Worksheet: Gas Pressure & Volume Calculations

PhysicsSheets

Specification: GCSE Physics (AQA 4.3.3.2 / Edexcel SP14)

Boyle's Law: For a fixed mass of gas at constant temperature, the pressure is inversely proportional to the volume.

Core Equation: $pV = \text{constant}$ or $p_1V_1 = p_2V_2$

Rearranged Forms: $p_2 = \frac{p_1V_1}{V_2}$ | $V_2 = \frac{p_1V_1}{p_2}$ | $p_1 = \frac{p_2V_2}{V_1}$ | $V_1 = \frac{p_2V_2}{p_1}$

Units: Pressure (p) in Pascals (Pa) or kilopascals (kPa). Volume (V) in cubic metres (m^3) or cubic centimetres (cm^3).

Section A: Formula Recall & Unit Conversions

1. State the standard SI unit and symbol for each variable in the gas pressure-volume equation:

a) Pressure (p): _____

b) Volume (V): _____

2. Rearrange the formula $p_1V_1 = p_2V_2$ to make the specified variable the subject:

a) $p_2 =$ _____

b) $V_1 =$ _____

3. Complete the following unit conversions:

a) 250 kPa = _____

b) 500 cm^3 = _____

c) 0.02 m^3 = _____

d) 120 000 Pa = _____

Section B: Practice Calculations

Show your working clearly, including the equation, substitution, and final answer with correct units and appropriate significant figures.

4. A fixed mass of gas is kept at a constant temperature.

a) A gas has an initial pressure of 100 kPa and a volume of 2.0 m^3. If its volume is increased to 4.0 m^3, calculate the new pressure of the gas.

b) A gas in a container has a pressure of 200 kPa and a volume of 0.50 m^3. If the pressure is reduced to 50 kPa, calculate the new volume of the gas.

c) A gas is initially at a pressure of 150 kPa and occupies a volume of 1000 cm^3. If the gas is compressed to a volume of 500 cm^3, calculate the new pressure in Pascals (Pa).

d) A gas cylinder contains 0.003 m^3 of gas at a pressure of 1.2×10^5 Pa. If the gas is released into a larger container where its pressure drops to 400 kPa, calculate the new volume of the gas in cubic centimetres (cm^3). Give your answer to 2 significant figures.

Section C: Challenge Context

5. A student uses a syringe to investigate the relationship between pressure and volume of a fixed mass of air at constant temperature.

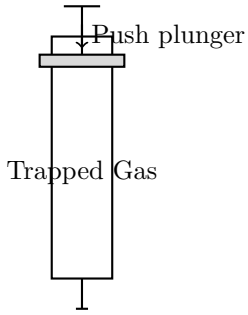

Figure 1: Syringe with trapped gas

a) Initially, the trapped air has a volume of 2.5 litres at an atmospheric pressure of 100 kPa. The student pushes the plunger in, compressing the air to a new volume of 500 cm^3. Calculate the new pressure of the air in Pascals (Pa).

b) Explain, in terms of the air particles, why the pressure inside the syringe increases when the plunger is pushed in (decreasing the volume).