GCE A LEVEL MARKING SCHEME

AUTUMN 2021

A LEVEL
CHEMISTRY - COMPONENT 3
A410U30-1

INTRODUCTION

This marking scheme was used by WJEC for the 2021 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 3: CHEMISTRY IN PRACTICE

AUTUMN 2021 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.

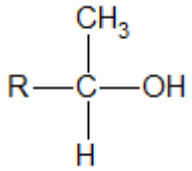
cao = correct answer only
ecf = error carried forward
bod = benefit of doubt

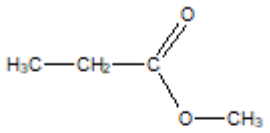
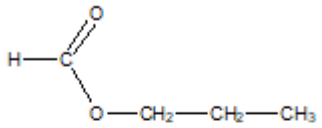
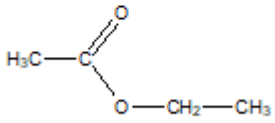
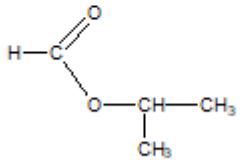
Credit should be awarded for correct and relevant alternative responses which are not recorded in the mark scheme.

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
1	*(a)*	(i)		$C_3H_8O(l) + 4½O_2(g) \rightarrow 3CO_2(g) + 4H_2O(l)$ balanced equation (1) state symbols (1)	2			2		
		(ii)		spirit burner containing propan-1-ol and metal can containing water accept beaker in place of metal can (1) known volume / mass of water added to metal can (1) award (1) for **both** measurements • initial and final temperature of the water (allow temperature change of the water) • mass of the burner before and after heating (allow change in mass of the burner) use of $\Delta H = -\frac{m \times c \times \Delta T}{n}$ (1)	2	2		4		4
	(b)	(i)		suitable scale selected on x-axis and y-axis (1) all points plotted correctly (tolerance ±½ square) and line of best fit drawn (1)		2		2	2	
		(ii)		as the number of moles of ethanol (in the mixture) increases the heat evolved (in kJ) decreases linear relationship – neutral answer			1	1	1	

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
		(iii)		–2005 accept 2005		1		1		
		(iv)		n(CH_3CH_2OH) from graph = 0.0072 (1) mass of CH_3CH_2OH = 0.0072 × 46.06 = 0.332 (1)		1	1	2	1	
		(v)		line starting from same point on right-hand side as plotted line (1) gradient greater than plotted line (1)			2	2	2	
				Question 1 total	**4**	**6**	**4**	**14**	**6**	**4**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
2	*(a)*			award (1) for either of following • reacts with phenol to produce the (nucleophilic) phenoxide ion • removes the proton from phenol		1		1		1
	(b)	(i)		benzoic anhydride (accept benzoic acid)		1		1		1
		(ii)		award (1) for either of following benzoyl chloride more reactive not an equilibrium process			1	1		1
	(c)			dissolve solid in minimum volume of hot ethanol (1) award (1) each for any **two** of following • heat ethanol using a hot plate / hot water bath / electric heating mantle • filter off any insoluble impurities whilst hot • allow to cool (to crystallise solid) • filter and dry		3		3		3

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(d)			$n(C_6H_5OH) = \frac{1.5}{94.06} = 0.016$ (1) mass of $C_7H_5OCl = 3.0 \times 1.2 = 3.6$ g $n(C_7H_5OCl) = \frac{3.6}{140.55} = 0.026$ ⇨ in excess (1) theoretical mass of $(C_{13}H_{10}O_2) = 0.016 \times 198.1 = 3.2$ g (1) percentage yield $= \frac{2.9}{3.2} \times 100 = 91$ (1)		3	1	4	2	
	(e)			award (1) each for any **two** of following NMR HPLC GC mass spectra melting temperature		2		2		2
	(f)	(i)		CHI_3 (1)  (1)		2		2		2
		(ii)		acidified potassium dichromate solution (1) colour change from orange to green (1)	2			2		2

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
		(iii)		aldehyde		1		1		1
		(iv)		award (2) for **all** four ester structures award (1) for any **two** ester structures     **A** **B** award (1) for each of **A** and **B** correctly identified			4	4		2
				Question 2 total	**2**	**13**	**6**	**21**	**2**	**15**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
3				**Indicative content** 1. **$Fe(NO_3)_2$** identified from **pale green** solution 2. $Fe(NO_3)_2$ added to other five solutions 3. **Pale green precipitate** formed identifies **NaOH** 4. NaOH added to remaining four solutions • **two solutions** give **white precipitate** which are **soluble in** excess NaOH indicating **$Pb(NO_3)_2$** and **$Al_2(SO_4)_3$** • **two solutions** give **no observable reaction** indicating **$Ba(NO_3)_2$** and **KI** 5. Take one of the solutions which gave a white precipitate with NaOH and add in turn to both solutions that gave no observable reaction with NaOH • If white precipitate formed then **$Al_2(SO_4)_3$** and **$Ba(NO_3)_2$** both identified • If (bright) yellow precipitate formed then **$Pb(NO_3)_2$** and **KI** both identified	2		4	6		4
				5-6 marks Method outlined leads to the identification of all six solutions *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** Method outlined leads to the identification of $Fe(NO_3)_2$ and NaOH and solutions containing amphoteric and non-amphoteric metals *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.*						

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
				1-2 marks Method leads to the identification of $Fe(NO_3)_2$ and NaOH *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 3 total	**2**	**0**	**4**	**6**	**0**	**4**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
4	*(a)*	(i)		award (3) for **all** five points award (2) for point 4 and any **three** others award (1) for any three points 1. Record the mass of an empty crucible + lid 2. Add known mass of $CaSO_4.2H_2O$ and replace the crucible lid 3. Heat the crucible (with lid) containing the solid above a Bunsen burner flame / carefully lift lid but do not remove completely 4. Heat to constant mass 5. Weigh crucible + lid + solid (after cooling)		3		3		3
		(ii)		n($CaSO_4.2H_2O$) used = $\frac{5.20}{172.24}$ = 0.0302 (1) mass of anhydrous $CaSO_4$ formed must be measured mass = 136.2 × 0.0302 = 4.11 g (1) accept mass of water lost as an alternative mass = 0.0302 × 2 × 18.02 = 1.09 g		2		2	2	
	(b)			n($CaSO_4.2H_2O$) = $\frac{2.49}{172.24}$ = 0.0145 mol (1) $M_r(\mathbf{M}_2SO_4) = \frac{1.59}{0.0145}$ = 109.90 (1) $M_r(\mathbf{M}) = \frac{(109.90 - 96.1)}{2}$ = 6.91 ⇨ **M** is lithium (1)		2	1	3	2	
				Question 4 total	**0**	**7**	**1**	**8**	**4**	**3**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
5	*(a)*			$2I^- - 2e^- \rightarrow I_2$		1		1		
	(b)			$PbO_2 + 4H^+ + 2e^- \rightarrow Pb^{2+} + 2H_2O$			1	1		
	(c)			starch indicator blue/black to colourless	1			1		1
	(d)	(i)		$n(S_2O_3^{2-}) = 0.0510 \times \frac{21.95}{1000} = 0.00112$ $n(I_2)$ in 25.0 cm^3 = 0.000560 $n(I_2)$ formed in step 1 = 8 × 0.000560 = 0.00448	1			1	1	
		(ii)		$n(PbO_2)$ = 0.00448 in 200 cm^3 of solution (1) mass of PbO_2 = 0.00448 × 239 = 1.071 g percentage $PbO_2 = \frac{1.071}{1.18} \times 100 = 90.7$ (1)	1		1	2	2	
	(e)			$\frac{2 \times 0.005}{1.18} \times 100 = 0.85$		1		1	1	
	(f)	(i)		$2PbO_2(s) \rightarrow 2PbO(s) + O_2(g)$ ignore state symbols		1		1		

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
		(ii)		award (1) for conversion / correct units for p, V and T $n(O_2) = \frac{pV}{RT} = \frac{1.01 \times 10^5 \times 1.23 \times 10^{-4}}{8.31 \times 873} = 0.00171$ (1) $n(PbO_2) = 0.00342$ mass of $PbO_2 = 0.00342 \times 239 = 0.819$ (1)		3		3	3	
				Question 5 total	**3**	**6**	**2**	**11**	**7**	**1**

COMPONENT 3: CHEMISTRY IN PRACTICE

SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	Total	Maths	Prac
1	4	6	4	14	6	4
2	2	13	6	21	2	15
3	2	0	4	6	0	4
4	0	7	1	8	4	3
5	3	6	2	11	7	1
Totals	11	32	17	60	19	27