GCE A LEVEL MARKING SCHEME

SUMMER 2024

A LEVEL
CHEMISTRY – COMPONENT 2
A410U20-1

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.

GCE A LEVEL CHEMISTRY

COMPONENT 2: ORGANIC CHEMISTRY AND ANALYSIS

SUMMER 2024 MARK SCHEME

GENERAL INSTRUCTIONS

Recording of marks

Examiners must mark in red ink.

One tick must equate to one mark, apart from extended response questions where a level of response mark scheme is applied.

Question totals should be written in the box at the end of the question.

Question totals should be entered onto the grid on the front cover and these should be added to give the script total for each candidate.

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.

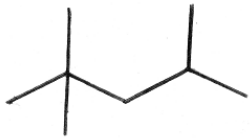
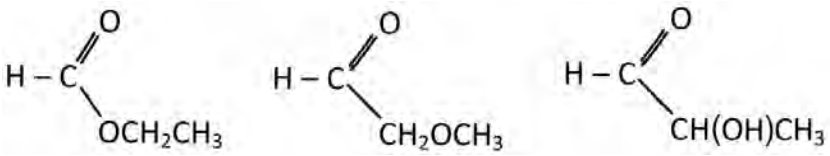
Marking abbreviations

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

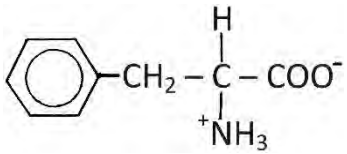
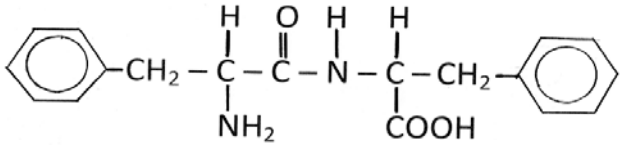
cao = correct answer only
ecf = error carried forward
bod = benefit of doubt

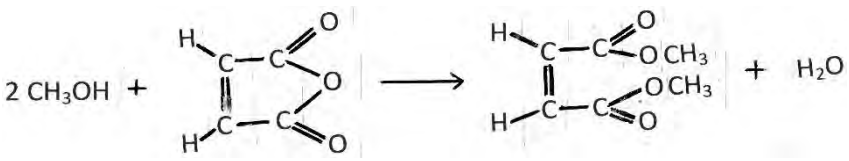
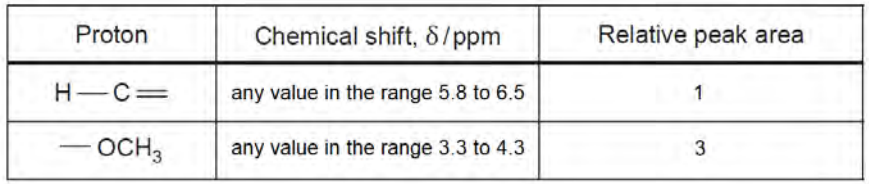
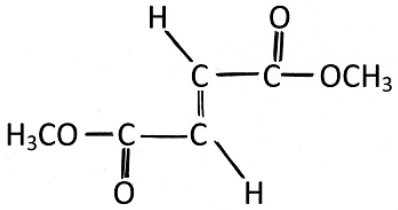
Credit should be awarded for correct and relevant alternative responses which are not recorded in the mark scheme.

Section A

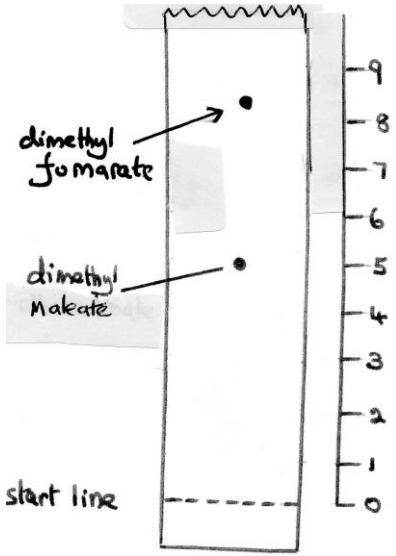
Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
1	(a)				1			1		
	(b)			$CH_3C(CH_3)_2CH_2CH(CH_3)CH_3 + \frac{25}{2} O_2 \rightarrow 8CO_2 + 9\ H_2O$ accept $C_8H_{18} + \frac{25}{2} O_2 \rightarrow 8CO_2 + 9H_2O$		1		1		
2				award (1) for any correct structure containing aldehyde group e.g.  award (1) for reasoning it contains an aldehyde group CHO will reduce Fehling's reagent (to Cu_2O)	1	1		2		2
3				award (1) for any of following phenylethanol 1-phenylethanol 2-phenylethanol	1			1		1

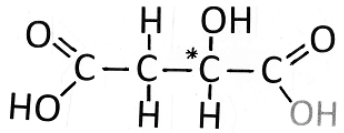
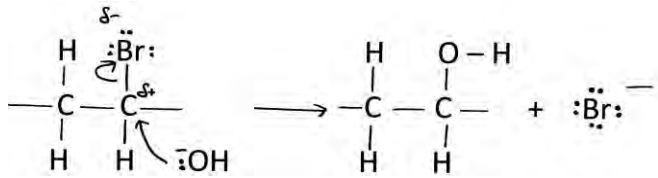
Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
4				prop-2-enenitrile accept propenenitrile	1			1		
5	(a)			M_r of the silver salt = 181 (1) M_r of the carboxylic acid = 181 – 108 + 1 = 74 (1)		2		2	1	
	(b)			'M_r' of the R group = 74 – 45 = 29 (1) alcohol is $CH_3CH_2CH_2OH$ (1)		1	1	2		

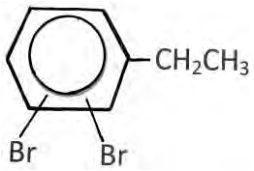
Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
6	(a)				1			1		
	(b)					1		1		
	(c)			2.74 g		1		1		
	(d)			number of moles of N_2 = $\frac{490}{24500}$ = 0.020 (1) (number of moles of phenylalanine is also 0.020) mass of phenylalanine = 0.020 × 165 = 3.30g purity = $\frac{3.30}{3.40}$ × 100 = 97.1% (1)	1	1		2	1	
				Section A total	**6**	**8**	**1**	**15**	**2**	**3**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
7	(a)				2			2		
	(b)			 award (2) for all four correct award (1) for any two correct		2		2		
	(c)				1			1		

Proton	Chemical shift, δ / ppm	Relative peak area
H — C =	any value in the range 5.8 to 6.5	1
— OCH_3	any value in the range 3.3 to 4.3	3

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(d)	(i)		5×10^{-4}		1		1		
		(ii)		7	1			1		
		(iii)		 spot is at 8.4 cm			1	1		1
		(iv)		(unreacted) dimethyl maleate (1) bromine (solution) / water (1)	1	1		2		2

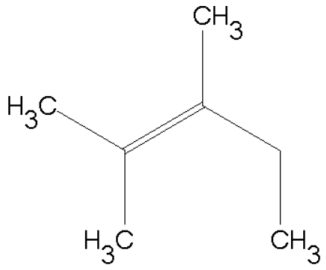
Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(e)	(i)			1			1		
		(ii)		each enantiomer rotates the plane of plane polarised light in opposite directions (resulting in zero rotation)	1			1		
		(iii)	I	H^+ / $H^{\delta+}$		1		1		
			II	 curly arrows (1) partial charges (1)		1	1	2		
			III	if not present in excess the added sodium hydroxide will simply neutralise the two COOH groups present			1	1		1
			IV	the bromine atom has higher electronegativity and attracts both electrons from the C—Br bond (resulting in heterolytic fission)		1		1		
				Question 7 total	**7**	**7**	**3**	**17**	**0**	**4**

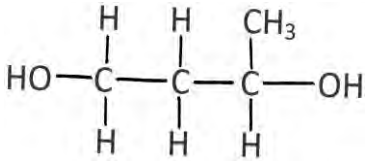
Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
8	(a)	(i)		bromine and iron(III) bromide / Br_2 and $FeBr_3$		1		1		1
		(ii)		17	1			1		1
		(iii)	I	award (1) for both of following structures  substitution can occur elsewhere in the ring (1)	1	1		2		
			II			1		1		
	(b)			alcoholic sodium hydroxide solution (1) a small molecule / HBr is removed (1)	1	1		2		2
	(c)			add aqueous bromine dropwise (1) bromine decolourised (1)	1	1		2		2

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(d)	(i)		to react with benzoic acid (1) to give water soluble sodium benzoate (1) (other possible correct answers to discussed at the examiners' conference)			2	2		
		(ii)		the density of trichloromethane is greater than the density of the aqueous layer		1		1		1
		(iii)		moles of phenylethene = $\frac{3.00}{104}$ = 0.289 mol (1) moles of phenyloxirane = $\frac{2.50}{120}$ = 0.208 mol (1) mole ratio is 1:1 percentage yield = $\frac{0.208}{0.289}$ × 100 = 71.9% (1)		3		3	2	
	(e)			a peak would be seen between 1650 and 1750 cm^{-1} (1) indicating the presence of the C=O group (1)	2			2		

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(f)			<table><tr><th>Test</th><th>phenylethanal $C_6H_5CH_2CHO$</th><th>phenylethanone $C_6H_5C(O)CH_3$</th></tr><tr><td>alkaline iodine</td><td>no observable reaction</td><td>yellow precipitate formed</td></tr><tr><td>Tollens' reagent</td><td>silver mirror formed</td><td>no observable reaction</td></tr><tr><td>warming with acidified potassium dichromate</td><td>solution turns from orange to green</td><td>no observable reaction</td></tr></table> award (3) for all correct award (2) for any four or five correct award (1) for any two or three correct		3		3		3
				Question 8 total	**6**	**12**	**2**	**20**	**2**	**10**

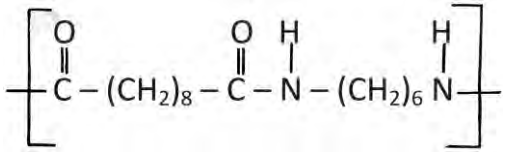
Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
9	(a)			award (1) each for any two disadvantages e.g. • separation may be difficult as 1-iodobutane and octane have similar boiling temperatures • the mass of 1-iodobutane needed is greater than the mass of 1-bromobutane needed to obtain a similar yield i.e. lower atom economy			2	2		
	(b)			$CH_3CH_2CH_2CH_3 + Cl\bullet \rightarrow CH_3CH_2C\bullet HCH_3 + HCl$ balanced equation (1) correct formula of radical (1)		2		2		
	(c)	(i)		electrophilic addition	1			1		
		(ii)		zinc chloride / $ZnCl_2$	1			1		1
		(iii)		award (1) for either of following • there can be only one mono-chlorinated product using route 2 • some 1-chlorobutane is produced using route 1			1	1		
	(d)	(i)		award (1) for either of following all alkenes containing one C=C have the same percentages of carbon and hydrogen only gives the empirical formula			1	1		
		(ii)		cycloheptane is not an alkene / does not contain a C=C bond		1		1		

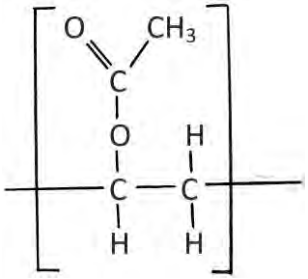
Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
		(iii)		award (1) each for any two of following it cannot be a symmetrical alkene the double bond cannot be in the middle of the carbon chain at least one of R_1-R_4 must be different to the others accept other sensible answers			2	2		
		(iv)		$CH_3C{=}O$		1		1		
		(v)		$M_r = 4.90 \times \frac{35.0}{1.75} = 98$		1		1	1	
		(vi)		award (2) for any correct representation of 2,3-dimethylpent-2-ene  if not correct award (1) for structure of any asymmetric alkene of formula C_7H_{14}			2	2		

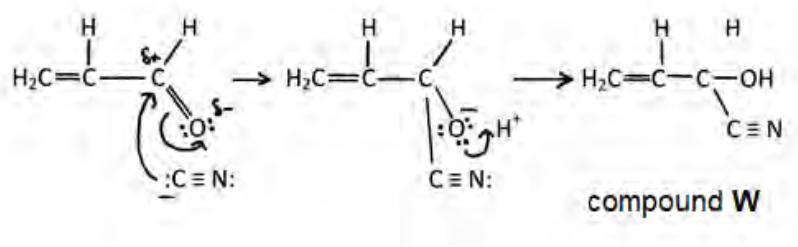
Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(e)			compound **Q** shows a singlet for both the CH_2 and CH_3 protons (1) compound **R** shows a quartet for the CH proton and a doublet for the CH_3 protons (1)		2		2		
	(f)						1	1		
				Question 9 total	**2**	**7**	**9**	**18**	**1**	**1**

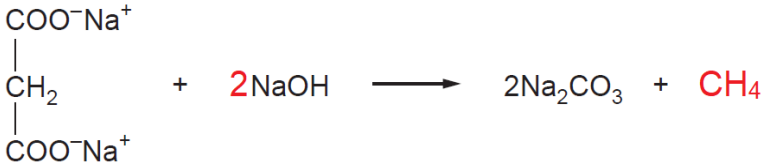
Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
10	(a)			**Indicative content** • 10.9 g of methyl benzoate is used • M_r of methyl benzoate is 136 • 0.080 mol of methyl benzoate is used • 80-100 cm^3 of aqueous sodium hydroxide is needed • heat / reflux • until one layer is present • allow mixture to cool • acidify with hydrochloric acid • filter and wash the precipitated benzoic acid • dry the product **5-6 marks** Mass and volume calculated; each stage of the method considered; method gives dry sample *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	3	6	2	6

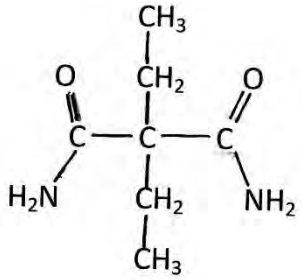
Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
				3-4 marks Good attempt at mass and volume calculation; most stages of the method considered *The candidate constructs an account correctly linking some relevant points showing some reasoning. The answer addresses the question with some omissions. The candidate usually uses scientific conventions and vocabulary appropriately and accurately*. **1-2 marks** Attempt at mass calculation; reference to some stages of the method *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)	I	$ClCH_2(CH_2)_2CH_2Cl + 2KCN \rightarrow NC(CH_2)_4CN + 2KCl$		1		1		
			II	^-CN	1			1		
			III	award (1) for any of following lithium tetrahydridoaluminate(III) / $LiAlH_4$ hydrogen with Ni catalyst sodium and ethanol	1			1		1
		(ii)		$HOOC(CH_2)_8COOH + 2SOCl_2 \rightarrow ClOC(CH_2)_8COCl + 2HCl + 2SO_2$		1		1		
		(iii)				1		1		
		(iv)		when a small molecule / HCl is lost do not accept 'water is lost' accept nucleophilic addition followed by elimination	1			1		

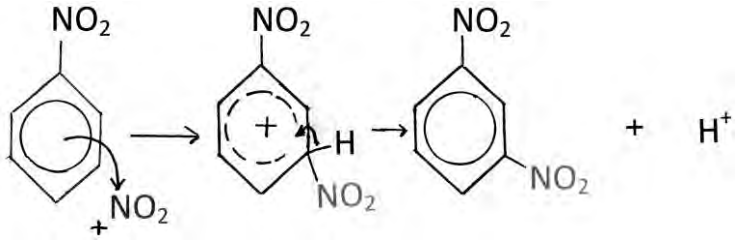
Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(c)					1		1		
	(d)	(i)		$2CH_2CH(ONO_2)(s) + \frac{5}{2}O_2(g) \rightarrow 4CO_2(g) + N_2(g) + 3H_2O(l)$		1		1		
		(ii)		when 2 mol of solid reacts increase in number of moles of gas = $(4 + 1) - \frac{5}{2}$ = 2.5 mol (1) increase in gas volume when 1 mol of solid reacts $\frac{2.5 \times 24.5}{2}$ = 30.6 dm^3 (1)			2	2	1	
				Question 10 total	**3**	**8**	**5**	**16**	**3**	**7**

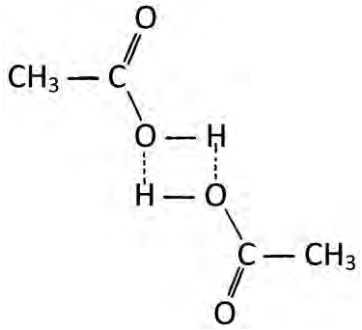
Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
11	(a)	(i)		propane-1,2,3-triol		1		1		
		(ii)		dehydration		1		1		
		(iii)		moles of prop-2-enal obtained = $\frac{6.7}{56}$ = 0.120 (1) mole ratio 1:1 percentage yield = $\frac{0.120}{0.30}$ × 100 = 39.9% (1)		2		2	1	
		(iv)		61	1			1		
		(v)	I	 award (1) for appropriate charges award (1) for curly arrows		2		2		
			II	initial attack is by the nucleophile $^{-}$CN (1) HCN adds across the C=O bond (1)	2			2		

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(b)	(i)		lithium tetrahydridoaluminate(III) / $LiAlH_4$ (1) hydrogen is added / oxygen is lost (1)	2			2		
		(ii)		benzene-1,4-dioic acid accept terephthalic acid		1		1		
	(c)	(i)				2		2		
		(ii)		sodium hydrogencarbonate / $NaHCO_3$ (1) accept sodium carbonate / Na_2CO_3 reaction complete when no more effervescence seen (1) phenol does not react with sodium hydrogencarbonate (to give carbon dioxide) (1)		3		3		3
		(iii)		no purple coloration seen			1	1		1
				Question 11 total	**5**	**12**	**1**	**18**	**1**	**4**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
12	(a)			**Indicative content** • number of moles of sulfuric acid calculated ⇨ 0.040 mol • chemical equation for the reaction of ammonia with sulfuric acid • chemical equation for the reaction producing ammonia • mole ratio of diamide to sulfuric acid ⇨ 1:1 • M_r of diamide calculated ⇨ 158 • M_r of R calculated ⇨ 70 • molecular formula of R ⇨ C_5H_{10} • only two proton environments in R group; splitting pattern and peak areas ⇨ R has two ethyl groups bonded to a central carbon atom • structure of the diamide 		2	4	6	2	2

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
				5-6 marks Correct calculations and equations; all the relevant information used 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** Good attempt at calculations/equations to find mole ratio; some correct features in the structure *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 correct conclusions drawn from the information *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)				2		2		
		(ii)	I	Fe / Sn and hydrochloric acid	1			1		1
			II	NaOH / sodium hydroxide	1			1		1
		(iii)		HNO_2 / $NaNO_2$, HCl / nitric(III) acid / sodium nitrate(III) and hydrochloric acid 0-10°C	2			2		2
		(iv)		amine group in the azo dye has a lone pair of electrons on the nitrogen atom and acts as an electron pair donor / proton acceptor			1	1		

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(c)	(i)		120		1		1		
		(ii)		actual M_r of ethanoic acid is 60 (1) in benzene the ethanoic acid is present as dimeric molecules  (1)		1	1	2		
				Question 12 total	**4**	**6**	**6**	**16**	**2**	**6**

COMPONENT 2: ORGANIC CHEMISTRY AND ANALYSIS

SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	TOTAL	Maths	Practical
Section A	6	8	1	15	2	3
7	7	7	3	17	0	4
8	6	12	2	20	2	10
9	2	7	9	18	1	1
10	3	8	5	16	3	7
11	5	12	1	18	1	4
12	4	6	6	16	2	6
Totals	33	60	27	120	11	35