

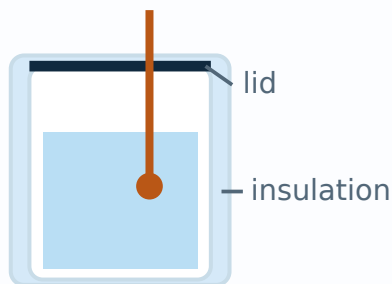
P1 Thermal insulation practical

Separate Physics extras | AQA 8463 | CORE

Use alongside the shared topic notes. Foundation + Higher content.

Plan a fair comparison

Required practical 2: compare insulating materials or investigate one factor, such as insulation thickness.



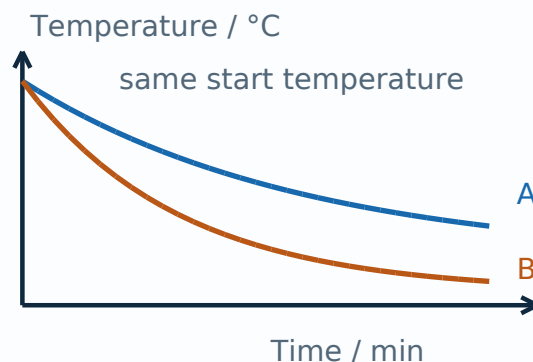
Measure temperature at fixed times

Use identical containers and lids, equal masses of water, the same initial temperature and the same room conditions. Change only the chosen factor.

Keep the thermometer position fixed. Use hot water carefully and support containers securely.

Measure and interpret

Record temperature at regular intervals for the same duration. Repeat trials and calculate a mean temperature drop.



A smaller temperature fall in the same time indicates better insulation. Curve A cools more slowly than B in this example.

Compare at the same temperature difference from the room: cooling usually slows as this difference decreases.

Evaluate the evidence

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Variables: material or thickness is independent; temperature change is dependent. Water mass, start temperature, exposed area and time are controls.

A lid reduces energy transfer by evaporation and convection. Insulation reduces transfer through the container; it does not prevent every transfer.

Repeat readings reduce the effect of random variation. Use the spread of results to judge how convincing a small difference is.

$$\Delta\theta = \theta_{\text{start}} - \theta_{\text{end}}$$

Example: 75 °C to 61 °C is a fall of 14 °C. Another material falling by 9 °C is more effective under the same conditions.

Explain: thicker walls or lower thermal conductivity reduce the rate of conduction.

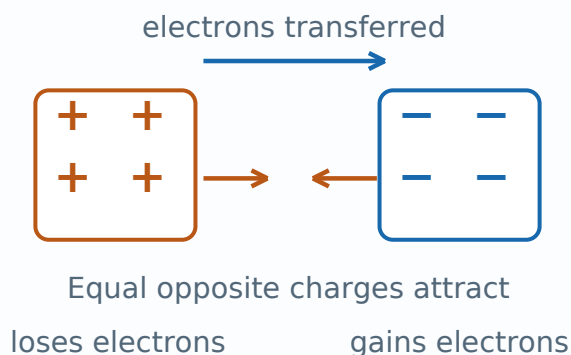
P2 Static charge and electric fields

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Use alongside the shared topic notes. Foundation + Higher content.

Charge by electron transfer

Rubbing suitable insulators transfers **electrons**. The material gaining electrons becomes negative; the other is left with an equal positive charge.

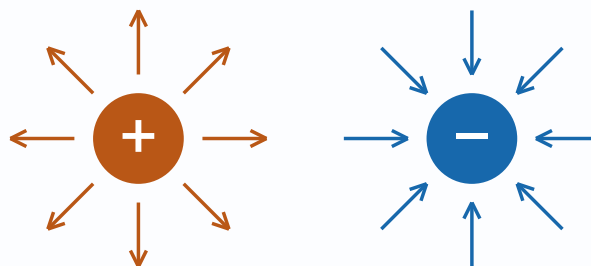


Like charges repel. Unlike charges attract. These are non-contact forces: the objects need not touch.

Protons remain within nuclei. Charge is transferred, not created. A charged insulator holds charge because electrons cannot flow freely through it.

Read an electric field

A charged object produces an electric field. A second charge in the field experiences a force.



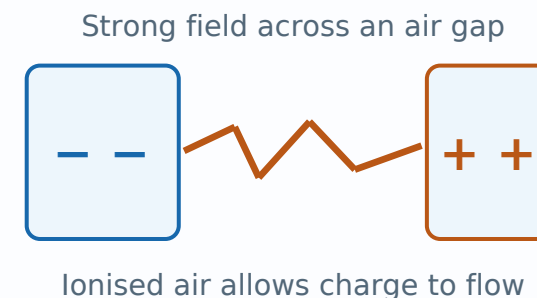
Direction: force on a positive test charge

Field arrows show the force direction on a **positive** test charge. They point away from a positive sphere and towards a negative sphere.

The field is stronger closer to the sphere. Closer field lines represent a stronger field; a negative test charge feels a force opposite the arrows.

Explain a spark

A large potential difference can produce a strong electric field across an air gap.



The strong field can ionise air. Charged particles then move through the air, briefly carrying a current: a spark.

Evidence: repulsion shows two objects carry the same type of charge. Attraction alone is less conclusive because a charged object can also attract a neutral object.

Reasoning chain: electron transfer → charge imbalance → electric field → force or discharge.

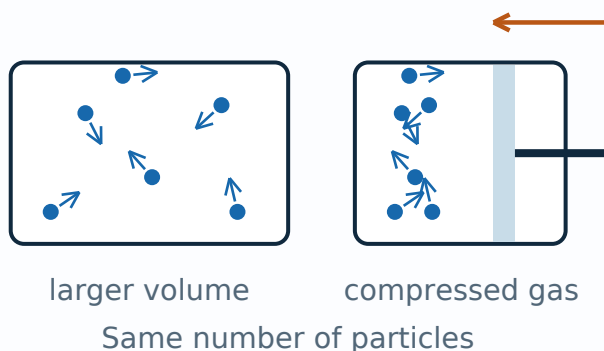
P3 Pressure and volume of a gas

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Use alongside the shared topic notes. Foundation + Higher content.

Use the particle model

Gas particles move randomly and collide with the container walls. The collisions produce forces normal to the walls.

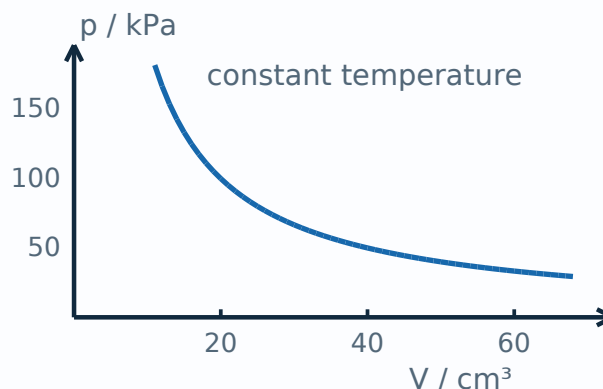


For a fixed mass at constant temperature, a larger volume means fewer collisions with each unit area of wall each second. Pressure decreases.

At constant temperature the average kinetic energy stays the same. It is not the number of particles that changes.

Apply the inverse relation

$$p_1 V_1 = p_2 V_2$$



Conditions: fixed mass of gas and constant temperature. Pressure $\times$ volume stays constant, so doubling volume halves pressure.

Use consistent pressure and volume units on both sides. SI units are Pa and m^3 ; $1 \text{ cm}^3 = 10^{-6} \text{ m}^3$.

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Calculate and investigate

Example: a sealed gas has volume 40 cm^3 at 100 kPa . It is slowly compressed to 25 cm^3 at the same temperature.

$$p_2 = \frac{100 \times 40}{25}$$

The new pressure is **160 kPa**. This is reasonable: a smaller volume gives a higher pressure.

A gas syringe and pressure sensor can test the relationship. Keep the gas sealed, change volume slowly and allow the gas to return to room temperature before reading.

A graph of p against V curves. A graph of p against $1/V$ is a straight line through the origin for this model.

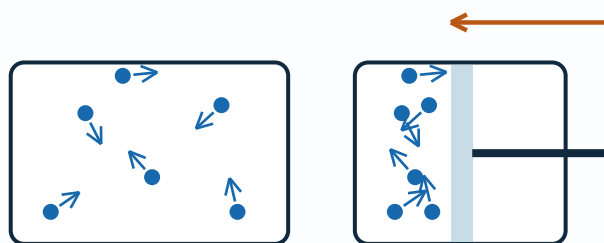
P3 Doing work on a gas

Separate Physics extras | AQA 8463 | HIGHER ONLY

Use alongside the shared topic notes. Higher-tier material is kept on this separate page.

Compression transfers energy

A force acting through a distance does work. Pushing a piston into an enclosed gas transfers energy to the gas.



larger volume

compressed gas

Same number of particles

The internal energy of the gas increases. Its temperature can rise because the average kinetic energy of its particles increases.

A bicycle pump can warm during rapid compression. Some heating may also come from friction in the pump.

Follow the energy transfer

Initial store: energy in the person's chemical store is transferred mechanically as the piston moves.

During compression: work is done on the gas. Its internal energy can increase even without heating from a hotter object.

$$W = F s$$

This shared equation applies when the force is constant and the movement is along its line of action.

Example: a constant 40 N force moving 0.15 m transfers 6 J mechanically. Do not assume that all 6 J stays in the gas if energy also transfers to the surroundings.

Keep the conditions clear

Rapid compression: little time for energy to leave the gas, so a temperature rise is more likely.

Slow compression with cooling: energy can transfer to the surroundings, allowing the temperature to remain approximately constant.

Use $pV = \text{constant}$ only when the temperature is constant and the mass of gas is fixed. Rapid compression that heats the gas does not meet these conditions.

Exam explanation: force moves piston → work done on gas → internal energy rises → average kinetic energy rises → temperature rises.

Temperature and internal energy are different ideas: temperature links to average particle kinetic energy; internal energy includes the particles' kinetic and potential energies.

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P4 Radiation: hazards and medical uses

Separate Physics extras | AQA 8463 | CORE

Use alongside the shared topic notes. Foundation + Higher content.

Background and dose

Background radiation is always present. Natural sources include rocks and cosmic rays; artificial sources include fallout from weapons testing and nuclear accidents.

Sources vary with place and occupation



Natural sources + artificial sources

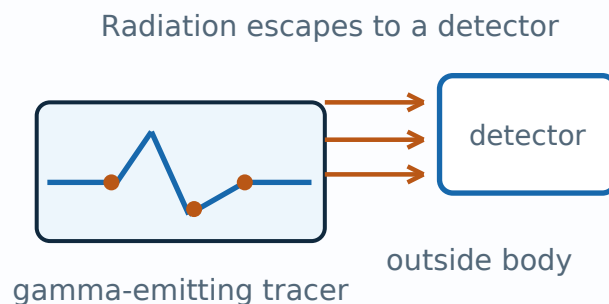
Dose depends on location and occupation. Compare evidence rather than assuming every exposure has the same risk.

Dose is measured in sieverts: **1 Sv = 1000 mSv**. AQA does not require recall of this unit.

Choose a useful half-life

Radioisotope half-lives range widely. For the same number of unstable nuclei, a shorter half-life gives a higher activity.

A short half-life may create a high initial hazard but activity falls quickly. A long half-life may keep material hazardous for much longer.



A medical tracer should emit radiation detectable outside the body and have a half-life long enough for the test, but short enough to limit the patient's dose.

Balance benefit and risk

Diagnosis: a suitable tracer follows a body process; a detector maps radiation leaving the body. Gamma radiation can escape from inside the patient.

Treatment: targeted radiation damages or destroys unwanted tissue. Healthy tissue can also be harmed, so dose and targeting matter.

External beams can be directed from several angles so the tumour receives a larger total dose than surrounding tissues.

Evaluate benefits against risks using the supplied data, the seriousness of the condition, dose and available alternatives.

Do not confuse: irradiation is exposure to radiation; contamination is the unwanted presence of radioactive material on or in something.

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P4 Nuclear fission and fusion

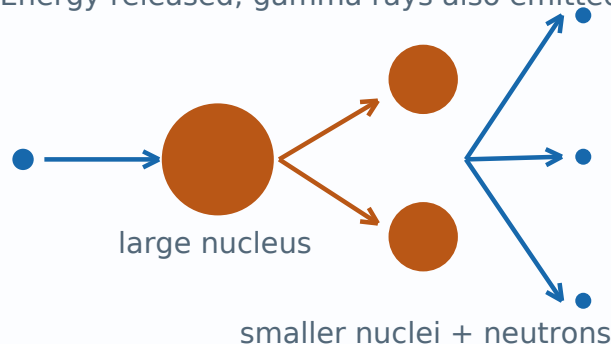
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Fission: a nucleus splits

Fission splits a large unstable nucleus, such as uranium or plutonium. Spontaneous fission is rare; usually a neutron is first absorbed.

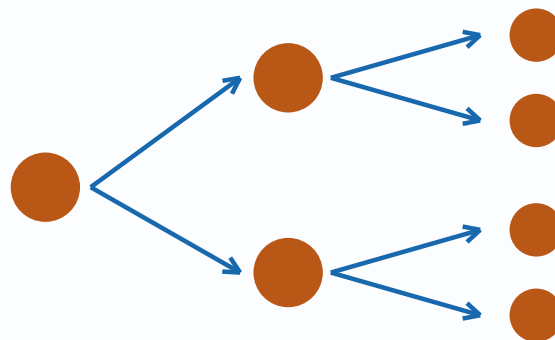
Energy released; gamma rays also emitted



Two smaller nuclei, two or three neutrons and gamma rays are produced. Energy is released; the fission products have kinetic energy.

Read diagrams by tracking the incident neutron, the parent nucleus and the emitted products.

A chain reaction develops



Emitted neutrons can trigger more fissions

Emitted neutrons can be absorbed by other unstable nuclei, causing further fissions and more neutron emission.

In a reactor the chain reaction is controlled so energy is released at a controlled rate. An uncontrolled chain reaction releases energy very rapidly.

Explain the chain: neutron absorbed → nucleus splits → neutrons released → more nuclei split.

A neutron that escapes the material or is absorbed without fission does not continue that branch of the chain.

Fusion: light nuclei join

Nuclei join; energy can be released



Fusion powers stars

Fusion joins two light nuclei to make a heavier nucleus. Some mass may be converted into the energy of radiation.

Very high temperatures allow nuclei to approach closely enough to fuse despite electrical repulsion between their positive charges.

Compare: fission splits a heavy nucleus; fusion joins light nuclei. Both can release energy through changes in nuclei.

Fusion is the source of energy in stars. It is a nuclear process, not chemical burning.