OCR A-Level Chemistry A

Atomic structure and isotopes mark scheme · goes with “Atomic structure and isotopes” · whiteboardchemistry.com/revision/exam-questions/ocr-a-level-chemistry/

Mark schemes

Atomic structure and isotopes · 10 questions

Q1 · June 2018 · Paper 1 (Periodic table, elements and physical chemistry) · Q1 · [1 mark]

Answer: **C**

80%

Q2 · June 2022 · AS Paper 1 (Breadth in chemistry) · Q22 · [7 marks]

OCR MARK SCHEME

22(a)

FIRST CHECK ANSWER ON THE ANSWER LINE

***IF** answer = 190.47 (to 2 DP) award 2 marks*

$$\frac{(188 \times 12.13) + (189 \times 16.75) + (190 \times 27.23) + (192 \times 43.89)}{100}$$

OR 190.4677 **OR** 190.468 ✓

= 190.47 (to 2 DP) ✓

[2 marks]

EXAMINER GUIDANCE

For 1 mark: ALLOW ECF → to 2 DP if:

- %s used with wrong isotopes ONCE

OR

- transposed decimal places for ONE %

22(b)

Shaded cells were given in the question.

Element	Mass number	Protons	Neutrons	Electrons	Charge
Ni	62	28	34	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^8 4s^2$	0 ✓
P	33	15	18	$1s^2 2s^2 2p^6 3s^2 3p^6$	3− ✓

Mark by row

[2 marks]

Easiest to check element first

***ALLOW** P^{3-}*

***ALLOW** names for elements*

***IGNORE** charges with element in 1st column, even if wrong.*

For electron configuration,

***ALLOW** $4s^2$ before $3d^8$*

i.e. $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^8$

***ALLOW** upper case D, etc and subscripts,*

e.g. .....$4S_2 3D_1$

***ALLOW** $[Ar]3d^8 4s^2$*

22(c)

Molar ratios

Zn : H : N : O

$$= \frac{21.99}{65.4} : \frac{4.04}{1.0} : \frac{9.41}{14.0} : \frac{64.56}{16.0}$$

OR 0.336 : 4.04 : 0.672 : 4.04

OR 1 : 12 : 2 : 12 ✓

Empirical formula

$ZnH_{12}N_2O_{12}$ ✓

Any order

With water of crystallisation

$ZnN_2O_6 \cdot 6H_2O$

OR $Zn(NO_3)_2 \cdot 6H_2O$ ✓

***NOTE**: If only the correct answer of $ZnN_2O_6 \cdot 6H_2O$ **OR** $Zn(NO_3)_2 \cdot 6H_2O$ is seen with no working, award 1 mark only*

ALLOW ECF from incorrect molar ratios of Zn : H : N : O

e.g. from use of atomic number(s)

***ALLOW** $Zn(NO_3)_2(H_2O)_6$*

ALLOW ECF from incorrect empirical formula

e.g. $ZnNO_3 \cdot 3H_2O$ from ZnH_6NO_6

Inverse fractions → NO MARKS

[3 marks]

Q3 · June 2024 · AS Paper 1 (Breadth in chemistry) · Q2 · [1 mark]

Answer: **C**

Protons: 12 · Neutrons: 13 · Electrons: 10

Q4 · June 2024 · AS Paper 1 (Breadth in chemistry) · Q20 · [1 mark]

Answer: **C**

CH_3CHOH^+

Q5 · June 2024 · AS Paper 1 (Breadth in chemistry) · Q21 · [7 marks]

OCR MARK SCHEME

21(a)

FIRST CHECK ANSWER ON THE ANSWER LINE

IF *answer = 54.63 (to 2 DP) award 2 marks*

$$\frac{(54 \times 78.54) + (56 \times 8.88) + (57 \times 5.10) + (58 \times 7.48)}{100}$$

OR 54.6298 **OR** 54.630 ✓

= 54.63 (to 2 DP) ✓

[2 marks]

EXAMINER GUIDANCE

For 1 mark: **ALLOW ECF** → to 2 DP if:

- %s used with wrong isotopes ONCE

OR

- transposed decimal places for ONE %

21(b)(i)

iron(III) oxide ✓

[1 mark]

IGNORE *iron(3) oxide, iron(III) dioxide, etc*

i.e. MUST be systematic

ALLOW *no brackets*

21(b)(ii)

$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$ ✓

[1 mark]

ALLOW *multiples*

e.g. $2Fe_2O_3 + 6CO \rightarrow 4Fe + 6CO_2$

ALLOW *1 Fe_2O_3 ..... but* ***NOT*** *0 Fe_2O_3 .....*

21(c)

FIRST CHECK ANSWER ON THE ANSWER LINE

IF *answer = 1.8(0) (dm^3) award 3 marks*

$n(Fe(NO_3)_3) = \frac{4.836}{241.8} = 0.02(00)$ (mol) ✓

$n(NO_2 + O_2) = 0.06 + 0.015$

ALLOW ECF *throughout*

ALLOW *no trailing zeroes (e.g. 0.02 for 0.0200)*

Only award **ECF** using moles for NO_2, O_2, $NO_2 + O_2$

OR $\frac{15}{4} \times 0.0200$

OR 0.0750 (mol) ✓

Total volume = 0.0750 × 24 = 1.8(0) (dm^3) ✓

DO NOT ALLOW *0.02 × 24 = 0.48 dm^3*

0.48 dm^3 is 1 mark only for whole question

[3 marks]

e.g. NO_2: 0.06 × 24 = 1.44 (dm^3)

O_2: 0.015 × 24 = 0.36 (dm^3)

ALLOW

Omission of ÷4 for 1 NO_2 AND/**OR** O_2

e.g. 1.8 × 24 = 7.2 (dm^3)

ALLOW *use of ideal gas equation using sensible p and T for final mark. e.g.*

from 100 kPa and 293 K

→ $V = \frac{nRT}{p} = \frac{0.075 \times 8.314 \times 293}{1000} =$ 1.83 dm^3

ALLOW *1 DP: 1.8 dm^3*

from 100 kPa and 298 K

→ $V = \frac{nRT}{p} = \frac{0.075 \times 8.314 \times 298}{1000} =$ 1.86 dm^3

ALLOW *1 DP: 1.9 dm^3*

from 100 kPa and 273 K

→ $V = \frac{nRT}{p} = \frac{0.075 \times 8.314 \times 273}{1000} =$ 1.7(0) dm^3

Examples of 'sensible' *p* and *T*:

p = 100 kPa, 101 kPa, 101,325 Pa

T = 273 – 298 K

Q6 · June 2024 · AS Paper 1 (Breadth in chemistry) · Q6 · [1 mark]

Answer: **B**

The elements are ordered by increasing atomic mass.

Q7 · June 2025 · AS Paper 1 (Breadth in chemistry) · Q21 · [13 marks]

OCR MARK SCHEME EXAMINER GUIDANCE

21(a)

Species	Protons	Neutrons	Electrons
^{34}S	16	18	16
$^{32}S^{2-}$	16	16	18

4 correct ✓✓

3 correct ✓

[2 marks]

***NOTE**: Look out for the 2– on $^{32}S^{2-}$*

***ALLOW** $^{32}S^{-2}$*

21(b)

FIRST CHECK ANSWER ON THE ANSWER LINE **IF answer = 24.34 (to 2 DP) award 2 marks**

$$\frac{75.45 \times 24 + 15.21 \times 25 + 9.34 \times 26}{100}$$

OR 24.3389 **OR** 24.339 ✓

= 24.34 (to 2 DP) ✓

[2 marks]

For 1 mark: ALLOW ECF → to 2 DP if:

- %s used with wrong isotopes ONCE

OR

- transposed decimal places for ONE %

21(c)

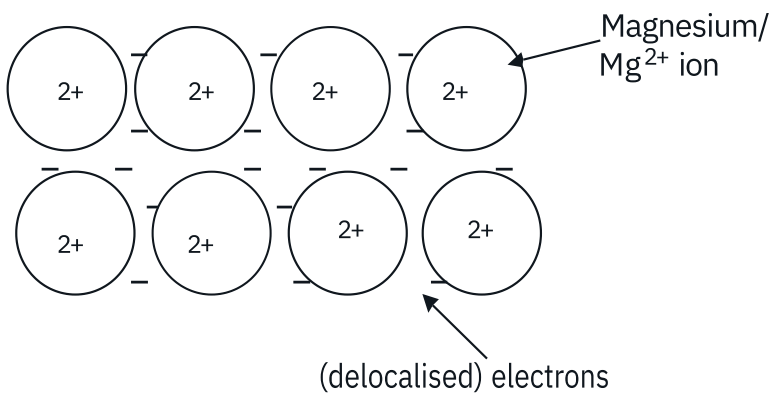


Diagram showing a regular arrangement of labelled 'Mg^{2+} ions' or '2+ ions' ✓

Scattering of labelled electrons between other species

AND

statement anywhere of delocalised electrons (can be in text or in diagram) ✓

Delocalised electrons move/flow (in an electric field/across a p.d.) ✓

Idea of movement required

Regular arrangement must have at least 2 rows of correctly charged ions and a minimum of 2 ions per row

***ALLOW** as label: positive ions, cations if correct charge is seen within circle*

***ALLOW** for labelled Mg^{2+} ions: circles with Mg^{2+} inside*

***DO NOT ALLOW** incorrect charge for ions e.g.+ , 3+ etc*

***DO NOT ALLOW** for label of ions:*

nuclei **OR** positive atom **OR** protons

***ALLOW** e– or 'e' as a label for electron*

***IGNORE** "–" for electron label (i.e. needs an additional label)*

***ALLOW** 'electrons are mobile (charge carriers)' **OR** 'sea of electrons moves'*

***IGNORE** electrons are free*

[3 marks]

DO NOT ALLOW *ions can move*

21(d)(i)

FIRST CHECK ANSWER ON THE ANSWER LINE **IF** answer = 2.0×10^{-1} award 3 marks

$n(H_2) = \dfrac{60}{24000} = 2.50 \times 10^{-3}$ **OR** 0.0025(0) (mol) ✓

$n(HCl) = 5.00 \times 10^{-3}$ **OR** 0.005(00) (mole ratio = 2:1) ✓

$c(HCl) = \dfrac{5.00 \times 10^{-3}}{0.0245} = 0.204 = 2.0 \times 10^{-1}$

2 SF and standard form required ✓

[3 marks]

ALLOW ECF *throughout*

ALLOW *use of ideal gas equation for all 3 marks provided 'sensible' p and T used:*

e.g.

from 101 kPa and 298 K

→ $nH_2 = 0.0024459$ → nHCl = 0.0048919 → cHCl 0.1996688 → 2.0×10^{-1} (2SF and standard form)

from 100 kPa and 273 K

→ $nH_2 = 0.0026435$→ nHCl = 0.005287 → 0.21579656 → 2.2×10^{-1} (2SF and standard form)

Examples of 'sensible'

p = 100 kPa, 101 kPa, 101,325 Pa

T = 273 – 298 K

Common errors (final answer)

Use of $24.5cm^3$ for H_2 volume

8.3×10^{-2} → 2 marks

Incorrect units for H_2 volume (i.e. 60/24)

2.0×10^{2} → 2 marks

Not 2SF or standard form

0.204 → 2 marks

calculator 0.2040816327

21(d)(ii)

Concentration

(Acid) concentration decreases ✓

Collisions

Fewer collisions per second

OR less frequent collisions ✓

Reaction stops/graph plateaus

(Acid/reactant/limiting reagent) has reacted/been used up ✓

[3 marks]

For Concentration and Collisions, **ALLOW ORA** for initial conditions (when t = 0), but answer must be comparative (e.g. initially the concentration is highest/higher)

ALLOW *'fewer particles in a given volume/space' for concentration decreases*

IGNORE *amount of acid decreases*

IGNORE *magnesium concentration decreases*

(Mg is solid)

DO NOT ALLOW *(line increases so) rate increases*

IGNORE *references to energy even if incorrect*

IGNORE *responses not linked to time, e.g.*

- fewer successful collisions
- fewer collisions, less chance of collisions

No link to rate.

ALLOW *idea that reaction stops e.g. no more collisions*

DO NOT ALLOW *Magnesium/reactantS used up*

(Magnesium is in excess)

Q8 · June 2025 · Paper 1 (Periodic table, elements and physical chemistry) · Q1 · [1 mark]

Answer: **C**

X and Z

Q9 · June 2025 · Paper 2 (Synthesis and analytical techniques) · Q11 · [1 mark]

Answer: **A**

Q10 · June 2025 · Paper 3 (Unified chemistry) · Q1 · [8 marks]

OCR MARK SCHEME EXAMINER GUIDANCE

1(a)(i)

m/z	Number of protons	Number of neutrons	Number of electrons
79	35	44	34
81	35	46	34

Protons **AND** Neutrons correct ✓

Electrons correct ✓

[2 marks]

1(a)(ii)

Explanation

(*m/z*) 158: $^{79}Br^{79}Br$ **OR** $^{79}Br_2$ **OR** 79 + 79

(*m/z*) 160: $^{79}Br^{81}Br$ **OR** $^{81}Br^{79}Br$ **OR** 79 + 81

(*m/z*) 162: $^{81}Br^{81}Br$ **OR** $^{81}Br_2$ **OR** 81 + 81

3 correct ✓ ✓

2 correct ✓

Relative abundancies

1 : 2 : 1 ✓

OR

25 : 50 : 25

[3 marks]

Mark explanation and Relative Abundances together

IGNORE *charges*

m/z value needs linking with isotopes in Br_2

ALLOW *0.25 : 0.5 : 0.25*

ALLOW *peak at 160 is twice/double 158 and 162*

1(b)

Shaded cells were given in the question.

Compound	Number of peaks	CH_2 splitting pattern(s)
$BrCH_2CH_2Br$	1	Singlet ✓
$BrCH_2CH_2CH_2Br$	**AND** 2 ✓	Triplet **AND** Quintet ✓

Mark number of peaks and splitting patterns independently

[3 marks]

For $BrCH_2CH_2Br$ splitting pattern,

ALLOW *'No splitting'* ***OR*** *'None'*

For $BrCH_2CH_2CH_2Br$ splitting pattern

ALLOW

multiplet,

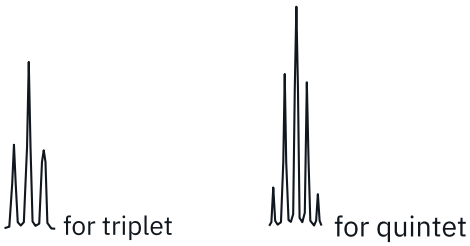
quinruplet, quinlet, quinret, pentet, pentuplet, pentex etc

ALLOW *splitting patterns shown as numbers*

i.e. '1' for singlet, '3' for triplet, '5' for quintet

ALLOW *diagrams to show splitting pattern*

e.g.



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