



GCE

Chemistry A

Advanced GCE A2 H434

Advanced Subsidiary GCE AS H034

Mark Schemes for the Units

June 2009

H034/H434/MS/R/09

F322

Mark Scheme

June 2009

F322 Chains, Energy and Resources

Question		Expected Answers	Marks	Additional Guidance
1	(a)	C_nH_{2n+2} ✓	1	ALLOW $C_nH_{2(n+1)}$ ✓ IGNORE size of subscripts
	(b)	(i) $C_8H_{18} + 8\frac{1}{2}O_2 \rightarrow 8CO + 9H_2O$ ✓	1	ALLOW any correct multiples IGNORE state symbols
		(ii) limited supply of air OR not enough O_2 ✓	1	ALLOW use of air or oxygen IGNORE it is not completely oxidised
	(c)	(i) $2CO + 2NO \rightarrow 2CO_2 + N_2$ ✓	1	ALLOW any correct multiples including fractions IGNORE state symbols
	(c)	(ii) CO and NO are adsorbed (onto surface) OR reactants are adsorbed (onto surface) ✓ weakening of bonds OR lowers activation energy ✓ CO_2 and N_2 desorbs (from the surface) OR products desorbs (from the surface) ✓	3	ALLOW CO and NO stick onto surface OR CO and NO form weak attractions to the surface OR gases are adsorbed onto surface NOT absorb but allow ecf for deabsorb later on IGNORE alternative pathway Requires less energy is not sufficient ALLOW products leave the surface OR products diffuse away from surface OR weak attraction to surface is broken ALLOW deadsorb
	(d)	skeletal formula of a branched isomer of C_8H_{18} ✓ skeletal formula of a cyclic hydrocarbon OR skeletal formula of substituted arene of C_8H_{10} ✓	2	ALLOW any ring between C_3 and C_8 with 8 carbon atoms per molecule IGNORE wrong names If two correct structural or displayed formulae drawn award one mark

Question		Expected Answers	Marks	Additional Guidance
	(e)	<p>Any TWO from: atmospheric concentration ✓ ability to absorb infrared radiation ✓ residence time ✓</p>	2	<p>ALLOW the amount of the gas OR abundance of gas ALLOW how much IR it absorbs OR ability to absorb heat IGNORE global warming potential / heat reflected / how much is produced ALLOW how long it stays in the atmosphere</p>
		<p>Any TWO from: deep in the oceans OR on the sea-bed ✓ storage in geological formations OR under the sea-bed ✓ by reaction (with metal oxides) to form carbonates ✓</p>	2	<p>ALLOW piped into disused or partially filled oil wells ALLOW stored as a carbonate OR equation to show formation of suitable carbonate from an oxide IGNORE mineral storage IGNORE reforestation</p>
		Total	13	

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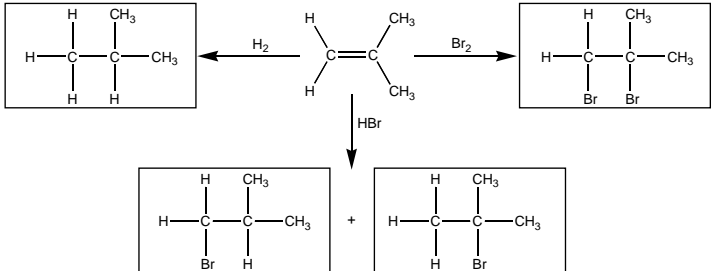
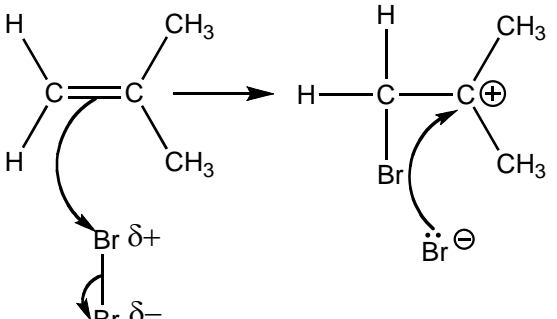
Question		Expected Answers	Marks	Additional Guidance
2	(a) (i)	The enthalpy change for the complete combustion ✓ of 1 mol (of a substance) ✓	2	ALLOW energy change for combustion in excess oxygen OR energy released during complete combustion OR energy change for combustion in excess air NOT energy required This mark is not stand alone but must relate to statement about an enthalpy change even if the statement was not awarded a mark
	(b) (i)	56.430 (kJ) ✓	1	ALLOW 56.43 (kJ) OR 56.4 kJ ✓ OR 56 kJ ALLOW -56.43 i.e. ignore sign
	(ii)	M_r [CH ₃ (CH ₂) ₄ OH] = 88.0 ✓ n = 0.0200 mol ✓	2	ALLOW 88 ALLOW 0.02 OR ecf from wrong M_r ALLOW full marks for 0.02 with no working out
	(iii)	(-)2821.5 ✓ = (-)2820 (3 SF) ✓ correct minus sign ✓	3	ALLOW correct substitution into formula (b)(i) ÷ (b)(ii) e.g. 56.4 ÷ 0.02 this is essentially a mark for the working ALLOW ecf from i.e. answer from (b)(i) ÷ (b)(ii) The minus mark is stand alone and is independent of the numerical answer
	(c) (i)	pressure: 100 kPa OR 101 kPa AND temperature: 298 K OR 25 °C ✓	1	units needed ALLOW 1 bar OR 1 atm OR 760 mmHg ALLOW any stated temperature so for example 100kPa and 40°C would be credited with a mark IGNORE any reference to moles or concentration
	(ii)	6C(s) + 7H ₂ (g) → C ₆ H ₁₄ (l) ✓	1	ALLOW graphite / gr
	(iii)	many different hydrocarbons would form OR activation energy too high OR reaction too slow OR they don't react together ✓	1	ALLOW can form different isomers OR can form different structures IGNORE reaction may be reversible

Question		Expected Answers	Marks	Additional Guidance
	(iv)	$6 \times -394 + 7 \times -286$ shown OR calculated as -4366 ✓ -4366 and -4163 added OR subtracted ✓ correct answer $-4366 - (-4163) = -203$ ✓	3	ALLOW THREE marks for -203 on its own with no working out or written on the answer line ALLOW TWO marks for $+203, +3483, +1513, +1767$ or -8529 on its own with no working out ALLOW ONE mark for or $-3483, -1513, -1767$ or $+8529$ on its own with no working out units NOT needed Positive sign not needed for endothermic answers
		Total	14	

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Question	Expected Answers	Marks	Rationale
3 (a)	 <p>one mark for each correct structure ✓ ✓ ✓ ✓</p>	4	<p>ALLOW skeletal formula OR displayed formulae IGNORE molecular formulae IF two answers given e.g. name and structure then both must be correct to be given a mark</p> <p>ALLOW methylpropane OR $(\text{CH}_3)_3\text{CH}$ ✓</p> <p>ALLOW 1,2-dibromo-methylpropane OR $\text{CH}_2\text{BrCBr}(\text{CH}_3)_2$ ✓</p> <p>ALLOW 1-bromo-methylpropane OR $\text{CH}_2\text{BrCH}(\text{CH}_3)_2$ ✓</p> <p>ALLOW 2-bromo-methylpropane OR $\text{CH}_3\text{CBr}(\text{CH}_3)_2$ ✓</p> <p>ALLOW ecf if wrong carbon skeleton is used in all of the structures mark first structure wrong and then apply ecf for the rest</p>
(b)	<p>curly arrow from double bond to $\text{Br}^{\delta+}$ and curly arrow from $\text{Br}-\text{Br}$ bond pair to $\text{Br}^{\delta-}$ in 1st step ✓</p> <p>curly arrow in 2nd step from bromide ion ✓</p> <p>correct dipole shown on Br_2 ✓</p> <p>correct carbocation shown ✓</p> 	4	<p>Curly arrow must start from the double bond and not a carbon atom, other curly arrow must start from $\text{Br}-\text{Br}$ bond</p> <p>ALLOW curly arrow from any part of bromide ion The bromide ion does not need to show a lone pair</p> <p>Dipole must be partial charge and not full charge Carbocation needs a full charge and not a partial charge (charges do not need to be surrounded by a circle)</p> <p>ALLOW carbocation on carbon 1 where electrophile attacks carbon 2 i.e. $^+\text{CH}_2\text{CBr}(\text{CH}_3)_2$</p>

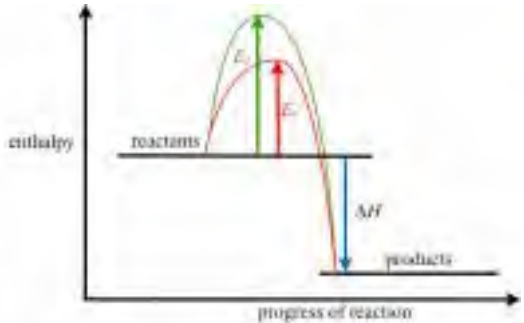
Question		Expected Answers	Marks	Rationale
(c)	(i)	C_6H_{10} ✓	1	
	(ii)	$M_r(\text{cyclohexanol}) = 100$ ✓ amount of cyclohexanol = 0.0765 mol ✓ percentage yield = 35.0% ✓	3	ALLOW full marks for correct answer with no or limited working out ALLOW ecf from wrong molar mass i.e. $7.65 \div$ molar mass ALLOW ecf from wrong amount in moles i.e. $[0.0268 \div \text{moles}] \times 100$ ALLOW 35% ALLOW two marks for 0.35% If M_r of 82 is used then % yield will be 28.7 or 29 and this is worth two marks
(d)	(i)	(sum of) the molecular masses of the desired product ÷ sum of molecular masses of all products × 100 ✓	1	ALLOW (sum of) the molecular masses of the desired product ÷ sum of molecular masses of all reactants × 100 ✓
	(ii)	this preparation is addition OR has 100% atom economy OR there is only one product ✓ preparation from cyclohexanol has less than 100% atom economy OR H_2O is produced as well OR calculated atom economy = 82% ✓	2	ALLOW no by products formed ALLOW other substances formed OR cyclohexene is not the only product
		Total	15	

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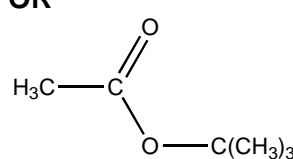
Mark Scheme

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Question		Expected Answers	Marks	Additional Guidance
4	(a)	<p>high pressure as fewer moles (of gas) on right-hand side OR high pressure as volume of products less than that of reactants ✓</p> <p>low temperature as (forward) reaction is exothermic ✓</p>	2	<p>ALLOW ora ALLOW fewer particles OR fewer molecules</p> <p>ALLOW ora</p>
	(b)	<p>Too expensive to use a high pressure ✓</p> <p>Too slow to use a low temperature ✓</p>	2	<p>ALLOW high pressures provide a safety risk OR high pressure is too dangerous</p> <p>ALLOW with low temperature molecules cannot overcome activation barrier</p>
	(c) (i)	<p>Cl + O₃ → ClO + O₂ ✓ ClO + O → Cl + O₂ ✓ overall: O₃ + O → 2O₂ ✓</p> <p>OR</p> <p>Cl + CH₄ → CH₃ + HCl ✓ CH₃ + Cl₂ → CH₃Cl + Cl ✓ overall: CH₄ + Cl₂ → CH₃Cl + HCl ✓</p>	3	<p>Marks must come from one or other of the radical process and not from both of them. If two processes are described then an incorrect step in one process will contradict a correct step in the other process.</p> <p>ALLOW overall equation mark even if the steps are wrong the radicals do NOT need a single dot IGNORE any state symbols</p> <p>ALLOW Cl + O₃ → ClO + O₂ ✓ ClO + O₃ → Cl + 2O₂ ✓ overall: 2O₃ → 3O₂ ✓</p> <p>ALLOW any saturated hydrocarbon including cyclic ALLOW ecf for second step and overall reaction if wrong hydrocarbon used e.g. C₂H₄ is used in first step</p>

Question	Expected Answers	Marks	Additional Guidance
(ii)	<p>ΔH shown and products below reactants ✓</p> <p>E_a shown ✓</p> <p>E_c shown $< E_a$ ✓</p> 	3	<p>NOT double headed arrows but apply ecf for more than one double headed arrow</p> <p>ALLOW one mark if two correctly labelled curves are drawn but the arrows are not shown or are incorrectly drawn</p> <p>The arrows must be positioned as closely as possible to the maximum height of the curves but allow some degree of bod</p>
(d)	<p>Any FOUR from:</p> <p>catalyst not used up in reaction ✓</p> <p>reactions take place at lower temperatures ✓</p> <p>with lower energy demand OR lower activation energy OR use less fuel ✓</p> <p>so less carbon dioxide emitted into atmosphere OR so fossil fuels last longer ✓</p> <p>different reactions can be used ✓</p> <p>with better atom economy OR less waste ✓</p> <p>less hazardous chemicals ✓</p> <p>catalysts or enzymes can generate specific products ✓</p>	4	<p>ALLOW catalysts can work at room temperature OR enzymes work at room temperature</p> <p>IGNORE cheaper</p>
Total		14	

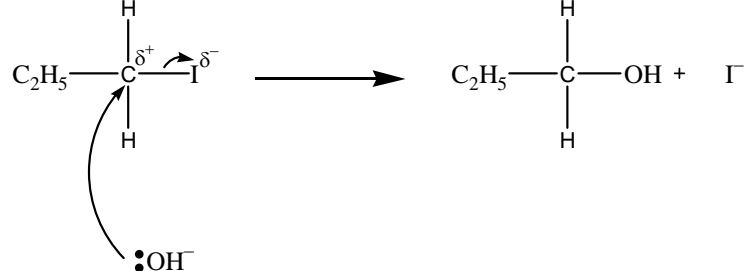
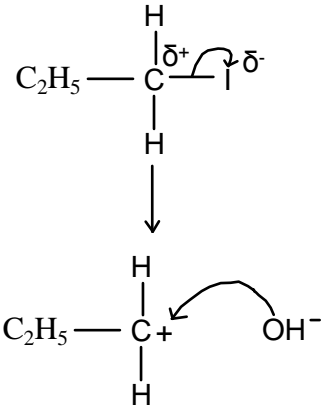
Question		Expected Answers	Marks	Additional Guidance
5	(a)	<p>method 1: fermentation of sugars or carbohydrates OR reaction with yeast with sugar or carbohydrates ✓ $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$ ✓</p> <p>method 2: hydration of ethene OR reaction of ethene with water OR reaction of steam with ethene ✓ $C_2H_4 + H_2O \rightarrow C_2H_5OH$ ✓</p>	4	<p>ALLOW sugar from equation</p> <p>ALLOW C_2H_6O in equation ALLOW correct multiples IGNORE state symbols</p> <p>ALLOW ethene from the equation IGNORE mention of any catalyst ALLOW C_2H_6O in equation OR H_2O over the arrow ALLOW correct multiples IGNORE state symbols</p>
	(b)	(i)	2	<p>If name and formula given both need to be correct ALLOW propanone OR acetone IGNORE propone NOT incorrect named compound</p> <p>ALLOW $C_3H_8O + [O] \rightarrow C_3H_6O + H_2O$ ALLOW O instead of [O] ALLOW correct multiples IGNORE state symbols</p>
		(ii)	3	<p>ALLOW $C=O$ and $O-H$ marks independent of compound identified i.e. stand alone marks ALLOW correct bonds shown by the appropriate absorption on the IR spectrum IGNORE reference to $C-O$ bond</p>
	(c)	(i)	1	ALLOW methylpropan-2-ol OR tertiarybutanol

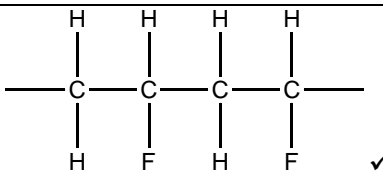
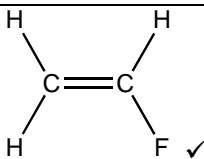
Question		Expected Answers	Marks	Additional Guidance
	(ii)	ester ✓	1	
	(iii)	$\text{CH}_3\text{CO}_2\text{C}(\text{CH}_3)_3$ OR $\text{CH}_3\text{COOC}(\text{CH}_3)_3$ OR  ester group shown ✓ rest of molecule ✓	2	ALLOW skeletal formula OR displayed formula ALLOW ester linkage even if rest of structure is wrong
Total			13	

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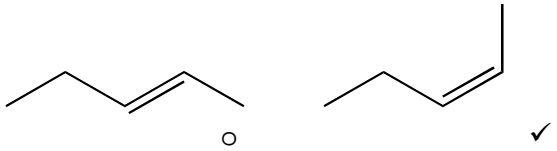
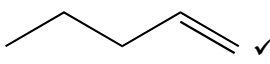
Question	Expected Answers	Marks	Additional Guidance
6 (a) (i)	 <p>C-I curly arrow from the bond not from carbon atom ✓</p> <p>curly arrow from the OH⁻ ✓</p> <p>correct partial charges on C-I ✓</p>	3	<p>no need to show any lone pairs on oxygen but must have a clear negative sign rather than partial negative 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</p> <p>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)	<p>C-I bonds broken more easily ✓</p> <p>C-I bonds are weaker OR have less bond enthalpy OR C-I bonds are longer ✓</p>	2	<p>ALLOW ora e.g. C-Br bonds are stronger OR broken less easily</p>

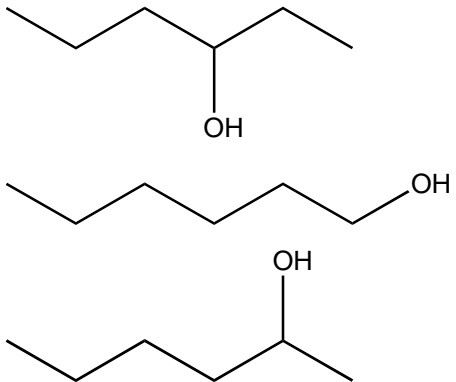
Question		Expected Answers	Marks	Additional Guidance
	(c)	<p>Any TWO from: CFCs take many years to reach the ozone layer OR long residence time ✓</p> <p>CFCs are still being used ✓</p> <p>there are other ozone depleting substances ✓</p>	2	<p>IGNORE because chlorine radicals stay in the stratosphere</p> <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	

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Question	Expected Answers	Marks	Additional Guidance
7 (a)	<p>Structural isomer compounds with the same molecular formula ✓ but with different structural formulae ✓</p> <p>Stereoisomer compounds with the same structural formula ✓ but with different arrangements in space ✓</p> <p>Evidence of using M_r of 70 to calculate molecular formula of C_5H_{10} ✓</p> <p>F and G are</p>  <p>Correct identification of the <i>E</i> and <i>Z</i> isomers ✓</p> <p>H is  ✓</p> <p>E/Z happens because double bonds restricts rotation ✓</p> <p>different groups on each carbon of the double bond ✓</p>	11	<p>ALLOW same molecular formula ✓ but different structures ✓ Second marking point is DEPENDENT on first mark</p> <p>ALLOW compounds with the same structure Second marking point is DEPENDENT on first mark</p> <p>This is the QWC mark</p> <p>IGNORE wrong names of F, G and H</p> <p>ALLOW structural or displayed formulae for F, G and H e.g. H is $CH_3CH_2CH_2CHCH_2$</p> <p>ALLOW identification using <i>trans</i> and <i>cis</i> and ALLOW this marking point as identification of another example of identifying <i>E/Z</i> or <i>cis</i> and <i>trans</i> if not done for F and G</p> <p>ALLOW one mark if no structures drawn but correct names given for F, G and H i.e. <i>E</i>-pent-2-ene, <i>Z</i>-pent-2-ene and pent-1-ene</p> <p>ALLOW ecf on structures if wrong molecular formula used or consistent error or slip such as having just sticks</p>

Question	Expected Answers	Marks	Additional Guidance
(b)	<p>from IR absorption, J contains O–H OR from IR J is an alcohol ✓</p> $C : H : O = \frac{70.59}{12.0} : \frac{13.72}{1.0} : \frac{15.69}{16.0}$ <p>OR 5.8825 : 13.72 : 0.9806 ✓</p> <p>empirical formula = C₆H₁₄O ✓</p> <p>(from mass spectrum), <i>M_r</i> = 102 ✓</p> <p>evidence that it has been shown that the empirical formula is the molecular formulae e.g. <i>M_r</i> of C₆H₁₄O = 102 so empirical formula is molecular formula ✓</p>  <p>One mark for each correct structure ✓ ✓ ✓</p>	8	<p>This is a QWC mark</p> <p>ALLOW two marks for correct empirical formula with no working out</p> <p>This is a QWC mark</p> <p>ALLOW structural or displayed formulae IGNORE incorrect names</p> <p>ALLOW one minor slip in drawing structures e.g. one missing hydrogen but ALLOW ecf for bigger slips such as showing just sticks and no hydrogen atoms ALLOW bond to H in OH</p> <p>ALLOW one mark for three isomers of C₆H₁₃OH whether branched or unbranched as a catch mark if no other mark has been awarded for the structures</p> <p>If more than three isomers of C₆H₁₃OH drawn</p> <ul style="list-style-type: none"> • 1 branched and 3 unbranched award two marks • any other combination award one mark <p>ALLOW one mark for hexan-1-ol, hexan-2-ol and hexan-3-ol if structures not drawn</p>
Total		19	

Grade Thresholds

Advanced GCE (Chemistry A) (H034 H434) June 2009 Examination Series

Unit Threshold Marks

Unit		Maximum Mark	a	b	c	d	e	u
F321	Raw	60	50	43	37	31	25	0
	UMS	90	72	63	54	45	36	0
F322	Raw	100	75	65	55	46	37	0
	UMS	150	120	105	90	75	60	0
F323	Raw	40	34	31	28	25	22	0
	UMS	60	48	42	36	30	24	0

Specification Aggregation Results

Overall threshold marks in UMS (ie after conversion of raw marks to uniform marks)

	Maximum Mark	A	B	C	D	E	U
H034	300	240	210	180	150	120	0

The cumulative percentage of candidates awarded each grade was as follows:

	A	B	C	D	E	U	Total Number of Candidates
H034	17.6	35.1	52.8	68.8	82.2	100.0	16327

16327 candidates aggregated this series

For a description of how UMS marks are calculated see:

http://www.ocr.org.uk/learners/ums_results.html

Statistics are correct at the time of publication.