EXAM PAPERS PRACTICE

Boost your performance and confidence with these topic-based exam questions

Practice questions created by actual examiners and assessment experts

Detailed mark scheme

Suitable for all boards

Designed to test your ability and thoroughly prepare you

Time allowed
84 Minutes

Score /67

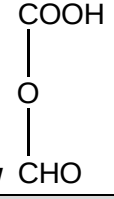
Percentage %

CHEMISTRY

OCR AS & A LEVEL

Mark Schemes

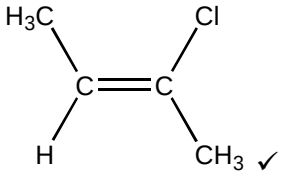
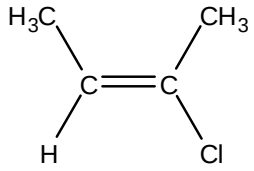
Module 4: Core organic chemistry

Question			Expected Answers	Marks	Additional Guidance
1			**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 ✓ **Percentage composition** Mole ratio C : H : O = 2.23 : 2.22 : 4.44 ✓ Empirical formula is CHO_2 ✓ (mass of one mole is 90 g) so M_r is 90 ✓ QWC – molecular formula is $C_2H_2O_4$ with working out from M_r ✓ Structure is  ✓	8	**ANNOTATE WITH TICKS AND CROSSES** **QWC** –Structure linked to information at least once **ALLOW** 1720 indicates presence of aldehydes, ketones, esters, carboxylic acid, amides **ALLOW** 2900 indicates carboxylic acid **ALLOW** 1080 indicates alcohol, esters, carboxylic acids **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 **ALLOW** 0.0945/0.00105 = 90  **ALLOW**
			Total	**8**	

Question			er	Marks	Guidance
2	(a)	(	(*m*/*z* =) 46 ✓	1	
		(ii)	CH_3O^+ **OR** CH_2OH^+ ✓	1	**MUST** show '+'
		(iii)	C_2H_6O ✓	1	**ALLOW** H_2CO_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)		*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
	(d)		No absorption between 1640 and 1750 cm^{-1} **AND** no (broad) absorption between 3200 and 3550 cm^{-1} ✓	1	**ALLOW** the only significant absorption is at around 2850 to 3100 cm^{-1} due to C–H bond **OR** There is an absorption around 2850 to 3100 cm^{-1} due to C–H bond **AND no** absorptions by C=O and O–H bonds **IGNORE** comments about C—O **ALLOW** any values within the wavenumber range
	(e)		C=O because of absorption between 1640 and 1750 cm^{-1} **AND** O–H (broad) absorption between 2500 to 3300 cm^{-1} ✓ Carboxyl group **OR** carboxylic acid ✓	2	**ALLOW** any values within the wavenumber range **ALLOW** O–H (broad) absorption between 2500 to 3500 cm^{-1} (from spectrum) **IGNORE** C–O **ALLOW** carboxylic acid if linked with O–H absorption **IGNORE** alcohol, ester, aldehyde, ketone or amide
			Total	**10**	

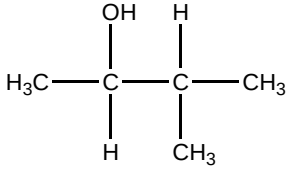
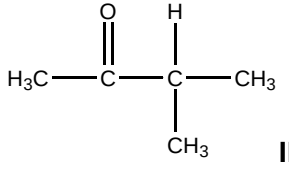
Question			Answer	Mark	Guidance
4	(a)		**B** ✓	1	**ALLOW** CF_2CF_2 **OR** C_2F_4 **OR** tetrafluoroethene
	(b)	(i)	 ✓	1	**ALLOW** correct structural **OR** displayed **OR** skeletal **OR** mixture of the above **ALLOW** *E* isomer 
		(ii)	HCl ✓	1	**DO NOT ALLOW** Cl_2 **IGNORE** names **IGNORE** nitrogen 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

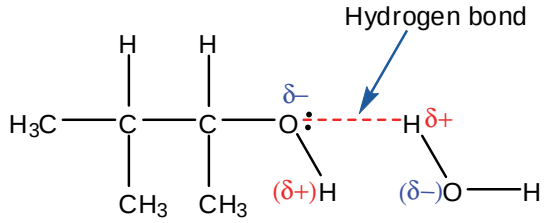
Question	Answer	Mark	Guidance
(ii)	*Benefit of ozone layer to life (1 mark)* Ozone absorbs **UV** (radiation) **UV** at Earth's surface is reduced ✓ **OR** *Maintenance of O_3 concentration* (1 mark) $_3 \rightleftharpoons O_2 + O$ ✓ O --- *Production of radicals from **G** (1 mark)* $_2Cl_2 \longrightarrow C\ l + CF_2Cl$ ✓ --- CF *Breakdown of O_3 (2 marks)* $l + O_3 \longrightarrow C\ lO + O_2$ ✓ $lO + O \longrightarrow Cl + O_2$ C **OR** $ClO + O_3 \longrightarrow Cl + 2O_2$ ✓ C	5	**ANNOTATE ANSWER WITH TICKS AND CROSSES ETC** For all equations, **IGNORE** dots on radicals --- Essential idea for first mark is that **UV** is removed in some way. **ALLOW** Prevents **UV** damaging life or stated type of damage, e.g. cataracts, skin cancer, mutation, crop damage **DO NOT ALLOW** ozone absorbs IR --- **ALLOW** $_3 \longrightarrow O_2 + O$ $_2 + O \longrightarrow O_3$ O **AND** **DO NOT ALLOW** $2O_3 \rightleftharpoons 3O_2$ O **OR** $O_3 + O \longrightarrow 2O_2$ for this mark --- **DO NOT ALLOW** equations with other CFCs **DO NOT ALLOW** $CF_2Cl_2 \longrightarrow 2C\ l + CF_2$ --- These are the only acceptable equations **IGNORE** overall equation *(does not show role of catalyst)* e.g. $O_3 + O \longrightarrow 2O_2$

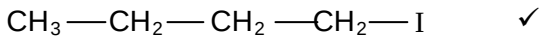
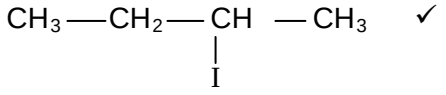
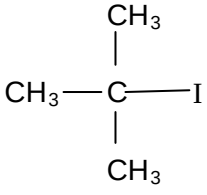
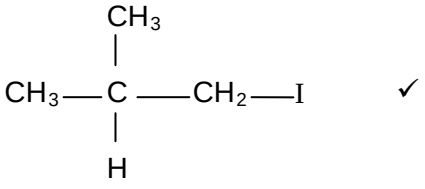
Question			Answer	Mark	Guidance
	(iii)		**D** ✓	1	**ALLOW** CHF_2Cl **ALLOW B OR** C_2F_4 **OR** CF_2CF_2
	(d)	(i)	**bond** vibrates (more) **OR bond** bends (more) **OR bond** stretches (more) ✓	1	**BOND essential** **IGNORE** molecule vibrates/rotates Assume "It" refers to the molecule and is insufficient **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_3C^+ ✓ $CF_2\ Cl^+$ ✓	2	**ALLOW** 1 mark for Cl_3C **AND** $CF_2\ Cl$ *i.e. no + charge used* **ALLOW** 1 mark for Cl_3C^- **AND** $CF_2\ Cl^-$ *i.e. – charge used on both*
			Total	**13**	

Question			Answer	Mark	Guidance
5	(a)	(i)	**FIRST, CHECK THE ANSWER ON ANSWER LINE** **IF ΔH_c = –2260 (kJ mol $^{-1}$) award 4 marks** **IF ΔH_c = (+)2260 (kJ mol $^{-1}$) award 3 marks (incorrect sign)** **IF ΔH_c = (±)2257(.2) (kJ mol $^{-1}$) award 3 marks (not 3 sf)**	4	ANNOTATE ANSWER WITH TICKS AND CROSSES ETC
			Moles Amount, *n*, $C_5H_{12}O$ calculated correctly = 0.0175 (mol) ✓		
			Energy *q* calculated correctly = 39501 (J) **OR** 39.5(01) (kJ) ✓		**Note:** $q = 180 \times 4.18 \times 52.5$ **ALLOW** 39501 **OR** correctly rounded to 3 sig. fig. (J) **IGNORE** sign **IGNORE** working
			Calculating ΔH correctly calculates ΔH in kJ mol^{-1} to 3 or more sig figs ✓		**Note:** from 39501 J and 0.0175 mol ΔH = (-)2257.2 kJ mol^{-1} **IGNORE** sign at this intermediate stage **ALLOW** ECF from incorrect q and/or incorrect n
			Rounding and Sign calculated value of ΔH rounded to 3 sig. fig. with minus sign✓		Final answer must have **correct sign** and **three sig figs**
		(ii)	**ANY TWO FROM THE FOLLOWING** ✓✓ incomplete combustion non-standard conditions evaporation of alcohol/water specific heat capacity of beaker/apparatus	2	**IGNORE** heat loss (*in question*) **ALLOW** burns incompletely **IGNORE** incomplete reaction

Question			Answer	Mark	Guidance
	(b)	(i)	$5C(s) + 6H_2(g) + ½O_2(g) \longrightarrow C_5H_{12}O(l)$ ✓	1	Balancing numbers **AND** species **AND** states all required **DO NOT ALLOW** multiples of this equation
		(ii)	**FIRST, CHECK THE ANSWER ON ANSWER LINE** **IF enthalpy change = –3320 (kJ mol^{-1}) award 3 marks** **IF enthalpy change = (+)3320 (kJ mol^{-1}) award 2 marks** --- Working for CO_2 **AND** H_2O seen anywhere 5 × (–)394 **AND** 6 × (–)286 **OR** (–)1970 **AND** **OR** (–)3686 ✓ (–)1716 Calculates ΔH_c **A further 2 marks** for correct answer **AND** correct sign = 5 × –394 + 6 × –286 – –366 = –3320 (kJ mol^{-1}) ✓✓ **A further 1 mark** for correct answer **AND** incorrect or no sign = (+)3320 (kJ mol^{-1}) ✓ *Cycle wrong way around:* *–366 – (5 × –394 + 6 × –286)*	3	**ANNOTATE ANSWER WITH TICKS AND CROSSES ETC** **IF there is an alternative answer, check to see if there is any ECF credit possible** **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

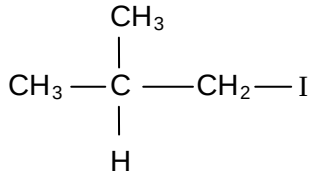
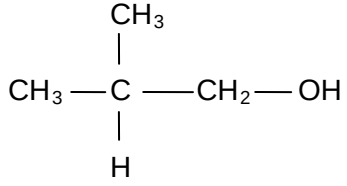
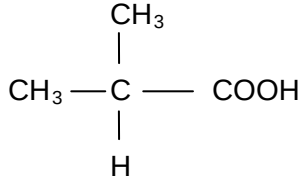
Question	Answer	Mark	Guidance
(c)		6	**ANNOTATE ANSWER WITH TICKS AND CROSSES ETC**
	QWC: Evidence of the **IR** absorption at 1720 (cm^{-1}) for presence of C=O/carbonyl group ✓		**LOOK ON THE SPECTRUM** for labelled peaks which can be given credit **BOTH IR** at ~1720 (cm^{-1}) **AND** C=O required **ALLOW** ranges from *Data Sheet*, i.e. C=O within range 1640–1750 cm^{-1};
	QWC: No carboxylic acid OH absorption in IR **OR** no peak between 2500–3300 cm^{-1} **AND** so **J** is a secondary alcohol **OR** so **K** is a ketone ✓		**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**
	Alcohol J  ✓✓		**ALLOW** 1 mark for the structure of an alcohol with the molecular formula $C_5H_{12}O$ **DO NOT ALLOW** pentan-1-ol (*primary and unbranched*) or 2-methylbutan-2-ol (*branched but tertiary*)
	Compound K Structure of a carbonyl compound that could be obtained from alcohol **J** ✓		**DO NOT ALLOW** any marks for **J** and **K** if more than one structure is given for **J** **Note:** 'sticks' in either **J** and/or **K** will lose only 1 mark **ALLOW** 1 mark for:  **IF** a structure is not given for **J**
	Equation Balanced equation for conversion of **J** to **K** ✓ e. $CH_3CHOHCH(CH_3)_2 + [O] \longrightarrow CH_3COCH(CH_3)_2 + H_2O$		**NOTE:** structures for **J** and **K** could be awarded from the equation, even if not labelled. **ALLOW** molecular formulae in equation i.e. $C_5H_{12}O + [O] \longrightarrow C_5H_{10}O + H_2O$ **DO NOT ALLOW** equations that form a carboxylic acid

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

Question			Answer	Marks	Guidance
6	(a)		1-bromopentane reacts faster **OR** 1-chloropentane reacts slower ✓ C–C*l* stronger bond (than C–Br bond) **OR** C–C*l* shorter bond (than C–Br bond) **OR** C–C*l* bond is harder to break **OR** needs more energy to break C–C*l* bond **OR** bond enthalpy of C–C*l* greater (than C–Br bond) ✓	2	**ALLOW** takes more time to react **ALLOW** chloro compound reacts slower than bromine compound **DO NOT ALLOW** bromine reacts faster than chlorine **ALLOW** ORA Answer must refer to the C–C*l* bond or C–Br bonds
	(b)	(i)	 ✓  ✓  ✓  ✓	4	**ALLOW** correct structural **OR** displayed **OR** skeletal formula **OR** mixture of the above (as long as unambiguous) n.b. C_2H_5 is unambiguous but C_3H_7 is ambiguous **IGNORE** incorrect name Mark incorrect answers first of all. • One incorrect answers maximum 3 marks • Two incorrect answers maximum 2 marks • Three incorrect answers maximum 1 mark • Four incorrect answers scores 0 mark **ALLOW** 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	**IGNORE** any structures drawn **DO NOT ALLOW** C_4H_9OH

Question			er	Marks	Guidance
6	(b)	(iii)	**infrared** 1700–1730 cm^{-1} indicates carbonyl group ✓ broad 2900 cm^{-1} indicates O–H bond **AND** it is a **carboxylic acid** ✓ **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 ✓	6	**ANNOTATE ANSWER WITH TICKS AND CROSSES ETC** **LOOK ON THE SPECTRUM** for labeled absorbances which can be given credit **ALLOW** has a C=O bond because it has absorbance within range 1640–1750 cm^{-1} **ALLOW** 2900 cm^{-1} indicates O–H in carboxylic acid **ALLOW** has O–H bond in carboxylic aid 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** If two marking points from the explanation mark are given both must be correct

Question			er	Marks	Guidance
			B is  ✓ **C** is  ✓ **D** is  ✓		**ALLOW** correct structural **OR** displayed **OR** skeletal formula **OR** mixture of the above (as long as unambiguous) **IGNORE** incorrect names for **B**, **C** and **D** Mark correct branched structures first of all. If there are no correct branched structures and **C** is $CH_3CH_2CH_2CH_2OH$ then **ALLOW** one mark for $CH_3CH_2CH_2COOH$ and one mark for $CH_3CH_2CH_2CH_2I$
			Total	**13**	