GCE A LEVEL MARKING SCHEME

SUMMER 2025

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 2025 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				$k = Ae^{\frac{-E_a}{RT}}$	1			1		
2				silicon has available *d*-orbitals / *d*-orbitals in outer shell but carbon does not (so water can bond to silicon but not to carbon)	1			1		
3	(a)			catalyst in a different physical state to reactants	1			1		
	(b)			award (1) for any heterogeneous catalyst and reaction e.g. • Fe in Haber process • V_2O_5 in contact process • Ni in hydrogenation (of alkenes)	1			1		
4				$2MnO_4^- + 5(COOH)_2 + 6H^+ \rightarrow 2Mn^{2+} + 10CO_2 + 8H_2O$		1		1		
5				lilac flame test ⇨ potassium ions (1) smell of rotten eggs ⇨ iodide ions (1) award (1) for potassium iodide if no reasons given		2		2		2

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
6	(a)			initially forms a grey-green precipitate that dissolves in excess to form a green solution	1			1		1
	(b)	(i)		**A** ⇨ salt bridge **B** ⇨ platinum (electrodes) both needed for (1)	1			1		
		(ii)		direction of electron flow from hydrogen to chromium half-cell		1		1		
				Section A total	**6**	**4**	**0**	**10**	**0**	**3**

SECTION B

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
7	(a)	(i)		gases are produced and they have higher entropy than solids	1			1		
		(ii)		temperature = 1773 K (1) $\Delta H = T\Delta S = 1773 \times 0.379$ (1) $\Delta H = 672$ kJ mol^{-1} (1) ecf possible		3		3	2	
		(iii)	I	$Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$	1			1		1

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
			II	in general $\Delta_{sol}H = \Delta_{hyd}H(M^{2+}) + \Delta_{hyd}H(SO_4^{2-}) + \Delta_{latt}H$ (1) award (1) for calculating both $\Delta_{sol}H$ values $\Delta_{sol}H(MgSO_4) = -1920 + (-1059) + 2833 = -146$ kJ mol^{-1} $\Delta_{sol}H(BaSO_4) = -1360 + (-1059) + 2474 = +55$ kJ mol^{-1} negative enthalpy of solution means it is soluble and (significantly) positive value means that it is insoluble (1) accept references to exothermic/endothermic ecf possible alternative method $\Delta_{hyd}H(Mg^{2+}) + \Delta_{hyd}H(SO_4^{2-}) = -2979$ kJ mol^{-1} (1) $\Delta_{hyd}H(Ba^{2+}) + \Delta_{hyd}H(SO_4^{2-}) = -2419$ kJ mol^{-1} (1) value of lattice breaking enthalpy of $MgSO_4$ is lower than the sum of the hydration enthalpies of its ions so it is soluble, while the value of lattice breaking enthalpy of $BaSO_4$ is higher than the sum of the hydration enthalpies of its ions so it is insoluble (1)		3		3	2	
	(b)			pH value between 4.0 and 6.8 (1) NH_4^+ partially dissociates to release H^+ ions / $NH_4^+ \rightleftharpoons NH_3 + H^+$ (1)		2		2		
	(c)			sulfuric acid ⇨ white precipitate (1) potassium iodide ⇨ bright/canary yellow precipitate (1)	2			2		2

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(d)			at 100 K only O_2 present as a gas $n(O_2) = \frac{1.01 \times 10^5 \times 1.028 \times 10^{-3}}{8.31 \times 100}$ = 0.125 mol (1) at 200 K both O_2 and CO_2 are gases $n(O_2) + n(CO_2) = \frac{1.01 \times 10^5 \times 1.194 \times 10^{-2}}{8.31 \times 200}$ = 0.725 mol (1) $n(CO_2)$ = 0.725 – 0.125 = 0.600 mol ⇨ $n(CaCO_3)$ in rock sample = 0.600 mol (1) mass of $CaCO_3$ in rock sample = 0.600 × 100.1 = 60.06 g percentage $CaCO_3$ in rock sample = $\frac{60.06}{81.3}$ × 100 = 73.9% (1) ecf possible accept alternative methods		2	2	4	3	
				Question 7 total	**4**	**10**	**2**	**16**	**7**	**3**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
8	(a)	(i)		$3Cl_2 + 6NaOH \rightarrow NaClO_3 + 5NaCl + 3H_2O$	1			1		
		(ii)		same element has been oxidised and reduced (1) chlorine has been oxidised from 0 to +5 in sodium chlorate(V) and reduced to –1 in chloride (1)	1	1		2		
	(b)	(i)		add to ice / cold water	1			1		1
		(ii)		award (1) for either of following • incorrect as reaction is second order overall and these do not have constant half-life • incorrect as when one concentration halves the other also changes and affects rate and half-life			1	1		
		(iii)	I	must have tangent drawn on graph award (2) for a good tangent giving a rate in the range1.55-2.35 × 10^{-4} mol dm^{-3} min^{-1} award (1) for a reasonable tangent giving a rate in the range 1.40-3.00 × 10^{-4}		2		2	2	2

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
			II	award (1) for initial concentrations $[ClO^-] = 3.50 \times 10^{-3}$ $[Br^-] = 4.00 \times 10^{-3}$ $k = \frac{\text{initial rate}}{[ClO^-]\,[Br^-]}$ (1) $k = \frac{2.00 \times 10^{-4}}{3.50 \times 10^{-3} \times 4.00 \times 10^{-3}} = 14.3$ (1) accept any value following from rate calculated in part I award (1) for correct unit ⇨ $mol^{-1}\ dm^3\ min^{-1}$ ecf possible for unit if incorrect rate equation given		1 2	1	4	4	
			III	no difference (1) award (1) for either of following • each time one chloride ion is produced one bromate ion is produced • concentration of chloride produced will always be the same as the concentration of bromate			2	2		
				Question 8 total	**3**	**6**	**4**	**13**	**6**	**3**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
9	(a)			–162 – (–111 – 14) (1) = –37 kJ mol^{-1} (1) enthalpies of formation give more accurate value as bond energies are average values (1) award (2) for value of –19 kJ mol^{-1} based on bond energies		1	1 1	3	1	
	(b)	(i)		award (1) each for any **two** of following • less dissociation of CH_3COOH • HI releases H^+ ions so the weak acid equilibrium shifts to the reactants • CH_3COO^- ions combine with H^+ ions to form CH_3COOH			2	2		
		(ii)		pH = – log 0.250 (1) pH = 0.60 (1)		2		2	2	

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
		(iii)		**Indicative content** 1. Buffer formed from mixture of a weak acid and a salt of the weak acid 2. Add sodium ethanoate (or any other Group 1 metal ethanoate or small amount of sodium hydroxide) 3. $CH_3COOH \rightleftharpoons CH_3COO^- + H^+$ (or equivalent explanation) 4. $CH_3COONa \rightarrow CH_3COO^- + Na^+$ (or equivalent explanation) 5. Addition of a small amount of acid shifts equilibrium to left hand side removing H^+ 6. Addition of a small amount of base removes H^+ so equilibrium shifts to the right to replace H^+ OR OH^- ions react with undissociated acid molecules forming ethanoate ions and water 7. Buffer with pH 4.45 has $[H^+] = 3.548 \times 10^{-5}$ mol dm^{-3} 8. $[CH_3COONa] = \frac{[CH_3COOH]}{3.548 \times 10^{-5}} \times 1.74 \times 10^{-5} = 0.0490$ mol dm^{-3} 9. Mass of $CH_3COONa = 0.0490 \times 0.1 \times M_r = 0.402$ g	2	2	2	6	2	2

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
				5-6 marks Clear explanation of how the buffer works and required mass of sodium ethanoate calculated; both equations included *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** Basic description of how the buffer is made and what happens when either acid or base is added; one equation included *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** Substance needed to form a buffer is identified; attempt to describe what happens when either acid or base is added *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.						
	(c)	(i)		reaction is exothermic (must attempt reason to gain this mark) (1) award (1) for either of following • as temperature increases, equilibrium shifts to the left • as temperature decreases, equilibrium shifts to the right			2	2		

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
		(ii)		award (1) for equilibrium concentrations [CO] = 6.18×10^{-4} mol dm^{-3} [RuL_5CH_3] = 1.113×10^{-3} mol dm^{-3}			1			
				$K_c = \frac{[(RuL_5COCH_3)]}{[(RuL_5CH_3)]\,[CO]}$ (1)		1				
				K_c = 199 mol^{-1} dm^3 (1)		1		4	3	
				award (1) for any temperature in the range 60-64°C ecf possible for temperature if it fits in the range			1			
				ecf possible for K_c value only when there is an error in calculating equilibrium concentrations of CO and [RuL_5CH_3]						
				Question 9 total	**2**	**7**	**10**	**19**	**8**	**2**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
10	(a)			use nitric acid (1) as hydrochloric acid will give a precipitate with silver and lead (but nitrates are both soluble) (1)			2	2		2
	(b)			amphoteric metals react with both acids **and** bases/alkalis (1) zinc / tin (1)	2			2		1
	(c)	(i)		$2Cu^{2+} + 4I^- \rightarrow 2CuI + I_2$ (1) $I_2 + 2S_2O_3^{2-} \rightarrow 2I^- + S_4O_6^{2-}$ (1) 2 × Cu^{2+} produces 1 × I_2 which reacts with 2 × $S_2O_3^{2-}$ so 2 × Cu^{2+} ≡ 2 × $S_2O_3^{2-}$ ⇨ 1 mol Cu^{2+} is equivalent to 1 mol $S_2O_3^{2-}$ (1)	2	1		3		
		(ii)		n(Cu) in 25.0 cm^3 = n($S_2O_3^{2-}$) in 33.05 cm^3 n($S_2O_3^{2-}$) = 0.05 × $\frac{33.05}{1000}$ = 1.6525 × 10^{-3} mol (1) mass of copper in sample = 1.6525 × 10^{-3} × 10 × 63.5 = 1.05 g (1) percentage by mass = $\frac{1.05}{1.72}$ × 100 = 61.0% (1) alloy must be cupronickel (1) ecf possible		2	2	4	2	4

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(d)	(i)		ligands split the *d*-orbitals into two upper and three lower energy levels (can gain from diagram) (1) electrons absorb specific frequencies of light to promote electrons from lower to higher energy levels (1) colour seen corresponds to the frequencies not absorbed OR red/green absorbed so blue transmitted (1)	3			3		
		(ii)		*d*-orbitals are full (so electrons cannot be promoted)	1			1		
		(iii)		credit answer based on any one of three peaks 18000-12000 cm^{-1} (1) ⇨ the chloro complex absorbs but the aqua does not (1) 22000-18000 cm^{-1} (1) ⇨ the aqua complex absorbs but the chloro does not (1) 10000-6000 cm^{-1} (1) ⇨ the aqua complex absorbs but the chloro does not (1) do not credit wavenumber value if no reason given or if reason is incorrect credit wavenumber value if reason is partially correct but lacks comparison			2	2		

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(e)	(i)		credit either of following approaches EMF of cell between Cu^{+}/Cu^{2+} and Cu^{+}/Cu has a <u>value of 0.36V</u> (1) value is <u>positive</u> so reaction can occur / is feasible (1) standard electrode potential for Cu^{+}/Cu^{2+} is <u>less positive</u> than Cu^{+}/Cu (1) so one Cu^{+} can reduce another to form Cu (1)		2		2		
		(ii)	I	Tl^{+} / thallium(I) ions (must give oxidation state) (must attempt reason to gain this mark) (1) award (1) for either of following • copper(I) ions are strong enough reducing agents to reduce Tl^{3+} to Tl^{+} but not strong enough to reduce Tl^{+} to Tl • standard electrode potential for Tl^{3+}/Tl^{+} is more positive than Cu^{2+}/Cu^{+} but Tl^{+}/Tl is less positive (than Cu^{2+}/Cu^{+}) • EMF for reaction between Tl^{3+}/Tl^{+} and Cu^{2+}/Cu^{+} is +1.09V so reaction occurs; EMF for reaction between Tl^{+}/Tl and Cu^{2+}/Cu^{+} is –0.50V so does not occur		1	1	2		
			II	thallium(I) as the inert pair effect increases down the group		1		1		
				Question 10 total	**8**	**7**	**7**	**22**	**2**	**7**

UNIT 3

SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	TOTAL MARK	MATHS	PRAC
Section A	6	4	0	10	0	3
7	4	10	2	16	7	3
8	3	6	4	13	6	3
9	2	7	10	19	8	2
10	8	7	7	22	2	7
TOTAL	23	34	23	80	23	18