15 The ideal gas equation – Part 2

Name: _____ Class: _____ Date: _____

Vocabulary

Write each word three times.

English	**Write it 3 times** (English)		
ideal gas			
equation of state			
molar gas constant			

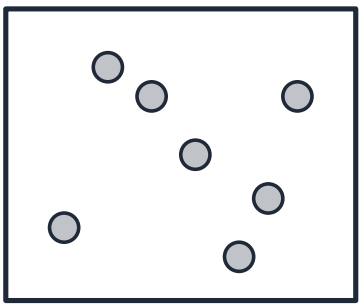
Recall

An **ideal gas** follows a simple law linking its pressure, volume and temperature – one equation covers the air in a tyre, a balloon, or a syringe.

New ideas

Read these first. Each idea has a short worked example. Then do the Practice.

1 The equation of state



gas: p, V, T, n moles

$$pV = nRT$$

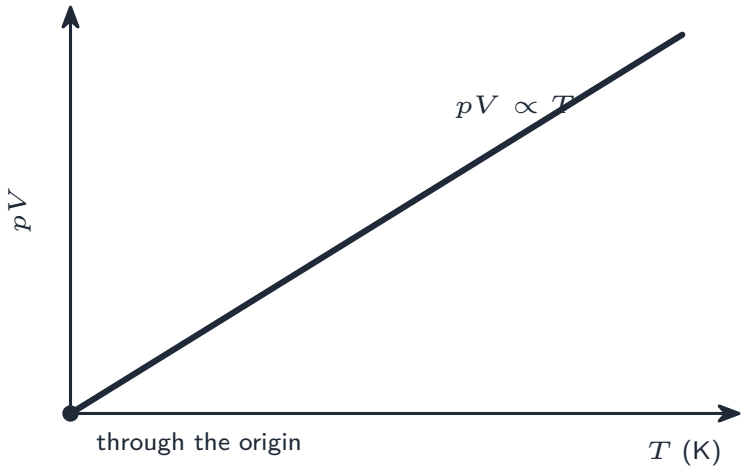
The **equation of state** of an ideal gas is

$$pV = nRT,$$

where n is the number of moles and $R = 8.31$ J mol^{-1}K^{-1} is the **molar gas constant**. Temperature T must be in kelvin.

Worked example. Find the pressure of 2.0 mol of gas in a 0.050 m^3 container at 300 K: $p = \dfrac{nRT}{V} = \dfrac{2.0 \times 8.31 \times 300}{0.050} \approx 1.0 \times 10^5$ Pa.

2 The straight-line link



For a fixed amount of gas, $pV \propto T$ – a straight line through the origin when T is in kelvin.

Worked example. A sealed gas is heated from 300 K to 600 K. Since $pV \propto T$ and T doubles, the product pV also doubles.

> **Watch out:** T must be in kelvin in $pV = nRT$. Putting in degrees Celsius gives the wrong answer – and total nonsense near 0 °C.

Practice

Try these in order.

15.1 Write the *equation of state* of an ideal gas. [1]

15.2 In that equation, what does n stand for? [1]

15.3 In which unit must the temperature T be given? [1]

15.4 A gas has $n = 1.5$ mol, $T = 400$ K and $V = 0.020$ m^3. Find the pressure ($R = 8.31$). [2]

15.5 For a fixed gas, pV is proportional to what? [1]

15.6 A sealed gas is heated from 300 K to 600 K at constant pressure. What happens to its volume? Explain. [2]

15.7 Challenge. A student writes "the gas is at 27 °C, so I put $T = 27$ into $pV = nRT$." Explain the mistake and give the value that should be used. [2]