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

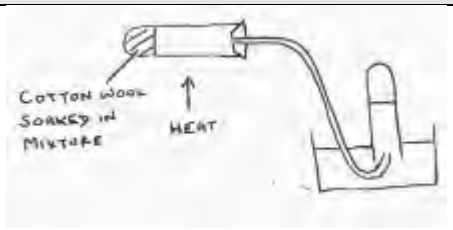
Question Number	Correct Answer	Reject	Mark
1(a)(ii)	$C_4H_9Br + H_2O \rightarrow C_4H_9OH + HBr$ OR $C_4H_9Br + H_2O \rightarrow C_4H_9OH + H^+ + Br^-$ Ignore state symbols even if incorrect		**(1)**

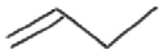
Question Number	Correct Answer	Reject	Mark
1(a)(iii)	Cream **ALLOW** **Pale** yellow/off-white **(1)** $Ag^+(aq) + Br^-(aq) \rightarrow AgBr(s)$ **(1)**	**Just "**yellow" **Just "**white"	**(2)**

Question Number	Correct Answer	Reject	Mark
1(a)(iv)	**trated** ammonia (solution) / **Concentrated** NH_3 ((aq)) ALLOW 'c' or 'conc' for concentrated **IGNORE** 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)**	**Any two from** • Tertiary is the fastest / primary is the slowest • The C-Br bond is weakest in 2-methylbromopropane / in the tertiary (compound) ALLOW here: The weaker the C-Br bond, the faster the hydrolysis • (This is because the) methyl groups donate electrons OR methyl groups are electron releasing OR (positive) inductive effect of methyl groups **IGNORE** Any resultant effect on the polarity of the C-Br bond, even if incorrect • Tertiary carbocation OR intermediate formed by tertiary is (more) stable ALLOW branched for tertiary in all points **IGNORE** Any references to steric hindrance Any references to S_N1 and/or S_N2	If states that tertiary bromoalkane **dissolves** fastest	**(2)**

Question Number	Correct Answer	Reject	Mark
1(b)(i)	 **M1: All three of the following points** • (Cotton) wool / mineral wool / ceramic fibre (soaked in reactant) • in a reasonably horizontal test tube • heating (shown anywhere under horizontal tube) **(1)** **M2:** Collection of gas over water / in a gas syringe **(1)** Ignore Bunsen valve Mark these scoring points independently		**(2)**

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)	Ethanol dissolves silver nitrate / silver ions **and** halogenoalkanes OR Ethanol (molecule) is polar and non-polar (solvent) OR Ethanol dissolves ionic and covalent compounds ALLOW Ethanol dissolves ionic and non-polar compounds Ethanol dissolves both types (of compound) So that the reactants can mix 'miscible' for 'dissolves' IGNORE Any references to rate	Ethanol is non-polar Just 'ethanol dissolves halogenoalkanes' Just 'water does not dissolve halogenoalkanes' Just 'they dissolve in ethanol'	1

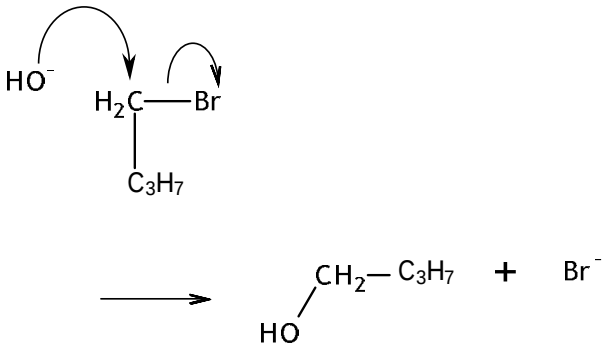
Question Number	Acceptable Answers	Reject	Mark
2(a)(ii)	To allow the temperature (of all the liquids) to equilibrate / to reach 50°C OR So that all the substances are at the same temperature ALLOW So that the temperature is constant		1

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

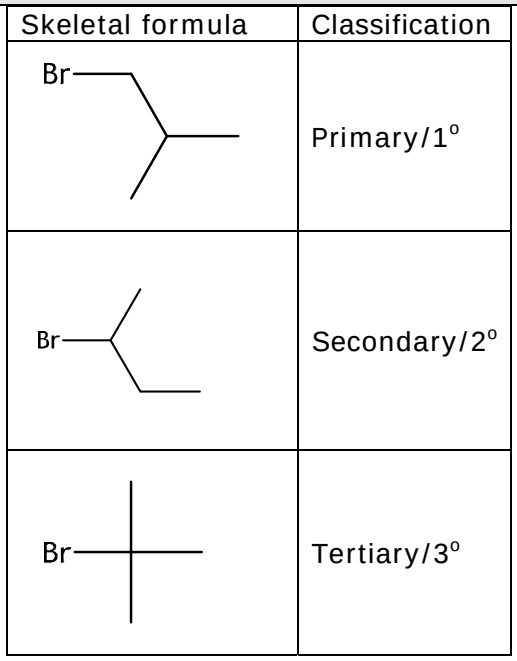
Question Number	Acceptable Answers	Reject	Mark
2(a)(iv)	Order: iodo, bromo, chloro ALLOW AgI, AgBr, AgCl OR I, Br, Cl OR Iodine, bromine, chlorine (1) C—I is the weakest bond OR I^- is best leaving group ALLOW (if MP1 awarded) Rate depends on the strength of the C—X bond (1) IGNORE Explanations of the 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_N2 alone scores one mark	 S_N1	2

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

Question Number	Acceptable Answers	Reject	Mark
2 (b)(iii)	Penalise omission of charge on hydroxide ion once only (in MP2) **First mark**  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) **Second mark** Lone pair on **oxygen** of OH^- {HO:} (1) **Third mark** Partial charge on C—Br bond { $C^{\delta+}$—$Br^{\delta-}$} (1) ALLOW Correct S_N1 mechanism for full marks Curly arrow from hydroxide group from any part of the group including the charge. IGNORE transition state (even if incorrect) products (even if incorrect)	OH with no / partial charge C^+—Br^-	3

Question Number	Acceptable Answers	Reject	Mark
2(b)(iv)	PCl_5: misty /steamy /white fumes/gas IGNORE Tests on product (e.g. turns blue litmus red) (1) $K_2Cr_2O_7$: orange solution turns green ALLOW Orange to blue (1) $K_2Cr_2O_7$ preferred because PCl_5 reacts with water (as well as alcohols) ALLOW $K_2Cr_2O_7$ preferred because PCl_5 reacts with alkali / OH^- /OH (1) IGNORE References to primary, secondary and tertiary alcohols	smoke Just 'fumes'/ 'effervescence' PCl_5 reacts with carboxylic acids	3

Question Number	Acceptable Answers	Reject	Mark
2(c)	 Look at the structural formulae first: three structures correct scores 2 marks. two structures correct scores 1 If all three structures correct (any format), then all **three** classifications correct scores 1 Penalise displayed, partially displayed or structural formulae once only IGNORE Bond angles and names	Just the classifications	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)	$CHCl_3 + \bullet Cl \rightarrow \bullet CCl_3 + HCl$ **(1)** $\bullet CCl_3 + Cl_2 \rightarrow CCl_4 + \bullet Cl$ **(1)** Max (1) if 2 equations based on methane.		2

Question Number	Acceptable Answers	Reject	Mark
3(c)(iii)	$\bullet CCl_3 + \bullet Cl \rightarrow CCl_4$		1

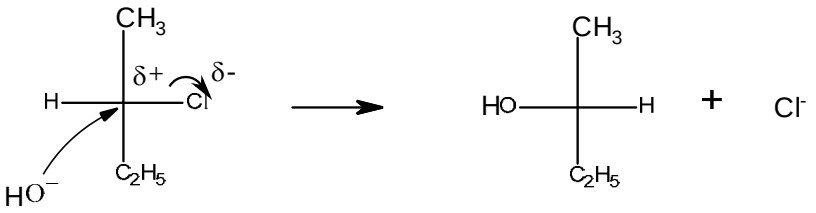
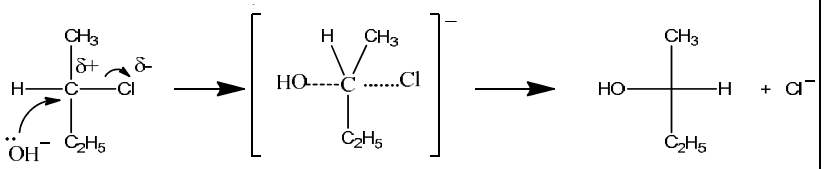
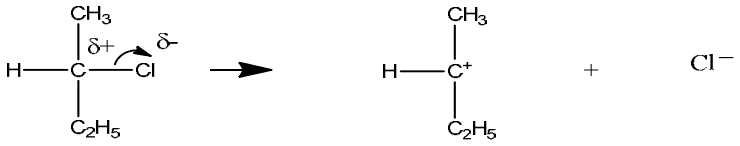
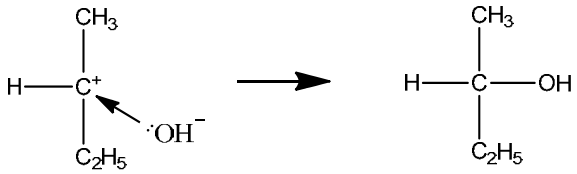
Question Number	Acceptable Answers	Reject	Mark
3(d)	100% as only one product / 100% as no by product(s) / 100% as no waste product (formed)	**Just** "atom economy is **high(er)**" / no mention of 100%	1

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
4 (a)(iv)	  ALLOW   Arrow from OH^- to appropriate C (connected / previously connected) to Cl **(1)** Arrow from C-Cl bond to Cl producing Cl^- **(1)** Accept three dimensional diagrams ; displayed formulae; CH_3CH_2 for C_2H_5 Use of C_4H_9Cl as formula can score 1 for arrow from C-Cl bond to Cl Lone pair on hydroxide ion need not be shown ALLOW solid lines instead of dotted lines in the transition state	OH without charge $Cl^{\cdot}$ (chlorine radical)	**2**

Question Number	Acceptable Answers	Reject	Mark
4(b)	Steamy / misty / white **and** fumes / gas **(1)** IGNORE fizzing $CH_3CH_2CH(OH)CH_3 + PCl_5 \rightarrow CH_3CH_2CHClCH_3 + HCl + POCl_3$ **(1)** ALLOW C_4H_9OH and C_4H_9Cl ALLOW PCl_3O Accept displayed formulae ALLOW missing bracket in alcohol Stand alone marks	White smoke Solid $CH_3CH_2CH_2CH_2OH$ $C_4H_{10}O$	**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)	$CH_3CH_2COCH_3$ 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**