3.4 The Ideal Gas Law

Name: ____________ Class: ________ Date: __________ **Total: 14 marks**

KEY WORDS kelvin 开尔文 • solution 溶液

Objective

Build the skills to answer exam questions on the **ideal gas law** $PV = nRT$.

You must be able to:

- use $PV = nRT$ with $R = 0.08206$ L atm mol^{-1}K^{-1}
- convert temperature to **kelvin** 开尔文 and match units
- combine states with $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

1 Worked examples

Study these first. Each one shows the method for a question type used later — follow the steps and you can do the Practice and Exam-style questions yourself.

The ideal gas law

$$PV = nRT.$$

Use consistent units: P in atm, V in L, n in mol, T in **kelvin** ($T_K = T_C + 273$), with $R = 0.08206$ L atm mol^{-1}K^{-1}.

A worked calculation

Find the volume of 2.0 mol of gas at 1.0 atm and 300 K:

$$V = \frac{nRT}{P} = \frac{(2.0)(0.08206)(300)}{1.0} = 49.2 \text{ L}.$$

Always convert to kelvin

A temperature in °C must become K first. 25°C = 298 K. Forgetting this is a common lost mark.

The combined gas law

When n is fixed and conditions change,

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}.$$

Solve for the unknown, keeping temperatures in kelvin.

2 Practice

Now apply the methods above.

2.1 Convert 27°C to kelvin. [1]

2.2 Find n for a gas with $P = 2.0$ atm, $V = 10.0$ L, $T = 300$ K. [3]

2.3 A gas at 1.0 atm and 2.0 L is compressed to 0.5 L at constant T. Find the new pressure. [2]

3 Exam-style questions

3.1 In $PV = nRT$, the temperature must be in [1]

- **A** °C
- **B** kelvin
- **C** °F
- **D** any unit

3.2 A 5.0 L container holds 0.25 mol of gas at 350 K.

(a) Find the pressure in atm. [3]

(b) State what happens to the pressure if the temperature is doubled at constant volume. [1]

3.3 A balloon has volume 2.0 L at 300 K. Find its volume at 360 K if the pressure is unchanged. [3]

Solutions

2.1 $27 + 273 = 300$ K.

2.2 $n = \dfrac{PV}{RT} = \dfrac{(2.0)(10.0)}{(0.08206)(300)} = 0.81$ mol.

2.3 $P_2 = \dfrac{P_1V_1}{V_2} = \dfrac{(1.0)(2.0)}{0.5} = 4.0$ atm.

3.1 B — kelvin.

3.2 (a) $P = \dfrac{nRT}{V} = \dfrac{(0.25)(0.08206)(350)}{5.0} = 1.44$ atm. (b) The pressure doubles.

3.3 $\dfrac{V_1}{T_1} = \dfrac{V_2}{T_2}$; $V_2 = 2.0 \times \dfrac{360}{300} = 2.4$ L.