

Gas particles, pressure and heat conduction

AP Physics 2 (algebra-based) · Lab

Name: _____ Date: _____ Class: _____

A sealed syringe lets you vary the volume of a fixed amount of air while a sensor reads the pressure. In this lab you test whether pressure and volume are inversely proportional at constant temperature, and you use the graph's gradient to estimate how many moles of air are trapped. It trains data analysis for AP Physics 2.

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

Aim

Test whether the pressure of trapped air varies as $1/V$ at constant temperature, and use the gradient of the graph to estimate the amount of air in the syringe.

Equipment

- 60 mL plastic syringe with luer connector
- pressure sensor and data logger
- short rigid tube (the dead volume is 3 mL)
- thermometer

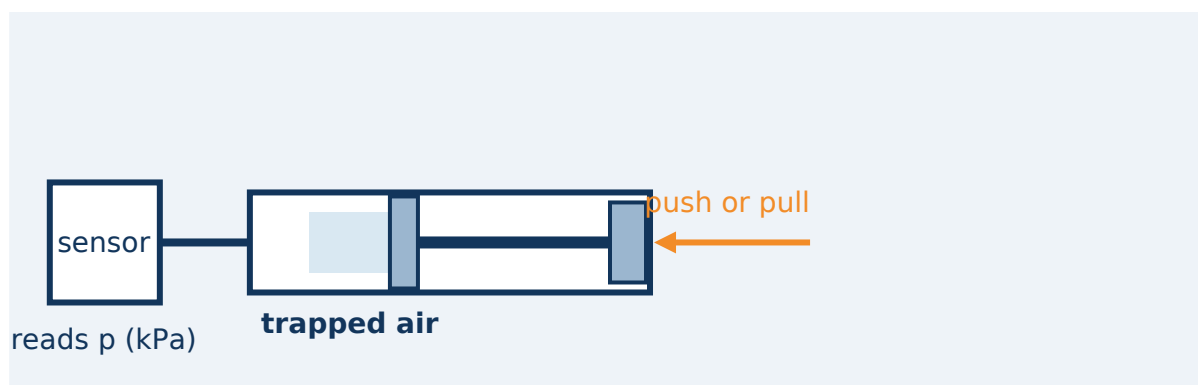
Safety

Safety

Do not exceed the pressure rating of the sensor. Keep fingers clear of the plunger when you release it, and wear eye protection.

Method

1. Connect the syringe, tube and sensor. Set the plunger to 20 mL and record the pressure and room temperature (294 K).
2. Push the plunger slowly to 25 mL, 30 mL, 35 mL, 40 mL and 45 mL, waiting 20 s at each so the air returns to room temperature.
3. At each setting add 3 mL dead volume to get the total volume V .
4. Repeat the series once and average the pressures.



Set-up: syringe, pressure sensor and short rigid tube.

Results

Sample measurements (one student, pressure in kPa, volume in mL, $p \times V$ in kPa·mL):

Syringe reading (mL)	V total (mL)	p (kPa)	1/V (mL ⁻¹)	pV (kPa·mL)
20	23	101.0	0.0435	2323
25	28	83.1	0.0357	2327
30	33	70.2	0.0303	2317
35	38	61.3	0.0263	2329
40	43	53.8	0.0233	2313
45	48	48.5	0.0208	2328

Analysis questions

Question 1 Why the dead volume

Explain why 3 mL is added to each syringe reading.

Question 2 Check the product

Calculate the mean of pV and its spread. Does the data support Boyle's law?

Question 3 The graph

Plot p against 1/V. Describe the shape and explain what it shows.

Question 4 Gradient

Work out the slope of the line of best fit, in kPa·mL.

Question 5 Amount of air

Convert the gradient to joules and use it with $T = 294 \text{ K}$ to find n .

Question 6 Temperature control

Explain why the plunger is moved slowly and why a wait is needed between readings.

Question 7 Improvement

Suggest one improvement that reduces the uncertainty in n .