GCE A LEVEL MARKING SCHEME

SUMMER 2024

A LEVEL
CHEMISTRY – COMPONENT 1
A410U10-1

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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.

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GCE A LEVEL CHEMISTRY

COMPONENT 1 – PHYSICAL AND INORGANIC CHEMISTRY

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.

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Marking abbreviations

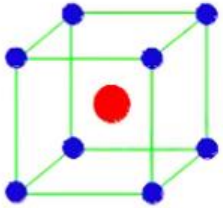
The following may be used in marking schemes or in the marking of scripts to indicate reasons for the marks awarded.

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.

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SECTION A

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
1	(a)			$1s^2 2s^2 2p^6$		1		1		
	(b)			 accept any **one** dumbbell shaped orbital	1			1		
2	(a)			 accept any clear body centred cubic structure	1			1		
	(b)			ions can move in liquid state but not when solid	1			1		

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Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
3				phosphorus can expand its octet (1) but nitrogen cannot (1) or phosphorus has available d-orbitals (1) but nitrogen does not (1)	1 1			2		
4	(a)			colorimetry accept clock reaction sampling and quenching	1			1		1
	(b)			award (2) for correct rate equation rate = $k[C_6H_{10}]^1[Br_2]^2$ if equation not wholly correct award (1) for **both** orders correct order with respect to cyclohexene = 1 order with respect to bromine = 2		2		2	1	
5				moles of $Mg(OH)_2 = \frac{10.0}{58.32} = 0.171$ mol (1) mass of MgO = 0.171 × 40.3 = 6.91 g (1)		2		2	1	

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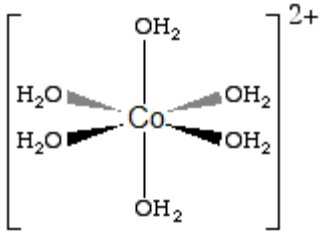
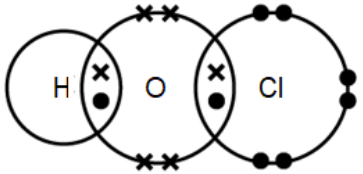
Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
6				award (2) for correct formula ⇨ ClF_3 if formula not correct award (1) for either of following • use of isotopes to confirm one Cl only e.g. peaks in 3:1 ratio separated by 2 units suggests one chlorine atom • use of M_r to identify formula e.g. remainder of M_r is 57 so must be three fluorine atoms		2		2		
7				when a system at equilibrium experiences a change in conditions, the equilibrium position shifts to minimise/counteract the change	1			1		
8				award (1) for any of following vanadium pentoxide vanadium(V) oxide V_2O_5	1			1		
				Section A total	**8**	**7**	**0**	**15**	**2**	**1**

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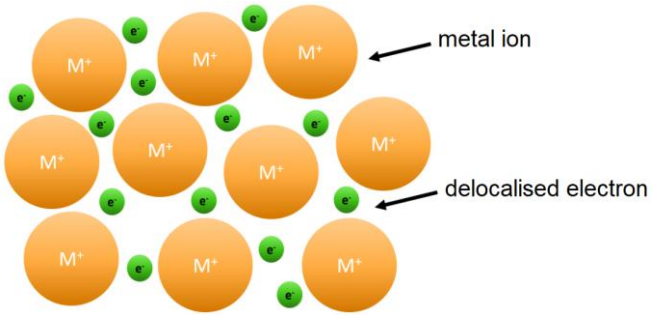
SECTION B

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
9	(a)	(i)		$[H^+] = \frac{1.0 \times 10^{-14}}{0.5} = 2.0 \times 10^{-14}$ (1) pH = – log 2.0×10^{-14} = 13.7 (1) ecf possible		2		2	2	
		(ii)		half of acid converted to salt (so mixture is a buffer) / [acid] = [salt] (1) pH = pK_a = – log 1.34×10^{-5} (1) pH = 4.87 (1) ecf possible		3		3	2	
		(iii)	I	2 $CH_3CH_2COOH + CaCO_3 \rightarrow H_2O + CO_2 + (CH_3CH_2COO)_2Ca$ award (1) for correct formula for salt award (1) for balancing (only if salt formula is correct)	1	1		2		
			II	award (1) each for any **three** of the following • measure temperature every 30 seconds at start to allow temperature to become constant • measure temperature every 30 seconds at end and plot to allow for heat transfer from environment • perform experiment in polystyrene/insulated cup to reduce heat transfer from environment • use powdered $CaCO_3$ and mix to ensure reaction occurs quickly must give change and explanation for mark to be awarded			3	3		3

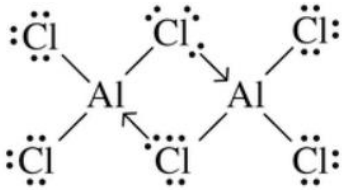
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Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
	(b)	(i)		 accept any clear 3D structure with all bonds from Co going to O	1			1		
		(ii)		pink	1			1		1
	(c)	(i)			1			1		
		(ii)		+1	1			1		
		(iii)		to kill bacteria / to disinfect	1			1		
				Question 9 total	**6**	**6**	**3**	**15**	**4**	**4**

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Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
10	(a)			 diagram showing (lattice of metal ions in a) sea of delocalised electrons (1) electrons can move (when a potential difference is applied) (1)	2			2		
	(b)	(i)		award (1) for each correct product symbol **and** mass number Fr **and** 223 Th **and** 227 if neither mark awarded, credit two correct symbols or two correct mass numbers		2		2		
		(ii)		$A_r = \frac{227x + [228 \times (100-x)]}{100}$ (1) $100A_r = 22800 - x$ (1) x = 88% (1)		1	2	3	2	

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Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
	(c)	(i)		aluminium hydroxide is amphoteric as it reacts with both acids and bases (1) award (1) for reaction with acid e.g. $Al(OH)_3 + 3H^+ \rightarrow Al^{3+} + 3H_2O$ $Al(OH)_3 + 3HCl \rightarrow AlCl_3 + 3H_2O$ award (1) for reaction with base e.g. $Al(OH)_3 + OH^- \rightarrow [Al(OH)_4]^-$ $Al(OH)_3 + NaOH \rightarrow NaAl(OH)_4$	1	2		3		2
		(ii)		aluminium atom has 6 outer shell electrons OR fewer than 8 outer shell electrons (so it is electron deficient) (1) chlorine atoms have lone pairs (1) lone pairs can form coordinate bonds to form a dimer (1) all marks may be awarded from an appropriately labelled diagram 	3			3		

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Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
	(d)	(i)		294 minutes is three half-lives (1) 8.75 mg of ^{238}Pu is present (1)		2		2	1	
		(ii)		half-life of Pu isotope needs to be much longer than that of Am isotope / 98 minutes / 294 minutes or its decay would affect amount of Pu present			1	1		
				Question 10 total	**6**	**7**	**3**	**16**	**3**	**2**

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Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
11	(a)	(i)		unit of rate constant is that of a first order reaction		1		1		
		(ii)		$k = Ae^{\frac{-E_a}{RT}}$ ⇨ $E_a = -RT\ln\left(\frac{k}{A}\right)$ (1) T = 310 K (1) E_a = 50.5 kJ mol^{-1} (1)		1	1 1	3	3	
	(b)	(i)		potential difference when half-cell is connected to standard hydrogen electrode (1) under standard conditions (1)	2			2		
		(ii)		Ti^{2+}, Cr^{2+}, Fe^{2+} – must show charges and give all three for this mark (1) standard electrode potential of peroxynitrous acid is more positive than that of these three half-cells so can oxidise these ions but not the others (1)		2		2		

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Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
	(c)			for peroxynitrous acid $[H^+] = \sqrt{K_a \times [\text{acid}]} = 1.26 \times 10^{-4}$ mol dm^{-3} (1) pH = 3.90 (1) for nitric acid pH = –log(0.1) = 1.00 (1) change in pH = (–)2.90 (1) ecf possible		1 1	1 1 1	4	3	
	(d)			**Indicative content** 1. Place $NaHCO_3$ in a beaker. 2. Add a small amount OR given volume below 150 cm^3 of deionised water. 3. Stir with a glass rod until all the solid dissolves. 4. Transfer to the volumetric/standard flask using a funnel. 5. Wash beaker / glass rod / funnel and place washings in volumetric/standard flask. 6. Remove funnel and add deionised water up to the mark. 7. Put a stopper in the flask and invert several times to mix thoroughly. moles of $NaHCO_3 = \frac{20.0}{84.01} = 0.238$ mol concentration $= \frac{0.238}{0.250} = 0.952$ mol dm^{-3}	4	2		6	2	6

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Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
				5-6 marks Correct calculation of sodium hydrogencarbonate concentration; five correct steps in the method in the correct order *The candidate constructs a relevant, coherent and logically structured account including all key elements of the indicative content. A sustained and substantiated reasoning is evident and scientific conventions and vocabulary are used accurately throughout.* **3-4 marks** Correct calculation of moles of sodium hydrogencarbonate; four correct steps in the method *The candidate constructs a coherent account including most 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 are generally sound.* **1-2 marks** Three steps in the method; refers to two pieces of apparatus *The candidate attempts to link at least three 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*						
				Question 11 total	**6**	**8**	**4**	**18**	**8**	**6**

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Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
12	(a)			award (1) for conversion of units $p = 1.01 \times 10^5$ Pa and $V = 3.72 \times 10^{-5}$ m^3 $n = \frac{pV}{RT}$(1) $n = 1.56 \times 10^{-3}$ mol ⇨ **c** = 1 (1)		1	2	3	3	
	(b)			20.90 cm^3		1		1	1	

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Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
	(c)			two possible methods method 1 initial moles of HNO_3 = 0.500 × $\frac{25.0}{1000}$ = 0.0125 mol (1) moles of NaOH = 0.300 × $\frac{20.90}{1000}$ = 6.27 × 10^{-3} mol (1) moles of HCl reacting = 6.23 × 10^{-3} mol (1) reacting ratio is 4:1 with 2 due to carbonate ion ⇨ **b** = 2 (1) method 2 if **b** = 2 then each formula unit reacts with four H^+ ions due to one carbonate ion and two hydroxide ions (1) mineral reacts with 1.56 × 10^{-3} × 4 = 6.24 × 10^{-3} mol of acid (1) initial moles of HNO_3 = 0.500 × $\frac{25.0}{1000}$ = 0.0125 mol ⇨ leaves 6.26 × 10^{-3} mol of acid (1) this reacts with 6.26 × 10^{-3} × $\frac{1000}{0.300}$ = 20.90 cm^3 of NaOH ⇨ fits with titration data (1)			4	4	3	

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Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
	(d)			relative mass from iron ≈ 210 – (2 × 17) – 60 ≈ 116 (1) number of iron atoms ≈ $\frac{116}{55.8}$ ≈ 2 ⇨ formula is $Fe_2(OH)_2(CO_3)$ (1)			2	2		
	(e)	(i)		must be +2 as negative ions have overall –4 charge			1	1		
		(ii)		add acid then sodium hydroxide / add sodium hydroxide to solution formed in test 1 (1) green precipitate forms (1) ecf possible – accept brown precipitate if +3 given in part (i)		2		2		2
				Question 12 total	**0**	**4**	**9**	**13**	**7**	**2**

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Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
13	(a)			low low **both** needed	1			1		
	(b)			$K_p = \frac{{p_{N_2O}}^2}{{p_{N_2}}^2 \times p_{O_2}}$ (1) unit ⇨ Pa^{-1} (1)		2		2	1	
	(c)			initial p_{NO} = 101000 Pa (1) $p_{N_2O} = p_{NO_2} = 33667$ Pa (1) $K_p = \frac{p_{N_2O} \times p_{NO_2}}{{p_{NO}}^3}$ (1) $K_p = 1.61 \times 10^{18}$ (1) accept answer in the range 1.60 to 1.62 × 10^{18}	1	3		4	3	

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Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
	(d)	(i)		it is an element in its standard state	1			1		
		(ii)		enthalpy change = [2 × (–635)] + [4 × (34)] + 0 – [2 × (–937)] (1) 740 (1)		2		2	1	
		(iii)		entropy change = [2 × (40)] + [4 × (240)] + [205] – [2 × (193)] (1) 859 (1)		2		2	1	
		(iv)		minimum temp = $\frac{\Delta H}{\Delta S}$ = $\frac{740000}{859}$ = 861 K (1) 588°C (1)		2		2	2	
				Question 13 total	**3**	**11**	**0**	**14**	**8**	**0**

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Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
14	(a)			**Indicative content** 1. TEST: Add water and shake 2. RESULT: **A**, **B**, **C** and **F** dissolve completely; **D** and **E** do not 3. RESULT: **C** and **D** give a blue solution 4. TEST: Flame test 5. RESULT: **B** gives apple green flame; all others are inconclusive 6. TEST: Add hydrochloric acid 7. RESULT: **D** and **E** effervesce; others do not; **B** and **C** dissolve 8. TEST: Add nitric acid 9. RESULT: **D** and **E** effervesce; others do not; all dissolve 10. RESULT: **C** and **D** give a blue solution 11. TEST: Add drops of sodium hydroxide (after nitric acid) 12. RESULT: **C** gives blue precipitate; **D** gives mix of blue and white precipitates; others give white precipitate 13. TEST: Add excess sodium hydroxide (after nitric acid) 14. RESULT: **E** and **F** redissolve completely; others do not (some redissolve partially) **5-6 marks** Sufficient tests and results are given to identify each mixture; method clearly indicates how the observations are used for identification *The candidate constructs a relevant, coherent and logically structured method including all key elements of the indicative content. A sustained and substantiated line of reasoning is evident and scientific conventions and vocabulary are used accurately throughout.*			6	6		6

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Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
				3-4 marks Sufficient tests and results are given to identify almost all mixtures; includes four tests with corresponding observations *The candidate constructs a coherent account including most 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 are generally sound.* **1-2 marks** Two tests given with corresponding results *The candidate attempts to link at least two 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.*						

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Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
	(b)	(i)		both give cream precipitates (1) allow mixture of white and yellow precipitates for solution **H**	1			1		1
		(ii)		add concentrated ammonia (1) award (1) for appropriate observation e.g. • bromide precipitate dissolves completely whilst the other dissolves partially • bromide precipitate dissolves completely whilst only the chloride dissolves (and the iodide remains) in the other • precipitate in solution **G** dissolves completely whilst the precipitate in solution **H** dissolves partially • cream precipitate dissolves completely from solution **G** and turns yellow in solution **H**	2			2		2
	(c)	(i)		canary yellow precipitate (1) $Pb^{2+} + 2I^- \rightarrow PbI_2$ (1)	2			2		2
		(ii)		brown solution with white solid (1) $2Cu^{2+} + 4I^- \rightarrow 2CuI + I_2$ (1)	2			2		2
				Question 14 total	**7**	**0**	**6**	**13**	**0**	**13**

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Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
15	(a)			the energy to remove outermost electron from an atom in the gas phase	1			1		
	(b)			lithium 7300 kJ mol^{-1} magnesium 1450 kJ mol^{-1} silicon 1580 kJ mol^{-1} sodium 4560 kJ mol^{-1} award (1) for any two correct award (2) for all four correct second electron of Na/Li are in an inner shell closer to nucleus (with less shielding) so higher ionisation energy (1) Li electron is in innermost shell – no shielding so higher ionisation energy than Na (1) Si has a greater nuclear charge than Mg so it has a greater ionisation energy (1)			5	5		
	(c)	(i)		energy required = – (–698) – (–2258) + (–795) – (178) – (242) (1) 1741 kJ mol^{-1} (1)		2		2	1	
		(ii)		accept value in the range 200-800 kJ mol^{-1} first ionisation energy must be smaller than second ionisation energy ecf possible from part (i)			1	1		

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Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
	(d)	(i)		award (1) for reference to not having six electron pairs e.g. • Xe has seven electron pairs • Xe has a lone pair / one lone pair • appropriate dot-and-cross diagram award (1) for reference to shape / bond angles e.g. • octahedral shape is due to six electron pairs • seven electron pairs gives a different shape • bond angles must be less than 90° • lone pair repels more than bonded pairs		2		2		
		(ii)		volume of 100 g of HF = $\frac{100}{1.66}$ = 60.24 cm^3 = 60.24 × 10^{-3} dm^3 (1) moles of XeF_2 = $\frac{162}{169}$ = 0.9586 mol (1) solubility = $\frac{0.9586}{60.24 \times 10^{-3}}$ = 15.9 mol dm^{-3} (1)		3		3	2	
		(iii)		SiF_4 has fewer electrons in a molecule than XeF_4 (1) weaker van der Waals forces between the molecules (1)		2		2		
				Question 15 total	**1**	**9**	**6**	**16**	**3**	**0**

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COMPONENT 1: PHYSICAL AND INORGANIC CHEMISTRY

SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	TOTAL	Maths	Practical
Section A	8	7	0	15	2	1
9	6	6	3	15	4	4
10	6	7	3	16	3	2
11	6	8	4	18	8	6
12	0	4	9	13	7	2
13	3	11	0	14	8	0
14	7	0	6	13	0	13
15	1	9	6	16	3	0
Totals	37	52	31	120	35	28

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