KS3 SCIENCE · CHEMISTRY

Particles and states of matter

Name _____

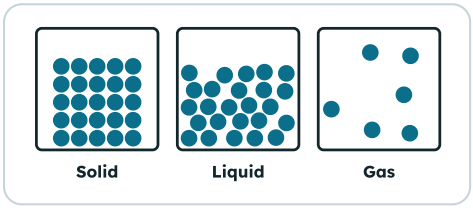


1. Solids, liquids and gases

	SOLID	LIQUID	GAS
Shape	Keeps its own shape	Takes the shape of its container	Fills its container
Volume	Fixed	Fixed	Not fixed
Squash it?	No: very hard to squash	No: very hard to squash	Yes
Does it flow?	No	Yes	Yes

Sand and sugar can be poured, but each grain is a tiny solid with its own shape.

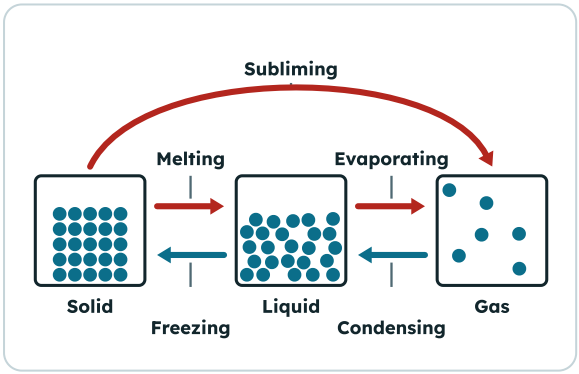
2. The particle model



	SOLID	LIQUID	GAS
Arrangement	Close together, in a regular pattern	Close together, in no pattern	Far apart
Movement	Vibrate about fixed positions	Slide past each other	Fast, in every direction

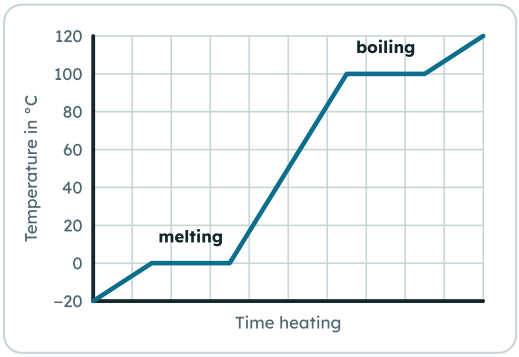
- Everything is made of **particles**, far too small to see. The particles are the same in each state: only their arrangement and movement change.
- A solid keeps its shape because its particles stay in fixed positions. A liquid flows because its particles can slide past each other.
- A gas can be squashed because there are big gaps between its particles. In solids and liquids the particles already touch.

3. Changes of state



- Red arrows: the substance is heated. Blue arrows: it is cooled.
- **Melting:** the particles gain energy and vibrate faster, until they break away from their fixed positions and can slide past each other.
- **Evaporation** happens at the surface of a liquid, at any temperature. **Boiling** happens all through the liquid, at its boiling point.
- **Subliming** is a solid turning straight into a gas, as dry ice (solid carbon dioxide) does.
- No particles are made or lost, so the **mass stays the same**: 10 g of ice melts into 10 g of water.

4. Energy and changes of state



- Heating gives particles more energy. The temperature rises, **except while the substance is changing state**.
- While a pure solid melts, the temperature stays level. The energy is being used to break the particles away from their fixed positions.
- The level parts of a **heating curve** show the **melting point** and the **boiling point**. For water these are 0 °C and 100 °C.
- A substance is a solid below its melting point, a liquid above it, and a gas above its boiling point.
- Melting and boiling: the particles take in energy. Condensing and freezing: they lose energy to the surroundings.



5. Gas pressure

- Gas particles fly about and hit the walls of their container. Each hit gives a tiny push. Together the pushes make **gas pressure**.
- **More particles** (pump in more gas): more hits, so the pressure goes up.
- **Less space** (squash the gas): the particles hit the walls more often, so the pressure goes up.
- **Hotter** (in a sealed container): the particles move faster and hit the walls harder and more often, so the pressure goes up. Cooling does the opposite.
- A **vacuum** is a space with no particles in it, so it has no gas pressure.



6. Diffusion

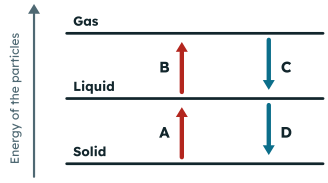
- The particles of liquids and gases move about at random, so they spread out and mix. This is **diffusion**.
- Particles spread from a **high concentration** (many particles) to a **low concentration** (few), until they are evenly mixed.
- Diffusion is **faster in a gas than in a liquid**: gas particles are far apart, so they travel a long way between collisions. Heating speeds diffusion up.
- **Brownian motion:** a speck of smoke in air jiggles about at random, because air particles too small to see keep hitting it. This is evidence that particles exist and move.



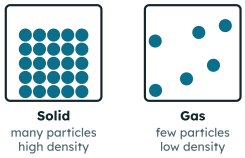
7. Density

density = mass ÷ volume

- Mass in g, volume in cm^3, density in g/cm^3. A block with a mass of 54 g and a volume of 20 cm^3 has a density of 54 ÷ 20 = 2.7 g/cm^3.
- A solid is usually much denser than a gas: its particles are packed close together, so more mass fits into the same space.
- Water has a density of 1 g/cm^3. Less dense things, such as cork, float on water. Denser things, such as steel, sink.



Energy of the particles. A melting, B boiling: energy taken in. C condensing, D freezing: energy given out.



Density: the same space holds far more particles of a solid than of a gas.

Key words

Particle: a tiny piece of matter, far too small to see

Liquid: flows and takes the shape of its container, but has a fixed volume

Freezing: changing from a liquid to a solid

Condensing: changing from a gas to a liquid

Boiling point: the temperature at which a liquid boils

Brownian motion: the random jiggling of a tiny speck as particles hit it

Particle model: the idea that everything is made of tiny moving particles

Gas: spreads out to fill its container, and can be squashed

Evaporating: a liquid turning into a gas at its surface, at any temperature

Subliming: changing from a solid straight to a gas

Gas pressure: caused by gas particles hitting the walls of their container

Density: the mass of one cubic centimetre of a substance

Solid: has a fixed shape and a fixed volume

Melting: changing from a solid to a liquid

Boiling: a liquid turning into a gas all through the liquid

Melting point: the temperature at which a solid melts

Diffusion: particles spreading out from where there are many to where there are few

Vacuum: a space with no particles in it

Pictures are illustrations made for this sheet, not real photographs.