Boyle's law: PV = constant

FizziQ activity · High school · 25 min

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In the FizziQ Web Ideal Gas simulation, students compress a virtual gas at constant temperature, recording P and V in the browser to verify PV = constant.

Learning objectives

- Experimentally verify Boyle's law (PV = constant at constant T)
- Record pressure and volume simultaneously during an isothermal transformation
- Plot a P(V) isotherm and identify its shape as a hyperbola
- Verify the constancy of the PV product
- Linearize the relationship by plotting P versus 1/V

Instruments and sensors

FizziQ Web Ideal Gas simulation

Materials

- Computer, tablet, or smartphone with FizziQ Web
- Note: the protocol remains adaptable to any comparable simulation-based data acquisition tool.

Protocol

1. Open the Ideal Gas simulation in FizziQ Web (Experiment → Simulations → Ideal Gas).
2. Set the temperature to 293 K (20°C). This temperature will remain fixed throughout the experiment.
3. Select the quantities to record: enable Pressure and Volume. Choose table mode to export data easily.
4. Position the piston at its maximum (largest volume). Note the initial P and V values.
5. Click REC to start recording. Slowly move the piston inward to reduce the volume in small steps.
6. Move the piston across its full range, from maximum to minimum volume, taking time to cover the entire range evenly.
7. Stop the recording (REC). The P and V data are automatically exported to the experiment notebook.
8. Plot the graph of P versus V. Is the curve a straight line? What shape do you recognize?
9. Add a calculated column to the table: PV (pressure × volume product). Is this quantity constant?
10. Add a column 1/V and plot P versus 1/V. Do you get a straight line through the origin? The slope of this line gives nRT.

Expected results

The P(V) graph is a decreasing hyperbola: when V decreases, P increases. The product PV is constant for all measurements (within reading precision), confirming Boyle's law. The P(1/V) graph is a straight line through the origin with slope nRT. The product PV equals nRT, consistent with the ideal gas law.

Questions

- If you halve the volume, by what factor is the pressure multiplied?
- What does the product PV physically represent? Why is it constant at fixed temperature?
- How does the isotherm curve change if the temperature increases?
- What would the P(V) graph look like for a real gas at very high pressure?
- Can you determine the number of moles from the slope of P(1/V)?

- Why is Boyle's law only valid at constant temperature?

Going further

- Plot several isotherms (at 273 K, 293 K, 313 K, 333 K) on the same graph and compare
- Calculate nR from the slope of P(1/V) and verify consistency with the simulation parameters
- Compare the simulation results with a real experiment using a syringe and the smartphone barometer
- Investigate how many data points are needed for a reliable verification of the law
- Plot PV versus V and verify that the result is a horizontal line