GCE A LEVEL MARKING SCHEME

SUMMER 2024

A LEVEL
CHEMISTRY – UNIT 4
1410U40-1

About this marking scheme

The purpose of this marking scheme is to provide teachers, learners, and other interested parties, with an understanding of the assessment criteria used to assess this specific assessment.

This marking scheme reflects the criteria by which this assessment was marked in a live series and was finalised following detailed discussion at an examiners' conference. A team of qualified examiners were trained specifically in the application of this marking scheme. The aim of the conference was to ensure that the marking scheme was interpreted and applied in the same way by all examiners. It may not be possible, or appropriate, to capture every variation that a candidate may present in their responses within this marking scheme. However, during the training conference, examiners were guided in using their professional judgement to credit alternative valid responses as instructed by the document, and through reviewing exemplar responses.

Without the benefit of participation in the examiners' conference, teachers, learners and other users, may have different views on certain matters of detail or interpretation. Therefore, it is strongly recommended that this marking scheme is used alongside other guidance, such as published exemplar materials or Guidance for Teaching. This marking scheme is final and will not be changed, unless in the event that a clear error is identified, as it reflects the criteria used to assess candidate responses during the live series.

WJEC GCE A LEVEL CHEMISTRY

UNIT 4 – ORGANIC CHEMISTRY AND ANALYSIS

SUMMER 2024 MARK SCHEME

GENERAL INSTRUCTIONS

Extended response questions

A level of response mark scheme is applied. The complete response should be read in order to establish the most appropriate band. Award the higher mark if there is a good match with content and communication criteria. Award the lower mark if either content or communication barely meets the criteria.

Marking rules

All work should be seen to have been marked.

Marking schemes will indicate when explicit working is deemed to be a necessary part of a correct answer.

Crossed out responses not replaced should be marked.

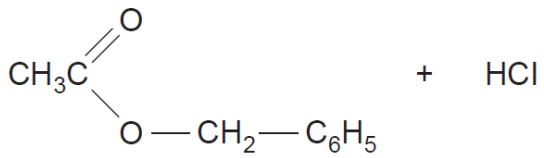
Marking abbreviations

The following may be used in marking schemes or in the marking of scripts to indicate reasons for the marks awarded.

cao	=	correct answer only
ecf	=	error carried forward
bod	=	benefit of doubt

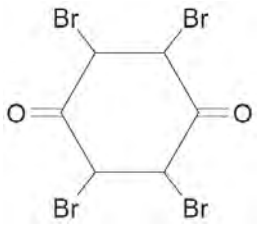
Credit should be awarded for correct and relevant alternative responses which are not recorded in the mark scheme.

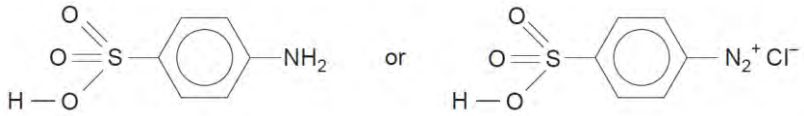
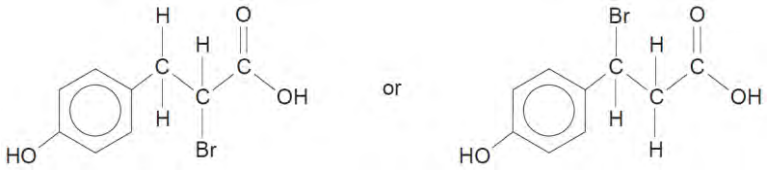
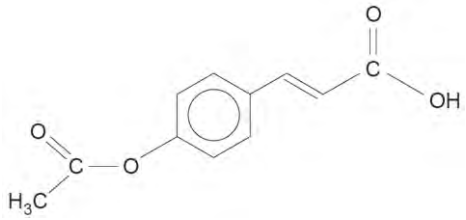
SECTION A

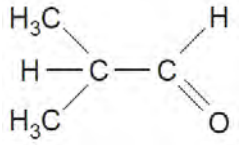
Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
1				 + HCl		1		1		
2	(a)			7.44×10^{14}		1		1	1	
	(b)			it is yellow because the blue end / the rest of the visible spectrum is absorbed	1			1		
3				compound **F** (1) it contains an O—H bond at 3200-3500 cm^{-1} and a C=C at 1620 cm^{-1} but no C=O at 1650-1750 cm^{-1} (1)			2	2		
4				award (1) for any valid formula e.g. $(C_6H_5)_3C\bullet$		1		1		

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
5				2 signals present (1) as all the <u>C</u>H carbon atoms are equivalent and all the <u>C</u>H_3 carbon atoms are equivalent (1)			2	2		
6				$\frac{58.0}{(44+111)} \times 100$ = 37.4 (2) award (1) if value given to anything other than 3 sig figs		2		2	1	
				Section A total	**1**	**5**	**4**	**10**	**2**	**0**

SECTION B

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
7	(a)	(i)		concentrated nitric acid and concentrated sulfuric acid	1			1		1
		(ii)		NO_2^+	1			1		
	(b)	(i)		reduction		1		1		
		(ii)		tin and concentrated hydrochloric acid accept formulae		1		1		1
		(iii)		nitrous acid / nitric(III) acid / sodium nitrite and hydrochloric acid accept formulae		1		1		1
		(iv)		orange to green (solutions)	1			1		1
		(v)	I	electrophilic addition	1			1		
			II			1		1		

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(c)	(i)					1	1		
		(ii)		award (1) for either of following it acts as an acid and loses a proton to ^{-}OH (giving water) the base ^{-}OH removes a proton from the acid group		1		1		
	(d)	(i)		purple coloration / solution do not accept reference to a precipitate	1			1		1
		(ii)		fizzing / effervescence	1			1		1
		(iii)				1		1		
		(iv)					1	1		
				Question 7 total	**6**	**6**	**2**	**14**	**0**	**6**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
8	(a)	(i)		it is acting as a base / it removes protons			1	1		
		(ii)		nucleophilic substitution	1			1		
		(iii)	I	M_r of —CHO fragment is 29 ⇨ M_r of R is 72 – 29 = 43 (1) R is C_3H_7 but branched ⇨ compound **S** is  (1)		1	1	2		
			II	orange / red	1			1		1
			III	mixture melts at a lower temperature and over a greater range			1	1		1
	(b)	(i)		use a **separating / dropping funnel** and run off the lower aqueous layer	1			1		1
		(ii)		$NaOH / I_2$ or $KI / NaOCl$ (1) yellow solid (1)	2			2		2

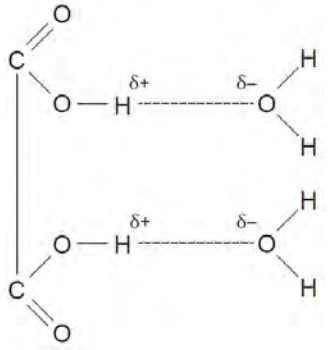
<table>
<tr><th colspan="4" rowspan="2">Question</th><th rowspan="2">Marking details</th><th colspan="6">Marks available</th></tr>
<tr><th>AO1</th><th>AO2</th><th>AO3</th><th>Total</th><th>Maths</th><th>Prac</th></tr>
<tr><td></td><td></td><td>(iii)</td><td></td><td>award (1) for each correct column

<table><tr><th>Protons</th><th>Splitting pattern</th><th>Relative peak area</th></tr><tr><td>CH_3CO</td><td>singlet</td><td>3 (or 1)</td></tr><tr><td>$(CH_3)_3C$</td><td>singlet</td><td>9 (or 3)</td></tr></table></td><td></td><td>2</td><td></td><td>2</td><td></td><td></td></tr>
<tr><td></td><td></td><td>(iv)</td><td>I</td><td>the alcohol has hydrogen bonding (the others do not) (1)

therefore more energy is needed to separate the molecules (hence higher boiling temperature) (1)</td><td></td><td>2</td><td></td><td>2</td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td>II</td><td>similar – they each show four separate signals (four environments) (1)

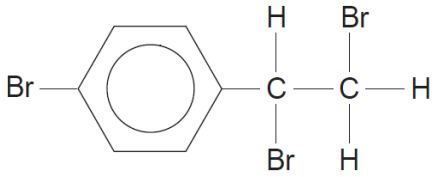
different – the (four) signals will be in different positions (1)

accept any other sensible answers</td><td></td><td>2</td><td></td><td>2</td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td>Question 8 total</td><td>5</td><td>7</td><td>3</td><td>15</td><td>0</td><td>5</td></tr>
</table>

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
9	(a)	(i)		**2** C_4H_9OH + **2** CO + **½** O_2		1		1		
		(ii)		award (1) for any of following cost of the catalyst separation of liquid materials from the catalyst cost of (maintaining) very high pressure accept any other valid suggestion		1		1		
		(iii)		ethanedioic acid is able to **hydrogen bond** to water molecules (hence its solubility) (1)  (1) hydrogen bonding to just one water molecule is acceptable the ester does not contain an O—H bond, so cannot hydrogen bond with water (hence largely insoluble) (1)	1 1	1		3		

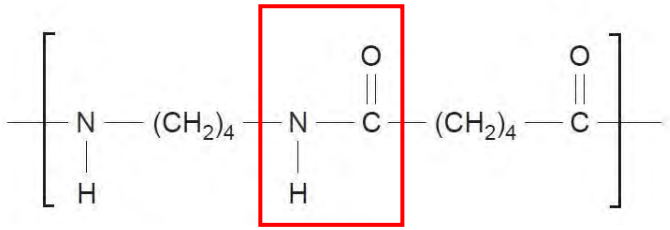
Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(b)	(i)		moles of $(COO)_2Ca$ present = $\frac{11.52}{128}$ = 0.0900 (1) 1:1 ratio therefore 0.0900 mol of H_2SO_4 needed volume needed = $\frac{0.0900}{2} \times 1000$ = 45.0 cm^3 (1)	1	1		2	1	
		(ii)		7.15g of $(COOH)_2.2H_2O$ dissolves in 50 cm^3 of solution at 20°C (1) total moles of $(COOH)_2.2H_2O$ present is 0.0900 total mass of $(COOH)_2.2H_2O$ formed = 0.0900 × 126 = 11.34 g (1) therefore, mass crystallising out = 11.34 – 7.15 = 4.19 g (1) ecf possible from incorrect moles in (b)(i)	1	1	1	3	2	
	(c)			$3CF_2H_2 + 3(COO)_2Na_2 \rightarrow C_6F_6 + 3Na_2CO_3 + 3H_2O$ award (1) for all formulae correct award (1) balancing only if all formulae correct		2		2		

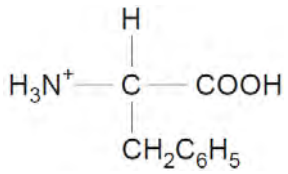
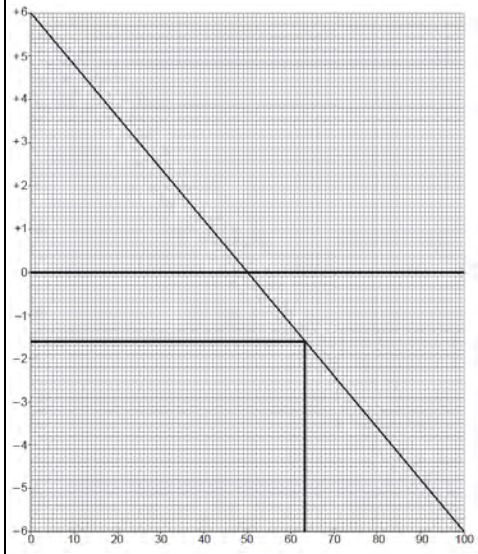
Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(d)			percentage of mass lost from graph = $\frac{5.40 - 4.73}{5.40} \times 100$ = 12.4% (1) percentage 'mass lost' in M_r = $\frac{28}{225} \times 100$ = 12.4% equation must be correct as the values are the same (1) accept same reasoning using 'remaining mass' ⇨ 87.6% *alternative method* moles of barium ethanedioate = $\frac{5.4}{225}$ = 0.024 (1) moles of barium carbonate = $\frac{4.73}{197}$ = 0.024 same number of moles therefore 1:1 stoichiometry (1)		1	1	2	1	
	(e)			ethylbenzene		1		1		
				Question 9 total	**4**	**9**	**2**	**15**	**4**	**0**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
10	(a)			**Indicative content** mass of carbon in 5.35 g of compound **B** is 1.50 g molecular formula is $C_8H_7Br_3$ M_r is 343 there is a chiral carbon atom formula of silver bromide is AgBr mass of bromine in 4.77 g of silver bromide is 2.03 g NaOH hydrolyses aliphatic C—Br bonds % Br in hydrolysis product is 46.6 % Br in compound **B** is $\frac{3 \times 79.9 \times 100}{343}$ = 69.9 therefore two of the three bromine atoms in compound **B** are removed ⇨ they must be in the side chain bromine atom not removed must be on the ring compound **B** is  accept aromatic bromine in any position		3	3	6	2	2

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
				5-6 marks All the information used effectively; sufficient explanation to deduce the correct structure *The candidate constructs an articulate, integrated account, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses scientific conventions and vocabulary appropriately and accurately*. **3-4 marks** Most of the information used effectively; some features of the structure correctly identified and explained *The candidate constructs an account correctly linking some relevant points showing some reasoning. The answer addresses the question with some omissions. The candidate usually uses scientific conventions and vocabulary appropriately and accurately*. **1-2 marks** Some of the information used correctly; simple conclusions drawn *The candidate makes some relevant points showing limited reasoning. The answer addresses the question with significant omissions. The candidate makes limited use of scientific conventions and vocabulary.* **0 marks** *The candidate does not make any attempt or give a relevant answer worthy of credit.*						

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(b)	(i)		eight —OH groups react 8 × 0.0700 mol of ethanoic anhydride needed = 0.560 mol (1) mass = 102 × 0.560 = 57.1 g minimum volume = $\frac{57.1}{1.08}$ = 52.9 cm^3 (1)	1	1		2	1	
		(ii)		award (1) each for any two of following percentage yield reaction rate / time needed need of a catalyst energy costs – must be qualified (and not related to heating)			2	2		
	(c)	(i)		red-brown precipitate/solid	1			1		1
		(ii)		aldehyde / CHO	1			1		1
				Question 10 total	**3**	**4**	**5**	**12**	**3**	**4**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
11	(a)	(i)		award (1) for correct product NH_3 award (1) for correct balancing (only if product is correct) **2** NaOH **2** NH_3		2		2		
		(ii)		$0.075 \times \frac{60}{100}$ = 0.045 mol of the diamine formed (1) mass of diamine = 0.045 × 88 = 3.96 g (1)	1	1		2	1	
		(iii)			1			1		
		(iv)	I	award (1) for any of following only one stage involved therefore quicker only one stage involved therefore probably higher percentage yield fewer waste products therefore greener			1	1		
			II	award (1) for either of following no more effervescence / bubbles (of nitrogen) evolved no more precipitation of the acid			1	1		1

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(b)	(i)		elimination of water	1			1		
		(ii)			1			1		
		(iii)		distance travelled by spot = 8.0 × 0.54 = 4.3 cm (1) spot marked on diagram at 5.3 cm (1)	1	1		2	1	
	(c)			 appropriate scale (1) lines drawn correctly (1) award (1) for correct values (+) 36-37% (–) 63-64%			3	3	2	
				Question 11 total	**5**	**4**	**5**	**14**	**4**	**1**

UNIT 4

SUMMARY OF ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	TOTAL MARK	MATHS	PRAC
Section A	1	5	4	10	2	0
7	6	6	2	14	0	6
8	5	7	3	15	0	5
9	4	9	2	15	4	0
10	3	4	5	12	3	4
11	5	4	5	14	4	1
Total	24	35	21	80	13	13