Exercise walk-through

The Ideal Gas Law ▪ 9.2

eXercise

You must be able to

- state and apply the **ideal gas law** 理想气体定律 $PV = nRT$ (and $PV = Nk_BT$)
- analyse changes in pressure, volume, and temperature of a fixed amount of gas
- explain when a real gas behaves approximately as an **ideal gas**

Method — The ideal gas law

$PV = nRT$, with $R = 8.31$ J mol^{-1} K^{-1} and T in kelvin. For a **fixed** amount of gas, $\frac{PV}{T}$ is constant.

Method — The combined gas law

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}.$$

At constant T, doubling P halves V (Boyle's law).

Method — When a real gas is ideal

Low pressure and high temperature — the particles are far apart and their forces are weak.

Practice 2.1 ▪ 1 mark

A gas at constant temperature has its pressure doubled. State what happens to its volume.

Solution 2.1

Method: When a real gas is ideal

Worked steps

it halves (Boyle's law, PV constant at fixed T) B1.

Practice 2.2 ▪ 2 marks

Find the volume of 2.0 mol of gas at 300 K and 1.0×10^5 Pa (take $R = 8.31$ J mol^{-1} K^{-1}).

Solution 2.2

Worked steps

$$V = \frac{nRT}{P} = \frac{2.0 \times 8.31 \times 300}{1.0 \times 10^5} = 0.050\ \text{m}^3$$ M1 A1.

Practice 2.3 ▪ 2 marks

State two conditions under which a real gas behaves like an ideal gas.

Solution 2.3

Method: When a real gas is ideal

Worked steps

low pressure; high temperature B1 B1.

Exam-style 3.1 ▪ 1 mark

The ideal gas law is

A $PV = nRT$

B $P = \rho gh$

C $PV = \frac{1}{2}mv^2$

D $V = IR$

Solution 3.1

A $PV = nRT$ ✓

B $P = \rho g h$

C $PV = \frac{1}{2}mv^2$

D $V = IR$

Worked steps

A.

Exam-style 3.2 ▪ 1 mark

A fixed amount of gas is heated at constant volume. Its pressure

A falls

B rises

C stays constant

D halves

Solution 3.2

Method: The ideal gas law

A falls

B rises ✓

C stays constant

D halves

Worked steps

B.

Exam-style 3.3 ▪ 3 marks

A sealed rigid 0.020 m^3 container holds gas at 2.0×10^5 Pa and 300 K. It is heated to 450 K.

(a) Find the new pressure.

(b) State the assumption you made about the volume.

Solution 3.3

Worked steps

(a) $\frac{P_1}{T_1} = \frac{P_2}{T_2} \Rightarrow P_2 = 2.0 \times 10^5 \times \frac{450}{300} = 3.0 \times 10^5$ Pa M1 M1 A1. (b) the volume stays constant (the container is rigid) B1.