



## Mark Scheme (Results)

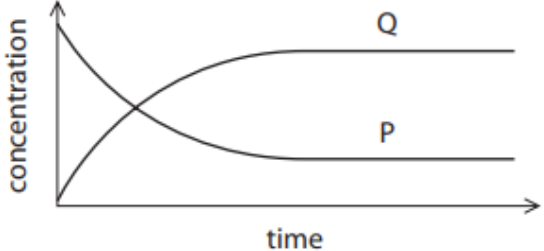
Summer 2019

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

### Section A (Multiple Choice)

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

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

Question number	Answer	Mark
3	<p>The only correct answer is A</p>  <p><i>B is not correct because it shows the concentration of both reactants and products decreasing</i></p> <p><i>C is not correct because both concentration of reactants and products are still changing</i></p> <p><i>D is not correct because concentrations of P and Q remain unchanged</i></p>	(1)

Question number	Answer	Mark
4	<p>The only correct answer is D     <math>(2\text{NOCl(g)} \rightleftharpoons 2\text{NO(g)} + \text{Cl}_2\text{(g)})</math></p> <p><i>A is not correct because the equilibrium will move to the left hand side (more molecules)</i></p> <p><i>B is not correct because the equilibrium will not change as both sides have the same number of molecules</i></p> <p><i>C is not correct because the equilibrium will move to the left hand side (more molecules)</i></p>	(1)

Question number	Answer	Mark
5	<p><b>The only correct answer is C</b> (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><b>The only correct answer is C</b> (+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 <math>\text{SO}_3^{2-}</math> 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><b>The only correct answer is B</b> (<math>6\text{NaOH} + 3\text{Br}_2 \rightarrow 5\text{NaBr} + \text{NaBrO}_3 + 3\text{H}_2\text{O}</math>)</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><b>The only correct answer is B</b> (<math>\text{BaSO}_4</math>)</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)

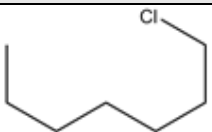
Question number	Answer	Mark
9	<p><b>The only correct answer is B</b> (<math>-75 \text{ kJ mol}^{-1}</math>)</p> <p><i>A is not correct because the 2 equations have been added together</i></p> <p><i>C is not correct because the second equation has been subtracted from the first equation</i></p> <p><i>D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

Question number	Answer	Mark
10	<p><b>The only correct answer is B</b> (<math>-122</math>)</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><b>The only correct answer is C</b>     (<math>\frac{1}{2}\text{Br}_2(\text{l}) \rightarrow \text{Br}(\text{g})</math>)</p> <p><i>A is not correct because 2 moles of Br atoms form and Br<sub>2</sub> 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 Br<sub>2</sub> is in gaseous state</i></p>	(1)

Question number	Answer	Mark
12	<p><b>The only correct answer is A</b>     (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 cm<sup>3</sup>, not 50 cm<sup>3</sup></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 cm<sup>3</sup>, not 50 cm<sup>3</sup></i></p>	(1)

Question number	Answer	Mark
13	<p><b>The only correct answer is A</b>     (<math>\text{NH}_4^+</math>)</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)

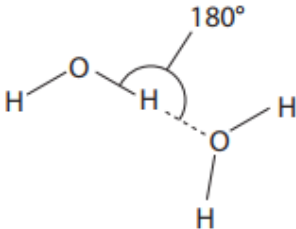
Question number	Answer	Mark
14	<div style="text-align: center;">  </div> <p>The only correct answer is A</p> <p><i>B is not correct because it is an isomer with 1 branch, so lower London forces</i></p> <p><i>C is not correct because it is an isomer with 2 branches, so lower London forces</i></p> <p><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><b>The only correct answer is D</b> (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><b>The only correct answer is C</b> (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      (<math>d \div a</math>)</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><b>The only correct answer is D</b>    (<math>\text{CH}_3\text{CH}_2\text{COOH}</math>)</p> <p><i>A is not correct because it will not have a major peak at <math>m/z = 57</math></i></p> <p><i>B is not correct because it will not have a major peak at <math>m/z = 57</math></i></p> <p><i>C is not correct because it will not have a major peak at <math>m/z = 57</math></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"> <li><math>2\text{I}^- \rightarrow \text{I}_2 + 2\text{e}^{(-)}</math> (1)</li> <li><math>2\text{H}^+ + 2\text{e}^- + \text{H}_2\text{O}_2 \rightarrow 2\text{H}_2\text{O}</math> (1)</li> </ul>	Allow $2\text{I}^- - 2\text{e}^{(-)} \rightarrow \text{I}_2$  Ignore state symbols, even if incorrect  Allow multiples  Allow equations in either order	(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  $2\text{HI} + \text{H}_2\text{O}_2 \rightarrow \text{I}_2 + 2\text{H}_2\text{O}$	Ignore state symbols, even if incorrect  Allow multiples  No TE from (a)(i)  Do not award uncanceled electrons	(1)

Question Number	Answer	Additional guidance	Mark
<b>19(b)(i)</b>	<p>An answer that makes reference to the following points:</p> <p>(pale) yellow aqueous layer <b>(1)</b></p> <p>Pink cyclohexane layer <b>(1)</b></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>	<b>(2)</b>

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 / $\text{Na}_2\text{SO}_4$ / magnesium sulfate / $\text{MgSO}_4$ / calcium chloride / $\text{CaCl}_2$ / calcium sulfate / $\text{CaSO}_4$ / calcium oxide / $\text{CaO}$	Allow silica gel  Do not award concentrated sulfuric acid / phosphoric acid  Do not award $\text{CuSO}_4$ / $\text{CaCO}_3$	(1)

(Total for Question 19 = 8 marks)

Question Number	Answer	Additional guidance	Mark
20(a)(i)	<ul style="list-style-type: none"> <li>magnesium nitrate decomposes / breaks down (when heated with a Bunsen burner)</li> </ul>	<p>Ignore references to evaporation</p> <p>Do not award 'reacts with oxygen'</p> <p>Do not award <b>just</b> the idea that magnesium nitrate reacts</p> <p>Ignore products of decomposition even if incorrect</p> <p>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"> <li>calculate mass of water removed (1)</li> <li>calculates moles of water removed (1)</li> <li>calculates moles of anhydrous magnesium nitrate (1)</li> <li>deduces x (1)</li> </ul> <p>OR</p> <ul style="list-style-type: none"> <li>calculates moles of anhydrous magnesium nitrate (1)</li> <li>Calculates Mr of hydrated salt (1)</li> <li>Writes expression to find x in terms of mass and <i>M</i> (1)</li> <li>deduces <b>x</b> (1)</li> </ul>	<p>Example of calculation  <math>5.12 - 2.97 = 2.15 \text{ g}</math></p> <p><math>2.15 / 18 = 0.11944 \text{ (mol)}</math>  M1 could be subsumed in M2</p> <p><math>2.97/148.3 = 0.0200 \text{ (mol)}</math></p> <p><math>0.11944:0.0200 = 6:1</math> so <math>x = 6</math> (must be integer)</p> <p><math>2.97/148.3 = 0.0200 \text{ (mol)}</math></p> <p><math>5.12/0.0200 = 256</math></p> <p><math>148.3 + 18x = 256</math></p> <p><math>x = 6</math> (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"> <li>large(r) amount of energy required to break <b>ionic</b> bonds (in lattice / <math>\text{MgCO}_3</math> / solid) (1)</li> <li>small(er) amount of energy released during hydration (of ions) / when ions form bonds to water (1)</li> </ul> <p><b>OR</b></p> <p>Lattice energy is <b>more exothermic</b> (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 <b>greater</b> than hydration enthalpy'</p>	(2)

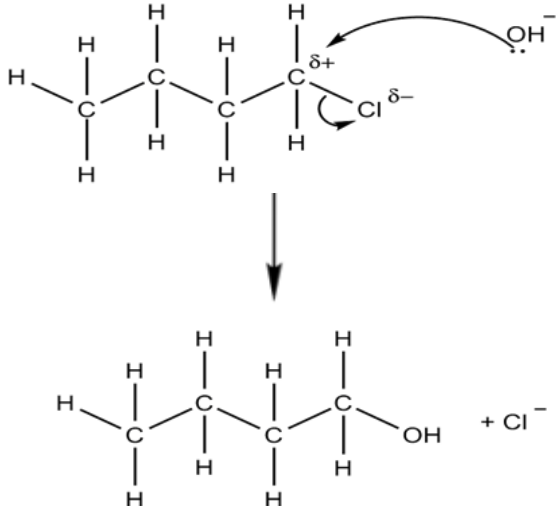
Question Number	Answer	Additional guidance	Mark
20(b)(ii)	<ul style="list-style-type: none"> <li>• application of Hess's Law (1)</li> <li>• calculation of <math>\Delta_f H^\ominus</math> (1)</li> </ul>	<p>Example of calculation:</p> <p><math>+(-394 - 602) + 1096</math></p> <p>(+) 100 (kJ mol<sup>-1</sup>)</p> <p>Correct answer with no working scores 2 marks</p> <p>- 100 (kJ mol<sup>-1</sup>) scores 1 mark          (+) 702 (kJ mol<sup>-1</sup>) scores 1 mark          (+) 494 (kJ mol<sup>-1</sup>) scores 1 mark          - 2092 (kJ mol<sup>-1</sup>) scores 1 mark          (+) 2092 (kJ mol<sup>-1</sup>) scores 1 mark</p> <p>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"> <li>Group 2 carbonates increase in (thermal) stability as you go down the group (1)</li> <li>size of the (metal) <b>ion</b> increases / charge density (of ion) decreases (1)</li> <li>so metal ion is less polarising</li> </ul> <p>or</p> <p>(electron cloud of) anion less distorted (1)</p> <ul style="list-style-type: none"> <li>so weakens (covalent) bonds in carbonate ion less / more energy needed to break (covalent) bonds in carbonate (1)</li> </ul>	<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"> <li>water / H<sub>2</sub>O / aqueous</li> </ul>	Do not award <b>just</b> ethanol / alcohol But allow 'water and ethanol'	(1)

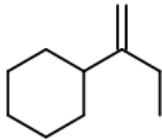
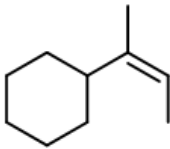
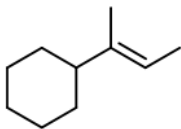
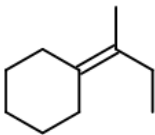
Question Number	Answer	Additional guidance	Mark
21(a)(ii)	<ul style="list-style-type: none"> <li>correct mechanism name and type</li> </ul>	Nucleophilic substitution  Allow nucleophile for nucleophilic  Ignore S <sub>N</sub> 2 or S <sub>N</sub> 1  Ignore hydrolysis	(1)

Question Number	Answer	Additional guidance	Mark
21(a)(iii)	<p>A mechanism that shows:</p> <ul style="list-style-type: none"> <li>dipole on C-Cl bond and arrow from bond to Cl or just beyond (1)</li> <li>arrow from lone pair on OH<sup>-</sup> ion to carbon (1)</li> <li>both products (1)</li> </ul> 	<p>Ignore S<sub>N</sub>2 transition state Do not award M2 if covalent bond in KOH</p> <p>Allow KCl as a product if KOH or K<sup>+</sup> is shown on LHS</p> <p>Allow skeletal formulae / C<sub>3</sub>H<sub>7</sub>CH<sub>2</sub>Cl</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>moles of alcohol formed (1)</li> <li>moles of 1-chlorobutane required (1)</li> <li>mass of 1-chlorobutane required (1)</li> <li>volume of 1-chlorobutane required, to 2 or 3SF (1)</li> </ul>	<p><u>Example of calculation</u></p> <p><math>12.1 / 74.0 = 0.16351 \text{ (mol)}</math></p> <p><math>(0.16351/64) \times 100 = 0.25549 \text{ (mol)}</math></p> <p><math>0.25549 \times 92.5 = 23.633 \text{ (g)}</math></p> <p><math>23.633 / 0.886 = 26.674</math>  <math>= 26.7 / 27 \text{ (cm}^3\text{)}</math></p> <p>Correct answer with no working scores 4 marks</p> <p>Allow TE at each step</p> <p>Ignore rounding in steps 1-3</p> <p>Ignore SF except 1 SF in steps 1-3</p> <p>Units, if given, must be correct in M4</p>	(4)

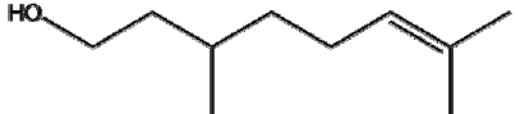
(Total for Question 21 = 9 marks)

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"> <li>add <math>\text{PCl}_5</math> / phosphorus(V) chloride /phosphorus pentachloride (1)</li> <li>misty fumes evolved (that turn damp blue litmus red / form white smoke with ammonia) (1)</li> </ul> <p>OR</p> <ul style="list-style-type: none"> <li>Add sodium / Na (1)</li> <li>Effervescence / bubbles seen / fizzing (1)</li> </ul> <p>OR</p> <ul style="list-style-type: none"> <li>Add Lucas' Reagent (1)</li> <li>Solution turns cloudy immediately / quickly (1)</li> </ul>	<p>M2 dependent on correct reagent seen in M1.</p> <p>Allow <math>\text{PCl}_3</math></p> <p>Allow steamy fumes / white fumes</p> <p>Do not award white smoke <b>unless</b> 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 data-bbox="436 310 596 448">  </div> <div data-bbox="674 467 714 500">(1)</div> <div data-bbox="432 548 600 695">  </div> <div data-bbox="693 711 735 743">(1)</div> <div data-bbox="438 813 617 940">  </div> <div data-bbox="669 946 714 979">(1)</div> <div data-bbox="443 1049 596 1183">  </div> <div data-bbox="686 1222 728 1255">(1)</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"> <li>• Peak at 3750 – 3200 (<math>\text{cm}^{-1}</math>) due to O-H bond present in reactant / absent in product (1)</li> <li>• Peak at 1000-1300 (<math>\text{cm}^{-1}</math>) due to C-O bond present in reactant / absent in product (1)</li> <li>• Peak at 1669 – 1645 (<math>\text{cm}^{-1}</math>) due to C=C bond present in product / absent in reactant (1)</li> <li>• Peak at 3095 – 3010 (<math>\text{cm}^{-1}</math>) due to <b>C-H bond</b> present in <b>alkene</b> in product / absent in reactant (1)</li> </ul>	<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>Longest chain has eight carbon atoms, with terminal OH group (1)</li> <li>rest of structure correct (1)</li> </ul>	 <p>Accept structural , skeletal or displayed formulae</p> <p>Ignore connectivity except O-H-C</p> <p>Allow 1 mark for correct displayed formulae with missing hydrocarbon hydrogens</p> <p>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	<b>(1)</b>

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><tr><th>Number of indicative marking points seen in answer</th><th>Number of marks awarded for indicative marking points</th></tr><tr><td>6</td><td>4</td></tr><tr><td>5-4</td><td>3</td></tr><tr><td>3-2</td><td>2</td></tr><tr><td>1</td><td>1</td></tr><tr><td>0</td><td>0</td></tr></table> <p>The following table shows how the marks should be awarded for structure and lines of reasoning</p> <table><tr><td></td><td>Number of marks awarded</td></tr></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><b>Indicative content</b></p> <ol style="list-style-type: none"> <li>1. The higher the concentration (of acid or <math>\text{Cr}_2\text{O}_7^{2-}</math>) the higher the rate</li> <li>2. Because the collision frequency increases</li> <li>3. The higher the temperature the faster the rate</li> <li>4. Because more particles have an energy greater than the activation energy / more successful collisions</li> <li>5. Excess / concentrated oxidising agent ensures complete oxidation</li> <li>6. Heat under reflux ensures complete oxidation</li> </ol>	<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(c)	<ul style="list-style-type: none"> <li>colour of the potassium dichromate(VI) / chromium(III) will mask the colour of the indicator</li> </ul> <p>or</p> <p>the reaction mixture will contain hydrogen ions / acid (present from the oxidising agent)</p>	<p>Ignore references to 'not a sharp colour change'</p> <p>Allow any named mineral acid</p>	(1)

Question Number	Answer	Additional guidance	Mark
23(d)(i)	<p>An answer that makes reference to the following points</p> <ul style="list-style-type: none"> <li>colourless (1)</li> </ul> <p>to</p> <ul style="list-style-type: none"> <li>(pale) pink (1)</li> </ul>	<p>Colours in the reverse order scores one</p> <p>Do not award red / purple</p>	(2)

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"> <li>First titre likely to be a rangefinder / rough titration / estimate (so done quickly) (1)</li> <li>There was an air bubble (in the burette jet which fills before the titration starts) (1)</li> <li><b>Burette</b> rinsed with water (rather than sodium hydroxide) (1)</li> </ul>	<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><b>Ignore</b> pre-titration errors parallax errors water in conical flask</p> <p><b>Do not award</b> 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"> <li>calculation of average titre (1)</li> <li>calculation of moles of NaOH(aq) in average titre and deduction of moles of propanoic acid in 25.0 cm<sup>3</sup> (1)</li> <li>calculation of moles of propanoic acid in 250 cm<sup>3</sup> (1)</li> <li>Evidence of correct <math>M_r</math> (1)</li> <li>calculation of mass of propanoic acid in the sample (1)</li> </ul>	<p><u>Example of calculation</u></p> <p><math>(22.20 + 22.10) / 2 = 22.15 \text{ cm}^3</math></p> <p><math>(22.15/1000) \times 0.00668 = 1.47962 \times 10^{-4} \text{ (mol)}</math></p> <p>1:1 reaction so = <math>1.47962 \times 10^{-4} \text{ (mol)}</math></p> <p><math>1.47962 \times 10^{-4} \times 10 = 1.47962 \times 10^{-3} \text{ (mol)}</math></p> <p>74 ( g mol<sup>-1</sup>)</p> <p><math>1.47962 \times 10^{-3} \times 74 = 0.10949 \text{ (g)}</math></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<sup>-1</sup> and comparison to limit (1)</p>	<p>Example of calculation</p> <p><math>0.109 \times 10^3 = 109 \text{ (mg)}</math></p> <p>Comment</p> <p>This mark may be evident in d(iii)</p> <p><math>109 \times 20 = 2180 \text{ (mg kg}^{-1}\text{)}</math> 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"> <li>• (below the limit) the food would become mouldy (too quickly) / would not stop the food decomposing / would not be an effective preservative</li> <li>• (or above the limit) the food tastes bad / becomes (too) acidic / becomes inedible / becomes corrosive / becomes toxic</li> </ul>	Ignore harmful	(1)

**(Total for Question 23 = 20 marks)**

**Total for Section C = 20 marks**

**TOTAL FOR PAPER = 80 MARKS**