
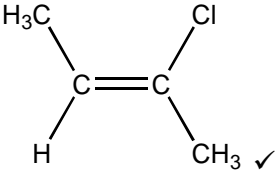
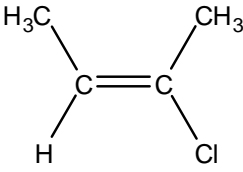


Question	Expected Answers	Marks	Additional Guidance
1	<p>Infrared QWC – 1720 cm⁻¹ indicates carbonyl group ✓ QWC – broad 2900 cm⁻¹ indicates O–H bond in carboxylic acid ✓ QWC – 1080 cm⁻¹ indicates C–O bond ✓</p> <p>Percentage composition Mole ratio C : H : O = 2.23 : 2.22 : 4.44 ✓ Empirical formula is CHO₂ ✓</p> <p>(mass of one mole is 90 g) so <i>M_r</i> is 90 ✓</p> <p>QWC – molecular formula is C₂H₂O₄ with working out from <i>M_r</i> ✓</p> <p>Structure is $\begin{array}{c} \text{COOH} \\ \\ \text{COOH} \end{array}$ ✓</p>	8	<p>ANNOTATE WITH TICKS AND CROSSES  QWC –Structure linked to information at least once</p> <p>ALLOW 1720 indicates presence of aldehydes, ketones, esters, carboxylic acid, amides ALLOW 2900 indicates carboxylic acid</p> <p>ALLOW 1080 indicates alcohol, esters, carboxylic acids</p> <p>ALLOW 26.7/12.0. 2.22/1.0 and 71.1/16.0 ALLOW COOH ALLOW two marks for correct empirical formula with no working out</p> <p>ALLOW 0.0945/0.00105 = 90</p> <p>$\begin{array}{c} \text{COOH} \\ \\ \text{O} \\ \\ \text{CHO} \end{array}$</p> <p>ALLOW CHO</p>
	Total	8	

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

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

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

Question	Answer	Mark	Guidance
(ii)	<p><i>Benefit of ozone layer to life (1 mark)</i></p> <p>Ozone absorbs UV (radiation)</p> <p>UV at Earth's surface is reduced ✓</p> <p>OR-----</p> <p><i>Maintenance of O₃ 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 O₃ (2 marks)</i></p> $Cl + O_3 \longrightarrow ClO + O_2 \checkmark$ <p>OR</p> $ClO + O_3 \longrightarrow Cl + 2O_2 \checkmark$ <p>C</p>	5	<p>ANNOTATE ANSWER WITH TICKS AND CROSSES ETC</p> <p>For all equations, IGNORE dots on radicals</p> <p>-----</p> <p>Essential idea for first mark is that UV is removed in some way.</p> <p>ALLOW Prevents UV damaging life or stated type of damage, e.g. cataracts, skin cancer, mutation, crop damage</p> <p>DO NOT ALLOW ozone absorbs IR</p> <p>-----</p> <p>ALLOW</p> $3 \longrightarrow O_2 + O$ $O_2 + O \longrightarrow O_3$ <p>AND</p> <p>DO NOT ALLOW $2O_3 \rightleftharpoons 3O_2$</p> <p>OR $O_3 + O \longrightarrow 2O_2$ for this mark</p> <p>-----</p> <p>DO NOT ALLOW equations with other CFCs</p> <p>DO NOT ALLOW $CF_2Cl_2 \longrightarrow 2Cl + CF_2$</p> <p>-----</p> <p>These are the only acceptable equations</p> <p>IGNORE overall equation (<i>does not show role of catalyst</i>) e.g. $O_3 + O \longrightarrow 2O_2$</p>

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

Question		Answer	Mark	Guidance
5	(a) (i)	<p>FIRST, CHECK THE ANSWER ON ANSWER LINE IF $\Delta H_c = -2260$ (kJ mol⁻¹) award 4 marks IF $\Delta H_c = (+)2260$ (kJ mol⁻¹) award 3 marks (incorrect sign) IF $\Delta H_c = (\pm)2257(.2)$ (kJ mol⁻¹) award 3 marks (not 3 sf)</p> <p>Moles Amount, n, C₅H₁₂O calculated correctly = 0.0175 (mol) ✓</p> <p>Energy q calculated correctly = 39501 (J) OR 39.5(01) (kJ) ✓</p> <p>Calculating ΔH correctly calculates ΔH in kJ mol⁻¹ to 3 or more sig figs ✓</p> <p>Rounding and Sign calculated value of ΔH rounded to 3 sig. fig. with minus sign ✓</p>	4	<p>ANNOTATE ANSWER WITH TICKS AND CROSSES ETC</p> <p>Note: $q = 180 \times 4.18 \times 52.5$ ALLOW 39501 OR correctly rounded to 3 sig. fig. (J) IGNORE sign IGNORE working</p> <p>Note: from 39501 J and 0.0175 mol $\Delta H = (-)2257.2$ kJ mol⁻¹</p> <p>IGNORE sign at this intermediate stage ALLOW ECF from incorrect q and/or incorrect n</p> <p>Final answer must have correct sign and three sig figs</p>
	(ii)	<p>ANY TWO FROM THE FOLLOWING ✓✓</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>IGNORE heat loss (<i>in question</i>)</p> <p>ALLOW burns incompletely IGNORE 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 AND species AND states all required DO NOT ALLOW multiples of this equation
	(ii)	<p>FIRST, CHECK THE ANSWER ON ANSWER LINE IF enthalpy change = $-3320 \text{ (kJ mol}^{-1}\text{)}$ award 3 marks IF enthalpy change = $(+)$$3320 \text{ (kJ mol}^{-1}\text{)}$ award 2 marks</p> <p>----- Working for CO_2 AND H_2O seen anywhere</p> <p>$5 \times (-)394$ AND $6 \times (-)286$ OR $(-)1970$ AND OR $(-)3686 \checkmark$ $(-)1716$</p> <p>Calculates ΔH_c</p> <p>A further 2 marks for correct answer AND correct sign $= 5 \times -394 + 6 \times -286 - -366$ $= -3320 \text{ (kJ mol}^{-1}\text{)} \checkmark\checkmark$</p> <p>A further 1 mark for correct answer AND incorrect or no sign $= (+)3320 \text{ (kJ mol}^{-1}\text{)} \checkmark$ <i>Cycle wrong way around:</i> $-366 - (5 \times -394 + 6 \times -286)$</p>	3	<p>ANNOTATE ANSWER WITH TICKS AND CROSSES ETC</p> <p>IF there is an alternative answer, check to see if there is any ECF credit possible</p> <p>Common incorrect answers are shown below Award 2 marks for -1744 OR -1890 OR -314 OR -4052 Award 1 mark for 1744 OR 1890 OR 314 OR 4052</p>

Question	Answer	Mark	Guidance
(c)	<p>QWC: Evidence of the IR absorption at 1720 (cm⁻¹) for presence of C=O/carbonyl group ✓</p> <p>QWC: No carboxylic acid OH absorption in IR OR no peak between 2500–3300 cm⁻¹</p> <p>AND so J is a secondary alcohol OR so K is a ketone ✓</p> <p>Alcohol J</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>Compound K Structure of a carbonyl compound that could be obtained from alcohol J ✓</p> <p>Equation Balanced equation for conversion of J to K ✓ e. $\text{CH}_3\text{CHOHCH}(\text{CH}_3)_2 + [\text{O}] \longrightarrow \text{CH}_3\text{COCH}(\text{CH}_3)_2 + \text{H}_2\text{O}$</p>	6	<p>ANNOTATE ANSWER WITH TICKS AND CROSSES ETC</p> <p>LOOK ON THE SPECTRUM for labelled peaks which can be given credit BOTH IR at ~1720 (cm⁻¹) AND C=O required ALLOW ranges from <i>Data Sheet</i>, i.e. C=O within range 1640–1750 cm⁻¹;</p> <p>IGNORE any reference to C-O absorption For structures of J and K, ALLOW correct structural OR displayed OR skeletal formula OR mixture of the above IGNORE any names given for J and K</p> <p>ALLOW 1 mark for the structure of an alcohol with the molecular formula C₅H₁₂O DO NOT ALLOW pentan-1-ol (<i>primary and unbranched</i>) or 2-methylbutan-2-ol (<i>branched but tertiary</i>)</p> <p>DO NOT ALLOW any marks for J and K if more than one structure is given for J</p> <p>Note: ‘sticks’ in either J and/or K will lose only 1 mark</p> <p>ALLOW 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 \\ \quad \quad \\ \quad \quad \text{CH}_3 \end{array} $ <p style="text-align: right;">IF a structure is not given for J</p> <p>NOTE: structures for J and K could be awarded from the equation, even if not labelled.</p> <p>ALLOW molecular formulae in equation i.e. C₅H₁₂O + [O] → C₅H₁₀O + H₂O DO NOT ALLOW equations that form a carboxylic acid</p>

Question		Answer	Mark	Guidance
	(d)	<p>Labelled diagram showing at least one H-bond between alcohol molecule and water ✓</p> <p>e.</p>	1	<p>IF diagram is not labelled ALLOW 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>IGNORE alcohol R group, even if wrong</p> <p>ALLOW structural OR displayed OR skeletal formula OR mixture of the above</p>
		Total	17	

Question		Answer	Marks	Guidance
6	(a)	<p>1-bromopentane reacts faster OR 1-chloropentane reacts slower ✓</p> <p>C–C/ stronger bond (than C–Br bond) OR C–C/ shorter bond (than C–Br bond) OR C–C/ bond is harder to break OR needs more energy to break C–C/ bond OR bond enthalpy of C–C/ greater (than C–Br bond) ✓</p>	2	<p>ALLOW takes more time to react ALLOW chloro compound reacts slower than bromine compound DO NOT ALLOW bromine reacts faster than chlorine</p> <p>ALLOW ORA</p> <p>Answer must refer to the C–C/ bond or C–Br bonds</p>
	(b) (i)	<p>$\text{CH}_3\text{—CH}_2\text{—CH}_2\text{—CH}_2\text{—I}$ ✓</p> <p>$\text{CH}_3\text{—CH}_2\text{—CH—CH}_3$ ✓ I</p> <p>$\text{CH}_3\text{—C—I}$ ✓ CH₃</p> <p>$\text{CH}_3\text{—C—CH}_2\text{—I}$ ✓ H</p>	4	<p>ALLOW correct structural OR displayed OR skeletal formula OR mixture of the above (as long as unambiguous) n.b. C₂H₅ is unambiguous but C₃H₇ is ambiguous</p> <p>IGNORE incorrect name</p> <p>Mark incorrect answers first of all.</p> <ul style="list-style-type: none"> • One incorrect answers maximum 3 marks • Two incorrect answers maximum 2 marks • Three incorrect answers maximum 1 mark • Four incorrect answers scores 0 mark <p>ALLOW as a slip one stick with no H on in a displayed formula</p>

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

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

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