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RECOGNISING ACHIEVEMENT

GCE

Chemistry A

Advanced Subsidiary GCE

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

Mark Scheme for January 2011

Oxford Cambridge and RSA Examinations

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

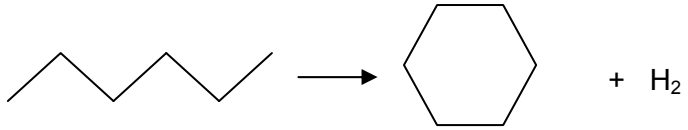
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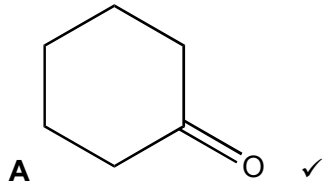
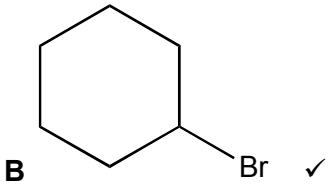
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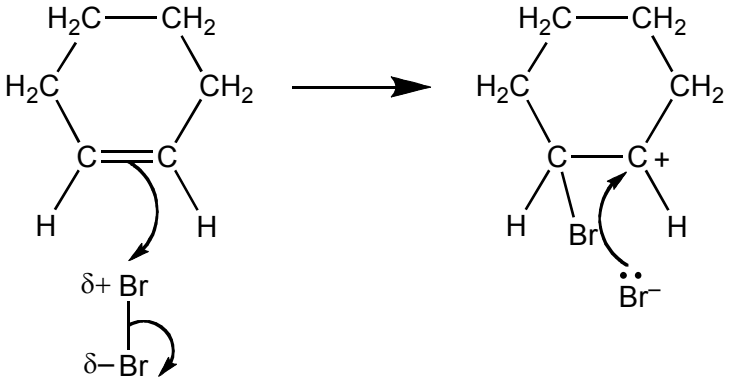
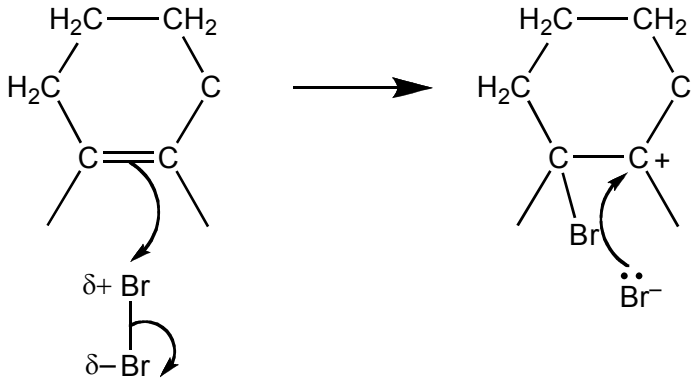
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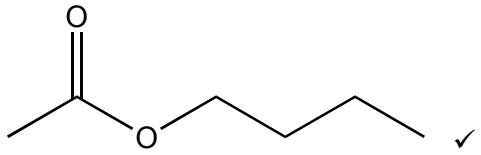
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Question			Answer	Mark	Guidance
1	(a)		(The hydrocarbons have) different boiling points ✓ The larger the molecules the stronger the van der Waals' forces ✓	2	**PLEASE READ COMMENT ON PAGE 3** **ALLOW** longer chains have higher boiling points **OR** separation based on boiling point **OR** condense at different temperatures **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** 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 **DO NOT ALLOW** intermolecular force unless qualified as van der Waals' somewhere
	(b)	(i)	C_nH_{2n} ✓	1	
		(ii)	$C_6H_{14} \rightarrow C_6H_{12} + H_2$ ✓	1	**ALLOW** displayed, skeletal or structural formulae or combination in the equation 

Question			Answer	Mark	Guidance
1	(b)	(iii)	cyclohexane has more efficient combustion ✓	1	Assume comments refer to cyclohexane unless specified otherwise **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 **ALLOW** ORA for hexane **IGNORE** cyclohexane increases volatility of fuel **IGNORE** cyclohexane has a lower boiling point cyclohexane is a better fuel on its own is **NOT** sufficient cyclohexane burns more cleanly on its own is **NOT** sufficient
	(c)	(i)	*Unsaturated:* Contains (at least one) **carbon–carbon** double bond **OR** C=C **OR** multiple carbon–carbon bond ✓ *hydrocarbon*: Contains hydrogen and carbon **only** ✓	2	**DO NOT ALLOW** just 'contains a double bond' **DO NOT ALLOW** 'a mixture of carbon and hydrogen' **OR** 'contains carbon and hydrogen' **OR** carbon and hydrogen molecules only
		(ii)	More than one hydrogen atom is substituted **OR** 'multisubstitution' (by chlorine) **OR** further substitution occurs ✓	1	**ALLOW** can get dichloro-compounds (**IGNORE** numbering) **ALLOW** reaction forms more than one **organic** product **DO NOT ALLOW** 'forms termination products' on its own Reaction is not specific **OR** reaction is difficult to control is **NOT** sufficient

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)	**A**  ✓ **B**  ✓	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

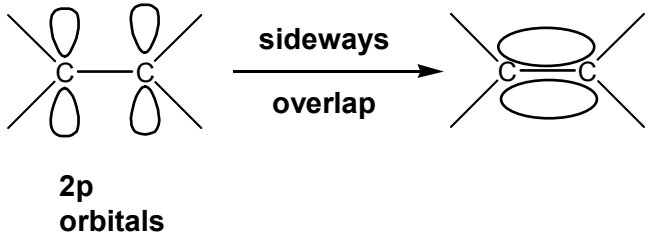
Question			Answer	Mark	Guidance
1	(c)	(v)	Correct dipole on Br_2 / correct partial charges on Br_2 ✓ Correct curly arrow from double bond to attack bromine atom and correct curly arrow to show heterolytic fission of Br–Br ✓ Correct carbocation / carbonium ion drawn with the **full** positive charge shown: C^+ ✓ 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 ✓  	4	**ANNOTATE WITH TICKS AND CROSSES** Curly arrow must come from covalent bonds and not atoms **DO NOT ALLOW** $C^{\delta+}$ for charge on carbonium ion Curly arrow from bromide ion can come from the negative charge or the lone pair **DO NOT ALLOW** $Br^{\delta-}$ instead of Br^- Lone pair does not need to be shown on Br^- or used in mechanism Treat missing hydrogens on the CH_2 as a slip Treat missing hydrogens on the double bond or carbonium ion as a slip providing a bond is shown ie  **ALLOW** use of skeletal formulae in mechanism
			Total	**15**	

Question			Answer	Mark	Guidance
2	(a)		 ✓	1	**IGNORE** any structural or displayed formula shown even if wrong (ie treat as rough working)
	(b)		(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 ✓ Atom economy = $100 \times \frac{116.0}{134.0}$ ✓	2	Remember the marks are for the working out and not for the answer **IGNORE** lack of decimal place in answer **ALLOW** correct expressions to calculate the M_r or the atom economy eg Atom economy = $100 \times \frac{(6\times12)+(12\times1)+(2\times16)}{116+18}$ Award 2 marks for this expression: $100 \times \frac{116.0}{134.0}$ or similar expressions such as that above (subsumes 1st marking point)
	(c)	(i)	**acid** (catalyst) ✓ heat **OR** reflux ✓	2	**ALLOW** any acid, concentrated or dilute **ALLOW** 'high temperature' **OR** any temperature from 70 ºC to 120 ºC Warm is **not** sufficient **but ALLOW** warm to 80 ºC **IGNORE** pressure

Question			Answer	Mark	Guidance
2	(c)	(ii)	maximum mass of ester than can be made is 9.7972973 (g) ✓ % yield = $\frac{6.57}{9.80} \times 100$ ✓ **ALLOW** 2 or more sig figs up to calculated value but rounded up correctly, ie **ALLOW** $\frac{6.57}{9.797} \times 100$ **OR** $\frac{6.57}{9.8} \times 100$	2	**ALLOW** moles of butan-1-ol = 0.08445946 **AND** moles of ester = 0.05663791 **OR** moles of butan-1-ol = $\frac{6.25}{74}$ **AND** moles of ester = $\frac{6.57}{116}$ for one mark **ALLOW** % yield = $\frac{0.05664}{0.08446} \times 100$ for one mark **ALLOW** 2 or more sig figs up to calculated value but rounded up correctly, ie $\frac{0.057}{0.084} \times 100$ **OR** $\frac{0.0566}{0.0845} \times 100$ Remember the marks are for the working out
	(d)		Link between yield **AND** explanation required: (high percentage) yield shows a high % conversion (of reactants into products) ✓ Link between atom economy **AND** explanation required: (low) atom economy shows a **lot** of waste (product) **OR** (low) atom economy shows not much desired product ✓	2	**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' There are waste products is **NOT** sufficient Reaction forms many products is **NOT** sufficient **ALLOW** undesired product(s) as alternative for waste **IGNORE** a lot of by-products but …….. **ALLOW** a lot of **waste** by-products **ALLOW** (low) atom economy shows a **lot** of HCl **OR** a lot of SO_2 is made **ALLOW** (low) atom economy shows not much ester / butyl ethanoate made

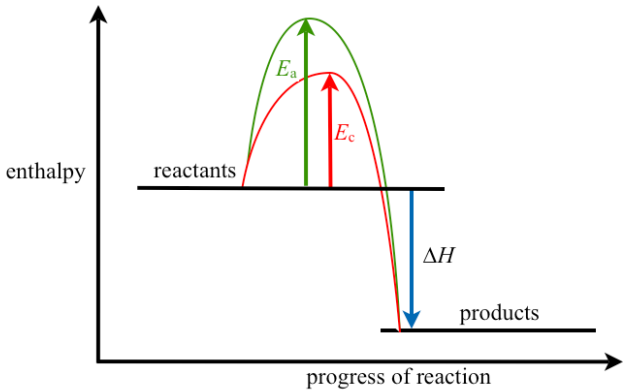
Question			Answer	Mark	Guidance
2	(e)		**NOTE**: **Comparison** essential throughout, ie **higher**, **less**, etc. **ANY TWO FROM** Less waste (products) **OR** higher atom economy ✓ Less toxic reactants **OR** less toxic (waste) products **OR** less corrosive reactants **OR** less corrosive (waste)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

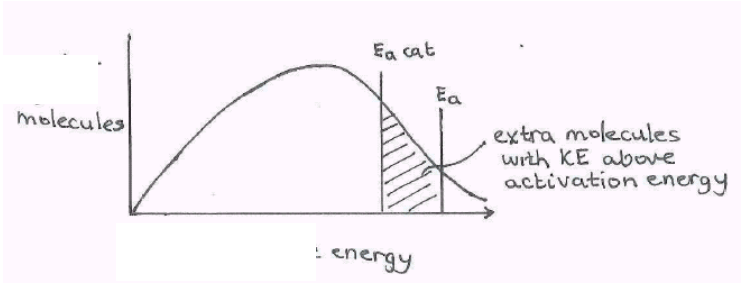
Question			Answer	Mark	Guidance
3	(a)		(enthalpy change when) the number of moles of reactants ✓ as specified in the (balanced) equation react together ✓	 2	**ALLOW** (enthalpy change when) the number of moles of products **ALLOW** molar quantities / amounts Enthalpy change that occurs during a reaction is **not** sufficient
	(b)	(i)	Q = 50 × 4.2 × 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)	ΔH_r = 2 × (2.3 ÷ 0.200) ✓ 23 ✓ + sign ✓	 3	**ALLOW ECF** from answer from 2 × [**(i)** ÷ answer to **(ii)**] Answer from 2 × [**(i)** ÷ 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 ΔH_r = 2.3 ÷ 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)**, ΔH_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

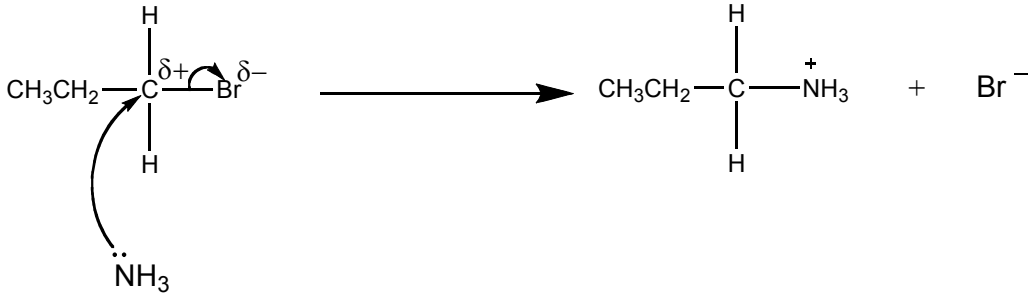
Question			Answer	Mark	Guidance
3	(c)	(v)	Bond enthalpies may not be the same as the average bond enthalpy **OR** The idea that bonds have different strengths in different environments ✓	1	**DO NOT ALLOW** answers involving heat loss **OR** the use of non standard conditions Average bond enthalpies are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

Question			Answer	Mark	Guidance
4	(a)	(i)	$Cl + O_3 \rightarrow ClO + O_2$ ✓ $ClO + O \rightarrow Cl + O_2$ ✓	2	**ALLOW** any correct multiples **ALLOW** $ClO + O_3 \rightarrow 2O_2 + Cl$ **IGNORE** state symbols and dots
		(ii)	$O_3 + O \rightarrow 2O_2$ ✓	1	**ALLOW** any correct multiple **ALLOW** $2O_3 \rightarrow 3O_2$ **IGNORE** state symbols and dots
	(b)		Adsorption of reactants **OR** NO and CO attached to surface ✓ Bonds weaken in reactants ✓ Chemical reaction **OR** rearrangement of electrons ✓ Desorption ✓	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** deadsorption **ALLOW** deabsorption if absorption given at start of answer

Question			Answer	Mark	Guidance
4	(c)		one activation energy labelled on enthalpy profile diagram ✓ idea that activation energy is lowered ✓ catalyst has a different reaction pathway **OR** different reaction mechanism **OR** two curves drawn on profile ✓ **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 ✓		**ANNOTATE WITH TICKS AND CROSSES** **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 marks can be awarded via, reaction profile, in words or from Boltzmann **IGNORE** any enthalpy change label drawn  **IGNORE** missing progress of reaction

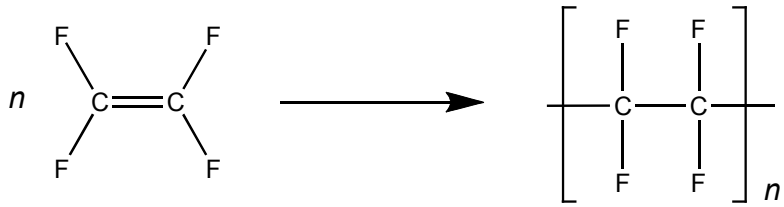
Question			Answer	Mark	Guidance
4	(c)		Drawing of Boltzmann distribution **AND** axes labelled (number of) molecules and energy ✓		Boltzmann distribution - must start at origin and must not end up at 0 on *y*-axis ie must not touch *x*-axis. **DO NOT ALLOW** Boltzmann mark if two distributions are drawn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

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

Question			Answer	Mark	Guidance
5	(a)	(i)	$CH_3CH_2I + 2NH_3 \rightarrow CH_3CH_2NH_2 + NH_4I$ correct reactants ✓ correct products and balanced ✓	2	**ALLOW** $CH_3CH_2I + NH_3 \rightarrow CH_3CH_2NH_2 + HI$ **ALLOW** $CH_3CH_2I + NH_3 \rightarrow CH_3CH_2NH_3I$
		(ii)	 Correct curly arrow from the lone pair of ammonia to the carbon atom of C–Br ✓ Correct dipole on $C^{\delta+}$–$Br^{\delta-}$ bond **and** curly arrow showing the heterolytic fission of the C–Br bond ✓ Correct missing product: Br^- ✓	3	Curly arrow **must** start from the lone pair on nitrogen and go to the carbon atom **DO NOT ALLOW** NH_3^- **OR** $^-NH_3$ **ALLOW** δ– on the N atom of NH_3 Curly arrow must start from the bond and go to the Br

Question			Answer	Mark	Guidance
5	(b)		***Effect of halogen in RX (3 marks)*** Any correct comparison of rate **OR** reaction time between at least **TWO** of chloroalkane, bromoalkane and iodoalkane ✓		**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 **DO NOT ALLOW** references to halogens as elements: *ie* chlorine is less reactive than bromine than iodine **DO NOT ALLOW** chloride, bromide and iodide
			Bond strength **OR** bond enthalpy/bond energy mentioned anywhere as a factor (even if reasoning is incorrect) ✓		**ALLOW** this mark if mentioned within effect of halogen, branching **OR** temperature
			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 ✓		***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

Question			Answer	Mark	Guidance
5	(b)		***Effect of branching (2 marks)*** Any correct comparison of rate or reaction time between at least **TWO** of the bromoalkanes ✓ 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 ✓ ***Effect of temperature (2 marks)*** **QWC** – Use of 50 ºC and 60 ºC using information in the table to show that rate increases with temperature ✓ At higher temperature, particles have more energy **OR** At higher temperature, particles move faster ✓	7	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 ✓ **DO NOT ALLOW** short chains hydrolyse faster than long chains ***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 **ALLOW** an explanation based on relative stabilities of tertiary, secondary and/or primary carbocations Answer must **quote evidence** from the table to get this mark Rate increases with temperature is **NOT** sufficient **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 **ALLOW ORA**

Question			Answer	Mark	Guidance
5	(c)	(i)			
			Correct monomer ✓		
			Correct polymer ✓		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 Fl for F
			Balanced equation – correct use of *n* in the equation ✓	3	*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) $nC_2F_4 \rightarrow -(-C_2F_4-)_n-$ scores 1 mark for the correct use of *n*
		(ii)	(PVC) produces hydrogen chloride **OR** produces acidic gases **OR** (PVC) produces phosgene **OR** produces toxic gases **OR** (PVC) produces dioxins ✓	1	**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 **IGNORE** CO and CO_2 are greenhouse gases **IGNORE** chlorine radicals and ozone depletion **IGNORE** causes pollution
			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

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)		**ANY THREE FROM** $C_6H_{12}O_6 \rightarrow 2CO_2 + 2C_2H_5OH$ ✓ Use of yeast/zymase at 25–45 ºC **OR** warm with yeast/zymase ✓ Anaerobic **OR** lack of oxygen ✓ (Separate bioethanol) by (fractional) distillation ✓	3	**IGNORE** state symbols **ALLOW** correct multiples **DO NOT ALLOW** yeast/zymase and heat **DO NOT ALLOW** yeast/zymase and reflux
	(b)	(i)	$C_{15}H_{30}O_2 + 21½O_2 \rightarrow 15CO_2 + 15H_2O$ ✓✓	2	**ALLOW** $\frac{43}{2}$ for 21½ **DO NOT ALLOW** [O] **ALLOW** one mark for correct products if equation is wrong
		(ii)	(Energy needed) for processing biofuel makes carbon dioxide ✓	1	**ALLOW** (energy needed) for transport makes carbon dioxide
	(c)		**ANY THREE FROM** Fossil fuels are finite resources **OR** biofuels are renewable ✓ Allows fossil fuels to be used as a feedstock for organic compounds ✓ Less food crops may be grown **OR** Land not used to grow food crops ✓ (rain) forests have to be cut down to provide land **OR** deforestation ✓ Shortage of fertile soils **OR** reduces fertility of soils ✓ No risk of large scale pollution from exploitation of fossil fuels ✓	3	**ANNOTATE WITH TICKS AND CROSSES** **ALLOW** fossil fuels are non-renewable **OR** plants are a renewable resource **OR** bio-fuels is (more) sustainable **OR** fossil fuels are not sustainable **ALLOW** decrease the need for fossil fuels Destroys habitats is **NOT** sufficient **IGNORE** comments about availability / fertilisers / pesticides

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 *Z* 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

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