OCR
RECOGNISING ACHIEVEMENT

GCE

Chemistry A

Advanced GCE **A2 H434**

Advanced Subsidiary GCE **AS H034**

Mark Schemes for the Units

June 2009

H034/H434/MS/R/09

Oxford Cambridge and RSA Examinations

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Advanced Subsidiary GCE Chemistry (H034)

MARK SCHEME FOR THE UNITS

F321 Atoms, Bonds and Groups

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<table>
<tr><th></th><th>protons</th><th>neutrons</th><th>electrons</th></tr>
<tr><td>^{24}Mg</td><td>12</td><td>12</td><td>12</td></tr>
<tr><td>^{25}Mg</td><td>12</td><td>13</td><td>12</td></tr>
</table>
^{24}Mg line correct ✓
^{25}Mg line correct ✓</td><td>2</td><td>mark by row</td></tr>
<tr><td></td><td></td><td>(ii)</td><td><u>24 x 78.60 + 25 x 10.11 + 26 x 11.29</u>
100

OR 18.8640 + 2.5275 + 2.9354

OR 24.3269 ✓

A_r = 24.33 (to 4 sig figs) ✓</td><td>2</td><td>ALLOW two marks for A_r = 24.33 with no working out

ALLOW one mark for ecf from incorrect sum provided final answer is between 24 and 26 and is to 4 significant figures, e.g. 24.3235 ✖ gives ecf of 24.32 ✓</td></tr>
<tr><td></td><td></td><td>(iii)</td><td>The (weighted) mean mass of an atom
OR (weighted) average mass of an atom ✓

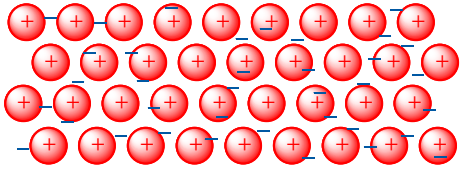
relative to 1/12th (the mass) ✓

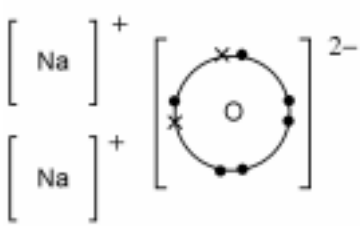
of (one atom of) ^{12}C ✓</td><td>3</td><td>ALLOW The (weighted) mean mass
OR (weighted) average mass of an atom
OR average atomic mass ✓
compared with (the mass of) carbon-12 ✓
which is 12 ✓

For 1st marking point, ALLOW mean mass of the isotopes
OR average mass of the isotopes
Do NOT ALLOW the singular: isotope

ALLOW mass of one mole of atoms ✓
compared to 1/12th ✓
(the mass) of one mole / 12 g of carbon-12 ✓</td></tr>
</table>

Question			Expected Answers	Marks	Additional Guidance
					mass of one mole of atoms ✓ 1/12th ✓ the mass of one mole / 12 g of carbon-12 ✓
	(b)	**(i)**	Mg ✓ oxidation number changes from 0 to (+)2 **OR** oxidation number increases by 2 ✓	**2**	**ALLOW** correct oxidation numbers shown in equation 2nd mark is dependent on identification of Mg **IGNORE** electrons
		(ii)	Mg/solid dissolves **OR** Mg/solid disappears **OR** (Mg/solid) forms a solution ✓ bubbles **OR** fizzes **OR** effervesces **OR** gas produced ✓	**2**	**IGNORE** metal reacts **IGNORE** temperature change **IGNORE** steam produced **DO NOT ALLOW** carbon dioxide gas produced **DO NOT ALLOW** hydrogen produced without **gas**
	(c)	**(i)**	$M(MgSO_4)$ = 120.4 OR 120 (g mol^{-1}) ✓ mol $MgSO_4$ = $\frac{1.51}{120.4}$ = *0.0125 mol* ✓	**2**	**ALLOW** 0.013 up to calculator value of 0.012541528 correctly rounded (from M = 120.4 g mol^{-1}) **ALLOW** 0.013 up to calculator value of 0.012583333 correctly rounded (from M = 120 g mol^{-1}) **ALLOW** ecf from incorrect M i.e. 1.51 ÷ M
		(ii)	$\frac{1.57}{18.0}$ = 0.0872(2) (mol) ✓	**1**	**ALLOW** 0.09 up to calculator value of 0.08722222
		(iii)	***x*** = 7 ✓	**1**	**ALLOW** ecf i.e. answer to (ii) ÷ answer to (i) **ALLOW** correctly calculated answer from 1 significant figure up to calculator value, ie, ***x*** does not have to be a whole number. Likely response = 6.95 ✓
			Total	**15**	

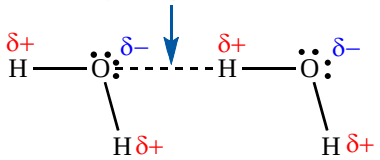
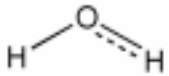
Question			Expected Answers	Marks	Additional Guidance
2	(a)		 regular arrangement of **labelled** + ions with some attempt to show electrons ✓ scattering of labelled electrons **between** other species **OR** a statement anywhere of **delocalised** electrons (can be in text below) ✓ metallic bond as (electrostatic) **attraction** between the electrons and the positive ions ✓	3	Lattice must have at least 2 rows of positive ions If a metal ion is shown (e.g. Na^+), it must have the correct charge **ALLOW** for labels: + ions, positive ions, cations If '+' is unlabelled in diagram, award the label for '+' from a statement of 'positive ions' in text below **DO NOT ALLOW** as label or text positive atom **OR** protons **OR** nuclei **ALLOW** e^- **OR** e as label for electron **DO NOT ALLOW** '–' as label for electron
	(b)	**(i)**	$4\ Na + O_2 \longrightarrow 2\ Na_2O$ **OR** $2\ Na + ½\ O_2 \longrightarrow Na_2O$ ✓	**1**	**ALLOW** correct multiples including fractions **IGNORE** state symbols
		(ii)	(electrostatic) attraction between oppositely charged ions✓	**1**	

Question			Expected Answers	Marks	Additional Guidance
		(iii)	 Na shown with either 8 or 0 electrons **AND** O shown with 8 electrons **with** 6 crosses and 2 dots (or vice versa) ✓ Correct charges on both ions ✓	**2**	**For 1st mark,** if 8 electrons shown around cation then 'extra' electron(s) around anion must match symbol chosen for electrons in cation Shell circles not required **IGNORE** inner shell electrons **ALLOW:** $2[Na^+]$ $2[Na]^+$ $[Na^+]_2$ (brackets not required) **DO NOT ALLOW** $[Na_2]^{2+}$ / $[Na_2]^+$ / $[2Na]^{2+}$ **DO NOT ALLOW**: $[Na_2]^{2+}$ $[Na_2]^+$ $[2Na]^{2+}$ $[Na]_2^+$
	(c)		sodium is a (good) conductor because it has mobile electrons **OR** delocalised electrons **OR** electrons can move ✓ sodium oxide does not conduct as a solid ✓ sodium oxide conducts when it is a liquid ✓ ions cannot move in a solid ✓ **ions** can move **OR** are mobile when liquid ✓	**5**	**Throughout this question, 'conducts' and 'carries charge' are treated as equivalent terms.** **DO NOT ALLOW** 'free electrons' for mobile electrons **ALLOW** poor conductor **OR** bad conductor 'Sodium oxide only conducts when liquid' is insufficient to award 'solid conductivity' mark **ALLOW** ions are fixed in place **IGNORE** electrons **IGNORE** charge carriers **IGNORE** 'delocalised ions' or 'free ions' for mobile ions Any mention of electrons moving is a **CON**
			Total	**12**	

Question			Expected Answers	Marks	Additional Guidance
3	(a)	(i)	mol HCl = 1.50×10^{-2} ✓ volume HCl(aq) = 75.0 ✓	2	**ALLOW** answers to 2 significant figures **ALLOW** ecf from wrong number of moles i.e. $\frac{\text{moles of HCl} \times 1000}{0.200}$ **ALLOW** one mark for 37.5 (from incorrect 1:1 ratio)
		(ii)	180 ✓	1	No other acceptable answer
	(b)		$CaCO_3(s) \longrightarrow CaO(s) + CO_2(g)$ equation ✓ state symbols ✓	2	state symbols are **dependent** on correct formulae of $CaCO_3$, CaO and CO_2 **DO NOT ALLOW** the 'equation mark' if O_2 is seen on both sides (but note that the 'state symbol mark' may still be accessible)
	(c)	(i)	$Ca(OH)_2$ ✓	1	**IGNORE** charges, even if wrong
		(ii)	$Ca(NO_3)_2$ ✓	1	**IGNORE** charges, even if wrong
			Total	7	

Question			Expected Answers	Marks	Additional Guidance
4	(a)	(i)	the energy required to remove one electron ✓ from each atom in one mole ✓ of gaseous atoms ✓	3	**ALLOW** 3 marks for: the energy required to remove one mole of electrons ✓ from one mole of atoms ✓ atoms in the gaseous state ✓ If no definition, **ALLOW one** mark for the equation below, including state symbols. $X(g) \rightarrow X^+(g) + e^-$ / $X(g) - e^- \rightarrow X^+(g)$ **ALLOW** e for electron **IGNORE** state symbol for electron
	(b)	(i)	outer electrons closer to nucleus **OR** radii decreases ✓ nuclear charge increases **OR** protons increase ✓ electrons added to the same shell **OR** screening **OR** shielding remains the same ✓	3	 **IGNORE** 'atomic number increases' **IGNORE** 'nucleus gets bigger' 'charge increases' is not sufficient **ALLOW** 'effective nuclear charge increases' **OR** 'shielded nuclear charge increases' **ALLOW** shielding is similar
		(ii)	atomic radii increase **OR** there are more shells ✓ there is **more** shielding **OR more** screening ✓	3	**ALLOW** electrons in higher energy level **ALLOW** electrons are further from the nucleus **DO NOT ALLOW** more orbitals **OR** more sub-shells **DO NOT ALLOW** different shell or new shell There must be a clear comparison: *e.g.* '**more** shielding'**, 'increased** shielding'. *i.e.* **DO NOT ALLOW** just 'shielding'. **ALLOW** '**more** electron repulsion from inner shells'

Question			Expected Answers	Marks	Additional Guidance
			the nuclear attraction decreases **OR** Increased shielding / distance outweigh the increased nuclear charge ✓		**Nuclear OR proton(s) OR nucleus spelt correctly ONCE** **ALLOW** 'nuclear pull' **IGNORE** any reference to 'effective nuclear charge'
	(c)	**(i)**	$O^{+}(g) \longrightarrow O^{2+}(g) + e^{-}$ ✓	**1**	answer **must have** state symbols **ALLOW** e for electron **ALLOW** $O^{+}(g) - e^{-} \rightarrow O^{2+}(g)$ **DO NOT ALLOW** $O^{+}(g) + e^{-} \longrightarrow O^{2+}(g) + 2e^{-}$ **IGNORE** state symbol for electron
		(ii)	the O^{+} ion, is smaller than the O atom **OR** the electron repulsion/shielding is smaller **OR** the proton : electron ratio in the 2+ ion is greater than in the 1+ ion ✓	**1**	**ALLOW** the outer electrons in an O^{+} ion are closer to the nucleus than an O atom **DO NOT ALLOW** 'removed from next shell down'
			Total	**11**	

Question			Expected Answers	Marks	Additional Guidance
5	(a)	(i)	number of protons (in the nucleus) ✓	1	**ALLOW** proton number **ALLOW** number of protons in an atom **IGNORE** reference to electrons
		(ii)	$(1s^2)2s^22p^63s^23p^63d^24s^2$ ✓	1	**ALLOW** $1s^2$ written twice **ALLOW** subscripts **ALLOW** $4s^2$ before $3d^{2+}$
		(iii)	Mn / manganese **and** d ✓	1	**ALLOW** D
	(b)	(i)	Hydrogen bond  Shape of water with at least one H with δ+ and at least one O with δ– ✓ H-bond between H in one water molecule and a lone pair of an O in another water molecule✓ hydrogen bond labelled **OR** H_2O has hydrogen bonding ✓	3	all marks can be awarded from a labelled diagram If HO_2 shown then **DO NOT ALLOW** 1st mark Dipole could be described in words so it does **not** need to be part of diagram. At least one hydrogen bond **must** clearly hit a lone pair Lone pair interaction could be described in words so it does **not** need to be part of diagram. **DO NOT ALLOW** hydrogen bonding if described in context of intramolecular bonding, *ie* 
		(ii)	no hydrogen bonding **OR** weaker intermolecular forces ✓	1	**DO NOT ALLOW** 'weaker'/ 'weak' hydrogen bonding **ALLOW** weaker van der Waals' forces **ALLOW** weaker dipole-dipole interactions **DO NOT ALLOW** 'weak intermolecular forces' (ie comparison essential here) **DO NOT ALLOW** 'no intermolecular forces'

Question			Expected Answers	Marks	Additional Guidance
	(c)		van der Waals' forces **OR** induced dipole interactions ✓ number of electrons increases ✓ **Down the group**, intermolecular forces / van der Waals' forces increase **OR** **Down the group**, more energy needed to break intermolecular / van der Waals' forces ✓	3	**electron(s) must be seen and spelt correctly ONCE** **ALLOW** number of electron shells increases **ALLOW** iodine has most electrons **ALLOW** chlorine has the least electrons For **'Down the group'** **ALLOW** 'Increase in boiling points' or 'Molecules get bigger'
	(d)	(i)	goes brown ✓	1	**ALLOW** yellow **OR** orange **OR** any shade of yellow, orange and brown, *e.g.* reddish-brown **IGNORE** precipitate
		(ii)	iodine and (potassium) chloride ✓ $Cl_2 + 2I^- \longrightarrow I_2 + 2Cl^-$ ✓	2	**DO NOT ALLOW** formulae (*i.e.* names essential) **ALLOW** any correct multiple including fractions **IGNORE** state symbols
		(iii)	chlorine / Cl_2 is more reactive (than iodine) **OR** chlorine / Cl_2 is a more powerful oxidising agent ✓	1	**ALLOW** chlorine is better at electron capture **OR** chlorine attracts electrons more **ALLOW** iodine is less reactive (than chlorine) **ALLOW** iodide (ion) / I^- is a stronger reducing agent **DO NOT ALLOW** Cl is more reactive **DO NOT ALLOW** explanation in terms of displacement **DO NOT ALLOW** chlorine is more electronegative
		(iv)	goes purple / violet / lilac / pink ✓	1	**ALLOW** pink **OR** any combination of purple, violet, lilac and pink
			Total	15	

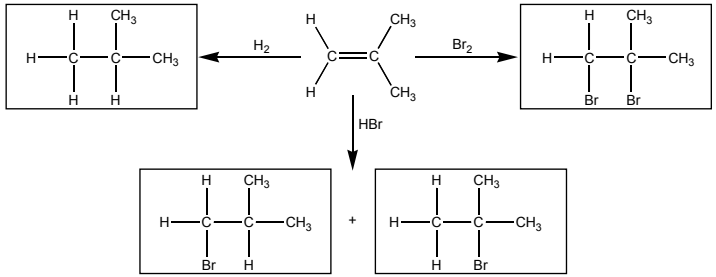
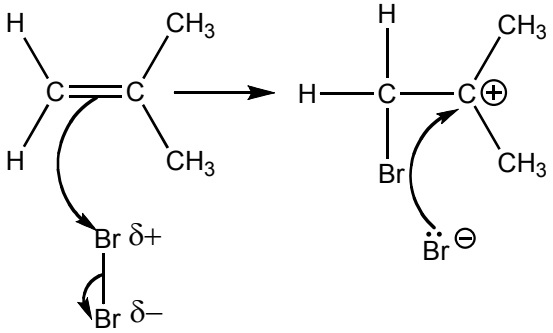
F322 Chains, Energy and Resources

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)	$C_8H_{18} + 8½O_2 \rightarrow 8CO + 9H_2O$ ✓	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)		**Any TWO from:** atmospheric concentration ✓ ability to absorb infrared radiation ✓ residence time ✓	2	 **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
			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 ✓	2	 **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
			Total	13	

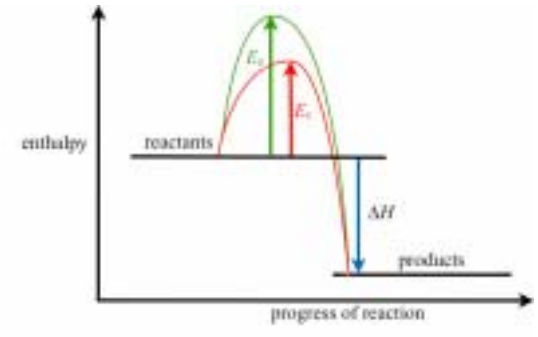
Question			Expected Answers	Marks	Additional Guidance
2	(a)	(i)	The enthalpy change for the complete combustion ✓ of 1 mol (of a substance) ✓	2	**ALLOW** energy change for combustion in excess oxygen **OR** energy released during complete combustion **OR** energy change for combustion in excess air **NOT** 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 [$CH_3(CH_2)_4OH$] = 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^{o}C would be credited with a mark **IGNORE** any reference to moles or concentration
		(ii)	6C(s) + 7H_2(g) → C_6H_{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

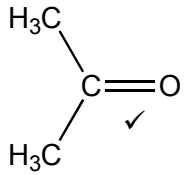
Question			Expected Answers	Marks	Additional Guidance
		(iv)	6 × –394 + 7 × –286 shown **OR** calculated as –4366 ✓ –4366 and –4163 added **OR** subtracted ✓ correct answer –4366 – (–4163) = –203 ✓	3	**ALLOW THREE** marks for –203 on its own with no working out or written on the answer line **ALLOW TWO** 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	

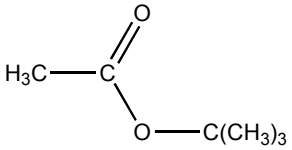
Question			Expected Answers	Marks	Rationale
3	(a)		 one mark for each correct structure ✓ ✓ ✓ ✓	4	**ALLOW** skeletal formula OR displayed formulae **IGNORE** molecular formulae **IF** two answers given e.g. name and structure then both must be correct to be given a mark **ALLOW** methylpropane **OR** $(CH_3)_3CH$ ✓ **ALLOW** 1,2-dibromo-methylpropane **OR** $CH_2BrCBr(CH_3)_2$ ✓ **ALLOW** 1-bromo-methylpropane **OR** $CH_2BrCH(CH_3)_2$ ✓ **ALLOW** 2-bromo-methylpropane **OR** $CH_3CBr(CH_3)_2$ ✓ **ALLOW** ecf if wrong carbon skeleton is used in all of the structures mark first structure wrong and then apply ecf for the rest
	(b)		curly arrow from double bond to $Br^{\delta+}$ and curly arrow from Br—Br bond pair to $Br^{\delta-}$ in 1st step ✓ curly arrow in 2nd step from bromide ion ✓ correct dipole shown on Br_2 ✓ correct carbocation shown ✓ 	4	Curly arrow must start from the double bond and not a carbon atom, other curly arrow must start from Br—Br bond **ALLOW** curly arrow from any part of bromide ion The bromide ion does not need to show a lone pair 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) **ALLOW** carbocation on carbon 1 where electrophile attacks carbon 2 i.e. $^{+}CH_2CBr(CH_3)_2$

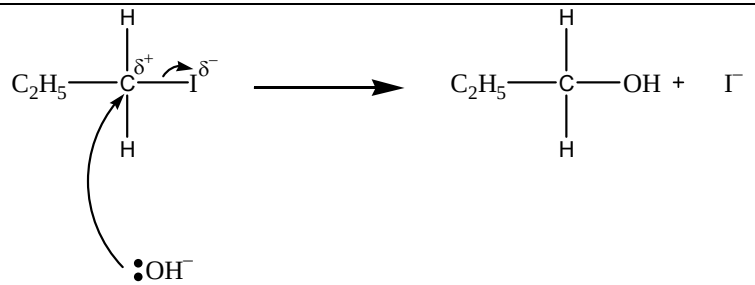
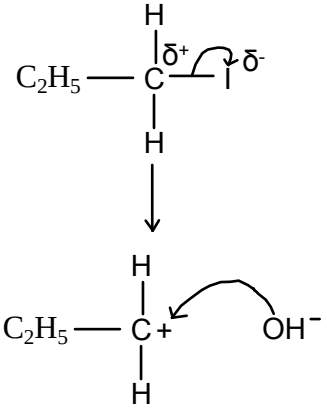
Question			Expected Answers	Marks	Rationale
	(c)	(i)	C_6H_{10} ✓	1	
		(ii)	M_r(cyclohexanol) = 100 ✓ amount of cyclohexanol = 0.0765 mol ✓ percentage yield = 35.0% ✓	3	**ALLOW** full marks for correct answer with no or limited working out **ALLOW** ecf from wrong molar mass i.e. 7.65 ÷ molar mass **ALLOW** ecf from wrong amount in moles i.e. [0.0268 ÷ moles] × 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 than100% 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	

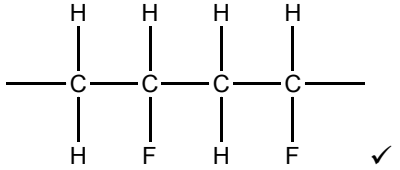
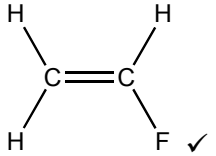
Question			Expected Answers	Marks	Additional Guidance
4	(a)		high pressure as fewer moles (of gas) on right-hand side OR high pressure as volume of products less than that of reactants ✓ low temperature as (forward) reaction is exothermic ✓	2	**ALLOW** ora **ALLOW** fewer particles **OR** fewer molecules **ALLOW** ora
	(b)		Too expensive to use a high pressure ✓ Too slow to use a low temperature ✓	2	**ALLOW** high pressures provide a safety risk **OR** high pressure is too dangerous **ALLOW** with low temperature molecules cannot overcome activation barrier
	(c)	(i)	$Cl + O_3 \rightarrow ClO + O_2$ ✓ $ClO + O \rightarrow Cl + O_2$ ✓ overall: $O_3 + O \rightarrow 2O_2$ ✓ **OR** $Cl + CH_4 \rightarrow CH_3 + HCl$ ✓ $CH_3 + Cl_2 \rightarrow CH_3Cl + Cl$ ✓ overall: $CH_4 + Cl_2 \rightarrow CH_3Cl + HCl$ ✓	3	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. **ALLOW** overall equation mark even if the steps are wrong the radicals do **NOT** need a single dot **IGNORE** any state symbols **ALLOW** $Cl + O_3 \rightarrow ClO + O_2$ ✓ $ClO + O_3 \rightarrow Cl + 2O_2$ ✓ overall: $2O_3 \rightarrow 3O_2$ ✓ **ALLOW** any saturated hydrocarbon including cyclic **ALLOW** ecf for second step and overall reaction if wrong hydrocarbon used e.g. C_2H_4 is used in first step

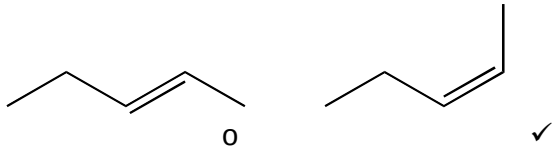
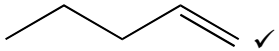
Question			Expected Answers	Marks	Additional Guidance
		(ii)	Δ*H* shown **and** products below reactants ✓ E_a shown ✓ E_c shown < E_a ✓  	3	**NOT** double headed arrows but apply ecf for more than one double headed arrow **ALLOW** one mark if two correctly labelled curves are drawn but the arrows are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

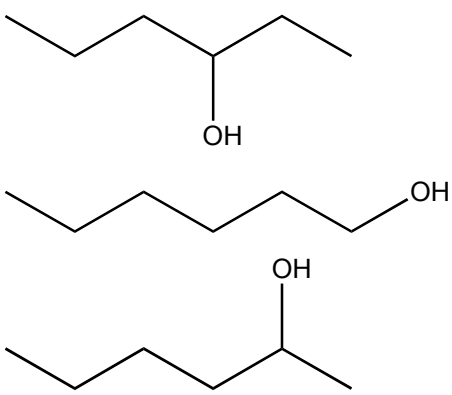
Question			Expected Answers	Marks	Additional Guidance
5	(a)		**method 1:** fermentation of sugars or carbohydrates **OR** reaction with yeast with sugar or carbohydrates ✓ $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$ ✓ **method 2:** hydration of ethene OR reaction of ethene with water **OR** reaction of steam with ethene ✓ $C_2H_4 + H_2O \rightarrow C_2H_5OH$ ✓	**4**	**ALLOW** sugar from equation **ALLOW** C_2H_6O in equation **ALLOW** correct multiples **IGNORE** state symbols **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
	(b)	(i)	$(CH_3)_2CO$ **OR**  ✓ $(CH_3)_2CHOH + [O] \longrightarrow (CH_3)_2CO + H_2O$ ✓	**2**	If name and formula given both need to be correct **ALLOW** propanone **OR** acetone **IGNORE** propone **NOT** incorrect named compound **ALLOW** $C_3H_8O + [O] \rightarrow C_3H_6O + H_2O$ **ALLOW** O instead of [O] **ALLOW** correct multiples **IGNORE** state symbols
		(ii)	CH_3CH_2COOH **OR** propanoic acid ✓ Any number or range of numbers between 1750–1640 (cm^{-1}) for C=O ✓ Any number or range of numbers between 2500–3300 (cm^{-1}) for O–H ✓	**3**	 **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
	(c)	(i)	2-methylpropan-2-ol ✓	**1**	**ALLOW** methylpropan-2-ol **OR** tertiarybutanol

Question			Expected Answers	Marks	Additional Guidance
		(ii)	ester ✓	1	
		(iii)	$CH_3CO_2C(CH_3)_3$ **OR** $CH_3COOC(CH_3)_3$ **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**	

Question			Expected Answers	Marks	Additional Guidance
6	(a)	(i)	 C–I curly arrow from the bond not from carbon atom ✓ curly arrow from the OH^- ✓ correct partial charges on C—I ✓	3	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 **ALLOW** curly arrow from a negative charge or from any part of hydroxide ion If S_N1 mechanism is given then use the mark scheme below correct partial charges on C—I ✓ C–I curly arrow from the bond not from carbon atom ✓ curly arrow from the OH^- to the **correct** carbocation ✓ 
		(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)		**Any TWO from:** CFCs take many years to reach the ozone layer **OR** long residence time ✓ CFCs are still being used ✓ there are other ozone depleting substances ✓	2	 **IGNORE** because chlorine radicals stay in the stratosphere **ALLOW** other named ozone depleting substances e.g. NO and HFCs
	(d)	(i)	 ✓	1	Free bonds at bond ends must be present **ALLOW** minor slip e.g. missing one hydrogen and left as a stick **ALLOW** more than two repeat units but must be a whole number of repeat units **IGNORE** brackets, use of numbers and n in the drawn structure
		(ii)	 ✓	1	**ALLOW** skeletal formula **ALLOW** CH_2CHF
	(e)		**Any two from:** separation into types and recycling **OR** sort plastics, melt and remould ✓ combustion for energy generation ✓ used for cracking **OR** feedstock for plastics or chemicals ✓	2	**IGNORE** biodegradable used as a fuel is insufficient releases energy is insufficient **ALLOW** burning plastics to release energy **ALLOW** organic feedstock / raw materials to make organic compounds
			Total	12	

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

Question	Expected Answers	Marks	Additional Guidance
(b)	from IR absorption, **J** contains O–H **OR** from IR **J** is an alcohol✓ C : H : O = $\frac{70.59}{12.0}$: $\frac{13.72}{1.0}$: $\frac{15.69}{16.0}$ **OR** 5.8825 : 13.72 : 0.9806 ✓ empirical formula = $C_6H_{14}O$ ✓ (from mass spectrum), M_r = 102 ✓ evidence that it has been shown that the empirical formula is the molecular formulae e.g. M_r of $C_6H_{14}O$ = 102 so empirical formula is molecular formula ✓  One mark for each correct structure ✓ ✓ ✓	8	This is a QWC mark **ALLOW two** marks for correct empirical formula with no working out This is a QWC mark **ALLOW** structural or displayed formulae **IGNORE** incorrect names **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 **ALLOW one** mark for three isomers of $C_6H_{13}OH$ whether branched or unbranched as a catch mark if no other mark has been awarded for the structures If more than three isomers of $C_6H_{13}OH$ drawn • 1 branched and 3 unbranched award **two** marks • any other combination award **one** mark **ALLOW** one mark for hexan-1-ol, hexan-2-ol and hexan-3-ol if structures not drawn
	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.

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