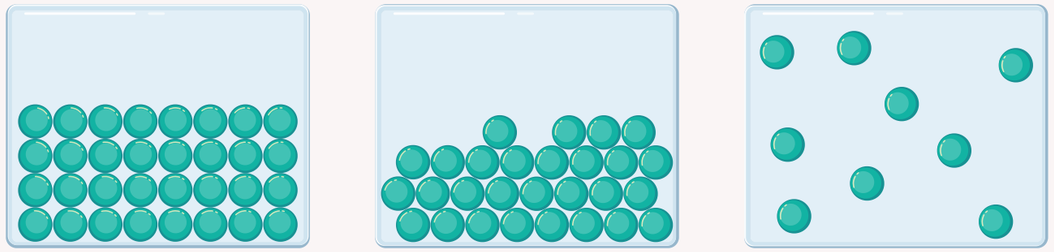
02 Kinetic Particle Theory



1 Solids, Liquids and Gases

1.1 The kinetic particle theory

The **kinetic particle theory** states that all matter is made up of tiny _____ that are in constant, _____ motion.



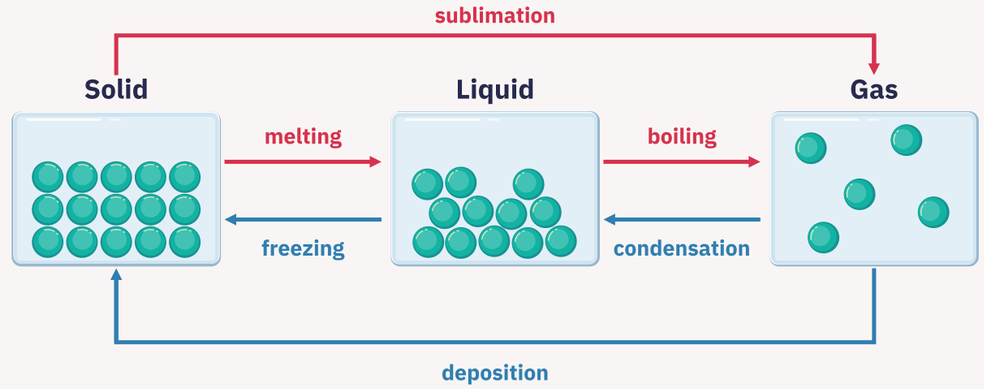
- The particles may be atoms, molecules or ions.

1.2 Comparing the three states

	Solid	Liquid	Gas
Arrangement	very closely packed, in an _____ way	closely packed, in a disorderly way	very far apart, in a _____ way
Movement	vibrate and rotate about _____ positions	slide past one another	move quickly and randomly in any direction
Kinetic energy	very low	low	high
Forces of attraction	very strong	strong	very weak
Shape and volume	definite shape and volume	no definite shape, definite volume	no definite shape or volume
Compressed?	no	no	_____

1 Solids, Liquids and Gases (continued)

1.3 Changes of state



Energy absorbed

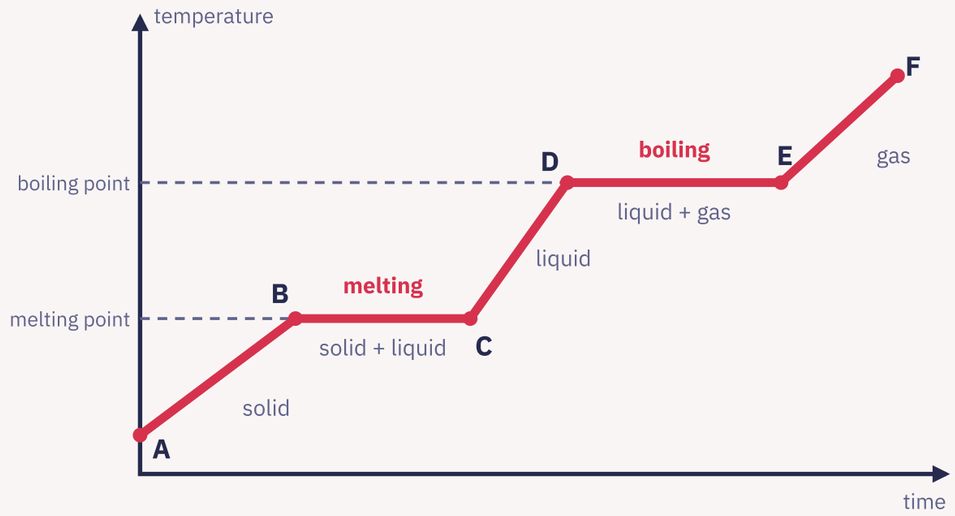
The particles gain energy: _____, boiling (and evaporation) and sublimation.

Energy released

The particles lose energy: freezing, _____ and deposition.

- **Sublimation** is a solid changing straight to a gas, e.g. dry ice (solid carbon dioxide). **Deposition** is a gas changing straight to a solid.

1.4 Heating curve

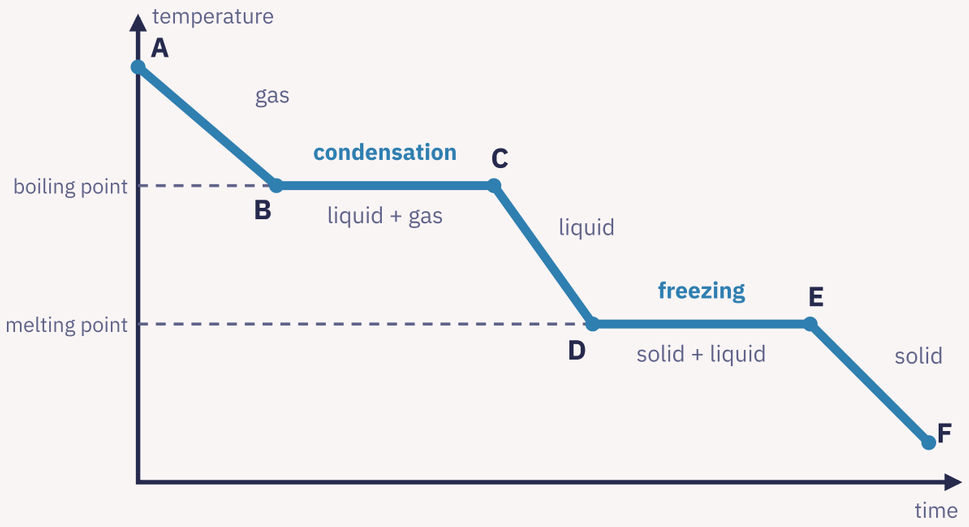


1. **A to B** (solid) and **C to D** (liquid) and **E to F** (gas): thermal energy is converted to _____, so the particles move faster and the temperature rises.
2. **B to C** (melting) and **D to E** (boiling): the energy absorbed overcomes the forces of attraction and increases the _____ of the particles as they move apart. Their kinetic energy does not change, so the temperature stays constant.

NOTE In each flat section of a heating or cooling curve, **two states** are present together.

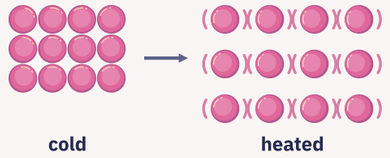
1 Solids, Liquids and Gases (continued)

1.5 Cooling curve



1. **A to B** (gas) and **C to D** (liquid) and **E to F** (solid): kinetic energy is converted to thermal energy and lost to the _____, so the particles slow down and the temperature falls.
2. **B to C** (condensation) and **D to E** (freezing): the forces of attraction pull the particles closer together, so their _____ falls and energy is released. This keeps the temperature constant.

1.6 Expansion and contraction



Expansion

Heated particles vibrate more and sit slightly further _____, so a solid expands.

Contraction

Cooled particles lose energy, vibrate less and come _____.

NOTE Water is unusual: its particles are more closely packed in liquid water than in ice, so ice is less dense than water and floats.

1.7 Evaporation and boiling

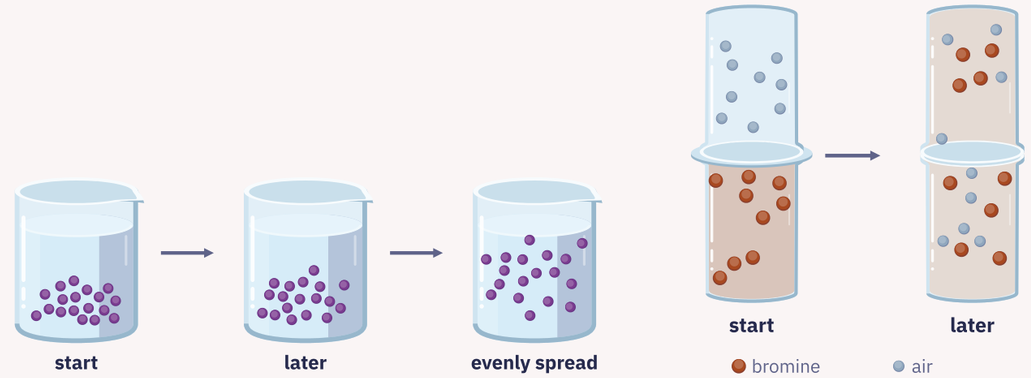
	Evaporation	Boiling
Temperature	any temperature	only at the _____
Where	at the surface only	throughout the liquid, with bubbles
Rate	slow	fast

NOTE In evaporation, only the particles at the surface with enough energy escape into the air.

2 How Particles Move

2.1 Diffusion

Diffusion is the net movement of particles from a _____ concentration to a _____ concentration.



Ink spreading through water | **Bromine spreading into air**

- Diffusion happens in liquids and gases. It explains everyday effects such as a smell spreading through a room.
- The particles keep moving once evenly spread, but there is no net change in _____.

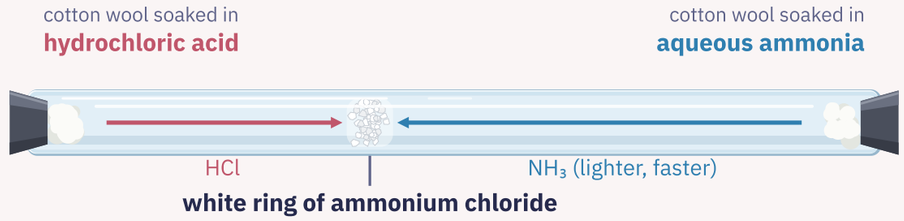
2.2 What affects the rate of diffusion

Temperature

A higher temperature gives particles more kinetic energy, so the rate of diffusion _____.

Particle mass

Heavier particles move more slowly, so the rate of diffusion _____.



- Ammonia and hydrogen chloride diffuse towards each other and react to form white ammonium chloride.
- The white ring forms nearer the _____ end, because the lighter ammonia particles diffuse faster and travel further.
- Porous pot: if the gas outside is lighter, it diffuses into the pot faster than the gas inside diffuses out, so the pressure inside **rises**.

WORKED EXAMPLE You can smell cooking food from across a room. Explain this using the kinetic particle theory.

Heating gives some particles at the surface enough kinetic energy to **escape** into the air as a vapour.

The particles are in constant random motion, so they **diffuse** through the air from the food to your nose.