Exercise walk-through

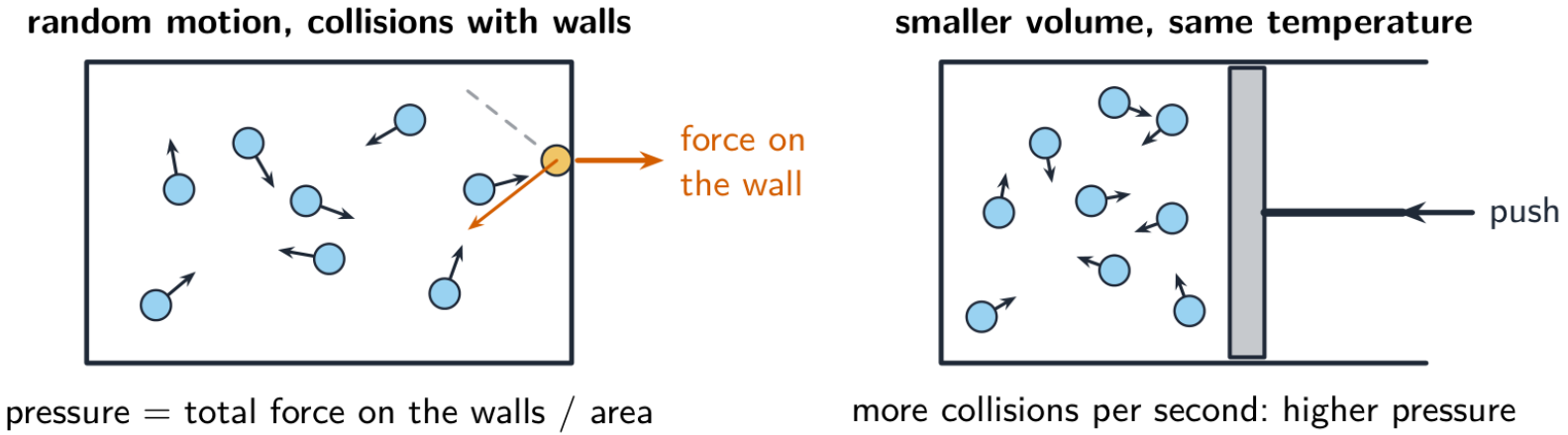
3.5
Particle motion in gases (4.3.3.1)

AQA · GCSE · Physics

Particle motion in gases

- The particles of a gas are in constant random motion.
- The temperature of a gas is related to the average kinetic energy of its particles: the hotter the gas, the faster they move.
- **Pressure** in a gas is caused by its particles colliding with the walls of the container.
- Each collision exerts a force at right angles to the wall, and **pressure** is the total force on each square metre.

Figure: Particle motion in gases



- Particles hitting the walls exert forces at right angles to them; compressing the gas makes the collisions more frequent.
- Match each part of the diagram to the text.

Exercise 2.1

2.1 Describe the motion of gas molecules, in two phrases the scheme credits. [2]



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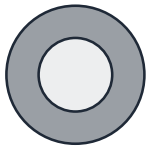
2.1 The molecules are in constant random motion.

Exercise 2.2

2.2 What does the temperature of a gas tell you about its molecules? [1]

gas temperature

2.3 A car tyre's air warms after motorway driving. State and explain the change in tyre pressure, at constant volume. [3]



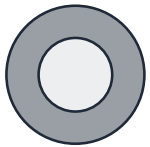
tyre air warms
volume constant

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gas temperature

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tyre air warms
volume constant

2.2 The temperature is related to the **average kinetic energy** of the molecules – a higher temperature means faster molecules on average.

2.3 The pressure increases: the warmer air's molecules move faster on average, so they collide with the tyre walls more often and harder, raising the force per unit area.

Exercise 3.1

3.1 A sealed syringe of air is held at fixed volume in a water bath.

(a) The bath's temperature is increased. Explain why the pressure in the syringe increases. [3]

(b) The syringe is then allowed to expand instead (constant temperature, larger volume). Explain what happens to the pressure. [2]



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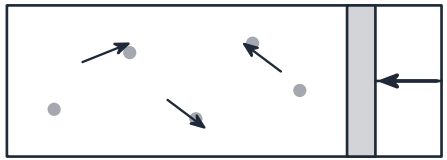
3.1 (a) The fixed volume keeps the wall area unchanged (implicit). Warming increases the molecules' average kinetic energy, so they move faster; faster molecules collide with the walls more frequently and each collision transfers a larger force, so the pressure increases. (b) At constant temperature the average molecular speed is unchanged; in the larger volume there are fewer wall collisions per unit area per second, so pressure decreases. The piston area need not change.

Setup for exercise 3.2

3.2 A student compresses air quickly in a bicycle pump and the pump becomes warm.

(a) Explain why the air's temperature rises, in terms of what the compression does to the molecules. [3]

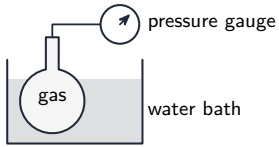
(b) The student then compresses the same pump very slowly, and the pump stays near room temperature. Explain the difference. [2]



air sealed in the pump

Exercise 3.2

3.3 The table shows the pressure of a fixed mass of gas at constant volume as its temperature changes.



Temperature in °C	**20**	**40**	**60**	**80**
Pressure in kPa	101	108	115	122

(a) Describe the relationship shown. [2]

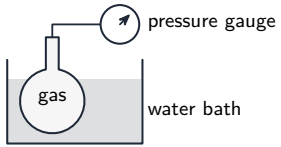
(b) The gas is cooled to 0 °C at the same volume. Estimate the pressure. [2]

(c) Explain the relationship using the particle model. [3]

(d) A second gas has molecules of smaller mass at the same temperature. Compare the average kinetic energies and explain whether the average molecular speeds are the same. [2]

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Full solution on next slide

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Full solution 3.2

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3.3 (a) Pressure increases **linearly** (equal steps of 7 kPa per 20 °C) with temperature at constant volume. (b) Continuing the pattern: 3.5 kPa per 10 °C below 20 °C gives $101 - 7 = \mathbf{94}$ kPa; accept 93–94 kPa from the gradient. (c) Higher temperature means greater average kinetic energy of the molecules; they hit the walls more often and harder; at constant volume the wall area is fixed, so force per unit area – pressure – rises in step with temperature. (d) The gases have the same average molecular kinetic energy at the same temperature. The lighter molecules move **faster** on average: $E_k = \frac{1}{2}mv^2$, so the same kinetic energy with smaller molecular mass requires greater mean-square speed. No pressure comparison follows from temperature and molecular mass alone.