AP PHYSICS 2 • EXERCISE SHEET

9.2 The Ideal Gas Law

Name: ____________ Class: ________ Date: __________ **Total: 11 marks**

Objective

Build the skills to answer exam questions on **the ideal gas law**.

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**

1 Worked examples

Study these first. Each one shows the method for a question type used later.

■ 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.

■ The combined gas law

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

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

■ When a real gas is ideal

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

2 Practice

2.1 A gas at constant temperature has its pressure doubled. State what happens to its volume. [1]

2.2 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}). [2]

2.3 State two conditions under which a real gas behaves like an ideal gas. [2]

3 Exam-style questions

3.1 The ideal gas law is [1]

- **A** $PV = nRT$
- **B** $P = \rho g h$
- **C** $PV = \frac{1}{2}mv^2$
- **D** $V = IR$

3.2 A fixed amount of gas is heated at constant volume. Its pressure [1]

- **A** falls
- **B** rises
- **C** stays constant
- **D** halves

3.3 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. [3]

(b) State the assumption you made about the volume. [1]

4 Go further

- work through the **9.2 The Ideal Gas Law** lesson on the **Learn** page;
- read the **Thermodynamics** section of the AP Physics 2 handout on the **Know** page.

Solutions

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

2.2 $V = \dfrac{nRT}{P} = \dfrac{2.0 \times 8.31 \times 300}{1.0 \times 10^5} = 0.050\ \text{m}^3$.

2.3 low pressure; high temperature.

3.1 **A**.

3.2 **B**.

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