
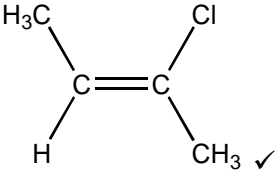
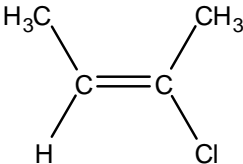


Question	Expected Answers	Marks	Additional Guidance
1	<p><b>Infrared</b>            QWC – 1720 cm<sup>-1</sup> indicates carbonyl group ✓            QWC – broad 2900 cm<sup>-1</sup> indicates O–H bond in <b>carboxylic acid</b> ✓            QWC – 1080 cm<sup>-1</sup> indicates C–O bond ✓</p> <p><b>Percentage composition</b>            Mole ratio C : H : O = 2.23 : 2.22 : 4.44 ✓            Empirical formula is CHO<sub>2</sub> ✓</p> <p>(mass of one mole is 90 g) so <i>M<sub>r</sub></i> is 90 ✓</p> <p>QWC – molecular formula is C<sub>2</sub>H<sub>2</sub>O<sub>4</sub> with working out from <i>M<sub>r</sub></i> ✓</p> <p>Structure is <math>\begin{array}{c} \text{COOH} \\   \\ \text{COOH} \end{array}</math> ✓</p>	8	<p><b>ANNOTATE WITH TICKS AND CROSSES</b>   <b>QWC</b> –Structure linked to information at least once</p> <p><b>ALLOW</b> 1720 indicates presence of aldehydes, ketones, esters, carboxylic acid, amides  <b>ALLOW</b> 2900 indicates carboxylic acid</p> <p><b>ALLOW</b> 1080 indicates alcohol, esters, carboxylic acids</p> <p><b>ALLOW</b> 26.7/12.0. 2.22/1.0 and 71.1/16.0  <b>ALLOW</b> COOH  <b>ALLOW two</b> marks for correct empirical formula with no working out</p> <p><b>ALLOW</b> 0.0945/0.00105 = 90</p> <p><math>\begin{array}{c} \text{COOH} \\   \\ \text{O} \\   \\ \text{CHO} \end{array}</math></p> <p><b>ALLOW</b> CHO</p>
	<b>Total</b>	<b>8</b>	

Question			er	Marks	Guidance
2	(a)	(	$(m/z =) 46 \checkmark$	1	
		(ii)	$\text{CH}_3\text{O}^+ \text{ OR } \text{CH}_2\text{OH}^+ \checkmark$	1	<b>MUST</b> show '+'
		(iii)	$\text{C}_2\text{H}_6\text{O} \checkmark$	1	<b>ALLOW</b> $\text{H}_2\text{CO}_2$
	(b)		$\frac{63 \times 72.2 + 65 \times 27.8}{100} \text{ OR } 63.556 \text{ OR } 63.56 \checkmark$ $A_r = 63.6 \checkmark$ Copper / Cu $\checkmark$	3	<b>ALLOW</b> two marks for 63.6 with no working out
			<b>Total</b>	<b>6</b>	

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



Question		Answer	Mark	Guidance
4	(a)	B ✓	1	<b>ALLOW</b> CF <sub>2</sub> CF <sub>2</sub> OR C <sub>2</sub> F <sub>4</sub> OR tetrafluoroethene
	(b)	(i) <div style="text-align: center;">  </div>	1	<b>ALLOW</b> correct structural <b>OR</b> displayed <b>OR</b> skeletal <b>OR</b> mixture of the above  <b>ALLOW</b> <i>E</i> isomer  <div style="text-align: center;">  </div>
		(ii) HCl ✓	1	<b>DO NOT ALLOW</b> Cl <sub>2</sub> <b>IGNORE</b> names <b>IGNORE</b> nitrogen oxides / NO <sub>x</sub>
	(c)	(i) <b>ANY TWO FROM THE FOLLOWING</b> ✓  Low reactivity <b>OR</b> will not burn/non-flammable  Volatile <b>OR</b> low boiling point  non-poisonous <b>OR</b> non-toxic	1	<b>ALLOW</b> inert <b>OR</b> stable <b>DO NOT ALLOW</b> inflammable  <b>ALLOW</b> it is a gas <b>IGNORE</b> easily compressed  <b>IGNORE</b> not harmful  <b>IGNORE</b> references to solubility

Question	Answer	Mark	Guidance
(ii)	<p><i>Benefit of ozone layer to life (1 mark)</i></p> <p>Ozone absorbs <b>UV</b> (radiation)</p> <p><b>UV</b> at Earth's surface is reduced ✓</p> <p><b>OR</b>-----</p> <p><i>Maintenance of O<sub>3</sub> concentration (1 mark)</i></p> $3 \rightleftharpoons O_2 + O \checkmark$ <p>O</p> <p>-----</p> <p><i>Production of radicals from G (1 mark)</i></p> $2Cl_2 \longrightarrow Cl + CF_2Cl \checkmark$ <p>-----</p> <p>CF</p> <p><i>Breakdown of O<sub>3</sub> (2 marks)</i></p> $Cl + O_3 \longrightarrow ClO + O_2 \checkmark$ <p><b>OR</b></p> $ClO + O_3 \longrightarrow Cl + 2O_2 \checkmark$ <p>C</p>	5	<p><b>ANNOTATE ANSWER WITH TICKS AND CROSSES ETC</b></p> <p>For all equations, <b>IGNORE</b> dots on radicals</p> <p>-----</p> <p>Essential idea for first mark is that <b>UV</b> is removed in some way.</p> <p><b>ALLOW</b> Prevents <b>UV</b> damaging life or stated type of damage, e.g. cataracts, skin cancer, mutation, crop damage</p> <p><b>DO NOT ALLOW</b> ozone absorbs IR</p> <p>-----</p> <p><b>ALLOW</b></p> $3 \longrightarrow O_2 + O$ $O_2 + O \longrightarrow O_3$ <p><b>AND</b></p> <p><b>DO NOT ALLOW</b> <math>2O_3 \rightleftharpoons 3O_2</math></p> <p><b>OR</b> <math>O_3 + O \longrightarrow 2O_2</math> for this mark</p> <p>-----</p> <p><b>DO NOT ALLOW</b> equations with other CFCs</p> <p><b>DO NOT ALLOW</b> <math>CF_2Cl_2 \longrightarrow 2Cl + CF_2</math></p> <p>-----</p> <p>These are the only acceptable equations</p> <p><b>IGNORE</b> overall equation (<i>does not show role of catalyst</i>) e.g. <math>O_3 + O \longrightarrow 2O_2</math></p>

Question		Answer	Mark	Guidance
	(iii)	D ✓	1	ALLOW CHF <sub>2</sub> Cl ALLOW B OR C <sub>2</sub> F <sub>4</sub> OR CF <sub>2</sub> CF <sub>2</sub>
(d)	(i)	bond vibrates (more) OR bond bends (more) OR bond stretches (more) ✓	1	<b>BOND essential</b>  IGNORE molecule vibrates/rotates Assume "It" refers to the molecule and is insufficient <b>DO NOT ALLOW</b> any reference to bond breaking  <b>DO NOT ALLOW</b> a stated bond if <b>not</b> present in <b>C</b> and <b>F</b> e.g. C–O, C–H not prese
	(ii)	Cl <sub>3</sub> C <sup>+</sup> ✓ CF <sub>2</sub> Cl <sup>+</sup> ✓	2	<b>ALLOW</b> 1 mark for Cl <sub>3</sub> C <b>AND</b> CF <sub>2</sub> Cl <i>i.e. no + charge used</i>  <b>ALLOW</b> 1 mark for Cl <sub>3</sub> C <sup>-</sup> <b>AND</b> CF <sub>2</sub> Cl <sup>-</sup> <i>i.e. – charge used on both</i>
<b>Total</b>			<b>13</b>	

Question		Answer	Mark	Guidance
5	(a) (i)	<p><b>FIRST, CHECK THE ANSWER ON ANSWER LINE</b>  <b>IF <math>\Delta H_c = -2260</math> (kJ mol<sup>-1</sup>) award 4 marks</b>  <b>IF <math>\Delta H_c = (+)2260</math> (kJ mol<sup>-1</sup>) award 3 marks (incorrect sign)</b>  <b>IF <math>\Delta H_c = (\pm)2257(.2)</math> (kJ mol<sup>-1</sup>) award 3 marks (not 3 sf)</b></p> <p><b>Moles</b>  Amount, <math>n</math>, C<sub>5</sub>H<sub>12</sub>O calculated correctly = 0.0175 (mol) ✓</p> <p><b>Energy</b>  <math>q</math> calculated correctly = 39501 (J) <b>OR</b> 39.5(01) (kJ) ✓</p> <p><b>Calculating <math>\Delta H</math></b>  correctly calculates <math>\Delta H</math> in kJ mol<sup>-1</sup> to 3 or more sig figs ✓</p> <p><b>Rounding and Sign</b>  calculated value of <math>\Delta H</math> rounded to 3 sig. fig. with minus sign ✓</p>	4	<p><b>ANNOTATE ANSWER WITH TICKS AND CROSSES ETC</b></p> <p><b>Note:</b> <math>q = 180 \times 4.18 \times 52.5</math>  <b>ALLOW</b> 39501 <b>OR</b> correctly rounded to 3 sig. fig. (J)  <b>IGNORE</b> sign  <b>IGNORE</b> working</p> <p><b>Note:</b> from 39501 J and 0.0175 mol <math>\Delta H = (-)2257.2</math> kJ mol<sup>-1</sup></p> <p><b>IGNORE</b> sign at this intermediate stage  <b>ALLOW</b> ECF from incorrect <math>q</math> and/or incorrect <math>n</math></p> <p>Final answer must have <b>correct sign</b> and <b>three sig figs</b></p>
	(ii)	<p><b>ANY TWO FROM THE FOLLOWING</b> ✓✓</p> <p>incomplete combustion</p> <p>non-standard conditions</p> <p>evaporation of alcohol/water</p> <p>specific heat capacity of beaker/apparatus</p>	2	<p><b>IGNORE</b> heat loss (<i>in question</i>)</p> <p><b>ALLOW</b> burns incompletely  <b>IGNORE</b> incomplete reaction</p>



Question		Answer	Mark	Guidance
(b)	(i)	$5\text{C(s)} + 6\text{H}_2\text{(g)} + \frac{1}{2}\text{O}_2\text{(g)} \longrightarrow \text{C}_5\text{H}_{12}\text{O(l)} \checkmark$	1	Balancing numbers <b>AND</b> species <b>AND</b> states all required  <b>DO NOT ALLOW</b> multiples of this equation
	(ii)	<p><b>FIRST, CHECK THE ANSWER ON ANSWER LINE</b>  <b>IF enthalpy change = <math>-3320 \text{ (kJ mol}^{-1}\text{)}</math> award 3 marks</b>  <b>IF enthalpy change = <math>(+)</math><math>3320 \text{ (kJ mol}^{-1}\text{)}</math> award 2 marks</b></p> <p>-----</p> <p>Working for <math>\text{CO}_2</math> <b>AND</b> <math>\text{H}_2\text{O}</math> seen anywhere</p> <p><math>5 \times (-)394</math> <b>AND</b> <math>6 \times (-)286</math>  <b>OR</b> <math>(-)1970</math> <b>AND</b>  <b>OR</b> <math>(-)3686 \checkmark</math> <math>(-)1716</math></p> <p>Calculates <math>\Delta H_c</math></p> <p><b>A further 2 marks</b> for correct answer <b>AND</b> correct sign  <math>= 5 \times -394 + 6 \times -286 - -366</math>  <math>= -3320 \text{ (kJ mol}^{-1}\text{)} \checkmark\checkmark</math></p> <p><b>A further 1 mark</b> for correct answer <b>AND</b> incorrect or no sign  <math>= (+)3320 \text{ (kJ mol}^{-1}\text{)} \checkmark</math>  <i>Cycle wrong way around:</i>  <math>-366 - (5 \times -394 + 6 \times -286)</math></p>	3	<p><b>ANNOTATE ANSWER WITH TICKS AND CROSSES ETC</b></p> <p><b>IF there is an alternative answer, check to see if there is any ECF credit possible</b></p> <p><b>Common incorrect answers are shown below</b>  <b>Award 2 marks for</b>  <math>-1744</math> <b>OR</b> <math>-1890</math> <b>OR</b> <math>-314</math> <b>OR</b> <math>-4052</math>  <b>Award 1 mark for</b>  <math>1744</math> <b>OR</b> <math>1890</math> <b>OR</b> <math>314</math> <b>OR</b> <math>4052</math></p>

Question	Answer	Mark	Guidance
(c)	<p><b>QWC:</b> Evidence of the <b>IR</b> absorption at 1720 (cm<sup>-1</sup>) for presence of C=O/carbonyl group ✓</p> <p><b>QWC:</b> No carboxylic acid OH absorption in IR <b>OR</b> no peak between 2500–3300 cm<sup>-1</sup></p> <p><b>AND</b> so <b>J</b> is a secondary alcohol <b>OR</b> so <b>K</b> is a ketone ✓</p> <p><b>Alcohol J</b></p> $  \begin{array}{c}  \text{OH} \quad \text{H} \\    \quad   \\  \text{H}_3\text{C}-\text{C}-\text{C}-\text{CH}_3 \\    \quad   \\  \text{H} \quad \text{CH}_3  \end{array}  $ <p style="text-align: right;">✓✓</p> <p><b>Compound K</b> Structure of a carbonyl compound that could be obtained from alcohol <b>J</b> ✓</p> <p><b>Equation</b> Balanced equation for conversion of <b>J</b> to <b>K</b> ✓ e.  <math display="block">\text{CH}_3\text{CHOHCH}(\text{CH}_3)_2 + [\text{O}] \longrightarrow \text{CH}_3\text{COCH}(\text{CH}_3)_2 + \text{H}_2\text{O}</math></p>	6	<p><b>ANNOTATE ANSWER WITH TICKS AND CROSSES ETC</b></p> <p><b>LOOK ON THE SPECTRUM</b> for labelled peaks which can be given credit <b>BOTH IR</b> at ~1720 (cm<sup>-1</sup>) <b>AND</b> C=O required <b>ALLOW</b> ranges from <i>Data Sheet</i>, i.e. C=O within range 1640–1750 cm<sup>-1</sup>;</p> <p><b>IGNORE</b> any reference to C-O absorption For structures of <b>J</b> and <b>K</b>, <b>ALLOW</b> correct structural <b>OR</b> displayed <b>OR</b> skeletal formula <b>OR</b> mixture of the above <b>IGNORE</b> any names given for <b>J</b> and <b>K</b></p> <p><b>ALLOW</b> 1 mark for the structure of an alcohol with the molecular formula C<sub>5</sub>H<sub>12</sub>O <b>DO NOT ALLOW</b> pentan-1-ol (<i>primary and unbranched</i>) or 2-methylbutan-2-ol (<i>branched but tertiary</i>)</p> <p><b>DO NOT ALLOW</b> any marks for <b>J</b> and <b>K</b> if more than one structure is given for <b>J</b></p> <p><b>Note:</b> ‘sticks’ in either <b>J</b> and/or <b>K</b> will lose only 1 mark</p> <p><b>ALLOW</b> 1 mark for:</p> $  \begin{array}{c}  \text{O} \quad \text{H} \\     \quad   \\  \text{H}_3\text{C}-\text{C}-\text{C}-\text{CH}_3 \\    \\  \text{CH}_3  \end{array}  $ <p style="text-align: right;"><b>IF</b> a structure is not given for <b>J</b></p> <p><b>NOTE:</b> structures for <b>J</b> and <b>K</b> could be awarded from the equation, even if not labelled.</p> <p><b>ALLOW</b> molecular formulae in equation i.e. C<sub>5</sub>H<sub>12</sub>O + [O] → C<sub>5</sub>H<sub>10</sub>O + H<sub>2</sub>O <b>DO NOT ALLOW</b> equations that form a carboxylic acid</p>

Question		Answer	Mark	Guidance
	(d)	<p><b>Labelled</b> diagram showing at least one H-bond between alcohol molecule and water ✓</p> <p>e.</p>	1	<p><b>IF</b> diagram is not labelled <b>ALLOW</b> Hydrogen bonds / H bonds from text</p> <p>Diagram should include role of an O lone pair and dipole charges on each end of H bond.</p> <p><b>IGNORE</b> alcohol R group, even if wrong</p> <p><b>ALLOW</b> structural <b>OR</b> displayed <b>OR</b> skeletal formula <b>OR</b> mixture of the above</p>
			<b>Total</b>	<b>17</b>

Question	Answer	Marks	Guidance
6 (a)	1-bromopentane reacts faster <b>OR</b> 1-chloropentane reacts slower ✓  C–C/ stronger bond (than C–Br bond) <b>OR</b> C–C/ shorter bond (than C–Br bond) <b>OR</b> C–C/ bond is harder to break <b>OR</b> needs more energy to break C–C/ bond <b>OR</b> bond enthalpy of C–C/ greater (than C–Br bond) ✓	2	<b>ALLOW</b> takes more time to react <b>ALLOW</b> chloro compound reacts slower than bromine compound <b>DO NOT ALLOW</b> bromine reacts faster than chlorine  <b>ALLOW</b> ORA  Answer must refer to the C–C/ bond or C–Br bonds
(b) (i)	$\text{CH}_3\text{—CH}_2\text{—CH}_2\text{—CH}_2\text{—I} \quad \checkmark$ $\begin{array}{c} \text{CH}_3\text{—CH}_2\text{—CH—CH}_3 \\   \\ \text{I} \end{array} \quad \checkmark$ $\begin{array}{c} \text{CH}_3 \\   \\ \text{CH}_3\text{—C—I} \\   \\ \text{CH}_3 \end{array} \quad \checkmark$ $\begin{array}{c} \text{CH}_3 \\   \\ \text{CH}_3\text{—C—CH}_2\text{—I} \\   \\ \text{H} \end{array} \quad \checkmark$	4	<b>ALLOW</b> correct structural <b>OR</b> displayed <b>OR</b> skeletal formula <b>OR</b> mixture of the above (as long as unambiguous) n.b. C <sub>2</sub> H <sub>5</sub> is unambiguous but C <sub>3</sub> H <sub>7</sub> is ambiguous  <b>IGNORE</b> incorrect name  Mark incorrect answers first of all. <ul style="list-style-type: none"> <li>• One incorrect answers maximum 3 marks</li> <li>• Two incorrect answers maximum 2 marks</li> <li>• Three incorrect answers maximum 1 mark</li> <li>• Four incorrect answers scores 0 mark</li> </ul> <b>ALLOW</b> as a slip one stick with no H on in a displayed formula

Question			er	Marks	Guidance
6	(b)	(ii)	$C_4H_{10}O$ ✓	1	<b>IGNORE</b> any structures drawn <b>DO NOT ALLOW</b> $C_4H_9OH$

Question			er	Marks	Guidance
6	(b)	(iii)	<p><b>infrared</b></p> <p>1700–1730 <math>\text{cm}^{-1}</math> indicates carbonyl group ✓</p> <p>broad 2900 <math>\text{cm}^{-1}</math> indicates O–H bond <b>AND</b> it is a <b>carboxylic acid</b> ✓</p> <p><b>explanation mark</b>  <b>B</b> has a branched structure because of relationship to methylpropene  <b>OR</b>  <b>C</b> has a branched structure because of relationship to methylpropene  <b>OR</b>  <b>C</b> must be a primary alcohol because it is oxidised to a carboxylic acid <b>OR</b> a primary alcohol because it reacts with acidified dichromate to make a carboxylic acid  <b>OR</b>  <b>C</b> cannot be a tertiary alcohol because it is oxidised <b>OR</b> cannot be a tertiary alcohol because it does react with acidified dichromate  ✓</p>	6	<p><b>ANNOTATE ANSWER WITH TICKS AND CROSSES ETC</b></p> <p><b>LOOK ON THE SPECTRUM</b> for labeled absorbances which can be given credit</p> <p><b>ALLOW</b> has a C=O bond because it has absorbance within range 1640–1750 <math>\text{cm}^{-1}</math></p> <p><b>ALLOW</b> 2900 <math>\text{cm}^{-1}</math> indicates O–H in carboxylic acid  <b>ALLOW</b> has O–H bond in carboxylic acid because it has absorbance within range 2500–3300 <math>\text{cm}^{-1}</math>  The presence of carboxylic acid can be anywhere in the text including the structure for <b>D</b></p> <p>If two marking points from the explanation mark are given both must be correct</p>

Question	er	Marks	Guidance
	<p><b>B</b> is <math display="block">\begin{array}{c} \text{CH}_3 \\   \\ \text{CH}_3 - \text{C} - \text{CH}_2 - \text{I} \\   \\ \text{H} \end{array}</math> ✓</p> <p><b>C</b> is <math display="block">\begin{array}{c} \text{CH}_3 \\   \\ \text{CH}_3 - \text{C} - \text{CH}_2 - \text{OH} \\   \\ \text{H} \end{array}</math> ✓</p> <p><b>D</b> is <math display="block">\begin{array}{c} \text{CH}_3 \\   \\ \text{CH}_3 - \text{C} - \text{COOH} \\   \\ \text{H} \end{array}</math> ✓</p>		<p><b>ALLOW</b> correct structural <b>OR</b> displayed <b>OR</b> skeletal formula <b>OR</b> mixture of the above (as long as unambiguous)</p> <p><b>IGNORE</b> incorrect names for <b>B</b>, <b>C</b> and <b>D</b></p> <p>Mark correct branched structures first of all.</p> <p>If there are no correct branched structures and <b>C</b> is <math>\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}</math> then <b>ALLOW</b> one mark for <math>\text{CH}_3\text{CH}_2\text{CH}_2\text{COOH}</math> and one mark for <math>\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{I}</math></p>
	<b>Total</b>	<b>13</b>	