GCE A LEVEL MARKING SCHEME

SUMMER 2019

A LEVEL
CHEMISTRY - UNIT 3
1410U30-1

INTRODUCTION

This marking scheme was used by WJEC for the 2019 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.

UNIT 3: PHYSICAL AND INORGANIC CHEMISTRY

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.

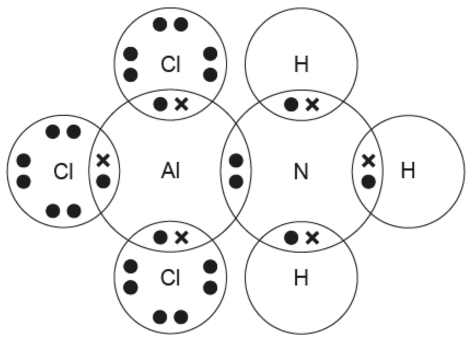
Marking abbreviations

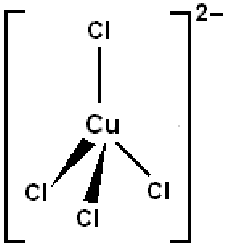
The following may be used in marking schemes or in the marking of scripts to indicate reasons for the marks awarded.

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

Credit should be awarded 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				$3d^7$ allow any clear representation		1		1		
2				 NH_3 structure (1) dots and crosses showing coordinate bond and covalent bonds around Al atom (1)		2		2		
3				$K_w = [H^+][OH^-]$	1			1		
4				platinum as it is unreactive	1			1		
5				$SiCl_4$ has available d-orbitals whilst carbon does not (so water can bond to Si atom)	1			1		
6				forms a gas and gases have a greater entropy than liquids (and solids)		1		1		

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
7	*(a)*			$Fe_3O_4 + 4CO \rightarrow 3Fe + 4CO_2$ ignore state symbols		1		1		
	(b)			award (1) for either of following • stability of +2 oxidation state increases down the group (due to the inert pair effect) • carbon stable as +4 and lead stable as +2	1			1		
8						1		1		1
				Section A total	**4**	**6**	**0**	**10**	**0**	**1**

Section B

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
9	*(a)*	(i)		121 kJ mol^{-1}		1		1		
		(ii)		$\Delta H = -(-728) - (242) - (1735) - (178) + (-795)$ (1) $\Delta H = -2222$ kJ mol^{-1} (1)		2		2	1	
		(iii)		award (1) for any value in range 900-1600 kJ mol^{-1} award (1) for either of following • ionisation energies increase for successive ionisation energies (so value must be more than half the ionisation of the first two electrons) • second ionisation energy is greater than first ionisation energy		1	1	2		

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(b)	(i)		at minimum temperature $\Delta G = 0$ so equation gives $\Delta S = \Delta H/T$ (1) change units giving T = 473 K and 78000 J mol^{-1} (1) ΔS = 165 J K^{-1} mol^{-1} (allow 164.9) (1) ECF possible	 1	1 1		 3	 3	
		(ii)		0.0284 mol of $CaCl_2$ (1) 0.1138 mol of water (1) x = 4 (1) ECF possible		3		3	2	
		(iii)		brick-red	1			1		1
	(c)			$CaCl_2$ misty fumes (and white solid) (1) $CaBr_2$ will produce orange fumes / solution as well as misty fumes (and white solid) (1) accept will **also** produce orange fumes if first mark awarded bromide is easier to oxidise than chloride (so can be oxidised by the sulfuric acid) (1)	3			3		1 1
				Question 9 total	**5**	**9**	**1**	**15**	**6**	**3**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
10	*(a)*	(i)		rate = $k[CH_3I][S_2O_3^{2-}]$ award (1) for rate equation containing $k[CH_3I]$ award (1) for second order rate equation		1	1	2		
		(ii)		change E_a to 81100 J mol^{-1} (1) rearrange equation to $T = -\frac{Ea}{\left(R\ ln\frac{k}{A}\right)}$ (1) T = 346 K (1)	1		1 1	3	3	
	(b)	(i)		quenching is the sudden stopping / significant slowing of a chemical reaction in a sample (1) ensure sample composition does not change between taking sample and analysis OR during analysis (1)	1 1			2		2
		(ii)		starch	1			1		1
		(iii)		canary/bright yellow	1			1		1

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(c)	(i)	I	catalyst in the same physical state as reaction	1			1		
			II	award (1) each for any **two** of following • transition metals have empty orbitals so can form bonds to reactant molecules / form complex • transition metals have variable oxidation states (so they can oxidise/reduce the reactants) • products are released and the metal returns to the original oxidation state	2			2		
		(ii)		$[H^+]^2 = K_a \times [\text{acid}]$ $[H^+] = 1.97 \times 10^{-3}$ mol dm^{-3} pH = 2.7		3		3	3	
				Question 10 total	**8**	**4**	**3**	**15**	**6**	**4**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
11	*(a)*	(i)		$MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$ (1) $2MnO_4^- + 5H_2C_2O_4 + 6H^+ \rightarrow 2Mn^{2+} + 10CO_2 + 8H_2O$ (1)	1	1		2		
		(ii)	I	31.67 cm^3 accept 31.65 cm^3		1		1	1	1
			II	moles of manganate(VII) = $\frac{31.67 \times 0.0505}{1000}$ = 1.599×10^{-3} mol (1) ECF possible from mean volume moles of oxalic acid = $1.599 \times 10^{-3} \times 2.5 = 4.00 \times 10^{-3}$ mol (1) ECF possible from equation concentration of saturated solution = $\frac{4.00 \times 10^{-3}}{0.025} \times 10 = 1.60$ mol dm^{-3} (1)		3		3	2	

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(b)			**Indicative content** 1. Oxalic acid has two acidic protons 2. The K_a/acidity/ease of removal of each proton is different so they give two different vertical regions 3. First vertical region occurs at half the volume of second as each occurs after removing same number of protons 4. Flat regions from 5-10 and 20-25 due to formation of buffer 5. Alice, Brychan and David methods will work 6. Indicators only work if they change colour within a vertical region 7. Alice's method allows the first and second equivalence points to be found by plotting a curve 8. Brychan's indicator will change colour fully during the second vertical region 9. David's indicator will change colour fully during the first vertical region 10. Carys's method will not work as indicator will change colour gradually as sodium hydroxide is added		3	3	6		3

				5-6 marks The candidate includes at least six relevant points *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 is used accurately throughout.* **3-4 marks** The candidate includes at least five relevant points *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** The candidate includes at least three relevant points *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.*						
				Question 11 total	**1**	**8**	**3**	**12**	**3**	**4**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
12	*(a)*	(i)		all four carbonates (1) acids react with metal carbonates to form carbon dioxide gas (1)	2			2		2
		(ii)		(hydrochloric acid would form) <u>insoluble</u> compound with Pb^{2+} (1) should use nitric acid / ethanoic acid (1)			2	2		2
		(iii)		award (2) for **all** four correct award (1) for **any** two correct Mg^{2+}(aq) white (precipitate) Fe^{2+}(aq) (dark) green (precipitate) Cr^{3+}(aq) (grey) green (precipitate) Pb^{2+}(aq) white (precipitate)	2			2		2
		(iv)		add excess sodium hydroxide (1) award (1) for either of following • magnesium hydroxide white precipitate remains but lead hydroxide precipitate dissolves (giving a colourless solution) • iron(II) hydroxide green precipitate remains but chromium hydroxide precipitate dissolves (giving a dark green solution) lead and chromium are amphoteric (iron and magnesium are not) (1)			3	3		3

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(b)	(i)		Mg^{2+} $\frac{91}{24.3}$ = 3.7449 Ca^{2+} $\frac{50}{40.1}$ = 1.2469 (1) ratio is 3Mg: 1Ca (1) formula must contain 4 × CO_3 so it is $Mg_3Ca(CO_3)_4$ (1) accept alternative correct representations e.g. $CaCO_3.3MgCO_3$ $(MgCO_3)3.CaCO_3$		1	2	3	2	
		(ii)		concentration = 1.25 × 10^{-6} mol dm^{-3} (from calcium or magnesium concentrations) (1) moles of solid used = $\frac{220 \times 10^{-6}}{353}$ = 0.6232 × 10^{-6} mol (1) volume = 0.50 dm^3 (1) allow any value in the range 0.498-0.501 dm^3		1 1	1	3	2	
				Question 12 total	**4**	**3**	**8**	**15**	**4**	**9**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
13	*(a)*			Elfed's reaction produces Cr^{2+} (1)			1			
				dichromate(VI) can be reduced to Cr^{3+} and further to Cr^{2+} as E^{θ} values for these two processes are more positive than that for Zn^{2+}/Zn / EMF values for reactions are positive (2.09 V and 0.34 V) (1)			1			
				Fatima's reaction produces Cr^{3+} (1)			1			
				oxygen oxidises Cr^{2+} back to Cr^{3+} as E^{θ} value is more positive than that for Cr^{3+}/Cr^{2+} / EMF value for reaction is positive (0.82 V) (1)			1	4		

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(b)	(i)		$K_c = \frac{[CrO_4^{2-}]^2[H^+]^2}{[Cr_2O_7^{2-}]\ \ [H_2O]}$		1		1		
		(ii)		1 dm^3 contains 1000g of water (1) $\frac{1000}{18.02}$ = 55.5 in 1 dm^3 (1)	1	 1		 2		
		(iii)		$[H^+]^2 = \frac{Kc \times [Cr_2O_7^{2-}] \times [H_2O]}{[CrO_4^{2-}]^2}$ (1) $[H^+]^2 = 2.356 \times 10^{-12}$ or $[H^+] = 1.535 \times 10^{-6}$ mol dm^{-3} (1) pH = 5.81 (1) student is incorrect as this solution is acidic (1)		1	 1 1 1	 4	 3	
		(iv)		if K_c increases the reaction is shifting to the right (1) if a reaction shifts to right when heated it must be endothermic (1)		1	 1	 2		
				Question 13 total	**1**	**4**	**8**	**13**	**3**	**0**

UNIT 3: PHYSICAL AND INORGANIC CHEMISTRY

SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	Total	Maths	Prac
Section A	4	6	0	10	0	1
9	5	9	1	15	6	3
10	8	4	3	15	6	4
11	1	8	3	12	3	4
12	4	3	8	15	4	9
13	1	4	8	13	3	0
Totals	23	34	23	80	22	21