Boyle’s law: pressure and volume

Student activity • observation and reasoning

YEAR 11 / LESSON 77 / PHYSICS + SCIENCE (DOUBLE AWARD)

The question

How does pressure change when a fixed amount of gas occupies less volume?

Analyse explicitly invented ideal data, with absolute pressure and constant temperature stated.

Equipment

- Booklet, graph paper, ruler and calculator

Paper-based data analysis. No sealed syringes, compressed-gas cylinders, weights on pistons or pressure vessels are operated.

Course coverage: Shared Physics / Double Award: 5.20, 5.22. Fixed gas mass at constant temperature; $p_1V_1 = p_2V_2$.

Plan, model or apparatus sketch

Draw the particle, pressure or magnetic-field model and label directions and quantities.

Method and reasoning

Read the whole sequence before starting

YEAR 11 / LESSON 77 / PHYSICS + SCIENCE (DOUBLE AWARD)

1. Draw a gas cylinder with a movable piston and a fixed number of particles. Show the piston at two volumes without changing the number of particles or the temperature.

2. Use the practice pairs V/cm³ = 60, 50, 40, 30 and p/kPa = 100, 120, 150, 200. These are absolute pressures in an ideal model, not classroom readings.

3. Calculate pV for every pair and state its unit. Plot pressure against volume, then pressure against 1/V using a separate labelled graph.

4. Explain the curved inverse relation and the straight-line relation with reciprocal volume. Do not describe p against V as a straight line.

5. Calculate the final pressure when the practice gas at 100 kPa and 60 cm³ is compressed to 45 cm³ at the same temperature. Explain why rapid compression can invalidate a constant-temperature assumption.

6. Distinguish absolute pressure from gauge pressure. Explain why a gauge reading needs the atmospheric-pressure offset before using the gas law.

Cleanup

- Keep graphs with the stated assumptions and return calculators.

Record your evidence

Blank spaces are for your own work

YEAR 11 / LESSON 77 / PHYSICS + SCIENCE (DOUBLE AWARD)

Reference and task data

Practice data satisfy pV = 6000 kPa cm³. The final pressure at 45 cm³ is about 133 kPa absolute. Consistent volume units may be used on both sides of $p_1V_1 = p_2V_2$. The gas amount and temperature must remain fixed.

V / cm³	p / kPa absolute	pV / kPa cm³	1/V / cm⁻³
60	100		
50	120		
40	150		
30	200		

Show your calculations, labelled model or correction here.

Explain and evaluate

Use evidence and show calculation steps where relevant

YEAR 11 / LESSON 77 / PHYSICS + SCIENCE (DOUBLE AWARD)

1. What two conditions are fixed?

2. Find pV for the first pair.

3. What happens to p if V halves?

4. Which graph is linear?

5. Find p at 45 cm^3.

6. Why not insert gauge pressure directly?