The A* Guide to Ideal Gas Equations

nRT

Five traps cost A-grade students marks on **PV = nRT**. This guide removes all five — with a worked exam question, practice, and a pre-submission checklist.

INSIDE

Full worked exam question, mark by mark

INSIDE

Unit conversion quick-reference sheet

INSIDE

Two practice questions, fully answered

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Five properties, one relationship

The ideal gas equation ties together everything you can measure about a gas. Get comfortable with what each letter stands for and what unit it must be in, and the calculation itself becomes the easy part.

$$PV = nRT$$

P	**Pressure** Pa	**V**	**Volume** m^3
n	**Number of moles** mol	**T**	**Temperature** K

R — **The universal gas constant — given in the exam, always 8.31**
$J\ K^{-1}\ mol^{-1}$

> Follow the method in this guide and you will never get an ideal gas exam question wrong again.

Using the equation on something that isn't a gas

Every variable you put into PV = nRT must belong to a gas. The single most common way students lose marks is substituting the moles of a solid or a liquid reactant straight into the equation, because that is the number the question handed them.

WHAT STUDENTS DO

Read "1.00 kg of TNT", work out the moles of TNT, and substitute that number as *n*.

WHAT EARNS THE MARK

Check the state symbol. TNT is (s). Use the balanced equation to convert moles of TNT into moles of *gas*, then substitute.

Where to look before you write anything

01 **State symbols in the equation.** (g) is your permission to use PV = nRT. (s), (l) and (aq) are not.

02 **The wording of the question.** "Calculate the volume of gas produced" is telling you that *n* must be the total moles of gaseous products only.

03 **Your bonding knowledge.** If no state symbols are given, you are expected to know which substances are gases at the stated temperature.

REMEMBER

Moles of reactant and moles of gas are almost never the same number. One line of working converts between them, and that line is worth a mark.

Not knowing the SI units by heart

You cannot spot a conversion you need to make if you do not know what the correct unit looks like. Learn this table until it is automatic — everything else on the next page depends on it.

VARIABLE	SI UNIT	ALSO APPEARS AS
Pressure, P	Pa	kPa, atm
Volume, V	m^3	cm^3, dm^3, mm^3
Number of moles, n	mol	Given indirectly as a mass, or as a density and a volume
Temperature, T	K	°C
Gas constant, R	$J\ K^{-1}\ mol^{-1}$	Never converted — always given

> The units of R are the giveaway. Joules, kelvin and moles are all SI, so every other quantity you substitute must be SI too. That single observation tells you when a conversion is needed.

QUICK REFERENCE — PRINT THIS PAGE

Converting units correctly

Knowing a conversion is needed and performing it correctly are two different marks. Volume is where most errors happen, because the factor is cubed.

FROM	TO	OPERATION	WHY
kPa	Pa	× 1000	kilo = 1000
°C	K	+ 273	0 K = −273 °C
cm^3	m^3	÷ 100^3	100 cm = 1 m
dm^3	m^3	÷ 10^3	10 dm = 1 m
mm^3	m^3	÷ 1000^3	1000 mm = 1 m
Density + volume	Mass (g)	density × volume	d = m / v
Mass (g)	Moles	mass ÷ M_r	n = mass / M_r

THE ONE PEOPLE GET WRONG

250 cm^3 is not 2.50 m^3. Dividing by 100 instead of 100^3 makes the answer wrong by a factor of ten thousand — and it is still wrong even though every other step was right.

Rearranging and rounding

4 · Making a different variable the subject

Rearrange before you substitute, never after. Doing the algebra with numbers already in place is how sign and division errors creep in. All four forms come from the same equation:

$PV = nRT$	$V = nRT/P$	$n = PV/RT$	$T = PV/nR$

Practise writing all four from memory in your independent study.

5 · Significant figures

Count the significant figures in every value the question gives you. Your answer is given to the *smallest* of those counts. This is a whole mark, and it is the cheapest one on the paper to lose.

60.0

3 significant figures. A trailing zero **after** a decimal point is significant.

60

1 significant figure. A zero **before** a decimal point is not.

> Carry the full number through your working and round only at the very end. Rounding at every step compounds the error and can move your answer outside the mark scheme's accepted range.

5 marks

All five traps in one question

TNT ($C_7H_5N_3O_6$) is an explosive because it can decompose very quickly and exothermically to form a large volume of gas. An equation for this decomposition is

$$2\ C_7H_5N_3O_6(s) \rightarrow 3\ N_2(g) + 5\ H_2(g) + 12\ CO(g) + 2\ C(s)$$

Calculate the volume of gas, in m^3, measured at 1250 °C and 101 000 Pa, produced by the decomposition of 1.00 kg of TNT (M_r = 227.0). The gas constant, R = 8.31 J mol^{-1} K^{-1}.

M1	The moles of gas are not given, so start from the mass of TNT.	1000 / 227.0 = 4.405 mol
M2	TNT is a solid — see the state symbol. Convert moles of TNT to moles of gas using the equation: 20 moles of gas from every 2 of TNT.	4.405 × 20/2 = 44.05 mol
M3	The question asks for a volume, so make V the subject before substituting.	V = nRT / P
M4	Temperature is in °C. Convert to kelvin. Pressure is already in Pa, so it needs nothing.	1250 + 273 = 1523 K
M5	Mass, temperature and pressure are all given to 3 s.f., so the answer is given to 3 s.f.	5.51982… → 5.52

ANSWER

$V = 5.52\ m^3$

(44.05 × 8.31 × 1523) / 101 000

WATCH IT WORKED THROUGH

Worked example video →

youtube.com/watch?v=5PpuMwjUEVk

PRINT THIS PAGE

Eight ticks before you move on

Run this list every time you finish an ideal gas calculation, in homework and in mocks, until you no longer need it. Thirty seconds here protects five marks.

- [ ] Is every substance in my calculation actually a **gas**? Check the state symbols.
- [ ] Have I used the balanced equation to get moles of **gas**, not moles of reactant?
- [ ] Is pressure in **Pa**? (kPa × 1000)
- [ ] Is temperature in **K**? (°C + 273)
- [ ] Is volume in **m**^{3}? Did I cube the conversion factor?
- [ ] Did I rearrange for the correct subject **before** substituting?
- [ ] Is my answer rounded to the **smallest** number of significant figures in the question?
- [ ] Have I written the **unit** next to my final answer?

> Examiners mark what is on the page, not what you meant. Every item above is something a mark scheme explicitly looks for.

Answers on page 10

Two questions. No peeking.

Work them through in the space below, then check every line against the checklist on page 8 before you turn over.

QUESTION 1 | 4 marks

A sealed flask of volume 250 cm^3 contains 0.320 g of oxygen gas, O_2, at a pressure of 98.0 kPa. Calculate the temperature of the gas, in K.

$M_r(O_2) = 32.0$ · $R = 8.31\ J\ K^{-1}\ mol^{-1}$

QUESTION 2 | 5 marks

Sodium azide is used in car airbags because it decomposes almost instantly to nitrogen gas:

$$2\ NaN_3(s) \rightarrow 2\ Na(s) + 3\ N_2(g)$$

Calculate the volume of gas, in cm^3, produced by the complete decomposition of 65.0 g of sodium azide at 25.0 °C and 101 kPa.

$M_r(NaN_3) = 65.0$ · $R = 8.31\ J\ K^{-1}\ mol^{-1}$

Mark by mark

QUESTION 1 — $T = 295$ K

M1	Mass to moles.	0.320 / 32.0 = 0.0100 mol
M2	Volume $cm^3 \rightarrow m^3$: divide by 100^3, not 100.	2.50×10^{-4} m^3
M3	Pressure kPa → Pa, and rearrange for T.	98 000 Pa · T = PV/nR
M4	Substitute and round to 3 s.f.	24.5 / 0.0831 = 295 K

QUESTION 2 — $V = 3.68 \times 10^4$ cm^3

M1	Mass of sodium azide to moles, then moles of gas from the equation: 3 N_2 per 2 NaN_3.	65.0 / 65.0 = 1.00 mol 1.00 × 3/2 = 1.50 mol
M2	Correct values for temperature and pressure: °C → K, kPa → Pa.	298 K · 101 000 Pa
M3	Rearrange for V before substituting.	V = nRT / P
M4	Value in m^3.	3714.6 / 101 000 = 0.03678 m^3
M5	Convert $m^3 \rightarrow cm^3$ ($\times 100^3$) and give to 3 s.f.	36 778 → 3.68×10^4 cm^3

Both questions were built from the same five traps. If you dropped a mark, it will map onto one of them — go back to that page rather than doing more questions.

WATCH IT WORKED THROUGH

Worked example video →

youtube.com/watch?v=5PpuMwjUEVk

WHY THIS MATTERS NOW

Your Year 12 foundation dictates your Year 13 grade

This guide covers one calculation. There are a dozen more like it, and Year 13 assumes every one of them is already secure.

Small errors, big consequences

Multi-step calculation traps cost strong students enough marks to derail Medicine and Russell Group offers — not because the chemistry was misunderstood, but because a conversion or a rounding was missed.

Year 13 does not slow down

The pace assumes flawless Year 12 foundations. Miss these traps and the mocks expose them in thermodynamics, kinetics and buffers — the topics where marks are hardest to win back.

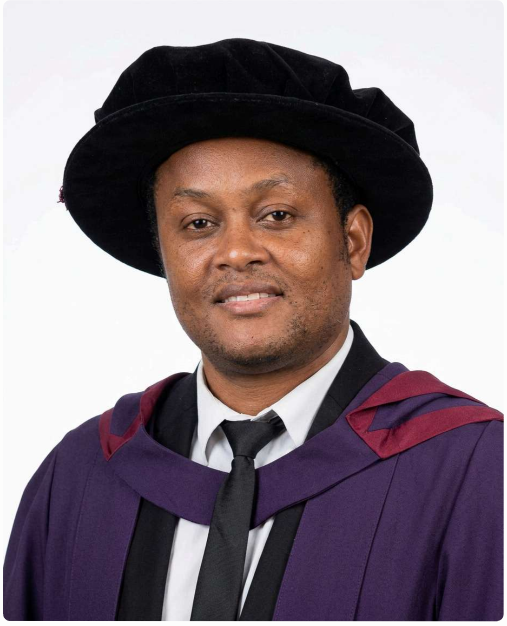
Mechanisms escalate too

Year 12 nucleophilic substitution becomes Year 13 nucleophilic addition–elimination. Without mastering basic curly arrows, complex multi-step mechanisms are not survivable.

The gap is rarely understanding. It is the distance between knowing the chemistry and proving it the way AQA awards marks.

ABOUT

Dr John Nwokocha



John Nwokocha holds a PhD in Organic Chemistry from Loughborough University and has fifteen years of teaching, research and examining experience, including eight years teaching A-Level Chemistry.

Chemistry with Dr John was born from a passion to support students to understand chemistry and achieve the grades they need to unlock their future aspirations.

Having marked the papers, he teaches from the other side of the mark scheme: what an examiner is trained to look for, in what order, and where the marks quietly disappear.

PhD ORGANIC CHEMISTRY LOUGHBOROUGH UNIVERSITY	**15 yrs** TEACHING, RESEARCH & EXAMINING	**AQA** ONLY — NO MIXED-BOARD GENERIC TEACHING	**Max 6** STUDENTS PER COHORT

My principles

Weekly live teaching	Live small-group teaching each week, capped at six students and recorded for review.
Regular Actionable Feedback	Weekly homework tasks with Personalised Video Feedback marked to Exam Standards with clear action plans.
Independent Study Guidance	Clear guidance with quality resources so independent study is effective, efficient and fulfilling.
Transparency	Monthly check-ins with parent and student so progress is celebrated and any issues are resolved quickly.

PRICING ON PAGE 15

The Y12 Chemistry Super Starter Programme

A head start for new Year 12 students who want to avoid the common problems students face, so the journey to an A/A* stays smooth.

This is for new Y12 students who are

01

Aiming for A/A* predicted grades in Chemistry

02

Aiming for Oxbridge, Medicine, Vet or Russell Group universities

Why it works

Targeted diagnostics	Rather than re-teaching GCSE, we isolate the exact stumbling blocks that pull Year 12 grades down in October — amount of substance, bonding, organic fundamentals.
Micro-step skill building	Stoichiometry and IUPAC nomenclature broken into bite-sized logical frameworks, so the "A-Level shock" never arrives.
Study habit reset	Passive learning is replaced with real independent study: reading mark schemes, tracking error patterns, taking notes that work.
Early sight of hard topics	Students preview the earliest and most difficult concepts, so they settle in confidently when teaching starts.

> Staying consistently good is your best chance at the A/A* predicted grades required for Medicine, Veterinary, Oxbridge and Russell Group universities.

PRICING ON PAGE 15

The Y13 Accelerator Programme

A small-group AQA programme that closes the gaps in Year 12 knowledge before they derail Year 13 results. Most UK medical schools require a grade A in Chemistry and increasingly the best demand A*.

Why it works

Targeted Diagnostics and Strategic Revision	We locate and fill gaps in knowledge quickly, before they deteriorate the grade any further.
Accelerated Topic Coverage	Most schools barely finish the curriculum by May, leaving no time for exam practice, and students underperform their predicted grade in the final mock. We cover every topic by March, freeing quality time for exam technique — and seeing topics early builds confidence for when class reaches them.
Mark Scheme Decryption and Exam Focus	Beyond mark schemes and examiner reports, we study keywords and question types — including the notorious 6–8 mark Level of Response and extended answer questions.
Synoptic Problem Solving	We explicitly teach the links between topics — organic synthesis, energetics, bonding — because exam questions combine them. This is where elite problem-solving is built.

> Staying consistently good is your best chance at the A/A* Final Exam grades required for Medicine, Veterinary, Oxbridge and Russell Group universities.

Two levels of support

The same pricing applies to both the Year 12 Super Starter and the Year 13 Accelerator programmes. Only one cohort is enrolled per year group each academic year — 12 places in total across Year 12 and Year 13.

Both programmes start with a three-month term — that is the minimum time it takes for the habits to hold and the grades to move. After that it continues month to month, and most students stay to the exam.

Core

£750

FIRST 3 MONTHS

Then £250/month thereafter

- Weekly 90-minute live small-group session, max 6 students
- Weekly homework with written, actionable feedback
- Full access to session recordings
- Monthly progress check-in with parent and student

Ultimate

MOST SUPPORT

£1,125

FIRST 3 MONTHS

Then £375/month thereafter

- Everything in Core
- 2 × 30-minute 1-to-1 clinics every month
- Priority booking for additional clinics
- Full resource library — revision guides, past-paper walkthroughs, mark-scheme breakdowns

STEP 01

Short application and diagnostic task

STEP 02

1-to-1 consultation with you and your child

STEP 03

Placement in a cohort at a similar level

START HERE

Book a free 1-to-1 consultation →

15 minutes, no obligation

OR APPLY DIRECTLY

Start the application →

September cohorts, capped at 6