OCR
Oxford Cambridge and RSA

GCE

Chemistry A

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

Advanced Subsidiary GCE

Mark Scheme for June 2014

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

OCR will not enter into any discussion or correspondence in connection with this mark scheme.

Annotation	Meaning
BP	Blank Page – this annotation must be used on all blank pages within an answer booklet (structured or unstructured) and on each page of an additional object where there is no candidate response.
BOD	Benefit of doubt given
CON	Contradiction
	Incorrect response
ECF	Error carried forward
I	Ignore
NAQ	Not answered question
NBOD	Benefit of doubt not given
POT	Power of 10 error
^	Omission mark
RE	Rounding error
SF	Error in number of significant figures
	Correct response

Abbreviations, annotations and conventions used in the detailed Mark Scheme (to include abbreviations and subject-specific conventions).

Annotation	Meaning
DO NOT ALLOW	Answers which are not worthy of credit
IGNORE	Statements which are irrelevant
ALLOW	Answers that can be accepted
( )	Words which are not essential to gain credit
__	Underlined words must be present in answer to score a mark
ECF	Error carried forward
AW	Alternative wording
ORA	Or reverse argument

Subject-specific Marking Instructions

The following questions should be annotated with ticks to show where marks have been awarded in the body of the text:

2(b), 3(a), 4(a), 4(b)(iii), 6(a)(i), 7(d), 8(a), 8(b)

All questions where an ECF has been applied.

Checking additional pages

All the Additional Pages in the examination script must be checked to see if any candidates include any answers.

- When you open question **1(a)(i)** you will see a view of page 22 one of the Additional Pages.
- If the page is blank then, using the marking mode, annotate the page with an omission mark, ^.
- Scroll down to page 24 and annotate with a ^ if the page is blank.
- If pages 23 or 24 are not blank then use the paper clip icon to link the pages to the correct questions.

- You may need to contact your Team Leader if you do not know how to do this.

Generic comments

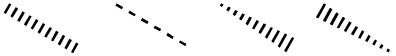
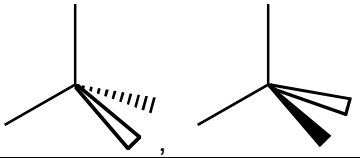
ORGANIC STRUCTURES
For a 'structure' or 'structural formula',
- **ALLOW** correct structural **OR** displayed **OR** skeletal formula **OR** mixture of the above (as long as unambiguous)

For an alkyl group shown within a structure,
- **ALLOW** bond drawn to C or H,
  e.g. **ALLOW** CH_3–,CH_2–, C_3H_7–, etc.
- **ALLOW** vertical 'bond' to any part of an alkyl group

For an OH group shown within a structure,
- **DO NOT ALLOW** formula with horizontal —HO **OR** OH –
- **ALLOW** vertical 'bond' to any part of the OH group

For a CHO group shown within a structure,
- **DO NOT ALLOW** COH

For a 3D structure,

• For bond in the plane of paper, a solid line is expected:	
• For bond out of plane of paper, a solid wedge is expected:	
• For bond into plane of paper, **ALLOW**:	
• **ALLOW** a hollow wedge for 'in bond' OR an 'out bond', provided it is different from the other in or out wedge e.g.:	 ,

NAMES

Names including alkyl groups:
- **ALLOW** alkanyl, e.g. ethanyl (i.e. **IGNORE** 'an')
- **DO NOT ALLOW** alkol, e.g. ethol (ie 'an' is essential)

Names of esters:
- Two words are expected, e.g. ethyl ethanoate
- **ALLOW** one word, e.g. ethylethanoate

Names with multiple numbers and hyphens:
Use of 'e'
- **ALLOW** superfluous 'e' , e.g. propane-1-ol ('e' is kept if followed by consonant)
- **ALLOW** absence of 'e', e.g. propan-1,2-diol ('e' is omitted if followed by vowel)

Hyphens separate name from numbers:
- **ALLOW** absence of hyphens, e.g. propane 1,2 diol

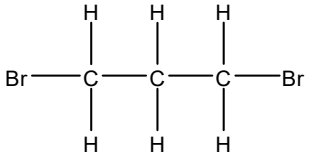
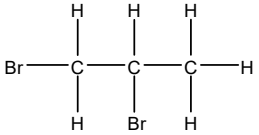
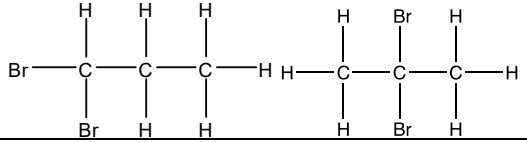
Multiple locant numbers must be clearly separated:
- **ALLOW** full stops: e.g. 1.2 OR spaces: 1 2
- **DO NOT ALLOW e.g.** 12

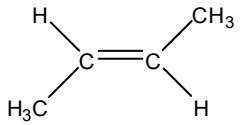
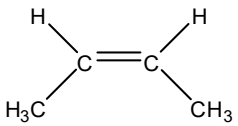
Locant numbers in formula must be correct
- **DO NOT ALLOW** propan-3-ol

Order of substituents should be alphabetical:
- **ALLOW** any order (as long as unambiguous), e.g. 2-chloro-3-bromobutane

ABBREVIATIONS
van der Waal's forces
ALLOW vdw forces **OR** VDW forces (and any combination of upper and lower cases)

Question			Answer	Mark	Guidance
1	(a)	(i)	(series of compounds with the) same functional group **OR** same/similar chemical properties **OR** same/similar chemical reactions ✓ each **successive/subsequent** member differing by CH_2 ✓	2	**IGNORE** references to physical properties **IGNORE** has same general formula (in question) **DO NOT ALLOW** have the same empirical formula **OR** have the same molecular formula
		(ii)	C_nH_{2n} ✓	1	
		(iii)	More carbons (in ring) **OR** more (surface area of) contact **AND** **more van der Waals** forces **OR stronger van der Waals** forces ✓ More energy needed to break the intermolecular forces ✓	2	**Both answers need to be comparisons** **ALLOW** ORA throughout **ALLOW** has more electrons **OR** larger (carbon) ring **OR** higher molecular mass **IGNORE** bigger molecule **IGNORE** chain instead of ring **DO NOT ALLOW** 'more contact between atoms' **ALLOW** 'VDW' for van der Waals 'More intermolecular forces' is **not** sufficient **ALLOW** it is harder to overcome the intermolecular forces **ALLOW** intermolecular bonds / van der Waals bonds **ALLOW** more energy is needed to separate molecules **IGNORE** more energy is needed to break bonds

Question			Answer	Mark	Guidance
	(b)		tetrahedral ✓ four **bonding** pairs repel **OR** four **bonds** repel ✓	2	**Mark each point independently** **IGNORE** surrounded by four atoms **IGNORE** four areas of electron charge repel **IGNORE** four electron pairs repel (*one could be lp*) **DO NOT ALLOW** atoms repel
	(c)		 ✓	1	**ALLOW** correct structural **OR** displayed **OR** skeletal formula **OR** mixture of the above (as long as unambiguous) **ALLOW** structure of 1,2-isomer  **IGNORE** molecular formula **DO NOT ALLOW,** structure of 1,1-isomer **OR** 2,2-isomer 
	(d)	(i)	$C_6H_{14} \rightarrow C_6H_{12} + H_2$ ✓	1	**ALLOW** correct structural **OR** displayed **OR** skeletal formula **OR** mixture of the above (as long as unambiguous) **ALLOW** any correct multiple **IGNORE** state symbols

Question			Answer	Mark	Guidance
		(ii)	Cyclohexane will burn more efficiently ✓	1	**KEY IDEA IS COMBUSTION OR BURNING** **Assume 'it' refers to cyclohexane** **ALLOW ORA** for hexane **ALLOW** cyclohexane allows smoother burning **OR** promotes more efficient combustion **OR** increases octane number **OR** reduces knocking **OR** less likely to produce pre-ignition **OR** burns better **OR** easier to burn **OR** combusts more easily **OR** improves combustion **OR** burns more cleanly **DO NOT ALLOW** cyclohexane ignites more easily **IGNORE** cyclohexane increase volatility of fuel **IGNORE** reference to boiling points **IGNORE** cyclohexane gives a better fuel
	(e)	**(i)**	(Compounds with the) same structural formula but a different arrangement (of atoms) in space ✓	1	**ALLOW** different spatial arrangement of atoms. **DO NOT ALLOW** different displayed formula.
		(ii)	 ✓  ✓	2	**ALLOW** displayed **OR** skeletal formula **OR** mixture of the above. **ALLOW** structures in either order **IGNORE** molecular formula **IGNORE** structural formula **IGNORE** names **IGNORE** E/Z and cis/trans labels **ALLOW** 1 mark for a pair of E/Z isomers of an incorrect hydrocarbon structure with **four** C atoms e.g. C, or CH or CH_2 instead of CH_3 groups.

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Mark</th><th>Guidance</th></tr>
<tr><td></td><td>(f)</td><td>(i)</td><td>
<table>
<tr><th>Step</th><th>Equation</th></tr>
<tr><td>Initiation
(1 mark)</td><td>$Br_2 \rightarrow 2Br\bullet$ ✓</td></tr>
<tr><td>Propagation
(2 marks)</td><td>$C_6H_{12} + Br\bullet \rightarrow C_6H_{11}\bullet + HBr$ ✓

$C_6H_{11}\bullet + Br_2 \rightarrow C_6H_{11}Br + Br\bullet$ ✓</td></tr>
<tr><td>Termination
(2 marks)</td><td>$C_6H_{11}\bullet + Br\bullet \rightarrow C_6H_{11}Br$

$C_6H_{11}\bullet + C_6H_{11}\bullet \rightarrow C_{12}H_{22}$

$Br\bullet + Br\bullet \rightarrow Br_2$

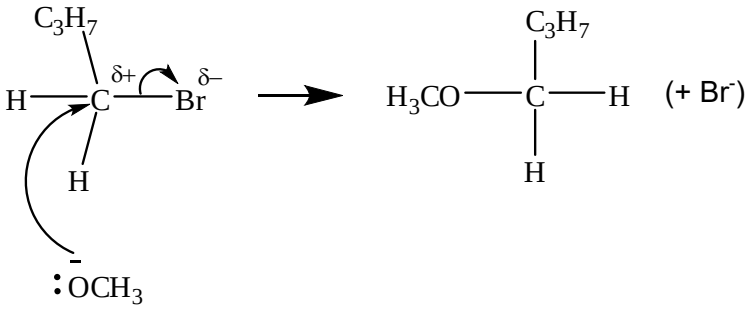
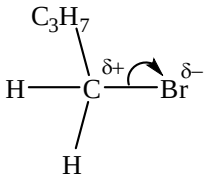
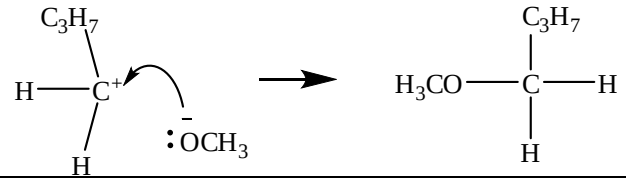
Two correct ✓
All three correct ✓✓</td></tr>
</table>
</td><td>5</td><td>IGNORE state symbols

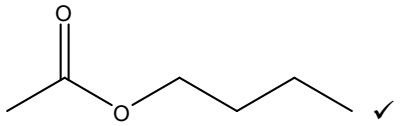
IGNORE dots

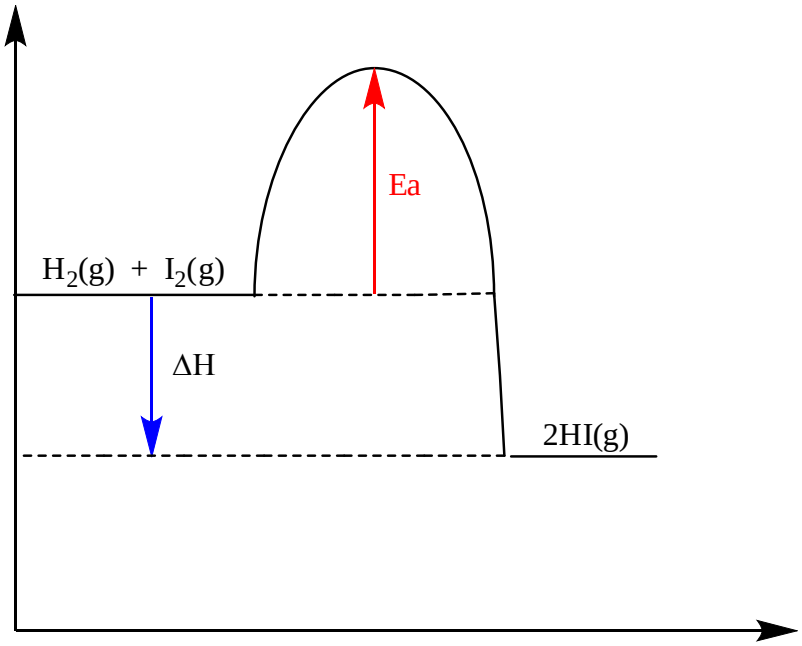
If an incorrect hydrocarbon with six C atoms is used:
DO NOT ALLOW any marks for the propagation steps but
ALLOW ECF for termination steps (i.e. 3 max)</td></tr>
<tr><td></td><td></td><td>(ii)</td><td>The breaking of a (Br-Br) bond AND forms (two) radicals
OR
the breaking of a (Br-Br) bond AND one electron (from the bond pair) goes to each atom/bromine ✓</td><td>1</td><td>ALLOW ‘the breaking of a covalent bond’
ALLOW the splitting of the bond in bromine

ALLOW the breaking of a covalent bond where each atom keeps one of the bonding electrons
IGNORE particle for atom
ALLOW one electron goes to each product / species
DO NOT ALLOW molecule or compound for atom
IGNORE homolytic fission equations</td></tr>
<tr><td></td><td>(g)</td><td>(i)</td><td>$C_6H_{12} + 2Br_2 \rightarrow C_6H_{10}Br_2 + 2HBr$ ✓</td><td>1</td><td>ALLOW molecular formula only.</td></tr>
<tr><td></td><td></td><td>(ii)</td><td>1,1-dibromocyclohexane
OR 1,2-dibromocyclohexane
OR 1,3-dibromocyclohexane
OR 1,4-dibromocyclohexane ✓</td><td>1</td><td>Locant numbers MUST lowest possible e.g. DO NOT ALLOW 2,4-dibromocyclohexane etc.

IGNORE structures</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>21</td><td></td></tr>
</table>

Question			Answer	Mark	Guidance
2	(a)		It is an electron pair donor **OR** can donate a lone pair ✓	1	
	(b)			3	**ANNOTATE ANSWER WITH TICKS AND CROSSES ETC** **IGNORE** connectivity to C_3H_7 throughout
			Dipole shown on the C-Br bond, $C^{\delta+}$ and $Br^{\delta-}$ and curly arrow from the C-Br bond to the Br atom ✓		**IGNORE** alkyl group in first marking point. Curly arrow must start from C–Br bond and not from C atom. Dipole must be partial charge and not full charge
			Curly arrow from $:\bar{O}CH_3$ to carbon atom in the C-Br bond ✓		CH_3O^- curly arrow must come from one lone pair on O of CH_3O^- ion **OR** from negative sign on O of the CH_3O^- ion **ALLOW** arrow from lone pair on O in OCH_3^- Lone pair not required **DO NOT ALLOW** $CH_3O^{\delta-}$ **DO NOT ALLOW** incorrect connectivity of CH_3O group in the final product $-CH_3O$ **IGNORE** $Br^{\delta-}$ as a product
			Correct organic product ✓		
			S_N1 mechanism		**ALLOW S_N1 mechanism**
					Dipole shown on the C–Br bond, $C^{\delta+}$ and $Br^{\delta-}$ and curly arrow from C–Br bond to the Br atom ✓
					curly arrow from CH_3O^- to carbonium ion✓ correct organic product ✓

Question			Answer	Mark	Guidance
	(c)		1-Iodobutane increases the rate ✓ **AND** C—I bonds are weaker (than C—Br) **OR** C—I bond has a lower bond enthalpy **OR** C—I bond needs a smaller amount of energy to break **OR** C—I bond is easier to break ✓	1	All statements must be **comparative** **ALLOW ORA** **IGNORE** C—I bond is longer **IGNORE** polarity and references to electronegativity
	(d)		 ✓ butyl ethanoate ✓	2	**ALLOW** only skeletal formula **DO NOT ALLOW ECF** from incorrect structure. **ALLOW** butylethanoate **ALLOW** butanyl for butyl **DO NOT ALLOW** but**ly**
	(e)	(i)	(136.9 × 100) = 47% 291.1✓	1	**ALLOW** 47 up to calculator value correctly rounded. 47.0 or 47.03 or 47.029 will be correct common answers **IGNORE** any working shown.
	(e)	(ii)	NaBr **OR** LiBr ✓	1	**ALLOW** correct name or formula **DO NOT ALLOW** HBr (it is an acid)
	(e)	(iii)	**Look at answer if 88.8% AWARD 3 marks** **if 88.75% AWARD 2 marks (not 3 sig. fig.)** Moles of butan-1-ol = 0.08(00) ✓ Moles of 1-bromobutane = 0.071(0) ✓ % yield = 88.8% ✓	3	Answer **MUST** be to 3 significant figures. **ALLOW** ECF but do not allow a yield >100% **ALLOW** Mass of 1-bromobutane expected = 10.952 g
			Total	12	

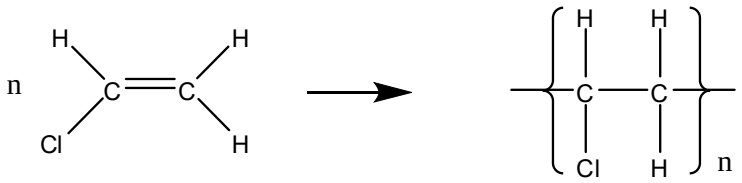
Question			Answer	Mark	Guidance
3	(a)		**There are 3 marking points required for 2 marks**  H_2 and I_2 on LHS **AND** 2HI on RHS **AND** correctly labelled Ea ✓ Δ*H* labelled with product below reactant **AND** arrow downwards ✓	2	**ANNOTATE ANSWER WITH TICKS AND CROSSES ETC** **IGNORE** state symbols. ***E_a*:** **ALLOW** (+)173 only as an alternative label for Ea **ALLOW** no arrowhead or arrowheads at both ends of activation energy line The E_a line must point to maximum (or near to the maximum) on the curve **OR** span approximately 80% of the distance between reactants and maximum regardless of position **ALLOW** AE or A_E for E_a ***ΔH:*** **IF** there is no Δ*H* labelled **ALLOW** –9 as an alternative label for Δ*H*. **IF** Δ*H* is labelled **IGNORE** any numerical value. **DO NOT ALLOW** –ΔH. **ALLOW** this arrow even if it has a small gap at the top and bottom i.e. does not quite reach reactant or product line
	(b)		(+)182 ✓	**1**	This is the **ONLY** acceptable answer

Question			Answer	Mark	Guidance
	(c)		**Look at answer if +63 kJ AWARD 2 marks** **If 63 (no sign) OR-63 (incorrect sign) AWARD 1 mark** No of moles of HI = 14 moles ✓ Enthalpy Change = +63 kJ ✓	2	**ALLOW** one mark for +126 kJ Sign and value required. **ALLOW** ECF from incorrect number of moles of HI
	(d)	(i)	Rate of the forward reaction is equal to the rate of the reverse reaction ✓ **OR** concentrations do not change✓	1	**ALLOW** both reaction**s** occur at same rate **IGNORE** conc. of reactants = conc. of products
		(ii)	 More H_2 and I_2 **OR** less HI ✓ (equilibrium position shifts) to the left **AND** (Forward) reaction is exothermic **OR** reverse reaction is endothermic **OR** in the endothermic direction✓	2	**Mark each point independently** **ALLOW** more reactants **OR** less products **Note: ALLOW** suitable alternatives for to the left e.g. towards reactants **OR** towards H_2 / I_2 **OR** in reverse direction **OR** favours the left. **ALLOW** gives out heat for exothermic **ALLOW** takes in heat for endothermic **IGNORE** responses in terms of rate
		(iii)	No effect **AND** Same number of (gaseous) moles on both sides ✓	1	 **ALLOW** same number of molecules on each side

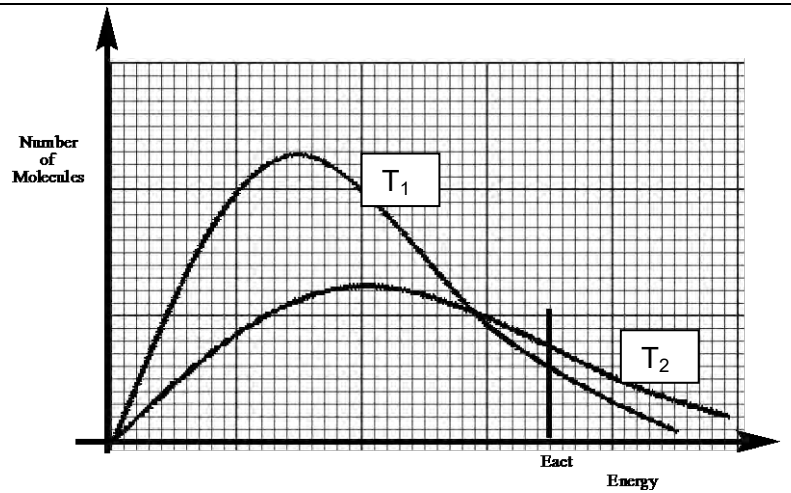
Question			Answer	Mark	Guidance
	(e)		**Look at answer if (+)298 AWARD 2 marks** **If answer is -298 AWARD 1 mark (incorrect sign)** **2 x H-I bond enthalpy correctly calculated** (436 +151-(-9) =) (+)596 ✓ **H-I bond enthalpy correctly calculated** (Bond energy for H-I $\frac{(+)596}{2}$ =) (+)298 kJ mol^{-1} ✓	**2**	**ALLOW** 1 mark for (+)293.5 kJ mol^{-1} (bonds broken divided by 2) **ALLOW** 1 mark for (+)289 kJ mol^{-1} (incorrect expression i.e. [$\frac{436 +151+(-9)}{2}$])
			Total	**11**	

Question			Answer	Mark	Guidance
4	(a)		**FIRST, CHECK THE ANSWER ON ANSWER LINE** **IF answer = –38.3 (kJ mol^{-1}) award 4 marks** **IF answer = (+)38.3 (kJ mol^{-1}) award 3 marks (incorrect sign)** **IF answer = -38,300 (kJ mol^{-1}) award 3 marks (used J instead of kJ).** **Energy** q calculated correctly = 1149.5(J)✓ **OR** 1.1495 (kJ) ✓ **Moles** Amount, n, of Na_2CO_3 calculated correctly= 0.03(00) ✓ **Calculating ΔH** correctly calculates ΔH in kJ mol^{-1} to 3 or more sig figs✓ **Rounding and Sign** calculated value of ΔH rounded to 3 sig. fig. with minus sign✓	4	**ANNOTATE ANSWER WITH TICKS AND CROSSES ETC** **Note**: q = 50.0 × 4.18 × 5.5 **ALLOW** 1149.5 **OR** correctly rounded to 3 sig figs (J) **IGNORE** sign **IGNORE** working **ALLOW** 53.18 × 4.18 × 5.5 **OR** 1222.6082 **OR** 1220 **OR** correctly rounded to 3 or more sig figs in J or kJ **IGNORE** working **IGNORE** trailing zeros **IGNORE** sign at this intermediate stage **ALLOW** ECF from incorrect q and/or incorrect n Final answer must have **correct sign** and **three sig figs** **ALLOW** –40.8 kJ mol^{-1} if 53.18 used in calculation of q **ALLOW** –40.7 kJ mol^{-1} if q is rounded to 1220 from 53.18 earlier
	(b)	(i)	(Enthalpy change) when one mole of a compound ✓ is formed from its elements ✓ 298 K / 25 °C **AND** 1 atm / 100 kPa / 101 kPa / 1 bar ✓	3	**ALLOW** energy required **OR** energy released **ALLOW** one mole of substance **OR** one mole of product **DO NOT ALLOW** one mole of element **IGNORE** reference to concentration

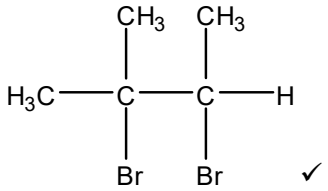
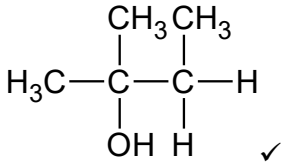
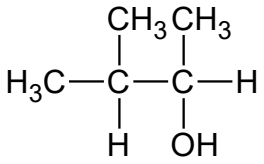
Question			Answer	Mark	Guidance
		(ii)	$\frac{1}{2}N_2(g) + 2H_2(g) + \frac{1}{2}Cl_2(g) + 2O_2(g) \rightarrow NH_4ClO_4(s)$ correct species ✓ correct state symbols **and** balancing ✓	**2**	**Second mark can only be awarded if all species in the equation are correct** **DO NOT ALLOW** multiples of this equation
		(iii)	**FIRST, CHECK THE ANSWER ON ANSWER LINE** **IF answer = (+)90 award 3 marks** **IF answer = –90 award 2 marks** **IF answer = ±270 award 2 marks** **IF answer = ±2947 award 1 mark** **Processing ΔH_f values** ±(3832 – 885) ±2947✓ **OR** ± (3832 – 885) **subtraction using ΔH reaction** ±(2947-2677)= ±270 ✓ **Calculation of ΔH formation NO** 270/3 = (+)90 ✓	**3**	**ANNOTATE ANSWER WITH TICKS AND CROSSES ETC** **Note:** ±2947 = ± [–1676 + (–704) + (6 x –242)] – (3 x –295)] **ALLOW ECF** for dividing by 3 from working that includes at least one ΔH_f and one balancing number and ΔH (-2677) for 1 mark
			Total	**12**	

Question			Answer	Mark	Guidance
5	(a)		 Correct polymer with side links ✓ Balanced equation for formation of correct polymer - correct use of *n* in the equation and brackets ✓	2	**Displayed formulae MUST be used to award each mark** *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)
	(b)	**(i)**	$CH_2CHCl + 2O_2 \longrightarrow CO + CO_2 + HCl + H_2O$ ✓	**1**	**ALLOW** any other correctly balanced equation with the same reactants and products **ALLOW** C_2H_3Cl for CH_2CHCl
		(ii)	Sodium hydrogencarbonate neutralises HC*l* ✓	**1**	**Assume that 'it' refers to sodium hydrogencarbonate but DO NOT ALLOW** other chemicals e.g. sodium **ALLOW** $NaHCO_3$ is a base **ALLOW** forms a salt or sodium chloride or NaCl **ALLOW** equation to show formation of NaCl from $NaHCO_3$ and HCl even if not balanced. **IGNORE** reacts

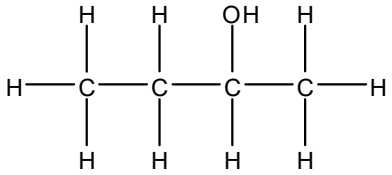
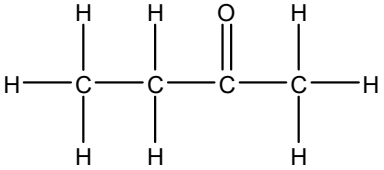
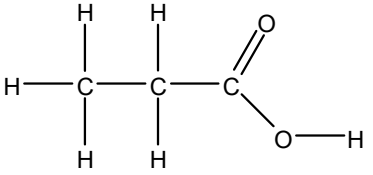
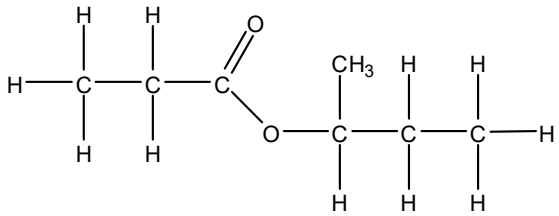
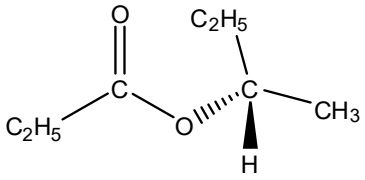
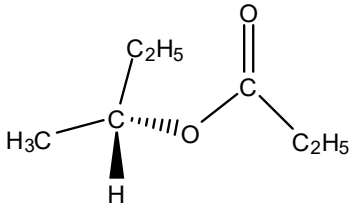
Question			Answer	Mark	Guidance
	(c)		**ANY TWO from** abundance (in atmosphere) **OR** amount (in atmosphere) **OR** (atmospheric) concentration **OR** percentage (in air) ✓ **OR** ability to absorb **infrared/IR** (radiation)✓ **OR** residence time ✓	**2**	 **ALLOW** absorption of infrared/IR
	(d)	**(i)**	Any balanced equation between a metal oxide and carbon dioxide to form a carbonate e.g $CaO + CO_2 \longrightarrow CaCO_3$ ✓	**1**	**ALLOW** MO for metal oxide
		(ii)	**ANY ONE FROM** deep in oceans **OR** in geological formations **OR** (deep) in rocks **OR** in mines **OR** in oil wells **OR** in gas fields ✓	**1**	**Assume that 'it' refers to carbon dioxide but DO NOT ALLOW** carbon **DO NOT ALLOW** reacted with oxides or stored as carbonates.
			Total	**8**	

Question			Answer	Mark	Guidance
6	(a)	(i)	 axes labelled (number of) molecules and (kinetic) energy ✓	4	**ANNOTATE ANSWER WITH TICKS AND CROSSES ETC** Candidates do not need Ea on graph **ALLOW** particles instead of molecules on the y axis **DO NOT ALLOW** atoms instead of particles/molecules **ALLOW ECF** for the incorrect use of atoms (instead of molecules/particles) **DO NOT ALLOW** enthalpy on the x-axis
			Correct drawing of a two Boltzmann distributions i.e. both curves must start within the first small square nearest to the origin **AND** must not touch the x axis at high energy ✓		**DO NOT ALLOW** increase of more than one small square at high energy end of curve. Maximum of curve for higher temperature to right **AND** lower than maximum of lower temperature curve **AND** above lower temp line at higher energy Higher temp line should intersect lower temp line once
			Drawing of Boltzmann distribution at **two** different temperatures with higher and lower temperature clearly identified (ie $T_2>T_1$) ✓		**DO NOT ALLOW** lower activation energy **QWC** requires more molecules have or exceed activation energy/E_a. **IGNORE** more molecules have enough energy to react for the **QWC** mark (as not linked to E_a) **ORA** if states the effect when the temperature is lower **IGNORE** (more) successful collisions
			QWC - (At a higher temperature) more molecules have energy above activation energy **OR** greater area under the curve above the activation energy✓		

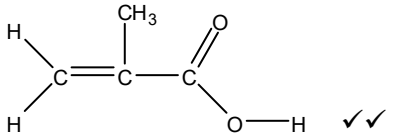
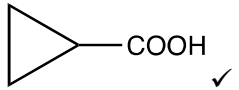
Question			Answer	Mark	Guidance
	(a)	(ii)	(Decreasing the pressure) decreases the rate of reaction **AND** Decreased concentration of molecules **OR** Number of molecules remains the same but the volume increases **OR** Less molecules per (unit) volume ✓ Less **frequent** collisions ✓	2	**Correct effect on rate must be linked to reason for the first marking point.** **ALLOW** molecules are further apart **IGNORE** less crowded **ALLOW** particles or atoms for molecules **ALLOW** 'space' for volume **DO NOT ALLOW** area instead of volume **ALLOW** collisions occur less often **OR** decreased rate of collision **IGNORE** less chance of collisions 'less collisions' alone is **not** sufficient **IGNORE** successful
	(b)	(i)	$C_6H_{12}O_6 \longrightarrow 2C_2H_5OH + 2CO_2$ ✓ Temperature: Between 20 °C and 45 °C inclusive **AND** Condition: Absence of oxygen **OR** anaerobic ✓	2	**ALLOW** correct molecular **OR** structural **OR** displayed **OR** skeletal formula **OR** mixture of the above (as long as unambiguous) **IGNORE** state symbols **DO NOT ALLOW** acidic or alkaline conditions **If there is a contradiction or an incorrect answer in any condition given then do not award this mark.** **ALLOW** conditions shown in the equation A limited supply of oxygen is **not** sufficient **IGNORE** pressure **IGNORE** yeast (in question) **ALLOW** Lack of oxygen
	(b)	(ii)	$2NO + 2CO \longrightarrow 2CO_2 + N_2$ ✓	1	**ALLOW** multiples **IGNORE** state symbols
			Total	9	

Question			Answer	Mark	Guidance
7	(a)		 ✓	1	**ALLOW** correct structural **OR** displayed **OR** skeletal formula **OR** mixture of the above **DO NOT ALLOW** molecular formula **ALLOW** dichloro or diiodo compound instead of the dibromo compound as the **only** alternatives.
	(b)		Reagent **A**: correct halogen✓ e.g. Br_2 / bromine	1	**ALLOW** Cl_2 if dichloro compound drawn **ALLOW** I_2 if diiodo compound drawn **IGNORE** state symbols Answer must match box from **(a)** to score
	(c)	(i)	Steam **AND** acid catalyst ✓	1	**ALLOW** H^+ / named acid / H_2SO_4 / H_3PO_4 **ALLOW** $H_2O(g)$ **ALLOW** water only if a temperature of 100 °C or above is quoted. **IGNORE** any temperature given with steam **IGNORE** pressure
		(ii)	(compounds or molecules) having the same molecular formula but different structural formulae ✓	1	**ALLOW** different structure **OR** different displayed formula **OR** different skeletal formula for structure Same formula is **not** sufficient Different arrangement of atoms is **not** sufficient
		(iii)	 ✓  ✓	2	**ALLOW** correct structural **OR** displayed **OR** skeletal formula **OR** mixture of the above **ALLOW** any vertical bond to OH **DO NOT ALLOW** OH–
		(iv)	Does not contain OH group(s) **OR** does not contain hydroxyl group(s) **OR** is not an alcohol ✓ Does not form hydrogen bonds with water ✓	2	**ALLOW ORA** throughout **DO NOT ALLOW** OH^- (ions) / hydroxide (ions) 'Does not form hydrogen bonds' is **not** sufficient

Question			Answer	Mark	Guidance
	(d)		Reagents: Acid/H^+ and (potassium or sodium) dichromate/$Cr_2O_7^{2-}$ seen **once**✓ Observations: Orange to Green **OR** Orange to Blue✓ Distillation / Distil produces aldehyde/CH_3CH_2CHO: ✓ $CH_3CH_2CH_2OH + [O] \longrightarrow CH_3CH_2CHO + H_2O$ ✓ Reflux (of propan-1-ol) produces carboxylic acid/CH_3CH_2COOH✓ $CH_3CH_2CH_2OH + 2[O] \longrightarrow CH_3CH_2COOH + H_2O$ ✓	6	**ANNOTATE ANSWER WITH TICKS AND CROSSES ETC** **ALLOW** H_2SO_4 and $K_2Cr_2O_7$ **ALLOW** correct displayed formula **OR** correct structural formula **OR** skeletal formula **OR** a mixture of the above **DO NOT ALLOW** molecular formulae **ALLOW** C_3H_7OH for propan-1-ol in equations **DO NOT ALLOW** CH_3CH_2COH for aldehyde **IGNORE** further oxidation of aldehyde **ALLOW** $CH_3CH_2CO_2H$ for carboxylic acid
			Total	**14**	

Question			Answer	Mark	Guidance
8	(a)		Molar mass of **B** = 74 ✓ **B-F** clearly identified **B/alcohol:**  ✓ **C/ketone:**  ✓ **D/carboxylic acid:**  ✓ **E and F:**  ✓ H_2O/water ✓	6	**ANNOTATE ANSWER WITH TICKS AND CROSSES ETC** **Check and annotate page 19 below this response** Molar mass = $\frac{2.59}{0.035}$ = 74 For structure of **B, C, D** or **E/F ALLOW** correct displayed **OR** correct structural formula **OR** correct skeletal formula **OR** mixture of the above as long as unambiguous**.** **DO NOT ALLOW** missing H atom(s) in a displayed formula for one structure but **ALLOW** missing H atoms in subsequent structures. **IGNORE** names of organic compounds **E** and **F** can be identified either way round **ALLOW** H_2O or displayed formula for mark For **E** and **F** – **ALLOW** the two optical isomers  

Question			Answer	Mark	Guidance
8	(b)		**Molecular formula for G: 2 marks** Mole ratio C : H : O = $\frac{55.8}{12.0} : \frac{7.0}{1.0} : \frac{37.2}{16.0}$ **OR** 4.65 : 7.0 : 2.33/2.325 **OR** 2 : 3 : 1 **OR** C_2H_3O ✓ Molecular formula of **G** $C_4H_6O_2$ ✓ **Mass spectrum for G: 2 marks** Peak **X or peak 41** indicates $C_3H_5^+$ ✓ Peak **Y or peak 45** indicates $COOH^+$ ✓ **Infrared for G: 1 mark** Peak at 1640–1750 cm^{-1} indicates presence of C=O **AND** Peak at 2500–3300 cm^{-1} (indicates the presence of) –OH group linked carboxylic acid/COOH **QWC** ✓	7	**ANNOTATE ANSWER WITH TICKS AND CROSSES ETC** **ALLOW** mass of C = 0.558 x 86 **or** 48 **AND** mass of H = 0.07 x 86 **or** 6 **AND** mass of O = 0.372 x 86 = 32 + charge required for each response **ALLOW** one mark if both formulae are correct but with no charge/incorrect charge **ALLOW** any possible fragments that contain C, H and/or O that have the correct mass. E.g. Peak X indicates C_2OH^+, Peak **Y** indicates $C_2H_5O^+$ Unfeasible fragments are not allowed e.g. $C_3H_9^+$ (too many H atoms) **LOOK ON THE SPECTRUM** for labelled absorbance which can be given credit Candidates must link absorbance to bond in order to gain the mark **ALLOW** 1700 cm^{-1} For 2500–3300 cm^{-1}, **ALLOW** 2900 cm^{-1} or any stated wavenumber with range 2500–3300 cm^{-1} **ALLOW** wavenumber range up to 2400–3500 cm^{-1}

Question	Answer	Mark	Guidance
	Structure of G: 2 marks Correct structure:  ✓✓ 1 mark for one of the following structures of $C_4H_6O_2$: $H_2C=CH-CH_2-COOH$ **OR** $H_3C-CH=CH-COOH$ **OR**  ✓		**ALLOW** structural, skeletal or displayed formula. **DO NOT ALLOW ECF** from incorrect molecular formula
	Total	**13**	

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