

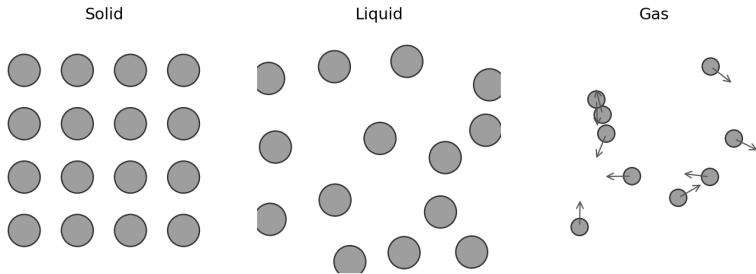
Topic 3: Particle model of matter

AQA GCSE Physics 8463 · spec 4.3 · sheets 3.1–3.6

The particle model: matter from the inside

- Why a spoon sinks and a ship floats; why sweat cools you.
- Every equation of this topic is printed on the sheet.
- Physics only: gas pressure laws and work on a gas (HT).

Three states, one model



- Solid: fixed pattern. Liquid: touching, sliding. Gas: far apart, random.
- Density is mass per unit volume: $\rho = m/V$.
- Convert g/cm^3 to kg/m^3 ($\times 1000$) before substituting.

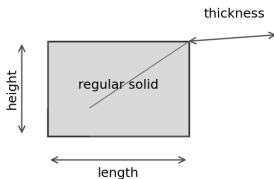
Your turn: a metal ring

- A ring has mass 9.46 g and volume 0.44 cm^3 .
- Find the density in kg/m^3 before the answer appears.

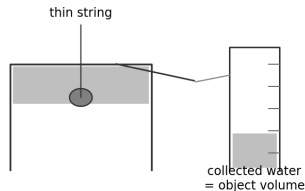
A metal ring worked

- 1 Convert** $m = 9.46 \times 10^{-3} \text{ kg}$; $V = 0.44 \text{ cm}^3 = 4.4 \times 10^{-7} \text{ m}^3$.
- 2 Equation** $\rho = m/V$.
- 3 Answer** $\rho = 21\,500 \text{ kg/m}^3$.

RP5: density of any object



$V = l \times h \times t$; m from a balance



displacement can (eureka can)

- Regular: measure dimensions; $V = l \times w \times t$.
- Irregular: displacement can; collected volume = object volume.
- Liquid: mass difference in a measuring cylinder.

Changes of state conserve mass

- Melting, freezing, boiling, evaporating, condensing, sublimating.
- Mass is conserved; these are physical changes.
- Internal energy = total kinetic + potential energy of the particles.

Two routes for heating energy

- Temperature rises: kinetic energy grows.
- State changes: potential energy grows at constant temperature.
- That is why melting ice stays at 0 °C.

Specific heat capacity, particle view

- $\Delta E = mc\Delta\theta$ with $\Delta\theta$ a change, not a reading.
- Smaller c : bigger temperature rise for the same energy.
- Water stores a lot of energy per degree ($c = 4200 \text{ J/kg } ^\circ\text{C}$).

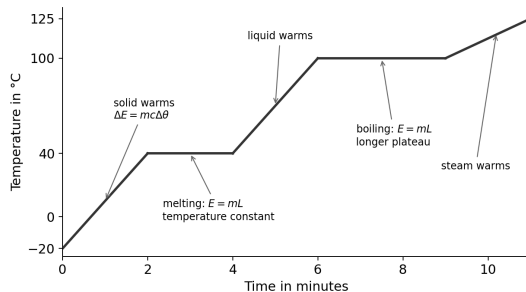
Your turn: a heating pad

- A 0.20 kg pad, $c = 900 \text{ J/kg } ^\circ\text{C}$, warms from $22 \text{ } ^\circ\text{C}$ to $46 \text{ } ^\circ\text{C}$.
- Calculate the energy transferred.

Heating pad worked

- 1 **Change** $\Delta\theta = 46 - 22 = 24\text{ }^{\circ}\text{C}$.
- 2 **Equation** $\Delta E = mc\Delta\theta = 0.20 \times 900 \times 24$.
- 3 **Answer** $\Delta E = 4320\text{ J}$.

Latent heat: energy at constant temperature



- $E = mL$: one kilogram changes state, no temperature change.
- Fusion (solid-liquid) is much smaller than vaporisation.
- Heating graphs: rising is $mc\Delta\theta$, flat is mL .

Your turn: boiler energy

- A 30 W heater runs 11 minutes and boils off 6.6×10^{-3} kg of water at 100 °C.
- Calculate the specific latent heat.

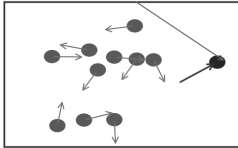
Boiler energy worked

- 1 **Energy** $E = Pt = 30 \text{ W} \times 660 \text{ s} = 19\,800 \text{ J}.$
- 2 **Rearrange** $L = E/m.$
- 3 **Answer** $L = 3.0 \times 10^6 \text{ J/kg}.$

Molecules in constant random motion

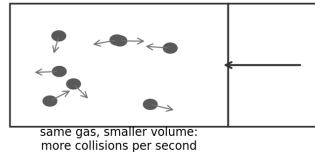
Collisions make pressure

force at right
angles to wall



Compressing raises pressure

piston moves in



- Temperature measures the average kinetic energy of the molecules.
- Collisions with the walls exert forces at right angles.
- Pressure is the total collision force per unit area.

Warmer gas, harder hits

- Temperature up at constant volume: pressure up.
- Faster molecules hit more often and harder.
- Reverse for cooling.

pV is constant

- Pressure in gases (physics only): $p_1 V_1 = p_2 V_2$.
- Bigger volume, fewer collisions per second per unit area.
- Keep units consistent on both sides.

Your turn: syringe

- A syringe holds 50 cm^3 of air at 100 kPa ; it is compressed to 20 cm^3 .
- Calculate the new pressure.

Syringe worked

- 1 **Rearrange** $p_2 = \frac{p_1 V_1}{V_2}$.
- 2 **Substitute** $p_2 = \frac{100 \text{ kPa} \times 50 \text{ cm}^3}{20 \text{ cm}^3}$.
- 3 **Answer** $p_2 = 250 \text{ kPa}$.

Doing work on a gas warms it

- (HT) Work is energy transferred by a force.
- Compressing: work done on the gas raises internal energy.
- Bicycle pump: the handle warms.

Check yourself

- Checklist before you call this topic done.
- Convert units; RP5 from memory; read the plateaus.
- Collisions explain pressure; pV constant; work warms a gas.