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Physics Topic P6
Particles at Work – Molecules and matter

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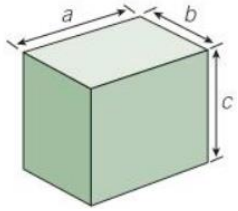
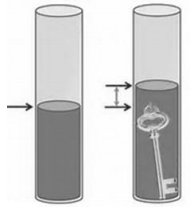
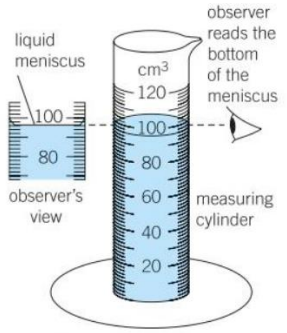
Section 1: Key Terms

Density	How much **mass** a substance contains **compared to its volume**. Solids are usually dense because the particles are closely packed.
State of matter	The way in which the **particles are arranged** – solid, liquid or gas.
Change of state	When a substance **changes from one state of matter** to another (e.g. melting is the change from a solid to a liquid). Energy changes the state, not the temperature.
Physical change	A change that can be **reversed** to recover the original material. **E.g. a change of state.**
Chemical change	A change that **creates new products**. It **should not be reversed**. E.g. a chemical reaction.
Internal energy	The **energy stored** inside a system **by the particles** (atoms and molecules) that make up the system. Internal energy is the **total kinetic energy and potential energy of all the particles.**
Kinetic energy	**Energy stored** within **moving objects** (e.g. particles).
Potential energy	**Energy stored** in **particles** because of their **position.** The **further apart** particles are, **the greater the potential energy.**
Specific heat capacity	The specific heat capacity of a substance is the **amount of energy** required to **raise the temperature of one kilogram** of the substance **by one degree Celsius**.
Temperature	The **average kinetic energy** of the **particles**.
Specific latent heat	The **amount of energy** required to **change the state of one kilogram** of the substance with **no change in temperature**.
Latent heat of fusion	**Energy required** to change state from **solid to liquid**.
Latent heat of vaporisation	**Energy required** to change state from **liquid to vapour**.
Gas Pressure	The **force** exerted by gases on surface as the **particles collide** with it. **As temperature increases, gas pressure increases** if the volume stays constant.

Section 2: Density

The **density of water** is **1000kg/m^3** . Objects that have a lower density than water will float in water. **Density** can be **calculated** by measuring its **mass** and **volume**.

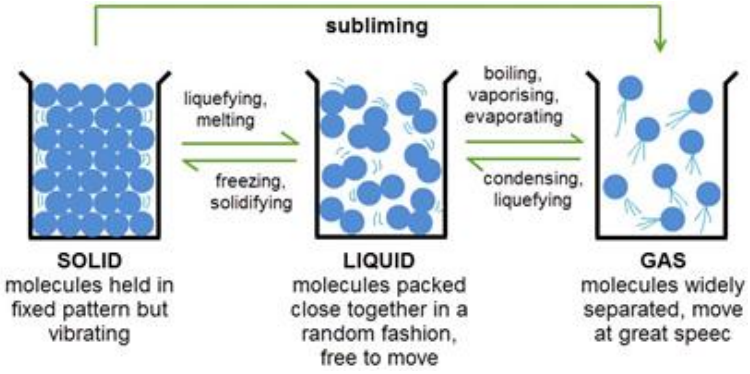
Measure **volume** of a **cuboid** = a x b x c	
Volume of **an irregular object** can be found by **dropping in a liquid** and **measuring Displacement**.	
When reading a meniscus the observer must read the **bottom** of the **meniscus**.	

Calculation	Equation	Symbol equation	Units
Density	Density = $\frac{\text{mass}}{\text{volume}}$	$\rho = \frac{m}{v}$	Density = kg/m^3 Mass = kg Volume = m^3

Section 3: States of matter

Everything around you is made up of matter and exists in one of **three states**. **Solids**, **liquids** and **gases** are made of particles, the physical arrangement of particles determines the state of a particular substance.

Kinetic theory of matter



Changes of state

Condensation	Process in which a gas turns into a liquid
Evaporation	Process in which a liquid turns into a gas
Freezing	Process in which a liquid turns into a solid
Melting	Process in which a solid turns into a liquid
Sublimation	Process in which a solid turns into a gas

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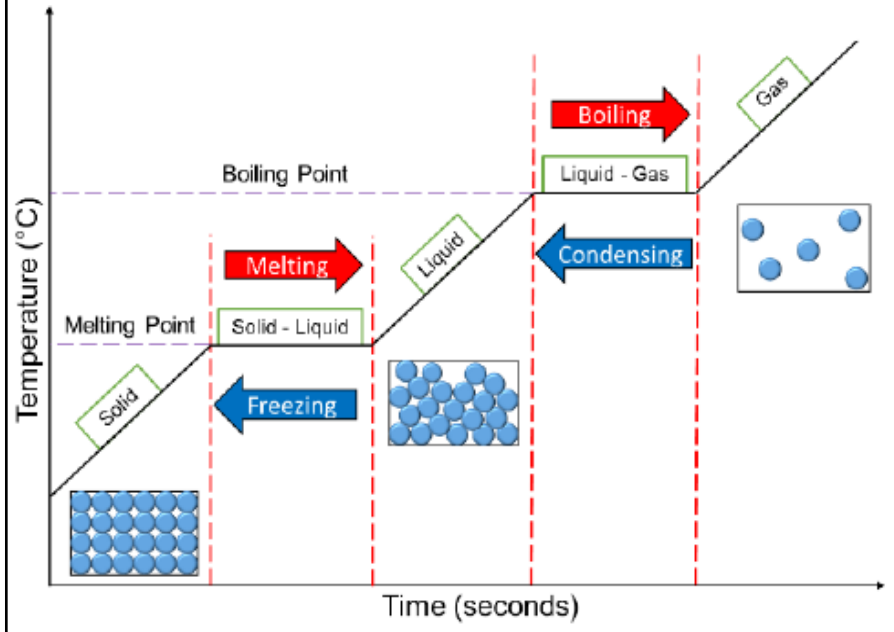
Section 4: The Heating Curve



Solid	Particles are closely packed, fixed and arranged in regular layers. As more energy is absorbed the kinetic energy and therefore the internal energy of the material increases.
Melting	Temperature doesn't change. Energy is used to weaken the forces between particles. As more energy is absorbed the potential energy and therefore the internal energy of the material increases.
Liquid	Particles are touching but no longer arranged regularly. They are able to move. As more energy is absorbed the kinetic energy and therefore the internal energy of the material increases.
Evaporation	Temperature doesn't change. Energy is used to weaken the forces between particles. As more energy is absorbed the potential energy and therefore the internal energy of the material increases.
Boiling point	The temperature at which a liquid boils and turns into a gas
Melting point	The temperature at which a solid melts and turns into a liquid.
Gas	Particles move randomly. As more energy is absorbed the particles move more quickly and the temperature increases.

State	Particle arrangement	Distance between molecules	Strength of forces	Movement of particles	Internal energy
Solid	Fixed	Close together	Strong	vibrates	Lowest internal energy
Liquid	Not fixed	Touching but not arranged regularly	Weak	Move about	Higher than solids but lower than gases
Gas	Not fixed	Far apart	Very weak (insignificant)	Move about freely	Highest internal energy.

Section 5: Internal energy

The energy stored by the **particles** of a substance is called its **internal** energy. This is caused by their individual motions and positions. The internal energy is the sum of a particles

- **kinetic energy** (due their individual motions relative to each other.)
- **potential energy** (due to their individual positions relative to each other.)

Increasing the temperature increases the **internal energy** of a substance because:

- Increasing temperature increases kinetic energy
- If it melts or boils, the potential energy increases.

Section 6: Specific latent heat

The **latent heat** is the **energy needed** for a substance to **change its state without changing** its **temperature**.

Specific latent heat of fusion $L_f = \frac{\text{energy, E}}{\text{mass, m}}$

Specific latent heat of vaporisation $L_v = \frac{\text{energy, E}}{\text{mass, m}}$

Section 7: Gas Pressure

Gas Pressure	Caused by the force exerted when particles collide with their container
Increasing temperature increases the gas pressure	Gas molecules move faster and hit the surfaces with more force. The number of impacts between the gas molecules and the surface of the container increases, so the total force of impact increases
Motion of gases	The unpredictable motion of smoke particles is evidence of the random motion of gas molecules – this is called Brownian motion
Gas pressure and Volume **(Triple only)**	A fixed mass of gas at a constant temperature, the pressure is increased if the volume is decreased as the number of molecular impacts per second increases
Boyle's Law **(Triple only)**	Pressure (p) x Volume (V) = constant (Pa) (m^3)