A-LEVEL CHEMISTRY • EXERCISE SHEET

4.1 The gaseous state: ideal and real gases and pV = nRT

Name: _____ Class: _____ Date: _____ **Total: 11 marks**

Objective

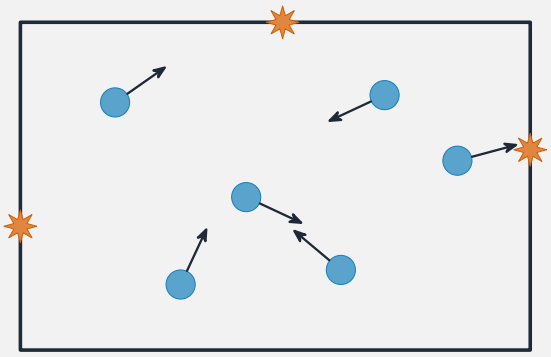
Build the skills to answer exam questions on **the gaseous state** —the origin of gas **pressure** 压强, the **ideal gas** 理想气体 model, and the ideal gas equation $pV = nRT$.

You must be able to:

- explain the origin of pressure in terms of collisions with the container walls
- state the assumptions of an ideal gas
- use $pV = nRT$ in calculations, including finding M_r

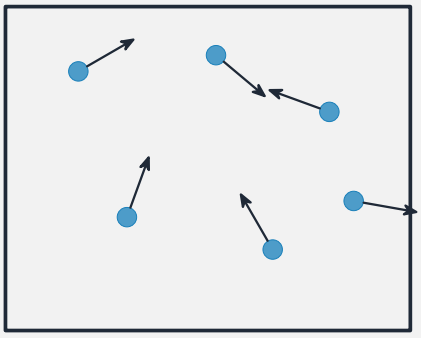
1 Worked examples

■ Gas pressure and the ideal gas

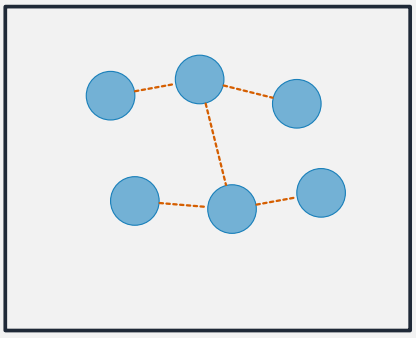


fast particles collide with the walls; the many pushes make the **pressure**

Pressure comes from the many collisions of fast gas molecules with the container walls



ideal gas (model)
point particles, *no* forces



real gas: high p, low T
real size + attractions (dashed)

An ideal gas has zero particle volume and no intermolecular forces —real gases obey it best at low pressure, high temperature

The ideal gas equation

$$pV = nRT$$

(p in Pa, V in m^3, T in K, $R = 8.31$ J $K^{-1}mol^{-1}$). **Convert first:** °C → K (+273); $cm^3/dm^3 \rightarrow m^3$.

Example. Volume of 0.50 mol at 27 °C, 100 kPa: $T = 300$ K, $p = 1.00 \times 10^5$ Pa; $V = nRT/p = (0.50 \times 8.31 \times 300)/(1.00 \times 10^5) = 0.0125$ m^3.

Finding M_r. Since $n = m/M$: $M = \dfrac{mRT}{pV}$.

2 Practice

2.1 State the **two** assumptions made about an ideal gas. [2]

2.2 Convert 25 °C to kelvin. [1]

3 Exam-style questions

3.1 A real gas behaves **most** like an ideal gas at: [1]

- **A** high pressure and low temperature
- **B** low pressure and high temperature
- **C** high pressure and high temperature

- **D** low pressure and low temperature

3.2 In the equation $pV = nRT$, the temperature T must be in: [1]

- **A** °C
- **B** kelvin
- **C** °F
- **D** joules

3.3 Calculate the volume, in m^3, of 2.0 mol of an ideal gas at 127 °C and a pressure of 2.0×10^5 Pa. ($R = 8.31$). [3]

3.4 A gas of mass 1.32 g occupies 750 cm^3 at 100 kPa and 27 °C. Calculate its molar mass. ($R = 8.31$). [3]

4 Go further

You are now ready for the real exam questions on this subtopic. Open the **4.1 The gaseous state** past-paper sheet in the Library, or try these in **Practice mode**:

- 9701/11 N25 —Q11 (gases)
- 9701/12 N25 —Q8 (ideal gas equation)
- 9701/51 N25 —Q2 (gases, planning/calculation)

Solutions

2.1 the particles have zero volume; there are no intermolecular forces of attraction.

2.2 $25 + 273 = 298$ K.

3.1 B. Low pressure and high temperature (particles far apart, forces negligible).

3.2 B. Temperature must be in kelvin.

3.3 $T = 400$ K; $V = nRT/p = (2.0 \times 8.31 \times 400)/(2.0 \times 10^5) = 0.0332$ m^3.

3.4 convert: $V = 7.50 \times 10^{-4}$ m^3, $T = 300$ K, $p = 1.00 \times 10^5$ Pa; $M = \dfrac{mRT}{pV} = \dfrac{1.32 \times 8.31 \times 300}{(1.00 \times 10^5)(7.50 \times 10^{-4})} = 43.9$ g mol^{-1}.