GCE A LEVEL MARKING SCHEME

SUMMER 2018

A LEVEL
CHEMISTRY - COMPONENT 1
A410U10-1

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.

COMPONENT 1: 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.

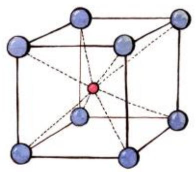
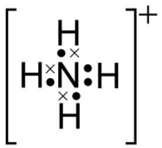
Marking abbreviations

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.	(a)			$1s^2 2s^2 2p^6 3s^2 3p^3$ accept arrows in boxes	1			1		
	(b)			outermost electron in sulfur is paired in same orbital and outer electron in phosphorus is unpaired (can allow second part from arrows in boxes diagram in (a)) (1) electron-electron repulsion makes it easier to remove outer electron for sulfur (1)	2			2		
2.					1			1		
3.				solution where the pH remains constant when <u>small amounts</u> of acid or base are added	1			1		1
4.				 (1) in a covalent bond the shared pair has one electron from each atom but in a coordinate bond both electrons come from the same atom (1)	2			2		

Question				Marking details	Marks available					
					AO1	**AO2**	**AO3**	**Total**	**Maths**	**Prac**
5.				$Ca + 2H_2O \rightarrow Ca(OH)_2 + H_2$	1			1		1
6.				S atom has two bond pairs and two lone pairs (1) so it will form a V-shape / bent / non-linear molecule (1)	 1	1		 2		
7.	(a)			$\mathbf{3}Cl_2 + \mathbf{6}NaOH \rightarrow \mathbf{5}NaCl + \mathbf{1}NaClO_3 + \mathbf{3}H_2O$ accept no number before $NaClO_3$	1			1		
	(b)			chlorine is 0 at the start and at the end is −1 (in NaCl) and +5 (in $NaClO_3$) (1) it is a disproportionation reaction as the <u>same element</u> has been oxidised and reduced / oxidation state of <u>same element</u> has become more positive and more negative (1)	 1	1		 2		
8.				1 mol dm^{-3} $H^+(aq)$ or named acid 1 atm pressure of $H_2(g)$ platinum electrode 298 K award (2) for all four points; (1) for any two points credit possible from labelled diagram	2			2		2
				Section A total	**13**	**2**	**0**	**15**	**0**	**4**

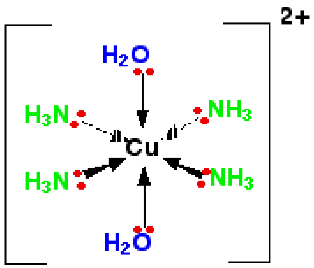
Section B

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
9.	(a)	(i)		645	1			1		
		(ii)		77 + 376 + 121 − 364 − 645 (1) −435 (1)		2		2	1	
		(iii)	I	$\Delta_{sol}H^{\ominus}$[CsCl] = $\Delta_{hyd}H^{\ominus}[Cs^+]$ + $\Delta_{hyd}H^{\ominus}[Cl^-]$ − $\Delta_{lattform}H^{\ominus}$[CsCl] (1) $\Delta_{hyd}H^{\ominus}[Cs^+]$ = 18 − (−364) + (−645) = −263 (1)		2		2	1	
			II	entropy must be considered (1) overall entropy must increase for a reaction to occur (1) entropy increase as ions move from solid to solution outweighs entropy reduction of environment due to endothermic reaction (1) OR entropy must be considered (1) Gibbs free energy combines entropy and enthalpy and must be negative (1) in this case entropy change is very positive as ions move from solid to solution (1)	1	2		3		

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(b)			$\frac{376}{6.02 \times 20^{23}} = 6.25 \times 10^{-22}$ kJ (1) 6.25×10^{-19} J (1) $f = \frac{E}{h}$ = 942 THz (1)		3		3	3	
				Question 9 total	**2**	**9**	**0**	**11**	**5**	**0**

Question				Marking details	AO1	AO2	AO3	Total	Maths	Prac
10.	(a)	(i)		**Indicative content** 1. Increasing pressure shifts equilibrium to side with fewer gas molecules 2. In this case high pressure shifts equilibrium to form more ethanal / more products 3. High pressure increases rate of reaction 4. High pressure should be used as it gives high yield and faster rate 5. High pressures are more expensive to run / risk of explosion / safety limits pressures that can be used 6. High temperatures give a faster reaction 7. Higher temperatures shift exothermic equilibria in the endothermic direction 8. This shifts to the left / away from products / gives lower yield 9. Temperature chosen must be compromise between yield and rate of reaction 10. Catalyst increases rate without changing amount of product 11. Catalyst allows a lower temperature to be used giving a better yield		2	4	6		
				5-6 marks The candidate includes eight relevant points, including suggesting appropriate temperature and pressure (points 4 and 9) and point 11 *The candidate constructs a relevant, coherent and logically structured account including all 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 five relevant points and backs up their choice of either temperature or pressure using the ideas of Le Chatelier *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** Candidate includes four relevant points *The candidate attempts to link at least two relevant points from the indicative material. Coherence is limited by omission and/or inclusion of irrelevant materials. 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.*						

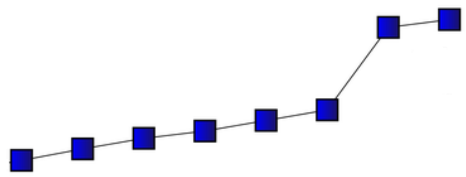
Marks available: AO1, AO2, AO3, Total, Maths, Prac

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
		(ii)		M_r values of 28.04 (or 28) and 44.04 (or 44) (1) 100 % yield would be $\dfrac{2 \times 10^6}{28.04} \times 44.04 = 3.14 \times 10^6$ g (1) 95 % yield = 2.98×10^6 g = 2.98×10^3 kg (1)		3		3	3	
	(b)	(i)		$[Cu(H_2O)_6]^{2+}$	1			1		
		(ii)		d-orbitals are full in Cu^+ (1) so electrons can't move / no d-d transitions (1)	2			2		
		(iii)		solution turns (from pale blue) to royal blue (1)  (1) different ligands cause different splitting (1) so different frequencies of light are absorbed (1)	1 1 1	1		4		2
				Question 10 total	**6**	**6**	**4**	**16**	**3**	**2**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
11.	(a)			could not be lead(II) iodide as this is yellow do **not** award if more than one compound named	1			1		1
	(b)	(i)		sodium carbonate and potassium carbonate are both <u>soluble</u> and none of the remaining tests would distinguish between them			1	1		1
		(ii)		hydrochloric acid would not form a soluble salt with lead(II) carbonate (1) hydrochloric acid would introduce chloride ions which will react with silver nitrate in later tests (1) nitric acid should be used (1)		1	1 1	3		3
		(iii)		potassium gives lilac flame sodium gives yellow / orange flame calcium gives brick red / orange red flame award (2) for all three correct award (1) for any two correct award max (1) if any reference to white or other colour for magnesium ignore any reference to white or greyish-white for lead	2			2		2

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
		(iv)		lead(II) nitrate and magnesium sulfate could not be distinguished (1) add potassium iodide (1) yellow precipitate with Pb^{2+} (1) no change with Mg^{2+} (1) OR add NaOH to excess (1) white precipitate with Mg^{2+} that remains with excess (1) white precipitate with Pb^{2+} that dissolves in excess (1) if any other pair of compounds given – credit possible for test if not already used			4	4		4
				Question 11 total	**3**	**1**	**7**	**11**	**0**	**11**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
12.	(a)			9 protons and 9 neutrons	1			1		
	(b)			positron / β^+ emission must be occurring (1) gamma emission may be occurring (1)		2		2		
	(c)	(i)		$[CH^{18}F_2OH]^+$ / $[CH_2{}^{18}F_2O]^+$		1		1		
		(ii)		relative heights of peaks containing $^{18}F_2$ and $^{19}F_2$ is 1:1 (1) must be 1:1 ratio (1) two half-lives to decay from 4:1 to 1:1 (1) time taken = 220 minutes (1) ecf possible from incorrect number of half-lives			4	4		

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(d)	(i)		 six points prior to jump and then two points (1) gradual increase within each shell (1)		2		2		
		(ii)		two shells so element in second period (1) six ionisations before first jump (six outer electrons) so Group 6 (1) do not accept references to s/p block		2		2		
				Question 12 total	**1**	**7**	**4**	**12**	**0**	**0**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
13.	(a)			moles thiosulfate = 2.809×10^{-3} (1) moles Cu^{2+} in 25 cm^3 = 2.809×10^{-3} moles Cu^{2+} in 250 cm^3 = 2.809×10^{-2} (1) percentage by mass = $\dfrac{(2.809 \times 10^{-2} \times 63.5)}{2.877}$ (1) percentage by mass = 62.0% (1) **must** show method		2	2	4	4	3
	(b)			mass of precipitate in weighing 1 [$Cu(OH)_2$ and $Zn(OH)_2$] = 1.78g mass of precipitate in weighing 2 [$Cu(OH)_2$ only] = 1.11g (1) moles $Cu(OH)_2$ = $\dfrac{1.11}{97.52}$ = 0.01138 moles Zn $(OH)_2$ = $\dfrac{0.67}{99.42}$ = 6.74×10^{-3} (1) percentage by mass = $\dfrac{(0.01138 \times 63.5)}{(0.01138 \times 63.5) + (6.74 \times 10^{-3} \times 65.4)}$ (1) percentage by mass = 62.1% (1) **must** show method		2	2	4	4	2

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(c)			the evidence supports this as the percentages of copper are the same in both methods (within experimental error) − allow reverse argument if values do not match (1) could confirm this by analysis (or any named analytical method) of first solution for percentage by mass of zinc / undertake qualitative analysis to exclude the presence of other metals in alloy / appropriate alternative method (1)			2	2		2
	(d)	(i)		$[H^+] = 10^{-pH} = 10^{1.2}$ (1) $[HNO_3] = 15.8 \text{ mol dm}^{-3}$ (1)		2		2	2	
		(ii)		$[H^+] = \frac{10^{-14}}{2} = 5 \times 10^{-15}$ (1) $pH = -\log(5 \times 10^{-15}) = 14.3$ (1)		2		2	2	
				Question 13 total	**0**	**8**	**6**	**14**	**12**	**7**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
14.	(a)			chlorine is a gas, bromine is a liquid and iodine is a solid (1) forces between molecules are van der Waals (1) van der Waals' forces increase in strength down the group as the number of electrons increases (1)	3			3		
	(b)	(i)		[Ca^{2+}] 6.7 mol dm^{-3} for anhydrous and 5.0 mol dm^{-3} for hydrated (1) student is incorrect (must give valid reason) (1) ecf possible		1	1	2	1	
		(ii)		can dissolve as they can form hydrogen bonds with water molecules (1) these are formed with the —OH groups of the alcohol (1) the —OH forms a larger proportion of the butanol than the octanol / a larger part of the octanol cannot form hydrogen bonds / same amount of hydrogen bonding but more van der Waals forces between molecules of octan-1-ol (1)	1 1	1		3		
	(c)	(i)		temperature of 298K and 1 atm pressure	1			1		
		(ii)	I	20% (1) line goes flat showing all AIBN reacted so only dioxane left to absorb (1)		2		2		2

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
			II	**Indicative content** 1. Absorbance decreases gradually and levels out to a final value 2. Rate of decrease slows as time progresses 3. Rate decreases as the concentration of AIBN decreases / rate is dependent on concentration of AIBN or reactant 4. As concentration decreases there are fewer molecules of AIBN in the same volume of solvent 5. The molecules collide less frequently 6. Final value is when all AIBN has reacted / reaction is at an end 7. First order as it has constant half-life / first order as rate halves when concentration halves / rate is proportional to concentration in a first order reaction 8. Calculation of two half-lives OR calculation of rates at two different concentrations (must allow for 20% absorbance due to solvent)	2	2	2	6	1	3

5-6 marks
The candidate includes six relevant points, including points 7 and 8
The candidate constructs a relevant, coherent and logically structured account 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.

3-4 marks
The candidate includes four relevant points, including point 7
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
Candidate includes three relevant points
The candidate attempts to link at least two relevant points from the indicative material. Coherence is limited by omission and/or inclusion of irrelevant materials. 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				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
		(iii)	I	$k = Ae^{\frac{-E_a}{RT}}$ negative included in numerator (1) *R* included in denominator (1)	2			2		
			II	E_a = 100.6 kJ mol^{-1} (1) accept any value from 100620-100645 J mol^{-1} $\frac{-E_a}{RT}$ = −20.19 (1) ecf possible (value divided by −8.31 × 600) *k* = 11.8 s^{-1} (1) Megan is correct (must have a calculated value to gain mark) (1) ecf possible from value		2	2	4	4	
				Question 14 total	**10**	**8**	**5**	**23**	**6**	**5**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
15.	(a)			ethyne cannot form hydrogen bonds with water molecules	1			1		
	(b)	(i)		units changed to 293 K and 135000 Pa (1) moles in 1 cm^3 = $\frac{(135000 \times 1 \times 10^{-6})}{(8.31 \times 293)}$ = 5.54×10^{-5} (1) mass of 1 cm^3 = $5.54 \times 10^{-5} \times 26.02$ (1) density = 1.44×10^{-3} g cm^{-3} (1)		4		4	4	
		(ii)		density at 20°C = $1.27 \times 10^{-3} \times \frac{273}{298}$ = 1.18×10^{-3} g cm^{-3} (1) the student is incorrect as ethyne is heavier than air at the same temperature (1) ecf possible			2	2		
	(c)	(i)		enthalpy change of combustion should be for 1 mol of hydrocarbon not 2 mol (1) water should be in its standard state (of liquid not gas) (1)		2		2		

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
		(ii)		award (2) for Hess's cycle or correctly structured calculation e.g. $\Delta H = 4[\Delta_f H(CO_2)] + 2[\Delta_f H(H_2O)] + 2[\Delta_{vap} H(H_2O)] - 2[\Delta_f H(C_2H_2)]$ award (1) if either vaporisation not included, value for one C_2H_2 calculated or one change has an incorrect number $\Delta H = -2432$ kJ mol^{-1} (1) this is the better method as bond energies use average values rather than values for these specific compounds (1) if bond energies method selected award (2) max reactants = 5802 kJ mol^{-1} and products = 7796 kJ mol^{-1} (1) $\Delta H = -1994$ kJ mol^{-1} (1) if both methods used correctly award (3) max if no statement of which is the better method		4		4	2	

Question				Marking details	Marks available					
					AO1	**AO2**	**AO3**	**Total**	**Maths**	**Prac**
		(iii)	I	percentage error = 0.53%		1		1		1
			II	if too small a volume of water is used then evaporation affects volume or boiling uses energy to convert liquid to vapour (1) if too great a volume of water is used the percentage error in temperature measurement increases (1)			2	2		2
			III	reduce heat loss to environment e.g. shielding from air currents (1) ensure temperature measurements are correct e.g. measure until constant temperature at the start or measure every 30 s after heating to ensure temperature reaches equilibrium (1)			2	2		2
				Question 15 total	**1**	**11**	**6**	**18**	**6**	**5**

COMPONENT 1: PHYSICAL AND INORGANIC CHEMISTRY

SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	Total	Maths	Prac
Section A	13	2	0	15	0	4
9	2	9	0	11	5	0
10	6	6	4	16	3	2
11	3	1	7	11	0	11
12	1	7	4	12	0	0
13	0	8	6	14	12	7
14	10	8	5	23	6	5
15	1	11	6	18	6	5
Totals	36	52	32	120	32	34