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Supplement

Some of the content in the specification is 'Supplemental'. This content will only be assessed if you're taking the Extended version of the Cambridge International GCSE. We've marked up all the content that's only for the Extended course with purple brackets, like the ones on this box, or the example below.

Information or questions with a bracket like this are for the Extended Course only.

Supplement

States of Matter

Materials can be **solids**, **liquids** or **gases**. The particles in **solids**, **liquids** and **gases** are arranged differently.

The Three States of Matter — Solid, Liquid and Gas

- 1) Materials come in **three** different forms — **solid**, **liquid** and **gas**. These are the three **states of matter**.
- 2) Which **state** you get (**solid**, **liquid** or **gas**) depends on how **strong** the forces of attraction are between the particles of the material.
- 3) How strong the forces are depends on three things:
 - the **material**
 - the **temperature**
 - the **pressure**.

The idea that everything is made up of tiny particles (like atoms, ions and molecules), whose state depends on the energy and movement of the particles, is known as the kinetic particle model of matter.

Solids



- 1) In solids, there are **strong forces** of attraction between particles, which hold them **close together in fixed positions** to form a very regular **lattice arrangement**.
- 2) The particles **don't move** from their positions, so all solids keep a **definite shape** and **volume**, and don't flow like liquids.
- 3) The particles **vibrate** about their positions — the **hotter** the solid becomes, the **more** they vibrate (causing solids to **expand** slightly when heated).

Liquids



- 1) In liquids, there is a **weak force** of attraction between the particles. They're randomly arranged and **free to move** past each other, but they tend to **stick closely together**.
- 2) Liquids have a definite volume but **don't keep a definite shape**, and will flow to fill the bottom of a container.
- 3) The particles are **constantly moving** with **random motion**. The **hotter** the liquid gets, the **faster** they move. This causes liquids to **expand** slightly when heated.

Gases



- 1) In gases, the force of attraction between the particles is **very weak** — they're **free to move** and are **far apart**. The particles in gases travel in **straight lines**.
- 2) Gases **don't keep a definite shape** or **volume** and will always **fill** any container.
- 3) The particles move **constantly** with **random motion**. The **hotter** the gas gets, the **faster** they move. Gases either **expand** when heated, or their **pressure increases**.

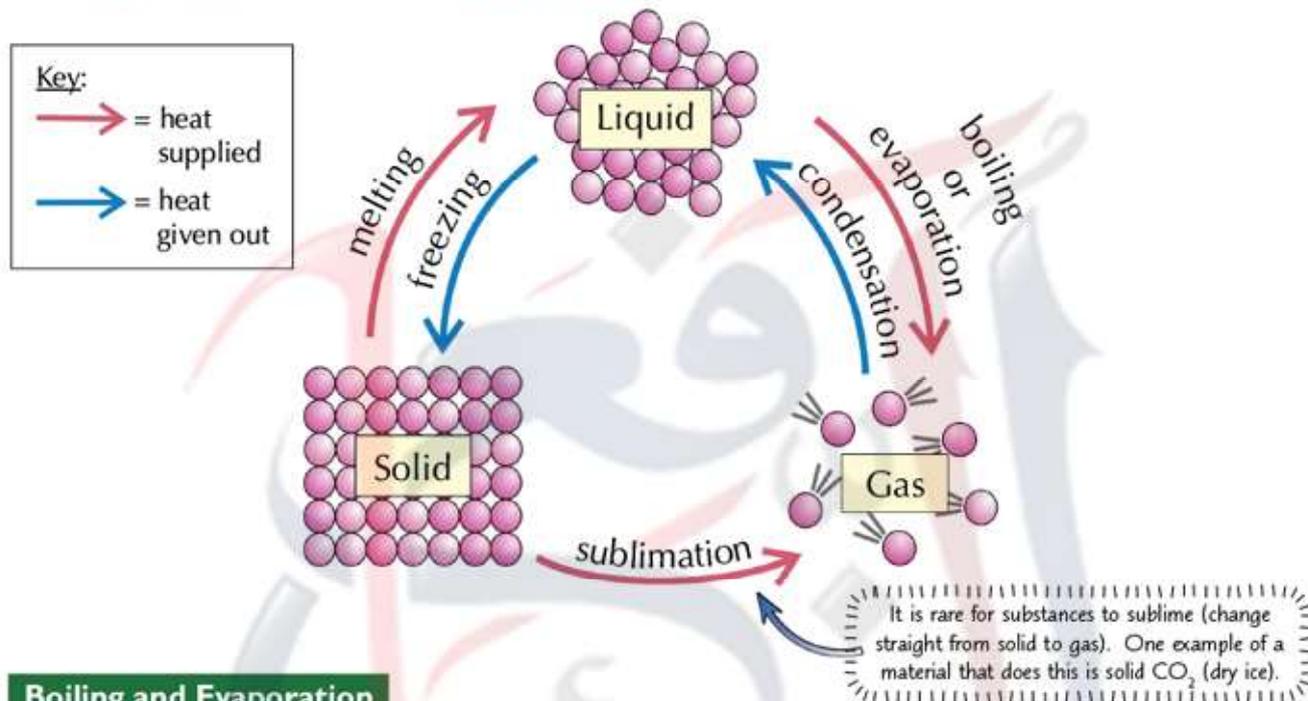
Gases can be compressed easily as the particles are far apart and can be squeezed closer together.

Changes of State

Substances don't just stay in one state. They can **change** depending on how much **energy** they have.

Substances Can Change from One State to Another

If you **heat** or **cool** a substance it can **change state**. Here are the state changes you need to know:



Boiling and Evaporation

- 1) Boiling and evaporation are both changes of state that involve a liquid changing to a gas.
- 2) Boiling happens when a liquid is heated to its boiling point. When you boil it, all of the liquid will gradually turn into a gas.
- 3) Evaporation can happen at temperatures lower than the liquid's boiling point. More energetic particles that are near the surface of the liquid can escape and become gas particles.

Changing the Energy of Particles Can Cause a Change of State

- 1) When a solid is heated, its particles gain more kinetic energy.
- 2) This makes the particles vibrate more, which weakens the forces that hold the solid together. This makes the solid expand.
- 3) At a certain temperature, the particles have enough energy to break free from their positions. This is called melting and the solid turns into a liquid.
- 4) When a liquid is heated, the particles get even more kinetic energy.
- 5) This energy makes the particles move faster, which weakens and breaks the bonds holding the liquid together.
- 6) At a certain temperature, the particles have enough kinetic energy to break their bonds. This is called boiling and the liquid turns into a gas.
- 7) The amount of energy needed to cause a substance to change state depends on the strength of the forces between the particles.

The opposite happens if you cool a substance — the particles lose energy and the forces between the particles get stronger. That's what happens when a gas becomes a liquid and when a liquid becomes a solid.

Changing state happens with changing temperature

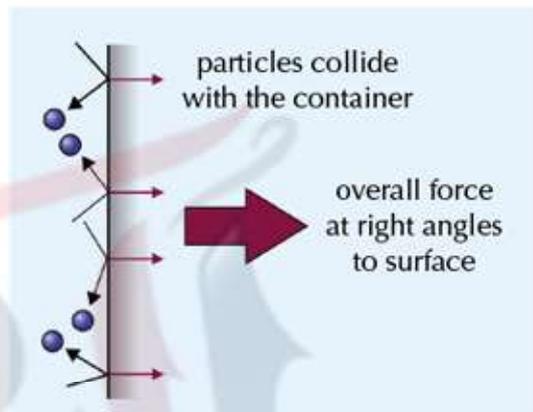
You need to know the terms for all those changes of state. Obviously some will be a bit more familiar than others, but that cycle diagram at the top of the page is a really good way of remembering them all.

Movement of Particles

Gases and liquids are made up of particles that can move. This explains a lot of their behaviour.

Colliding Gas Particles Create Pressure

- 1) The particles in a gas constantly move about randomly.
- 2) As the particles move, they bump into each other — and whatever else gets in the way.
- 3) When the particles collide with something, they exert a force on it.
- 4) In a sealed container the gas particles hit the container walls, creating an outward pressure.
- 5) The size of this pressure depends on the number of gas particles present and how fast they are moving.
- 6) The faster the particles move, the more often they hit the container walls. They also hit the walls harder.
- 7) So the faster the particles are moving and the more particles that are present, the greater the pressure will be.



Increasing the Temperature Makes Particles Move Faster

- 1) If you heat a gas, the particles move faster and gain more kinetic energy.
- 2) This increase in energy means the particles hit the container walls harder and more frequently. This produces a larger force on the walls, creating more pressure.
- 3) The opposite is true too — if you cool a gas, the particles will move more slowly, causing the pressure to decrease.

Diffusion is Caused by the Random Movement of Particles



Diffusion is when a substance moves from an area of higher concentration (where there's lots of it) to an area of lower concentration (where there's less of it).

Diffusion does not require any energy input — it occurs passively over time as particles move around.

Diffusion happens because the particles in a liquid or gas move around randomly. They constantly bump into each other and bounce around until they're evenly spread out.

