GCE A LEVEL MARKING SCHEME

SUMMER 2024

A LEVEL
CHEMISTRY – UNIT 3
1410U30-1

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.

WJEC GCE A LEVEL CHEMISTRY UNIT 3

SUMMER 2024 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.

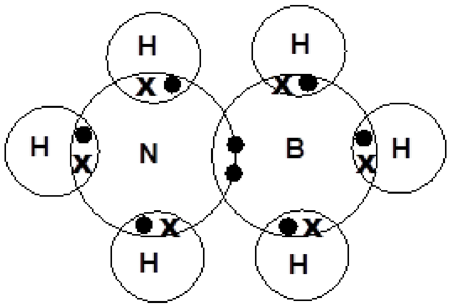
cao	=	correct answer only
ecf	=	error carried forward
bod	=	benefit of doubt

Credit will be given 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)			$Mg^{2+}(g) + 2Cl^{-}(g) \rightarrow MgCl_2(s)$		1		1		
	(b)			standard enthalpy change of hydration	1			1		
2	(a)			oxidation state of chlorine at start is 0; at end it is –1 (in NaCl) and +1 (in NaOCl) (1)		1				
				chlorine (or same element) has been both oxidised and reduced (1)	1			2		
	(b)			bleach	1			1		
3				$[H^+] = \frac{1.00 \times 10^{-14}}{2 \times 2.34 \times 10^{-2}} = 2.13 \times 10^{-13}$ mol dm^{-3} (1) pH = – log 2.13×10^{-13} = 12.7 (1) ecf possible		2		2	2	
4				more efficient release of energy from fuel	1			1		
5				+3 (must give reason to gain this mark) (1)		1				
				inert pair effect increases down the group (so oxidation state of [group number – 2] is more stable) (1)	1			2		
				Section A total	**5**	**5**	**0**	**10**	**2**	**0**

SECTION B

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
6	(a)	(i)		base is a proton acceptor (1) lone pair on nitrogen (can form coordinate bond with H^+) (1)	2			2		
		(ii)	I	award (1) for any of following ammonium salt of any strong acid e.g. ammonium sulfate, ammonium nitrate, ammonium chloride any strong acid e.g. sulfuric acid, nitric acid, hydrochloric acid	1			1		
			II	award (1) for any sensible answer e.g. using enzymes storage of biological molecules fermentation	1			1		1
	(b)	(i)		 accept correct versions using triangles (or other symbols) to differentiate between electrons	1			1		

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
		(ii)		award (2) for **all** three boxes correct award (1) for any **two** boxes correct <table><tr><th></th><th>Similarity between hexagonal boron nitride and graphite</th><th>Difference between hexagonal boron nitride and graphite</th></tr><tr><td>Structure</td><td>layers of hexagonal sheets present in both</td><td>layers in register in boron nitride and out of register in graphite / atoms of adjacent layers above one another in boron nitride but not in graphite</td></tr><tr><td>Bonding</td><td>each atom is bonded by covalent bonds to three others in both graphite and BN</td><td>delocalised electrons in graphite but not in boron nitride / bonds are non-polar in graphite but polar in boron nitride</td></tr></table>	2			2		
	(c)			phosphorus has available / accessible d-orbitals (1) whilst nitrogen does not (1) or phosphorus can expand its octet (1) but nitrogen cannot (1)	2			2		
				Question 6 total	**9**	**0**	**0**	**9**	**0**	**0**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
7	(a)			$5\ cm^3$ must give reason to keep total volume constant / to ensure concentration of hydrogensulfate(IV) stays constant			1	1		1
	(b)			first order (1) must attempt to show reasoning award (1) for suitable explanation/reasoning e.g. • when concentration (of iodate) is doubled the time taken halves • time taken is inversely proportional to concentration (of iodate) • rate goes from 0.006 to 0.012 when concentration (of iodate) doubles • rate doubles when concentration (of iodate) doubles		1	1	2	2	2
	(c)			award (1) for suitable rate equation with overall order of four e.g. rate = $k\ [IO_3^-]\ [HSO_3^-]^3$			2	2		
	(d)			award (1) for any balanced equation with IO_3^- / HSO_3^- as reactants e.g. $IO_3^- + 3HSO_3^- \rightarrow I^- + 3HSO_4^-$ ecf possible from part (c)			1	1		

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(e)	(i)		bright/canary yellow	1			1		1
		(ii)		moles of gas at 200°C = 5.653 × 10^{-3} mol (1) moles of gas at 20°C = 4.562 × 10^{-3} mol (1) [if the same error made in both calculations above then penalise once only] moles of iodine = 1.091 × 10^{-3} mol ⇨ percentage of iodine = 19.3% (1)			3	3	3	
				Question 7 total	**1**	**1**	**8**	**10**	**5**	**4**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
8	(a)			award (1) for either of following energy of the *d*-electrons are similar successive ionisation energies are similar	1			1		
	(b)	(i)		blue (1) the frequency of light that is <u>not absorbed</u> is in this region (1)		2		2		
		(ii)	I	a (small) molecule/ion with a lone pair (that can bond to a transition metal ion)	1			1		
			II	award (1) for any of following lone pair from ligand combines with empty orbital lone pair from ligand can combine with electron deficient transition metal atom sharing of a pair of electrons which are both from ligand forms a coordinate bond (1)	2			2		
	(c)	(i)		$2I^- \rightleftharpoons I_2 + 2e^-$		1		1		
		(ii)		$VO_2^+ + 2H^+ + e^- \rightleftharpoons VO^{2+} + H_2O$		1		1		

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(d)	(i)		catalyst in a different physical state from the reactants / reaction	1			1		
		(ii)	I	$[2 \times \Delta_f H(SO_3)] - [2 \times \Delta_f H(SO_2)] = -197$ (1) $\Delta_f H(SO_3) = -395.5$ kJ mol^{-1} (1)		2		2	2	
			II	$T = \frac{\Delta H}{\Delta S}$ (1) $T = 1053$ K (1) student is incorrect must give reason ΔG is negative below this temperature so the reaction is feasible at a lower temperature (1)		2	1	3	2	
			III	initial concentrations of SO_2 and O_2 = 0.020 mol dm^{-3} (1) equilibrium concentrations – both needed for (1) $[SO_2]$ = 0.006 mol dm^{-3} $[O_2]$ = 0.013 mol dm^{-3} $K_c = \frac{(0.014)^2}{(0.006)^2 \times (0.013)} = 419$ (1) mol^{-1} dm^3 (1)		4		4	4	
				Question 8 total	**5**	**12**	**1**	**18**	**8**	**0**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
9	(a)	(i)		all **three** needed chloride – white bromide – cream (accept off-white) yellow – iodide	1			1		1
		(ii)		$\Delta_f H^\theta$ (AgBr) = 105.6 + (½ × –243.1) – 84.4 (1) $\Delta_f H^\theta$ (AgBr) = **–**100.35 (1) AgCl more stable than AgBr (ecf possible from values) (1) as standard enthalpy of formation is more negative (1)		2	2	4	1	
	(b)	(i)	I	$Cu + 2Ag^+ \rightarrow Cu^{2+} + 2Ag$		1		1		
			II	E^θ (Cu) must be more negative/less positive than +0.80V (1) award (1) for either of following reasons reaction is feasible when EMF is positive reaction is feasible when reduction half-cell is more positive than oxidation half-cell			2	2		

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
		(ii)	I	award (2) for correct answer $E^{\theta} = 0.80 - 0.93 = -0.13$ V if incorrect award (1) for use of 0.93 V		1	1	2	1	
			II	as concentration of Ag^{+} decreases the $Ag^{+} + e^{-} \rightleftharpoons Ag$ equilibrium shifts to the left (1) this makes E for this reaction less positive (1) EMF of the cell is $E_{Ag} - E_{Pb}$ so the value becomes less positive (1)			3	3		
				Question 9 total	**1**	**4**	**8**	**13**	**2**	**1**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
10	(a)			$[H^+] = 10^{-3.24}$ (1) $[H^+] = 5.75 \times 10^{-4}$ mol dm^{-3} (1)		2		2	2	
	(b)	(i)		filtration		1		1		1
		(ii)	I	excess sodium hydroxide dissolves any precipitate produced by zinc (1) excess ensures that **all** iron ions are precipitated (1)			2	2		2
			II	moles $Fe_2O_3 = \frac{14.5 \times 10^{-3}}{159.6} = 9.085 \times 10^{-5}$ mol (1) concentration $= \frac{2 \times (9.085 \times 10^{-5})}{0.025} = 7.27 \times 10^{-3}$ mol dm^{-3} (1)		2		2	2	
			III	$\frac{0.2}{14.5} \times 100 = 1.4\%$		1		1	1	
		(iii)	I	solution turns (pale) pink do not accept purple to pink	1			1		1
			II	moles of MnO_4^- $= 3.80 \times 10^{-5}$ mol (1) $[Fe^{2+}] = 7.60 \times 10^{-3}$ mol dm^{-3} (1) ecf possible		2		2	2	

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
		(iv)		award (1) for percentage difference between the two values ⇨ either 4.3% or 4.5% (1) students' decision is **not** valid award (1) for sensible explanation e.g. • total of percentage errors for both methods is 2.2% (1.4% + 0.8%) and the percentage difference is greater than this • total of percentage errors in titration and gravimetric analysis allow a difference of only 0.16×10^{-3} • values are $7.60 \pm 0.10 \times 10^{-3}$ and $7.27 \pm 0.06 \times 10^{-3}$ and these ranges do not overlap			2	2	2	
	(c)	(i)		royal blue / dark blue do not accept blue / pale blue or any reference to a precipitate	1			1		1
		(ii)		**Indicative content** 1. A negative ΔG means products are more likely to be present than reactants 2. Higher product concentration leads to large value of K_c 3. Formation of the Cu-cyclen complex breaks four Cu-ammonia bonds and forms four Cu-cyclen bonds 4. As the bonds broken and bonds made are of similar strengths enthalpy change will be small 5. For a negative ΔG, ΔS must be positive OR $T\Delta S$ must be greater than ΔH as $\Delta G = \Delta H - T\Delta S$ 6. The forward reaction produces more (aqueous) molecules as four NH_3 are released 7. The entropy of free ammonia would be higher than cyclen so ΔS would be positive		2	4	6	1	

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
				5-6 marks The candidate includes five points with valid discussion of entropy, enthalpy and the position of equilibrium *There is a sustained line of reasoning which is coherent, relevant, substantiated and logically structured. The information included in the response is relevant to the argument.* **3-4 marks** The candidate includes four points with valid discussion of two of entropy, enthalpy and the position of equilibrium *There is a line of reasoning which is partially coherent, largely relevant, supported by some evidence and with some structure. Mainly relevant information is included in the response but there may be some minor errors or the inclusion of some information not relevant to the argument.* **1-2 marks** The candidate includes two relevant points *There is a basic line of reasoning which is not coherent, supported by limited evidence and with very little structure. There may be significant errors or the inclusion of information not relevant to the argument.* **0 marks** No attempt made or no response worthy of credit.						
				Question 10 total	**2**	**10**	**8**	**20**	**10**	**5**

UNIT 3

SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	TOTAL MARK	MATHS	PRAC
Section A	5	5	0	10	2	0
6	9	0	0	9	0	0
7	1	1	8	10	5	4
8	5	12	1	18	8	0
9	1	4	8	13	2	1
10	2	10	8	20	10	5
Total	23	32	25	80	27	10