Pearson Edexcel

Mark Scheme (Results)

Summer 2025

Pearson Edexcel International Advanced Subsidiary Level In Chemistry (WCH11)
Paper 01 Structure, Bonding and Introduction to Organic Chemistry

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Summer 2025
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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

Using the Mark Scheme

Examiners should look for qualities to reward rather than faults to penalise. This does NOT mean giving credit for incorrect or inadequate answers, but it does mean allowing candidates to be rewarded for answers showing correct application of principles and knowledge. Examiners should therefore read carefully and consider every response: even if it is not what is expected it may be worthy of credit.

The mark scheme gives examiners:
- an idea of the types of response expected
- how individual marks are to be awarded
- the total mark for each question
- examples of responses that should NOT receive credit.

/ means that the responses are alternatives and either answer should receive full credit.
( ) means that a phrase/word is not essential for the award of the mark, but helps the examiner to get the sense of the expected answer.

Phrases/words in **bold** indicate that the meaning of the phrase or the actual word is **essential** to the answer.
ecf/TE/cq (error carried forward) means that a wrong answer given in an earlier part of a question is used correctly in answer to a later part of the same question.

Candidates must make their meaning clear to the examiner to gain the mark. Make sure that the answer makes sense. Do not give credit for correct words/phrases which are put together in a meaningless manner. Answers must be in the correct context.

Quality of Written Communication

Questions which involve the writing of continuous prose will expect candidates to:
- write legibly, with accurate use of spelling, grammar and punctuation in order to make the meaning clear
- select and use a form and style of writing appropriate to purpose and to complex subject matter
- organise information clearly and coherently, using specialist vocabulary when appropriate.

Full marks will be awarded if the candidate has demonstrated the above abilities. Questions where QWC is likely to be particularly important are indicated (QWC) in the mark scheme, but this does not preclude others.

Section A

Question Number	Answer	Mark
1	**The only correct answer is B** (*neutron number 44, electron number 36*) ***A** is incorrect because the number of electrons is for a ^{79}Br atom* ***C** is incorrect because the number of neutrons is for a ^{81}Br atom* ***D** is incorrect because the number of neutrons is for a $^{81}Br^-$ ion*	**(1)**

Question Number	Answer	Mark
2	**The only correct answer is A** ($0.072\ dm^3$) ***B** is incorrect because it has not allowed for the correct stoichiometry (not divided by 2)* ***C** is incorrect because it has not allowed for the correct stoichiometry (multiplied by 2)* ***D** is incorrect because the concentration has not been divided by 1000*	**(1)**

Question Number	Answer	Mark
3	**The only correct answer is D** (0.025 mol of copper(II) sulfate) ***A*** *is incorrect because 0.33 mol water has a mass of 5.94 g* ***B*** *is incorrect because 0.25 mol magnesium has a mass of 6.075 g* ***C*** *is incorrect because 0.033 mol glucose has a mass of 5.94 g*	**(1)**

Question Number	Answer	Mark
4	**The only correct answer is D** (1.672×10^{21}) ***A*** *is incorrect because mole calculation has been inverted and multiplied by L* ***B*** *is incorrect because L has been divided by incorrectly calculated moles* ***C*** *is incorrect because 0.5 g has been used instead of 0.05 g of water*	**(1)**

Question Number	Answer	Mark
5	**The only correct answer is B** (1 kg of urea) ***A*** *is incorrect because 2 kg of sodium nitrate contains 329.4 g of nitrogen* ***C*** *is incorrect because 1 kg of ammonium nitrate contains 350 g of nitrogen* ***D*** *is incorrect because 1 kg of ammonium sulphate contains 212 g of nitrogen*	**(1)**

Question Number	Answer	Mark
6	**The only correct answer is B** (vaporisation, ionisation, deflection, detection) ***A*** *is incorrect because deflection is the third step not the first* ***C*** *is incorrect because ionisation is the second step not the first* ***D*** *is incorrect because deflection is the third step not the second*	**(1)**

Question Number	Answer	Mark
7	**The only correct answer is A** (I only) ***B*** *is incorrect because II and III are not polar molecules* ***C*** *is incorrect because III is not a polar molecule* ***D*** *is incorrect because II and III are not polar molecules*	**(1)**

Question Number	Answer	Mark
8	**The only correct answer is D** (buckminsterfullerene C_{60}) ***A*** *is incorrect because silver has a giant metallic lattice* ***B*** *is incorrect because sodium chloride has a giant ionic lattice* ***C*** *is incorrect because carbon has giant covalent lattice*	**(1)**

Question Number	Answer	Mark
9	**The only correct answer is B** ($CH_4 + H_2O \rightarrow 3H_2 + CO$) ***A*** *is incorrect because atom economy is 11.1%* ***C*** *is incorrect because atom economy is 4.35%* ***D*** *is incorrect because atom economy is 12.0%*	**(1)**

Question Number	Answer	Mark
10	**The only correct answer is C** ($Cu + 2AgNO_3 \rightarrow Cu(NO_3)_2 + 2Ag$) ***A*** *is incorrect because atom economy is 59.4%* ***B*** *is incorrect because atom economy is 65.8%* ***D*** *is incorrect because atom economy is 91.2%*	**(1)**

Question Number	Answer	Mark
11	**The only correct answer is C** (20 cm^3) ***A*** *is incorrect because this is half the volume of butane that could be burned in 130 cm^3 oxygen* ***B*** *is incorrect because this is three quarters of the volume of butane that could be burned in 130 cm^3 oxygen* ***D*** *is incorrect because this is double the volume of butane that could be burned in 130 cm^3 oxygen*	**(1)**

Question Number	Answer	Mark
12	**The only correct answer is A** (CH_2O) ***B*** *is incorrect because there is too much hydrogen in the empirical formula* ***C*** *is incorrect because there is too much carbon in the empirical formula* ***D*** *is incorrect because there is too much oxygen in the empirical formula*	**(1)**

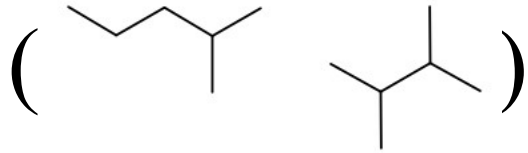
Question Number	Answer	Mark
13	**The only correct answer is D** (thermal decomposition) ***A*** *is incorrect because the alkane has not been burned* ***B*** *is incorrect because the alkane has not been hydrolysed* ***C*** *is incorrect because the alkane has not been neutralised*	**(1)**

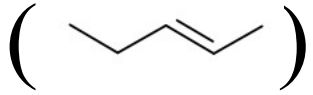
Question Number	Answer	Mark
14(a)	**The only correct answer is A**  ***B*** *is incorrect because hydrogen peroxide is not concentrated enough to be toxic, nor is it flammable* ***C*** *is incorrect because hydrogen peroxide is not flammable* ***D*** *is incorrect because hydrogen peroxide is not concentrated enough to be toxic*	**(1)**

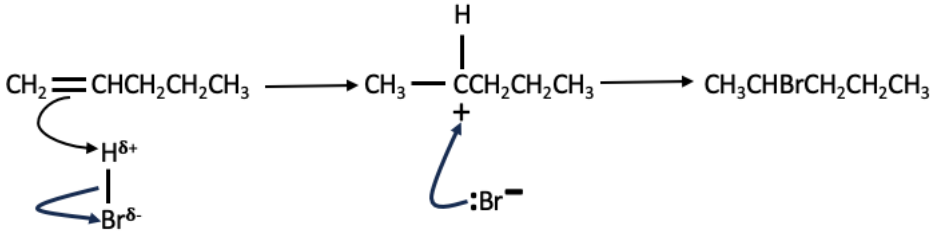
Question Number	Answer	Mark
14(b)	**The only correct answer is C** (II and III) ***A*** *is incorrect because using an alternative method that involves less hazardous materials would not work* ***B*** *is incorrect because working on a smaller scale has not been included* ***D*** *is incorrect because using an alternative method that involves less hazardous materials is not appropriate*	**(1)**

Question Number	Answer	Mark
15	**The only correct answer is D** ($C_{13}H_{28}$) ***A*** *is incorrect because* $2(C_2H_4)+2(C_3H_6)+(C_3H_8) \neq C_8H_{18}$ ***B*** *is incorrect because* $2(C_2H_4)+2(C_3H_6)+(C_3H_8) \neq C_{10}H_{22}$ ***C*** *is incorrect because* $2(C_2H_4)+2(C_3H_6)+(C_3H_8) \neq C_{11}H_{24}$	**(1)**

Question Number	Answer	Mark
16	**The only correct answer is C** (2.107×10^{24}) ***A*** *is incorrect because moles of methane correctly calculated multiplied by L* ***B*** *is incorrect because moles of methane incorrectly calculated and then multiplied by L* ***D*** *is incorrect because moles of methane incorrectly calculated and then multiplied by 4 and L*	**(1)**

Question Number	Answer	Mark
17	**The only correct answer is A**  ***B*** *is incorrect because the first structure is* C_5H_{12} *and the second* C_6H_{14} ***C*** *is incorrect because the first structure is* C_5H_{12} *and the second* C_6H_{14} ***D*** *is incorrect because the first structure is* C_5H_{12} *and the second* C_4H_{10}	**(1)**

Question Number	Answer	Mark
18	**The only correct answer is D**  ***A*** *is incorrect because this molecule has two methyl groups at one end of the carbon to carbon double bond* ***B*** *is incorrect because this molecule has two methyl groups at one end of the carbon to carbon double bond* ***C*** *is incorrect because this molecule has two methyl groups at each end of the carbon to carbon double bond*	**(1)**

Question Number	Answer	Mark
19	**The only correct answer is B**  *A is incorrect because the arrow goes from the carbocation to the bromide ion* *C is incorrect because the arrow goes from $H^{\delta+}$ to the double bond* *D is incorrect because the bromide ion has a partial negative charge*	**(1)** **Computer**

TOTAL FOR SECTION A = 20 MARKS

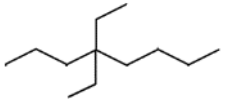
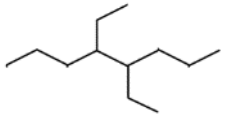
Section B

Question Number	Answer	Additional Guidance	Mark
20(a)	Method • convert °C to K **(1)** • kPa to Pa **and** 415 cm^3 to m^3 **(1)** • substitution into $pV = nRT$ **and** rearrangement **(1)** • evaluation **(1)**	Example of calculation 20 + 273 = 293 101 x 1000 = 101000 **and** 415 ÷ 1000000 = 415 x 10^{-6} / 4.15 x 10^{-4} n = 101000 × 415 x 10^{-6} ÷ 8.31 × 293 n = 0.0172 mol Ignore SF except 1 SF TE on M1 and M2 but no TE from M3 to M4 Correct answer with no working scores (4)	**(4)**

Question Number	Answer	Additional Guidance	Mark
20(b)(i)	An answer that makes reference to the following point: • (burned / reacted) in sufficient / excess **oxygen**	Allow a reaction in which all of the atoms in the fuel are fully oxidised. Ignore any reference to carbon dioxide and water	**(1)**

Question Number	Answer	Additional Guidance	Mark
20(b)(ii)	An answer that makes reference to the following point: • correctly balanced equation **(1)** • state symbols correct **(1)**	$C_{12}H_{26}(l) + 18.5O_2(g) \rightarrow 12CO_2(g) + 13H_2O(l)$ Accept $13H_2O(g)$ Allow multiples	**(2)**

Question Number	Answer		Additional Guidance	Mark
20(b)(iii)	Method		Example of calculation	**(6)**
	• calculation of litres of fuel used	**(1)**	(11400) × **9.25** = 105 450 (1.0545×10^5)	
	• calculation of mass of fuel used	**(1)**	(105 450) × **0.749** (× 1000) = 78 982 000 (7.8982×10^7)(g)	
	• calculation of mol of fuel used	**(1)**	(78 982 000) **÷ 170** = 464 600 (4.6460×10^5) (mol)	
	• calculation of mol of carbon dioxide	**(1)**	(464 600) × **12** = 5 575 200 (5.5752×10^6) (mol) (*check mole ratio from 20bii*)	
	• calculation of mass of carbon dioxide	**(1)**	(5 575 200) × **44** = 245 310 000 (2.4531×10^8) (g)	
	• calculation of mass (kg) of carbon dioxide/passenger **and** to 3SF	**(1)**	(245 310 000) **÷ 800** (÷ 1000)= (306 640 (3.0664×10^5) (g) 307 (kg) Allow 306 (kg) Allow 307000 / 306000 **g** If all six operations have **not** been carried out ignore SF Allow TE throughout	

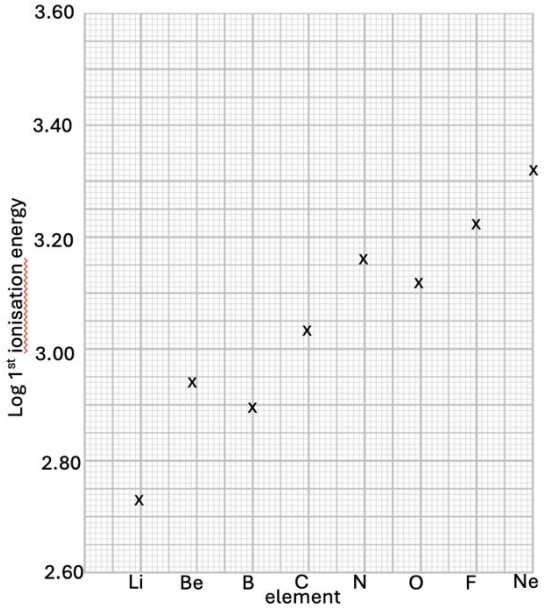
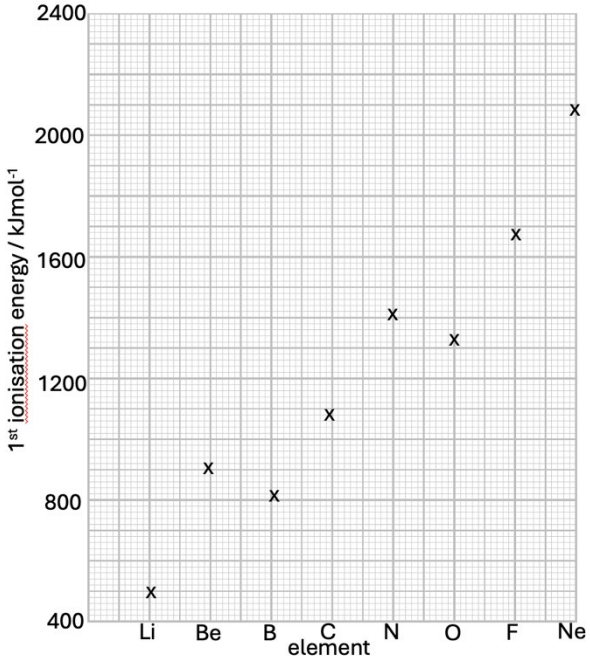
Question Number	Answer	Additional Guidance	Mark
20(b)(iv)	•  **(1)** •  **(1)**	Ignore any names even if incorrect Allow 1 mark for two correct non skeletal formulae	**(2)**

(Total for Question 20 = 15 marks)

Question Number	Answer	Additional Guidance	Mark
21(a)	An answer that makes reference to the following points: • Ca 2+ ions to Ca 3+ ions (and 1 mol only) **(1)** • one electron with charge **(1)** **and** balanced ionisation equation • correct state symbols **(1)**	 $Ca^{2+}(g) \rightarrow Ca^{3+}(g) + e^-$ Allow $Ca^{2+}(g) - e^- \rightarrow Ca^{3+}(g)$ Ignore state symbol on electron	**(3)**

Question Number	Answer	Additional Guidance	Mark
(2)	An explanation that makes reference to the following points: • the big(gest) / large / most jump / difference / gap is between ionisation 6 and 7 **(1)** • so the element must be sulphur / S **(1)**	**Mark independently** Allow between 8496 and 27107 ($kJ\ mol^{-1}$) Ignore mention of jump between 4 and 5	

Question Number	Answer	Additional Guidance	Mark
21(b)(ii)	An answer that makes reference to the following point: • (there is a gradual) increase (in the first ionisation energies across Period 3)		**(1)**

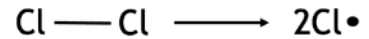
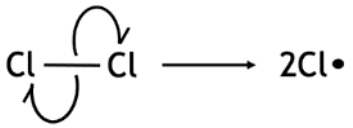
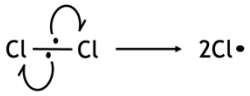
Question Number	Answer	Additional Guidance	Mark
21(c)(i)	An answer that makes reference to the following points:  	 	**(3)**
	• axes labelled correctly with units on y axis **(1)**	Allow x axis as atomic numbers Allow log axis on y axis	
	• suitable scale **(1)**	Points plotted must cover at least 50% of the graph in both directions	
	• all points correctly plotted **(1)**	Allow ±1 small square Ignore lines between points / line of best fit	

Question Number	Answer	Additional Guidance	Mark
21(c)(ii)	An explanation that makes reference to the following points: (because beryllium has a higher first ionisation energy than boron) • the removal of the electron is from a (2)s orbital in beryllium rather than a (2)p orbital in boron **(1)** • the (2)p orbital is higher in energy **(1)**	Penalise any other shell once only Ignore correct electronic configurations Accept the (2)p orbital is more shielded Ignore further away from the nucleus	**(2)**

Question Number	Answer	Additional Guidance	Mark
21(c)(iii)	An explanation that makes reference to the following points: (because nitrogen has a higher first ionisation energy than carbon) • the electrons from both nitrogen and carbon are (removed / lost) **from** (2)p orbitals. **(1)** • but the nucleus of the nitrogen atom contains one more proton than carbon **(1)**	Allow same orbital / subshell Ignore comments about similar/same shielding Allow greater nuclear charge / more protons Ignore greater atomic number Do not award comments about repulsion between paired electrons	**(2)**

(Total for Question 21 = 13 marks)

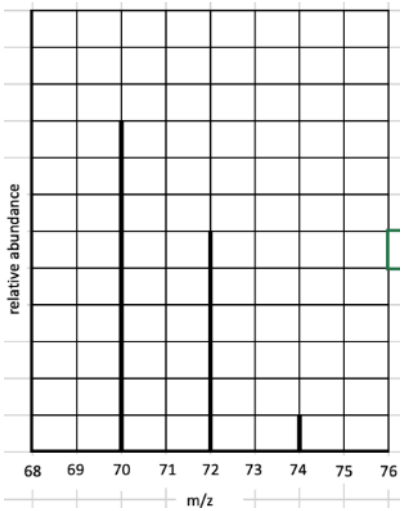
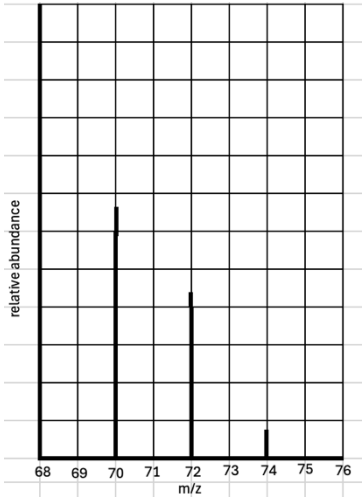
Question Number	Answer	Additional Guidance	Mark
22(a)	An answer that makes reference to the following point: • free-radical substitution reaction		**(1)**

Question Number	Answer	Additional Guidance	Mark
22(b)(i)	An answer that makes reference to the following points: • a balanced equation **(1)** • a pair of single headed arrows (fish hooks) on the Cl—Cl bond in the reactant **(1)**	 Do not award charges  Allow 	**(2)**

Question Number	Answer	Additional Guidance	Mark
22(b)(ii)	An answer that makes reference to the following points: • first propagation **(1)** • second propagation **(1)**	The radical could be anywhere on the organic materials $CH_3CH_2CH_2CH_3 + Cl\bullet \rightarrow CH_3CH_2CH_2CH_2\bullet + HCl$ Allow $C_4H_{10} + Cl\bullet \rightarrow C_4H_9\bullet + HCl$ $CH_3CH_2CH_2CH_2\bullet + Cl_2 \rightarrow CH_3CH_2CH_2CH_2Cl + Cl\bullet$ Allow $C_4H_9\bullet + Cl_2 \rightarrow C_4H_9Cl + Cl\bullet$ Penalise use of incorrect alkane once only	**(2)**

Question Number	Answer	Additional Guidance	Mark
22(b)(iii)	An answer that makes reference to the following point: • termination step fusion of two butyl radicals	$CH_3CH_2CH_2CH_2\bullet + CH_3CH_2CH_2CH_2\bullet \rightarrow CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_3$ Allow $C_4H_9\bullet + C_4H_9\bullet \rightarrow C_8H_{18}$ Do not award if charges are shown	**(1)**

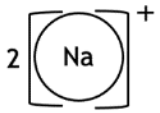
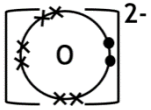
Question Number	Answer	Additional Guidance	Mark
22(c)	Method • calculation of moles of butane **(1)** • calculation of theoretical mass of trichlorobutane **(1)** • % yield **(1)** Alternative method • calculation of moles of butane **(1)** • calculation of actual moles of trichlorobutane **(1)** • % yield ((M2/M1) x 100)) **(1)**	<u>Example of calculation</u> 10/58 = 0.17241 mol butane mol trichlorobutane 0.17241 0.17241 x 161.5 = 27.844(g) 1/ 27.844 x 100 = 3.591% 10/58 = 0.17241 mol butane $1/161.5 = 6.19195 \times 10^{-3}$ $[6.19195 \times 10^{-3} / 0.17241] \times 100$ = 3.591% TE throughout, but final answer must be less than 100% Correct answer with some working scores 3 Ignore SF except for 1 SF	**(3)**

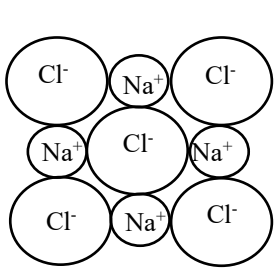
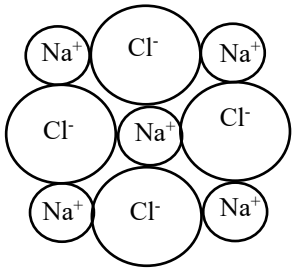
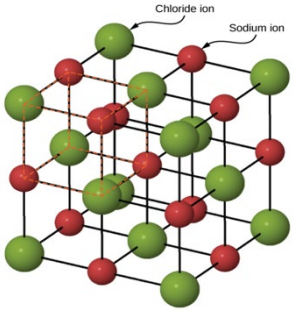
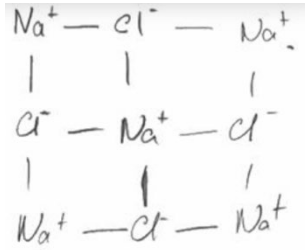
Question Number	Answer	Additional Guidance	Mark
22(d)	An answer that makes reference to the following points:  • 3 lines drawn at 70, 72, 74 **(1)** • ratio 9 (at 70):6 (at 72):1 (at 74) **(1)**	 Accept 56.25% (5.6 squares) : 37.5% (3.8 squares): 6.25% (0.6 squares) assuming 1 square is 10%	**(2)**

(Total for Question 22 = 11 marks)

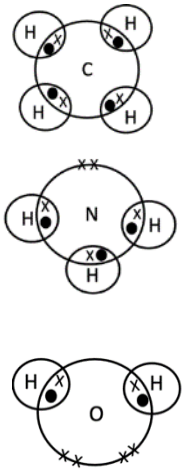
Question Number	Answer	Additional Guidance	Mark
23(a)(i)	An answer that makes reference to the following point: • (electrostatic force of) **attraction** between oppositely charged ions	 Allow attraction between cations / positively charged metal ions and anions	**(1)**

Question Number	Answer	Additional Guidance	Mark
23(a)(ii)	An explanation that makes reference to the following points: • magnesium **ions** have a higher charge. **(1)** • magnesium ions have a smaller radius. **(1)**	Allow ORA about sodium ions Allow Mg^{2+} and Na^{+} Allow magnesium has a smaller ionic radius / magnesium ions are smaller If no other mark awarded allow one mark for Mg^{2+} / magnesium ion has a greater charge density Penalise any mention of covalent bonding or intermolecular forces once only.	**(2)**

Question Number	Answer	Additional Guidance	Mark
23(a)(iii)	An answer that makes reference to the following points: •  **(1)** •  **(1)**	**Mark independently** Allow eight electrons on outer shell instead of no electrons or no circle Allow single sodium ion Do not award Na^{+}_{2} Allow transferred electrons in any pattern Do not award all dots or all crosses for the oxide ion Ignore omission of square brackets	**(2)**

Question Number	Answer	Additional Guidance	Mark
23(a)(iv)	An answer that makes reference to the following points: • At least 9 correctly labelled sodium **and** chloride ions **(1)** • The correct structure of alternating sodium / positive and chloride / negative (ions) either in rows or 3D lattice **(1)**	 **or**    Ignore size of ions Do not award M1 if suggestion that sodium chloride is not NaCl	**(2)**

Question Number	Answer	Additional Guidance	Mark
23(b)(i)	An answer that makes reference to the following point: • (electrostatic force of) **attraction** between the **shared pair** of electrons and the nuclei (of two atoms)		**(1)**

Question Number	Answer	Additional Guidance	Mark
23(b)(ii)	An answer that makes reference to the following points: • structure of methane **(1)** • structure of ammonia **(1)** • structure of water **(1)**		**(3)**

<table>
<tr><th>Question Number</th><th>Answer</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr><td>23(b)(iii)</td><td>An answer that makes reference to the following points:

• shape and bond angle for methane (1)

• shape and bond angle for ammonia (1)

• shape and bond angle for water (1)</td><td><table><tr><th>molecule</th><th>shape</th><th>bond angle</th></tr><tr><td>methane</td><td>tetrahedral</td><td>109.5°</td></tr><tr><td>ammonia</td><td>(trigonal) pyramidal</td><td>107°</td></tr><tr><td>water</td><td>non-linear / bent / V-shaped</td><td>104.5°</td></tr></table>
If no other mark scored 1 mark for either three correct bond angles or three correct shapes</td><td>(3)</td></tr>
</table>

<table>
<tr><th>Question Number</th><th>Answer</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr><td>23(b)(iv)</td><td>An answer that makes reference to the following points:

(Both ammonia and water have four pairs of electrons around the central atom)

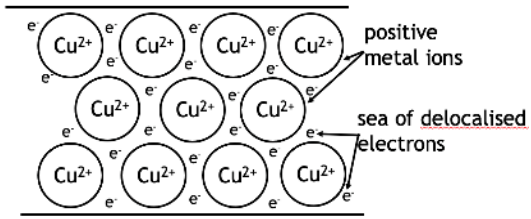
• ammonia has one lone pair and water has two lone pairs (1)

• lone pairs (of electrons) repel more than bonded pairs. (1)</td><td>Allow water has an extra lone pair

Ignore bond angles even if incorrect.</td><td>(2)</td></tr>
</table>

Question Number	Answer	Additional Guidance	Mark
23(b)(v)	An answer that makes reference to the following points: • ethene is a simple molecule • ethene has weak intermolecular forces • poly(ethene) is a polymer • poly(ethene) strong intermolecular forces All four bullet points scores 2 Two or three bullet points scores 1	Allow London / van der Waals / dispersion forces for intermolecular forces Ignore monomer Do not award reference to breaking covalent bonds Allow poly(ethene) is a macromolecule / giant molecule for polymer Do not award reference to breaking covalent bonds	**(2)**

Question Number	Answer	Additional Guidance	Mark
23(c)(i)	An answer that makes reference to the following point: • **electrostatic** (force of) **attraction** between the positive / metal ions and the (sea of delocalised) electrons.		**(1)**

Question Number	Answer	Additional Guidance	Mark
23(c)(ii)	An explanation that makes reference to the following points: • **delocalised** electrons are able to move / flow (through the lattice and carry a charge) **(1)** • diagram showing lattice of Cu^{2+} ions and (sea of) electrons interspersed within the structure – approximately twice as many electrons as ions **(1)**	Delocalised electrons may be labelled in the diagram  Do not award ions move	**(2)**

(Total for Question 23 = 21 marks)

TOTAL FOR SECTION B = 60 MARKS
TOTAL FOR PAPER = 80 MARKS

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