



Mark Scheme (Results)

October 2021

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(a)	<p>The only correct answer is C (10)</p> <p><i>A is incorrect because this is the ratio by mass</i></p> <p><i>B is incorrect because in the mass ratio the unit of kg has been ignored and this is based on 10 mg of sulfur in 1 g of fuel</i></p> <p><i>D is incorrect because this is based on 10 g of sulfur in 1 kg of fuel</i></p>	(1)

Question Number	Answer	Mark
1(b)	<p>The only correct answer is A (0.024 dm³)</p> <p><i>B is incorrect because the molar mass of sulfur has not been taken into account</i></p> <p><i>C is incorrect because the mass ratio has been ignored</i></p> <p><i>D is incorrect because the units of mg have been ignored</i></p>	(1)

Question Number	Answer	Mark
2	<p>The only correct answer is D ($\text{Cl}^+(\text{g}) \rightarrow \text{Cl}^{2+}(\text{g}) + \text{e}^-$)</p> <p><i>A is incorrect because the equation represents an electron is added to an ion rather than being removed</i></p> <p><i>B is incorrect because the equation represents electrons being added to an atom</i></p> <p><i>C is incorrect because one electron is being removed from each of two atoms</i></p>	(1)

Question Number	Answer	Mark
3(a)	<p>The only correct answer is B (electrons are removed from molecules or atoms and positive ions are formed)</p> <p><i>A is incorrect because the sample has been vaporised previously</i></p> <p><i>C is incorrect because electrons are not added to atoms (in this mass spectrometer)</i></p> <p><i>D is incorrect because acceleration occurs in region S</i></p>	(1)

Question Number	Answer	Mark
3(b)	<p>The only correct answer is A (ions with a greater mass have a smaller deflection)</p> <p><i>B is incorrect because ions with a greater mass have a smaller deflection</i></p> <p><i>C is incorrect because ions with a greater charge have a greater deflection</i></p> <p><i>D is incorrect because ions are not speeded up in a magnetic field</i></p>	(1)

Question Number	Answer	Mark
4(a)	<p>The only correct answer is B (0.029)</p> <p><i>A is incorrect because this is just the number of moles of sodium</i></p> <p><i>C is incorrect because this assumes the number of moles of sodium is 0.1</i></p> <p><i>D is incorrect because this is the concentration in g dm⁻³</i></p>	(1)

Question	Answer	Mark
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Number		
4(b)	<p>The only correct answer is A (120)</p> <p><i>B is incorrect because the mole ratio of 1:1 has been used</i></p> <p><i>C is incorrect because the mole ratio has been taken as 2:1 rather than 1:2</i></p> <p><i>D is incorrect because the mass of sodium has been taken as the number of moles</i></p>	(1)

Question Number	Answer	Mark
4(c)	<p>The only correct answer is A ($\text{H}^+(\text{aq}) + \text{OH}^-(\text{aq}) \rightarrow \text{H}_2\text{O}(\text{l})$)</p> <p><i>B is incorrect because the water has been ignored</i></p> <p><i>C is incorrect because the sulfuric acid has not been shown as ions</i></p> <p><i>D is incorrect because all the ions are shown but none are cancelled</i></p>	(1)

Question Number	Answer	Mark
4(d)	<p>The only correct answer is A (29.1 %)</p> <p><i>B is incorrect because this is the percentage ratio of magnesium hydroxide to sodium sulfate</i></p> <p><i>C is incorrect because this is the percentage ratio of magnesium hydroxide to magnesium sulfate</i></p> <p><i>D is incorrect because this is the percentage mole ratio of the product</i></p>	(1)

Question Number	Answer	Mark
5	<p>The only correct answer is C ($\text{N}^{3-} > \text{O}^{2-} > \text{F}^-$)</p> <p><i>A is incorrect because the size of positive ions decreases across Period 3</i></p> <p><i>B is incorrect because the size of positive ions increases down Group 1</i></p> <p><i>D is incorrect because the size of negative ions increases down Group 6</i></p>	(1)

Question Number	Answer	Mark
6	<p>The only correct answer is C (d)</p> <p><i>A is incorrect because the s block elements don't form stable 3+ ions</i></p> <p><i>B is incorrect because the elements which form stable 3+ ions do not have 21 electrons</i></p> <p><i>D is incorrect because elements in the f block have more than 21 electrons</i></p>	(1)

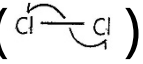
Question Number	Answer	Mark
7(a)	<p>The only correct answer is C (392.0)</p> <p><i>A is incorrect because the brackets have been ignored</i></p> <p><i>B is incorrect because the mass of water has been omitted</i></p> <p><i>D is incorrect because the iron has been doubled</i></p>	(1)

Question Number	Answer	Mark
7(b)	<p>The only correct answer is D (ionic, covalent and dative covalent)</p> <p><i>A is incorrect because there are both dative covalent and covalent bonds within the ions</i></p> <p><i>B is incorrect because there are dative covalent bonds within the ions</i></p> <p><i>C is incorrect because there are covalent bonds within the ions</i></p>	(1)

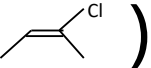
Question Number	Answer	Mark
7(c)	<p>The only correct answer is C (3.01×10^{23})</p> <p><i>A is incorrect because only one ammonium, one iron and one sulfate ion have been included</i></p> <p><i>B is incorrect because the iron ions have not been included</i></p> <p><i>D is incorrect because the water molecules have been included</i></p>	(1)

Question Number	Answer	Mark
8	<p>The only correct answer is B ($\text{Li} < \text{Be} < \text{B} < \text{C}$)</p> <p><i>A is incorrect because the melting temperatures of Group 7 elements increase going down the group</i></p> <p><i>C is incorrect because the melting temperatures of Group 1 elements decrease going down the group</i></p> <p><i>D is incorrect because silicon has the highest melting temperature in Period 3</i></p>	(1)

Question Number	Answer	Mark
9	<p>The only correct answer is B (polar, non-polar)</p> <p><i>A is incorrect because the SF_6 molecule is non-polar</i></p> <p><i>C is incorrect because the S-F bond is polar and the SF_6 molecule is non-polar</i></p> <p><i>D is incorrect because the S-F bond is polar</i></p>	(1)

Question Number	Answer	Mark
10(a)	<p>The only correct answer is B ()</p> <p><i>A is incorrect because the curly arrow indicates heterolytic fission</i></p> <p><i>C is incorrect because both arrows are full arrows rather than half arrows</i></p> <p><i>D is incorrect because the arrows are in the wrong direction</i></p>	(1)

Question Number	Answer	Mark
10(b)	<p>The only correct answer is D (HCl)</p> <p><i>A is incorrect because ethane could be formed by the combination of two methyl radicals</i></p> <p><i>B is incorrect because chloromethane could be formed by the combination of a methyl radical and a chlorine radical</i></p> <p><i>C is incorrect because dichloromethane could be formed from the combination of CH₂Cl radical and a chlorine radical</i></p>	(1)

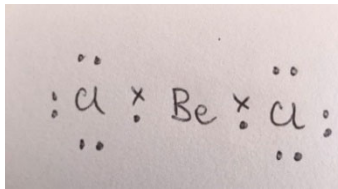
Question Number	Answer	Mark
11(a)	<p>The only correct answer is A ()</p> <p><i>B is incorrect because it is Z-1-chlorobut-2-ene</i></p> <p><i>C is incorrect because it is Z-2-chlorobut-2-ene</i></p> <p><i>D is incorrect because it is E-1-chlorobut-2-ene</i></p>	(1)

Question Number	Answer	Mark
11 (b)	<p>The only correct answer is D (11)</p> <p><i>A is incorrect because the C-H bonds and the sigma C-C have not been counted</i></p> <p><i>B is incorrect because some of the C-H bonds have not been counted</i></p> <p><i>C is incorrect because the C-C bond on the alkene bond has not been counted</i></p>	(1)

(Total for Section A = 20 marks)

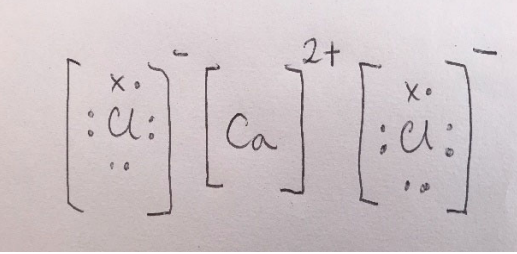
Section B

Question Number	Answer	Additional Guidance	Mark
12(a)	<ul style="list-style-type: none"> $2s^2$ (1) $2s^2 2p^6 3s^2 3p^6 4s^2$ (1) 	<p>Ignore extra $1s^2$ for both Be and Ca</p> <p>Accept $p_x^2 p_y^2 p_z^2$ for p^6</p>	(2)

Question Number	Answer	Additional Guidance	Mark
12(b)	<p>Answer that shows</p> <ul style="list-style-type: none"> 2 single covalent bonds (1) 6 non-bonding electrons shown on chlorine (1) 	<p>Example of correct dot-and-cross diagram:</p>  <p>Allow non-bonding electrons unpaired</p> <p>Allow all dots or all crosses</p> <p>Allow shared electrons on the axis of the bond</p> <p>If Ca in place of Be Max 1</p> <p>Ignore line showing covalent bond</p> <p>Ignore overlapping circles</p> <p>Ionic bond scores 0 overall</p> <p>Reject incorrect total number of electrons for M2</p>	(2)

Question Number	Answer	Additional Guidance	Mark
12(c)	<ul style="list-style-type: none"> a line/covalent bond is when electron(s) come from both/each atom(s) (1) arrow / dative covalent/ co-ordinate bond which is (a lone pair of) electrons donated from chlorine/ (only) one atom (1) 	<p>Ignore references to attraction between bonding pair and nucleus.</p> <p>Do not award any statement stating that the donation comes from Beryllium</p>	(2)

Question Number	Answer	Additional Guidance	Mark
12(d)	<ul style="list-style-type: none"> bond angle in $\text{BeCl}_2(\text{g})$/linear is 180° (1) bond angle in $\text{BeCl}_2(\text{s})$/polymeric is 109.5° (1) electron pairs/bonds repel each other to minimise repulsion (1) 4 electron pairs/bonds in solid or 2 bonding pairs/2 bonds (no lone pairs) in gas (1) 	<p>Ignore references to shape</p> <p>ALLOW any bond angle between 110° and 95°. [98° actual value] Ignore references to shape</p> <p>Allow to a maximum separation Do not award repulsion between atoms/elements or between lone pairs</p> <p>Ignore references to lp-lp/lp-bp repulsion</p>	(4)

Question Number	Answer	Additional Guidance	Mark
12(e)	<ul style="list-style-type: none"> correct charges shown and two chloride ions (1) electronic configuration of all ions (1) 	<p>Example of correct dot-and-cross diagram</p>  <p>Accept Ca with 8 electrons Allow all dots or all crosses or any combination Ignore inner electron shells</p>	(2)

Question Number	Answer	Additional Guidance	Mark
12(f)	<ul style="list-style-type: none"> Beryllium is smaller /has fewer electron shells/ has a higher charge density (than calcium) OR beryllium is more electronegative (than calcium) (1) Beryllium ion/ Be^{2+} is more polarising (than calcium /ion Ca^{2+}) OR calcium loses (outer) electrons more easily (than beryllium) OR difference in electronegativity between calcium and chlorine is greater (than between beryllium and chlorine) (1) beryllium-chlorine bond has a higher degree of covalency (than calcium-chlorine bond) (1) 	<p>Allow beryllium is more polarising than calcium</p> <p>Accept bonding in beryllium chloride is (more) covalent/ bonding in calcium chloride is (more) ionic. M3 is dependent on either M1 or M2 being scored Allow reverse arguments throughout</p>	(3)

(Total for Question 12 = 15 marks)

Question Number	Answer	Additional Guidance	Mark
13(a)(i)	<ul style="list-style-type: none"> expression for calculation of RAM of silicon (1) answer to two decimal places (1) 	<p>Example of calculation: $\frac{(28 \times 92.17) + (29 \times 4.71) + (30 \times 3.12)}{100}$ $= 28.1095$ $= 28.11$ </p> <p>Allow units g mol⁻¹/a.m.u only Correct answer scores 2 Allow TE from incorrect expression if answer lies between 28 and 30.</p>	(2)

Question Number	Answer	Additional Guidance	Mark
13(a)(ii)	Some silicon atoms (of mass 28) lose two electrons/have a charge of 2+	<p>Allow (formation of) Si²⁺ Do not award "atoms of mass 14"</p>	(1)

Question Number	Answer			Additional Guidance	Mark
13(a)(iii)					(1)
	²⁸ Si	14	14		
	²⁹ Si	14	15		
	³⁰ Si	14	16		

Question Number	Answer	Additional Guidance	Mark
13(b)	<ul style="list-style-type: none"> all atoms are joined together by covalent bonds/giant covalent(structure) (1) these are strong / take a lot of energy to break (so melting temperature is very high) (1) no electrons are free (to move)/ mobile/delocalised/ (so charge cannot be carried) (1) 	<p>Allow correct description of covalent bond Do not award intermolecular forces/ ionic bonds/ double covalent bonds. Ignore stoichiometry even if incorrect.</p> <p>Ignore high boiling temperature</p> <p>Ignore no free moving ions</p>	(3)

Question Number	Answer	Additional Guidance	Mark
13(c)	<ul style="list-style-type: none"> calculation of number of moles (1) calculation of whole number mole ratio (1) empirical formula (1) 	<p>Example of calculation</p> $\frac{12}{40.1} \quad \frac{8.43}{28.1} \quad \frac{14.47}{16}$ <p>OR 0.299 : 0.30 : 0.904</p> $1 : 1 : 3$ <p>CaSiO₃</p> <p>Correct formula with no working scores 1 mark only TE on use of atomic numbers Incorrect symbol(s) in formula loses M3</p>	(3)

Question Number	Answer	Additional Guidance	Mark
13(d)	<ul style="list-style-type: none"> calculation of moles carbon dioxide (1) conversion of temperature to K (1) rearrangement of expression (1) evaluation of answer in cm^3 (1) 	<p>Example of calculation: $3 \div 44 = 0.06818$</p> <p>$273 + 5 = 278$</p> <p>$V = \frac{0.06818 \times 8.31 \times 278}{1.3 \times 10^5}$ $(= 1.2116 \times 10^{-3} \text{m}^3)$</p> <p>$= 1211.6 / 1212 / 1210 / 1200 \text{ (cm}^3\text{)}$ TE throughout but do not award M4 for negative volume Ignore SF except 1 SF Correct answer with no working scores 4 marks</p>	(4)

(Total for Question 13 = 14 marks)

Question Number	Answer	Additional Guidance	Mark
14(a)	<ul style="list-style-type: none"> there is a “jump”/much bigger increase between the third and fourth ionisation energies (1) (First) 3 electrons in outer shell (1) 	Accept fourth electron is removed from a different (quantum) shell (which is closer to the nucleus)	(2)

Question Number	Answer	Additional Guidance	Mark
14(b)(i)	<ul style="list-style-type: none"> the number of protons increases /nuclear charge increases (1) the additional electrons are in the same shell/same energy level/ little additional shielding from electrons (1) 	Allow “same shielding” Ignore references to atomic radius even if incorrect Ignore electron repulsion	(2)

Question Number	Answer	Additional Guidance	Mark
14(b)(ii)	<ul style="list-style-type: none"> the first electron is removed from a (3)p orbital/subshell in aluminium/ (3)s orbital/subshell from magnesium (1) p electron(s) shielded by the s electrons (so requires less energy)/ p energy level is higher than s energy level (1) 	Do not award 2p/2s	(2)

Question Number	Answer	Additional Guidance	Mark
14(c)(i)	<p>An answer that makes reference to</p> <ul style="list-style-type: none"> delocalised /free (to move) electrons /sea of electrons (1) attracted to (a lattice of) metal/aluminium/positive ions/cations (1) 	<p>Allow charges up to 3+</p> <p>Correct fully labelled diagram scores 2 marks</p> <p>Ignore attraction of electrons to nuclei</p>	(2)

Question Number	Answer	Additional Guidance	Mark
14(c)(ii)	<p>An answer that makes reference to two of the following:</p> <ul style="list-style-type: none"> (delocalised) electrons can move/carry charge (1) aluminium has low density/light (weight) (1) aluminium is ductile/can be drawn into wires (1) aluminium forms an inert/oxide layer (1) 	<p>Allow good conductor of electricity</p> <p>Ignore malleable, strong, heat resistant, high melting temperature.</p>	(2)



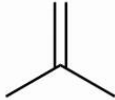
Question Number	Answer	Additional Guidance	Mark
14(d)(i)	$2 \text{ Al} + 3 \text{ H}_2\text{O} \rightarrow \text{Al}_2\text{O}_3 + 3 \text{ H}_2$	<p>Allow multiples</p> <p>Ignore state symbols even if incorrect</p>	(1)

Question Number	Answer	Additional Guidance	Mark
14(d)(ii)	<p>An answer that makes reference to two of the following:</p> <ul style="list-style-type: none"> reduces greenhouse gas emissions / carbon dioxide and which affects climate change / global warming (1) the production of hydrogen is portable (1) fossil fuels are non-renewable (unlike water) (1) aluminium can be recycled (1) 	<p>Allow reduces sulfur dioxide emissions and which reduces acid rain</p> <p>Do not award references to ozone depletion, carbon neutral</p> <p>Ignore renewable</p> <p>Ignore landfill, atom economy, references to cost</p>	(2)

(Total for Question 14 = 13 marks)

Question Number	Answer	Additional Guidance	Mark
15(a)	<p>An answer that makes reference to:</p> <ul style="list-style-type: none"> the mixture is boiled/ vapourised/ (fractionally) distilled (1) distillate condensing at a suitable temperature (range) is collected (1) 	<p>Do not award cracking/reforming</p> <p>Allow correct references to collecting fractions at different heights/temperatures (in the fractionating column)</p> <p>Allow simple descriptions of fractional distillation e.g. separated by boiling point/ temperature</p> <p>Do not award references to molecular mass or to melting temperature.</p>	(2)

Question Number	Answer	Additional Guidance	Mark
15(b)(i)	$(\text{C}_{18}\text{H}_{38} \rightarrow 2\text{C}_4\text{H}_8 +) \text{C}_{10}\text{H}_{22}$		(1)

Question Number	Answer	Additional Guidance	Mark
15(b)(ii)	<ul style="list-style-type: none"> cis and trans skeletal formulae (1) 2-methylpropene (1) 	 <p>and</p>   <p>Allow 1 mark for three correct non-skeletal formulae</p> <p>Ignore bond lengths and angles</p>	(2)

Question Number	Answer			Additional Guidance	Mark
15(b)(iii)				8 correct points scores 4 marks 6 or 7 correct points scores 3 marks 4 or 5 correct points scores 2 marks 2 or 3 correct points scores 1 mark	(4)
	Product	Name	Structural formula		
	1	1,2-dichlorobutane	CH ₃ CH ₂ CHClCH ₂ Cl		
	2	butane	CH ₃ CH ₂ CH ₂ CH ₃		
	3	butan(e)-1,2-diol	CH ₃ CH ₂ CHOHCH ₂ OH		
	4	butan(e)-2-ol	CH ₃ CH ₂ CHOHCH ₃		
				Allow displayed / skeletal formulae If two types of formula are shown both must be correct to score the point. Ignore punctuation errors , misplaced numbers e.g. 1,2-butan diol and connectivity of pendant -OH group. Penalise omission of “an” in 3 and 4 once only Penalise wrong number of carbon atoms once only Award 1 point for butan-1-ol and correct formula in Product 4	

Question Number	Answer	Additional Guidance	Mark
15(c)	<ul style="list-style-type: none"> correct repeat unit (1) two repeat units and continuation bonds (1) <p>ALLOW C₂H₅, CH₂CH₃ as pendant group</p>	<div style="text-align: center;"> $\begin{array}{cccc} \text{H} & \text{H} & \text{H} & \text{H} \\ & & & \\ \text{--- C ---} & \text{C ---} & \text{C ---} & \text{C ---} \\ & & & \\ \text{H} & \text{H-C-H} & \text{H} & \text{H-C-H} \\ & & & \\ & \text{H-C-H} & & \text{H-C-H} \\ & & & \\ & \text{H} & & \text{H} \end{array}$ </div> <p>Ignore brackets and n Allow ethyl groups on C2 and C3 or C1 and C4 M2 depends on M1 or near miss e.g. attachment of pendant group or use of alternative 4-carbon monomer alkene producing a valid polymer i.e. poly(but-2-ene)/poly(methylpropene). Do not award a dimer</p>	(2)

Question Number	Answer	Additional Guidance	Mark
15(d)	<ul style="list-style-type: none"> energy is produced /can be used to generate electricity or heat locally <p>Or</p> <p>prevents polymers going to landfill/storage/taking up space (1)</p> <ul style="list-style-type: none"> toxic/harmful/corrosive gases/substances may be produced <p>Or</p> <p>particulates/soot may be produced (1)</p>	<p>Allow production of hydrogen</p> <p>Ignore non-biodegradable, non-renewable, reduces polymer waste/pollution</p> <p>a named gas e.g. sulfur dioxide, hydrogen cyanide, dioxin without qualification is insufficient</p> <p>Do not award references to climate change</p>	(2)

Question Number	Answer	Additional Guidance	Mark
15(e)(i)	<ul style="list-style-type: none"> • volume CO₂ produced • volume of oxygen used • total volume of gas remaining <p>Alternative method</p> <ul style="list-style-type: none"> • moles CO₂ produced • moles oxygen remaining • total volume remaining 	<p>Example of calculation:</p> <p>4 x 35 = 140 (cm³)</p> <p>6.5 x 35 = 227.5/228 (cm³)</p> <p>300-227.5 + 140 (cm³) =212.5/213 (cm³)</p> <p>Alternative method</p> <p>35 / 24000 = 1.4583 x 10⁻³ / 1.458 x 10⁻³/1.46 x 10⁻³ 1.4583 x 10⁻³ x 4 = 5.8333 x 10⁻³ / 5.83 x 10⁻³ or 5.84 x 10⁻³ if rounded previously</p> <p>300/24000 = 1.25 x 10⁻² (1.46 x 10⁻³) x 6.5 = 9.49 x 10⁻³ moles (1.25 x 10⁻²) - (9.49 x 10⁻³) = 3.01 x 10⁻³ (mol)</p> <p>[(5.83 x 10⁻³) + (3.01 x 10⁻³)] x 24000 = 212.16/212 (cm³) Allow TE throughout. Correct answer with no working scores 3 marks IGNORE SF except 1 SF</p>	(3)

Question Number	Answer	Additional Guidance	Mark
15(e)(ii)	<ul style="list-style-type: none"> • carbon monoxide may be produced (incomplete combustion may occur) (1) • which is toxic/combines(irreversibly) with haemoglobin/ (1) 	<p>Do not award particulates</p> <p>M2 depends on clear link to gas produced by burning butane Ignore references to flammability of butane/global warming/greenhouse gases</p> <p>If no other mark awarded allow 1 mark for carbon dioxide causes suffocation.</p>	(2)

(Total for Question 15 = 18 marks)

(Total for Section B = 60 marks)

(Total for Paper = 80 marks)