

Question Number	Correct Answer	Reject	Mark
1(a)(i)	<p>As a (co-)solvent for both aqueous silver nitrate and bromoalkane</p> <p>OR</p> <p>As a (co-)solvent for polar and non-polar molecules</p> <p>OR</p> <p>To dissolve the halogenoalkane (as it is not water soluble)</p> <p>OR</p> <p>To allow the reagents/reactants to mix/dissolve</p>		(1)

Question Number	Correct Answer	Reject	Mark
1(a)(ii)	<p>$C_4H_9Br + H_2O \rightarrow C_4H_9OH + HBr$</p> <p>OR</p> <p>$C_4H_9Br + H_2O \rightarrow C_4H_9OH + H^+ + Br^-$</p> <p>Ignore state symbols even if incorrect</p>		(1)


Question Number	Correct Answer	Reject	Mark
1(a)(iii)	<p>Cream</p> <p>ALLOW</p> <p>Pale yellow/off-white</p> <p style="text-align: right;">(1)</p> <p>$Ag^+(aq) + Br^-(aq) \rightarrow AgBr(s)$</p> <p style="text-align: right;">(1)</p>	<p>Just "yellow"</p> <p>Just "white"</p>	(2)

Question Number	Correct Answer	Reject	Mark
1(a)(iv)	trated ammonia (solution) / Concentrated NH ₃ ((aq)) ALLOW 'c' or 'conc' for concentrated References to "excess"		(1)

Question Number	Correct Answer	Reject	Mark
1(a)(v)	C, B, A NOTE The letters must be in this order		1

Question Number	Correct Answer	Reject	Mark
*1(a)(vi)	<p>Any two from</p> <ul style="list-style-type: none"> • Tertiary is the fastest / primary is the slowest • The C-Br bond is weakest in 2-methylbromopropane / in the tertiary (compound) <p>ALLOW here: The weaker the C-Br bond, the faster the hydrolysis</p> <ul style="list-style-type: none"> • (This is because the) methyl groups donate electrons <p>OR</p> <p>methyl groups are electron releasing</p> <p>OR</p> <p>(positive) inductive effect of methyl groups</p> <p>IGNORE</p> <p>Any resultant effect on the polarity of the C-Br bond, even if incorrect</p> <ul style="list-style-type: none"> • Tertiary carbocation OR intermediate formed by tertiary is (more) stable <p>ALLOW branched for tertiary in all points</p> <p>IGNORE</p> <p>Any references to steric hindrance</p> <p>Any references to S_N1 and/or S_N2</p>	<p>If states that tertiary bromoalkane dissolves fastest</p>	(2)

Question Number	Correct Answer	Reject	Mark
<p>1 (b) (i)</p>	<div data-bbox="411 251 858 476" data-label="Image"> </div> <p>M1: All three of the following points</p> <ul style="list-style-type: none"> • (Cotton) wool / mineral wool / ceramic fibre (soaked in reactant) • in a reasonably horizontal test tube • heating (shown anywhere under horizontal tube) <p style="text-align: right;">(1)</p> <p>M2: Collection of gas over water / in a gas syringe</p> <p style="text-align: right;">(1)</p> <p>Ignore Bunsen valve</p> <p>Mark these scoring points independently</p>		<p>(2)</p>

Question Number	Correct Answer	Reject	Mark
1 (b) (ii)	But-1-ene ALLOW 1-butene  (1) (1)	Butene Butan-1-ene Butanene	(2)

Question Number	Correct Answer	Reject	Mark
1 (c) (i)	(Type) substitution (1) (Mechanism) nucleophilic (1) Allow words in either order Just "S_N 2" scores one mark	Elimination Electrophilic / (free) radical S _N 1	(2)

Question Number	Correct Answer	Reject	Mark
1 (c) (ii)	Butylamine/1-aminobutane/1-butylamine		(1)

Question Number	Acceptable Answers	Reject	Mark
2 (a) (i)	<p>Ethanol dissolves silver nitrate / silver ions and halogenoalkanes</p> <p>OR</p> <p>Ethanol (molecule) is polar and non-polar (solvent)</p> <p>OR</p> <p>Ethanol dissolves ionic and covalent compounds</p> <p>ALLOW</p> <p>Ethanol dissolves ionic and non-polar compounds</p> <p>Ethanol dissolves both types (of compound)</p> <p>So that the reactants can mix 'miscible' for 'dissolves'</p> <p>IGNORE</p> <p>Any references to rate</p>	<p>Ethanol is non-polar</p> <p>Just 'ethanol dissolves halogenoalkanes'</p> <p>Just 'water does not dissolve halogenoalkanes'</p> <p>Just 'they dissolve in ethanol'</p>	1

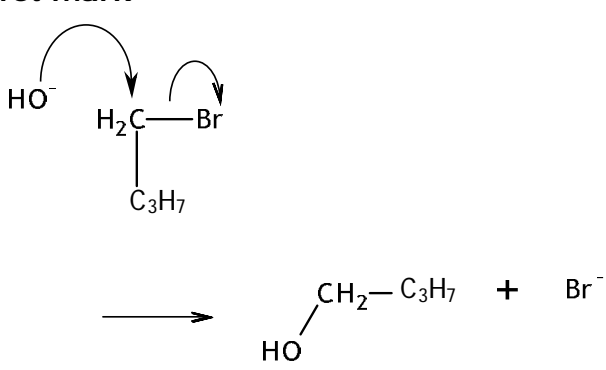
Question Number	Acceptable Answers	Reject	Mark
2(a) (ii)	<p>To allow the temperature (of all the liquids) to equilibrate / to reach 50°C</p> <p>OR</p> <p>So that all the substances are at the same temperature</p> <p>ALLOW</p> <p>So that the temperature is constant</p>		1

Question Number	Acceptable Answers	Reject	Mark
2(a) (iii)	<p>Silver bromide</p> <p>IGNORE</p> <p>Formula even if incorrect (1)</p> <p>$\text{Ag}^+ + \text{Br}^- \rightarrow \text{AgBr}$ (1)</p> <p>TE on incorrect silver halide</p> <p>ALLOW</p> <p>Ionic equations with uncanceled ions</p> <p>Ag^+Br^- as product</p> <p>IGNORE</p> <p>state symbols even if incorrect</p>	<p>Non-ionic equations</p>	2

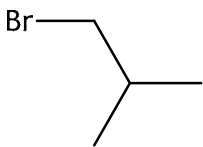
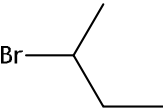
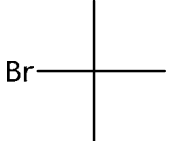
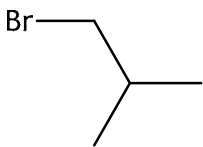
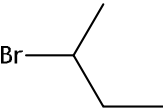
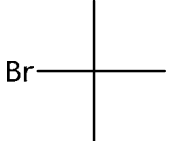
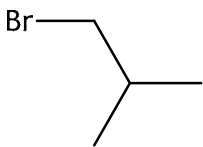
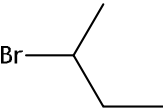
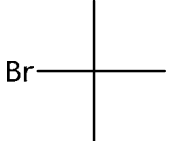
Question Number	Acceptable Answers	Reject	Mark
2(a)(iv)	Order: iodo, bromo, chloro ALLOW AgI, AgBr, AgCl OR I, Br, Cl OR Iodine, bromine, chlorine (1) C—I is the weakest bond OR I ⁻ is best leaving group ALLOW (if MP1 awarded) Rate depends on the strength of the C—X bond (1) IGNORE Explanations of the bond strengths, even if incorrect. References to bond length and atomic radius/size ALLOW Reverse argument for MP2	I ₂ , Br ₂ , Cl ₂ Rate depends on the reactivity of X / X ⁻	2

Question Number	Acceptable Answers	Reject	Mark
2(b)(i)	nucleophilic (1) substitution (1) Stand alone marks S _N 2 alone scores one mark	S _N 1	2

Question Number	Acceptable Answers	Reject	Mark
2(b)(ii)	<p>Some comparison is required.</p> <p>Hydroxide ion /OH⁻ is a stronger nucleophile (than water)</p> <p>ALLOW</p> <p>OH⁻ is a better electron pair donor (than water)</p> <p>Concentration of hydroxide ion / OH⁻ is higher</p> <p>OR</p> <p>Hydroxide ion / OH⁻ is charged</p> <p>More hydroxide ion / OH⁻ in NaOH (than water)</p> <p>IGNORE</p> <p>OH⁻ is more basic / alkaline</p> <p>Alkali is a stronger nucleophile</p> <p>OH⁻ is more reactive</p> <p>ALLOW</p> <p>Reverse argument</p>	<p>Use of NaOH/OH for OH⁻</p> <p>Just 'NaOH/alkali forms OH⁻ more readily'</p>	1

Question Number	Acceptable Answers	Reject	Mark
<p>2 (b) (iii)</p>	<p>Penalise omission of charge on hydroxide ion once only (in MP2)</p> <p>First mark</p>  <p>Both curly arrows First curly arrow from any part of the hydroxide ion (or the charge) to the carbon atom Second curly arrow from the C—Br bond to the bromine atom or just beyond (1)</p> <p>Second mark</p> <p>Lone pair on oxygen of OH⁻ {HO: } (1)</p> <p>Third mark</p> <p>Partial charge on C—Br bond { C^{δ+}—Br^{δ-} } (1)</p> <p>ALLOW Correct S_N1 mechanism for full marks</p> <p>Curly arrow from hydroxide group from any part of the group including the charge.</p> <p>IGNORE transition state (even if incorrect) products (even if incorrect)</p>	<p>OH with no / partial charge</p> <p>C⁺—Br⁻</p>	<p>3</p>

Question Number	Acceptable Answers	Reject	Mark
2(b)(iv)	<p>PCl₅: misty /steamy /white fumes/gas IGNORE Tests on product (e.g. turns blue litmus red) (1)</p> <p>K₂Cr₂O₇: orange solution turns green ALLOW Orange to blue (1)</p> <p>K₂Cr₂O₇ preferred because PCl₅ reacts with water (as well as alcohols) ALLOW K₂Cr₂O₇ preferred because PCl₅ reacts with alkali / OH⁻ /OH (1)</p> <p>IGNORE References to primary, secondary and tertiary alcohols</p>	<p>smoke Just 'fumes' / 'effervescence'</p> <p>PCl₅ reacts with carboxylic acids</p>	3

Question Number	Acceptable Answers	Reject	Mark								
2(c)	<table border="1"> <thead> <tr> <th>Skeletal formula</th> <th>Classification</th> </tr> </thead> <tbody> <tr> <td></td> <td>Primary/1°</td> </tr> <tr> <td></td> <td>Secondary/2°</td> </tr> <tr> <td></td> <td>Tertiary/3°</td> </tr> </tbody> </table> <p>Look at the structural formulae first: three structures correct scores 2 marks. two structures correct scores 1</p> <p>If all three structures correct (any format), then all three classifications correct scores 1</p> <p>Penalise displayed, partially displayed or structural formulae once only IGNORE Bond angles and names</p>	Skeletal formula	Classification		Primary/1°		Secondary/2°		Tertiary/3°	<p>Just the classifications</p>	3
Skeletal formula	Classification										
	Primary/1°										
	Secondary/2°										
	Tertiary/3°										

Question Number	Acceptable Answers	Reject	Mark
3(a)	UV light/ ultraviolet light/ (sun) light / UV radiation IGNORE References to heat and or pressure.		1

Question Number	Acceptable Answers	Reject	Mark
3(b)	Species/ particle with unpaired electron Allow atom	Single electron	1

Question Number	Acceptable Answers	Reject	Mark
3(c)(i)	Cl-Cl bond is weaker than a C-H bond / breaks more easily than a C-H bond OR Reverse argument		1

Question Number	Acceptable Answers	Reject	Mark
3(c)(ii)	$\text{CHCl}_3 + \bullet\text{Cl} \rightarrow \bullet\text{CCl}_3 + \text{HCl} \quad (1)$ $\bullet\text{CCl}_3 + \text{Cl}_2 \rightarrow \text{CCl}_4 + \bullet\text{Cl} \quad (1)$ Max (1) if 2 equations based on methane.		2

Question Number	Acceptable Answers	Reject	Mark
3(c)(iii)	$\bullet\text{CCl}_3 + \bullet\text{Cl} \rightarrow \text{CCl}_4$		1

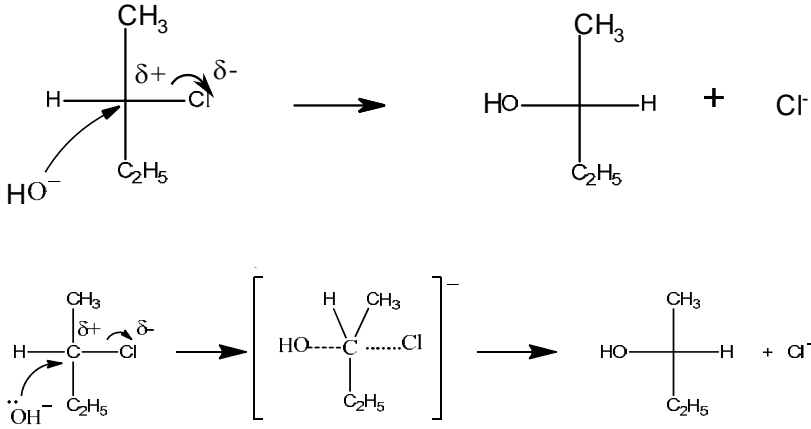
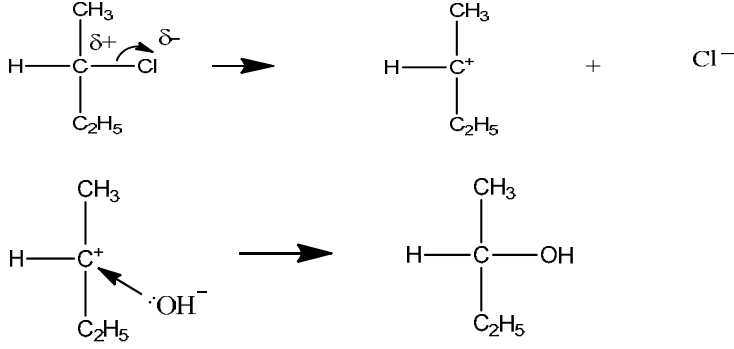
Question Number	Acceptable Answers	Reject	Mark
3(d)	100% as only one product / 100% as no by product(s) / 100% as no waste product (formed)	Just "atom economy is high(er) " / no mention of 100%	1

Total = 7 marks

Question Number	Acceptable Answers	Reject	Mark
4(a)(i)	Alcohol /ethanol (as solvent for NaOH) IGNORE heat / pressure	Any other reagents	1

Question Number	Acceptable Answers	Reject	Mark
4(a)(ii)	Elimination		1

Question Number	Acceptable Answers	Reject	Mark
4(a)(iii)	Water (as solvent for NaOH) / aqueous (NaOH) / aqueous (ethanol)	Aqueous silver nitrate	1

Question Number	Acceptable Answers	Reject	Mark
<p>4 (a) (iv)</p>	 <p>ALLOW</p>  <p>Arrow from OH⁻ to appropriate C (connected / previously connected) to Cl (1)</p> <p>Arrow from C-Cl bond to Cl producing Cl⁻ (1)</p> <p>Accept three dimensional diagrams ; displayed formulae; CH₃CH₂ for C₂H₅ Use of C₄H₉Cl as formula can score 1 for arrow from C-Cl bond to Cl Lone pair on hydroxide ion need not be shown</p> <p>ALLOW solid lines instead of dotted lines in the transition state</p>	<p>OH without charge</p> <p>Cl[•] (chlorine radical)</p>	<p>2</p>

Question Number	Acceptable Answers	Reject	Mark
4(b)	Steamy / misty / white and fumes / gas (1) IGNORE fizzing $\text{CH}_3\text{CH}_2\text{CH}(\text{OH})\text{CH}_3 + \text{PCl}_5 \rightarrow \text{CH}_3\text{CH}_2\text{CHClCH}_3 + \text{HCl} + \text{POCl}_3$ (1) ALLOW $\text{C}_4\text{H}_9\text{OH}$ and $\text{C}_4\text{H}_9\text{Cl}$ ALLOW PCl_3O Accept displayed formulae ALLOW missing bracket in alcohol Stand alone marks	White smoke Solid $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$ $\text{C}_4\text{H}_{10}\text{O}$	2

Question Number	Acceptable Answers	Reject	Mark
4(c)(i)	With butan-2-ol: (change from orange) to green / blue (1) With A : remains orange / no change (1) ALLOW 'no reaction' Any reference to 'yellow': max 1	Reference to gas given off or formation of precipitate Green-blue Just 'nothing'	2

Question Number	Acceptable Answers	Reject	Mark
4(c)(ii)	$\text{CH}_3\text{CH}_2\text{COCH}_3$ ALLOW displayed or skeletal		1

Question Number	Acceptable Answers	Reject	Mark
4(c)(iii)	Absorption / peak / trough for O-H / C-O / OH bond / alcohol CO bond would disappear OR Absorption / peak / trough for C=O / CO ketone bond would appear	Just - OH / CO Just 'alcohol peak' Just 'ketone peak'	1