

Gas particles, pressure and heat conduction

AP Physics 2 (algebra-based) · Lab answers

The sample data show a nearly constant product pV , so p varies as $1/V$ within experimental error. The gradient of the graph equals nRT , which gives a small amount of air of the order of 10^{-3} mol, as expected for a few tens of millilitres at atmospheric pressure.

Level: AP Physics 2 (algebra-based) · **Curriculum:** AP P2 Unit 9

Question 1 Why the dead volume

The air in the tube and sensor also belongs to the gas sample. Without the extra 3 mL the volume is too small, and the graph would not pass through the origin. **$V_{\text{total}} = \text{reading} + 3 \text{ mL}$** .

Question 2 Check the product

The products are 2323, 2327, 2317, 2329, 2313, 2328 kPa·mL, with a mean of **2323 kPa·mL**. They vary by less than 1%, so pV is constant within error and Boyle's law is supported.

Question 3 The graph

The points lie on a straight line through the origin. This shows **$p \propto 1/V$** , so pV is constant at constant temperature and amount.

Question 4 Gradient

Using the first and last points: $(101.0 - 48.5)/(0.04348 - 0.02083) = \mathbf{2318 \text{ kPa}\cdot\text{mL}}$. The least-squares fit gives 2325 kPa·mL.

Question 5 Amount of air

slope = nRT , and $1 \text{ kPa}\cdot\text{mL} = 1 \times 10^{-3} \text{ J}$. So $nRT = 2325 \times 10^{-3} \text{ J}$. $n = 2.32/(8.31 \times 294) = \mathbf{9.5 \times 10^{-4} \text{ mol}}$.

Question 6 Temperature control

Quick compression warms the gas and quick expansion cools it, so the temperature must be allowed to return to the room temperature. Waiting lets heat flow between the gas and the surroundings. **Constant T is required for $p \propto 1/V$** .

Question 7 Improvement

Use a lubricated syringe to cut leaks, take more points, repeat the series to average out random error, and use a water bath for steady temperature. **Repeating gives a smaller uncertainty in the gradient.**