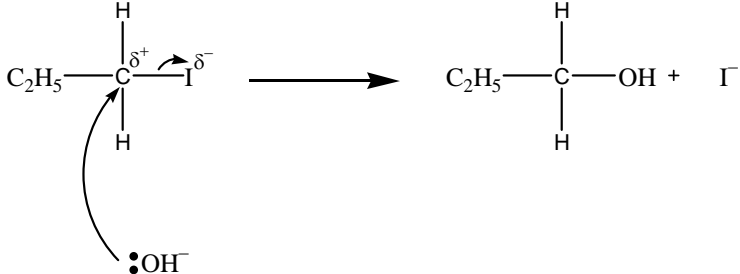
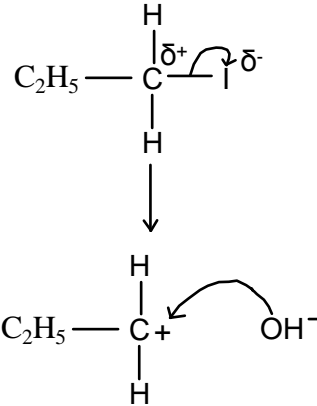


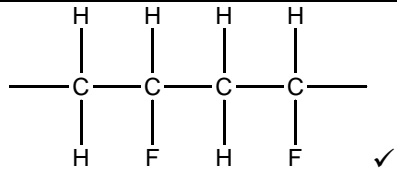
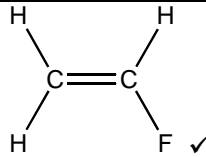
Question		Answer	Marks	Guidance
1	(a)	<p>1-bromopentane reacts faster OR 1-chloropentane reacts slower ✓</p> <p>C–C/ stronger bond (than C–Br bond) OR C–C/ shorter bond (than C–Br bond) OR C–C/ bond is harder to break OR needs more energy to break C–C/ bond OR bond enthalpy of C–C/ greater (than C–Br bond) ✓</p>	2	<p>ALLOW takes more time to react ALLOW chloro compound reacts slower than bromine compound DO NOT ALLOW bromine reacts faster than chlorine</p> <p>ALLOW ORA</p> <p>Answer must refer to the C–C/ bond or C–Br bonds</p>
	(b) (i)	<p>$\text{CH}_3\text{—CH}_2\text{—CH}_2\text{—CH}_2\text{—I}$ ✓</p> <p>$\text{CH}_3\text{—CH}_2\text{—CH—CH}_3$ ✓ I</p> <p>$\begin{array}{c} \text{CH}_3 \\ \\ \text{CH}_3\text{—C—I} \\ \\ \text{CH}_3 \end{array}$ ✓</p> <p>$\begin{array}{c} \text{CH}_3 \\ \\ \text{CH}_3\text{—C—CH}_2\text{—I} \\ \\ \text{H} \end{array}$ ✓</p>	4	<p>ALLOW correct structural OR displayed OR skeletal formula OR mixture of the above (as long as unambiguous) n.b. C₂H₅ is unambiguous but C₃H₇ is ambiguous</p> <p>IGNORE incorrect name</p> <p>Mark incorrect answers first of all.</p> <ul style="list-style-type: none"> • One incorrect answers maximum 3 marks • Two incorrect answers maximum 2 marks • Three incorrect answers maximum 1 mark • Four incorrect answers scores 0 mark <p>ALLOW as a slip one stick with no H on in a displayed formula</p>

Question			er	Marks	Guidance
	(b)	(ii)	$C_4H_{10}O$ ✓	1	IGNORE any structures drawn DO NOT ALLOW C_4H_9OH

Question		er	Marks	Guidance
(b)	(iii)	<p>infrared</p> <p>1700–1730 cm^{-1} indicates carbonyl group ✓</p> <p>broad 2900 cm^{-1} indicates O–H bond AND it is a carboxylic acid ✓</p> <p>explanation mark B has a branched structure because of relationship to methylpropene OR C has a branched structure because of relationship to methylpropene OR C must be a primary alcohol because it is oxidised to a carboxylic acid OR a primary alcohol because it reacts with acidified dichromate to make a carboxylic acid OR C cannot be a tertiary alcohol because it is oxidised OR cannot be a tertiary alcohol because it does react with acidified dichromate ✓</p>	6	<p>ANNOTATE ANSWER WITH TICKS AND CROSSES ETC</p> <p>LOOK ON THE SPECTRUM for labeled absorbances which can be given credit</p> <p>ALLOW has a C=O bond because it has absorbance within range 1640–1750 cm^{-1}</p> <p>ALLOW 2900 cm^{-1} indicates O–H in carboxylic acid ALLOW has O–H bond in carboxylic acid because it has absorbance within range 2500–3300 cm^{-1} The presence of carboxylic acid can be anywhere in the text including the structure for D</p> <p>If two marking points from the explanation mark are given both must be correct</p>

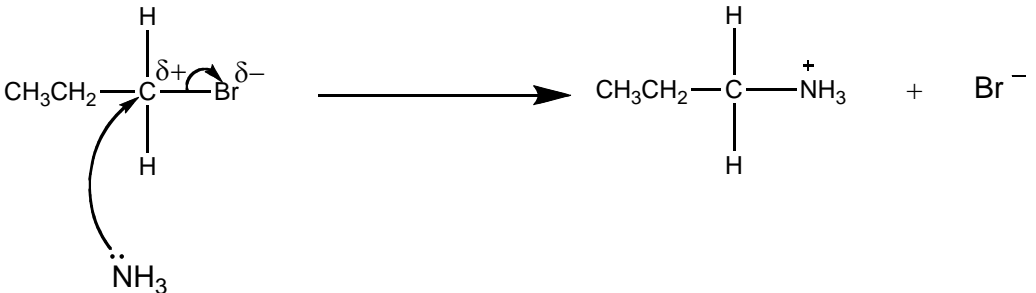
Question			er	Marks	Guidance
			<p>B is $\begin{array}{c} \text{CH}_3 \\ \\ \text{CH}_3 - \text{C} - \text{CH}_2 - \text{I} \\ \\ \text{H} \end{array}$ ✓</p> <p>C is $\begin{array}{c} \text{CH}_3 \\ \\ \text{CH}_3 - \text{C} - \text{CH}_2 - \text{OH} \\ \\ \text{H} \end{array}$ ✓</p> <p>D is $\begin{array}{c} \text{CH}_3 \\ \\ \text{CH}_3 - \text{C} - \text{COOH} \\ \\ \text{H} \end{array}$ ✓</p>		<p>ALLOW correct structural OR displayed OR skeletal formula OR mixture of the above (as long as unambiguous)</p> <p>IGNORE incorrect names for B, C and D</p> <p>Mark correct branched structures first of all.</p> <p>If there are no correct branched structures and C is $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$ then ALLOW one mark for $\text{CH}_3\text{CH}_2\text{CH}_2\text{COOH}$ and one mark for $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{I}$</p>
			Total	13	

Question	Expected Answers	Marks	Additional Guidance
2 (a) (i)	 <p>C-I curly arrow from the bond not from carbon atom ✓</p> <p>curly arrow from the OH⁻ ✓</p> <p>correct partial charges on C-I ✓</p>	3	<p>no need to show any lone pairs on oxygen but must have a clear negative sign rather than partial negative charge IGNORE lone pairs IGNORE products of this reaction</p> <p>ALLOW curly arrow from a negative charge or from any part of hydroxide ion</p> <p>If S_N1 mechanism is given then use the mark scheme below correct partial charges on C-I ✓</p> <p>C-I curly arrow from the bond not from carbon atom ✓</p> <p>curly arrow from the OH⁻ to the correct carbocation ✓</p> 
	(ii) nucleophilic substitution ✓	1	
(b)	C-I bonds broken more easily ✓ C-I bonds are weaker OR have less bond enthalpy OR C-I bonds are longer ✓	2	ALLOW ora e.g. C—Br bonds are stronger OR broken less easily

Question		Expected Answers	Marks	Additional Guidance
	(c)	<p>Any TWO from: CFCs take many years to reach the ozone layer OR long residence time ✓</p> <p>CFCs are still being used ✓</p> <p>there are other ozone depleting substances ✓</p>	2	<p>IGNORE because chlorine radicals stay in the stratosphere</p> <p>ALLOW other named ozone depleting substances e.g. NO and HFCs</p>
	(d) (i)		1	<p>Free bonds at bond ends must be present</p> <p>ALLOW minor slip e.g. missing one hydrogen and left as a stick</p> <p>ALLOW more than two repeat units but must be a whole number of repeat units</p> <p>IGNORE brackets, use of numbers and n in the drawn structure</p>
	(ii)		1	<p>ALLOW skeletal formula</p> <p>ALLOW CH₂CHF</p>
	(e)	<p>Any two from: separation into types and recycling OR sort plastics, melt and remould ✓</p> <p>combustion for energy generation ✓</p> <p>used for cracking OR feedstock for plastics or chemicals ✓</p>	2	<p>IGNORE biodegradable</p> <p>used as a fuel is insufficient releases energy is insufficient</p> <p>ALLOW burning plastics to release energy</p> <p>ALLOW organic feedstock / raw materials to make organic compounds</p>
Total			12	

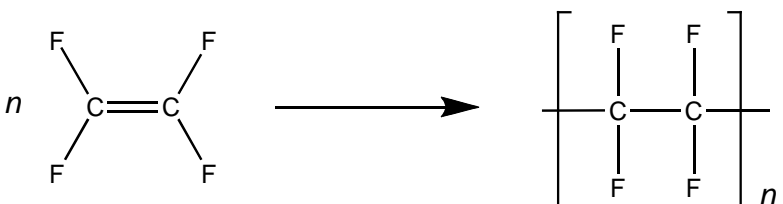
Question		er	Marks	Guidance
3	(a)	Shape – tetrahedral ✓ Bond angle 109.5° ✓	2	ALLOW 109–110°
	(b)	(Volatile OR non-toxic OR non-flammable OR easily vaporised ✓	1	ALLOW not carcinogenic / not an irritant / not harmful / not hazardous IGNORE cheap / not dangerous / gas / low boiling point DO NOT ALLOW inflammable
	(ii)	(C–F or C–Cl) bonds need a large amount of energy to break ✓	1	ALLOW (the C–F or C–Cl) bonds are strong / bonds have a large bond enthalpy ALLOW the molecule is not polar enough / non-polar molecule is not sufficient ALLOW the activation energy is too high DO NOT ALLOW dissolves IGNORE references to hydrogen bonding
	(c)	$\text{CF}_2\text{Cl}_2 \rightarrow \text{CF}_2\text{Cl} + \text{Cl} \checkmark$ AND ANY TWO FROM Cl catalyses the decomposition of ozone ✓ $\text{Cl} + \text{O}_3 \rightarrow \text{ClO} + \text{O}_2 \checkmark$ $\text{ClO} + \text{O} \rightarrow \text{Cl} + \text{O}_2 \checkmark$	3	ALLOW CF_2Cl_2 (breaks down to) produces chlorine atoms/radicals ALLOW equation with any CFC ALLOW $\text{ClO} + \text{O}_3 \rightarrow \text{Cl} + 2\text{O}_2$ ALLOW $\text{O}_3 + \text{O} \rightarrow 2\text{O}_2$ OR $3\text{O}_2 \rightarrow 2\text{O}_3$ for one mark if the two equations for the steps have not been given IGNORE other propagation equations

Question		er	Marks	Guidance
	(d)	Because (more) <u>UV</u> will reach the Earth's surface and risk of (skin) cancer increased/risk of cataracts/crop mutation increased ✓	1	DO NOT ALLOW global warming ALLOW protects from <u>UV</u> which causes skin cancer etc
	(e)	<i>Ideas related to uses</i> CFCs are still entering the atmosphere (from disused items) OR CFCs are still used (for some purposes and by some countries) ✓ <i>Ideas relating to lifetime within the atmosphere</i> CFCs have a long lifetime in the atmosphere OR it takes a long time for CFCs to reach upper atmosphere OR CFCs are inert ✓	2	ALLOW 'stratosphere' for 'upper atmosphere' ALLOW CFCs are still entering the ozone layer
		Total	10	

Question	Answer	Mark	Guidance
4 (a) (i)	$\text{CH}_3\text{CH}_2\text{I} + 2\text{NH}_3 \rightarrow \text{CH}_3\text{CH}_2\text{NH}_2 + \text{NH}_4\text{I}$ correct reactants ✓ correct products and balanced ✓	2	ALLOW $\text{CH}_3\text{CH}_2\text{I} + \text{NH}_3 \rightarrow \text{CH}_3\text{CH}_2\text{NH}_2 + \text{HI}$ ALLOW $\text{CH}_3\text{CH}_2\text{I} + \text{NH}_3 \rightarrow \text{CH}_3\text{CH}_2\text{NH}_3\text{I}$
	(ii)  <p>Correct curly arrow from the lone pair of ammonia to the carbon atom of C-Br ✓</p> <p>Correct dipole on C^{δ+}-Br^{δ-} bond and curly arrow showing the heterolytic fission of the C-Br bond ✓</p> <p>Correct missing product: Br⁻ ✓</p>	3	<p>Curly arrow must start from the lone pair on nitrogen and go to the carbon atom DO NOT ALLOW NH_3^- OR $^-\text{NH}_3$ ALLOW δ^- on the N atom of NH_3</p> <p>Curly arrow must start from the bond and go to the Br</p>

Question	Answer	Mark	Guidance
(b)	<p>Effect of halogen in RX (3 marks) Any correct comparison of rate OR reaction time between at least TWO of chloroalkane, bromoalkane and iodoalkane ✓</p> <p>Bond strength OR bond enthalpy/bond energy mentioned anywhere as a factor (even if reasoning is incorrect) ✓</p> <p>Any correct comparison of bond strength OR bond enthalpy/energy OR bond length OR ease of breaking of at least TWO of C–Cl, C–Br and C–I ✓</p>		<p>ANNOTATE WITH TICKS AND CROSSES Examples chloroalkane reacts the slowest iodo compound reacts the fastest C–I bond is hydrolysed faster than C–Br C–Br has shorter reaction time than C–Cl</p> <p>DO NOT ALLOW references to halogens as elements: <i>ie</i> chlorine is less reactive than bromine than iodine DO NOT ALLOW chloride, bromide and iodide</p> <p>ALLOW this mark if mentioned within effect of halogen, branching OR temperature</p> <p>Examples C–I bond is weaker than C–Br bond C–I bond is the weakest C–Cl bond is shorter than C–I bond C–Cl is strongest bond C–Br is broken more easily than C–Cl</p>

Question	Answer	Mark	Guidance
(b)	<p>Effect of branching (2 marks) Any correct comparison of rate or reaction time between at least TWO of the bromoalkanes ✓</p> <p>A sensible comparison of bond strength OR bond enthalpy/energy OR bond length OR ease of breaking of the C–Br bond in at least TWO of the bromoalkanes ✓</p> <p>Effect of temperature (2 marks) QWC – Use of 50 °C and 60 °C using information in the table to show that rate increases with temperature ✓</p> <p>At higher temperature, particles have more energy OR At higher temperature, particles move faster ✓</p>	7	<p>Tertiary hydrolyses faster than secondary OR reaction time is less with tertiary than primary OR secondary hydrolyses faster than primary OR branched hydrolyses faster than straight chains OR primary hydrolyses the slowest OR tertiary hydrolyses the fastest OR when halogen on carbon 1 is hydrolysed slower than when halogen is on carbon 2 ✓</p> <p>DO NOT ALLOW short chains hydrolyse faster than long chains</p> <p>Examples C–Hal is weaker in tertiary halogenoalkane OR C–Br bond is stronger when it is bonded to carbon 1 rather than carbon 2</p> <p>ALLOW an explanation based on relative stabilities of tertiary, secondary and/or primary carbocations</p> <p>Answer must quote evidence from the table to get this mark Rate increases with temperature is NOT sufficient</p> <p>ALLOW more energy available to break the C–Hal bond OR more energy vibrates the C–Hal more so bond can break more easily ALLOW more successful collisions at higher temperature ALLOW more molecules exceed activation energy</p> <p>ALLOW ORA</p>

Question	Answer	Mark	Guidance
(c) (i)	 <p>Correct monomer ✓</p> <p>Correct polymer ✓</p> <p>Balanced equation – correct use of n in the equation ✓</p>	3	<p>Polymer must have side links (do not have to cut through bracket) ALLOW a correct section of the polymer with side links ALLOW ECF from wrong monomer, including use of FI for F</p> <p>n on LHS can be at any height to the left of formula AND n on the RHS must be a subscript (essentially below the side link) On the LHS, DO NOT ALLOW $(C_2F_4)_n$ (the n must be in front of the monomer)</p> <p>$nC_2F_4 \rightarrow -(C_2F_4-)_n-$ scores 1 mark for the correct use of n</p>
(ii)	<p>(PVC) produces hydrogen chloride OR produces acidic gases OR (PVC) produces phosgene OR produces toxic gases OR (PVC) produces dioxins ✓</p>	1	<p>ALLOW produces poisonous gases OR produces gases that can kill IGNORE HF, Cl₂ and F₂ Makes a dangerous or harmful gas is NOT sufficient</p> <p>IGNORE CO and CO₂ are greenhouse gases IGNORE chlorine radicals and ozone depletion IGNORE causes pollution</p>
Total		16	