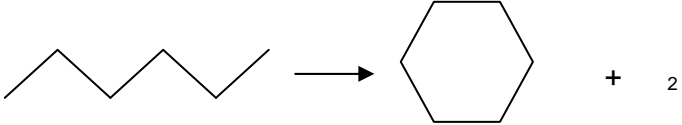
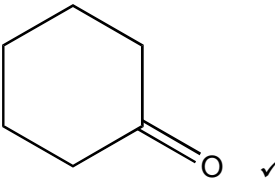
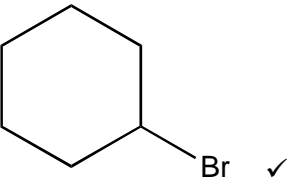
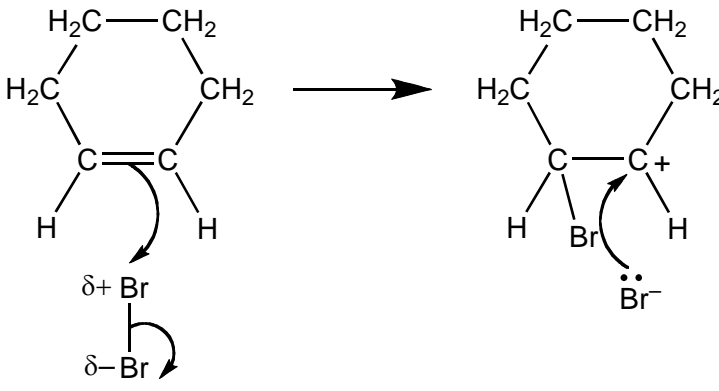
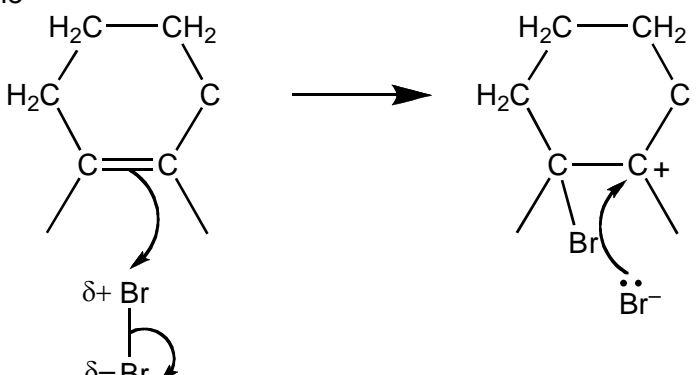


Question		Answer	Mark	Guidance
1	(a)	<p>(The hydrocarbons have) different boiling points ✓</p> <p>The larger the molecules the stronger the van der Waals' forces ✓</p>	2	<p>PLEASE READ COMMENT ON PAGE 3</p> <p>ALLOW longer chains have higher boiling points OR separation based on boiling point OR condense at different temperatures</p> <p>ALLOW the larger molecular size more van der Waals' forces OR longer chains have stronger van der Waals' force OR the more electrons, the stronger the van der Waals' forces OR the more surface contact the more van der Waals' forces IGNORE surface area ALLOW ORA</p> <p>van der Waals must be seen at least once in correct context ALLOW any 'recognisable' spelling of van der Waals', use of VDW is not sufficient</p> <p>DO NOT ALLOW intermolecular force unless qualified as van der Waals' somewhere</p>
	(b)	(i) C_nH_{2n} ✓	1	
		(ii) $C_6H_{14} \rightarrow C_6H_{12} + H_2$ ✓	1	<p>ALLOW displayed, skeletal or structural formulae or combination in the equation</p> 

Question		Answer	Mark	Guidance
	(b) (iii)	cyclohexane has more efficient combustion ✓	1	<p>Assume comments refer to cyclohexane unless specified otherwise</p> <p>ALLOW cyclohexane allows smoother burning OR cyclohexane increases octane number OR cyclohexane reduces knocking OR cyclohexane is less likely to produce pre-ignition OR cyclohexane is a more efficient fuel OR cyclohexane burns better OR easier to burn OR cyclohexane combusts more easily OR improves combustion DO NOT ALLOW cyclohexane ignites more easily</p> <p>ALLOW ORA for hexane</p> <p>IGNORE cyclohexane increases volatility of fuel IGNORE cyclohexane has a lower boiling point</p> <p>cyclohexane is a better fuel on its own is NOT sufficient cyclohexane burns more cleanly on its own is NOT sufficient</p>
	(c) (i)	<p><i>Unsaturated</i>: Contains (at least one) carbon–carbon double bond OR C=C OR multiple carbon–carbon bond ✓</p> <p><i>hydrocarbon</i>: Contains hydrogen and carbon only ✓</p>	2	<p>DO NOT ALLOW just ‘contains a double bond’</p> <p>DO NOT ALLOW ‘a mixture of carbon and hydrogen’ OR ‘contains carbon and hydrogen’ OR carbon and hydrogen molecules only</p>
	(ii)	<p>More than one hydrogen atom is substituted OR ‘multisubstitution’ (by chlorine) OR further substitution occurs ✓</p>	1	<p>ALLOW can get dichloro-compounds (IGNORE numbering) ALLOW reaction forms more than one organic product</p> <p>DO NOT ALLOW ‘forms termination products’ on its own</p> <p>Reaction is not specific OR reaction is difficult to control is NOT sufficient</p>

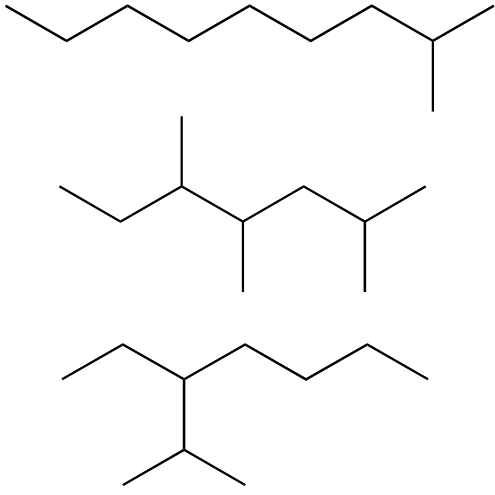
Question		Answer	Mark	Guidance
(c)	(iii)	Contains a lone pair that can be donated ✓	1	ALLOW it can donate an electron pair 'lone pair' on its own is NOT sufficient
	(iv)	<p>A  ✓</p> <p>B  ✓</p>	2	<p>ALLOW skeletal, displayed or structural formulae for A and B</p> <p>ALLOW combination of types of formulae as long as it is unambiguous</p> <p>DO NOT ALLOW molecular formula</p> <p>For A, ALLOW carbonyl group on any carbon atom as it is still cyclohexanone</p> <p>For B, ALLOW bromine atom on any carbon atom as it is still bromocyclohexane</p>

Question	Answer	Mark	Guidance
(c) (v)	<p>Correct dipole on Br₂ / correct partial charges on Br₂ ✓</p> <p>Correct curly arrow from double bond to attack bromine atom and correct curly arrow to show heterolytic fission of Br–Br ✓</p> <p>Correct carbocation / carbonium ion drawn with the full positive charge shown: C⁺ ✓</p> <p>Correct curly arrow from lone pair of Br[–] to correct carbon atom OR correct curly arrow from negative charge of Br[–] to correct carbon atom ✓</p> 	4	<p>ANNOTATE WITH TICKS AND CROSSES</p> <p>Curly arrow must come from covalent bonds and not atoms</p> <p>DO NOT ALLOW C^{δ+} for charge on carbonium ion</p> <p>Curly arrow from bromide ion can come from the negative charge or the lone pair DO NOT ALLOW Br^{δ-} instead of Br[–]</p> <p>Lone pair does not need to be shown on Br[–] or used in mechanism</p> <p>Treat missing hydrogens on the CH₂ as a slip Treat missing hydrogens on the double bond or carbonium ion as a slip providing a bond is shown</p> <p>ie</p>  <p>ALLOW use of skeletal formulae in mechanism</p>
	Total	15	

Question		Answer	Mark	Guidance
2	(a)	<p>ANY THREE FROM</p> <p>$C_6H_{12}O_6 \rightarrow 2CO_2 + 2C_2H_5OH$ ✓</p> <p>Use of yeast/zymase at 25–45 °C OR warm with yeast/zymase ✓</p> <p>Anaerobic OR lack of oxygen ✓</p> <p>(Separate bioethanol) by (fractional) distillation ✓</p>	3	<p>IGNORE state symbols</p> <p>ALLOW correct multiples</p> <p>DO NOT ALLOW yeast/zymase and heat DO NOT ALLOW yeast/zymase and reflux</p>
	(b)	(i)	2	<p>ALLOW $\frac{43}{2}$ for 21½</p> <p>DO NOT ALLOW [O]</p> <p>ALLOW one mark for correct products if equation is wrong</p>
		(ii)	1	<p>ALLOW (energy needed) for transport makes carbon dioxide</p>
	(c)	<p>ANY THREE FROM</p> <p>Fossil fuels are finite resources OR biofuels are renewable ✓</p> <p>Allows fossil fuels to be used as a feedstock for organic compounds ✓</p> <p>Less food crops may be grown OR Land not used to grow food crops ✓</p> <p>(rain) forests have to be cut down to provide land OR deforestation ✓</p> <p>Shortage of fertile soils OR reduces fertility of soils ✓</p> <p>No risk of large scale pollution from exploitation of fossil fuels ✓</p>	3	<p>ANNOTATE WITH TICKS AND CROSSES</p> <p>ALLOW fossil fuels are non-renewable OR plants are a renewable resource OR bio-fuels is (more) sustainable OR fossil fuels are not sustainable</p> <p>ALLOW decrease the need for fossil fuels</p> <p>Destroys habitats is NOT sufficient</p> <p>IGNORE comments about availability / fertilisers / pesticides</p>

Question		Answer	Mark	Guidance
	(d)	React with hydrogen OR hydrogenation ✓ Nickel catalyst ✓	2	IGNORE reference to pressure and temperature
	(e) (i)	Drawing of the <i>Z</i> isomer with the double bond shown in full ✓	1	Diagram must show a minimum of four carbon atoms and two hydrogen atoms and the correct orientation of the C=C double bond ALLOW minor slips with rest of structure eg missing atoms, bonds and subscripts
	(ii)	Double bond does not rotate OR restricted rotation of the double bond ✓ Each carbon atom of double bond is bonded to (two) different groups ✓	2	ALLOW π /pi bond does not rotate IGNORE 'bond does not move' ALLOW each carbon atom of double bond is bonded to (two) different atoms OR each carbon atom of double bond is bonded to a hydrogen and a carbon/different group OR each end of the π /pi-bond is bonded to different groups or atoms
Total			12	

Question		Expected Answers	Marks	Additional Guidance
3	(a)	Fractional distillation ✓ Because fractions have different boiling points ✓	2	DO NOT ALLOW just 'distillation' For fractions, ALLOW components OR hydrocarbons OR compounds ALLOW condense at different temperatures ALLOW because van der Waals' forces differ between molecules IGNORE reference to melting points IGNORE 'crude oil' OR 'mixture' has different boiling points' but ALLOW 'separates crude oil by boiling points
	(b) (i)	Decane ✓	1	DO NOT ALLOW deceane
	(ii)	Skeletal formula of branched C ₁₀ H ₂₂ ✓	1	Formula must be skeletal AND must not include any symbol, e.g. CH ₃ Any possible skeletal formulae e.g.

Question	Expected Answers	Marks	Additional Guidance
			
(iii)	<p>Decane has more surface contact OR branched chains have less surface contact ✓</p> <p>Decane has more van der Waals' forces OR branched chains have fewer van der Waals' forces ✓</p>	2	<p>Both answers need to be comparisons Assume 'it' refers to decane IGNORE surface area ALLOW straight chains can get closer together OR branched chains cannot get as close to one another IGNORE branched chain are more compact</p> <p>ALLOW Decane has stronger van der Waals' forces OR branched chains have weaker van der Waals' forces</p> <p>More intermolecular forces is not sufficient</p>
(iv)	<p>Branched chains have more efficient combustion OR decane has less efficient combustion ✓</p>	1	<p>ALLOW branched chains are easier to burn OR easier to combust OR burn better OR more efficient fuel OR less likely to produce pre-ignition or knocking OR increases octane rating</p> <p>ALLOW ORA for decane</p>

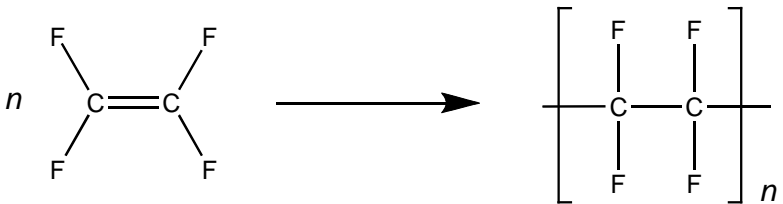
Question			Expected Answers	Marks	Additional Guidance
					Better fuel is NOT sufficient Burns more cleanly is NOT sufficient
	(c)	(i)	$\text{C}_{10}\text{H}_{22} + 15\frac{1}{2}\text{O}_2 \longrightarrow 10\text{CO}_2 + 11\text{H}_2\text{O}$ <p>All four species correct ✓</p> <p>balancing of four correct species ✓</p>	2	ALLOW any correct multiple IGNORE state symbols
		(ii)	$\text{N}_2 + \text{O}_2 \longrightarrow 2\text{NO} \quad \checkmark$	1	ALLOW any correct multiple including fractions IGNORE state symbols The mark is for the equation IGNORE writing

Question		Expected Answers	Marks	Additional Guidance
(d)	(i)	Species with an unpaired electron ✓	1	ALLOW atom, molecule or particle with an unpaired electron ALLOW 'has an unpaired electron' ALLOW particle formed by homolytic fission DO NOT ALLOW particle with a single electron OR particle with a free electron
	(ii)	catalyst ✓	1	
	(iii)	$O + O_2 \longrightarrow O_3$ OR O reacts with O_2 to make ozone OR the reaction is reversible ✓ Rate of formation of ozone is the same as rate of decomposition ✓	2	ALLOW $O_2 + O \rightleftharpoons O_3$ OR $O_3 \rightleftharpoons O_2 + O$ ✓✓ ALLOW is in equilibrium OR \rightleftharpoons in correct equation OR has steady state condition ✓ IGNORE other equations involving ozone
	(iv)	absorbs (harmful) UV ✓	1	ALLOW 'keeps out UV' OR 'filters UV' ALLOW increased UV could cause skin cancer OR increased UV could cause cataracts OR increased UV could cause mutation of crops ✓ IGNORE gamma
Total			15	

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) <div style="text-align: center; margin: 10px 0;"> </div> <p>Correct curly arrow from the lone pair of ammonia to the carbon atom of C-Br ✓</p> <p>Correct dipole on $\text{C}^{\delta+}-\text{Br}^{\delta-}$ 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, Cl_2 and F_2 Makes a dangerous or harmful gas is NOT sufficient</p> <p>IGNORE CO and CO_2 are greenhouse gases IGNORE chlorine radicals and ozone depletion IGNORE causes pollution</p>
Total		16	