GCE A LEVEL MARKING SCHEME

SUMMER 2022

A LEVEL
CHEMISTRY – COMPONENT 3
A410U30-1

INTRODUCTION

This marking scheme was used by WJEC for the 2022 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.

GCE A LEVEL CHEMISTRY

COMPONENT 3: CHEMISTRY IN PRACTICE

SUMMER 2022 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.

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
1				Set **1** dropwise addition of NaOH(aq), then in excess (1) award (2) for **all** three observations award (1) for any **two** observations **A** barium nitrate no precipitate forms / no change **B** aluminium nitrate white precipitate forms, dissolves in excess **C** magnesium nitrate white precipitate forms, does not dissolve in excess		2	1			1 2
				award (1) for any correct equation / ionic equation e.g. $Mg(NO_3)_2 + 2NaOH \rightarrow Mg(OH)_2 + 2NaNO_3$ $Al(NO_3)_3 + 3NaOH \rightarrow Al(OH)_3 + 3NaNO_3$ $Al(OH)_3 + NaOH \rightarrow Na[Al(OH)_4]$	1					
				Set **2** addition of Br_2(aq) (room temperature) (1) award (2) for **all** three observations award (1) for any **two** observations **D** phenol Br_2(aq) decolourised and white precipitate forms **E** ethanol no observable change **F** cyclohexene Br_2(aq) decolourised		2	1			1
				award (1) for any correct equation e.g. $C_6H_5OH + 3Br_2 \rightarrow C_6H_2Br_3OH + 3HBr$ $C_6H_{10} + Br_2 \rightarrow C_6H_{10}Br_2$	1					2

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
				Set **3** addition of NaOH(aq), gentle heat, followed by $AgNO_3$(aq) (1)			1			1
				award (1) for **both** observations **G** chlorobenzene no observable change **H** (chloromethyl)benzene white precipitate forms		1				1
				award (1) for any of following equations $C_6H_5CH_2Cl + NaOH \rightarrow C_6H_5CH_2OH + NaCl$ $AgNO_3 + Cl^- \rightarrow AgCl + NO_3^-$ $Ag^+ + Cl^- \rightarrow AgCl$	1					
				Set **4** addition of NaOH(aq), gentle heat and damp red litmus paper (1)			1			1
				award (1) for **both** observations **I** methyl ethanoate no observable change **J** ethanamide pungent smelling gas / turns damp red litmus paper turns blue		1				1
				award (1) for equation $CH_3CONH_2 + NaOH \rightarrow CH_3COONa + NH_3$	1			14		
				Question 1 total	**4**	**6**	**4**	**14**	**0**	**10**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
2	(a)			$Mg(OH)_2 + 2HCl \rightarrow MgCl_2 + 2H_2O$	1			1		
	(b)	(i)		using funnel rinse funnel / glass rod / beaker with <u>hydrochloric acid</u> ensuring that washings go into the flask **must** have reference to funnel and to rinsing at least one glassware item		1		1		1
		(ii)		award (1) for any of following no analyte is lost in the process no analyte is left in the funnel / on the glass rod / in the beaker everything that was in the beaker goes into the flask you know exactly what is in the flask neutral answer - to get an accurate result	1			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>Total</th><th>Maths</th><th>Prac</th></tr>
<tr><td></td><td>(c)</td><td>(i)</td><td></td><td>the same sodium hydroxide solution that is going to be used to fill the burette / used in the titration</td><td></td><td>1</td><td></td><td>1</td><td></td><td>1</td></tr>
<tr><td></td><td></td><td>(ii)</td><td></td><td>
<table>
<tr><th>Volume of NaOH(aq)</th><th>Titration 1</th><th>Titration 2</th><th>Titration 3</th><th>Titration 4</th><th>Titration 5</th></tr>
<tr><td>Initial burette reading / cm^3</td><td>2.90</td><td>0.55</td><td>6.15</td><td>21.90</td><td>0.90</td></tr>
<tr><td>Final burette reading / cm^3</td><td>25.95</td><td>23.25</td><td>28.00</td><td>43.85</td><td>22.80</td></tr>
<tr><td>Titre / cm^3</td><td>23.05</td><td>22.70</td><td>21.85</td><td>21.95</td><td>21.90</td></tr>
</table>

readings must be given to 2 dp

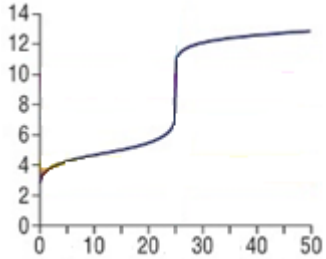
award (2) for all correct
award (1) for any two correct

award (1) for mean titre
21.90</td><td></td><td>3</td><td></td><td>3</td><td>2</td><td>3</td></tr>
</table>

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(d)	(i)		n(NaOH) = 0.148 × $\frac{21.90}{1000}$ = 0.00324 mol (1) 0.00324 mol HCl in 25.0 cm^3 of solution **W** 250 cm^3 of solution **W** originally contains 0.0324 mol of excess HCl (1)		2		2	1	
		(ii)		n(HCl) added to flask = 0.460 × $\frac{250}{1000}$ = 0.115 mol (1) n(HCl) which reacted with $Mg(OH)_2$ = 0.115 – 0.0324 = 0.0826 mol (1)		2		2	1	
		(iii)		$n(Mg(OH)_2)$ = ½ × 0.0826 = 0.0413 (1) mass $Mg(OH)_2$ = 0.0413 × 58.32 = 2.409 g percentage purity = $\frac{2.409}{2.762}$ × 100 = 87.2% (1)		2		2	1	
	(e)			any oxide / hydroxide / carbonate (1) this would react with HCl (making the analysis inaccurate) (1)			2	2		
				Question 2 total	**2**	**11**	**2**	**15**	**5**	**6**

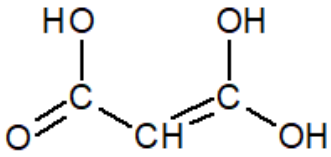
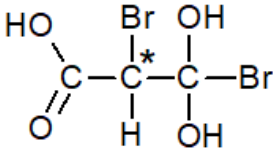
Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
3	(a)			key points of method • add the hydrochloric acid to the insulated polystyrene cup • measure the temperature at regular intervals e.g. every 30 s • when the temperature of the acid remains constant, at the next time interval, add the powdered potassium carbonate • stir the reaction mixture • continue to record temperature at regular time intervals • plot a temperature-time graph to determine the temperature change award (2) for any **four** points award (1) for any **two** points		2		2		2
	(b)			$n(K_2CO_3) = \frac{2.29}{138.2}$ = 0.0166 mol (1) $\Delta T = \frac{(43.2 \times 10^3) \times 0.0166}{30.0 \times 4.18}$ = 5.7°C (1)		2		2	1	1
	(c)			award (1) for T_{min} in the range 14.6-14.8 (based on straight line of best fit through points from 4 to 9 minutes and extending back to time of mixing) award (1) for ΔT = 14.7 – 19.0 = –4.3°C (±0.1) accept ΔT = 4.3°C ecf possible		2		2	2	1

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(d)			n = $\frac{4.03}{100.1}$ = 0.0403 mol (1) $\Delta H_2 = -\frac{30.0 \times 4.18 \times (-4.3)}{0.0403}$ = +13.4 kJ mol^{-1} (1)		2		2	1	1
	(e)			ΔH_1 = 110.8 kJ mol^{-1} (2) if answer incorrect award (1) for either of following $\Delta H_1 = 2\Delta H_2 - \Delta H_3 + \Delta H_4$ ΔH_1 = (2 × 13.4) + 43.2 + 40.8		2		2	2	
	(f)			the reaction needs large amount of heat so ΔT cannot sensibly be measured accept any reference to difficulty of measuring temperature change due to reaction when strong heating is required for the reaction to take place			1	1		1
				Question 3 total	**0**	**10**	**1**	**11**	**6**	**6**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
4	(a)			colour change yellow to blue (1) must attempt reason award (1) for reason OH^- removes H^+ so equilibrium position shifts to RHS increasing $[Ind^-]$		1	1 	2		1
	(b)	(i)		**Indicative content** basic weak acid/strong base curve shape • 25.0 cm^3 of base added at equivalence point • total 50.0 cm^3 of base added • end pH 12-13 • buffer region more detailed points • initial pH value calculated to be 2.87 • pH at equivalence point > 7 ⇨ salt of weak acid-strong base ⇨ hydrolysis forms OH^- ions • [salt] = [acid] at half-equivalence point • pK_a = pH at half-equivalence = 4.7  	3		3	6	2	4
				5-6 marks Calculates initial pH value and pH at half-equivalence; explanation of pH > 7 at equivalence point *The candidate constructs a relevant, coherent and logically structured account including all key elements of the indicative content. A sustained and substantiated line of reasoning is evident and scientific conventions and vocabulary is used accurately throughout.* **3-4 marks** Attempt at calculation of initial pH; buffer region in curve *The candidate constructs a coherent account including many of the key elements of the indicative content. Some reasoning is evident in the linking of key points and use of scientific conventions and vocabulary is generally sound.* **1-2 marks** Elements of the weak acid/strong base curve shape; 25.0 cm^3 of base at equivalence point *The candidate attempts to link at least two relevant points from the indicative material. Coherence is limited by omission and/or inclusion of irrelevant materials. There is some evidence of appropriate use of scientific conventions and vocabulary.* **0 marks** *The candidate does not make any attempt or give an answer worthy of credit.*						

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
		(ii)		award (1) for correct indicator and explanation indicator **C** pH change of indicator is on the vertical portion of the curve		1		1		1
	(c)	(i)		(sodium) propanoate will remove H^+ ions added	1			1		
		(ii)		propanoic acid concentration $\frac{0.5 \times 0.150}{0.750}$ = 0.100 mol dm^{-3} sodium propanoate concentration $\frac{0.25 \times 0.262}{0.750}$ = 0.0873 mol dm^{-3} (1) $K_a = \frac{[H^+][salt]}{[acid]}$ ⇨ $[H^+] = \frac{K_a \times [acid]}{[salt]}$ $[H^+] = \frac{1.34 \times 10^{-5} \times 0.100}{0.0873}$ = 1.54 × 10^{-5} (1) pH = 4.81 (1) alternative method pH = pK_a + log $\frac{[salt]}{[acid]}$ pH = 4.87 + log $\frac{0.0873}{0.100}$ (1) pH = 4.87 – 0.059 = 4.81 (1)		2	1	3	3	
				Question 4 total	**4**	**4**	**5**	**13**	**5**	**6**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
5	(a)			propanedioic acid accept 1,3-propanedioic acid		1		1		
	(b)			award credit for **any** of the following inferences/conclusions drawn from the information given 1. no reaction with 2,4-DNPH ⇨ no carbonyl group 2. aqueous bromine decolourised ⇨ **X** contains a C=C bond 3. reacts with sodium carbonate to form colourless gas ⇨ carboxylic acid group present 4. n(CO_2) = $\frac{83.0 \times 10^{-3}}{24.5}$ = 0.00339 mol n(**X**) = $\frac{0.704}{104.04}$ = 0.00677 mol 5. ratio CO_2 : **X** ⇨ 1:2 therefore one carboxylic acid group present 6. **X** does not show optical isomerism because none of the carbon atoms is bonded to four different groups / there is no chiral carbon 7. **X** does not have geometric isomerism because one carbon of the C=C group has two —OH groups attached 8. ^{1}H NMR spectrum of compound **X** would show three peaks ⇨ carboxylic —O<u>H</u> (area 1); —C<u>H</u>=C (area 1); alcohol —O<u>H</u> (area 2)						

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
				award (4) for points 1-5 **and** any **two** others award (3) for points 1-5 award (2) for any **five** points award (1) for any **three** points award (1) for each correct structure compound **X**  compound **Y**  chiral carbon **must** be identified	2	2	2	6	2	4
				Question 5 total	**2**	**3**	**2**	**7**	**2**	**4**

COMPONENT 3: CHEMISTRY IN PRACTICE

SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	Total	Maths	Prac
1	4	6	4	14	0	10
2	2	11	2	15	5	6
3	0	10	1	11	6	6
4	4	4	5	13	5	6
5	2	3	2	7	2	4
Totals	12	34	14	60	18	32