GCE A LEVEL MARKING SCHEME

SUMMER 2023

A LEVEL
CHEMISTRY – UNIT 5
1410U50-1

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.

GCE A LEVEL CHEMISTRY UNIT 5

PRACTICAL EXAMINATION

SUMMER 2023 MARK SCHEME

GENERAL INSTRUCTIONS

Recording of marks

Examiners must mark in red ink.

The mark total should be entered onto the grid on the front cover.

Marking rules

All work should be seen to have been marked.

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

EXPERIMENTAL TASK

Skill	Marking details	Marks available					
		AO1	AO2	AO3	Total	Maths	Prac
Teacher-awarded marks	making up a solution (1) efficient use of time (1) working safely (1)	3			3		3
Titration recording – table	appropriate table drawn (1) titles and units included (1)		2		2		2
Titration recording – data	all readings recorded to 0.05 cm^3 (1)		1		1		1
Titration recording – mean	award (2) for mean titre calculated and recorded to 2 decimal places award (1) for mean titre calculated but not recorded to 2 decimal places		2		2		2
Qualitative analysis	Observations **Test 1** flame test – yellow / golden / orange flame (1) nitrc acid – no mark awarded for observation sodium hydroxide solution – no change (1) sodium sulfate solution – no change (1)		1 1 1		3		3

Skill	Marking details	Marks available					
		AO1	AO2	AO3	Total	Maths	Prac
	Test 2 flame test – brick-red flame (1) nitrc acid – no mark awarded for observation sodium hydroxide solution – white precipitate / cloudy solution (1) sodium sulfate solution – white precipitate (1)						
Titration data – concordance and titre accuracy	award (2) for concordant results within 0.3 cm^3 award (1) for concordant results within 0.5 cm^3 Comparison with teacher's results ± 1.0 cm^3 3 marks ± 2.0 cm^3 2 marks ± 3.0 cm^3 1 mark		5		5		5

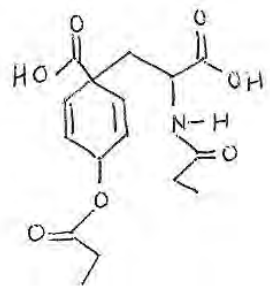
Skill	Marking details	Marks available					
		AO1	AO2	AO3	Total	Maths	Prac
Analysis of results Part A	assuming a mean titre of 18.00 cm^3 and 2.00 M HCl & 0.200 M NaOH solutions (i) moles of NaOH = $0.200 \times \frac{18.00}{1000}$ = 0.00360 mol ∴ 0.00360 mol of unreacted HCl in 25.0 cm^3 (1) (ii) Moles of unreacted HCl in 250 cm^3 = 10 × 0.00360 = 0.0360 (1) (iii) moles of HCl in beaker = $2.00 \times \frac{50}{1000}$ = 0.100 mol moles of HCl reacted = 0.100 – 0.0360 = 0.0640 mol (1) ∴ moles of CO_3^{2-} ions = $\frac{0.0640}{2}$ = 0.0320 mol (1) **Test 1** (iv) moles of $CaCO_3$ = $0.0320 \times \frac{2}{3}$ = 0.0213 mol (1) mass of $CaCO_3$ = 0.0213 × 100.1 = 2.13 g (1) (v) mass of Ca^{2+} ions in 2.13 g of $CaCO_3$ = 0.0213 × 40.1 = 0.854g (1) concentration of Ca^{2+} ions in original sample = $\frac{854}{10}$ = 85.4 mg/dm^3 value is greater than 50 mg/dm^3 so sample is hard water (1)		3	5	8	5	5

Skill	Marking details	Marks available					
		AO1	AO2	AO3	Total	Maths	Prac
	Test 2 (iv) moles of $CaCO_3$ = 0.0320 × $\frac{1}{3}$ = 0.0107 mol (1) mass of $CaCO_3$ = 0.0107 × 100.1g = 1.07 g (1) (vi) mass of Ca^{2+} ions in 1.07 g of $CaCO_3$ = 0.0107 × 40.1 = 0.429g (1) concentration of Ca^{2+} ions in original sample = $\frac{429}{10}$ = 42.9 mg/dm^3 value is less than 50mg/dm^3so sample is NOT hard water (1)						
Analysis of results Part B	(vi) **Test 1** – credit any **two** of the following three award (1) for simple inference and (1) for comparison or further explanation for both observations flame test - yellow / golden / orange colour shows Na^+ ions present (1) - Ca^{2+} ions would give a brick-red flame (1) sodium hydroxide solution - no precipitate indicates no Ca^{2+} ions (1) - confirms Na^+ ions because sodium hydroxide is soluble (1) sodium sulfate solution - no precipitate indicates no Ca^{2+} ions (1) - confirms Na^+ ions because sodium sulfate is soluble (1)		2	2			4

Skill	Marking details	Marks available					
		AO1	AO2	AO3	Total	Maths	Prac
	Test 2 – credit any **two** of the following three award (1) for simple inference and (1) for comparison or further explanation for both observations flame test - brick-red colour shows Ca^{2+} ions present (1) - Na^{+} ions would give a yellow / golden / orange flame (1) sodium hydroxide solution - white precipitate indicates Ca^{2+} ions present (1) - confirms no Na^{+} ions because sodium hydroxide is soluble (1) sodium sulfate solution - white precipitate indicates Ca^{2+} ions present (1) - confirms no Na^{+} ions because sodium sulfate is soluble (1) (vii) award (1) for any sensible comment e.g. The splint flame colour may obscure the brick-red coloration of Ca^{2+} ions or the yellow of Na^{+} ions Adding nitric acid identifies carbonate which is of no use Adding sulfate ions is not useful because calcium sulfate is sparingly soluble and sodium sulfate is soluble (viii) award (1) for any reference to calcium ions having the twice the charge of sodium ions reference to valence electrons – neutral answer			1 1			
	Total	**3**	**18**	**9**	**30**	**5**	**25**

PRACTICAL METHODS AND ANALYSIS TASK

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
1.	(a)		**1** carboxylic acid **2** primary amine **3** secondary alcohol award (2) if all homologous series identified and either of primary/secondary given award (1) for all three homologous series award (1) for any two homologous series and either of primary/secondary	2			2		
	(b)	(i)	award (1) each for up to **three** of following – reagent and observation needed sodium carbonate/sodium hydrogencarbonate (room temperature) ⇨ effervescence / bubbles (of colourless gas) acidified sodium dichromate(VI) (and heat) ⇨ (colour change) orange to green nitric(III) acid (room temperature) ⇨ effervescence / bubbles (of colourless gas) bromine water ⇨decolourised / (colour change) brown to colourless accept phosphorus(V) chloride ⇨ misty fumes ethanoic acid / conc sulfuric acid ⇨ sweet smell			3	3		3

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
		(ii)	award (1) for either of following – reagent and observation needed bromine water (room temperature) ⇨ (decolourised and) white precipitate formed (for compound **B**) iron(III) chloride solution (room temperature) ⇨ purple colouration (for compound **B**) do not accept purple precipitate			1	1		1
	(c)					1	1		1
	(d)		n(compound **A**) = $\frac{54.0}{227}$ = 0.238 mol n(H_2) = 2 × 0.238 = 0.476 mol (1) volume of H_2 = 0.476 × 24.5 = 11.70 dm^3 = 1.17 × 10^4 cm^3 (1) accept 1.2 × 10^4 cm^3		1	1	2	2	
Question 1 total				**2**	**1**	**6**	**9**	**2**	**5**

<table>
<tr><th colspan="3" 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>2.</td><td>(a)</td><td></td><td>
<table>
<tr><th colspan="2">Reaction</th><th>Reagents and conditions</th><th>Observation(s)</th></tr>
<tr><td>1</td><td>Nucleophilic substitution</td><td>1-chlorobutane with sodium hydroxide (gentle heat)
(acidify with) nitric acid and add silver nitrate solution</td><td>white precipitate formed</td></tr>
<tr><td>2</td><td>Ligand exchange</td><td>copper(II) sulfate and concentrated hydrochloric acid (room temperature)</td><td>blue solution turned yellow/green</td></tr>
<tr><td>3</td><td>Displacement</td><td>chlorine and sodium iodide (room temperature)</td><td>dark red/brown solution or grey/black precipitate formed</td></tr>
</table>
award (1) for correct reagent(s) and (1) for observation in each row

do not credit observation if reagent(s) not correct</td><td>3</td><td>3</td><td></td><td>6</td><td></td><td>6</td></tr>
<tr><td></td><td>(b)</td><td></td><td>$[CuCl_4]^{2-}$</td><td>1</td><td></td><td></td><td>1</td><td></td><td></td></tr>
<tr><td colspan="4">Question 2 total</td><td>4</td><td>3</td><td>0</td><td>7</td><td>0</td><td>6</td></tr>
</table>

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
3.	(a)	(i)	appropriate tangent drawn at 0.200 mol dm^{-3} (1) rate = $\frac{\text{change in concentration}}{\text{change in time}}$ = 0.00113 mol dm^{-3} s^{-1} (1) accept any value in the range 0.00100-0.00125 if it fits tangent drawn	1	1		2	2	
		(ii)	rate calculated at another point on the graph e.g. 0.00231 at 0.400 0.00052 at 0.100 (1) when concentration is doubled (or halved) that the rate doubles (or halves) therefore first order reaction (1) <u>alternative method</u> half-life calculated at two different pairs of concentrations e.g. concentration falls from 0.50 to 0.25 mol dm^{-3} in 120 s concentration falls from 0.20 to 0.10 mol dm^{-3} in 120 s (1) half-life is constant therefore first order reaction (1)	1	1		2	2	
	(b)		$k = \frac{0.00113}{0.200}$ = = 0.00565 (1) unit ⇨ s^{-1} (1) ecf possible from part (a)(i)	1	1		2	1	
			Question 3 total	**3**	**3**	**0**	**6**	**5**	**0**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
4.	(a)		n(HCl) used in titration = $0.100 \times \frac{9.50}{1000}$ = 9.5×10^{-4} mol n(NH_3) in 100 cm^3 of the organic layer = $9.5 \times 10^{-4} \times 4$ = 0.0038 mol (1) n(NH_3) in 100 cm^3 of 1.00 mol dm^{-3} solution = $1.00 \times \frac{100}{1000}$ = 0.100 mol n(NH_3) in 100 cm^3 of aqueous layer = 0.100 – 0.0038 = 0.0962 mol (1) $K_c = \frac{0.0962}{0.0038}$ = 25.3 (1) ecf possible only if sensible attempt at calculating the number of moles in both layers		3		3	3	
	(b)		award (1) for any of following total number of moles of NH_3 added initially is distributed between both layers all NH_3 must be in one layer or the other no moles of NH_3 are lost		1		1		1
	(c)		n(NH_3) in 25.0 cm^3 of aqueous layer = $\frac{0.0962}{4}$ = 0.02405 mol volume of HCl required = $\frac{0.02045}{0.1}$ = 0.2405 dm^3 = 240.5 cm^3 (1) award (1) for any of following volume of 0.1 mol dm^{-3} HCl needed is too large therefore replace with 1.0 mol dm^{-3} HCl ⇨ volume needed would be 24.05 cm^3 volume of 0.1 mol dm^{-3} HCl needed is too large therefore replace with HCl of greater concentration ⇨ volume needed would be less volume of 0.1 mol dm^{-3} HCl needed is too large therefore dilute the aqueous layer ⇨ volume needed would be less volume of 0.1 mol dm^{-3} HCl needed is too large therefore dilute the aqueous layer by a factor of 10 ⇨ volume needed would be ten times less		1	1	2	1	1

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
	(d)		measure 250 cm^3 of 8.00 mol dm^{-3} ammonia solution transfer to 2 dm^3 (volumetric) **flask** and make up to the mark with / add 1.75 dm^3 of deionised water (and put a stopper in the flask and invert to form homogenous solution)		2		2	1	2
Question 4 total				**0**	**7**	**1**	**8**	**5**	**4**

A2 UNIT 5: PRACTICAL EXAMINATION

SUMMARY OF ASSESSMENT OBJECTIVES

	Question	AO1	AO2	AO3	TOTAL MARK	MATHS	PRAC
Experimental Task	**Total**	**3**	**18**	**9**	**30**	**5**	**30**
Methods and Analysis	**Total**	**9**	**14**	**7**	**30**	**12**	**15**