



## Mark Scheme

Q1.

Question Number	Acceptable Answer	Additional Guidance	Mark
(i)	Reagent <ul style="list-style-type: none"> <li>(concentrated) NaOH/KOH <b>(1)</b></li> </ul> Conditions <ul style="list-style-type: none"> <li>ethanol (solvent) <u>and</u> heat/warm <b>(1)</b></li> </ul>	do not award OH <sup>-</sup> or just 'hydroxide' do not award M1 if 'acidified'  allow reflux M2 is dependent on M1 except for a near miss e.g. OH <sup>-</sup>	<b>(2)</b>
Question Number	Acceptable Answer	Additional Guidance	Mark
(ii)	<ul style="list-style-type: none"> <li>Reagent: KCN/NaCN /potassium cyanide / sodium cyanide <b>(1)</b></li> <li>Reason: increases the number of carbon atoms in the carbon chain/ length of carbon chain <b>(1)</b></li> </ul>	ignore any mention of the solvent (aq ethanol) and conditions (reflux) do not award just CN <sup>-</sup> /cyanide/HCN	<b>(2)</b>
Question Number	Acceptable Answer	Additional Guidance	Mark
(iii)	An explanation that makes reference to the following: <ul style="list-style-type: none"> <li>heating increases rate (of reaction) <b>(1)</b></li> <li>no sealed tube would result in loss of ammonia (gas)/ reactants / gas <b>(1)</b></li> </ul>	ignore reference to activation energy/ starting the reaction/ reaction is endothermic  ignore toxicity of reactants	<b>(2)</b>
Question Number	Acceptable Answer	Additional Guidance	Mark
(iv)	$\text{CH}_3 - \text{CH}_2 - \text{CH}_2 - \text{OH}$	allow displayed/structural/skeletal formula  ignore name  do not award just C <sub>3</sub> H <sub>7</sub> OH	<b>(1)</b>



Q2.

Question Number	Answer	Mark
(a)(i)	<p>The only correct answer is B</p> <p><i>A is not correct because X,Y,Z is chloro/bromo/iodo, and would be for increasing <b>rate</b> not time taken</i></p> <p><i>C is not correct because Y,X,Z is bromo/chloro/iodo, ie incorrect for rate or time taken</i></p> <p><i>D is not correct because Z,X,Y is iodo/chloro/bromo, also incorrect for either rate or time taken</i></p>	(1)

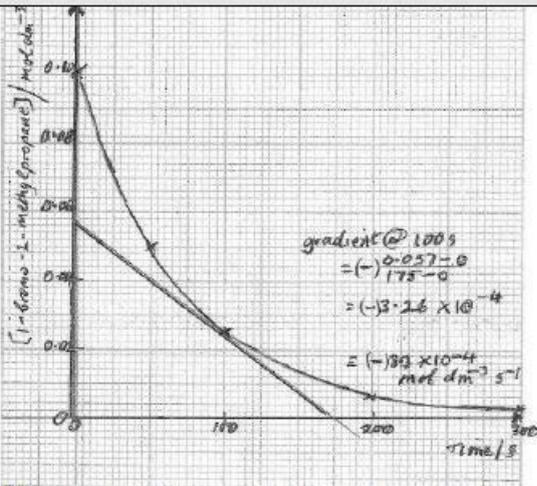
Question Number	Acceptable Answer	Additional Guidance	Mark
(a)(ii)	to increase the solubility of / dissolves the halogenoalkane / reactants / so that reactants are miscible	<p>Do not award just 'as a good solvent'</p> <p>Allow cosolvent / as a (good) solvent for both reactants</p> <p>Ignore 'stop formation of layers'</p> <p>Ignore 'to allow mixing'</p> <p>Comment Water, aqueous silver nitrate and just silver nitrate are all acceptable alternatives for the other reactant</p>	(1)

Question Number	Acceptable Answer	Additional Guidance	Mark
(a)(iii)	to allow the solutions to equilibrate / reach the same temperature /reach 50°C/reach the required temperature	<p>Do not award to keep temperature constant</p> <p>Ignore references to reaction rates</p> <p>Ignore reference to fair test</p>	(1)

Question Number	Acceptable Answer	Additional Guidance	Mark
(a)(iv)	<p>an explanation that makes reference to the following points:</p> <ul style="list-style-type: none"> <li>(the halogenoalkane is) hydrolysed by water (1)</li> <li>C- Hal bond breaks (heterolytically producing ions) (1)</li> </ul>	<p>reward recognition of reaction with water</p> <p>Do not award reaction with OH<sup>-</sup></p> <p>Comment Must be clear that the C-Hal bond is breaking. Allow statements like 'the halogen ion / halide breaks off'</p>	(2)



Question Number	Acceptable Answer	Additional Guidance	Mark
(a)(v)	$\text{Ag}^+(\text{aq}) + \text{Cl}^-(\text{aq}) \rightarrow \text{AgCl}(\text{s})$	Ignore previous workings. Mark the final equation. Do not award <b>uncancelled</b> spectator ions	(1)

Question Number	Acceptable Answer	Additional Guidance	Mark
(b)(i)	<p>Graph: both axes labelled and graph covering at least half the grid in both directions. (1)</p> <p>points plotted correctly (1)</p> <p>smooth line of best fit (1)</p>	 <p>Do not award 1-bromo-2-methylpropane without [ ] Do not award just 'concentration/mol dm<sup>-3</sup>' Allow 'concentration of 1-bromo-2-methylpropane/mol dm<sup>-3</sup>' Units required on both axes Accept / between label and mol dm<sup>-3</sup> or (mol dm<sup>-3</sup>)</p> <p>Non-linear scale on either axis loses M1 and M2 but can get M3 for a smooth curve based on their points</p> <p>Reversed axes loses M1 only Accuracy <math>\pm \frac{1}{2}</math> small square Do not award dot-to-dot lines</p>	(1)

Question Number	Acceptable Answer	Additional Guidance	Mark
(b)(ii)	<p>line drawn as tangent to curve at time 100 s. (1)</p> <p>gradient = <math>(-)</math> <math>3.3 \times 10^{-4}</math> (allow range <math>(-)</math> <math>2.5 \times 10^{-4}</math> to <math>(-)</math> <math>4.5 \times 10^{-4}</math>) (1)</p> <p><math>\text{mol dm}^{-3} \text{ s}^{-1}</math> (1)</p>	<p>ignore missing negative sign. Allow any SF except 1 Do not award answers that use only the one point at 100s Example <math>0.0250/100 = 2.5 \times 10^{-4}</math> Do not award for gradient of a straight line graph Do not award for gradient as a fraction</p> <p>Allow <math>\text{mol dm}^{-3} / \text{s}</math></p>	(3)



Question Number	Answer	Mark
(c)(i)	<p><b>The only correct answer is D</b></p> <p><b>A</b> is not correct because the <math>\text{OH}^-</math> ion is consumed, therefore not acting as a catalyst</p> <p><b>B</b> is not correct because the <math>\text{OH}^-</math> ion has negative charge and will not act as an electrophile</p> <p><b>C</b> is not correct because the <math>\text{OH}^-</math> ion does not have a single unpaired electron therefore not a free radical</p>	(1)

Question Number	Acceptable Answer	Additional Guidance	Mark
(c)(ii)	<p>correct structure of 1-bromo-2-methylpropane (1)</p> <p>dipole on C - Br bond, i.e. <math>\delta+</math> and <math>\delta-</math> (1)</p> <p>lone pair shown on <math>\text{OH}^-</math> and curly arrow from lone pair on <math>\text{OH}^-</math> to correct carbon (1)</p> <p>curly arrow from C-Br bond to Br and correct products (1)</p>	<p><math>\text{S}_{\text{N}}2</math> mechanism M1, M2 and M4 still available for <math>\text{S}_{\text{N}}1</math> mechanism</p> <p>TE for any other halogenoalkane, M2, M3 and M4 still available</p> <p>Lone pair must be located (anywhere) on the O atom of the hydroxide ion</p>	(4)

Question Number	Acceptable Answer	Mark
(c)(iii)	<p><b>The only correct answer is D</b></p> <p><b>A</b> is not correct because addition involves the joining together of two molecules to make a bigger one</p> <p><b>B</b> is not correct because elimination involves the loss of a small molecule during the reaction</p> <p><b>C</b> is not correct because there are no changes in oxidation number</p>	1



Q3.

Question Number	Acceptable Answer	Additional guidance	Mark
	<p>An answer that gives reference to the following</p> <ul style="list-style-type: none"> <li>• <b>(M1)</b> use of ethanol (as a solvent) <b>(1)</b></li> <li>• <b>(M2)</b> use of silver nitrate (solution) <b>(1)</b></li> <li>• <b>(M3)</b> equal amounts used of each halogenoalkane <b>(1)</b></li> <li>• <b>(M4)</b> measure the time taken for precipitate to form <b>(1)</b></li> <li>• <b>(M5)</b> use a water bath (to control a raised temperature) <b>(1)</b></li> </ul>	<p>Allow "alcohol"</p> <p>Do not award ammoniacal silver nitrate Ignore use of nitric acid</p> <p>Allow equal volumes/equal stated volumes</p> <p>Allow "time for cross to disappear" Do not award for a colour to form. M4 dependent on M2 or near miss.</p> <p>If hydroxide (ions) used for hydrolysis then measuring the reaction is too quick, so no M4. The solution would need to be acidified before the addition of silver nitrate if M2 is to be awarded. If hydrochloric acid is used, then only M1, M3 and M5 can be scored</p>	<b>(5)</b>



Q4.

Question Number	Acceptable Answers	Additional Guidance	Mark
(i)	<ul style="list-style-type: none"> <li>ionic equation</li> </ul>	<p>Example of equation:  <math>\text{CH}_3\text{CH}_2\text{CHBrCH}_3 + \text{OH}^- \rightarrow \text{CH}_3\text{CH}_2\text{CHOHCH}_3 + \text{Br}^-</math></p> <p>Allow  <math>\text{CH}_3\text{CH}_2\text{CHBrCH}_3 + \text{H}_2\text{O} \rightarrow \text{CH}_3\text{CH}_2\text{CHOHCH}_3 + \text{H}^+ + \text{Br}^-</math></p> <p>Allow displayed /skeletal formulae or any combination of these formulae provided the correct organic molecules are shown</p> <p>Ignore any working before the final equation, even if not crossed out</p> <p>Ignore equation with molecular formulae</p> <p>Ignore state symbols, even if incorrect</p> <p>Do not allow just an equation with uncanceled <math>\text{K}^+</math> ions</p>	(1)

Question Number	Acceptable Answers	Additional Guidance	Mark												
* (ii)	<p>This question assesses a 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" style="margin-left: 20px;"> <thead> <tr> <th>Number of indicative marking points seen in answer</th> <th>Number of marks awarded for indicative marking points</th> </tr> </thead> <tbody> <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> </tbody> </table> <p>The following table shows how the marks should be awarded for structure and lines of reasoning.</p>	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	<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, an answer 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 are no linkages between points, the same five indicative marking points would yield an overall score of 3 marks (3 marks for indicative content and no marks for linkages).</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 line of reasoning		
	Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout.	2	<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 score zero marks for reasoning.</p> <p>If there is any incorrect chemistry, deduct marks from the reasoning mark, for example:</p> <p>If a hydroxide solution is used, deduct 1 mark from reasoning mark            If colours of precipitates are incorrect, deduct 1 mark from reasoning mark</p> <p>Allow description of experiment from a labelled diagram</p>	
	Answer is partially structured with some linkages and lines of reasoning.	1		
	Answer has no linkages between points and is unstructured.	0		
	<p><b>Comment:</b>            Look for the indicative marking points first, then consider the mark for structure of answer and sustained line of reasoning</p> <p><b>Indicative content</b></p> <ul style="list-style-type: none"> <li><b>Ethanol</b> – use of ethanol as a solvent (added to each halogenoalkane / liquid in separate containers)</li> </ul>			



	<ul style="list-style-type: none"> <li>• <b>Fair test</b> – use of equal volumes/amounts / specified volumes/amounts in each tube <b>or</b> warm the tubes in a water bath / specified temperature / room temperature</li> <li>• <b>Silver nitrate</b> - silver nitrate (solution) / <math>\text{Ag}^+(\text{aq})</math> to each tube (of halogenoalkane)</li> <li>• <b>Time</b> - find the time taken for a precipitate to form</li> <li>• <b>Rate</b> - expected trend is 2-iodobutane &gt; 2-bromobutane &gt; 2-chlorobutane <b>or</b> 2-iodobutane is the fastest <u>and</u> 2-chlorobutane is the slowest</li> <li>• <b>Bond enthalpy</b> - bond enthalpy <math>\text{C-I} &lt; \text{C-Br} &lt; \text{C-Cl}</math> / decreases from <math>\text{C-Cl}</math> to <math>\text{C-I}</math> / <math>\text{C-Cl}</math> is the strongest <u>and</u> <math>\text{C-I}</math> is the weakest / <math>\text{C-X}</math> bond strength decreases down the group (of halogens)</li> </ul>	<p>Ignore nitric acid / <math>\text{HNO}_3</math></p> <p>Allow find how quickly the precipitates form</p> <p>Allow time taken for 2-iodobutane &lt; 2-bromobutane &lt; 2-chlorobutane Allow <math>\text{I}^-</math> forms first, <math>\text{Cl}^-</math> forms last Allow the halogenoalkanes get more reactive from chloro to iodo / 'down the group' Allow reverse trends</p> <p>Allow 'the bond enthalpy decreases down the group' or a comparison of bond enthalpy in 2-iodobutane and 2-chlorobutane</p> <p>Ignore references to bond length / bond polarity / electronegativity / effective nuclear charge</p>	
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Q5.

Question Number	Answer	Additional Guidance	Mark
(a)	<ul style="list-style-type: none"> <li>M1 axes labelled with units on axes, suitable uniform scale with points covering at least half the available space in both directions (1)</li> <li>M2 all points plotted correctly with straight line of best fit (1)</li> </ul>	<p>Example of graph</p> <p>Allow variables on either axis</p>	(2)

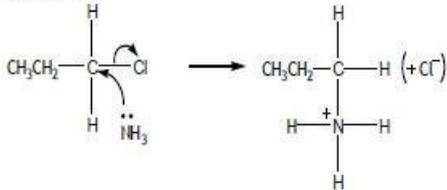
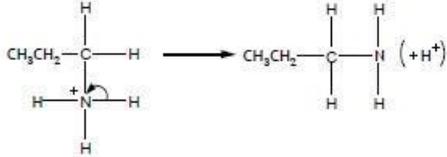
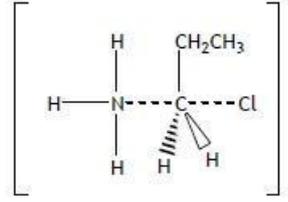
Question Number	Answer	Additional Guidance	Mark
(b)	<p>An answer that makes reference to the following points</p> <ul style="list-style-type: none"> <li>zero order with respect to hydroxide ions (1)</li> <li>The graph is a straight line so the rate of reaction is independent of the concentration of the hydroxide ions (1)</li> </ul>	M2 dependent on M1	(2)

Question Number	Answer	Additional Guidance	Mark
(c)	<p>An answer that makes reference to the following points</p> <ul style="list-style-type: none"> <li><math>S_N1</math> (1)</li> <li>as there is only one reactant in the rate determining step / as the hydroxide ions do not affect the rate (1)</li> </ul>	<p>Mark consequentially on order</p> <p>Allow TE from (b) e.g. if first order in (b) allow <math>S_N2</math></p>	(2)



Question Number	Answer	Additional Guidance	Mark
(d)	<ul style="list-style-type: none"> <li>the chloroalkane is tertiary</li> </ul>	Allow TE from first order in (b) and/or $S_N2$ in (c) e.g. if $S_N2$ in (c) allow primary  NOTE if first order wrt hydroxide ions in (b) but $S_N1$ given in (c) can score 1 mark in (d) for tertiary	(1)

Q6.

Question Number	Acceptable Answers	Additional Guidance	Mark
	<ul style="list-style-type: none"> <li>first two curly arrows and lone pair shown on nitrogen the (1)</li> <li>structure of intermediate including positive charge (1)</li> <li>third curly arrow and formation of final organic product (1)</li> </ul>	Ignore correct dipoles Allow non-displayed $NH_3^+$ for MP2 Ignore involvement of $Cl^-$ / $NH_3$ or wrong inorganic products for MP3  EITHER   Ignore depiction of transition state e.g. 	(3)



	<p>OR</p> <ul style="list-style-type: none"> <li>fission of C-Cl bond curly arrow <b>and</b> curly arrow from nitrogen in NH<sub>3</sub> with lone pair shown on N atom to correct carbocation (1)</li> <li>structure of resulting nitrogen-containing intermediate including positive charge (1)</li> <li>curly arrow resulting in breaking of an N-H bond and structure of the final organic product (1)</li> </ul>	<p>OR AWARD S<sub>N</sub>1 mechanism</p> $\text{CH}_3\text{CH}_2-\text{C}(\text{H})_2-\text{Cl} \longrightarrow \text{CH}_3\text{CH}_2-\text{C}^+(\text{H})_2 + \text{Cl}^-$ $\text{CH}_3\text{CH}_2-\text{C}^+(\text{H})_2 + \text{:NH}_3 \longrightarrow \text{CH}_3\text{CH}_2-\text{C}(\text{H})_2-\text{NH}_3^+$ $\text{CH}_3\text{CH}_2-\text{C}(\text{H})_2-\text{NH}_3^+ \longrightarrow \text{CH}_3\text{CH}_2-\text{C}(\text{H})_2-\text{N}(\text{H})_2 + \text{H}^+$	
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Q7.

Question Number	Answer			Additional Guidance	Mark
	 (1)	 (1)	 (1)	<p>Accept formulae in any order</p> <p>Award 2 if 3 correct displayed/structural formulae given</p> <p>Award 1 if 2 correct displayed/structural formulae given</p> <p>If more than 3 skeletal formulae drawn then deduct one mark for each additional formula</p> <p>2-methylpropene negates a correct formula only if four formulae given</p> <p>View any formulae given with skeletal formula as working and ignore</p> <p>Ignore names even if incorrect</p> <p>Penalise any other alkenes such as pentenes, once only</p>	(3)



Q8.

Question Number	Acceptable Answers	Additional Guidance	Mark
	<p>A synthetic pathway that includes:</p> <p><b>Conversion to alcohol</b></p> <ul style="list-style-type: none"> <li>• (aqueous ethanolic) potassium / sodium hydroxide <b>(1)</b></li> <li>• name or structure of propan-1-ol <b>(1)</b></li> </ul> <p><b>EITHER ROUTE 1</b></p> <p><b>Conversion to carboxylic acid</b></p> <ul style="list-style-type: none"> <li>• (oxidise some of the propan-1-ol using) potassium dichromate(VI) <b>and</b> (dilute) sulfuric acid <b>(1)</b></li> <li>• name or structure of propanoic acid <b>(1)</b></li> </ul> <p><b>Formation of ester</b></p> <ul style="list-style-type: none"> <li>• react propan-1-ol and propanoic acid together <b>and</b> using (concentrated) sulfuric acid (catalyst) <b>(1)</b></li> </ul> <p><b>PTO for ROUTE 2</b></p>	<p>Allow names or formulae for reagents but if both are given, both must be correct Allow correct species in unbalanced equations Allow any combination of structural, displayed or skeletal formulae for the intermediates Penalise missing H once only Ignore conditions e.g. heat / reflux</p> <p>Allow hydroxide ions / OH<sup>-</sup> Ignore concentration Do not award just ethanol / ethanolic</p> <p>Stand alone mark e.g. CH<sub>3</sub>CH<sub>2</sub>CH<sub>2</sub>OH Allow propanol if correct structure shown somewhere</p> <p>Allow acidified potassium dichromate(VI) / Cr<sub>2</sub>O<sub>7</sub><sup>2-</sup> <b>and</b> H<sup>+</sup> Allow acidified manganate(VII) Ignore concentration of acid / formation of aldehyde Do not award hydrochloric acid / HCl</p> <p>Stand alone mark e.g. CH<sub>3</sub>CH<sub>2</sub>COOH</p> <p>Stand alone mark for C<sub>3</sub> compounds Allow (concentrated) hydrochloric) acid / H<sup>+</sup> / H<sub>3</sub>O<sup>+</sup> instead of sulfuric acid Ignore concentration of acid</p> <p>Ignore incorrect structure of ester e.g. with H or O missing</p>	<b>(5)</b>



	<p><b>OR ROUTE 2</b></p> <p><b>Conversion to acyl chloride</b></p> <ul style="list-style-type: none"> <li>(oxidise some of the propan-1-ol using) potassium dichromate(VI) <b>and</b> (dilute) sulfuric acid</li> </ul> <p><b>and</b> add phosphorus(V) chloride to propanoic acid <b>(1)</b></p> <ul style="list-style-type: none"> <li>name or structure of propanoyl chloride <b>(1)</b></li> </ul> <p><b>Formation of ester</b></p> <ul style="list-style-type: none"> <li>react propan-1-ol and propanoyl chloride together <b>(1)</b></li> </ul>	<p>Allow acidified potassium dichromate(VI) / <math>\text{Cr}_2\text{O}_7^{2-}</math> <b>and</b> <math>\text{H}^+</math></p> <p>Allow acidified manganate(VII)</p> <p>Ignore concentration of acid / formation of aldehyde</p> <p>Do not award hydrochloric acid / HCl</p> <p>Stand alone mark e.g. <math>\text{CH}_3\text{CH}_2\text{COCl}</math></p> <p>Stand alone mark for <math>\text{C}_3</math> compounds</p> <p>Ignore incorrect structure of ester e.g. with H or O missing</p>	
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Q9.

Question Number	Answer	Mark
	<p>The only correct answer is C (3)</p> <p><i>A is not correct because the reaction forms but-1-ene and cis- and trans-but-2-ene</i></p> <p><i>B is not correct because the reaction forms but-1-ene and cis- and trans-but-2-ene</i></p> <p><i>D is not correct because the reaction forms but-1-ene and cis- and trans-but-2-ene</i></p>	<b>(1)</b>



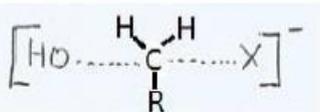
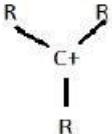
Q10.

Question Number	Acceptable Answer	Additional Guidance	Mark												
	<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="411 701 836 927"> <thead> <tr> <th data-bbox="411 701 624 801">Number of indicative marking points seen in answer</th> <th data-bbox="624 701 836 801">Number of marks awarded for indicative marking points</th> </tr> </thead> <tbody> <tr> <td data-bbox="411 801 624 831">6</td> <td data-bbox="624 801 836 831">4</td> </tr> <tr> <td data-bbox="411 831 624 860">5-4</td> <td data-bbox="624 831 836 860">3</td> </tr> <tr> <td data-bbox="411 860 624 889">3-2</td> <td data-bbox="624 860 836 889">2</td> </tr> <tr> <td data-bbox="411 889 624 918">1</td> <td data-bbox="624 889 836 918">1</td> </tr> <tr> <td data-bbox="411 918 624 947">0</td> <td data-bbox="624 918 836 947">0</td> </tr> </tbody> </table> <p>The following table shows how the marks should be awarded for structure and lines of reasoning</p>	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	<p>Guidance on how the mark scheme should be applied: The mark for indicative content should be added to the mark for lines of reasoning. For example, a response with four 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). 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 zero marks for linkages).</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>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 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). More than one indicative marking point may be made within the same comment or explanation</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> <ul style="list-style-type: none"> <li>(similarity)(both) are nucleophilic substitution <b>(1)</b></li> <li>Hydrolysis mechanism for <math>\text{RCH}_2\text{X}</math>/primary is <math>\text{S}_{\text{N}}2</math> via a transition state <b>and</b> <math>\text{R}_3\text{CX}</math>/tertiary is <math>\text{S}_{\text{N}}1</math> via a carbocation/intermediate <b>(1)</b></li> </ul>		<p>Words needed at least once provided <math>\text{S}_{\text{N}}1</math> and <math>\text{S}_{\text{N}}2</math> are given</p>



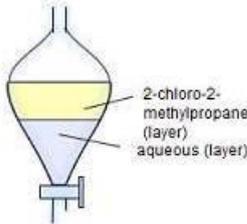
	<ul style="list-style-type: none"> <li>• <math>\text{RCH}_2\text{X}</math> and <math>\text{OH}^-</math> in the RDS (1)</li> <li>• <math>\text{R}_3\text{CX}</math> only in the RDS (1)</li> <li>• (<math>\text{RCH}_2\text{X}</math> forms a transition state with <math>\text{OH}^-</math>) diagram, including dotted lines and charge (1)</li> <li>• (<math>\text{R}_3\text{CX}</math> forms a carbocation / intermediate) diagram, including charge (1)</li> </ul>	<p>Allow "both/two species in the RDS"</p> <p>Allow correct rate equations for IP3 and IP4</p>  <p>Allow "-" either on the "OH" or the "X"</p> <p>Ignore point of attachment of OH</p> <p>Ignore dipoles within structure</p>  <p>Ignore shape</p> <p>Ignore references to comparative rates of reaction between <math>1^\circ</math> and <math>3^\circ</math> even if incorrect</p> <p>Ignore references to optical activity.</p>	
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Q11.

Question Number	Answer	Additional Guidance	Mark
	<p>An answer that makes reference to the following point:</p> <ul style="list-style-type: none"> <li>• (hydroxide ions in ethanol would give an) elimination reaction</li> </ul>	<p>Allow an alkene would form</p> <p>Ignore references to solubility in ethanol / ethanol is a (co-)solvent</p> <p>Ignore just 'causes another reaction'</p>	(1)



Q12.

Question Number	Acceptable Answers	Additional Guidance	Mark
(a)	<ul style="list-style-type: none"> <li>diagram of separating funnel (1)</li> <li>aqueous and organic layers labelled as shown (1)</li> </ul>	<p>Mark independently</p> <p>Allow any shape separating funnel with tap at the bottom (does not need to be labelled), with a narrowing top or vertical sides but do not allow a burette</p> <p>Allow stopper/bung in separating funnel</p>  <p>Allow two layers shown and just one labelled correctly</p> <p>Allow organic layer/ product for top layer / hydrochloric acid for aqueous layer</p> <p>Do not allow 'reactant' for top layer</p>	(2)

Question Number	Acceptable Answers	Additional Guidance	Mark
(b)	<ul style="list-style-type: none"> <li>to react with/ neutralise any (unreacted/ excess hydrochloric) acid (1)</li> <li>to release the carbon dioxide produced or to relieve the build-up of pressure (1)</li> </ul>	<p>Mark independently</p> <p>Allow to remove the (hydrochloric) acid</p> <p>Allow to neutralise the organic layer/ solution</p> <p>Allow to release gases</p> <p>Ignore just 'pressure builds up'</p> <p>Do not allow incorrect gases e.g. hydrogen</p>	(2)

Question Number	Answer	Mark
(c)	D (sodium sulfate)	(1)



Question Number	Acceptable Answers	Additional Guidance	Mark
(d)(i)	<p>A description that makes reference to the following points:</p> <ul style="list-style-type: none"> <li>the (bulb of the) thermometer should be opposite the opening to the condenser (1)</li> <li>the water in and out of the condenser should be reversed (1)</li> <li>put a vent after the condenser or leave a gap between the condenser and the receiver or conical flask must be open (1)</li> </ul>	<p>Allow these changes if shown on the diagram</p> <p>Allow thermometer should be higher up / above the liquid / should measure the temperature of the vapour / out of the mixture/liquid</p> <p>Allow water should enter the bottom (of the condenser)</p> <p>Ignore just 'vent' / the apparatus should not be completely sealed</p> <p>Ignore references to using a fume cupboard</p>	(3)
(d)(ii)	<ul style="list-style-type: none"> <li>50-52°C</li> </ul>	<p>Allow any range between 49 and 53°C, <u>provided</u> it includes 51°C</p> <p>Do not allow just 51°C</p>	(1)



Question Number	Acceptable Answers	Additional Guidance	Mark
(e)	<ul style="list-style-type: none"> <li>calculation of moles of alcohol used (1)</li> <li>calculation of theoretical volume of 2-chloro-2-methylpropane made or calculation of actual moles of 2-chloro-2-methylpropane or calculation of actual mass of 2-chloro-2-methylpropane (1)</li> <li>calculation of percentage yield (1)</li> </ul>	<p>Example of calculation</p> <p>mass of alcohol used = <math>15.0 \times 0.79 = 11.85</math> (g)  moles of alcohol used = <math>11.85/74.0 = 0.16014</math></p> <p>theoretical mass of chloro compound = <math>0.16014 \times 92.5 = 14.8125</math> (g)  theoretical volume = <math>14.8125/0.84 = 17.634</math> (cm<sup>3</sup>)  or  actual moles of chloro compound = <math>6.9 \times 0.84 / 92.5 = 0.062659</math>  or  actual mass of chloro compound = <math>0.062659 \times 92.5 = 5.796</math> (g)</p> <p>% yield = <math>(6.9/17.634) \times 100 = 39.1\%</math>  or  = <math>(0.062659/0.16014) \times 100 = 39.1\%</math>  or  = <math>(5.796/14.8125) \times 100 = 39.1\%</math></p> <p>TE on M1 and M2  Ignore SF except 1 SF</p>	(3)
		Correct answer without working scores 3	

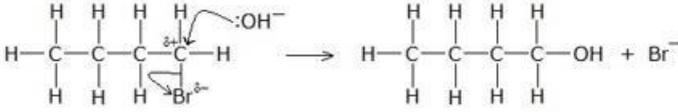
Question Number	Acceptable Answers	Additional Guidance	Mark
(f)	<ul style="list-style-type: none"> <li>curly arrow from C–O bond to O (1)</li> <li>curly arrow from lone pair on Cl<sup>-</sup> to C<sup>+</sup> (1)</li> </ul>	<p>Do not allow single-headed arrows  Do not allow additional, incorrect arrows</p>	(2)



Q13.

Question Number	Acceptable Answer	Additional Guidance	Mark
(i)	<ul style="list-style-type: none"> <li>substitution</li> </ul>	Allow hydrolysis Ignore nucleophilic Do not award electrophilic Do not award displacement	(1)

Question Number	Answer	Mark
(ii)	<p>The only correct answer is D (phosphorus(V) chloride   steamy fumes )</p> <p>A is not correct because this is the result with an acid</p> <p>B is not correct because this will identify the functional group in the starting 1-bromobutane</p> <p>C is not correct because this will identify the product of oxidation of an alcohol, not the alcohol itself</p>	(1)

Question Number	Acceptable Answer	Additional Guidance	Mark
(iii)	<ul style="list-style-type: none"> <li>curly arrow from lone pair of OH<sup>-</sup> (1)</li> <li>curly arrow from C-Br bond to, or just beyond, Br (1)</li> <li>partial charges on C and Br and Br<sup>-</sup> present as a product (1)</li> </ul>	 <p>Arrows may be shown on a transition state in an S<sub>N</sub>2 mechanism.</p> <p>Allow S<sub>N</sub>1 mechanism.            For S<sub>N</sub>1 must also have correct carbocation to score M3.</p> <p>Ignore K<sup>+</sup> on both sides or K<sup>+</sup> on the left and KBr on the right Ignore connectivity of OH group in product</p> <p>Do not award HBr as product on the right</p>	(3)



Q14.

Question Number	Answer	Additional Guidance	Mark
(i)	<p>an answer that makes reference to the following points:</p> <ul style="list-style-type: none"> <li>cream precipitate/precipitation (1)</li> <li>AgBr (1)</li> </ul>	<p>Allow off-white / very pale yellow for cream Do not allow just yellow Allow ppt / ppte / solid / crystals for precipitate</p> <p>Ignore silver bromide Ignore state (if shown)</p>	(2)

Question Number	Answer	Mark
(ii)	<p>The only correct answer is C (Z, Y, X)</p> <p><i>A is not correct because hydrolysis of primary halogenoalkane (X) is the slowest</i></p> <p><i>B is not correct because hydrolysis of primary halogenoalkane (X) is the slowest</i></p> <p><i>D is not correct because hydrolysis of primary halogenoalkane (X) is the slowest</i></p>	(1)

Q15.

Question Number	Answer	Mark
(i)	<p>The only correct answer is C (potassium cyanide)</p> <p><i>A is not correct because ammonia produces an amine</i></p> <p><i>B is not correct because there is no reaction with nitric acid</i></p> <p><i>D is not correct because silver nitrate makes silver chloride and an alcohol</i></p>	(1)



Question Number	Acceptable Answer	Additional Guidance	Mark
(ii)	<p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> <li>(Structural isomers are compounds with the same molecular formula / <math>C_4H_7N</math> (1)</li> <li>but different structural / displayed formula (1)</li> </ul>	<p>Do not award just 'formula' or just 'general formula'</p> <p>Ignore similar instead of same</p> <p>Allow different order or arrangement of atoms</p> <p>Ignore examples of isomers</p> <p>Do not award just 'different arrangement in space'</p>	(2)

Question Number	Acceptable Answer	Additional Guidance	Mark
(iii)	<p> <math display="block">  \begin{array}{c}  \text{H} \quad \text{H} \\    \quad   \\  \text{H}-\text{C}-\text{C}-\text{C}\equiv\text{N} \\    \quad   \\  \text{H} \quad \text{H}-\text{C}-\text{H} \\    \\  \text{H}  \end{array}  \quad (1)  </math> </p> <p>(2-)methyl(-1-)propan(e)nitrile (1)</p>	<p>All bonds must be shown</p> <p>Allow (2-)methylpropane(-1-)nitrile Do not award 2-cyanopropane</p> <p>M2 dependent on M1 or very near miss (such as correct structure not showing all bonds, or correct structure with H atoms not shown, or correct structure with nitrile with single or double bond)</p>	(2)



Q16.

Question Number	Answer	Additional Guidance	Mark
	<p>An explanation that makes reference to the following points:</p> <ul style="list-style-type: none"> <li>reactivity increases down Group (7) (1)</li> <li>because (C–X) bond enthalpy decreases / because (C–X) bond gets weaker down Group 7 (1)</li> </ul>	<p>Accept reverse argument</p> <p>References to halogen reactivity scores (0)</p> <p>Do not award references to ions/halides</p> <p>Do not award explanation in terms of just electronegativity or C–X dipoles</p> <p>Ignore references to atom size, shielding etc and references to intermolecular forces</p> <p>No TE on incorrect reactivity trend</p>	(2)

Q17.

Question Number	Answer	Additional Guidance	Mark
(i)	<p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> <li>potassium hydroxide / KOH (1)</li> <li>alcohol / ethanol and reflux (1)</li> </ul>	<p>Mark independently</p> <p>Allow sodium hydroxide / NaOH</p> <p>Allow just 'heat' in place of reflux</p> <p>Do not award aqueous ethanol</p>	(2)



Question Number	Answer	Additional Guidance	Mark
(ii)	<ul style="list-style-type: none"> <li>repeat unit</li> </ul>	<p><u>Example of repeat unit</u></p> $  \begin{array}{c}  \text{H} \\    \\  \text{H}-\text{C}-\text{H} \\    \\  \left[ \text{C}-\text{C} \right] \\    \quad   \\  \text{H} \quad \text{H} \\    \\  \text{H}-\text{C}-\text{H} \\    \\  \text{H}  \end{array}  $ <p>Allow non-displayed methyl groups (-CH<sub>3</sub>) Ignore connectivity of the methyl group Allow n outside brackets</p> <p>Ignore missing brackets / round brackets</p>	(1)

Question Number	Answer	Additional Guidance	Mark
(iii)	<ul style="list-style-type: none"> <li>curly arrow from double bond to H of HBr and correct structure of 2-methylpropene (1)</li> <li>curly arrow from H-Br bond to Br atom and correct dipole on HBr molecule (1)</li> <li>intermediate with + on correct Carbon and Br<sup>-</sup> (1)</li> <li>lone pair on Br<sup>-</sup> and curly arrow from lone pair to C<sup>+</sup> (1)</li> </ul>	<p><u>Example of mechanism</u></p> <p>incorrect structure of 2-methylpropene loses M1 only + on incorrect carbon loses M3 only</p>	(4)

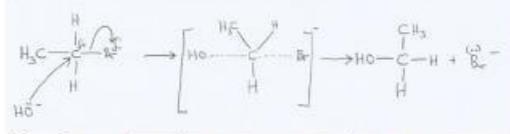


Q18.

Question Number	Acceptable Answer	Additional guidance	Mark
	<p>An explanation that makes reference to the following</p> <ul style="list-style-type: none"><li>the reaction rate is in the order 1-chlorobutane &lt; 1-bromobutane &lt; 1-iodobutane <b>(1)</b></li><li>because the C-Cl bond is stronger than the C-Br bond which is stronger than the C-I bond <b>(1)</b></li></ul>	<p>Accept reverse arguments Incorrect trend scores (0)</p> <p>Allow 'the C-Cl bond is the strongest' Ignore any reasoning given Do not award if reference is made to the bonding of the halide (ion)</p>	<b>(2)</b>



Q19.

Question Number	Answer	Additional Guidance	Mark
(i)	<ul style="list-style-type: none"> <li>• dipole on C–Br bond <b>and</b> curly arrow from C-Br bond to Br or just beyond <b>(1)</b></li> <li>• curly arrow from <b>lone pair</b> on oxygen of hydroxide ion to carbon bonded to Br <b>(1)</b></li> <li>• formula of transition state with correct charge, partial bonding <b>(1)</b></li> <li>• correct final products <b>(1)</b></li> </ul>	 <p>Dipole and curly arrow may be shown on transition state</p> <p>Allow curly arrow to C<sup>+</sup> of carbocation</p> <p>Do not award if carbocation formed as intermediate Square brackets are not essential Allow charge on Br or OH of transition state Allow longer bonds for partial bonding Ignore geometry of transition state</p> <p>Allow NaBr product if mechanism starts with NaOH</p> <p>Only penalise horizontal bond from the H of OH to C in the product e.g. OH–CH<sub>2</sub>CH<sub>3</sub></p> <p>Use of incorrect halogenoalkane loses this mark</p> <p>One mark max deducted for omission of charge on ions, including transition state</p> <p>S<sub>N</sub>1 mechanism can score M1, M2 and M4 but not M3. M2 can be awarded for curly arrow from the lone pair on the oxygen of the hydroxide ion to the C<sup>+</sup> of the carbocation intermediate</p>	<b>(4)</b>



Question Number	Answer	Additional Guidance	Mark
(ii)	Reagents: nitric acid / HNO <sub>3</sub> <b>and</b> silver nitrate (solution) / AgNO <sub>3</sub> <b>(1)</b>  (Result) cream/off-white precipitate <b>(1)</b>	Use of hydrochloric acid/HCl OR sulfuric acid/H <sub>2</sub> SO <sub>4</sub> scores <b>(0)</b> Do not award acidified silver nitrate If name and formula given then both must be correct  Allow (very) <b>pale</b> yellow Do not award just white or just yellow Ignore subsequent additions of ammonia even if incorrect Result mark dependent on reagents mark or 'near miss' such as omitting to add nitric acid, using ethanolic silver nitrate, incorrect formulae	<b>(2)</b>

Q20.

Question Number	Answer	Additional Guidance	Mark
(i)	$  \begin{array}{c}  \text{H} \quad \text{H} \\    \quad   \\  \text{H}-\text{C}-\text{C}-\text{H} \\    \quad   \\  \text{H} \quad \text{Cl}  \end{array}  $	Do not award skeletal or structural formulae	<b>(1)</b>



Question Number	Answer	Additional Guidance	Mark
(ii)	<ul style="list-style-type: none"> <li>• <b>M1 equation</b> to show formation of electrophile (1)</li> <li>• <b>M2 curly arrow</b> from anywhere on the central ring to positive carbon (1)</li> <li>• <b>M3 structure</b> of intermediate (1)</li> <li>• <b>M4 curly arrow</b> from C-H bond to reform the ring (1)</li> <li>• <b>M5 equation</b> showing regeneration of catalyst (1)</li> </ul>	<p><b>Example of mechanism</b> Penalise incorrect halogenoalkane in (a)(i) only</p> $\text{CH}_3\text{CH}_2\text{Cl} + \text{AlCl}_3 \rightarrow \text{CH}_3\text{CH}_2^+ + \text{AlCl}_4^-$ <p>Ignore any curly arrows given in the equation</p> <p>Allow curly arrow from anywhere within the hexagon Do not award if curly arrow to <math>\text{CH}_3</math> carbon in <math>\text{CH}_3\text{CH}_2^+</math> Do not award if curly arrow to <math>\text{C}_2\text{H}_5^+</math></p> <p>Horseshoe facing the tetrahedral carbon and covering at least three carbon atoms Some part of the positive charge in the horseshoe</p> <p>Do not award dotted lines unless clearly part of a 3D structure</p> <p><math>\text{AlCl}_4^- + \text{H}^+ \rightarrow \text{AlCl}_3 + \text{HCl}</math> Ignore regeneration step if part of the mechanism</p> <p><b>Mechanism</b></p> <p>Allow TE from (a)(i)</p>	(5)



Question Number	Answer	Additional Guidance	Mark
(iii)	<p>An explanation that makes reference to the following points:</p> <p>Phenol is likely to be more reactive because</p> <ul style="list-style-type: none"> <li>• <b>M1 lone pair on oxygen</b> (atom of –OH group) delocalises / is incorporated into the (benzene) ring / donated to the ring (1)</li> <li>• <b>M2</b> which increases the electron density (of the ring) (1)</li> <li>• <b>M3</b> making the ring / phenol more susceptible to electrophilic attack (1)</li> </ul>	<p>Do not award M2 if mention of "charge density" / "electronegativity"</p> <p>Ignore references to "the ring becomes more negative"</p> <p>Award "making the ring more nucleophilic" / "making the ring more susceptible to attack by a positive ion"</p> <p>Ignore references to "activation of the ring"</p>	(3)

Q21.

Question Number	Answer	Additional Guidance	Mark
(a)(i)	<ul style="list-style-type: none"> <li>• ethanol is added to dissolve both the halogenoalkane and water / to allow the halogenoalkane and water to mix / to form a homogeneous mixture / to act as a co-solvent</li> </ul>	<p>Allow silver nitrate as an alternative to water</p> <p>Allow so the halogenoalkane becomes soluble in water</p> <p>Do not award descriptions of dissolving one of the two reactants but not the other</p> <p>Do not award ethanol is a solvent</p> <p>Do not award to allow the halogens to mix</p>	(1)



Question Number	Answer	Additional Guidance	Mark
(a)(ii)	<ul style="list-style-type: none"> <li>so they are the same temperature</li> </ul> <p>OR</p> <ul style="list-style-type: none"> <li>so only the type of halogen affects the rate of reaction</li> </ul>	<p>(1)</p> <p>Allow to ensure the temperature remains constant Allow heat for temperature Ignore constant conditions Ignore to make it a fair test</p>	(1)

Question Number	Answer	Additional Guidance	Mark
(a)(iii)	<ul style="list-style-type: none"> <li>To ensure the reactants are mixed (thoroughly)</li> </ul>	<p>(1)</p> <p>Allow so the mixture is homogeneous Ignore so the particles collide Ignore to form the precipitate Do not award references to kinetic energy of the molecules</p>	(1)

Question Number	Answer	Additional Guidance	Mark
(b)(i)	<ul style="list-style-type: none"> <li>chloride white precipitate <b>and</b> bromide cream precipitate <b>and</b> iodide yellow precipitate</li> </ul>	<p>(1)</p> <p>Penalise the incorrect use of chlorine, bromine and iodine once only in 7(b)(i) and 7(b)(ii)</p> <p>Accept Off-white or (very) pale yellow</p> <p>Do not award pale yellow</p>	(1)



Question Number	Answer	Additional Guidance	Mark
(b)(ii)	<ul style="list-style-type: none"> <li>use of dilute <b>and</b> concentrated ammonia solution / aqueous ammonia</li> <li>silver chloride / precipitate from 1-chlorobutane is soluble in dilute (and concentrated ammonia) <b>and</b> silver bromide / precipitate for 1-bromobutane is soluble only in concentrated ammonia <b>and</b> silver iodide / precipitate from 1-iodobutane is insoluble in both dilute and concentrated ammonia</li> </ul>	<p>(1)</p> <p>(1)</p> <p>Allow partially soluble</p>	(2)

Question Number	Acceptable Answer	Additional Guidance	Mark												
(c)	<p>This question assesses a 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="386 1525 831 1789"> <thead> <tr> <th>Number of indicative marking points seen in answer</th> <th>Number of marks awarded for indicative marking points</th> </tr> </thead> <tbody> <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> </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	<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.</p> <p>For example, an answer with five indicative marking points, which 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 are no linkages between points, the same five indicative marking points would yield an overall score of 3 marks (3 marks for indicative content and no marks for linkages).</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														



The following table shows how the marks should be awarded for structure and lines of reasoning.		<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 score zero marks for reasoning.</p> <p>Reasoning marks may be reduced for extra incorrect chemistry</p>
	Number of marks awarded for structure answer and sustained of line of reasoning	
Answer shows a coherent and 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> <ul style="list-style-type: none"> <li>• IP1 Use equal amounts / numbers of moles / volumes of either halogenoalkane or silver nitrate solution</li> <li>• IP2 and IP3 Use isomeric primary, secondary and tertiary bromoalkanes e.g 1-bromobutane or 1-bromo-2-methylpropane <b>and</b> 2-bromobutane <b>and</b> 2-bromo-2-methylpropane</li> <li>• IP4 Time how long it takes for a precipitate to form / observe the order in which the precipitates form</li> <li>• IP5 Shorter the time the faster the rate</li> <li>• IP6 Correct order of precipitation given / tertiary forms before secondary before primary</li> </ul>	<p>Allow ethanol Do not award equal masses Ignore lack of ethanol</p> <p>Any two scores IP2 All 3 scores IP3 provided they are isomers Accept names or formulae but if both given they must both be correct</p> <p><math>1 \div \text{time} = \text{rate of reaction}</math></p>
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Q22.

Question Number	Answer	Additional Guidance	Mark
(i)	<ul style="list-style-type: none"> <li>zero (order 0 / 0 (order)</li> </ul>	Allow $x = 0$ / rate is proportional to $[\text{OH}^-]^0$ / rate = $k[\text{R-Br}][\text{OH}^-]^0$	(1)

Question Number	Answer	Additional Guidance	Mark
(ii)	<ul style="list-style-type: none"> <li>curly arrow from R-Br bond to, or just beyond, Br (1)</li> <li><math>\text{R}^+</math> and <math>\text{Br}^-</math> (1)</li> <li>lone pair on O of <math>\text{OH}^-</math> and curly arrow from lone pair to <math>\text{R}^+</math> (1)</li> </ul>	<p>Example of mechanism</p> $\text{R}-\text{Br} \longrightarrow \text{R}^+ + \text{Br}^-$ $\text{R}^+ + \text{OH}^- \longrightarrow \text{R}-\text{OH}$ <p>Ignore dipole on <math>\text{RBr}</math></p>	(3)

Q23.

Question Number	Answer	Additional Guidance	Mark
	<p>An explanation that makes reference to the following points:</p> <ul style="list-style-type: none"> <li>a racemic mixture / racemate is formed or equal amounts / an equimolar mixture of both optical isomers forms (1)</li> <li>intermediate / carbocation is (trigonal) planar around the reaction site / <math>\text{C}^+</math> / central carbon (1)</li> <li>(equal probability of) attack (by nucleophile / hydroxide ions) from either side / above and below / both sides / opposite sides (of the plane) (1)</li> </ul>	<p>Allow enantiomers / D-L isomers / (+) and (-) isomers Allow the two isomers rotate the plane of plane-polarised light in opposite directions and cancel out Ignore just 'mixture is not optically active' / 'mixture does not rotate the plane of plane-polarised light'</p> <p>Allow the intermediate / carbocation is planar (around the reaction site)</p> <p>Do not award 'the molecule is planar'</p>	(3)