



Mark Scheme (Results)

January 2023

Pearson Edexcel International Advanced
Subsidiary Level

In Chemistry (WCH11)

Paper 01: Structure, Bonding and Introduction
to Organic Chemistry

Section A

Question Number	Answer	Mark
1	<p>The only correct answer is C (SO₂)</p> <p><i>A is not correct because 2.50 g CO contains 5.38×10^{22} molecules</i> <i>B is not correct because 2.50 g CO₂ contains 3.42×10^{22} molecules</i> <i>D is not correct because 2.50 g SO₃ contains 1.88×10^{22} molecules</i></p>	(1)

Question Number	Answer	Mark
2	<p>The only correct answer is D (0.2335 mol dm⁻³)</p> <p><i>A is not correct because this is the number of moles of barium hydroxide in 250 cm³</i> <i>B is not correct because this is the number of moles of hydroxide ions in 250 cm³</i> <i>C is not correct because the stoichiometry has not been taken into account</i></p>	(1)

Question Number	Answer	Mark
3	<p>The only correct answer is B (V₂O₃)</p> <p><i>A is not correct because there are more moles of oxygen than vanadium</i> <i>C is not correct because the moles of oxygen are not twice as many as vanadium</i> <i>D is not correct because the moles of oxygen are not 2.5 times that of vanadium</i></p>	(1)

Question Number	Answer	Mark
4	<p>The only correct answer is C (13 900 Pa)</p> <p><i>A is not correct because the volume is converted into dm³</i> <i>B is not correct because the temperature has been converted into degrees Celsius</i> <i>D is not correct because the nRT has been multiplied by the volume instead of divided</i></p>	(1)

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

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

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

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

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




Question Number	Answer	Mark						
10	<p>The only correct answer is C ([Ar] <table><tr><td>↑</td><td>↑</td><td>↑</td><td>↑</td><td>↑</td></tr></table> <table><tr><td>↑</td></tr></table>)</p> <p><i>A is not correct because the electrons in 4s and 3d have been paired before all the orbitals had been occupied</i> <i>B is not correct because the electrons in the 4s orbital has been paired before all the 3d orbitals had been occupied</i> <i>D is not correct because 4s orbital is doubly filled and these electrons have parallel spins</i></p>	↑	↑	↑	↑	↑	↑	(1)
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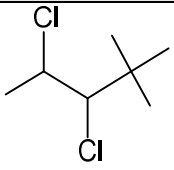
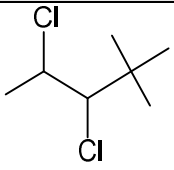
Question Number	Answer	Mark
11	<p>The only correct answer is B (Mg^{2+} and O^{2-})</p> <p><i>A is not correct because the ions are only singly charged</i> <i>C is not correct because the ions are larger</i> <i>D is not correct because the ions are larger and singly charged</i></p>	(1)

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

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

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

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

Question Number	Answer	Mark
16	 <p>The only correct answer is A ()</p> <p><i>B is not correct because this is 2,4-dichloro-2,3-dimethylpentane</i> <i>C is not correct because this is 2,3-dichloro-2,4-dimethylpentane</i> <i>D is not correct because this is 2,2-dichloro-3,4-dimethylpentane</i></p>	(1)
17	<p>The only correct answer is C (homologous)</p> <p><i>A is not correct because this is a type of reaction</i> <i>B is not correct because this is a type of bond breaking</i> <i>D is not correct because this is a type of bond breaking</i></p>	(1)
18	<p>The only correct answer is D ($\text{C}_3\text{H}_7^\bullet + \text{HCl} \rightarrow \text{C}_3\text{H}_7\text{Cl} + \text{H}^\bullet$)</p> <p><i>A is not correct because this is a termination step in the reaction</i> <i>B is not correct because this is a termination step in the reaction</i> <i>C is not correct because this is a propagation step in the reaction</i></p>	(1)

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

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

(Total for Section A = 20 marks)

Section B

Question Number	Answer	Additional Guidance	Mark
21(a)(i)	<p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> • C_8H_{18} (1) • 2,2,4-trimethylpentane (1) 	Allow incorrect dashes / commas / spaces	(2)

Question Number	Answer	Additional Guidance	Mark
21(a)(ii)	<ul style="list-style-type: none"> • reforming 	<p>Allow reformation</p> <p>Allow isomerisation</p>	(1)

Question Number	Answer	Additional Guidance	Mark
21(b)(i)	<ul style="list-style-type: none"> • correct equation (1) • state symbols (1) 	<p>Example of equation $C_7H_{16}(l) + 11O_2(g) \rightarrow 7CO_2(g) + 8H_2O(l)$</p> <p>Accept water as a gas</p> <p>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</p>	(2)

Question Number	Answer	Additional Guidance	Mark
21(b)(ii)	<ul style="list-style-type: none"> carbon monoxide / CO / soot / C / (carbon) particulates / unburnt heptane 	<p>Do not award carbon dioxide / CO₂ / nitrogen oxides / NO_x / sulfur oxides / SO_x / any other hydrocarbon</p> <p>Ignore water / H₂O</p> <p>If name and formula are given, both need to be correct</p>	(1)

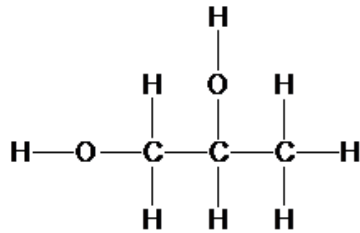
Question Number	Answer	Additional Guidance	Mark
21(c)	<p>An answer that makes reference to two of the following points:</p> <ul style="list-style-type: none"> (electric cars) do not emit carbon dioxide and (carbon dioxide) causes climate change / causes global warming / is a greenhouse gas) <p>OR</p> <p>(electric cars) can be powered by electricity from renewable sources (which do not contribute to climate change / global warming / greenhouse effect)</p> <ul style="list-style-type: none"> do not emit substances which cause (local) pollution / acid rain they are much quieter so reduce noise pollution 	<p>Ignore references to carbon monoxide as a greenhouse gas</p> <p>Ignore any references to the ozone layer, even if incorrect</p> <p>(1) Allow examples of renewable sources e.g. solar</p> <p>(1) Allow examples of substances e.g. nitrogen oxides / carbon particulates / carbon monoxide</p> <p>Ignore “less air pollution” and “pollutants” alone</p> <p>Ignore “acid rain” alone</p> <p>(1) Ignore reduce non-renewable fuel use / refineries</p> <p>Ignore catalytic converters</p> <p>Ignore “more carbon neutral”</p>	(2)

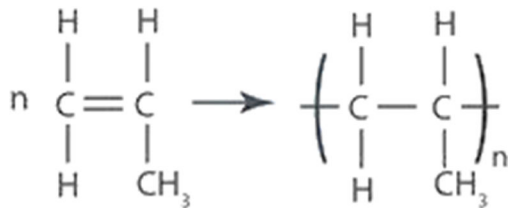
(Total for Question 21 = 8 marks)

Question Number	Answer	Additional Guidance	Mark
22(a)(i)	<ul style="list-style-type: none"> nickel / Ni 	Allow platinum / Pt / palladium / Pd Allow Raney nickel	(1)

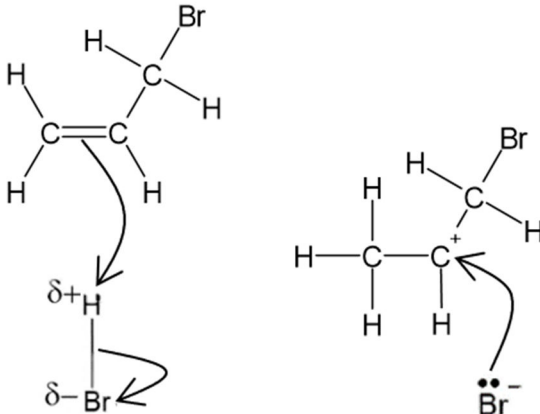
Question Number	Answer	Additional Guidance	Mark
22(a)(ii)	<ul style="list-style-type: none"> 1,2-dichloropropane 	Allow incorrect dashes / commas / spaces Allow minor spelling errors e.g. cloro Ignore formulae, even if incorrect Do not award propene	(1)

Question Number	Answer	Additional Guidance	Mark
22(a)(iii)	<ul style="list-style-type: none"> steam (1) phosphoric((V)) acid / H₃PO₄ (1) Or (concentrated) sulfuric acid / H₂SO₄ (1) (followed by) water (1) 	Allow H ₂ O(g) but not H ₂ O or water alone Allow acid and catalyst Do not award incorrect formulae e.g. H ₃ PO ₃ or H ₃ PO ₅ Do not award aqueous or dilute NB Water must be second for M2 If a mixture of the options if given max 1 mark Ignore temperatures and pressures	(2)

Question Number	Answer	Additional Guidance	Mark
22(a)(iv)	<ul style="list-style-type: none"> correct displayed structure 	 <p>Allow CH₃ on one end Allow OH shown without the bond between Do not award connections to alcohol hydrogen, BOD on middle of OH</p>	(1)

Question Number	Answer	Additional Guidance	Mark
22(b)(i)	<ul style="list-style-type: none"> correct repeat unit including extension bonds (1) rest of equation (1) 	 <p>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</p>	(2)

Question Number	Answer	Additional Guidance	Mark
22(b)(ii)	<p>An answer that makes reference to two of the following points:</p> <ul style="list-style-type: none"> • many polymers are not biodegradable • not all plastics can be recycled • incineration/burning releases toxic gases 	<p>(1) Allow (increase) landfill Allow polymers degrade very slowly / over a long time / many years</p> <p>(1) Ignore “non-renewable” Allow plastics need to be separated to be recycled</p> <p>(1) Allow named toxic gases Ignore harmful gases Ignore references to CO₂ / global warming etc.</p> <p>Ignore comments relating to wildlife and marine environments</p>	(2)

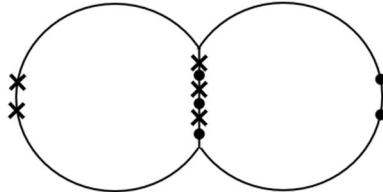
Question Number	Answer	Additional Guidance	Mark
22(c)(i)	<p>An answer that makes reference to:</p> <ul style="list-style-type: none"> • dipole on H–Br • arrow from H–Br bond to Br^{δ-} • curly arrow from double bond to H^(δ+) • correct carbocation intermediate • arrow from lone pair on Br • arrow to C⁺ on intermediate • charge on bromide <p>All marking points score 4 marks, 5/6 points score 3 marks, 3/4 points score 2, 2 points score 1 mark</p>	<p>Example of a mechanism:</p>  <p>Fishhook arrows only negate one of the 7 points</p> <p>Positive charge should be on the carbon not on a bond</p> <p>Final product, if given, should match the intermediate or negates 1 point</p>	(4)

Question Number	Answer	Additional Guidance	Mark
22(c)(ii)	<p>An explanation that makes reference to the following points:</p> <ul style="list-style-type: none"> 1,2-dibromopropane is formed from the secondary carbocation (intermediate) (1) the secondary (carbocation) is more stable (than the primary carbocation) (1) 	<p>Allow reverse arguments:</p> <p>1,3-dibromopropane is formed from the primary carbocation (intermediate) Do not award “1,2-dibromopropane is a secondary carbocation”</p> <p>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.</p> <p>the primary carbocation is less stable than the secondary carbocation</p> <p>Allow tertiary is more stable than the secondary/primary for M2 Ignore “secondary carbocation is stronger” Ignore Markovnikov even if incorrect</p> <p>Marks are independent</p>	(2)

(Total for Question 22 = 15 marks)

Question Number	Answer	Additional Guidance	Mark
23(a)	<ul style="list-style-type: none"> a suitable suggestion 	<p>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</p> <p>Allow air (distils at a) lower temperature / oil (distils at a) higher temperature Ignore different temperatures Do not award temperature alone</p> <p>Ignore comments about elements/compounds Ignore comments about numbers of fractions Ignore references to energy/cost</p>	(1)

Question Number	Answer	Additional Guidance	Mark
23(b)(i)	<ul style="list-style-type: none"> volume of oxygen needed per breath volume of air required 	<p>(1) Example of a calculation: $90 \times 500 \div 100 = 450 \text{ (cm}^3\text{)}$ Accept 0.45 (dm³)</p> <p>(1) $450 \times 100 \div 21 = 2142.9 \text{ cm}^3 / 2.1429 \text{ (dm}^3\text{)}$ Ignore SF except 1 SF</p> <p>Alternative calculation: Passing over zeolite reduces 100cm³ to $(21 \times 10/9) \text{ cm}^3 = 23.333\text{cm}^3$ (M1) So 1 breath requires $500 \times 100/23.333 = 2143 \text{ cm}^3 = 2.14(\text{dm}^3)$ (M2)</p> <p>Other alternate M1: $(500 \times 100) \div 21 = 2380 \text{ cm}^3/2.38 \text{ dm}^3$</p> <p>Correct answer (2.14) scores 2 The expression $\frac{90 \times 500}{21}$ scores 1 Answer in cm³ must contain units for two marks</p>	(2)

Question Number	Answer	Additional Guidance	Mark
23(b)(ii)	<ul style="list-style-type: none"> • three pairs of shared electrons between two atoms (1) • a lone pair on each atom (1) 	<p>Example of a diagram:</p>  <p>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</p>	(2)

Question Number	Answer	Additional Guidance	Mark
23(c)(i)	<ul style="list-style-type: none"> • calculation of mass of oxygen (1) • number of moles (1) • volume in dm³ (1) • conversion to m³ (1) <p>Common incorrect answer: 23.77(m³)/23.8(m³) = 3 marks (divide by 16 instead of M_r 32)</p>	<p>Example of a calculation: $13.9 \times 1140 = 15846 \text{ (g)}$ $15846 \div 32.0 = 495.19 \text{ (mol)}$ $495.19 \times 24.0 = 11884.5 \text{ (dm}^3\text{)}$ $11884.5 \div 1000 = 11.88 / 11.9 \text{ (m}^3\text{)}$ 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(m³) 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 $13.9 \div 24$) the answer is 0.0142m³.</p>	(4)

Question Number	Answer	Additional Guidance	Mark
23(c)(ii)	<ul style="list-style-type: none"> • mass of bottle stated to 2 or 3SF 	<p>Example of calculation: $80.0 - 15.846 = 64.154$ $= 64 / 64.2 \text{ (kg)}$ 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</p>	(1)

Question Number	Answer	Additional Guidance	Mark
23(c)(iii)	<p>An explanation that makes reference to:</p> <ul style="list-style-type: none"> the container has to have thick walls so that it will withstand the high pressure 	<p>(1) Allow “container is thick” Allow discussion of density of the material making the container Ignore references to density of the oxygen Ignore insulation</p> <p>(1) Allow great/extreme pressure Ignore “needs to be strong” Ignore explosion Do not award M2 for flammability of oxygen</p>	(2)

(Total for Question 23 = 12 marks)

Question Number	Answer	Additional Guidance	Mark
24(a)(i)	<ul style="list-style-type: none"> 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) 	<p>An example of the graph:</p> <p>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</p>	(2)

Question Number	Answer	Additional Guidance	Mark
24(a)(ii)	<ul style="list-style-type: none"> appropriate straight best fit line on graph (1) value for Mg radius (read from graph) (1) 	<p>At least one point above and below the line Allow a line connecting N^{3-}, F^-, Al^{3+}</p> <p>Allow 70 – 80 (pm)</p> <p>Marks are independent</p>	(2)

Question Number	Answer	Additional Guidance	Mark
24(a)(iii)	<p>An explanation that makes reference to the following points:</p> <ul style="list-style-type: none"> (ionic) radius decreases (with (increasing) atomic number) (1) because there are more protons (in the nucleus) (1) and the ions are isoelectronic (1) 	<p>Must be a trend not a comparison for M1 Ignore “across the period” Do not award atomic radius</p> <p>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)</p> <p>Accept there is no variation in shell/shielding / all have 10 electrons / the same number of electrons / same electronic configuration</p> <p>Ignore references to group</p>	(3)

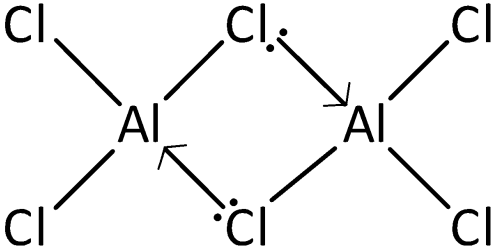
Question Number	Answer	Additional Guidance	Mark
24(b)(i)	<p>An answer that makes reference to the following point:</p> <ul style="list-style-type: none"> • giant ionic lattice 	<p>Allow crystal for lattice Allow giant ionic structure Do not award linear shape Do not award references to covalency or molecules</p> <p>Allow this answer given in 24(b)(ii) provided this is not negated by the 24(b)(i) answer</p>	(1)

Question Number	Answer	Additional Guidance	Mark
24(b)(ii)	<p>A description that makes reference to the following points:</p> <ul style="list-style-type: none"> • 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) 	<p>Allow poor conductor / insulator</p> <p>Ignore carry charge</p> <p>Allow because the ions are in fixed positions Do not award M3 if there is reference to sodium fluoride having delocalised electrons</p> <p>Must mention solutions and molten to gain all three marks</p>	(3)

Question Number	Answer	Additional Guidance	Mark
24(b)(iii)	<p>An explanation that makes reference to the following points:</p> <ul style="list-style-type: none"> the fluoride ion has a single charge and a small (ionic) radius / size (1) so the electron cloud is difficult to distort (1) 	<p>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</p> <p>Allow small/low charge</p> <p>Allow small size</p> <p>Ignore low size</p> <p>Do not award M1 for atomic radius</p> <p>Ignore comments about electronegativity</p> <p>Allow "it is difficult to distort"</p> <p>Marks are independent</p>	(2)

(Total for Question 24 = 13 marks)

Question Number	Answer	Additional Guidance	Mark
25(a)(i)	<ul style="list-style-type: none"> trigonal planar 	Allow triangular planar	(1)

Question Number	Answer	Additional Guidance	Mark
25(a)(ii)	<p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> eight correct covalent bonds correctly identifying the two dative covalent bonds between the monomers by means of arrow from chlorine to aluminium 	<p>An example of a diagram:</p>  <p>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</p>	(2)

Question Number	Answer	Additional Guidance	Mark
25(b)	<ul style="list-style-type: none"> balanced equation 	$\text{AlCl}_3 + 3\text{H}_2\text{O} \rightarrow 3\text{HCl} + \text{Al}(\text{OH})_3$ <p>Allow equation with Al_2Cl_6 Allow multiples Ignore state symbols even if incorrect</p>	(1)

Question Number	Answer	Additional Guidance	Mark
25(c)	<ul style="list-style-type: none"> • calculation of moles of sodium hydroxide • use of ratio • M_r of aluminium hydroxide <p>and</p> <p>mass of aluminium hydroxide</p>	<p>An example of a calculation:</p> <p>$0.15 \times 1.5 = 0.225 \text{ mol}$</p> <p>$0.225 \div 3 = 0.075$</p> <p>$27.0 + (3 \times (16 + 1)) = 78$</p> <p>$78 \times 0.075 = 5.85 \text{ (g)}$</p> <p>Correct answer scores 3 marks TE throughout Ignore SF except 1SF</p> <p>Common incorrect answer: 17.55(g) scores 2 (M1 and M3)</p>	(3)

Question Number	Answer	Additional Guidance	Mark
25(d)(i)	<p>A description that makes reference to the following points:</p> <ul style="list-style-type: none"> strong electrostatic (attraction) (1) between cations and delocalised electrons (1) Al^{3+} and 3 electrons per ion (1) 	<p>Do not award references to covalent bonding for M1</p> <p>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</p> <p>Allow +3 charge</p> <p>M2 and M3 may be shown in a diagram</p>	(3)

Question Number	Answer	Additional Guidance	Mark
25(d)(ii)	<p>An explanation that makes reference to the following points:</p> <ul style="list-style-type: none"> delocalised electrons flow (under a potential difference) (1) layers/ions/atoms slide over each other (while still being held together by delocalised electrons) (1) 	<p>Allow voltage is applied Allow delocalised electrons can move (and conduct/carry charge)</p> <p>Do not award mobile ions Do not award reference to intermolecular forces for M2</p>	(2)

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