GCE A LEVEL MARKING SCHEME

SUMMER 2023

A LEVEL
CHEMISTRY – UNIT 4
1410U40-1

INTRODUCTION

This marking scheme was used by WJEC for the 2023 examination. It was finalised after detailed discussion at examiners' conferences by all the examiners involved in the assessment. The conference was held shortly after the paper was taken so that reference could be made to the full range of candidates' responses, with photocopied scripts forming the basis of discussion. The aim of the conference was to ensure that the marking scheme was interpreted and applied in the same way by all examiners.

It is hoped that this information will be of assistance to centres but it is recognised at the same time that, without the benefit of participation in the examiners' conference, teachers may have different views on certain matters of detail or interpretation.

WJEC regrets that it cannot enter into any discussion or correspondence about this marking scheme.

WJEC GCE A LEVEL CHEMISTRY

UNIT 4 – ORGANIC CHEMISTRY AND ANALYSIS

SUMMER 2023 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.

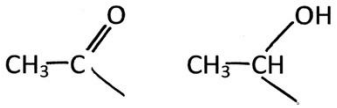
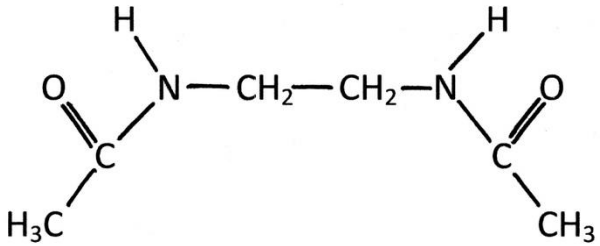
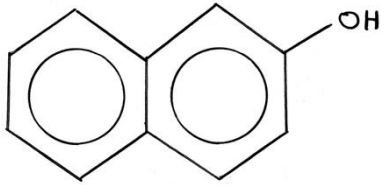
Crossed out responses not replaced should be marked.

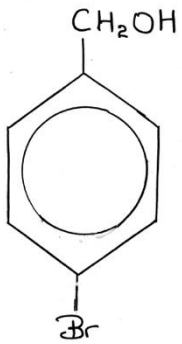
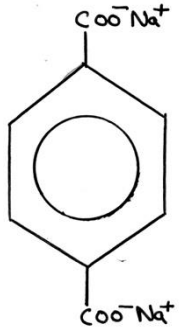
Marking abbreviations

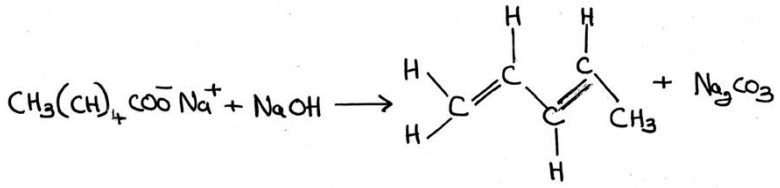
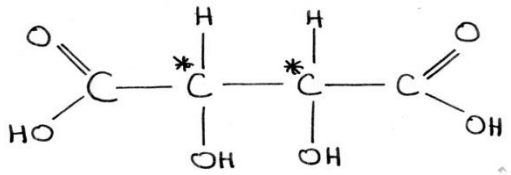
The following may be used in marking schemes or in the marking of scripts to indicate reasons for the marks awarded.

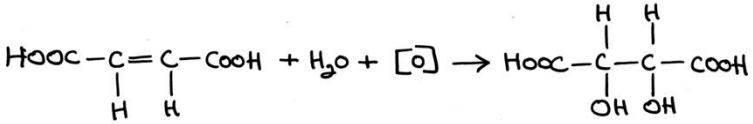
cao	=	correct answer only
ecf	=	error carried forward
bod	=	benefit of doubt

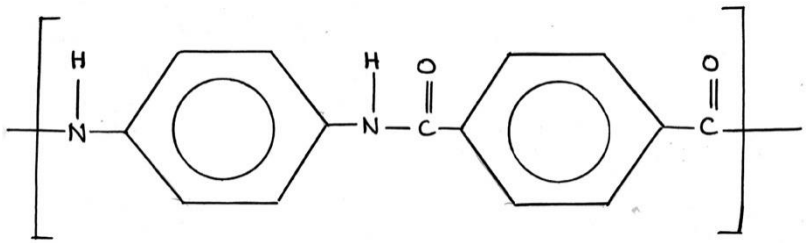
Credit should be awarded for correct and relevant alternative responses which are not recorded in the mark scheme.

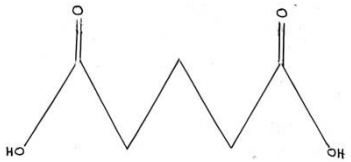
Question				Marking details	Marks available					
					AO1	AO2	AO3	Maths	Prac	Total
1.				$H_3C - CH = CH.CHO$ / $H_2C = C(CH_3)CHO$		1				1
2.				 (1) yellow solid (1) accept methyl carbonyl / methyl ketone / methyl secondary alcohol	2				1	2
3.	(a)			contains a **nitrogen** atom that has a **lone pair of electrons** (which can accept a proton)	1					1
	(b)					1				1
4.						1				1

Question				Marking details	Marks available					
					AO1	AO2	AO3	Maths	Prac	Total
5.				CHCl		1				1
6.						1				1
7.	(a)			alkaline potassium manganate(VII)		1			1	1
	(b)					1				1
				Total Section A	**3**	**7**	**0**	**0**	**2**	**10**

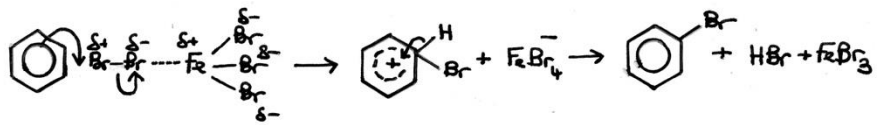
Question				Marking details	Marks available					
					AO1	AO2	AO3	Maths	Prac	Total
8.	(a)	(i)		$200cm^3$ at 100°C contains 8.0 g $200cm^3$ at 20°C contains 0.32 g (1) amount precipitated = 8.0 – 0.32 = 7.68 / 7.7 g (1) answer must be to two or three significant figures		2		1		2
		(ii)	I	loss of CO_2 / removal of a carboxyl (or COO) group	1				1	1
			II	award (1) for balanced equation award (1) for structure of the *E* form of the diene 			2			2
			III	0.4	1					1
	(b)	(i)		 award (1) for either chiral centre identified	1					1

Question				Marking details	Marks available					
					AO1	AO2	AO3	Maths	Prac	Total
		(ii)		enantiomers (1) neutral answer – stereoisomers racemic mixture / racemate (1)	2					2
	(c)			(stereoisomerism occurs when two forms of a compound have) the same structure but different positions in space / different 3D arrangement	1					1
	(d)						1			1
	(e)			polar OH / COOH groups dissolve by hydrogen bonding (1) but as the hydrocarbon chain length increases the polar groups form an increasingly smaller part of a largely non-polar molecule (1)	1	1				2
				Total question 8	**7**	**3**	**3**	**1**	**1**	**13**

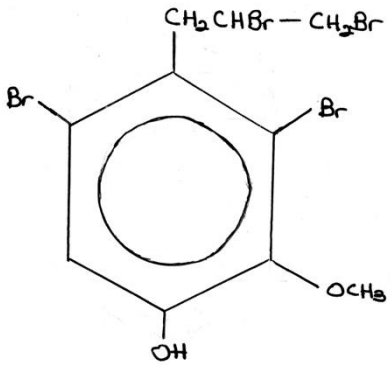
Question				Marking details	Marks available					
					AO1	AO2	AO3	Maths	Prac	Total
9.	(a)	(i)		hydrolysis	1					1
		(ii)		moles of NaOH = $\frac{75.00}{1000}$ × 0.400 = 0.0300 (1) total number of moles of acid is 0.0300 there are equal number of moles of each acid moles of R—COOH is 0.0150 ⇨ same moles of R—COCl (1) M_r of R—COCl = $\frac{1.598}{0.0150}$ = 106.5 (1)		2	1	2		3
		(iii)		award (1) for either of following • M_r of the COCl group is 63.5 therefore M_r of the R group is 43 • likely to be C_3H_7 – the NMR peak area ratio 6:1 suggests $(CH_3)_2CH$ formula of the acid chloride is $(CH_3)_2CHCOCl$ (1)			2			2
	(b)	(i)		$HOOC\text{-}C_6H_4\text{-}COOH + 2PCl_5 \rightarrow ClOC\text{-}C_6H_4\text{-}COCl + 2POCl_3 + 2HCl$			1			1
		(ii)				1				1

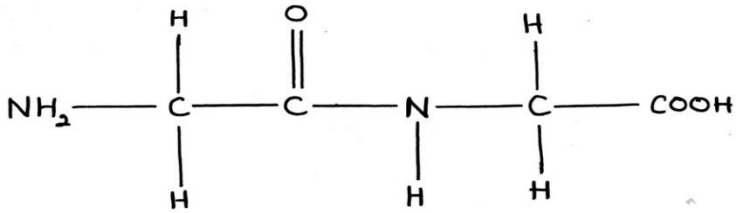
Question				Marking details	Marks available					
					AO1	AO2	AO3	Maths	Prac	Total
	(c)	(i)		award (1) for any of following hydrochloric acid (in the presence of zinc chloride) phosphorus pentachloride phosphorus trichloride thionyl chloride accept correct formulae		1			1	1
		(ii)		ammonia accept NH_3		1				1
		(iii)		nucleophilic substitution	1					1
		(iv)					1			1
	(d)			M_r benzene-1,4-dicarboxylic acid is 166 (1) M_r 'repeating unit' is 192 (1) mass of acid = 75 × $\frac{166}{192}$ × $\frac{90}{100}$ = = 58.4 kg (1)		1 1 1		1		3

Question				Marking details	Marks available					
					AO1	AO2	AO3	Maths	Prac	Total
				alternative method moles of 'repeating unit' = $\frac{75000}{192}$ = 390.5 mol (1) moles of acid = $\frac{90}{100}$ × 390.5 = 351.5 (1) mass of acid = $\frac{351.5 \times 166}{1000}$ = 58.3 (1)						
				Total question 9	**2**	**8**	**5**	**3**	**1**	**15**

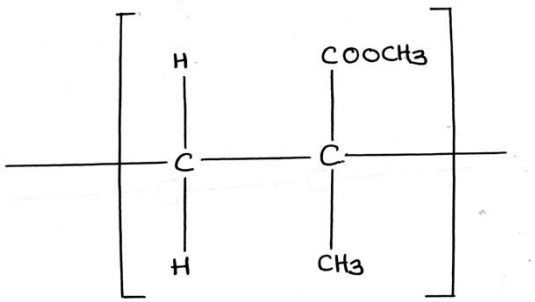
Question				Marking details	Marks available					
					AO1	AO2	AO3	Maths	Prac	Total
10.	(a)			•  accept valid variations on this mechanism • The Br–Br bond becomes polarised δ+ and δ− by • Electron movement/attraction from the π electron system • Polarisation from the electron deficient iron atom in $FeBr_3$ • Mechanism shows the catalyst $FeBr_3$ regeneration • Mechanism shows the production of the co-product, hydrogen bromide • In the absence of the catalyst there is reduced/little induced polarisation of the bromine molecule by the π electron system **5-6 marks** Good account including detailed comments about the mechanism in both the presence and absence of the catalyst. *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 has been provided but the account has less detailed comments about the mechanism in both the presence and absence of the catalyst. *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*.		3	3			6

Question				Marking details	Marks available					
					AO1	AO2	AO3	Maths	Prac	Total
				1-2 marks Some of the information has been provided but the account lacks details about the mechanism. *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.*						
	(b)	(i)		blue / purple colouration	1				1	1
		(ii)		award (1) for either of following goes from yellow-brown → colourless goes from yellow-brown → white (precipitate)	1				1	1

Question				Marking details	Marks available					
					AO1	AO2	AO3	Maths	Prac	Total
		(iii)		% bromine by mass = 66.4 (1) dividing by A_r (1) then dividing each by the smallest figure gives ratio leading to empirical formula of $C_5H_5Br_2O$ (1) compound contains two oxygen atoms / 10 carbon atoms so molecular formula is $C_{10}H_{10}Br_4O_2$ (1) possible structure is  (1)	1	1 1	1 1	3		5
		(iv)		eugenol is **acidic** (phenol) and will **react with NaOH to give a salt** (which is soluble in the aqueous layer) (1) eugenyl ethanoate is an **ester** and is **not soluble in the aqueous layer** (1)			2			2
				Total question 10	**3**	**5**	**7**	**3**	**2**	**15**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Maths	Prac	Total
11.	(a)	(i)				1				1
		(ii)		formed from two molecules of the same acid	1					1
	(b)	(i)	I	$^{+}NH_3$ — CH_2 — COO^{-}	1					1
			II	it does not have an acidic hydrogen atom (in the 'carboxylic acid' group)			1			1
		(ii)	I	$C_3H_5NO^{+}$ / CH_2-C(O)-N(H)-CH_2^{+}			1			1
			II	award (1) for two correct absorption values / ranges N—H ~3000-3500 cm^{-1} C=O ~ 1650-1750 cm^{-1}		1				1
	(c)	(i)		0.53		1			1	1
		(ii)		dye absorbs in the yellow / green region colours seen comprises the rest / is the complimentary colour / is made from red and blue			1			2

Question				Marking details	Marks available					
					AO1	AO2	AO3	Maths	Prac	Total
		(iii)		$E = \frac{hc}{\lambda}$ (1) $E = \frac{6.63 \times 10^{-34} \times 3.00 \times 10^{8}}{564 \times 10^{-9}}$ = 3.53 × 10^{-19} J (1) $E = \frac{3.53 \times 10^{-19} \times 6.02 \times 10^{23}}{1000}$ = 212 kJ mol^{-1} (1)	1	1	1	2		3
	(d)	(i)		M_r of 2-aminohexanoic acid = 131 (1) moles of 2-aminohexanoic acid = $\frac{0.500}{131}$ = 3.82 × 10^{-3} mol gives 3.82 × 10^{-3} mol of nitrogen volume of nitrogen = 3.82 × 10^{-3} × 24.5 × 1000 = 93.5 cm^3 (1) ecf possible e.g. from incorrect M_r	1	1		1	1	2
		(ii)		award (1) each for any two of following 2-aminohexanoic acid is impure temperature **less** than 298K / pressure **greater** than 1 atm incomplete reaction nitrogen is lost side reactions		1	1		2	2
				Total question 11	**4**	**6**	**5**	**3**	**4**	**15**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Maths	Prac	Total
12.	(a)	(i)		electrophilic addition		1				1
		(ii)		acidified (potassium) dichromate / H^+, $Cr_2O_7^{2-}$ / acidified potassium manganate(VII) / H^+, MnO_4^-	1				1	1
		(iii)		$ZnBr_2$			1			1
	(b)	(i)		^-CN		1				1
		(ii)		HCN is added across the C=O bond		1				1
		(iii)		dilute sulfuric acid / $H_2SO_4(aq)$ / dilute hydrochloric acid/ HCl(aq) neutral answer – water	1					1
		(iv)		dehydrating agent / removes water	1				1	1
		(v)				1				1

<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>Maths</th><th>Prac</th><th>Total</th></tr>
<tr><td></td><td></td><td>(vi)</td><td></td><td>in condensation polymerisation a small molecule is eliminated which does not occur with addition polymerisation

answer must refer clearly to both types of polymerisation</td><td>1</td><td></td><td></td><td></td><td></td><td>1</td></tr>
<tr><td></td><td>(c)</td><td>(i)</td><td></td><td>2,3,3-trichloropentane</td><td></td><td>1</td><td></td><td></td><td></td><td>1</td></tr>
<tr><td></td><td></td><td>(ii)</td><td></td><td><table><tr><th>Hydrogen proton</th><th>Splitting pattern</th></tr><tr><td>a</td><td>triplet</td></tr><tr><td>b</td><td>quartet</td></tr><tr><td>c</td><td>quartet</td></tr><tr><td>d</td><td>doublet</td></tr></table>
all four correct (2)
two or three correct (1)</td><td></td><td>2</td><td></td><td></td><td></td><td>2</td></tr>
<tr><td></td><td></td><td></td><td></td><td>Total question 12</td><td>4</td><td>7</td><td>1</td><td>0</td><td>2</td><td>12</td></tr>
</table>

UNIT 4 – SUMMARY OF ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	TOTAL MARK	MATHS	PRAC
1-7	3	7	0	**10**	0	2
8	7	3	3	**13**	1	1
9	2	8	5	**15**	3	1
10	3	5	7	**15**	3	2
11	4	6	5	**15**	3	4
12	4	7	1	**12**	0	2
TOTAL	**23**	**36**	**21**	**80**	**10**	**12**