GCE A LEVEL MARKING SCHEME

SUMMER 2024

A LEVEL
CHEMISTRY – COMPONENT 3
A410U30-1

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 3: CHEMISTRY IN PRACTICE

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.

<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>1</td><td>(a)</td><td></td><td></td><td>blue/black to colourless</td><td>1</td><td></td><td></td><td>1</td><td></td><td>1</td></tr>
<tr><td></td><td>(b)</td><td></td><td></td><td>titration 2

0.493 is the largest mass</td><td></td><td>1</td><td></td><td>1</td><td></td><td>1</td></tr>
<tr><td></td><td>(c)</td><td>(i)</td><td></td><td>
<table>
<tr><th></th><th>Correct order</th></tr>
<tr><td>Convert moles of IO_3^- to moles of $Ca(IO_3)_2..xH_2O$</td><td>3</td></tr>
<tr><td>Use the balanced equation(s) to calculate the number of moles of IO_3^- ions present in the solid sample</td><td>2</td></tr>
<tr><td>Calculate the value of x in $Ca(IO_3)_2..xH_2O$</td><td>5</td></tr>
<tr><td>Convert moles of $Ca(IO_3)_2..xH_2O$ to M_r of $Ca(IO_3)_2..xH_2O$</td><td>4</td></tr>
<tr><td>Calculate the number of moles of sodium thiosulfate used in the titration</td><td>1</td></tr>
</table>
</td><td></td><td>1</td><td></td><td>1</td><td></td><td>1</td></tr>
</table>

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
		(ii)		$n(S_2O_3^{2-}) = 0.540 \times 0.022 = 0.01188$ (1) $n(IO_3^-) = \frac{0.02376}{6} = 0.00198$ (1) $n(Ca(IO_3)_2.xH_2O) = 0.00099$ (1) $M_r(Ca(IO_3)_2.xH_2O) = 497.97$ (1) $xH_2O = (497.97 - 390.1) = 107.9$ $x = \frac{107.9}{18.02} = 6$ (1) ecf possible throughout		2	3	5	4	2
				Question 1 total	**1**	**4**	**3**	**8**	**4**	**5**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
2	(a)	(i)		**Indicative content** • second run should use half the $S_2O_8^{2-}$ concentration used in first run • all other concentrations and the total volume of solution kept the same • use volumetric pipette / burette to measure correct volumes of other solutions into the flask • take 5 cm^3 of $S_2O_8^{2-}$ solution and add 5 cm^3 of deionised water • add this solution rapidly to the flask and swirl to mix, starting the stopwatch immediately • stop the watch when the solution turns blue-black and record the time • if the rate is halved by halving the $S_2O_8^{2-}$ concentration, the reaction is first order with respect to $S_2O_8^{2-}$ **5-6 marks** Correct method outlined with reference to accurate measuring apparatus; clear understanding of link between data collected and reaction order *The candidate constructs a relevant, coherent and logically structured account including key elements of the indicative content. A sustained and substantiated line of reasoning is evident and scientific conventions and vocabulary are used accurately throughout.*		2	4	6		6

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
				3-4 marks Good attempt at method; some understanding of link between rate and reaction order *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** Some indication of repeating with different $S_2O_8^{2-}$ concentration; reference to different rate *The candidate attempts to link relevant points from the indicative content. Coherence is limited by omission and/or inclusion of irrelevant material. 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.						
		(ii)		repeat the experiment but replace the 4 cm^3 of deionised water with 4 cm^3 of iron(II) sulfate solution (keeping the total volume the same) (1) if the time taken for the blue-black colour to form is less than in part (i) then $Fe^{2+}(aq)$ acts as a catalyst (1)			2	2		2

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(b)	(i)		$Cr^{2+}(aq) \rightarrow Cr^{3+}(aq) + e^-$ ignore state symbols		1		1		
		(ii)		solution becomes less yellow-brown / more green (as the concentration of $Fe^{2+}(aq)$ increases)			1	1		1
		(iii)		$Cr^{2+}(aq) + Fe^{3+}(aq) \rightleftharpoons Cr^{3+}(aq) + Fe^{2+}(aq)$ (1) ignore state symbols award (1) for **both** of following correct oxidising agent ⇨ Fe^{3+} reducing agent ⇨ Cr^{2+}	1	1		2		
		(iv)		EMF increases because equilibrium shifts to the RHS (to produce more $Cr^{3+}(aq)$)			1	1		
				Question 2 total	**1**	**4**	**8**	**13**	**0**	**9**

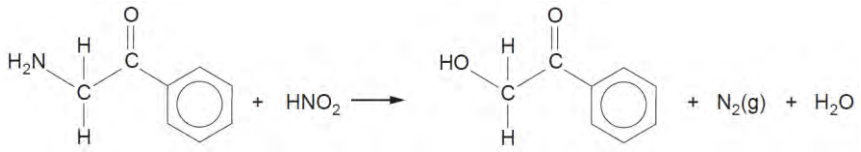
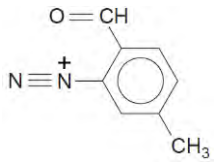
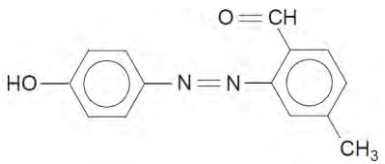
Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
3	(a)			weak ⇨ partially dissociates into its constituent ions when in solution (1) dilute ⇨ has a (relatively) small amount of acid dissolved in solution (1)	2			2		
	(b)			add Mg / Na_2CO_3 (1) nitric acid has more effervescence (than ethanoic acid) because $[H^+]$ is greater (1) accept any appropriate method based on reactions of organic acids		2		2		2

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(c)	(i)		$K_a = \frac{[H^+]\,[salt]}{[acid]}$ (1) pH = –log[H⁺] ⇨ [H⁺] = 3.98 × 10⁻⁶ (1) $\frac{1.78 \times 10^{-5}}{3.98 \times 10^{-6}} = \frac{[salt]}{[acid]}$ ratio of concentrations ⇨ $4.47 = \frac{[salt]}{[acid]}$ (1) alternative method $pH = pK_a + \log \frac{[salt]}{[acid]}$ (1) or $pH = pK_a - \log \frac{[acid]}{[salt]}$ $5.4 = 4.75 + \log \frac{[salt]}{[acid]}$ (1) or $5.4 = 4.75 - \log \frac{[acid]}{[salt]}$ $0.65 = \log \frac{[salt]}{[acid]}$ or $0.65 = -\log \frac{[acid]}{[salt]}$ ratio of concentrations ⇨ $4.47 = \frac{[salt]}{[acid]}$ (1) ecf possible throughout		1	2	3	3	

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
		(ii)		$4.47 = \frac{[\text{salt}]}{[\text{acid}]}$ $\frac{\text{volume of salt}}{1000 - \text{volume of salt}} = 4.47$ volume of salt = $\frac{4470}{5.47}$ = 817 cm^3 volume acid = (1000 – 817) = 183 cm^3 ecf possible from part (i)			1	1	1	
				Question 3 total	**2**	**3**	**3**	**8**	**4**	**2**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
4	(a)			$C_6H_5NH_3Cl + CH_3COONa \rightarrow C_6H_5NH_2 + CH_3COOH + NaCl$	1			1		
	(b)			dissolve solid in minimum volume of hot water (1) award (1) each for any **two** of following • heat water using a hot plate / hot water bath • filter off any insoluble impurities whilst hot • allow to cool (to crystallise solid) • filter solid and wash with small volume of cold water • dry product	1	2		3		3
	(c)	(i)		$n(C_6H_5NH_3Cl) = \frac{4.78}{129.6} = 0.0369$ mol (1) mass of $(CH_3CO)_2O = 10 \times 1.08 = 10.8$ g $n((CH_3CO)_2O) = \frac{10.8}{102.1} = 0.106$ mol mole ratio is 1:1 so ethanoic anhydride is in excess (1)			2	2	1	2
		(ii)		theoretical mass of $(C_6H_6NHCOCH_3)$ $= 0.0369 \times 135.1 = 4.99$ g (1) percentage yield $= \frac{3.59}{4.99} \times 100 = 71.9$ % (1)		2		2	1	2

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(d)	(i)		compound **C** has 4 signals (1) the other three all have 3 signals (1)			2	2		
		(ii)		award (1) for any of following reactions reagent **and** observation needed ammoniacal silver nitrate solution / Tollens' reagent ⇨ silver mirror formed Fehling's solution / Benedict's solution ⇨ brick-red / brown precipitate acidified $KMnO_4(aq)$ ⇨ purple to colourless acidified $K_2Cr_2O_7(aq)$ ⇨ orange to green		1		1		1
		(iii)		reagent **and** observation needed $I_2(aq)$ / NaOH(aq) or KI(aq) / NaClO(aq) ⇨ (pale) yellow precipitate		1		1		1

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
		(iv)	I			1		1		
			II	n(compound **B**) = $\frac{3.59}{135.1}$ = 0.0266 mol in 500 cm^3 (1) n(compound **B**) in 25 cm^3 = 0.00133 mol n(N_2) = 0.00133 mol (1) volume of N_2 = $\frac{0.00133 \times 8.31 \times 293}{1.01 \times 10^5}$ (1) volume of N_2 = 0.0000321 m^3 = 32.1 cm^3 (1)		4		4	3	
		(v)		intermediate  (1) compound **D**  (1)		2		2		
				Question 4 total	**2**	**13**	**4**	**19**	**5**	**9**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
5				Test 1 n(H_2O) = $\frac{5.41}{18.02}$ = 0.30 mol (1) mole ratio ⇨ 0.05:0.30 ⇨ z = 6 (1) Test 2A NaOH(aq) added dropwise initially and then in excess (dark) green precipitate formed, insoluble in excess (1) $Fe^{2+}(aq) + 2OH^-(aq) \rightarrow Fe(OH)_2(s)$ (1) Test 2B Fe^{2+} / $Fe(OH)_2$ oxidised to Fe^{3+} / $Fe(OH)_3$ on exposure to the air (1) Test 3A $BaCl_2$(aq) added and a (heavy) white precipitate formed (1) $Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$ (1) Test 3B n($BaSO_4$) = $\frac{17.16}{233.1}$ = 0.0736 mol (1) n(salt) = 0.736 × $\frac{50}{1000}$ = 0.0368 mol mole ratio ⇨ 0.0368:0.0736 ⇨ y = 2 (1) must show some working	4	4	4	12	4	6

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
				Test 4 B is Fe^{2+} $\frac{12.85}{100}$ × 434.3 = 55.8 ⇨ x = 1 (1) mass of A = 434.3 – 356.1 = 78.2 ⇨ A is potassium and w = 2 (1) must show some working formula of Tutton salt is $K_2Fe(SO_4)_2.6H_2O$ (1)						
				Question 5 total	**4**	**4**	**4**	**12**	**4**	**6**

COMPONENT 3: CHEMISTRY IN PRACTICE

SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	TOTAL	Maths	Practical
1	1	4	3	8	4	5
2	1	4	8	13	0	9
3	2	3	3	8	4	2
4	2	13	4	19	5	9
5	4	4	4	12	4	6
Totals	10	28	22	60	17	31