GCE A LEVEL MARKING SCHEME

SUMMER 2019

A LEVEL
CHEMISTRY - COMPONENT 1
A410U10-1

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.

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.

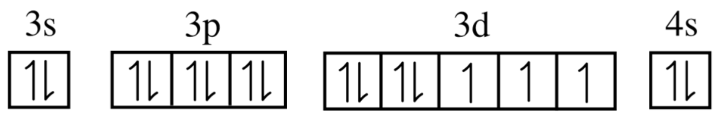
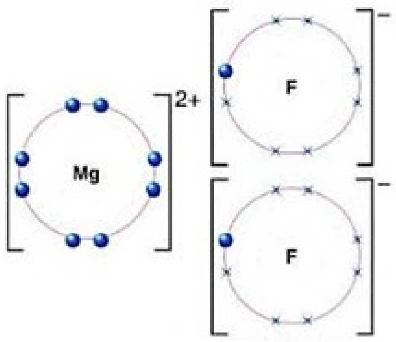
Marking abbreviations

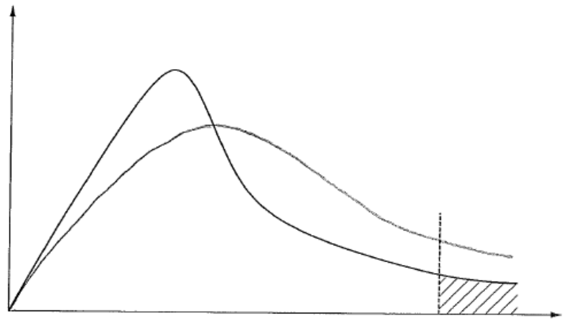
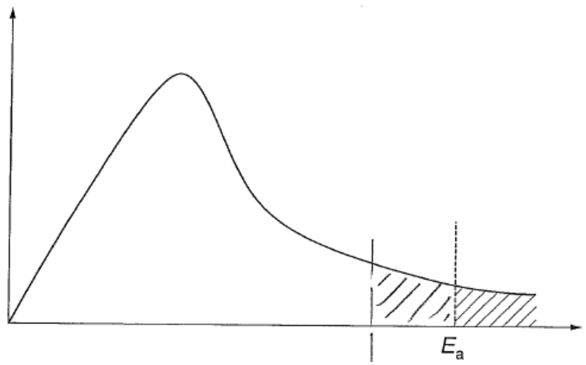
The following may be used in marking schemes or in the marking of scripts to indicate reasons for the marks awarded.

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					1			1		
2				$\frac{1}{12}$th the mass of an atom of carbon-12	1			1		
3				 ignore atoms if shown award (1) for Mg^{2+} ion with eight (or zero) dots or crosses award (1) for **two** $F^–$ ions with seven dots and one cross award (1) if one Mg^{2+} and two $F^–$ shown but with incorrect dots and crosses		2		2		

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
4	(a)			 peak must be to the right of original and lower with more molecules at energy above activation energy	1			1		
	(b)			 lower activation energy, clear indication of more molecules with energy above activation energy	1			1		

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
5				to melt iodine - need to break weak van der Waals forces between molecules (so low melting temperature) (1) to melt diamond - need to break covalent bonds between atoms (so very high melting temperature) (1)	1 1			2		
6				copper ions only coloured when ligands / water bind to them (1) heating removes (water) ligands and adding water replaces them (1)	1	1		2		
7				$\frac{(22.10 \times 10) + (77.90 \times 11)}{100}$ (1) 10.78 (1) **must** be to 4 sig figs		1 1		2	1	
8	*(a)*			27.20 cm^3 do **not** accept 27.2 cm^3	1			1	1	1
	(b)			$n(MnO_4^-) = \frac{27.20 \times 0.0200}{1000} = 5.44 \times 10^{-4}$ (1) $n(Fe^{2+}) = 5.44 \times 10^{-4} \times 5 = 2.72 \times 10^{-3}$ mol (1) ECF possible from *(a)*		1 1		1	1	
				Section A total	**8**	**7**	**0**	**15**	**3**	**1**

Section B

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
9	*(a)*	(i)		pH = –log [H^+]	1			1		
		(ii)		$K_a = \frac{[CH_3COO^-][H^+]}{[CH_3COOH]}$		1		1		
		(iii)		**Indicative content** 1. Strong acids are fully dissociated whilst weak acids are partially dissociated / weak acids dissociate in a reversible reaction but dissociation of strong acids are not reversible / both equations showing correct arrows 2. Doubling concentration of strong acid doubles concentration of H^+ because all H^+ ions are released 3. Doubling concentration of weak acid does not double concentration of H^+ 4. Doubling concentration of weak acid increases concentration by less than 2 / by approximately $\sqrt[2]{2}$ 5. pH will decrease when more H^+ are present not increase 6. When the concentration of a strong acid is doubled the pH decreases by 0.30 (shown by calculation for any two values) 7. pH for weak acid will decrease less than 0.30 when concentration is doubled 8. Student is correct in part for strong acids but incorrect for weak acids	2	2	2	6		

Question				Marking details
				5-6 marks The candidate includes at least six relevant points, including at least two referring to weak acids *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 at least four relevant points, including the difference between strong and weak acids (point 1) *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 at least 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
	(b)	(i)		award (1) for each of following • titrate sulfuric acid solution using sodium hydroxide and indicator • record volume needed to reach the first end point/indicator to change colour • add **same** volume of sodium hydroxide to sulfuric acid not containing indicator • evaporate solution to obtain solid alternative method award (1) for each of following • titrate sulfuric acid solution using sodium hydroxide and indicator • record volume needed to reach the final end point/indicator to change colour • add **half** volume of sodium hydroxide to sulfuric acid not containing indicator • evaporate solution to obtain solid	4			4		4
		(ii)		$M_r(NaHSO_4)$ = 120.11 **and** $M_r(H_2O)$ = 18.02 (1) $\frac{62.5}{120.11}$ = 0.520 and $\frac{37.5}{18.02}$ = 2.08 (1) x = 4 (1)		3		3	2	
		(iii)		halide is iodide (1) *must attempt to give a relevant reason* iodide is a stronger reducing agent than chloride or bromide so it can reduce the sulfuric acid to form H_2S (1) accept reverse argument	1		1	2		2

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(c)	(i)		electrons excited to higher energy levels (by absorbing energy equivalent to difference between energy levels) (1) drop to lower energy levels emitting light (corresponding only to the differences between the electron energy levels) (1)	2			2		
		(ii)		energy per atom = $\frac{1316 \times 1000}{6.02 \times 10^{23}}$ = 2.186 × 10^{-18} J (1) frequency = $\frac{2.186 \times 10^{-18}}{6.63 \times 10^{-34}}$ = 3.297 × 10^{15} Hz (1) wavelength = $\frac{3.00 \times 10^{8}}{3.297 \times 10^{15}}$ = 91.0 nm (1) ECF possible throughout		3		3	3	
				Question 9 total	**10**	**9**	**3**	**22**	**5**	**6**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
10	*(a)*			nitric acid (1) award (1) for any of following • must have anion that will not cause precipitate in steps 2 and 3 • all nitrates are soluble • cannot use hydrochloric acid as this reacts with $AgNO_3$ and cannot use sulfuric acid as this reacts with $BaCl_2$ • chloride and sulfate would interfere with later steps			2	2		2
	(b)			ion present is chloride (1) moles AgCl = $\frac{0.0672}{143.5}$ = 4.68 × 10^{-4} mol (1) moles chloride in original solution = 4.68 × 10^{-3} mol (1) ECF possible from incorrect halide	1	2		3	2	3
	(c)			the student is correct (1) *must suggest reason to gain this mark* there cannot be another anion as two of the three ions present identified / both anions identified (and the remaining ion must be a cation) (1)			2	2		2
	(d)	(i)		Cu^{2+} / $[Cu(H_2O)_6]^{2+}$	1			1		1
		(ii)		award (1) for either of following • need sample to be homogeneous • the sample is impure			1	1		1

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(e)	(i)		$[H^+] = 10^{-1.36} = 0.04365$ (1) moles acid in solution = $0.04365 \times \frac{25}{1000} = 1.091 \times 10^{-3}$ mol (1)		2		2	1	2
		(ii)		moles acid remaining in 250 cm^3 = 1.091×10^{-2} mol (1) original moles acid = 2.50×10^{-2} mol (1) moles hydroxide present = 1.41×10^{-2} mol (1)		1	2	3	2	3
	(f)			award (1) for **any** formula that contains ions following from answers given and has charges balanced e.g. $Cu(OH)Cl$, $Cu_4(OH)_3Cl$ if Cu^+ given as cation 3:1 ratio of hydroxide to chloride ions (1) $Cu_2(OH)_3Cl$ (1)		3		3	1	
				Question 10 total	**2**	**8**	**7**	**17**	**6**	**14**

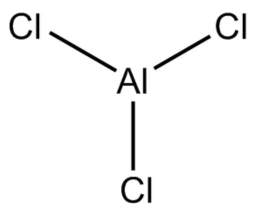
Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
11	*(a)*			outer electron is in a *p*-orbital	1			1		
	(b)	(i)		more electrons in atoms/molecules of selenium (than sulfur) (1) more van der Waals forces between molecules of selenium (than sulfur) (1)		2		2		
		(ii)		**Indicative content** 1. Electronegativity value between 2.19 and 2.57 2. Electronegativity increases across a period 3. Electronegativity decreases down a group 4. Electronegativity increases as (effective) nuclear charge increases / distance of outer shell from nucleus decreases 5. First ionisation energy value between 700 and 947 kJ mol^{-1} 6. First ionisation energy decreases down group 7. First ionisation energy dips slightly from Group 5 to Group 6 (even though general trend is an increase across period) 8. Outer electrons in arsenic are unpaired, however outer electron in selenium is paired in an orbital (can be shown by diagrams for both) 9. Electron-electron repulsion in selenium overcomes slight increase in nuclear charge 10. Standard electrode potential value between +0.17 V and +1.17 V 11. Stability of +4 oxidation state increases down the group so +6 is easier to reduce 12. Due to the inert pair effect 13. So standard electrode potential for +6 to +4 becomes more positive down group as electrons more easily gained		3	3	6		

Question					Marking details
					5-6 marks The candidate correctly predicts three values, using theory to support explanations for at least two of these *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 correctly predicts at least two values, using theory to support explanations for one of these *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 correctly predicts two values, using trends to explain at least one *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
	(c)	(i)		three half-lives (1) 360 days (1) ECF possible from incorrect number of half-lives		2		2		
		(ii)		award (1) each for any **two** of following • alpha particles are very ionising / high energy • cause mutations / damage DNA / damage biological molecules / cause cancer • alpha particles could not be detected outside body	2			2		
	(d)			moles propene = $\frac{2.70}{42.06}$ = 0.064 mol (1) mass = 0.0642 × 0.62 × 58.06 = 2.31g (1)		2		2	2	
				Question 11 total	**3**	**9**	**3**	**15**	**2**	**0**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
12	*(a)*			treatment of water supplies / disinfection of swimming pools do not accept 'in swimming pools'	1			1		
	(b)			$3Cl_2 + 6NaOH \rightarrow NaClO_3 + 5NaCl + 3H_2O$	1			1		
	(c)			moles chlorine gas = $\frac{2}{24.5}$ = 0.0816 mol (1) moles bromine = 0.0588 mol (1) percentage chlorine unreacted = 100 – $\left(\frac{0.0588 \times 100}{0.0816}\right)$ = 28 % **must** be given to 2 sig figs (1)		3		3	3	

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(d)	(i)		ionised by bombarding with high energy electrons / electrons fired from electron gun (1) deflected by magnetic field / electromagnet according to mass and charge (1)	2			2		
		(ii)	I	three chlorine atoms (1) award (1) for any of following • isotopes have masses 2 apart so difference between heaviest and lightest of 6 units means three chlorine atoms • three chlorine atoms give 4 possible isotope combinations and 4 peaks • three chlorine atoms give 4 possible isotope combinations as shown in the spectrum			2	2		
			II	ratio of two isotopes is three ^{35}Cl to one ^{37}Cl (1) ratio when three chlorines are present is therefore 3 × 3 × 3 : 1 × 1 × 1 which is 27 : 1 (1)	1		1	2	1	

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(e)	(i)		 bond angle 120°	1			1		
		(ii)		aluminium is electron deficient and chlorine atoms have lone pairs (1) can form coordinate bonds (to remove electron deficiency) (1)	2			2		
		(iii)		ClF_3 has two lone pairs, BF_3 has none (1) because ClF_3 has five pairs of (outer) electrons and BF_3 has three pairs (1) accept 'lone pairs repel more than bonded pairs' or ClF_3 will be based on trigonal bipyramid (not trigonal planar) (1)		1	1	2		
				Question 12 total	**8**	**4**	**4**	**16**	**4**	**0**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
13	*(a)*	(i)		higher pressures favour more product as there are fewer gas molecules in the products (1) higher pressures give greater rate of formation (1) pressures higher than this require more expensive equipment / greater risk / more energy needed to raise pressure further (1)	 1	1	 1	 3		
		(ii)		award (1) for any of following • not under standard conditions • one named condition not standard • does not produce one mole of ammonia	1			1		
		(iii)		$K_c = \frac{[NH_3]^2}{[N_2][H_2]^3}$		1		1		
		(iv)		increasing temperature will change in endothermic direction, decreasing products (1) this decreases value of K_c (1) **must** give reason to gain mark		1	 1	 2		
		(v)		at equilibrium 80% of N_2 ⇨ $[N_2]$ = 0.016 mol dm^{-3} (1) $[H_2]$ = 0.008 mol dm^{-3} and $[NH_3]$ = 0.008 mol dm^{-3} (1) K_c = 7813 (mol^{-2} dm^6) (1) ECF possible from part (iii)		1 1	 1	 3	 3	

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(b)	(i)		award (1) for either of following • ammonia is stable with respect to the elements whilst hydrazine is unstable • ammonia is more stable than the elements while hydrazine is less stable than the elements	1			1		
		(ii)	I	$\Delta_f H^\theta(H_2O_2) = (51) + (2 \times -286) - (2 \times -46) - (-241)$ (1) -188 kJ mol^{-1} (1)		2		2	2	
			II	$T = \Delta H^\theta / \Delta S^\theta$ (1) $\Delta S^\theta = -226$ J K^{-1} mol^{-1} (1) T = 1066 K (1)		3		3	2	
			III	student is **not** correct (1) MUST give reason ΔG^θ must be negative for reaction to occur and this is the temperature at which ΔG^θ becomes positive (1)			2	2		
		(iii)		award (1) for any sensible answer e.g. • more waste materials • lower atom economy		1		1		

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
		(iv)	I	addition of hydroxide will favour reaction the reverse reaction to remove OH^- (1) will make it a stronger reducing agent (1)			2	2		
			II	all four can be reduced (1) electrochemical potential for hydrazine acting as a reducing agent is more negative than electrochemical potentials for all the metals (or vice versa) (1)		1	1	2		
				Question 13 total	**3**	**12**	**8**	**23**	**7**	**0**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
14	*(a)*	(i)		appropriate tangent drawn on graph (1) rate = 1.60×10^{-7} (1) accept any value in the range 1.50×10^{-7} to 1.70×10^{-7} accept positive or negative value mol dm^{-3} s^{-1} (1)		3		3	3	3
		(ii)		calculate rate at 0.0010 mol dm^{-3} (or two other concentrations) (1) show that this is half the initial rate (0.80×10^{-7} mol dm^{-3}) (1) accept alternative method constant half-life of (8500-9000 seconds) (1) two half-lives indicated clearly (1)		2		2	2	2
	(b)			to ensure that changes in concentration of other reactants are negligible / other reactants do not affect the rate			1	1		
	(c)	(i)		award (1) for either of following • in the reaction one molecule of water is produced at the end of the reaction • no change in number of water molecules in the equation			1	1		
		(ii)		repeat experiment with different concentration of water but all other concentrations the same			1	1		1

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(d)	(i)		$mol^{-1}\,dm^{3}\,s^{-1}$	1			1	1	
		(ii)		change units (activation energy of 89500 J mol^{-1}) (1) rearrange equation to T = $\frac{-Ea}{\left[Rln\left(\frac{k}{A}\right)\right]}$ (1) accept alternative appropriate expression for T T = 292 K (1)	1		2	3	3	
				Question 14 total	**2**	**5**	**5**	**12**	**9**	**6**

COMPONENT 1: PHYSICAL AND INORGANIC CHEMISTRY

SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	Total	Maths	Prac
Section A	8	7	0	15	3	1
9	10	9	3	22	5	6
10	2	8	7	17	6	14
11	3	9	3	15	2	0
12	8	4	4	16	4	0
13	3	12	8	23	7	0
14	2	5	5	12	9	6
Totals	36	54	30	120	36	27