



CrackingCHEM

GCSE | A-LEVEL

UNDERSTAND • APPLY • SUCCEED

OCR A H432

Atomic Structure I

Original exam questions | TEST IT → EXAM STYLE → HARDER MIXED

SPECIFICATION-LED. PROGRESSIVE. EXAM-FOCUSED.

OCR A SPECIFICATION

2.1.1(a)-(e) | 4.2.4(f) crossover

TEST IT

EXAM STYLE

HARDER MIXED

STRETCH

9

9

3

1

22 ORIGINAL QUESTIONS

103 TOTAL MARKS

Independent practice material. Every question is original and has been designed from recurring OCR A assessment patterns.



START HERE

How to use this pack

A deliberate progression from recall to independent problem solving

- 1 Complete TEST IT without the notes. Correct gaps before moving on.
- 2 For every calculation, scan the question and identify exactly what the examiner wants.
- 3 Choose a relationship containing that target, rearrange it, insert the known values, then use another relationship if an unknown remains.
- 4 Complete HARDER MIXED last. These questions make you decide which chemistry to use.

✓ OCR A boundary

Use simple mass-spectral data for singly charged ions to calculate and interpret relative masses. Instrument operation is outside this pack.

Mass-spectrum shortcut

For a singly charged ion, $z = 1$. Therefore the numerical value of m/z equals the relative mass of that ion.

Write or type

The pale blue response lines are designed for printing and electronic completion. In Word, click a line and type directly onto it.

Originality and exam fit

The questions are original. Their structure, demand, command words and mark allocations are based on recurring OCR A assessment patterns rather than on any single past-paper question.



SECTION A

TEST IT

Nine short questions tied directly to individual specification points

QUESTION 1 | TEST IT

Complete the table for the three fundamental particles.

Particle	Relative charge	Relative mass	Location
proton			
neutron			
electron			

[9 marks]

QUESTION 2 | TEST IT

An ion is represented as $^{56}\text{Fe}^{2+}$. The atomic number of iron is 26. State the numbers of protons, neutrons and electrons in this ion.

[3 marks]

QUESTION 3 | TEST IT

An ion contains 17 protons, 18 neutrons and 18 electrons. State the element, mass number and charge of the ion.

[3 marks]

**QUESTION 4** | TEST IT

(a) Define the term isotope.

[2 marks]

(b) Explain why isotopes of the same element have the same chemical properties.

[1 mark]

(c) Explain why isotopes of the same element can have different physical properties.

[2 marks]

QUESTION 5 | TEST IT

(a) Define atomic number.

[1 mark]

(b) Define mass number.

[1 mark]

(c) Explain why a mass number is a whole number whereas a relative atomic mass often is not.

[2 marks]

QUESTION 6 | TEST IT

(a) Define relative isotopic mass.

[2 marks]

(b) Define relative atomic mass, A_r .

[2 marks]

**QUESTION 7** | TEST IT

Explain the difference between relative molecular mass and relative formula mass. State when each term is used and whether either quantity has a unit.

[4 marks]

QUESTION 8 | TEST IT

(a) State the quantity shown on the horizontal axis of a mass spectrum.

[1 mark]

(b) State the quantity shown on the vertical axis of a mass spectrum.

[1 mark]

(c) Explain why m/z is numerically equal to relative isotopic mass in a simple elemental spectrum containing singly charged ions.

[1 mark]

(d) State what the relative abundance of a peak represents.

[1 mark]

QUESTION 9 | TEST IT

A simple mass spectrum of an element gives the following data.

m/z	Relative abundance
24	79
25	10
26	11

Calculate the relative atomic mass of the element and use your answer to identify the element.

[4 marks]



SECTION B

EXAM STYLE

Nine original questions using recurring OCR A structures and mark allocations

✓ Calculation routine

Target -> relationship -> rearrange -> substitute known values -> find the next unknown -> final rounding.

QUESTION 10 | EXAM STYLE

The table gives particle data for four species.

Species	Protons	Neutrons	Electrons
A	17	18	18
B	17	20	17
C	18	20	18
D	18	22	20

(a) Which pair of species are isotopes of the same element?

[1 mark]

(b) Justify your choice using the particle data.

[1 mark]

QUESTION 11 | EXAM STYLE

Complete the table.

Species	Atomic number	Mass number	Protons	Neutrons	Electrons
$^{27}\text{Al}^{3+}$	13	27			
$^{37}\text{Cl}^{-}$	17	37			

[6 marks]

**QUESTION 12** | EXAM STYLE

An element has two isotopes. Their accurate relative isotopic masses are 78.918 and 80.916. The abundance ratio of the lighter isotope to the heavier isotope is 4.35 : 1.00.

Calculate the relative atomic mass of the element. Give your answer to three decimal places.

[4 marks]

QUESTION 13 | EXAM STYLE

An element has two isotopes. One isotope has relative isotopic mass 63 and abundance 69.0%. The second isotope has relative isotopic mass x and abundance 31.0%. The relative atomic mass is 63.62.

Calculate x .

[4 marks]

QUESTION 14 | EXAM STYLE

An element has isotopes with relative isotopic masses 24, 25 and 26. The isotope of mass 24 has an abundance of 79.0%. The relative atomic mass is 24.32.

Let the abundance of the isotope of mass 25 be $x\%$. Calculate the percentage abundance of each of the other two isotopes.

[5 marks]

**QUESTION 15** | EXAM STYLE

A mass spectrum gives relative intensity values that have not been converted into percentages.

m/z	Relative intensity
90	74.0
91	15.0
92	24.5
94	25.0
96	4.0

Calculate the relative atomic mass. Give your answer to two decimal places.

[4 marks]**QUESTION 16** | EXAM STYLE

An element has two isotopes with relative isotopic masses 10 and 11. The abundance of the isotope of mass 10 is x%. The relative atomic mass is 10.81.

Calculate the percentage abundance of each isotope.

[4 marks]**QUESTION 17** | EXAM STYLE

H = 1.0 C = 12.0 O = 16.0 S = 32.1 Ca = 40.1

(a) Calculate the relative molecular mass of H_2SO_4 .

[2 marks]

(b) Calculate the relative formula mass of CaCO_3 .

[2 marks]

**QUESTION 18** | EXAM STYLE

A mass spectrum of a compound has a molecular ion peak at $m/z = 86$ and a base peak at $m/z = 43$.

(a) State the relative molecular mass of the compound.

[1 mark]

(b) State what is meant by the base peak.

[1 mark]

(c) Explain why the base peak is not necessarily used to determine the relative molecular mass.

[1 mark]



SECTION C

HARDER MIXED

Three mixed questions plus one clearly labelled stretch and crossover challenge

Independent thinking

Several data sets are deliberately unfamiliar. Decide which information and relationship you need before calculating.

QUESTION 19 | HARDER MIXED

A student says that the data in Question 15 cannot be used because the relative intensity values do not add to 100.

- (a) Explain why the student is incorrect.

[1 mark]

- (b) Use the data from Question 15 to show that the relative atomic mass is 91.32.

[4 marks]

QUESTION 20 | STRETCH / SYNOPTIC

Stretch note: this unfamiliar-data calculation goes beyond the usual named Atomic Structure I calculation requirement.

A compound contains 54.5% carbon, 9.1% hydrogen and 36.4% oxygen by mass. Its mass spectrum has a molecular ion peak at $m/z = 88$ and a base peak at $m/z = 43$.

- (a) Determine the empirical formula of the compound.

[4 marks]

- (b) State the relative molecular mass of the compound.

[1 mark]



(c) Determine the molecular formula of the compound.

[2 marks]

(d) Explain why the peak at $m/z = 43$ is not used to determine the relative molecular mass.

[1 mark]

QUESTION 21 | HARDER MIXED

Element R has three isotopes with relative isotopic masses 64, 66 and 68. The isotope of mass 68 has an abundance of 25.0%. The abundance ratio of the isotopes of mass 64 and 66 is 3 : 2.

(a) Calculate the percentage abundance of each isotope.

[3 marks]

(b) Calculate the relative atomic mass of R.

[3 marks]

QUESTION 22 | HARDER MIXED

Element X has four isotopes. The data are shown below.

Relative isotopic mass	58	60	61	62
Abundance / %	68.0	x	1.1	3.6



(a) Calculate x.

[1 mark]

(b) Calculate the relative atomic mass of X. Give your answer to two decimal places.

[4 marks]

(c) X forms the ionic compound XCl_2 . Calculate its relative formula mass. Use $A_r(\text{Cl}) = 35.45$.

[2 marks]

(d) Explain why relative formula mass, rather than relative molecular mass, is used for XCl_2 .

[1 mark]

✓ **DONE**

Mark the pack using the answer section. Record the specification point behind every lost mark, then redo only those questions without the worked solution.



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OCR A H432

Atomic Structure I

Fully worked answers | OCR A-style marking guidance

FULLY WORKED. PRECISELY MARKED. BUILT FOR IMPROVEMENT.

OCR A SPECIFICATION

2.1.1(a)-(e) | 4.2.4(f) crossover

TEST IT

9

EXAM STYLE

9

HARDER MIXED

3

STRETCH

1

22 QUESTIONS MARKED

103 MARKS EXPLAINED

Independent practice material. Every question is original and has been designed from recurring OCR A assessment patterns.

OCR A MAP

How OCR A assesses this topic

Recurring structures identified across official papers and mark schemes

Specification area	Recurring OCR A demand	Frequent trap	Questions
Particles, A and Z	Direct and inverse particle counts; complete compact tables; connect charge to electrons.	Changing the proton count when an ion forms; subtracting electrons for a negative ion.	1-3, 10-11
Isotopes and properties	Exact definition; identify isotope pairs from data; explain same chemistry using electron configuration.	Defining isotopes using mass alone; using proton number to explain chemical properties.	4, 10
Relative mass definitions	Precise carbon-12 comparison; distinguish one isotope from a weighted mean; choose molecular or formula mass.	Omitting weighted mean; adding a unit to a relative mass.	5-7, 17, 22
Weighted means	Use percentages, ratios or raw intensities; work forwards or backwards; solve linked unknown abundances.	Dividing a ratio by 100; assuming intensities must sum to 100; rounding too early.	9, 12-16, 19, 21-22
Simple spectra	Read m/z and relative abundance; use singly charged ions; connect a molecular ion peak to relative molecular mass.	Treating the tallest peak as the molecular ion; confusing relative abundance with mass.	8-9, 15, 18-20
Molecular-ion crossover	Use the intact molecular ion within a later analytical calculation, often alongside formula work.	Using the base peak as the relative molecular mass; ignoring the empirical-formula multiplier.	18, 20

Research basis

The design analysis used relevant OCR A Chemistry H432 question papers and mark schemes from 2018 to 2025 and was checked against the current specification. Every question in this pack is original.

SECTION A

TEST IT answers

Specification-point checks with concise marking guidance

TEST IT 1

[9 marks]

- Proton: relative charge +1; relative mass 1; located in the nucleus. [3]
- Neutron: relative charge 0; relative mass 1; located in the nucleus. [3]
- Electron: relative charge -1; relative mass approximately 1/1840; located in a region around the nucleus. [3]

Common trap: The electron has a very small relative mass, not a relative mass of zero.

TEST IT 2

[3 marks]

- Protons = 26. [1]
- Neutrons = $56 - 26 = 30$. [1]
- Electrons = $26 - 2 = 24$. [1]

Common trap: A 2+ charge means that two electrons have been lost.

TEST IT 3

[3 marks]

- Element = chlorine because the proton number is 17. [1]
- Mass number = $17 + 18 = 35$. [1]
- Charge = -1 because there is one more electron than proton. [1]

TEST IT 4

[5 marks]

- (a) Atoms of the same element with the same number of protons but different numbers of neutrons. [2]
- (b) They have the same electron configuration, so they react in the same way. [1]
- (c) They have different neutron numbers and therefore different masses. [1]
- Some physical properties depend on mass, so these properties can differ. [1]

OCR wording: The chemical-property explanation must refer to the electron configuration, not simply to the proton number.

TEST IT 5

[4 marks]

- (a) Atomic number is the number of protons in the nucleus of an atom. [1]
- (b) Mass number is the total number of protons and neutrons in the nucleus of one atom. [1]
- (c) Mass number counts whole particles in one isotope, so it is a whole number. [1]
- Relative atomic mass is a weighted mean that includes isotope abundances, so it is often not a whole number. [1]

TEST IT 6

[4 marks]

- (a) The mass of an atom of an isotope compared with one-twelfth of the mass of a carbon-12 atom. [2]
- (b) The weighted mean mass of an atom of an element compared with one-twelfth of the mass of a carbon-12 atom. [2]

Common trap: Relative isotopic mass refers to one isotope. Relative atomic mass is a weighted mean for the element.

TEST IT 7

[4 marks]

- Relative molecular mass is the sum of the relative atomic masses in one molecule and is used for substances containing discrete molecules. [1]
- Relative formula mass is the sum of the relative atomic masses in one formula unit. [1]
- Relative formula mass is used for ionic compounds or giant structures that do not contain discrete molecules. [1]
- Neither quantity has a unit. [1]

TEST IT 8

[4 marks]

- (a) Horizontal axis: m/z . [1]
- (b) Vertical axis: relative abundance or relative intensity. [1]
- (c) The charge number z is 1, so the numerical value of m/z equals the relative isotopic mass. [1]
- (d) Relative abundance shows the proportion of ions producing that peak compared with the other ions detected. [1]

TEST IT 9

[4 marks]

$$A_r = [(24 \times 79) + (25 \times 10) + (26 \times 11)] / (79 + 10 + 11)$$

$$A_r = 2432 / 100 = 24.32$$

- Correct weighted products. [1]
- Divides by the total abundance. [1]
- $A_r = 24.32$. [1]
- The element is magnesium. [1]

SECTION B

EXAM STYLE answers

Method marks are separated so students can diagnose the exact lost step

EXAM STYLE 10

[2 marks]

- (a) A and B. [1]
- (b) They have the same number of protons but different numbers of neutrons. [1]

EXAM STYLE 11

[6 marks]

- $^{27}\text{Al}^{3+}$: 13 protons, 14 neutrons and 10 electrons. [3]
- $^{37}\text{Cl}^-$: 17 protons, 20 neutrons and 18 electrons. [3]

EXAM STYLE 12

[4 marks]

$$A_r = [(78.918 \times 4.35) + (80.916 \times 1.00)] / (4.35 + 1.00)$$

$$A_r = 424.2093 / 5.35$$

$$A_r = 79.291457... = 79.291 \text{ to three decimal places}$$

- Uses each accurate mass with its ratio value. [1]
- Divides by the total ratio, 5.35. [1]
- Obtains the unrounded value. [1]
- Final answer = 79.291. [1]

Common trap: A ratio is not a percentage. Divide by the total ratio, not by 100.

EXAM STYLE 13

[4 marks]

$$63.62 = [63(69.0) + x(31.0)] / 100$$

$$6362 = 4347 + 31x$$

$$31x = 2015$$

$$x = 65$$

- Forms the weighted-mean equation. [1]
- Correct rearrangement. [1]
- Solves for x. [1]
- Relative isotopic mass = 65. [1]

EXAM STYLE 14

[5 marks]

Abundance of mass 26 = $100 - 79 - x = 21 - x$
 $24.32 = [24(79) + 25x + 26(21 - x)] / 100$
 $2432 = 1896 + 25x + 546 - 26x$
 $2432 = 2442 - x$, so $x = 10$
 Mass 25 abundance = 10.0%; mass 26 abundance = 11.0%

- Expresses the third abundance as $21 - x$. [1]
- Forms the weighted-mean equation. [1]
- Correct expansion or equivalent rearrangement. [1]
- Mass 25 abundance = 10.0%. [1]
- Mass 26 abundance = 11.0%. [1]

Route choice: There are two unknown abundances, so first use the fact that all abundances total 100%.

EXAM STYLE 15

[4 marks]

Total relative intensity = $74.0 + 15.0 + 24.5 + 25.0 + 4.0 = 142.5$
 Weighted total = $(90 \times 74.0) + (91 \times 15.0) + (92 \times 24.5) + (94 \times 25.0) + (96 \times 4.0)$
 Weighted total = 13013.0
 $A_r = 13013.0 / 142.5 = 91.319... = 91.32$

- Uses the correct total intensity. [1]
- Forms the complete weighted sum. [1]
- Divides by 142.5. [1]
- Final answer = 91.32. [1]

EXAM STYLE 16

[4 marks]

Abundance of mass 11 = $(100 - x)\%$
 $10.81 = [10x + 11(100 - x)] / 100$
 $1081 = 10x + 1100 - 11x$
 $x = 19$
 Mass 10 abundance = 19%; mass 11 abundance = 81%

- Uses $100 - x$ for the second abundance. [1]
- Forms the weighted-mean equation. [1]
- Solves to obtain $x = 19$. [1]
- Gives both abundances: 19% and 81%. [1]

EXAM STYLE 17

[4 marks]

(a) $M_r(\text{H}_2\text{SO}_4) = 2(1.0) + 32.1 + 4(16.0) = 98.1$
 (b) Relative formula mass of $\text{CaCO}_3 = 40.1 + 12.0 + 3(16.0) = 100.1$

- Correct expression for H_2SO_4 . [1]
- $M_r(\text{H}_2\text{SO}_4) = 98.1$. [1]
- Correct expression for CaCO_3 . [1]
- Relative formula mass of $\text{CaCO}_3 = 100.1$. [1]

EXAM STYLE 18

[3 marks]

- (a) Relative molecular mass = 86 because the molecular ion is the intact molecule with one electron removed. [1]
- (b) The base peak is the most intense peak and is assigned a relative abundance of 100. [1]
- (c) The base peak may be produced by a fragment ion, so it does not necessarily represent the intact molecule. [1]

Common trap: The tallest peak is the base peak. The molecular ion peak is the one used to obtain the relative molecular mass.

SECTION C

HARDER MIXED answers

Full routes, crossover logic and common traps

HARDER MIXED 19

[5 marks]

- (a) Relative intensities are a comparative scale and do not have to total 100; the weighted mean uses their actual total. [1]

(b) Total intensity = 142.5

Weighted total = 13013.0

$A_r = 13013.0 / 142.5$

$A_r = 91.319... = 91.32$

- Correct denominator, 142.5. [1]
- Correct weighted numerator, 13013.0. [1]
- Correct division. [1]
- Final answer = 91.32. [1]

STRETCH / SYNOPTIC 20

[8 marks]

(a) Relative amounts: C = $54.5/12.0 = 4.542$; H = $9.1/1.0 = 9.10$; O = $36.4/16.0 = 2.275$

Divide by 2.275: C : H : O = 2.00 : 4.00 : 1.00

Empirical formula = C_2H_4O

(b) Molecular ion peak at $m/z = 88$, so $M_r = 88$

(c) Empirical formula mass = 44; multiplier = $88/44 = 2$

Molecular formula = $C_4H_8O_2$

- Divides each percentage by the correct relative atomic mass. [1]
- Divides all values by the smallest amount. [1]
- Obtains the ratio 2 : 4 : 1. [1]
- Empirical formula = C_2H_4O . [1]
- $M_r = 88$ from the molecular ion peak. [1]
- Finds the multiplier 2. [1]
- Molecular formula = $C_4H_8O_2$. [1]
- (d) The $m/z = 43$ base peak is the most abundant fragment ion, not the intact molecule. [1]

Crossover point: This stretch question combines Atomic Structure I mass-spectrum interpretation with empirical and molecular formula work.

HARDER MIXED 21**[6 marks]**

(a) Abundance remaining for masses 64 and 66 = $100.0 - 25.0 = 75.0\%$
 The ratio has $3 + 2 = 5$ parts, so one part = $75.0/5 = 15.0\%$
 Mass 64 = $3(15.0) = 45.0\%$; mass 66 = $2(15.0) = 30.0\%$; mass 68 = 25.0%
 (b) $A_r = [64(45.0) + 66(30.0) + 68(25.0)] / 100$
 $A_r = 6560/100 = 65.60$

- Finds the remaining abundance, 75.0%. [1]
- Splits the remainder in the ratio 3 : 2. [1]
- Gives all three abundances correctly. [1]
- Forms the weighted-mean expression. [1]
- Uses the correct denominator. [1]
- $A_r = 65.60$. [1]

HARDER MIXED 22**[8 marks]**

(a) $x = 100.0 - 68.0 - 1.1 - 3.6 = 27.3\%$
 (b) $A_r = [58(68.0) + 60(27.3) + 61(1.1) + 62(3.6)] / 100$
 $A_r = 5872.3/100 = 58.723 = 58.72$ to two decimal places
 (c) Relative formula mass of $\text{XCl}_2 = 58.723 + 2(35.45)$
 Relative formula mass = $129.623 = 129.62$

- $x = 27.3\%$. [1]
 - Uses all four isotope masses and abundances. [1]
 - Correct weighted total. [1]
 - Divides by 100. [1]
 - $A_r = 58.72$ to two decimal places. [1]
 - Uses one X and two Cl values. [1]
 - Relative formula mass = 129.62 . [1]
- (d) XCl_2 is ionic and contains a repeating lattice of formula units rather than discrete molecules. [1]

Final review

A correct final number is not enough preparation. Check that the route, denominator, rounding and chemical explanation would each earn the intended mark.