

Exercise walk-through

2.1

Kinetic particle model of matter

IGCSE Physics

States of matter

solid

regular; vibrate
about fixed positions

liquid

close; can slide – take
the container's shape

gas

far apart, fast;
fill the container

Temperature and the particle model

All matter is moving **particles** .

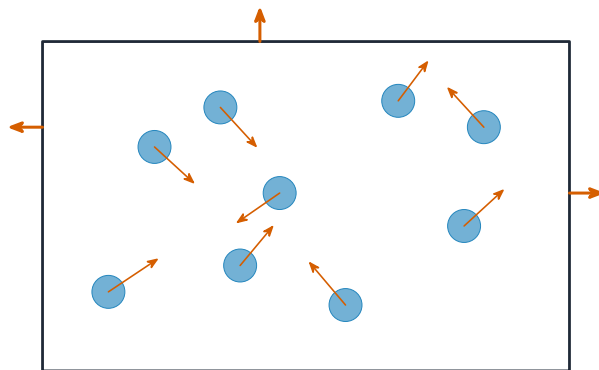
Temperature measures the **average kinetic energy** of the particles.

Lowest possible: **absolute zero** ,
 -273°C .

$$T(\text{K}) = \theta(^{\circ}\text{C}) + 273.$$



Gas pressure and Boyle's law



gas particles hit the walls — each hit is a tiny force.
Pressure = force per unit area

particle hits make the pressure

Fixed mass, constant temperature:

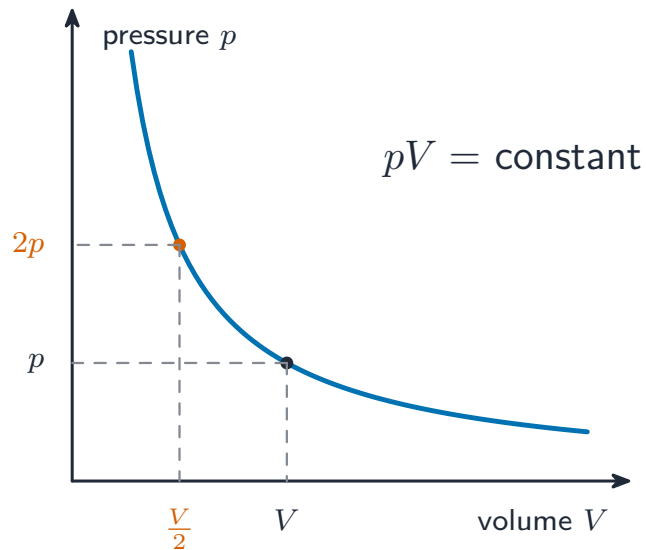
$$pV = \text{constant.}$$

$$200 \text{ cm}^3 \text{ at } 100 \text{ kPa} \rightarrow 50 \text{ cm}^3$$

$$p_2 = \frac{100 \times 200}{50} = 400 \text{ kPa}$$

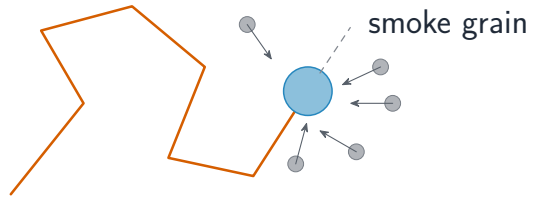
The gas pressure is the total force of countless particle hits on each unit area of the wall

Gas pressure



At constant temperature the pressure–volume graph is a curve: halve the volume and the pressure doubles, so pV stays constant

Brownian motion



fast, invisible air particles hit the smoke grain from random directions, so it moves in a jerky, random path

Smoke specks move in a **jerky, random** path – pushed by fast, invisible air particles.

Brownian motion

is strong evidence for the particle model.

Exercises 2.1·2.2

2.1 Describe the arrangement of particles in a solid.

[1]

2.2 A gas of volume 300 cm^3 at 120 kPa is compressed to 100 cm^3 at constant temperature. Find the new pressure.

[2]

Exercises 2.1·2.2

2.1 Describe the arrangement of particles in a solid.

[1]

2.1

- particles are close together in a fixed, regular pattern, vibrating about fixed positions

2.2 A gas of volume 300 cm^3 at 120 kPa is compressed to 100 cm^3 at constant temperature. Find the new pressure.

[2]

2.2

- $p_1 V_1 = p_2 V_2$

$$p_2 = \frac{p_1 V_1}{V_2} = \frac{(120 \text{ kPa})(300 \text{ cm}^3)}{100 \text{ cm}^3} = \mathbf{360 \text{ kPa}}$$

Exercise 3.1

3.1 Gas pressure on the container walls is caused by:

[1]

☐

A particles vibrating in fixed positions

B particles colliding with the walls

C the gas expanding

D the walls heating up

Exercise 3.1

3.1 Gas pressure on the container walls is caused by:

[1]

☐

A particles vibrating in fixed positions

B particles colliding with the walls

C the gas expanding

D the walls heating up

3.1 B

- pressure comes from particles colliding with the walls

Exercise 3.2 (a)

3.2 A fixed mass of gas at constant temperature has $p_1 = 150 \text{ kPa}$ and $V_1 = 400 \text{ cm}^3$.

(a) Find the volume when the pressure is increased to 250 kPa . [3]

Exercise 3.2 (a)

3.2 A fixed mass of gas at constant temperature has $p_1 = 150 \text{ kPa}$ and $V_1 = 400 \text{ cm}^3$.

(a) Find the volume when the pressure is increased to 250 kPa . [3]

(a) $p_1 V_1 = p_2 V_2$

$$p_1 V_1 = p_2 V_2 : \quad (150 \text{ kPa})(400 \text{ cm}^3) = (250 \text{ kPa})V_2$$

$$V_2 = \frac{p_1 V_1}{p_2} = \frac{60\,000 \text{ kPa cm}^3}{250 \text{ kPa}} = \mathbf{240 \text{ cm}^3}$$

Exercise 3.2 (b)

3.2 A fixed mass of gas at constant temperature has $p_1 = 150 \text{ kPa}$ and $V_1 = 400 \text{ cm}^3$.

(b) Explain, using the particle model, why the pressure rises as the volume falls. [2]

Exercise 3.2 (b)

3.2 A fixed mass of gas at constant temperature has $p_1 = 150 \text{ kPa}$ and $V_1 = 400 \text{ cm}^3$.

(b) Explain, using the particle model, why the pressure rises as the volume falls. [2]

(b) in a smaller volume the particles hit each unit of wall area more often

- so the pressure increases

Exercise 3.3

3.3 Explain how Brownian motion provides evidence for the kinetic particle model. [2]

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3.3

- the visible specks (e.g. smoke) move in a random, jerky way
- this is because they are struck by fast, invisible air particles – showing matter is made of moving particles