

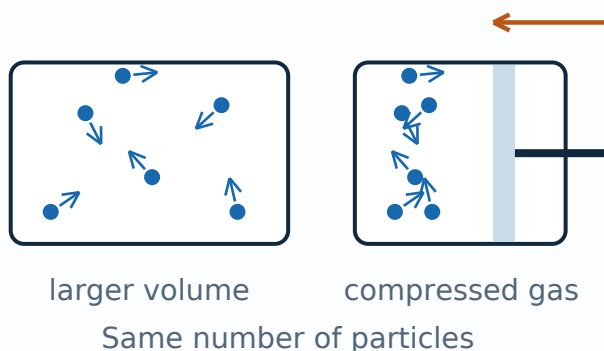
P3 Pressure and volume of a gas

Separate Physics extras | AQA 8463 | CORE

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.

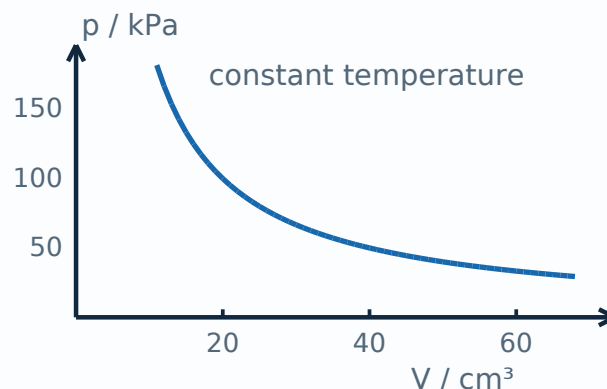


For a fixed mass at constant temperature, a larger volume means fewer collisions with each unit area of wall each second. Pressure decreases.

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.

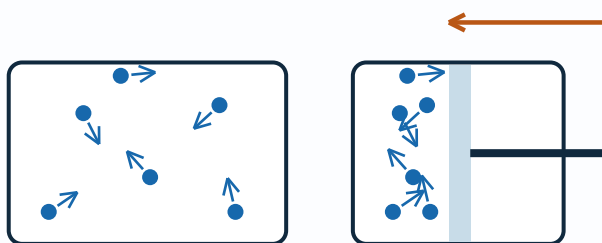
P3 Doing work on a gas

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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