



Amount of Substance I

OCR A Chemistry A H432 | Specification-led notes

SPEC → CRACK IT → TEST IT → DONE

EVERY SPECIFICATION POINT. EXPLAINED. PRACTISED. CHECKED OFF.

SPECIFICATION COVERAGE

OCR A REF	THIS PACK TEACHES
2.1.1(c)	Relative isotopic mass and relative atomic mass — definitions required
2.1.1(e)	Use and calculation of M_r and relative formula mass
2.1.3(a)	Amount, mole, Avogadro constant and molar mass
2.1.3(e)(i)	Calculations using amount in mol involving mass
1.1.3(c)	Appropriate significant figures in quantitative work

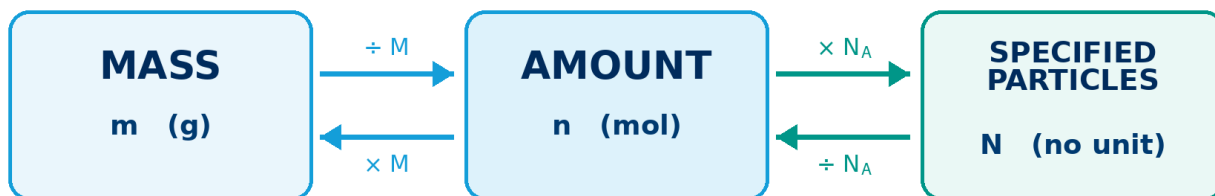
Written for first teaching in Year 12

Mapped to OCR A Chemistry A H432, specification version 3.1 (May 2026)

The big picture



YOUR ROUTE Always decide what the question gives, what it wants and which entity is being counted.



Choose the entity first: atoms • molecules • formula units • ions • electrons

The non-negotiable first step: write the entity next to N before using Avogadro's constant. "Particles" on its own is too vague.

SYMBOL	MEANING
m	mass of the sample, in g
M	molar mass, in g mol^{-1}
n	amount of substance, in mol
N	number of the specified particles; no unit
N_A	Avogadro constant = $6.02 \times 10^{23} \text{ mol}^{-1}$

OCR A BOUNDARY This pack stops before balanced equations, mole ratios, reacting masses, empirical formula, concentration, gases, yield and atom economy. Those belong in later units.



✓ DONE WHEN You can identify the correct route and name the exact entity before touching the calculator.

1. Relative isotopic mass and relative atomic mass



SPEC 2.1.1(c) Explain relative isotopic mass and relative atomic mass. OCR requires both definitions.



CRACK IT Build each definition from the same comparison standard.

TERM	OCR-READY DEFINITION
Relative isotopic mass	The mass of an atom of an isotope compared with one-twelfth of the mass of an atom of carbon-12.
Relative atomic mass, A_r	The weighted mean mass of an atom of an element compared with one-twelfth of the mass of an atom of carbon-12.

What every word is doing

- atom of an isotope makes relative isotopic mass specific to one isotope
- weighted mean allows for the different abundances of an element's isotopes
- compared with one-twelfth of carbon-12 makes the value relative, so it has no unit



EXAMINER TIP For A_r , "average" alone is not enough. Write weighted mean and include the carbon-12 comparison.



TEST IT 1 State the definitions of (a) relative isotopic mass and (b) relative atomic mass, A_r .

[4 marks]



✓ **DONE WHEN** You can reproduce both definitions accurately and explain why neither value has a unit.

2. Using relative masses



SPEC 2.1.1(e) Use M_r and relative formula mass, and calculate them from relative atomic masses.



CRACK IT Choose the name that matches the structure, then add the A_r values shown by the formula.

CONTEXT	USE
Simple molecular substance	Use relative molecular mass, M_r — for example H_2O or CO_2 .
Giant ionic or giant covalent substance	Use relative formula mass — for example $NaCl$ or SiO_2 .
OCR definition boundary	OCR requires use and calculation, but not a formal definition of M_r or relative formula mass.

CALCULATION METHOD

relative mass = sum of all A_r values in the formula

WORKED EXAMPLE | Brackets and subscripts

Calculate the relative formula mass of $Mg(NO_3)_2$ using $Mg = 24.3$, $N = 14.0$ and $O = 16.0$.

COUNT $Mg(NO_3)_2$ contains 1 Mg , 2 N and 6 O atoms.

SUBSTITUTE $(1 \times 24.3) + (2 \times 14.0) + (6 \times 16.0)$

CALCULATE $24.3 + 28.0 + 96.0 = 148.3$

ANSWER relative formula mass = **148.3**

SENSE CHECK A relative mass has no unit.

COMMON MISTAKE The 2 outside the bracket multiplies every atom inside the bracket. $Mg(NO_3)_2$ has six oxygen atoms, not three.



TEST IT 2 Calculate (a) M_r of C_2H_5OH and (b) the relative formula mass of $Mg(NO_3)_2$. Use $H = 1.0$, $C = 12.0$, $N = 14.0$, $O = 16.0$ and $Mg = 24.3$.

[5 marks]



✓ **DONE WHEN** You can count every atom correctly and give relative values without units.

3. Relative mass is not molar mass



SPEC 2.1.3(a)(iv) Explain and use molar mass: mass per mole, with units g mol^{-1} .



CRACK IT Same numerical value, different quantity and different unit.

QUANTITY	MEANING AND UNIT
A_r	Relative mass of one element's atoms; no unit.
M_r / relative formula mass	Relative value for a molecule or formula unit; no unit.
Molar mass, M	Mass of one mole of the stated substance; unit g mol^{-1} .

Example: water

$M_r(\text{H}_2\text{O})$	$(2 \times 1.0) + 16.0 = 18.0$ — no unit
$M(\text{H}_2\text{O})$	18.0 g mol^{-1}
Mass of 2.00 mol H_2O	$2.00 \text{ mol} \times 18.0 \text{ g mol}^{-1} = 36.0 \text{ g}$



EXAMINER TIP Read the symbol before writing the unit. $M_r = 18.0$, but $M = 18.0 \text{ g mol}^{-1}$.



TEST IT 3 For calcium hydroxide, $\text{Ca}(\text{OH})_2$: (a) calculate its relative formula mass; (b) state its molar mass with the correct unit; (c) explain why the two numerical values are equal but the units are different.

Use $\text{Ca} = 40.1$, $\text{O} = 16.0$ and $\text{H} = 1.0$.

[4 marks]



✓ **DONE WHEN** You never attach g mol^{-1} to A_r , M_r or relative formula mass.

4. The mole and Avogadro constant



SPEC 2.1.3(a)(i–iii) Explain amount of substance, the mole and the Avogadro constant, N_A .



CRACK IT A mole is a counting unit. It only becomes meaningful when the entity is named.

KEY FACT

1 mol = 6.02×10^{23} specified particles

$N_A = 6.02 \times 10^{23} \text{ mol}^{-1}$

Ne atoms 1 atom	O₂ molecules 2 O atoms	NaCl formula units 2 ions	Al₂(SO₄)₃ formula units 5 ions	Na⁺ ions 10 electrons
---	---	---	---	--

Amount of substance is written as n and measured in mol. The chemical formula states what one entity is.

COMMON MISTAKE Do not write “number of moles of oxygen” if the formula is O₂. State amount of O₂, because OCR uses amount with the substance’s formula.



TEST IT 4 For 1.00 mol of each substance, name the basic entity and state how many of the requested particles are present: (a) Ne atoms; (b) O₂ molecules and O atoms; (c) NaCl formula units and total ions.

[8 marks]



✓ **DONE WHEN** You can state the formula, entity and multiplier before doing a particle calculation.

5. Choose the entity before calculating



SPEC 2.1.3(a) Use amount of a stated substance and the Avogadro constant with the particle specified in the question.



CRACK IT Write a one-entity statement, then apply the formula multiplier.

FORMULA	ONE-ENTITY STATEMENT
CO_2	1 molecule contains 1 C atom and 2 O atoms
$\text{Al}_2(\text{SO}_4)_3$	1 formula unit contains 2 Al^{3+} ions and 3 SO_4^{2-} ions: 5 ions total
Na^+	1 Na^+ ion contains 10 electrons because sodium has atomic number 11 and has lost 1 electron

Multiplier method

WRITE THIS BEFORE THE CALCULATOR

number of moles of requested particles = no. of moles $\times$ no. per entity

WORKED EXAMPLE | Ions from a formula unit

Find the amount of sulfate ions in 0.120 mol of $\text{Al}_2(\text{SO}_4)_3$.

ENTITY 1 formula unit contains 3 sulfate ions.

MULTIPLY amount of $\text{SO}_4^{2-} = 0.120 \text{ mol} \times 3$

ANSWER amount of $\text{SO}_4^{2-} = 0.360 \text{ mol}$



EXAMINER TIP If the question asks for total ions, add the cation and anion subscripts. For $\text{Al}_2(\text{SO}_4)_3$ the multiplier is $2 + 3 = 5$, not 2×3 .



TEST IT 5 State the multiplier needed to convert amount of substance to the requested particle: (a) CO_2 to O atoms; (b) $\text{Al}_2(\text{SO}_4)_3$ to sulfate ions; (c) NaCl to total ions; (d) O_2 to O atoms; (e) Na^+ ions to electrons. Explain each choice.

[10 marks]



✓ **DONE WHEN** You can translate a formula into the number of atoms, ions or electrons requested.

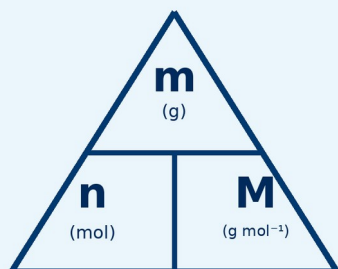
6. Mass and amount



SPEC 2.1.3(e)(i) Carry out calculations using amount in mol involving mass.



CRACK IT Put mass in g and molar mass in g mol^{-1} before substituting.



EQUATIONS TO LEARN

$$n = m \div M$$

$$m = n \times M$$

$$M = m \div n$$

WORKED EXAMPLE | Mass to amount

Calculate the amount of H_2SO_4 in 9.81 g. $M(\text{H}_2\text{SO}_4) = 98.1 \text{ g mol}^{-1}$.

WRITE $n = m \div M$

SUBSTITUTE $n = 9.81 \text{ g} \div 98.1 \text{ g mol}^{-1}$

CALCULATE $n = 0.100 \text{ mol}$

ANSWER **0.100 mol H_2SO_4**

SENSE CHECK The mass is about one-tenth of the molar mass, so the answer should be about 0.1 mol.

WORKED EXAMPLE | Amount to mass

Calculate the mass of 0.0750 mol of Na_2CO_3 . $M = 106 \text{ g mol}^{-1}$.

WRITE $m = n \times M$

SUBSTITUTE $m = 0.0750 \text{ mol} \times 106 \text{ g mol}^{-1}$

CALCULATE $m = 7.95 \text{ g}$

ANSWER **7.95 g Na_2CO_3**

COMMON MISTAKE M must be the molar mass of the entire formula shown, not the A_r of one element inside it.



TEST IT 6 Calculate (a) the amount of HCl in 7.30 g when $M = 36.5 \text{ g mol}^{-1}$ and (b) the mass of 0.0750 mol Na_2CO_3 when $M = 106 \text{ g mol}^{-1}$.

[4 marks]



✓ DONE WHEN You can move both ways between mass in g and amount in mol with correct units.

7. Amount and number of particles



SPEC 2.1.3(a)(iii) Use $N_A = 6.02 \times 10^{23} \text{ mol}^{-1}$ as the number of specified particles per mole.



CRACK IT Multiply by N_A to find the number of particles; divide by N_A to return to moles.

EQUATIONS TO USE

$$N = n \times N_A$$

$$n = N \div N_A$$

WORKED EXAMPLE | Moles to particles

Calculate the number of MgCl_2 formula units in 0.0350 mol.

ENTITY MgCl_2 is ionic, so count formula units.

WRITE $N = n \times N_A$

SUBSTITUTE $N = 0.0350 \times 6.02 \times 10^{23}$

ANSWER 2.11×10^{22} formula units

SENSE CHECK The amount is much less than 1 mol, so the answer must be less than 6.02×10^{23} .

WORKED EXAMPLE | Particles to moles

Calculate the number of moles represented by 9.03×10^{22} Ne atoms.

WRITE $n = N \div N_A$

SUBSTITUTE $n = (9.03 \times 10^{22}) \div (6.02 \times 10^{23})$

ANSWER 0.150 mol Ne



EXAMINER TIP A particle count is a number, so N has no unit. The label “atoms”, “molecules”, “formula units”, “ions” or “electrons” must still be stated.



TEST IT 7 Calculate (a) the number of MgCl_2 formula units in 0.0350 mol and (b) the amount of Ne in 9.03×10^{22} atoms.

[4 marks]



✓ **DONE WHEN** You can convert between amount and a correctly named particle count in standard form.

8. Counting atoms, ions and electrons



SPEC 2.1.3(a) Apply the mole and Avogadro constant to the particles specified by a chemical formula.



CRACK IT Separate the calculation into amount of substance → amount of requested particle
→ number of requested particles.

WORKED EXAMPLE | Atoms in molecules

Calculate the number of oxygen atoms in 0.250 mol CO_2 .

FORMULA 1 CO_2 molecule contains 2 O atoms.

MULTIPLIER amount of O atoms = $0.250 \text{ mol} \times 2 = 0.500 \text{ mol}$

AVOGADRO $N(\text{O atoms}) = 0.500 \times 6.02 \times 10^{23}$

ANSWER 3.01×10^{23} O atoms

WORKED EXAMPLE | Total ions from an ionic formula

Calculate the total number of ions in 0.0200 mol $\text{Al}_2(\text{SO}_4)_3$.

FORMULA 1 formula unit gives $2 \text{ Al}^{3+} + 3 \text{ SO}_4^{2-} = 5$ ions.

MULTIPLIER amount of ions = $0.0200 \text{ mol} \times 5 = 0.100 \text{ mol}$

AVOGADRO $N(\text{ions}) = 0.100 \times 6.02 \times 10^{23}$

ANSWER 6.02×10^{22} ions

COMMON MISTAKE When counting ions, keep a polyatomic ion together. Each SO_4^{2-} is one ion, not five ions.



TEST IT 8 Calculate (a) the number of H atoms in 0.0250 mol H_2SO_4 and (b) the total number of ions in 0.0200 mol $\text{Al}_2(\text{SO}_4)_3$.

[6 marks]



✓ **DONE WHEN** You can use formula subscripts without confusing atoms, ions and formula units.

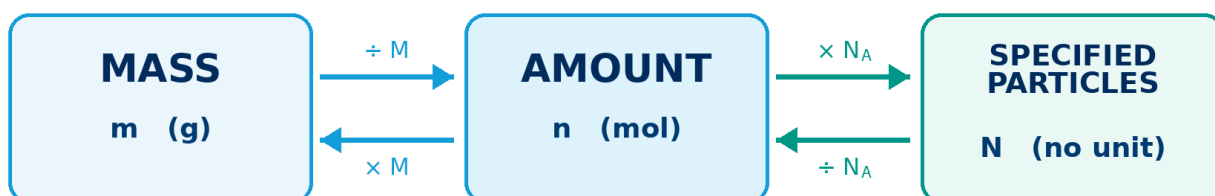
9. The full mass–mole–particle route



SPEC 2.1.3(a), 2.1.3(e)(i) Combine mass, amount and Avogadro constant calculations while keeping the specified particle explicit.



CRACK IT Mass never converts directly to particles. Moles are the bridge.



Choose the entity first: atoms • molecules • formula units • ions • electrons

WORKED EXAMPLE | Mass to a specified ion

Calculate the number of chloride ions in 5.55 g CaCl_2 . $M(\text{CaCl}_2) = 111 \text{ g mol}^{-1}$.

MASS $\rightarrow$ MOLES $n(\text{CaCl}_2) = 5.55 \div 111 = 0.0500 \text{ mol}$

ENTITY 1 formula unit contains 2 chloride ions.

MULTIPLIER $n(\text{Cl}^-) = 0.0500 \times 2 = 0.100 \text{ mol}$

MOLES $\rightarrow$ PARTICLES $N(\text{Cl}^-) = 0.100 \times 6.02 \times 10^{23}$

ANSWER 6.02×10^{22} chloride ions

SENSE CHECK 0.0500 mol formula units gives twice as many chloride ions: 0.100 mol.



TEST IT 9 Calculate the number of sulfate ions in 3.42 g $\text{Al}_2(\text{SO}_4)_3$. $M(\text{Al}_2(\text{SO}_4)_3) = 342 \text{ g mol}^{-1}$.

[5 marks]



✓ DONE WHEN You can show every bridge step and keep the requested entity attached to the number.

10. Reverse and unfamiliar calculations



SPEC 2.1.3(a), 2.1.3(e)(i) Select and rearrange the amount equations in unfamiliar contexts involving mass.



CRACK IT Work backwards from the requested particles. Do not guess a one-line formula.

WORKED EXAMPLE | Particles to mass

A sample contains 3.01×10^{22} CO_2 molecules. Calculate its mass. $M(\text{CO}_2) = 44.0 \text{ g mol}^{-1}$.

PARTICLES $\rightarrow$ MOLES $n(\text{CO}_2) = (3.01 \times 10^{22}) \div (6.02 \times 10^{23}) = 0.0500 \text{ mol}$

MOLES $\rightarrow$ MASS $m = nM = 0.0500 \times 44.0$

ANSWER 2.20 g CO_2

WORKED EXAMPLE | Use an ion count to identify an element

9.50 g of XCl_2 contains 1.204×10^{23} chloride ions. Identify X. Use $A_r(\text{Cl}) = 35.5$.

COUNT Each XCl_2 formula unit gives 2 chloride ions.

ION MOLES $n(\text{Cl}^-) = (1.204 \times 10^{23}) \div (6.02 \times 10^{23}) = 0.200 \text{ mol}$

FORMULA MOLES $n(\text{XCl}_2) = 0.200 \div 2 = 0.100 \text{ mol}$

MOLAR MASS $M(\text{XCl}_2) = 9.50 \div 0.100 = 95.0 \text{ g mol}^{-1}$

IDENTIFY $A_r(\text{X}) = 95.0 - (2 \times 35.5) = 24.0$

ANSWER X is magnesium, Mg



TEST IT 10 9.50 g of XCl_2 contains 1.204×10^{23} chloride ions. Use $A_r(\text{Cl}) = 35.5$ to calculate $A_r(\text{X})$ and identify X.

[5 marks]



✓ DONE WHEN You can reverse the route and explain every multiplier or divisor.

11. Precision, presentation and mastery



SPEC 1.1.3(c) Use an appropriate number of significant figures in quantitative work.



CRACK IT Keep full calculator values; round once, at the end.

CHECK	WHAT GOOD WORK LOOKS LIKE
Units	m in g; n in mol; M in g mol ⁻¹ ; N is a count with no unit.
Standard form	Write one non-zero digit before the decimal point: 2.11 × 10 ²² , not 21.1 × 10 ²¹ .
Significant figures	Usually match the least precise numerical data unless the question instructs otherwise.
Entity label	Finish with atoms, molecules, formula units, ions or electrons.
Sense check	Less than 1 mol means fewer than 6.02 × 10 ²³ basic entities.
COMMON MISTAKE Do not round an intermediate amount such as 0.04996 mol to 0.050 mol and then reuse it. Store the full value and round only the final answer.	

Final mastery checklist

- ☐ I can state both OCR-required relative-mass definitions.
- ☐ I can calculate M_r or relative formula mass and leave the answer unitless.
- ☐ I can distinguish a relative mass from molar mass in g mol⁻¹.
- ☐ I can use $n = m/M$ in both directions.
- ☐ I can use $N = nN_A$ in both directions.
- ☐ I identify the entity before applying Avogadro's constant.
- ☐ I use formula subscripts to count atoms, ions or electrons correctly.
- ☐ I can combine mass, mole and particle steps without skipping the mole.
- ☐ I use correct units, standard form and significant figures.
- ☐ I know which later Amount of Substance topics are deliberately not in this pack.



✓ **DONE WHEN** Every box is ticked without looking back at the notes.

TEST IT answers

Questions 1–5

1. Relative-mass definitions

Relative isotopic mass: mass of an atom of an isotope compared with one-twelfth of the mass of an atom of carbon-12.

Relative atomic mass: weighted mean mass of an atom of an element compared with one-twelfth of the mass of an atom of carbon-12.

[4 marks]

2. Relative-mass calculations

(a) $M_r(\text{C}_2\text{H}_5\text{OH}) = (2 \times 12.0) + (6 \times 1.0) + 16.0 = 46.0$.

(b) Relative formula mass of $\text{Mg}(\text{NO}_3)_2 = 24.3 + (2 \times 14.0) + (6 \times 16.0) = 148.3$.

Both answers have no unit.

[5 marks]

3. Relative formula mass and molar mass

(a) Relative formula mass of $\text{Ca}(\text{OH})_2 = 40.1 + (2 \times 16.0) + (2 \times 1.0) = 74.1$.

(b) $M(\text{Ca}(\text{OH})_2) = 74.1 \text{ g mol}^{-1}$.

(c) They are numerically equal because one mole has a mass in grams equal to the relative formula mass. Relative formula mass is a comparison and has no unit; molar mass is mass per mole and has unit g mol^{-1} .

[4 marks]

4. Basic entities

(a) Ne: atoms. 1.00 mol contains 6.02×10^{23} Ne atoms.

(b) O_2 : molecules. 1.00 mol contains 6.02×10^{23} O_2 molecules and 1.20×10^{24} O atoms.

(c) NaCl: formula units. 1.00 mol contains 6.02×10^{23} formula units and 1.20×10^{24} total ions.

[8 marks]

5. Formula multipliers

(a) **×2:** each CO_2 molecule contains 2 O atoms.

(b) **×3:** each $\text{Al}_2(\text{SO}_4)_3$ formula unit contains 3 sulfate ions.

(c) **×2:** each NaCl formula unit gives 1 Na^+ and 1 Cl^- ion.

(d) **×2:** each O_2 molecule contains 2 O atoms.

(e) **×10:** each Na^+ ion contains 10 electrons.

[10 marks]

TEST IT answers

Questions 6–10

6. Mass and amount

(a) $n(\text{HCl}) = m/M = 7.30/36.5 = 0.200 \text{ mol}$.

(b) $m(\text{Na}_2\text{CO}_3) = nM = 0.0750 \times 106 = 7.95 \text{ g}$.

[4 marks]

7. Amount and particles

(a) $N = nN_A = 0.0350 \times 6.02 \times 10^{23} = 2.11 \times 10^{22} \text{ MgCl}_2 \text{ formula units}$.

(b) $n = N/N_A = (9.03 \times 10^{22})/(6.02 \times 10^{23}) = 0.150 \text{ mol Ne}$.

[4 marks]

8. Counting atoms and ions

(a) $n(\text{H atoms}) = 0.0250 \times 2 = 0.0500 \text{ mol}$; $N = 0.0500 \times 6.02 \times 10^{23} = 3.01 \times 10^{22} \text{ H atoms}$.

(b) Each formula unit gives 5 ions. $n(\text{ions}) = 0.0200 \times 5 = 0.100 \text{ mol}$; $N = 0.100 \times 6.02 \times 10^{23} = 6.02 \times 10^{22} \text{ ions}$.

[6 marks]

9. Mass to sulfate ions

Moles of compound: $n(\text{Al}_2(\text{SO}_4)_3) = 3.42/342 = 0.0100 \text{ mol}$.

Moles of sulfate ions: $n(\text{SO}_4^{2-}) = 0.0100 \times 3 = 0.0300 \text{ mol}$.

Number of sulfate ions: $N = 0.0300 \times 6.02 \times 10^{23} = 1.81 \times 10^{22} \text{ sulfate ions}$.

[5 marks]

10. Identify X from the chloride-ion count

Moles of chloride ions: $n(\text{Cl}^-) = (1.204 \times 10^{23})/(6.02 \times 10^{23}) = 0.200 \text{ mol}$.

Moles of XCl_2 : $0.200/2 = 0.100 \text{ mol}$.

Molar mass of XCl_2 : $M = m/n = 9.50/0.100 = 95.0 \text{ g mol}^{-1}$.

Relative atomic mass of X: $A_r(\text{X}) = 95.0 - (2 \times 35.5) = 24.0$.

Identity: X is magnesium, Mg.

[5 marks]



MARKING NOTE Answers show full working. Alternative correct methods should reach the same chemically labelled result.