



GCE

Chemistry A

Advanced Subsidiary GCE

Unit **F322**: Chains, Energy and Resources

Mark Scheme for January 2011

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Mark schemes should be read in conjunction with the published question papers and the Report on the Examination.

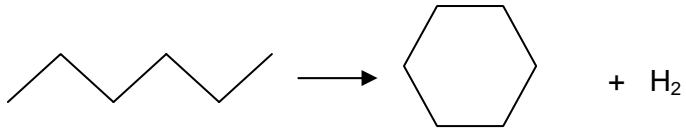
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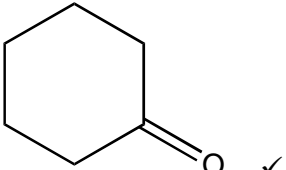
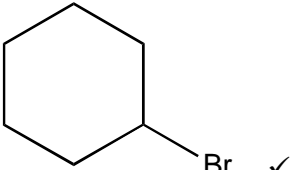
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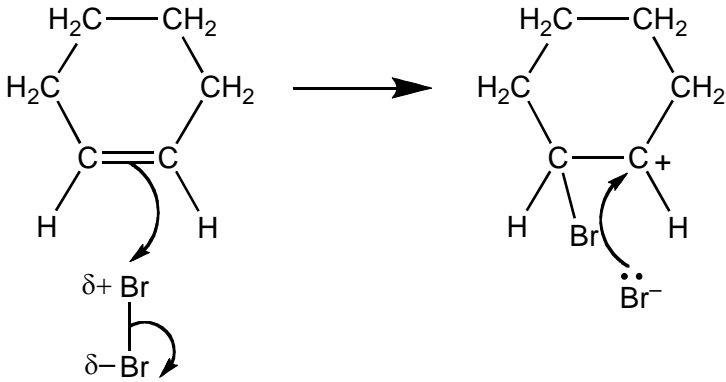
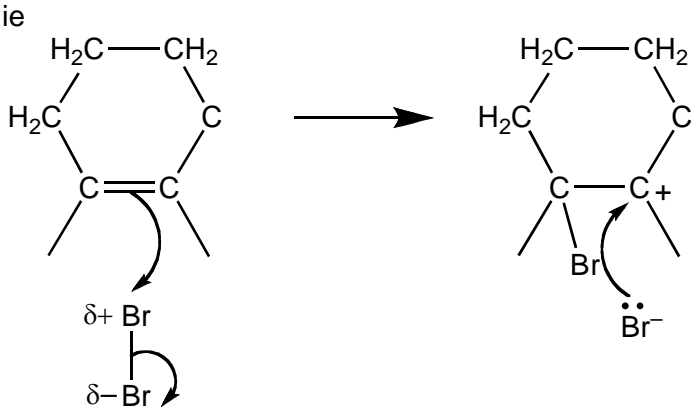
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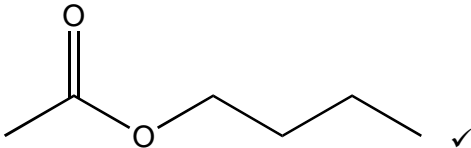
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Question		Answer	Mark	Guidance	
1	(a)	<p>(The hydrocarbons have) different boiling points ✓</p> <p>The larger the molecules the stronger the van der Waals' forces ✓</p>	2	<p>PLEASE READ COMMENT ON PAGE 3</p> <p>ALLOW longer chains have higher boiling 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
1	(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
1	(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	ALLOW skeletal, displayed or structural formulae for A and B ALLOW combination of types of formulae as long as it is unambiguous DO NOT ALLOW molecular formula For A , ALLOW carbonyl group on any carbon atom as it is still cyclohexanone For B , ALLOW bromine atom on any carbon atom as it is still bromocyclohexane

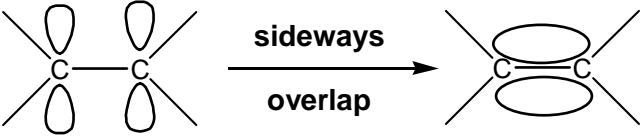
Question	Answer	Mark	Guidance
<p>1 (c) (v)</p>	<p>Correct dipole on Br₂ / correct partial charges on Br₂ ✓</p> <p>Correct curly arrow from double bond to attack bromine atom and correct curly arrow to show heterolytic fission of Br–Br ✓</p> <p>Correct carbocation / carbonium ion drawn with the full positive 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> 	<p>4</p>	<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>
	<p>Total</p>	<p>15</p>	

Question		Answer	Mark	Guidance
2	(a)		1	<p>IGNORE any structural or displayed formula shown even if wrong (ie treat as rough working)</p>
	(b)	<p>(M_r of all reactants or M_r of all products) is 134.0 OR 134 OR (M_r of desired product) is 116.0 OR 116 ✓</p> <p>Atom economy = $100 \times \frac{116.0}{134.0}$ ✓</p>	2	<p>Remember the marks are for the working out and not for the answer IGNORE lack of decimal place in answer</p> <p>ALLOW correct expressions to calculate the M_r or the atom economy eg</p> $\text{Atom economy} = 100 \times \frac{(6 \times 12) + (12 \times 1) + (2 \times 16)}{116 + 18}$ <p>Award 2 marks for this expression: $100 \times \frac{116.0}{134.0}$ or similar expressions such as that above (subsumes 1st marking point)</p>
	(c) (i)	<p>acid (catalyst) ✓</p> <p>heat OR reflux ✓</p>	2	<p>ALLOW any acid, concentrated or dilute</p> <p>ALLOW 'high temperature' OR any temperature from 70 °C to 120 °C Warm is not sufficient but ALLOW warm to 80 °C</p> <p>IGNORE pressure</p>

Question	Answer	Mark	Guidance
2 (c) (ii)	<p>maximum mass of ester than can be made is 9.7972973 (g) ✓</p> <p>$\% \text{ yield} = \frac{6.57}{9.80} \times 100 \checkmark$</p> <p>ALLOW 2 or more sig figs up to calculated value but rounded up correctly, ie ALLOW $\frac{6.57}{9.797} \times 100$ OR $\frac{6.57}{9.8} \times 100$</p>	2	<p>ALLOW moles of butan-1-ol = 0.08445946 AND moles of ester = 0.05663791</p> <p>OR moles of butan-1-ol = $\frac{6.25}{74}$ AND moles of ester = $\frac{6.57}{116}$</p> <p>for one mark</p> <p>ALLOW $\% \text{ yield} = \frac{0.05664}{0.08446} \times 100$ for one mark</p> <p>ALLOW 2 or more sig figs up to calculated value but rounded up correctly, ie $\frac{0.057}{0.084} \times 100$ OR $\frac{0.0566}{0.0845} \times 100$</p> <p>Remember the marks are for the working out</p>
(d)	<p>Link between yield AND explanation required:</p> <p>(high percentage) yield shows a high % conversion (of reactants into products) ✓</p> <p>Link between atom economy AND explanation required:</p> <p>(low) atom economy shows a lot of waste (product) OR (low) atom economy shows not much desired product ✓</p>	2	<p>ALLOW percentage yield takes into account the practical difficulties of the process OR high % yield very little experimental loss of product OR high % yield because the process is not reversible OR most of reactants react to form products DO NOT ALLOW 'a lot of product made'</p> <p>There are waste products is NOT sufficient Reaction forms many products is NOT sufficient</p> <p>ALLOW undesired product(s) as alternative for waste IGNORE a lot of by-products but ALLOW a lot of waste by-products</p> <p>ALLOW (low) atom economy shows a lot of HCl OR a lot of SO₂ is made ALLOW (low) atom economy shows not much ester / butyl ethanoate made</p>

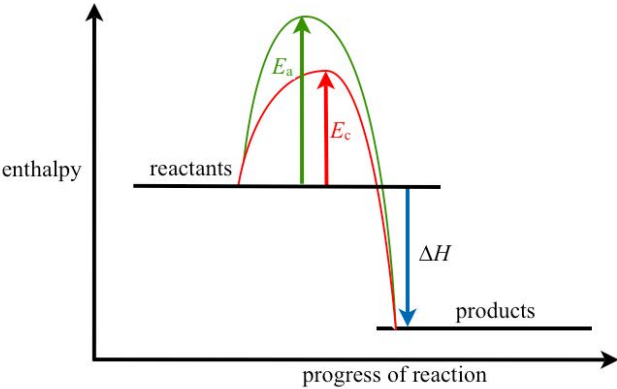
Question		Answer	Mark	Guidance
2	(e)	<p>NOTE: Comparison essential throughout, ie higher, less, etc.</p> <p>ANY TWO FROM Less waste (products) OR higher atom economy ✓</p> <p>Less toxic reactants OR less toxic (waste) products OR less corrosive reactants OR less corrosive (waste) products OR less harmful reactants OR less harmful (waste) products OR less hazardous reactants OR less hazardous (waste) products ✓</p> <p>Cheaper starting materials OR more readily available starting materials ✓</p> <p>Fewer steps OR one step rather than two steps ✓</p>	2	<p>ALLOW more sustainable</p> <p>ALLOW poisonous for toxic</p> <p>IGNORE 'dangerous'</p> <p>'Water is produced' is not sufficient</p> <p>Cheaper is not sufficient on its own</p> <p>IGNORE less energy OR easier to carry out OR reversible</p>
Total			11	

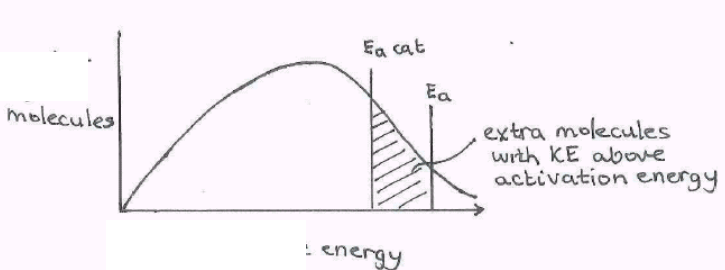
Question		Answer	Mark	Guidance
3	(a)	(enthalpy change when) the number of moles of reactants ✓ as specified in the (balanced) equation react together ✓	2	ALLOW (enthalpy change when) the number of moles of products ALLOW molar quantities / amounts Enthalpy change that occurs during a reaction is not sufficient
	(b) (i)	$Q = 50 \times 4.2 \times 11.0$ ✓ 2.3 ✓	2	ALLOW 2310 J ✓ 2300j ALLOW use 4.18 for c which gives 2.299 J ALLOW two marks for 2.31 / 2.310 with no working out ALLOW ECF ie Q divided by 1000 IGNORE any sign quoted
	(ii)	moles = 0.200 ✓	1	ALLOW 0.2 / 0.20
	(iii)	$\Delta H_r = 2 \times (2.3 \div 0.200)$ ✓ 23 ✓ + sign ✓	3	ALLOW ECF from answer from $2 \times [(i) \div \text{answer to (ii)}]$ Answer from $2 \times [(i) \div \text{answer to (ii)}]$ must have only 2 sig figs + sign must be written for 'sign mark' + sign is independent of answer ALLOW answers per mole of NH_4SCN $\Delta H_r = 2.3 \div 0.200$ for one mark 12 for the second mark + sign for the third mark NOTE If $c = 4.18$ has been used in b(i) , $\Delta H_r = +11$ by ECF for calculation per mole of NH_4SCN

Question			Answer	Mark	Guidance
3	(c)	(i)	(Enthalpy change) when one mole of bonds ✓ of (gaseous covalent) bonds is broken ✓	2	ALLOW energy required rather than enthalpy change DO NOT ALLOW energy released DO NOT ALLOW bonds formed
		(ii)	(Sideways) overlap of p orbitals ✓ Forming a π /pi bond ✓	2	IGNORE reference to σ bonds IGNORE incorrect diagram This diagram would score one mark – the π bond needs to be labelled for second mark  2p orbitals
		(iii)	π bond is weaker (than the σ bond) OR σ bond is stronger (than the π bond) ✓	1	There are two types of bonds is not sufficient DO NOT ALLOW π bond is stronger than the σ bond ALLOW the two bonds in double bond are not the same strength
		(iv)	bonds broken = (+)4010 AND bonds formed = (-)3931 Overall enthalpy change = +79 ✓	2	ALLOW Bonds broken = (+)690 AND bonds formed = (-)611 ✓ ALLOW 79 without a sign ALLOW -79 for one mark overall ALLOW ECF from incorrect enthalpy changes calculated for bonds broken and made

Question			Answer	Mark	Guidance
3	(c)	(v)	Bond enthalpies may not be the same as the average bond enthalpy OR The idea that bonds have different strengths in different environments ✓	1	DO NOT ALLOW answers involving heat loss OR the use of non standard conditions Average bond enthalpies are used is NOT sufficient
			Total	16	

Question			Answer	Mark	Guidance
4	(a)	(i)	$\text{Cl} + \text{O}_3 \rightarrow \text{ClO} + \text{O}_2 \checkmark$ $\text{ClO} + \text{O} \rightarrow \text{Cl} + \text{O}_2 \checkmark$	2	ALLOW any correct multiples ALLOW $\text{ClO} + \text{O}_3 \rightarrow 2\text{O}_2 + \text{Cl}$ IGNORE state symbols and dots
		(ii)	$\text{O}_3 + \text{O} \rightarrow 2\text{O}_2 \checkmark$	1	ALLOW any correct multiple ALLOW $2\text{O}_3 \rightarrow 3\text{O}_2$ IGNORE state symbols and dots
	(b)		Adsorption of reactants OR NO and CO attached to surface \checkmark Bonds weaken in reactants \checkmark Chemical reaction OR rearrangement of electrons \checkmark Desorption \checkmark	4	ANNOTATE WITH TICKS AND CROSSES ALLOW CO and NO (weakly) bonded to surface OR reactants bond to surface OR CO and NO form temporary bonds with the catalyst DO NOT ALLOW absorption ALLOW bonds weaken in NO OR bonds weaken in CO OR activation energy is lowered ALLOW bonds break and new bonds made in product OR N_2 and CO_2 made ALLOW products leave the surface OR N_2 and CO_2 no longer bonded to surface ALLOW desorption ALLOW deabsorption if absorption given at start of answer

Question	Answer	Mark	Guidance
<p>4 (c)</p>	<p>one activation energy labelled on enthalpy profile diagram ✓</p> <p>idea that activation energy is lowered ✓</p> <p>catalyst has a different reaction pathway OR different reaction mechanism OR two curves drawn on profile ✓</p> <p>QWC – correct diagram of reaction profile for endothermic or exothermic reaction with products and reactants at different heights – y axis labelled as energy or enthalpy ✓</p>		<p>ANNOTATE WITH TICKS AND CROSSES</p> <p>ALLOW double headed arrows on the activation energy label ALLOW vertical line with no arrows DO NOT ALLOW arrow just pointing downwards Be generous with respect to the position of the line and the maximum of the curve</p> <p>marks can be awarded via, reaction profile, in words or from Boltzmann</p> <p>IGNORE any enthalpy change label drawn</p>  <p>IGNORE missing progress of reaction</p>

Question	Answer	Mark	Guidance
4 (c)	<p>Drawing of Boltzmann distribution AND axes labelled (number of) molecules and energy ✓</p> <p>More molecules with energy above activation energy with a catalyst OR More molecules that overcome the activation energy ✓</p> <p>More effective collisions OR more successful collisions ✓</p>	7	<p>Boltzmann distribution - must start at origin and must not end up at 0 on y-axis ie must not touch x-axis. DO NOT ALLOW Boltzmann mark if two distributions are drawn one for non-catalysed and one for catalysed</p> <p>ALLOW particles instead of molecules</p> <p>DO NOT ALLOW atoms instead of particles</p>  <p>DO NOT ALLOW more molecules have sufficient energy to react</p>

Question	Answer	Mark	Guidance
4 (d)	<p>ANY FOUR FROM</p> <p>Enable reactions to occur with less waste OR enable reactions to take place with higher atom economy OR fewer undesired products ✓</p> <p>Enable reactions to happen with less toxic solvents/reactants OR enable reactions to produce less toxic waste/side products ✓</p> <p>Reactions can happen at room temperature OR reactions can happen at atmospheric pressure OR reactions can happen at a lower pressure OR reactions can happen at a lower temperature ✓</p> <p>Saves energy (costs) ✓</p> <p>Reduce carbon dioxide emissions OR reduces amount of fuel burnt OR reduces greenhouse gas emissions ✓</p> <p>Enable reactions to occur with more specificity OR enable reactions to produce correct stereoisomer ✓</p>	4	<p>ANNOTATE WITH TICKS AND CROSSES</p> <p>ALLOW make less hazardous waste ALLOW corrosive, poisonous, harmful, hazardous as alternative to toxic DO NOT ALLOW does not harm the environment IGNORE dangerous</p> <p>IGNORE less expensive IGNORE reduces activation energy</p> <p>IGNORE less pollution</p>
	Total	18	

Question	Answer	Mark	Guidance
5 (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 $\text{CH}_3\text{CH}_2\text{I} + \text{NH}_3 \rightarrow \text{CH}_3\text{CH}_2\text{NH}_3\text{I}$
	<div style="text-align: center;"> </div> <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>

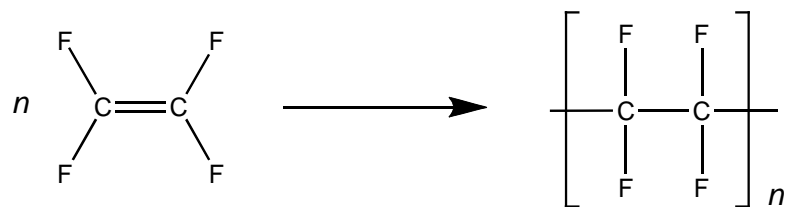
Question	Answer	Mark	Guidance
5 (b)	<p>Effect of halogen in RX (3 marks) Any correct comparison of rate OR reaction time between at least TWO of chloroalkane, bromoalkane and iodoalkane ✓</p> <p>Bond strength OR bond enthalpy/bond energy mentioned anywhere as a factor (even if reasoning is incorrect) ✓</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>

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Question	Answer	Mark	Guidance
5 (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
5 (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>
	<p>(ii) (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	

Question			Answer	Mark	Guidance
6	(a)	(i)	molecular ion is 58 OR m/z is 58 ✓ (58 – (36 + 6) = 16) so $x = 1$ ✓	2	ALLOW peak on the right is 58 OR parent ion is 58 ALLOW 58 shown on the spectrum eg the peak is labelled with a number OR there is a ring around the peak The M_r OR molecular mass is 58 with no evidence is not sufficient ALLOW $x = 1$ ALLOW Z is C_3H_6O
		(ii)	CH_3CH_2CHO OR CH_3COCH_3 ✓	1	ALLOW displayed or skeletal formulae ALLOW combination of types of formulae as long as it is unambiguous ALLOW other correct structures, eg enols, ethers and cyclic structures eg $CH_2=CHCH_2OH$ OR $CH_2=CHOCH_3$ OR structure of cyclopropanol DO NOT ALLOW a structure showing H with 2 bonds, ie $OH-C$
		(iii)	$C_2H_5^+$ ✓	1	ALLOW $CH_3CH_2^+$ OR COH^+ OR HCO^+ The positive sign must be included
	(b)		m/z values/peaks around 56 ✓	1	ALLOW peaks around 56 OR peak at 56 OR peaks around 55.8 DO NOT ALLOW peak at 55.8 DO NOT ALLOW peaks show the iron isotopes
	(c)	(i)	The number of m/z values (around 32) ✓	1	ALLOW the number of peaks IGNORE any reference to molecular ion peak
		(ii)	Different isotopic abundance ✓	1	ALLOW different percentage of each isotope OR different isotopes present ALLOW sulfur atoms have different number of neutrons OR different mass numbers

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Question		Answer	Mark	Guidance
6	(d)	No absorption between 1640 and 1750 cm^{-1} AND no (broad) absorption between 3200 and 3550 cm^{-1} ✓	1	ALLOW the only significant absorption is at around 2850 to 3100 cm^{-1} due to C–H bond OR There is an absorption around 2850 to 3100 cm^{-1} due to C–H bond AND no absorptions by C=O and O–H bonds IGNORE comments about C—O ALLOW any values within the wavenumber range
	(e)	C=O because of absorption between 1640 and 1750 cm^{-1} AND O–H (broad) absorption between 2500 to 3300 cm^{-1} ✓ Carboxyl group OR carboxylic acid ✓	2	ALLOW any values within the wavenumber range ALLOW O–H (broad) absorption between 2500 to 3500 cm^{-1} (from spectrum) IGNORE C–O ALLOW carboxylic acid if linked with O–H absorption IGNORE alcohol, ester, aldehyde, ketone or amide
Total			10	

Question		Answer	Mark	Guidance	
7	(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)	<p>$C_{15}H_{30}O_2 + 21\frac{1}{2}O_2 \rightarrow 15CO_2 + 15H_2O$ ✓✓</p>	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)	<p>(Energy needed) for processing biofuel makes carbon dioxide ✓</p>	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
7	(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	

OCR (Oxford Cambridge and RSA Examinations)
1 Hills Road
Cambridge
CB1 2EU

OCR Customer Contact Centre

14 – 19 Qualifications (General)

Telephone: 01223 553998

Facsimile: 01223 552627

Email: general.qualifications@ocr.org.uk

www.ocr.org.uk

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OCR (Oxford Cambridge and RSA Examinations)
Head office
Telephone: 01223 552552
Facsimile: 01223 552553

