GCE A LEVEL MARKING SCHEME

SUMMER 2018

A LEVEL (NEW)
CHEMISTRY - UNIT 3
2410U30-1

INTRODUCTION

This marking scheme was used by WJEC for the 2018 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

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.

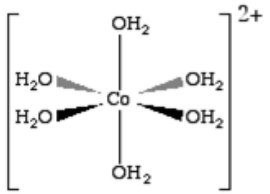
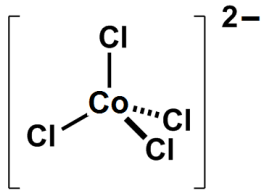
Section A

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
1.				$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^1$	1			1		
2.				$[Cr(OH)_6]^{3-}$	1			1		
3.	(a)			$6NaOH + 3Cl_2 \rightarrow NaClO_3 + 5NaCl + 3H_2O$	1			1		
	(b)			disproportionation where the same element is both oxidised and reduced	1			1		
4.				(white precipitate and) steamy fumes	1			1		1
5.				0.0093 mol dm^{-3} (1) 2.36 g dm^{-3} (1)		2		2	1	
6.				(Gibbs free energy is negative) as entropy increase of solution overcomes endothermic enthalpy change		1		1		
7.				pH between 2 and 6.5 (1) ammonium ion dissociates to release H^+ ions (1)		2		2		
				Section A total	**5**	**5**	**0**	**10**	**1**	**1**

Section B

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
8.	(a)			any **two** of following observations for (1) each • both release misty or steamy fumes • only sodium bromide gives orange fumes / orange solution • only sodium bromide gives pungent smell (of sulfur dioxide) bromide is more easily oxidised than chloride / sulfuric acid is a strong enough oxidising agent to oxidise bromide but not strong enough to oxidise chloride	2	1		3		2
	(b)	(i)		$K_a = \frac{[H^+][F^-]}{[HF\ ]}$		1		1		
		(ii)		$K_a \times [HF\ ] = [H^+]^2$ (1) $[H^+] = \sqrt{0.100 \times 7.20 \times 10^{-4}} = 0.00849$ (1) pH = − log $[H^+]$ = 2.07 (1)		3		3	3	

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
		(iii)		vertical part of titration curve is between 6.5 (allow ± 0.5) and 11 (allow ± 1) / vertical part lies in alkaline region (1) select an indicator whose colour change is complete in the vertical region (1)	2			2		2
		(iv)	I	HF $\rightleftharpoons$ $H^+ + F^-$ / reversible reaction (or equilibrium) (1) addition of a small amount of acid reacts with fluoride ions / shifts equilibrium to left (1) addition of a small amount of base removes hydrogen ions and these are replaced by HF dissociating / shifting equilibrium to the right / hydroxide ions react with HF molecules (1)	3			3		
			II	concentration of acid equal to concentration of salt (1) pH = − log [7.2×10^{-4}] = 3.14 (1)		2		2	1	
				Question 8 total	**7**	**7**	**0**	**14**	**4**	**4**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
9.	(a)			 (1)  (1)	2			2		
	(b)			ligands cause d-orbitals to split into three lower and two higher energy levels (1) electrons absorb energy and are promoted to a higher energy level (1) colour seen is the colours not absorbed (1)	3			3		

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(c)			white precipitate (1) silver chloride forms / silver ions cause a precipitate with chloride (1) solution turns pink (1) removal of chloride causes equilibrium to shift to left (1)		1 1	 1 1	 4		1 1
	(d)	(i)		$f = 5.79 \times 10^{14}$ (1) $E = hf = 3.84 \times 10^{-19}$ (1) E = 231 (1)		 3		 3	 3	
		(ii)		value above 600 nm as this is absorbed by chloro but not aqua / value below 560 nm as this is absorbed by aqua complex but not chloro		1		1		1

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
		(iii)		$K_c = \dfrac{[[CoCl_4]^{2-}] \times [H_2O]^6}{[[Co(H_2O)_6]^{2+}] \times [Cl^-]^4}$ (1) $mol^2\ dm^{-6}$ (1)		2		2	1	
		(iv)		concentration of aqua complex = 0.596 concentration of chloride = 0.224 / concentration of chloro complex = 0.124 award (2) for all three concentrations correct award (1) for any two correct K_c = 14.0 (1)			3	3	3	
				Question 9 total	**5**	**8**	**5**	**18**	**7**	**3**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
10.	(a)	(i)		inert pair effect becomes more significant down the group	1			1		
		(ii)		$PbO_2 + 4HCl \rightarrow PbCl_2 + 2H_2O + Cl_2$		1		1		
	(b)	(i)		1^{st} order with respect to hydrogen ions (1) 1^{st} order with respect to tin ions / 0^{th} order with respect to iron(III) ions (1) rate = $k[H^+][Sn^{2+}]$ (1)		1	1 1	3	1 1	
		(ii)		k = rate / $[H^+][Sn^{2+}]$ (1) ecf from rate equation given in part (i) k = 0.14 (1)		2		2	2	
		(iii)		**not** correct – **must** give a sensible reason (1) as the rate determining step should include one hydrogen ion / one tin ion / no iron(III) ion (1) ecf from rate equation given in part (i)			1 1	2		
	(c)	(i)		removing samples from the reaction mixture at set intervals and then stopping the reaction / adding large volume of water	1			1		1
		(ii)		reacting ratio $5Fe^{2+} : 1MnO_4^-$ concentration = 0.0558 mol dm^{-3}		2		2	2	
				Question 10 total	**2**	**6**	**4**	**12**	**6**	**1**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
11.	(a)			profile with start and end at same energies and activation energy of 58 kJ mol^{-1} allow tolerance ± 1 small square each way for peak maximum		1		1		
	(b)	(i)		$k = A\, e^{-E_a/RT}$ accept $\ln k = \ln A - \frac{Ea}{RT}$	1			1	1	
		(ii)		$e^{-Ea/RT} = 1.19 \times 10^{-4}$ (1) ecf possible from part (i) E_a = 22.5 kJ mol^{-1} (1) activation energy is lower so this catalyst is more effective (1) ecf from activation energy calculated			3	3	2	
	(c)			$\Delta_f H^\ominus = 2 \times \Delta_f H^\ominus(H_2O) - 2 \times \Delta_f H^\ominus(H_2O_2)$ (1) $2\Delta_f H^\ominus(H_2O_2) = (2 \times -286) - (-98) = -474$ $\Delta_f H^\ominus(H_2O_2) = -237$ (1)		1 1		2	1	

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(d)			positive because the reaction forms a gas (and gases have a higher entropy than liquids)		1				
	(e)	(i)	I	**A** $HCl/H^+(aq)$ (1 mol dm^{-3}) **B** platinum/Pt (electrode) **both** required	1			1		1
			II	electrons flowing from standard hydrogen electrode to dichromate half cell		1		1		1
			III	salt bridge completes circuit without allowing solutions to mix	1			1		1
			IV	this makes the reading less positive/smaller (must give reason to gain this mark) (1) increase in concentration of chromium(III) ions will shift equilibrium to the left (1)			1 1	 2		

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
		(ii)	I	$2Cr^{3+} + 3H_2O_2 + H_2O \rightarrow Cr_2O_7^{2-} + 8H^+$		1		1		
			II	reaction is feasible (must give reason to gain this mark) (1) as standard electrode potential for hydrogen peroxide is more positive than that for chromium/dichromate / EMF calculated as +0.44V and positive value means reaction is feasible (1)		1	1	2		
			III	electrochemical methods are better (must give reason for this mark) (1) because the reaction is in solution but standard enthalpies of formation use standard states			2	2		
				Question 11 total	**3**	**7**	**8**	**18**	**4**	**3**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
12.	(a)			carbonate (1) react with acid to release carbon dioxide (1)	1	 1		 2		 2
				Indicative content **A** lead nitrate or lead ethanoate **B** potassium iodide **C** copper(II) oxide **D** magnesium carbonate **E** barium carbonate • mixing **A** and **B** gives yellow precipitate so one must contain lead ions and the other iodide ions • **C** gives blue solution so contains copper(II) ions • **C** is insoluble but doesn't fizz with acid so oxide or hydroxide • **B** gives a white solid and brown solution with **C** – suggesting **B** contains iodide so **A** must contain lead ions • only soluble lead salt is lead nitrate (or lead ethanoate)			6	6		6

				5-6 marks Identifies six ions correctly (in addition to the carbonates); bright yellow precipitate is used to identify the presence of both iodide ions and lead(II) ions; the presence of copper(II) ions is linked to either the pale blue colour or the reaction with iodide. *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** Identifies four ions correctly (in addition to the carbonates); valid reason is given for at least two of copper(II) ions, iodide ions and lead(II) ions *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** Identifies three ions correctly (in addition to the carbonates); valid reason is given for at least one of copper(II) ions, iodide ions and lead(II) ions *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 12 total	**1**	**1**	**6**	**8**	**0**	**8**

UNIT 3: PHYSICAL AND INORGANIC CHEMISTRY

SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	Total	Maths	Prac
Section A	5	5	0	10	1	1
8.	7	7	0	14	4	4
9.	5	8	5	18	7	3
10.	2	6	4	12	6	1
11.	3	7	8	18	4	3
12.	1	1	6	8	0	8
Totals	23	34	23	80	22	20