Gas laws

International Baccalaureate · IB Diploma · Physics · SL

Scope and prerequisites

This handout covers selected SL topics for the course first assessed in 2025; it is not the whole syllabus.

Prerequisites: read the stated quantities and units, and use arithmetic and the model conditions below.

The examples are original and fictional: they are not real measurements or real student investigations.

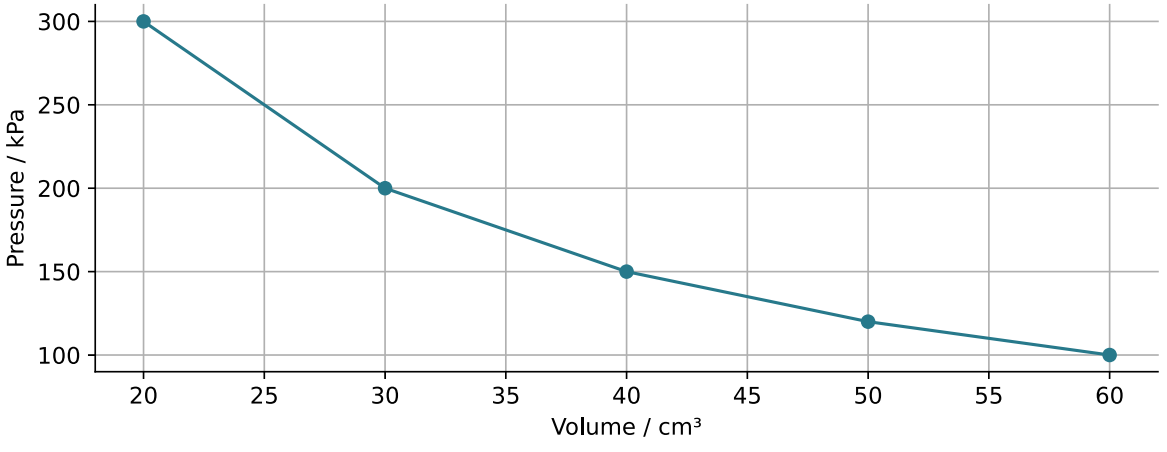
Gas models and absolute temperature

What would explain this observation?

- A sealed gas container changes pressure when heated. Celsius ratios cannot predict the pressure change because the gas model uses **absolute temperature**.

Build the model

- In a gas model, particles move randomly and pressure results from momentum transfer at walls.
- The **ideal gas** equation connects pressure, volume, amount and absolute temperature.
- absolute temperature: Temperature on the kelvin scale.
- ideal gas: A gas model with specified simplifying assumptions.



At constant temperature pV stays constant: $300 \times 20 = 100 \times 60 = 6{,}000$

Choose evidence that can test it

- At fixed amount and volume, pressure is proportional to kelvin temperature.
- At fixed temperature and amount, pressure is inversely proportional to volume.
- State which quantities are fixed before choosing a relationship.

In the lab: Use approved apparatus with a temperature range and pressure limit set by the teacher. Allow thermal equilibrium and record pressure against kelvin temperature. Never heat an improvised sealed vessel.

Work from known quantities

- Known: pressure is 100 kPa at 300 K, with fixed volume and amount.
- At 330 K, p2/p1=T2/T1. p2=p1 T2/T1=100×330/300=110 kPa.
- A 30 °C rise is a 30 K change, but the temperature ratio must use kelvin.

Your turn: At fixed volume, pressure is 120 kPa at 300 K. Find pressure at 350 K.

Check the conclusion and its limits

- An ideal gas is a model with conditions of validity.
- Celsius zero is not zero molecular motion, and internal energy is not determined by pressure alone.

Not true: A gas pressure ratio can always use Celsius temperatures. Ratios of temperatures are meaningful only from absolute zero. 300 K to 350 K is a ratio of 350/300; the same temperatures in Celsius, 27 and 77, give 77/27 - a different, wrong answer.

Key:

- In a gas model, particles move randomly and pressure results from momentum transfer at walls.
- At fixed amount and volume, pressure is proportional to kelvin temperature.
- Watch for: an ideal gas is a model with conditions of validity.

Write from a pressure of 96 kPa

- At fixed volume, the pressure is 80 kPa at 250 K.
- Find the pressure at 300 K. The ratio must use kelvin.

Write from a celsius trap

- A gas at 27 °C is warmed to 127 °C at fixed volume.
- Kelvin runs 300 K to 400 K, so pressure rises by 400 ÷ 300 ≈ 1.33 – treating 27 → 127 as the ratio is the classic error.

Write from a halved volume

- A gas's volume is halved at fixed temperature.
- Molecules meet the walls twice as often, so pressure doubles – Boyle's law as collision counting, pV constant.

Write from an absolute zero read

- A constant-volume gas's pressure line is extrapolated downward.
- It reaches zero pressure at $-273\ °C = 0\ K$ – the kelvin scale is DEFINED by that intercept, not found by a thermometer.

Write from a doubled kelvin temperature

- A fixed-volume gas at 150 K is warmed to 300 K.
- The pressure doubles – P over T is constant, and kelvin doubling IS pressure doubling at fixed volume.