



Mark Scheme (Results)

Summer 2019

Pearson International Advanced Subsidiary Level
In Chemistry (WCH12) Paper 01 Energetics,
Group Chemistry, Halogenoalkanes and
Alcohols

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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.
- Mark schemes will indicate within the table where, and which strands of QWC, are being assessed. The strands are as follows:
 - i) ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear
 - ii) select and use a form and style of writing appropriate to purpose and to complex subject matter
 - iii) organise information clearly and coherently, using specialist vocabulary when appropriate.

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 (Multiple Choice)

Question number	Answer	Mark
1	<p>The only correct answer is B (pressure)</p> <p><i>A is not correct because concentration of the acid does affect the rate of reaction</i></p> <p><i>C is not correct because surface area of the solid does affect the rate of reaction</i></p> <p><i>D is not correct because temperature does affect the rate of reaction</i></p>	(1)

Question number	Answer	Mark
2	<p>The only correct answer is D (64)</p> <p><i>A is not correct because it assumes the relationship between temperature and rate is linear</i></p> <p><i>B is not correct because it suggests a rate increase of 6×2</i></p> <p><i>C is not correct because it suggests a rate increase of 6^2 instead of 2^6</i></p>	(1)

Question number	Answer	Mark
3	<p data-bbox="327 313 716 342">The only correct answer is A</p> <div data-bbox="772 362 1310 613" style="text-align: center;"> </div> <p data-bbox="327 638 1528 667">B is not correct because it shows the concentration of both reactants and products decreasing</p> <p data-bbox="327 711 1451 740">C is not correct because both concentration of reactants and products are still changing</p> <p data-bbox="327 784 1241 813">D is not correct because concentrations of P and Q remain unchanged</p>	(1)

Question number	Answer	Mark
4	<p data-bbox="327 941 1129 971">The only correct answer is D $(2\text{NOCl}(\text{g}) \rightleftharpoons 2\text{NO}(\text{g}) + \text{Cl}_2(\text{g}))$</p> <p data-bbox="327 1015 1388 1044">A is not correct because the equilibrium will move to the left hand side (more molecules)</p> <p data-bbox="327 1088 1608 1117">B is not correct because the equilibrium will not change as both sides have the same number of molecules</p> <p data-bbox="327 1161 1388 1190">C is not correct because the equilibrium will move to the left hand side (more molecules)</p>	(1)

Question number	Answer	Mark
5	<p>The only correct answer is C (hydrogen chloride is formed in the reaction)</p> <p><i>A is not correct because chlorine does not increase oxidation state when HCl (misty fumes) forms</i></p> <p><i>B is not correct because sulfur does not increase oxidation state when HCl (misty fumes) forms</i></p> <p><i>D is not correct because chlorine will not be evident as misty fumes and does not form in the reaction</i></p>	(1)

Question number	Answer	Mark
6	<p>The only correct answer is C (+6)</p> <p><i>A is not correct because the oxidation number of S in a compound is not always -2</i></p> <p><i>B is not correct because this is the value for the SO_3^{2-} ion</i></p> <p><i>D is not correct because the sum of all the oxidation states should be equal to the charge on the ion, not 0</i></p>	(1)

Question number	Answer	Mark
7	<p>The only correct answer is B ($6\text{NaOH} + 3\text{Br}_2 \rightarrow 5\text{NaBr} + \text{NaBrO}_3 + 3\text{H}_2\text{O}$)</p> <p><i>A is not correct because it is a neutralisation reaction</i></p> <p><i>C is not correct because only Al is oxidised and only H is reduced</i></p> <p><i>D is not correct because no oxidation numbers change</i></p>	(1)

Question number	Answer	Mark
8	<p>The only correct answer is B (BaSO₄)</p> <p><i>A is not correct because solubility of sulfates decreases down Group 2 and Ca is above Ba</i></p> <p><i>C is not correct because Group 1 sulfates are soluble</i></p> <p><i>D is not correct because Group 1 sulfates are soluble</i></p>	(1)

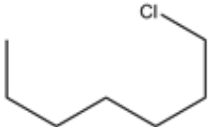
Question number	Answer	Mark
9	<p>The only correct answer is B (-75 kJ mol⁻¹)</p> <p><i>A is not correct because the 2 equations have been added together</i></p> <p><i>C is not correct because the second equation has been subtracted from the first equation</i></p> <p><i>D is not correct because both equations have been reversed and added together</i></p>	(1)

Question number	Answer	Mark
10	<p>The only correct answer is B (-122)</p> <p><i>A is not correct because it is the sum of formation of all product and reactant bonds</i></p> <p><i>C is not correct because the energy to break the bonds is less than the energy released when the new bonds form</i></p> <p><i>D is not correct because it is the sum of breaking all product and reactant bonds</i></p>	(1)

Question number	Answer	Mark
11	<p>The only correct answer is C ($\frac{1}{2}\text{Br}_2(\text{l}) \rightarrow \text{Br}(\text{g})$)</p> <p><i>A is not correct because 2 moles of Br atoms form and Br₂ is in gaseous state</i></p> <p><i>B is not correct because 2 moles of Br atoms form</i></p> <p><i>D is not correct because Br₂ is in gaseous state</i></p>	(1)

Question number	Answer	Mark
12	<p>The only correct answer is A (an increase of 6.0°C)</p> <p><i>B is not correct because neutralisation reactions are exothermic, so temperature will rise not fall</i></p> <p><i>C is not correct because the total volume of solution is 100 cm³, not 50 cm³</i></p> <p><i>D is not correct because neutralisation reactions are exothermic, so temperature will rise not fall and because the total volume of solution is 100 cm³, not 50 cm³</i></p>	(1)

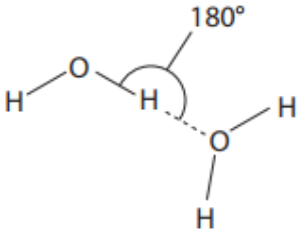
Question number	Answer	Mark
13	<p>The only correct answer is A (NH_4^+)</p> <p><i>B is not correct because the carbon has a lone pair of electrons</i></p> <p><i>C is not correct because the oxygen has a lone pair of electrons</i></p> <p><i>D is not correct because the nitrogen has a lone pair of electrons</i></p>	(1)

Question number	Answer	Mark
14	<div style="text-align: center;">  </div> <p>The only correct answer is A</p> <p><i>B is not correct because it is an isomer with 1 branch, so lower London forces</i></p> <p><i>C is not correct because it is an isomer with 2 branches, so lower London forces</i></p> <p><i>D is not correct because it is an isomer with 3 branches, so lower London forces</i></p>	(1)

Question number	Answer	Mark
15(a)	<p>The only correct answer is C (strontium bromide)</p> <p><i>A is not correct because the chloride will give a white precipitate</i></p> <p><i>B is not correct because the chloride will give a white precipitate</i></p> <p><i>D is not correct because the barium will give a green flame</i></p>	(1)

Question number	Answer	Mark
15(b)	<p>The only correct answer is D (red light is emitted as electrons return to lower energy levels)</p> <p><i>A is not correct because the electrons absorb heat as they are promoted</i></p> <p><i>B is not correct because the electrons emit light when they return to ground state</i></p> <p><i>C is not correct because light energy is emitted when the electrons return to the ground state</i></p>	(1)

Question number	Answer	Mark
16(a)	<p>The only correct answer is C (H-H bond enthalpy is greater than Si-H bond enthalpy)</p> <p><i>A is not correct because hydrogen bonding does explain why ice has a lower density than water</i></p> <p><i>B is not correct because hydrogen bonding does explain why HF has a higher boiling temperature than HCl</i></p> <p><i>D is not correct because hydrogen bonding does explain why alcohols are less volatile than similar alkanes</i></p>	(1)

Question number	Answer	Mark
16(b)	<p>The only correct answer is A</p>  <p><i>B is not correct because the 2 water molecules do not form a hydrogen bond between two hydrogen atoms</i></p> <p><i>C is not correct because the hydrogen bond angle is not 104.5°</i></p> <p><i>D is not correct because the angle between 2 water molecules should be 180° and water molecules should not have a bond angle of 180°</i></p>	(1)

Question number	Answer	Mark
17	<p>The only correct answer is B (d ÷ a)</p> <p><i>A is not correct because it is not a gradient of a tangent and is inverse of the rate</i></p> <p><i>C is not correct because it is the average rate</i></p> <p><i>D is not correct because it is the initial rate</i></p>	(1)

Question number	Answer	Mark
18	<p>The only correct answer is D (CH₃CH₂COOH)</p> <p><i>A is not correct because it will not have a major peak at m/z = 57</i></p> <p><i>B is not correct because it will not have a major peak at m/z = 57</i></p> <p><i>C is not correct because it will not have a major peak at m/z = 57</i></p>	(1)

Total for Section A = 20 marks

Section B

Question Number	Answer	Additional guidance	Mark
19(a)(i)	<ul style="list-style-type: none"> • $2\text{I}^- \rightarrow \text{I}_2 + 2\text{e}^{(-)}$ (1) • $2\text{H}^+ + 2\text{e}^- + \text{H}_2\text{O}_2 \rightarrow 2\text{H}_2\text{O}$ (1) 	<p>Allow $2\text{I}^- - 2\text{e}^{(-)} \rightarrow \text{I}_2$</p> <p>Ignore state symbols, even if incorrect</p> <p>Allow multiples</p> <p>Allow equations in either order</p>	(2)

Question Number	Answer	Additional guidance	Mark
19(a)(ii)	$2\text{I}^- + 2\text{H}^+ + \text{H}_2\text{O}_2 \rightarrow \text{I}_2 + 2\text{H}_2\text{O}$ OR $2\text{HI} + \text{H}_2\text{O}_2 \rightarrow \text{I}_2 + 2\text{H}_2\text{O}$	<p>Ignore state symbols, even if incorrect</p> <p>Allow multiples</p> <p>No TE from (a)(i)</p> <p>Do not award uncancelled electrons</p>	(1)

Question Number	Answer	Additional guidance	Mark
19(b)(i)	<p>An answer that makes reference to the following points:</p> <p>(pale) yellow aqueous layer (1)</p> <p>Pink cyclohexane layer (1)</p>	<p>Do not award just 'brown' / colourless / orange</p> <p>allow light brown / pale brown / yellow-brown / straw</p> <p>Allow purple / violet</p> <p>Do not award red / grey</p>	(2)

Question Number	Answer	Additional guidance	Mark
19(b)(ii)	<p>An explanation that makes reference to the following points:</p> <p>Cyclohexane and iodine form London forces (between molecules) (1)</p> <p>Hydrogen bonds between water molecules are stronger than London forces (between iodine and water molecules so less soluble in aqueous layer) (1)</p>	<p>Allow 'van der Waals' / dispersion forces / instantaneous dipole - induced dipole forces</p> <p>Allow 'Hydrogen bonds in water are strong'</p> <p>Allow one mark for answers that compare type of attraction without any reference to magnitude or answers based solely on polarity</p> <p>e.g. Just 'iodine forms London forces with cyclohexane but cannot form hydrogen bonds with water' scores 1 mark</p> <p>'iodine and cyclohexane are non-polar, but water is polar' scores 1</p> <p>e.g. 'Intermolecular forces formed by iodine and water are weaker than intermolecular forces in water' scores 1</p>	(2)

Question Number	Answer	Additional guidance	Mark
19(c)	(Anhydrous) sodium sulfate / Na_2SO_4 / magnesium sulfate / MgSO_4 / calcium chloride / CaCl_2 / calcium sulfate / CaSO_4 / calcium oxide / CaO	Allow silica gel Do not award concentrated sulfuric acid / phosphoric acid Do not award CuSO_4 / CaCO_3	(1)

(Total for Question 19 = 8 marks)

Question Number	Answer	Additional guidance	Mark
20(a)(i)	<ul style="list-style-type: none"><li data-bbox="394 347 1226 412">magnesium nitrate decomposes / breaks down (when heated with a Bunsen burner)	<p data-bbox="1287 347 1713 380">Ignore references to evaporation</p> <p data-bbox="1287 423 1719 526">Do not award 'reacts with oxygen' Do not award just the idea that magnesium nitrate reacts</p> <p data-bbox="1287 570 1793 634">Ignore products of decomposition even if incorrect</p> <p data-bbox="1287 678 1730 748">Ignore 'spitting' / any references to removing water too quickly</p>	(1)

Question Number	Answer	Additional guidance	Mark
20(a)(ii)	<ul style="list-style-type: none"> • calculate mass of water removed (1) • calculates moles of water removed (1) • calculates moles of anhydrous magnesium nitrate (1) • deduces x (1) <p style="text-align: center;">OR</p> <ul style="list-style-type: none"> • calculates moles of anhydrous magnesium nitrate (1) • Calculates Mr of hydrated salt (1) • Writes expression to find x in terms of mass and M (1) • deduces x (1) 	<p>Example of calculation $5.12 - 2.97 = 2.15 \text{ g}$</p> <p>$2.15 / 18 = 0.11944 \text{ (mol)}$ M1 could be subsumed in M2</p> <p>$2.97/148.3 = 0.0200 \text{ (mol)}$</p> <p>$0.11944:0.0200 = 6:1$ so $x = 6$ (must be integer)</p> <p>$2.97/148.3 = 0.0200 \text{ (mol)}$</p> <p>$5.12/0.0200 = 256$</p> <p>$148.3 + 18x = 256$</p> <p>$x = 6$ (must be integer)</p> <p>Allow TE at each step</p> <p>Correct answer with no working scores M4 only</p> <p>Ignore SF apart from M4, which must be 1SF</p>	(4)

Question Number	Answer	Additional guidance	Mark
20(b)(i)	<p>An explanation that makes reference to the following points:</p> <ul style="list-style-type: none"> • large(r) amount of energy required to break ionic bonds (in lattice / MgCO_3 / solid) (1) • small(er) amount of energy released during hydration (of ions) / when ions form bonds to water (1) <p>OR</p> <p>Lattice energy is more exothermic (1)</p> <p>than the hydration enthalpies (1)</p>	<p>Do not award molecules / atoms / London forces</p> <p>Ignore references to H bonds</p> <p>If no other mark is awarded allow 1 for 'lattice energy is greater than hydration enthalpy'</p>	(2)

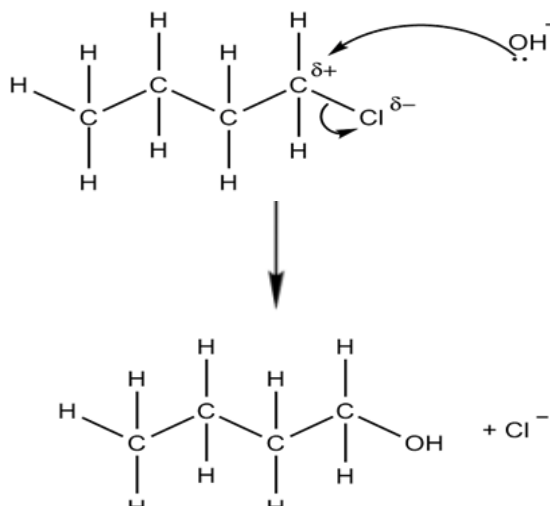
Question Number	Answer	Additional guidance	Mark
20(b)(ii)	<ul style="list-style-type: none"> <li data-bbox="415 386 1171 418">• application of Hess's Law (1) <li data-bbox="415 459 1171 492">• calculation of $\Delta_f H^\ominus$ (1) 	<p data-bbox="1287 310 1587 342">Example of calculation:</p> <p data-bbox="1287 383 1545 415">+(-394 -602) + 1096</p> <p data-bbox="1287 456 1499 488">(+) 100 (kJ mol⁻¹)</p> <p data-bbox="1287 529 1814 602">Correct answer with no working scores 2 marks</p> <p data-bbox="1287 643 1667 675">- 100 (kJ mol⁻¹) scores 1 mark</p> <p data-bbox="1287 683 1682 716">(+) 702 (kJ mol⁻¹) scores 1 mark</p> <p data-bbox="1287 724 1682 756">(+) 494 (kJ mol⁻¹) scores 1 mark</p> <p data-bbox="1287 764 1682 797">- 2092 (kJ mol⁻¹) scores 1 mark</p> <p data-bbox="1287 805 1698 837">(+) 2092 (kJ mol⁻¹) scores 1 mark</p> <p data-bbox="1287 878 1661 911">Ignore units even if incorrect</p>	(2)

Question Number	Answer	Additional guidance	Mark
20(b)(iii)	<p>An explanation that makes reference to the following points</p> <ul style="list-style-type: none"> • Group 2 carbonates increase in (thermal) stability as you go down the group (1) • size of the (metal) ion increases / charge density (of ion) decreases (1) • so metal ion is less polarising <p>or</p> <p>(electron cloud of) anion less distorted (1)</p> <ul style="list-style-type: none"> • so weakens (covalent) bonds in carbonate ion less / more energy needed to break (covalent) bonds in carbonate (1) 	<p>Accept reverse argument</p> <p>Each marking point is independent</p> <p>Ignore 'atomic radius'</p> <p>Allow C-O or C=O as alternative for 'bonds in carbonate'</p>	(4)

(Total for Question 20 = 13 marks)

Question Number	Answer	Additional guidance	Mark
21(a)(i)	<ul style="list-style-type: none"> water / H₂O / aqueous 	Do not award just ethanol / alcohol But allow 'water and ethanol'	(1)

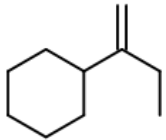
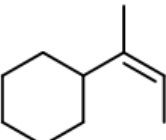
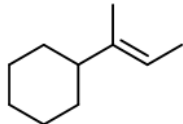
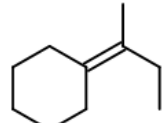
Question Number	Answer	Additional guidance	Mark
21(a)(ii)	<ul style="list-style-type: none"> correct mechanism name and type 	Nucleophilic substitution Allow nucleophile for nucleophilic Ignore S _N 2 or S _N 1 Ignore hydrolysis	(1)

Question Number	Answer	Additional guidance	Mark
21(a)(iii)	<p>A mechanism that shows:</p> <ul style="list-style-type: none"> • dipole on C-Cl bond and arrow from bond to Cl or just beyond (1) • arrow from lone pair on OH⁻ ion to carbon (1) • both products (1) 	<p>Ignore S_N2 transition state Do not award M2 if covalent bond in KOH</p> <p>Allow KCl as a product if KOH or K⁺ is shown on LHS</p> <p>Allow skeletal formulae / C₃H₇CH₂Cl</p> <p>Penalise use of half arrows once only in M1 and M2</p>	(3)

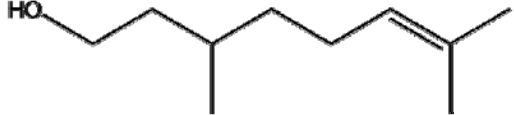
Question Number	Answer	Additional guidance	Mark
21 (b)	<ul style="list-style-type: none"> <li data-bbox="352 380 1213 412">• moles of alcohol formed (1) <li data-bbox="352 493 1213 526">• moles of 1-chlorobutane required (1) <li data-bbox="352 607 1213 639">• mass of 1-chlorobutane required (1) <li data-bbox="352 721 1213 753">• volume of 1-chlorobutane required, to 2 or 3SF (1) 	<p data-bbox="1346 310 1640 337"><u>Example of calculation</u></p> <p data-bbox="1346 380 1688 412">12.1 / 74.0 = 0.16351 (mol)</p> <p data-bbox="1346 493 1787 526">(0.16351/64) x 100 = 0.25549 (mol)</p> <p data-bbox="1346 607 1688 639">0.25549 x 92.5 = 23.633 (g)</p> <p data-bbox="1346 721 1717 786">23.633 / 0.886 = 26.674 = 26.7 / 27 (cm³)</p> <p data-bbox="1346 834 1871 899">Correct answer with no working scores 4 marks</p> <p data-bbox="1346 948 1619 980">Allow TE at each step</p> <p data-bbox="1346 1029 1709 1062">Ignore rounding in steps 1-3</p> <p data-bbox="1346 1110 1772 1143">Ignore SF except 1 SF in steps 1-3</p> <p data-bbox="1346 1192 1814 1224">Units, if given, must be correct in M4</p>	(4)

(Total for Question 21 = 9 marks)

Question Number	Answer	Additional guidance	Mark
22 (a)	<p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> • add PCl_5 / phosphorus(V) chloride /phosphorus pentachloride (1) • misty fumes evolved (that turn damp blue litmus red / form white smoke with ammonia) (1) <p>OR</p> <ul style="list-style-type: none"> • Add sodium / Na (1) • Effervescence / bubbles seen / fizzing (1) <p>OR</p> <ul style="list-style-type: none"> • Add Lucas' Reagent (1) • Solution turns cloudy immediately / quickly (1) 	<p>M2 dependent on correct reagent seen in M1.</p> <p>Allow PCl_3</p> <p>Allow steamy fumes / white fumes</p> <p>Do not award white smoke unless in conjunction with exposure of fumes to ammonia</p> <p>Ignore gas given off / hydrogen given off</p> <p>Do not award heat with acidified dichromate(VI) ions</p>	(2)

Question Number	Answer	Additional guidance	Mark
22 (b)(i)	<div style="display: flex; align-items: center; justify-content: center; margin-bottom: 20px;">  <div style="margin-left: 20px;">(1)</div> </div> <div style="display: flex; align-items: center; justify-content: center; margin-bottom: 20px;">  <div style="margin-left: 20px;">(1)</div> </div> <div style="display: flex; align-items: center; justify-content: center; margin-bottom: 20px;">  <div style="margin-left: 20px;">(1)</div> </div> <div style="display: flex; align-items: center; justify-content: center;">  <div style="margin-left: 20px;">(1)</div> </div>	Allow any unambiguous type of structure	(4)

Question Number	Answer	Additional guidance	Mark
22 (b)(ii)	<p>A description that makes reference to any two from the four following points:</p> <ul style="list-style-type: none"> • Peak at 3750 – 3200 (cm⁻¹) due to O-H bond present in reactant / absent in product (1) • Peak at 1000-1300 (cm⁻¹) due to C-O bond present in reactant / absent in product (1) • Peak at 1669 – 1645 (cm⁻¹) due to C=C bond present in product / absent in reactant (1) • Peak at 3095 – 3010 (cm⁻¹) due to C-H bond present in alkene in product / absent in reactant (1) 	<p>Allow two peaks quoted or two bonds for one mark</p> <p>Allow any wavenumber or range of wavenumbers within the allowable range.</p>	(2)

Question Number	Answer	Additional guidance	Mark
22 (c)	<ul style="list-style-type: none"> <li data-bbox="447 313 1213 386">• Longest chain has eight carbon atoms, with terminal OH group (1) <li data-bbox="447 423 1167 456">• rest of structure correct (1) 	 <p data-bbox="1287 435 1791 500">Accept structural , skeletal or displayed formulae</p> <p data-bbox="1287 545 1709 578">Ignore connectivity except O-H-C</p> <p data-bbox="1287 623 1745 727">Allow 1 mark for correct displayed formulae with missing hydrocarbon hydrogens</p> <p data-bbox="1287 773 1808 837">Allow 1 mark for correct structure of 2,6-dimethylhept-5-en-1-ol</p>	(2)

(Total for Question 22 = 10 marks)

Total for Section B = 40 marks

Section C

Question Number	Answer	Additional guidance	Mark
23 (a)	$\text{CH}_3\text{CH}_2\text{CH}_2\text{OH} + 2[\text{O}] \rightarrow \text{CH}_3\text{CH}_2\text{COOH} + \text{H}_2\text{O}$	Ignore state symbols even if incorrect Allow multiples Allow 2 correct equations via aldehyde Allow molecular formulae Ignore reagents above the arrow	(1)

Question Number	Acceptable Answer	Additional Guidance	Mark																
*23 (b)	<p>This question assesses the student's ability to show a coherent and logically structured answer with linkages and fully sustained reasoning.</p> <p>Marks are awarded for indicative content and for how the answer is structured and shows lines of reasoning.</p> <p>The following table shows how the marks should be awarded for indicative content.</p> <table border="1" data-bbox="438 643 1224 948"> <thead> <tr> <th data-bbox="438 643 831 753">Number of indicative marking points seen in answer</th> <th data-bbox="831 643 1224 753">Number of marks awarded for indicative marking points</th> </tr> </thead> <tbody> <tr> <td data-bbox="438 753 831 792">6</td> <td data-bbox="831 753 1224 792">4</td> </tr> <tr> <td data-bbox="438 792 831 831">5-4</td> <td data-bbox="831 792 1224 831">3</td> </tr> <tr> <td data-bbox="438 831 831 870">3-2</td> <td data-bbox="831 831 1224 870">2</td> </tr> <tr> <td data-bbox="438 870 831 909">1</td> <td data-bbox="831 870 1224 909">1</td> </tr> <tr> <td data-bbox="438 909 831 948">0</td> <td data-bbox="831 909 1224 948">0</td> </tr> </tbody> </table> <p>The following table shows how the marks should be awarded for structure and lines of reasoning</p> <table border="1" data-bbox="438 1321 1262 1359"> <thead> <tr> <th data-bbox="438 1321 877 1359"></th> <th data-bbox="877 1321 1262 1359">Number of marks awarded</th> </tr> </thead> <tbody> <tr> <td data-bbox="438 1321 877 1359"></td> <td data-bbox="877 1321 1262 1359"></td> </tr> </tbody> </table>	Number of indicative marking points seen in answer	Number of marks awarded for indicative marking points	6	4	5-4	3	3-2	2	1	1	0	0		Number of marks awarded			<p>Guidance on how the mark scheme should be applied.</p> <p>The mark for indicative content should be added to the mark for lines of reasoning. For example, a response with five indicative marking points that is partially structured with some linkages and lines of reasoning scores 4 marks (3 marks for indicative content and 1 mark for partial structure and some linkages and lines of reasoning).</p> <p>If there were no linkages between the points, then the same indicative marking points would yield an overall score of 3 marks (3 marks for indicative content and no marks for linkages).</p> <p>In general it would be expected that 5 or 6 indicative points would get 2 reasoning marks, and 3 or 4 indicative points would get 1 mark for reasoning, and 0, 1 or 2 indicative points would</p>	(6)
Number of indicative marking points seen in answer	Number of marks awarded for indicative marking points																		
6	4																		
5-4	3																		
3-2	2																		
1	1																		
0	0																		
	Number of marks awarded																		

		for structure of answer and sustained lines of reasoning	<p>score zero marks for reasoning.</p> <p>If there is any incorrect chemistry, deduct mark(s) from the reasoning. If no reasoning mark(s) awarded do not deduct mark(s).</p> <p>Comment: Look for the indicative marking points first, then consider the mark for the structure of the answer and sustained line of reasoning.</p>	
Answer shows a coherent logical structure with linkages and fully sustained lines of reasoning demonstrated throughout	2			
Answer is partially structured with some linkages and lines of reasoning	1			
Answer has no linkages between points and is unstructured	0			

	<p>Indicative content</p> <ol style="list-style-type: none"> 1. The higher the concentration (of acid or $\text{Cr}_2\text{O}_7^{2-}$) the higher the rate 2. Because the collision frequency increases 3. The higher the temperature the faster the rate 4. Because more particles have an energy greater than the activation energy / more successful collisions 5. Excess / concentrated oxidising agent ensures complete oxidation 6. Heat under reflux ensures complete oxidation 	<p>I2 can be scored independent of I1</p> <p>must be linked to heating / higher temperature.</p> <p>Allow 'more effective collisions',</p> <p>Allow 'only propanoic acid is formed' / 'no propanal is formed' as alternative for 'complete oxidation' in I5 and I6</p> <p>Ignore any reference to pressure</p>	
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Question Number	Answer	Additional guidance	Mark
23(d)(ii)	<p>An answer that makes reference to two of the following points:</p> <ul style="list-style-type: none"> • First titre likely to be a rangefinder / rough titration / estimate (so done quickly) (1) • There was an air bubble (in the burette jet which fills before the titration starts) (1) • Burette rinsed with water (rather than sodium hydroxide) (1) 	<p>Allow 'not added dropwise' (near end point) / 'overshot at end point'</p> <p>Allow 'some water still in the burette after rinsing'</p> <p>Ignore pre-titration errors parallax errors water in conical flask</p> <p>Do not award lack of swirling of conical flask water in pipette</p>	(2)

Question Number	Answer	Additional guidance	Mark
23(d)(iii)	<ul style="list-style-type: none"> • calculation of average titre (1) • calculation of moles of NaOH(aq) in average titre and deduction of moles of propanoic acid in 25.0 cm³ (1) • calculation of moles of propanoic acid in 250 cm³ (1) • Evidence of correct M_r (1) • calculation of mass of propanoic acid in the sample (1) 	<p><u>Example of calculation</u></p> <p>$(22.20 + 22.10) / 2 = 22.15 \text{ cm}^3$</p> <p>$(22.15/1000) \times 0.00668 = 1.47962 \times 10^{-4} \text{ (mol)}$</p> <p>1:1 reaction so = $1.47962 \times 10^{-4} \text{ (mol)}$</p> <p>$1.47962 \times 10^{-4} \times 10 = 1.47962 \times 10^{-3} \text{ (mol)}$</p> <p>74 (g mol⁻¹)</p> <p>$1.47962 \times 10^{-3} \times 74 = 0.10949 \text{ (g)}$</p> <p>= 0.109 (g) / 0.11 (g)</p> <p>Correct answer with no working scores 5</p> <p>Final answer to 2 or 3 SF</p> <p>Allow TE at each stage</p>	(5)

Question Number	Answer	Additional guidance	Mark
23(d)(iv)	<p>calculation of mass of propanoic acid in mg (1)</p> <p>calculation of mass of propanoic acid in mg kg⁻¹ and comparison to limit (1)</p>	<p>Example of calculation</p> <p>$0.109 \times 10^3 = 109 \text{ (mg)}$</p> <p>Comment This mark may be evident in d(iii)</p> <p>$109 \times 20 = 2180 \text{ (mg kg}^{-1}\text{)}$ so within permitted range M1 is subsumed by M2</p> <p>Allow TE from (d)(iii)</p> <p>Ignore SF except 1 SF</p>	(2)

Question Number	Answer	Additional guidance	Mark
23(d)(v)	<p>An answer that makes reference to one of the following points:</p> <ul style="list-style-type: none"> • (below the limit) the food would become mouldy (too quickly) / would not stop the food decomposing / would not be an effective preservative • (or above the limit) the food tastes bad / becomes (too) acidic / becomes inedible / becomes corrosive / becomes toxic 	Ignore harmful	(1)

(Total for Question 23 = 20 marks)

Total for Section C = 20 marks

TOTAL FOR PAPER = 80 MARKS

