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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.

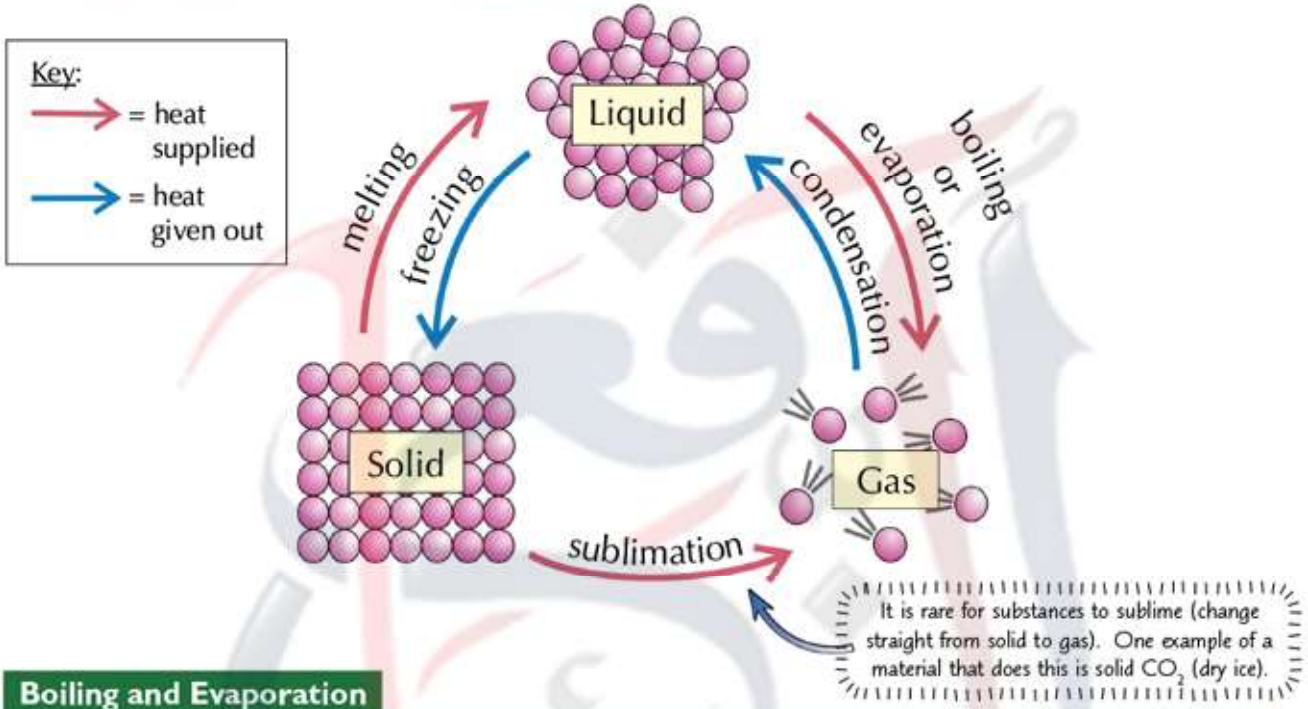
Gases can be compressed easily as the particles are far apart and can be squeezed closer together.

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:



It is rare for substances to sublime (change straight from solid to gas). One example of a material that does this is solid CO_2 (dry ice).

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**

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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.

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Changing state happens with changing temperature

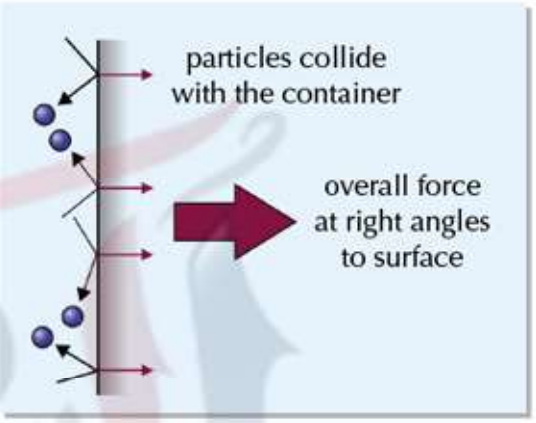
You need to know the terms for all those changes of state. Obviously some will be a bit more familiar than others, but that cycle diagram at the top of the page is a really good way of remembering them all.

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

KEY TERM

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.