Pearson Edexcel

Mark Scheme (Results)

January 2023

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

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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

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.

Section A

Question Number	Answer	Mark
1	**The only correct answer is C** (SO_2) ***A*** *is not correct because 2.50 g CO contains* 5.38×10^{22} *molecules* ***B*** *is not correct because 2.50 g* CO_2 *contains* 3.42×10^{22} *molecules* ***D*** *is not correct because 2.50 g* SO_3 *contains* 1.88×10^{22} *molecules*	**(1)**

Question Number	Answer	Mark
2	**The only correct answer is D** (0.2335 mol dm^{-3}) ***A*** *is not correct because this is the number of moles of barium hydroxide in 250* cm^3 ***B*** *is not correct because this is the number of moles of hydroxide ions in 250* cm^3 ***C*** *is not correct because the stoichiometry has not been taken into account*	**(1)**

Question Number	Answer	Mark
3	**The only correct answer is B** (V_2O_3) ***A*** *is not correct because there are more moles of oxygen than vanadium* ***C*** *is not correct because the moles of oxygen are not twice as many as vanadium* ***D*** *is not correct because the moles of oxygen are not 2.5 times that of vanadium*	**(1)**

Question Number	Answer	Mark
4	**The only correct answer is C** (13 900 Pa) ***A*** *is not correct because the volume is converted into* dm^3 ***B*** *is not correct because the temperature has been converted into degrees Celsius* ***D*** *is not correct because the nRT has been multiplied by the volume instead of divided*	**(1)**

Question Number	Answer	Mark
5	**The only correct answer is B** ($Mg^{2+}(aq) + 2OH^{-}(aq) \rightarrow Mg(OH)_2(s)$) ***A*** *is not correct because the magnesium ion should be 2+* ***C*** *is not correct because the magnesium ion should be 2+ and the magnesium hydroxide should be solid* ***D*** *is not correct because the magnesium hydroxide should be solid*	**(1)**

Question Number	Answer	Mark
6	**The only correct answer is A** (111 neutrons 77 electrons) ***B*** *is not correct because the atom has lost two electrons, not gained two electrons* ***C*** *is not correct because the number of neutrons is 111 and the atom has lost two electrons* ***D*** *is not correct because the number of neutrons is 111*	**(1)**

Question Number	Answer	Mark
7	**The only correct answer is C** (91.2) ***A*** *is not correct because this only takes into account the base peak* ***B*** *is not correct because this does not take into account the peak at 96* ***D*** *is not correct because this is the unweighted mean*	**(1)**

Question Number	Answer	Mark
8	**The only correct answer is B** ($J^{+}(g) \rightarrow J^{2+}(g) + e^{-}$) ***A*** *is not correct because the atom has lost two electrons* ***C*** *is not correct because the ion has lost two electrons* ***D*** *is not correct because this is the equation for the third ionisation*	**(1)**

Question Number	Answer	Mark
9	**The only correct answer is D** (fluorine has more protons) ***A*** *is not correct because although this is true, it is not a reason for the ionisation energy being higher* ***B*** *is not correct because fluorine and oxygen have the same number of shells of electrons* ***C*** *is not correct because although this is true, it is not a reason for the ionisation energy being higher*	**(1)**

Question Number	Answer	Mark
10	**The only correct answer is C** ([Ar] )	**(1)**
	A *is not correct because the electrons in 4s and 3d have been paired before all the orbitals had been occupied* ***B*** *is not correct because the electrons in the 4s orbital has been paired before all the 3d orbitals had been occupied* ***D*** *is not correct because 4s orbital is doubly filled and these electrons have parallel spins*	

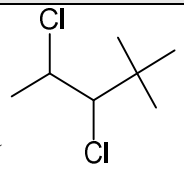
Question Number	Answer	Mark
11	**The only correct answer is B** (Mg^{2+} and O^{2-}) ***A*** *is not correct because the ions are only singly charged* ***C*** *is not correct because the ions are larger* ***D*** *is not correct because the ions are larger and singly charged*	**(1)**

Question Number	Answer	Mark
12	**The only correct answer is C** (touch screens) ***A*** *is not correct because this is a use of diamonds* ***B*** *is not correct because this is a use of graphite* ***D*** *is not correct because this use relies on graphene's strength*	**(1)**

Question Number	Answer	Mark
13	**The only correct answer is B** (CO_2 (180°)) ***A*** *is not correct because the bond angle is 120°* ***C*** *is not correct because the bond angle is 104.5°* ***D*** *is not correct because the bond angle is 107°*	**(1)**

Question Number	Answer	Mark
14	**The only correct answer is A** (1,1-dibromopropane) ***B*** *is not correct because the electronegative atoms are arranged symmetrically cancelling the dipoles* ***C*** *is not correct because the electronegative atoms are arranged symmetrically cancelling the dipoles* ***D*** *is not correct because the electronegative atoms are arranged symmetrically cancelling the dipoles*	**(1)**

Question Number	Answer	Mark
15	**The only correct answer is A** () ***B*** *is not correct because the symbols for oxidising and health hazard are shown* ***C*** *is not correct because the symbol for oxidising is shown* ***D*** *is not correct because the symbol for health hazard is shown*	**(1)**

Question Number	Answer	Mark
16	 **The only correct answer is A** ( ) ***B*** *is not correct because this is 2,4-dichloro-2,3-dimethylpentane* ***C*** *is not correct because this is 2,3-dichloro-2,4-dimethylpentane* ***D*** *is not correct because this is 2,2-dichloro-3,4-dimethylpentane*	**(1)**

Question Number	Answer	Mark
17	**The only correct answer is C** (homologous) ***A*** *is not correct because this is a type of reaction* ***B*** *is not correct because this is a type of bond breaking* ***D*** *is not correct because this is a type of bond breaking*	**(1)**

Question Number	Answer	Mark
18	**The only correct answer is D** ($C_3H_7^{\bullet} + HCl \rightarrow C_3H_7Cl + H^{\bullet}$) ***A*** *is not correct because this is a termination step in the reaction* ***B*** *is not correct because this is a termination step in the reaction* ***C*** *is not correct because this is a propagation step in the reaction*	**(1)**

Question Number	Answer	Mark
19	**The only correct answer is C** (further substitution products are formed) ***A*** *is not correct because this is not true* ***B*** *is not correct because ultraviolet radiation is used in industrial reactions* ***D*** *is not correct because termination products are formed in low concentrations*	**(1)**

Question Number	Answer	Mark
20	**The only correct answer is D** (2,5-dichlorohex-3-ene) ***A*** *is not correct because this does not form E-Z isomers* ***B*** *is not correct because this does not form E-Z isomers* ***C*** *is not correct because this does not form E-Z isomers*	**(1)**

(Total for Section A = 20 marks)

Section B

Question Number	Answer	Additional Guidance	Mark
21(a)(i)	An answer that makes reference to the following points: • C_8H_{18} **(1)** • 2,2,4–**tri**methylpentane **(1)**	Allow incorrect dashes / commas / spaces	**(2)**

Question Number	Answer	Additional Guidance	Mark
21(a)(ii)	• reforming	Allow reformation Allow isomerisation	**(1)**

Question Number	Answer	Additional Guidance	Mark
21(b)(i)	• correct equation **(1)** • state symbols **(1)**	Example of equation $C_7H_{16}(l) + 11O_2(g) \rightarrow 7CO_2(g) + 8H_2O(l)$ Accept water as a gas M2 is dependent on M1, or a near miss e.g. lack of balancing or balanced for the incorrect hydrocarbon. No M2 possible for hydrocarbons as products	**(2)**

Question Number	Answer	Additional Guidance	Mark
21(b)(ii)	• carbon monoxide / CO / soot / C / (carbon) particulates / unburnt heptane	Do not award carbon dioxide / CO_2 / nitrogen oxides / NO_x / sulfur oxides / SO_x / any other hydrocarbon Ignore water / H_2O If name and formula are given, both need to be correct	**(1)**

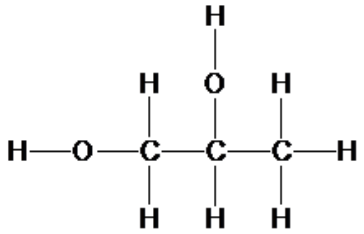
Question Number	Answer	Additional Guidance	Mark
21(c)	An answer that makes reference to two of the following points: • (electric cars) do not emit **carbon dioxide** **and** (carbon dioxide) causes climate change / causes global warming / is a greenhouse gas) OR (electric cars) can be powered by **electricity** from renewable sources (which do not contribute to climate change / global warming / greenhouse effect) **(1)** • do not emit substances which cause (local) pollution / acid rain **(1)** • they are much quieter so reduce noise pollution **(1)**	Ignore references to carbon monoxide as a greenhouse gas Ignore any references to the ozone layer, even if incorrect Allow examples of renewable sources e.g. solar Allow examples of substances e.g. nitrogen oxides / carbon particulates / carbon monoxide Ignore "less air pollution" and "pollutants" alone Ignore "acid rain" alone Ignore reduce non-renewable fuel use / refineries Ignore catalytic converters Ignore "more carbon neutral"	**(2)**

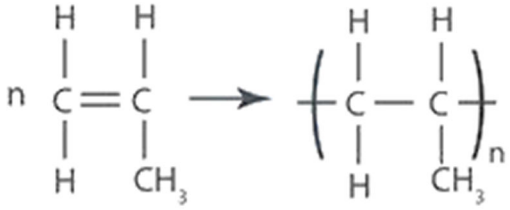
(Total for Question 21 = 8 marks)

Question Number	Answer	Additional Guidance	Mark
22(a)(i)	• nickel / Ni	Allow platinum / Pt / palladium / Pd Allow Raney nickel	**(1)**

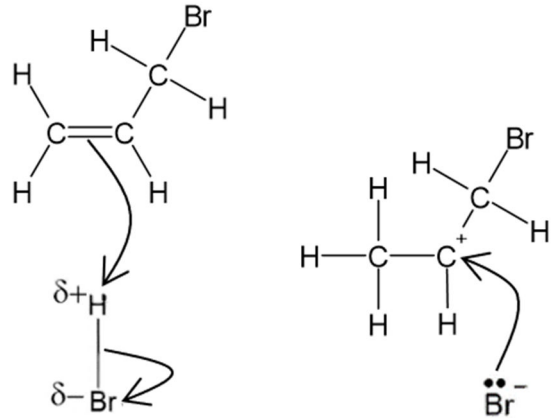
Question Number	Answer	Additional Guidance	Mark
22(a)(ii)	• 1,2-dichloropropane	Allow incorrect dashes / commas / spaces Allow minor spelling errors e.g. cloro Ignore formulae, even if incorrect Do not award propene	**(1)**

Question Number	Answer		Additional Guidance	Mark
22(a)(iii)	• steam	**(1)**	Allow $H_2O(g)$ but not H_2O or water alone	**(2)**
	• phosphoric((V)) acid / H_3PO_4	**(1)**	Allow acid **and** catalyst Do not award incorrect formulae e.g. H_3PO_3 or H_3PO_5	
	Or			
	• (concentrated) sulfuric acid / H_2SO_4	**(1)**	Do not award aqueous or dilute	
	• (followed by) water	**(1)**	NB Water must be second for M2	
			If a mixture of the options if given max 1 mark Ignore temperatures and pressures	

Question Number	Answer	Additional Guidance	Mark
22(a)(iv)	• correct displayed structure	 Allow CH_3 on one end Allow OH shown without the bond between Do not award connections to alcohol hydrogen, BOD on middle of OH	**(1)**

Question Number	Answer	Additional Guidance	Mark
22(b)(i)	• correct repeat unit including extension bonds **(1)** • rest of equation **(1)**	 Allow multiple repeat units for M1, but must be balanced for M2 Allow any shape brackets Allow n anywhere on the left-hand side of propene Ignore brackets on left-hand side M2 dependent on M1 or a near-miss	**(2)**

Question Number	Answer	Additional Guidance	Mark
22(b)(ii)	An answer that makes reference to two of the following points: • many polymers are not biodegradable **(1)** • not all plastics can be recycled **(1)** • incineration/burning releases toxic gases **(1)**	Allow (increase) landfill Allow polymers degrade very slowly / over a long time / many years Ignore "non-renewable" Allow plastics need to be separated to be recycled Allow named toxic gases Ignore harmful gases Ignore references to CO_2 / global warming etc. Ignore comments relating to wildlife and marine environments	**(2)**

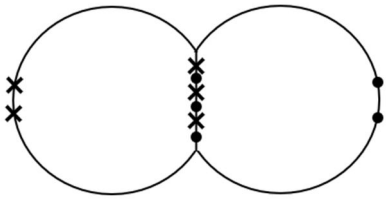
Question Number	Answer	Additional Guidance	Mark
22(c)(i)	An answer that makes reference to: • dipole on H–Br • arrow from H–Br bond to $Br^{\delta-}$ • curly arrow from double bond to $H^{(\delta+)}$ • correct carbocation intermediate • arrow from lone pair on Br • arrow to C^{+} on intermediate • charge on bromide All marking points score 4 marks, 5/6 points score 3 marks, 3/4 points score 2, 2 points score 1 mark	Example of a mechanism:  Fishhook arrows only negate one of the 7 points Positive charge should be on the carbon not on a bond Final product, if given, should match the intermediate or negates 1 point	**(4)**

Question Number	Answer		Additional Guidance	Mark
22(c)(ii)	An explanation that makes reference to the following points: • 1,2-dibromopropane is formed from the secondary carbocation (intermediate) • the secondary (carbocation) is more stable (than the primary carbocation)	**(1)** **(1)**	Allow reverse arguments: 1,3-dibromopropane is formed from the primary carbocation (intermediate) Do not award "1,2-dibromopropane is a secondary carbocation" Apply list principle for correct/incorrect answers, i.e. if one correct answer is given but an incorrect answer is also stated then no mark is awarded. the primary carbocation is less stable than the secondary carbocation Allow tertiary is more stable than the secondary/primary for M2 Ignore "secondary carbocation is stronger" Ignore Markovnikov even if incorrect Marks are independent	**(2)**

(Total for Question 22 = 15 marks)

Question Number	Answer	Additional Guidance	Mark
23(a)	• a suitable suggestion	the oil must be heated until it is a gas / the air must be cooled/compressed until it becomes a liquid Allow air must be liquefied first Allow air (distils at a) lower temperature / oil (distils at a) higher temperature Ignore different temperatures Do not award temperature alone Ignore comments about elements/compounds Ignore comments about numbers of fractions Ignore references to energy/cost	**(1)**

Question Number	Answer	Additional Guidance	Mark
23(b)(i)	• volume of oxygen needed per breath **(1)** • volume of air required **(1)**	Example of a calculation: $90 \times 500 \div 100 = 450$ (cm^3) Accept 0.45 (dm^3) $450 \times 100 \div 21 = 2142.9$ **cm^3** / 2.1429 (dm^3) Ignore SF except 1 SF Alternative calculation: Passing over zeolite reduces $100cm^3$ to $(21 \times 10/9)$ $cm^3 = 23.333cm^3$ (M1) So 1 breath requires $500 \times 100/23.333 = 2143$ **cm^3** $= 2.14(dm^3)$ (M2) Other alternate M1: $(500 \times 100) \div 21 =$ 2380 **cm^3**/2.38 dm^3 Correct answer (2.14) scores 2 The expression $\frac{90 \times 500}{21}$ scores 1 Answer in **cm^3** must contain units for two marks	**(2)**

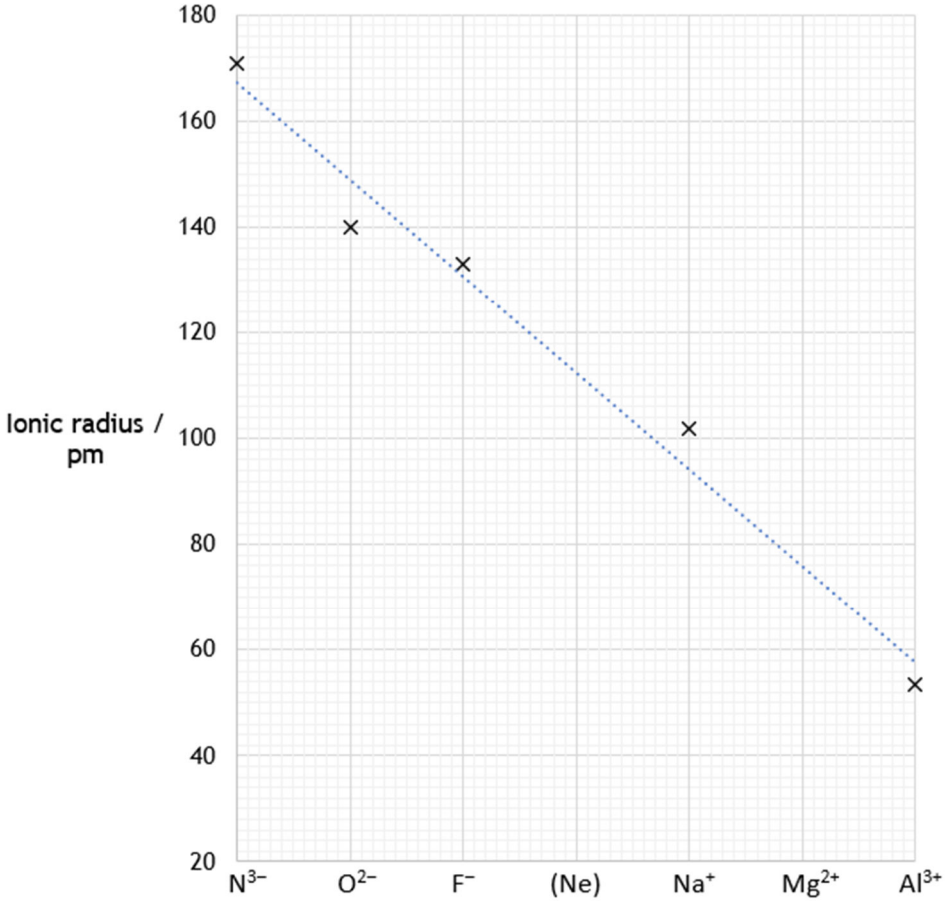
Question Number	Answer	Additional Guidance	Mark
23(b)(ii)	• three pairs of shared electrons between two atoms **(1)** • a lone pair on each atom **(1)**	Example of a diagram:  Circles are not required Allow any representation of electrons Allow lone pairs to be two individual electrons Ignore inner shells of electrons Ignore lines representing bonds	**(2)**

Question Number	Answer	Additional Guidance	Mark
23(c)(i)	• calculation of mass of oxygen **(1)** • number of moles **(1)** • volume in dm^3 **(1)** • conversion to m^3 **(1)** **Common incorrect answer:** $23.77(m^3)/23.8(m^3)$ = 3 marks (divide by 16 instead of M_r 32)	Example of a calculation: 13.9 × 1140 = 15846 (g) 15846 ÷ 32.0 = 495.19 (mol) 495.19 × 24.0 = 11884.5 (dm^3) 11884.5 ÷ 1000 = 11.88 / 11.9 (m^3) Incorrect rounding e.g. 11.8 loses M4 Ignore SF except 1 SF Correct answer with some working scores (4) TE throughout Allow 12.14 or 12.26(m^3) if calculated with *pV=nRT* for 4 marks TE on pV=nRT using moles from M2, so answer worked through would score 2 marks e.g. when using 0.579 mol (from 13.9÷24) the answer is 0.0142m^3.	**(4)**

Question Number	Answer	Additional Guidance	Mark
23(c)(ii)	• mass of bottle stated to 2 or 3SF	Example of calculation: 80.0 – 15.846 = 64.154 = 64 / 64.2 (kg) Allow answers in grams to 2 or 3SF TE on mass calculated in (c)(i) provided it gives a positive mass If no mass calculated in kg (c)(i) then allow the subtraction of a mass calculated in (c)(ii) if answer is positive and given to 2 or 3SF	**(1)**

Question Number	Answer	Additional Guidance	Mark
23(c)(iii)	An explanation that makes reference to: • the container has to have **thick** walls **(1)** • so that it will withstand the high **pressure** **(1)**	Allow "container is **thick**" Allow discussion of density of the material making the container Ignore references to density of the oxygen Ignore insulation Allow great/extreme **pressure** Ignore "needs to be strong" Ignore explosion Do not award M2 for flammability of oxygen	**(2)**

(Total for Question 23 = 12 marks)

Question Number	Answer	Additional Guidance	Mark
24(a)(i)	• axis labelled with unit **and** allowing the data to fill over half of y-axis **(1)** • 5 **points** in the table correctly plotted to within half a small square **(1)**	An example of the graph:  A scale of 30pm per large square does not score M1 Non-linear axes negate M1 **and** M2 – but an axis break is allowed NB trend line does not need to be present for M1 or M2 Ignore x-axis label even if incorrect Ignore point for Neon even if not on the line	**(2)**

Question Number	Answer		Additional Guidance	Mark
24(a)(ii)	• appropriate straight best fit line on graph	**(1)**	At least one point above and below the line Allow a line connecting N^{3-}, F^{-}, Al^{3+}	**(2)**
	• value for Mg radius (read from graph)	**(1)**	Allow 70 – 80 (pm) Marks are independent	

Question Number	Answer		Additional Guidance	Mark
24(a)(iii)	An explanation that makes reference to the following points:			**(3)**
	• (ionic) radius decreases (with (increasing) atomic number)	**(1)**	Must be a trend not a comparison for M1 Ignore "across the period" Do not award atomic radius	
	• because there are more protons (in the nucleus)	**(1)**	Allow nuclear charge increases Ignore mass to charge ratio Ignore atomic number Ignore electrostatic force between electrons and nucleus is increasing (if no mention of protons)	
	• and the ions are isoelectronic	**(1)**	Accept there is no variation in shell/shielding / all have 10 electrons / the same number of electrons / same electronic configuration Ignore references to group	

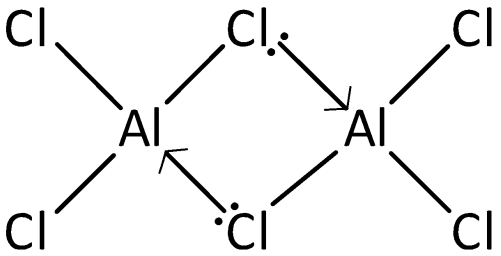
Question Number	Answer	Additional Guidance	Mark
24(b)(i)	An answer that makes reference to the following point: • **giant ionic** lattice	Allow crystal for lattice Allow giant ionic structure Do not award linear shape Do not award references to covalency or molecules Allow this answer given in 24(b)(ii) provided this is not negated by the 24(b)(i) answer	**(1)**

Question Number	Answer	Additional Guidance	Mark
24(b)(ii)	A description that makes reference to the following points: • sodium fluoride does not conduct electricity when **solid** **(1)** • sodium fluoride does conduct when in aqueous solution / molten **(1)** • because the ions cannot move (in a solid) **and** the ions are free to move when the substance is in solution / molten **(1)**	Allow poor conductor / insulator Ignore carry charge Allow because the ions are in fixed positions Do not award M3 if there is reference to sodium fluoride having delocalised electrons Must mention solutions **and** molten to gain all three marks	**(3)**

Question Number	Answer	Additional Guidance	Mark
24(b)(iii)	An explanation that makes reference to the following points: • the fluoride ion has a single charge **and** a small (ionic) radius / size **(1)** • so the electron cloud is difficult to **distort** **(1)**	Allow opposite argument i.e. ions that are large and bigger charges are easy to polarise, but you can't polarise fluoride due to its size and charge for M1 Allow small/low charge Allow small size Ignore low size Do not award M1 for atomic radius Ignore comments about electronegativity Allow "it is difficult to **distort**" Marks are independent	**(2)**

(Total for Question 24 = 13 marks)

Question Number	Answer	Additional Guidance	Mark
25(a)(i)	• trigonal planar	Allow triangular planar	**(1)**

Question Number	Answer	Additional Guidance	Mark
25(a)(ii)	An answer that makes reference to the following points: • eight correct covalent bonds **(1)** • correctly identifying the two dative covalent bonds between the monmoers by means of arrow from chlorine to aluminium **(1)**	An example of a diagram:  Bonds between aluminium atoms lose M1 Ignore bond angles and lengths Ignore dot-cross diagrams Ignore missing lone pair electrons on arrow Do not award lone pair on aluminium for M2	**(2)**

Question Number	Answer	Additional Guidance	Mark
25(b)	• balanced equation	$AlCl_3 + 3H_2O \rightarrow 3HCl + Al(OH)_3$ Allow equation with Al_2Cl_6 Allow multiples Ignore state symbols even if incorrect	**(1)**

Question Number	Answer		Additional Guidance	Mark
25(c)	• calculation of moles of sodium hydroxide • use of ratio • M_r of aluminium hydroxide **and** mass of aluminium hydroxide	**(1)** **(1)** **(1)**	An example of a calculation: 0.15 × 1.5 = 0.225 mol 0.225 ÷ 3 = 0.075 27.0 + (3 × (16 + 1)) = 78 78 × 0.075 = 5.85 (g) Correct answer scores 3 marks TE throughout Ignore SF except 1SF **Common incorrect answer:** 17.55(g) scores 2 (M1 and M3)	**(3)**

Question Number	Answer		Additional Guidance	Mark
25(d)(i)	A description that makes reference to the following points:			**(3)**
	• **strong** electrostatic (attraction)	**(1)**	Do not award references to covalent bonding for M1	
	• between cations and delocalised electrons	**(1)**	Allow "positively charged ions" for cations Allow aluminium ions for cations Do not award nuclei / protons Do not award M2 for reference to intermolecular forces	
	• Al^{3+} **and** 3 electrons per ion	**(1)**	Allow +3 charge M2 and M3 may be shown in a diagram	

Question Number	Answer		Additional Guidance	Mark
25(d)(ii)	An explanation that makes reference to the following points:			**(2)**
	• **delocalised** electrons flow (under a potential difference)	**(1)**	Allow voltage is applied Allow **delocalised** electrons can move (and conduct/carry charge)	
	• layers/ions/atoms slide over each other (while still being held together by delocalised electrons)	**(1)**	Do not award mobile ions Do not award reference to intermolecular forces for M2	

(Total for Question 25 = 12 marks)
(Total for Section B = 60 marks)
(Total for Paper = 80 marks)

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