces	Very strong forces holding particles together.	Intermediate forces (weaker than solids).	Negligible (almost non-existent) forces.
Energy Level	Lowest kinetic energy.	Moderate kinetic energy.	Highest kinetic energy.
Shape & Volume	Fixed shape & fixed volume.	Takes container shape, fixed volume.	No fixed shape, expands to fill volume.
Compressibility	Incompressible.	Incompressible.	Highly compressible.

2. Interconversion of States

State changes are physical processes involving heat gain (endothermic) or heat loss (exothermic), altering particle kinetic energy without changing chemical identity.

Process	State Change	Thermal Effect	Particle Behavior
Melting	Solid → Liquid	Heat Absorbed	Particles gain energy, vibrate faster until forces break.
Boiling	Liquid → Gas	Heat Absorbed	Particles gain enough energy to overcome all attraction.
Evaporation	Liquid → Gas	Heat Absorbed	High-energy surface particles escape below boiling pt.
Condensation	Gas → Liquid	Heat Released	Particles lose energy, move slower and draw closer.
Freezing	Liquid → Solid	Heat Released	Particles lock into a rigid lattice arrangement.
Sublimation	Solid → Gas	Heat Absorbed	

Process	State Change	Thermal Effect	Particle Behavior
			Direct transition without forming liquid phase (e.g., CO_2).

⚠️ **Key Exam Distinction: Boiling vs. Evaporation**

- **Boiling:** Occurs at a *specific fixed temperature* (boiling point) throughout the entire liquid body. Fast process with visible bubbles.
- **Evaporation:** Occurs at *any temperature* below boiling point, only at the *liquid surface*. Slower cooling process.

3. Diffusion & Molecular Mass

Diffusion is the net movement of particles from a region of higher concentration to lower concentration down a concentration gradient, caused by random molecular motion.

Factors Affecting Diffusion Rate

- **Temperature:** Higher temperature increases average kinetic energy, causing particles to move and diffuse faster.
- **Relative Molecular Mass (M_r):** Lighter gas particles (lower M_r) travel faster than heavier ones (higher M_r) at the same temperature.

🧪 **Classic Exam Experiment: NH_3 vs. HCl Diffusion**

When concentrated Ammonia (NH_3, M_r = 17) and Hydrochloric Acid (HCl, M_r = 36.5) cotton wool plugs are placed at opposite ends of a sealed glass tube, a white ring of Ammonium Chloride (NH_4Cl) forms **closer to the HCl end** because ammonia gas is lighter and diffuses much faster.