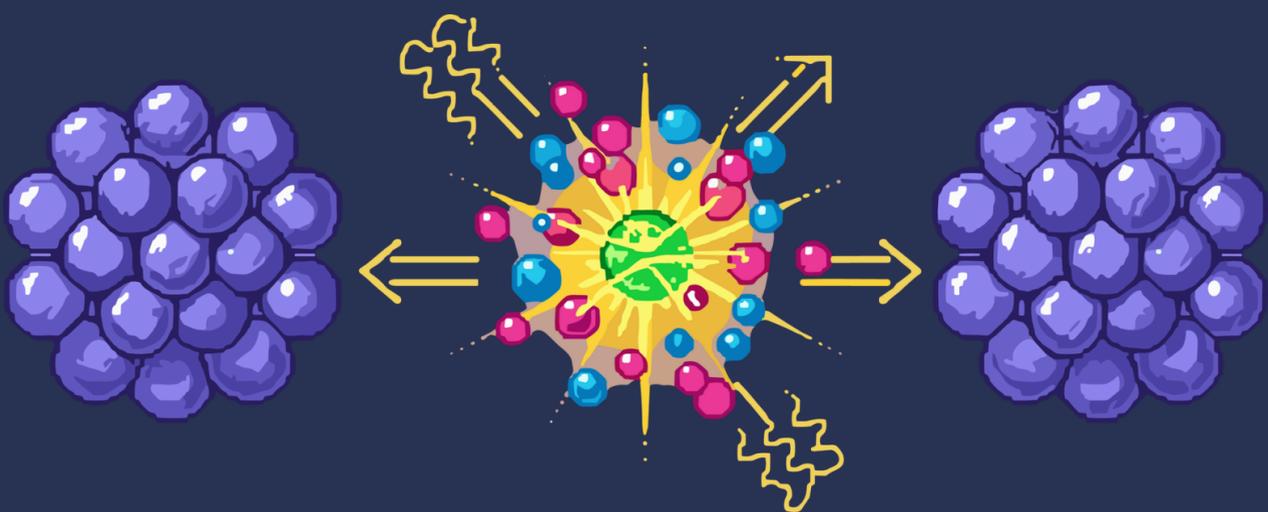


GCSE PHYSICS

PARTICLE MODEL OF MATTER



CHECKLIST

4.3.1 Changes of State and the Particle Model			
Topic	Success Criteria	Progress	
Density of Materials	I can recall and apply the correct equation to calculate the density of an object.		
	I can rearrange the equation linking density, mass and volume to calculate the mass or volume of an object.		
	I can use the particle model to explain the different states of matter.		
	I can use the particle model to explain differences in density.		
	I can recognise and draw simple diagrams to model the difference between solids, liquids and gases.		
	I can describe how to use appropriate apparatus to make and record the measurements needed to determine the densities of regular solid objects and liquids (required practical activity 5).		
	I can calculate the volume of regular solid objects and liquids (required practical activity 5).		
	I can describe how to use appropriate apparatus to make and record the measurements needed to determine the densities of irregularly shaped objects using a displacement technique (required practical activity 5).		
Changes of State	I can describe the different changes of state.		
	I can describe what happens to the mass of a substance when it changes state.		
	I can explain why a change of state is different to a chemical change.		

CHECKLIST

4.3.2 Internal Energy and Energy Transfers			
Topic	Success Criteria	Progress	
Internal Energy	I can describe where energy is stored inside a system.		
	I can give a definition for internal energy.		
	I can explain how heating affects the energy stored within a system.		
	I can explain the effects that heating can have on a system.		
Temperature Changes in a System and Specific Heat Capacity	I can describe what affects the temperature increase of a system.		
	I can calculate the energy change involved when the temperature of a material changes by applying the correct equation from the physics equation sheet.		
Changes of State and Specific Latent Heat	I can give a definition for specific latent heat.		
	I can distinguish between the specific latent heat of fusion and the specific latent heat of vaporisation.		
	I can describe what happens to the energy transferred to a substance as it changes state.		
	I can calculate the energy change involved when a substance changes state by applying the correct equation from the physics equation sheet.		
	I can interpret heating and cooling graphs that include changes of state.		
	I can distinguish between specific heat capacity and specific latent heat.		

CHECKLIST

4.3.3 Particle Model and Pressure				
Topic	Success Criteria	Progress		
Particle Motion in Gases	I can describe the motion of the molecules of a gas.			
	I can describe how the temperature of a gas is related to the average kinetic energy of the molecules.			
	I can explain how the motion of the molecules in a gas is related to its temperature.			
	I can explain how the motion of the molecules in a gas is related to its pressure.			
Pressure in Gases	I can describe the effect of changes in pressure on a gas.			
	I can state the direction of the net force on the walls of the gas container (or any surface).			
	I can use the particle model to explain how increasing the volume in which a gas is contained, at a constant temperature, affects the pressure.			
	I can calculate the change in the pressure of a gas or the volume of a gas when either the pressure or volume is increased or decreased by applying the correct equation from the physics equation sheet.			
Increasing the Pressure of a Gas (HT Only)	I can recall that work is the transfer of energy by a force.			
	I can describe the effect of doing work on a gas on the internal energy and temperature of the gas.			
	I can explain how doing work on an enclosed gas leads to an increase in the temperature of the gas.			

INTRODUCTION TO THE PARTICLE MODEL

The particle model explains that all substances are made of extremely small particles (atoms or molecules). These particles are always moving, and the way they are arranged and how much energy they have determines whether a substance is a solid, liquid, or gas.

Key concepts: particles, arrangement, movement, kinetic energy, potential energy, states of matter.

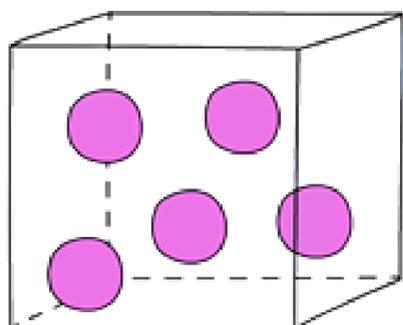
Examples:

- Perfume smell spreading through a room happens because gas particles move randomly and spread out.
- Sugar dissolving in water happens because particles mix and spread

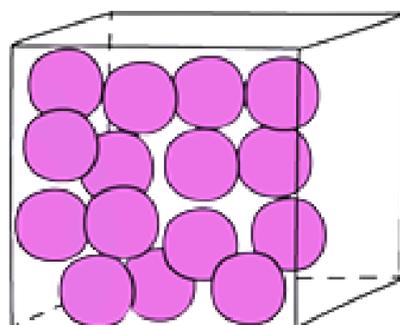
Density

Density is the mass per unit volume of a substance. It tells us how much matter is packed into a given space.

- kg/m^3 (if mass in kg and volume in m^3)
- g/cm^3 (if mass in g and volume in cm^3)



LESS DENSE



MORE DENSE

$$\rho = \frac{M}{V}$$

density

Volume

mass

SOLIDS

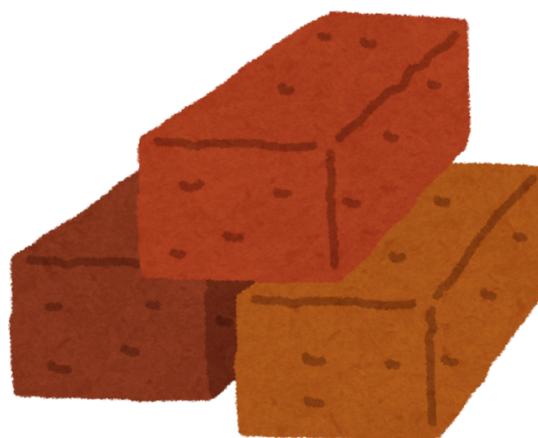
A solid has a fixed shape and a fixed volume because its particles are packed closely together in a regular arrangement. The particles do not move around freely; they only vibrate in place.

Particle behaviour in solids:

- Particles are tightly packed with very small gaps.
- Strong forces hold particles in fixed positions.
- Only vibration happens, not sliding.

Key properties:

- Definite shape (rigid)
- Definite volume
- Not easily compressed
- Usually high density



LIQUIDS

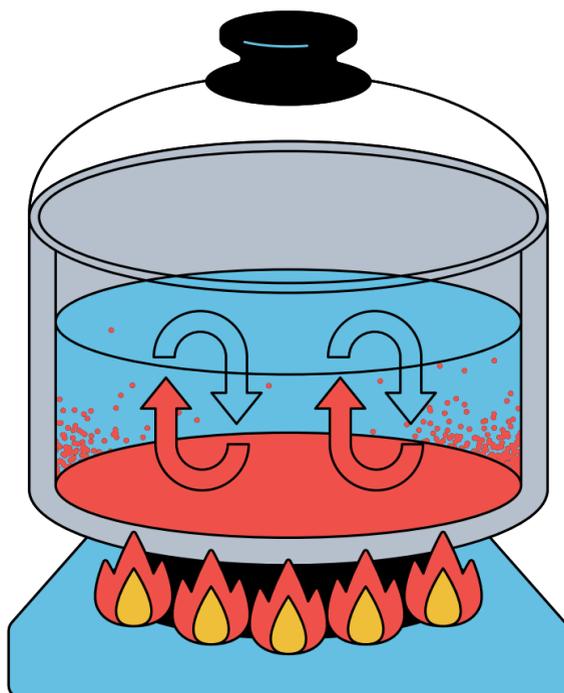
A liquid has a fixed volume, but no fixed shape. Liquid particles are still close together, but they are arranged randomly and have enough energy to slide past each other, which allows the liquid to flow.

Particle behaviour in Liquids:

- Particles are close together but not locked in a pattern.
- Forces still hold them fairly close, but less strongly than in solids.
- Particles can move around each other.

Key properties:

- Takes the shape of its container
- Fixed volume
- Not easily compressed
- Can flow



GASES

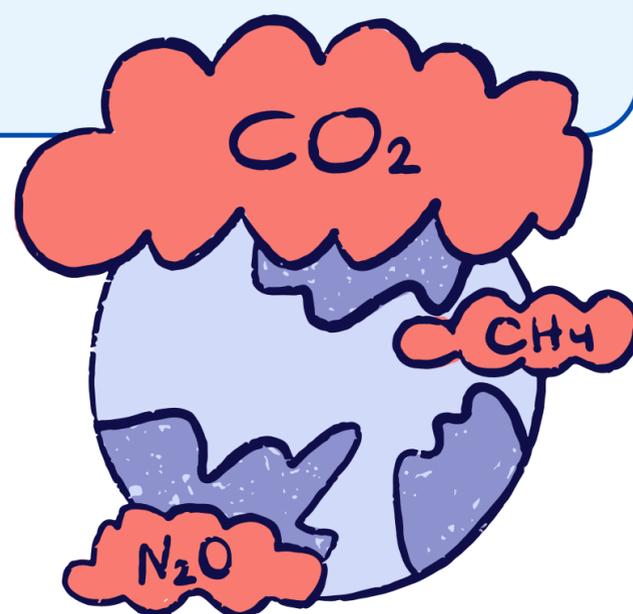
A gas has no fixed shape and no fixed volume. Gas particles are far apart and move randomly at high speeds. Because of the large spaces between particles, gases are compressible and expand to fill their container.

Particle behaviour in Gases:

- Particles are widely spaced with weak forces between them.
- Move freely and collide with each other and container walls.
- Spread out to fill any available space.

Key properties:

- Takes the shape of the container
- Expands to fill the container (no fixed volume)
- Easily compressed
- Low density



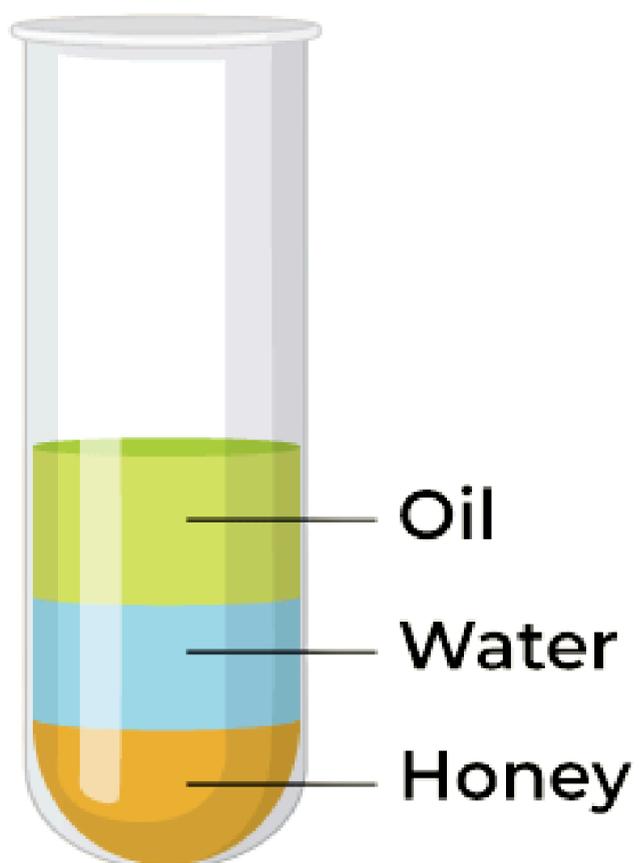
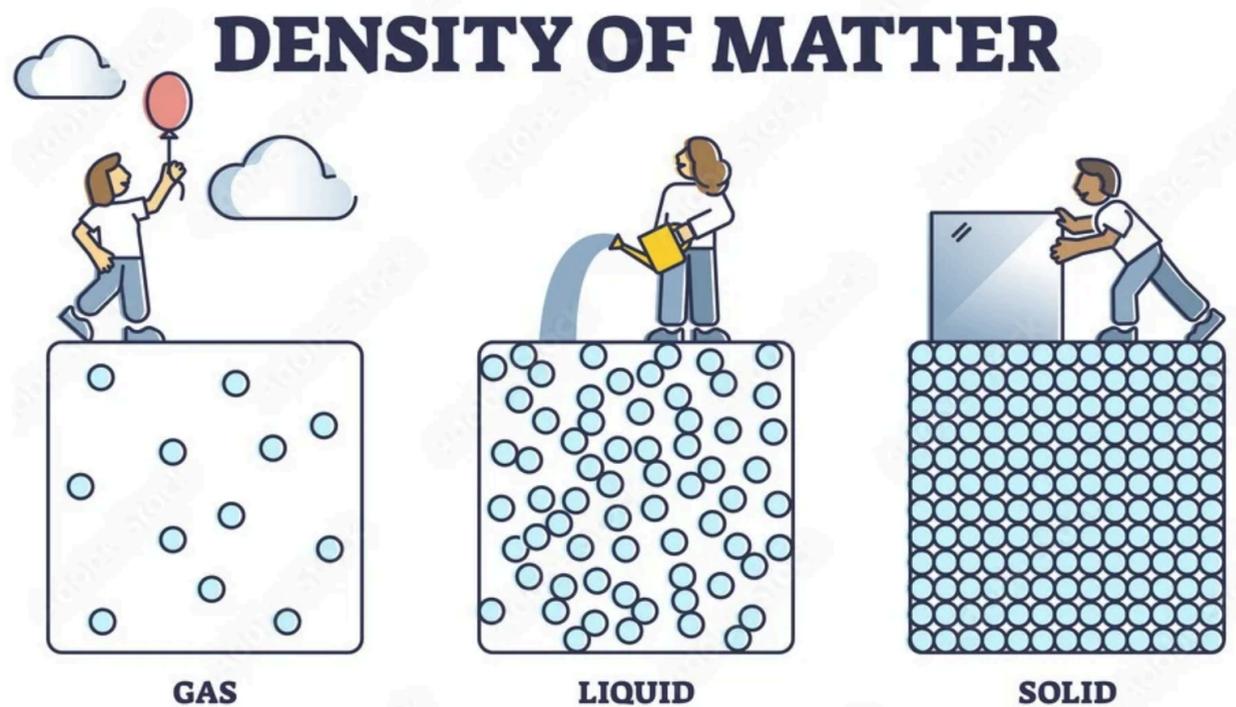
DIFFERENCES IN DENSITY

Solids and liquids have similar densities because their particles are close together.

Gases have much lower density because their particles are far apart.

Example:

- Water has a much higher density than air.

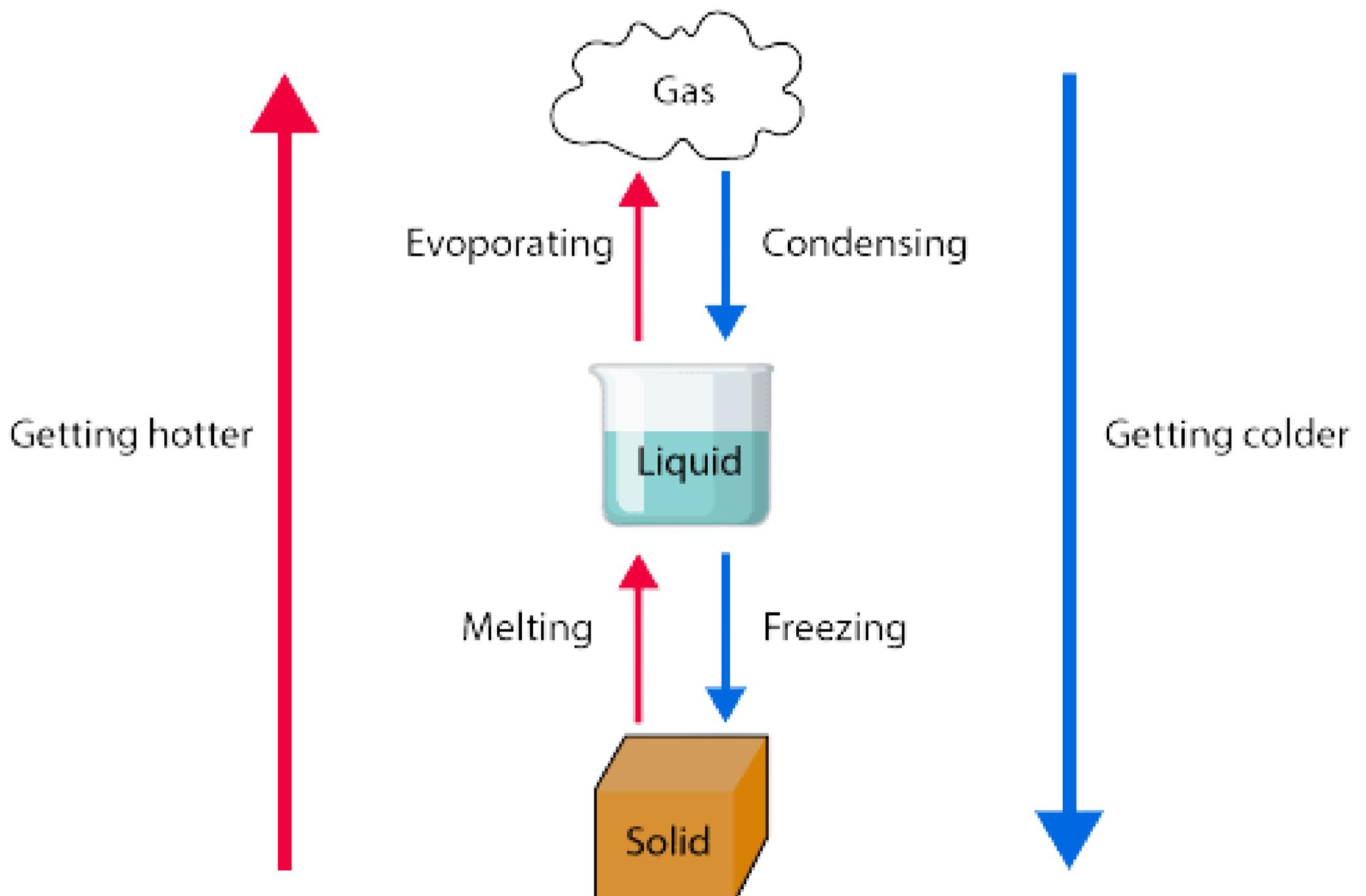


CHANGES OF STATE

A change of state is a physical change where a substance changes between solid, liquid, and gas. The substance itself stays the same (for example, water is still water whether it is ice, liquid water, or steam).

Key changes:

- Melting: solid → liquid
- Freezing: liquid → solid
- Boiling/Evaporation: liquid → gas
- Condensation: gas → liquid
- Sublimation: solid → gas



INTERNAL ENERGY

Internal energy is the total energy stored inside a substance due to:

1. Kinetic energy of particles (their movement/vibration)
2. Potential energy of particles (their positions and spacing)

Key points:

- When temperature increases, particles move faster, so kinetic energy increases.
- During melting/boiling, temperature does not rise because energy is used to increase potential energy by separating particles.

Example:

- Heating water increases internal energy.
- Boiling water increases internal energy even though the temperature stays at 100°C during boiling.

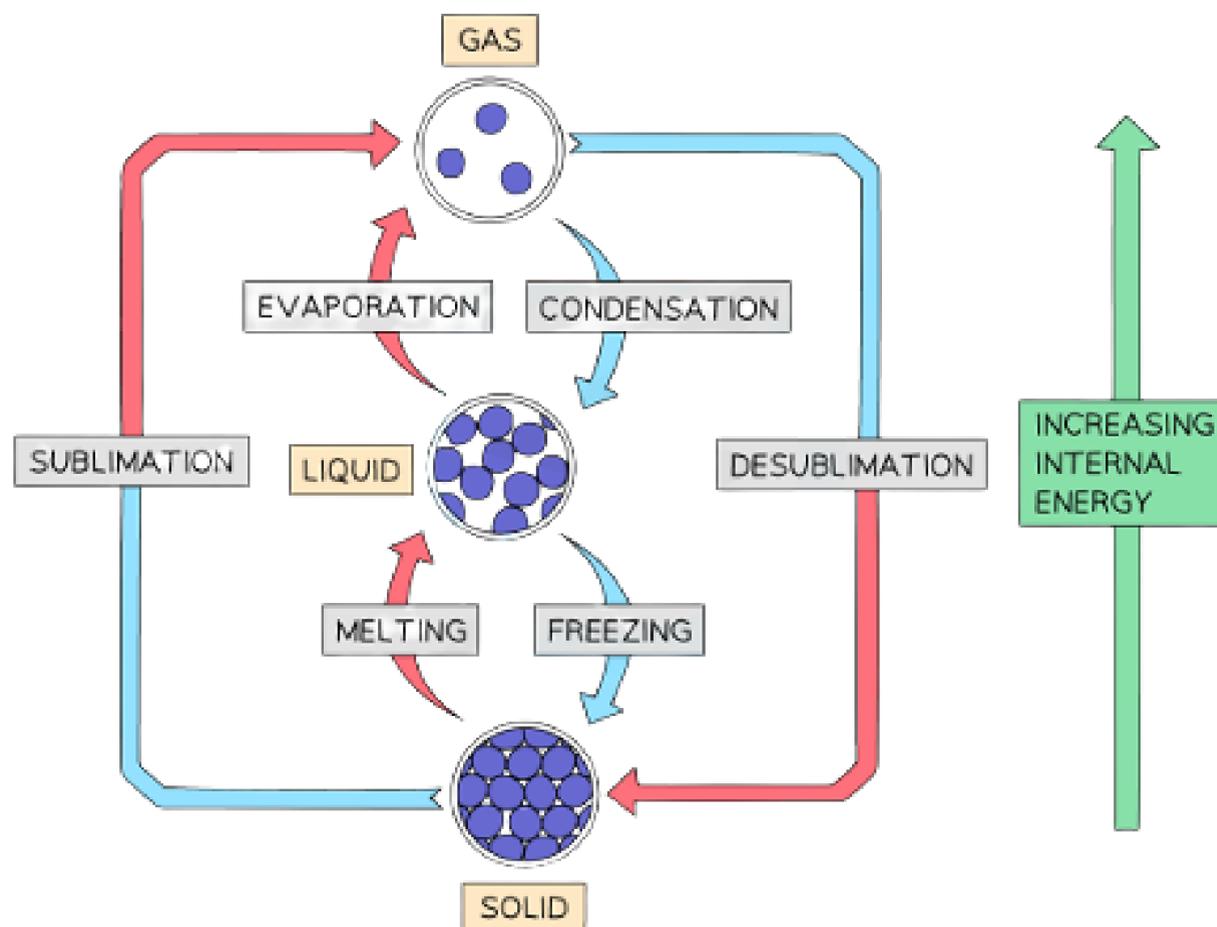
CHANGE OF STATE

(WHY TEMPERATURE CAN STAY CONSTANT)

- When a substance reaches a specific temperature (like melting point or boiling point), something different happens:
- The energy you keep supplying stops increasing kinetic energy.
- Instead, energy is transferred into the potential energy store of the particles.
- That energy is used to overcome intermolecular forces (the attractions holding particles close together).
- Particles separate more, so the substance changes state (solid → liquid, liquid → gas).

Key outcome:

- During a state change, temperature stays the same even though energy is still being absorbed.
- Because the energy is being used for separating particles, not speeding them up



LATENT HEAT AND SPECIFIC LATENT HEAT

Latent heat is the energy involved in a change of state without changing temperature. Specific latent heat is the energy needed to change the state of 1 kg of a substance.

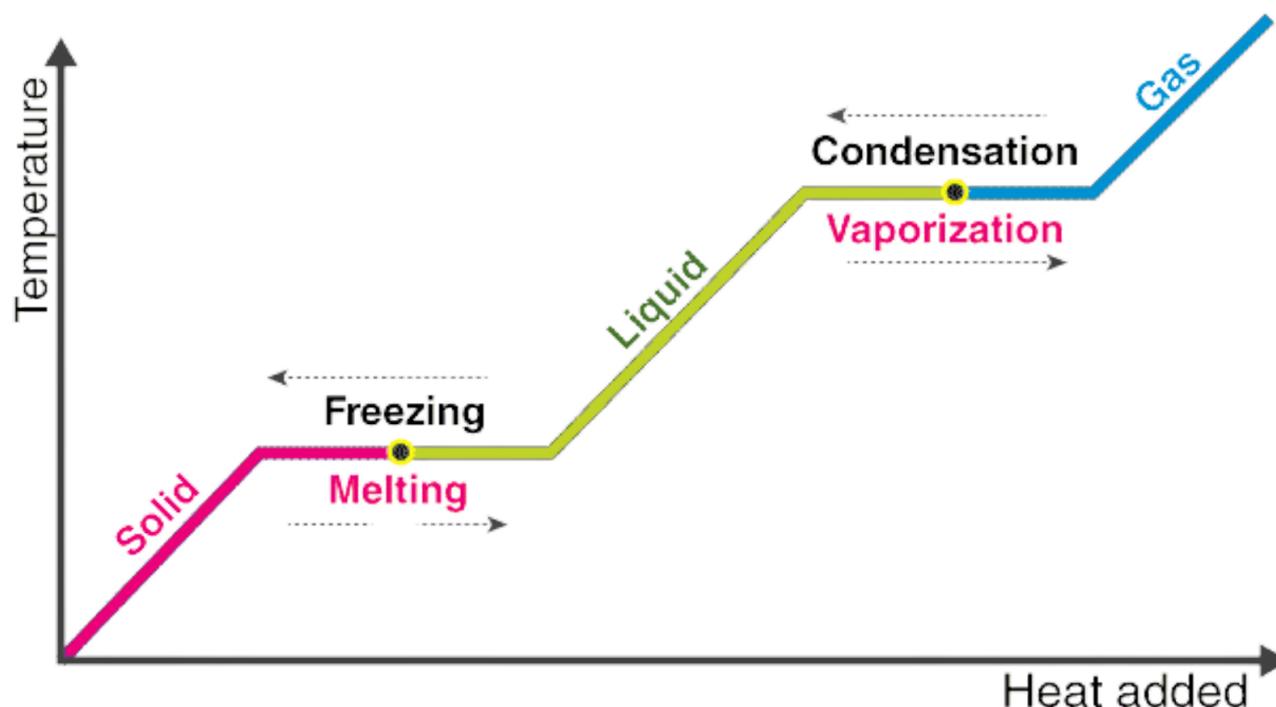
$$\text{Energy} = \text{mass} \times \text{specific latent heat}$$

J kg J/kg

$$E = mL$$

Key points:

- During melting and boiling, temperature stays constant because energy is used to overcome forces between particles.
- Two types:
 - Fusion: solid ↔ liquid
 - Vaporisation: liquid ↔ gas



GAS PRESSURE

- Gas pressure happens because gas particles collide with the walls of the container. The more frequent and stronger the collisions, the higher the pressure.

Key points:

- Higher temperature → particles move faster → more collisions → higher pressure (if volume is constant).
Smaller volume → particles hit walls more often → higher pressure (if temperature is constant).

Examples:

- A tyre gets higher pressure after driving because the air warms up.
- Compressing air in a pump increases pressure.



PRESSURE AND VOLUME (BOYLE'S LAW)

- For a fixed mass of gas at constant temperature, pressure and volume are inversely related.

Equation:

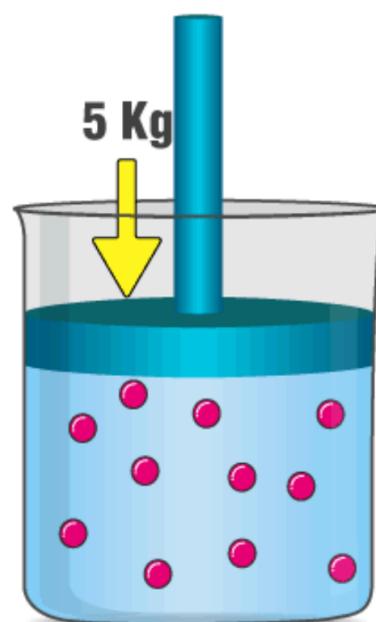
$$P_1V_1 = P_2V_2$$

Key points:

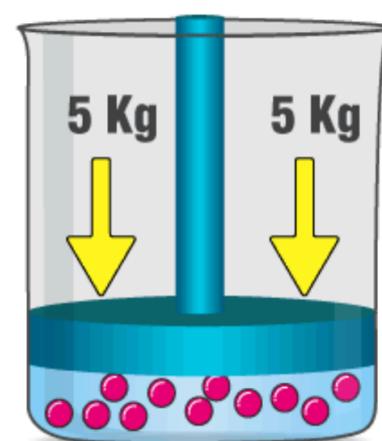
- Volume decreases → pressure increases.
- Volume increases → pressure decreases.
- Only works if temperature and mass of gas stay constant.

Uses:

- Medical syringes and pumps.
- Air compressors.
- Scuba diving (pressure changes with depth).



$V_1 \propto 1/P_1$



$V_2 \propto 1/P_2$

WORK DONE ON A GAS

When a gas is compressed, work is done on the gas, transferring energy to it. This increases internal energy and often increases temperature. When a gas expands, the gas does work and can cool down.

Key points:

- Work done on gas (compression) → temperature rises.
- Work done by gas (expansion) → temperature falls.

Uses:

- Diesel engines (compression increases temperature to ignite fuel).
- Cooling in refrigeration systems.
- Understanding pressurised gas release.

Examples:

- Bicycle pump warms up during rapid pumping.
- Carbon dioxide can cool so much during expansion that it forms dry ice.

