

3.4 The Ideal Gas Law

Name: _____ Class: _____ Date: _____

Total: 14 marks

Objective

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

You must be able to:

- use $PV = nRT$ with $R = 0.08206 \text{ L atm mol}^{-1}\text{K}^{-1}$
- 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 $R = 0.08206 \text{ L atm mol}^{-1}\text{K}^{-1}$.

■ 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. $25^\circ\text{C} = 298 \text{ K}$. 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 $P = 2.0 \text{ atm}$, $V = 10.0 \text{ L}$, $T = 300 \text{ K}$. [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** $^{\circ}\text{C}$
 - **B** kelvin
 - **C** $^{\circ}\text{F}$
 - **D** any unit
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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]

4 Go further

You are now ready for the real exam questions on this subtopic:

- work through the **3.4 The Ideal Gas Law** lesson on the **Learn** page;
- read the **The Ideal Gas Law** section of the AP Chemistry handout on the **Know** page.

Solutions

2.1 $27 + 273 = 300 \text{ K}$.

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

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

3.1 B —kelvin.

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

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