



GCE AS MARKING SCHEME

SUMMER 2022

**AS
CHEMISTRY – UNIT 2
2410U20-1**

INTRODUCTION

This marking scheme was used by WJEC for the 2022 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.

GCE CHEMISTRY – ASSESSMENT MATERIALS

SUMMER 2022 MARK SCHEME

GENERAL INSTRUCTIONS

Recording of marks

Examiners must mark in red ink.

One tick must equate to one mark (apart from the 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.

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.

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

Extended response questions

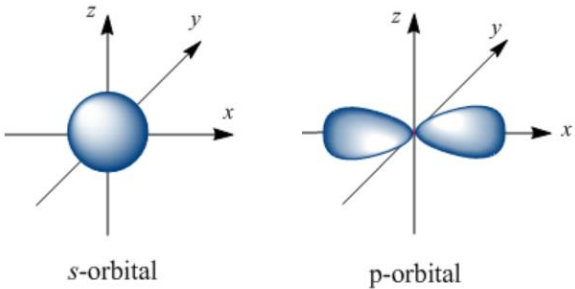
A level of response mark scheme is used. Before applying the mark scheme please read through the whole answer from start to finish. Firstly, decide which level descriptor matches best with the candidate's response: remember that you should be considering the overall quality of the response. Then decide which mark to award within the level. Award the higher mark in the level if there is a good match with both the content statements and the communication statements.

Marking abbreviations

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

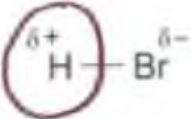
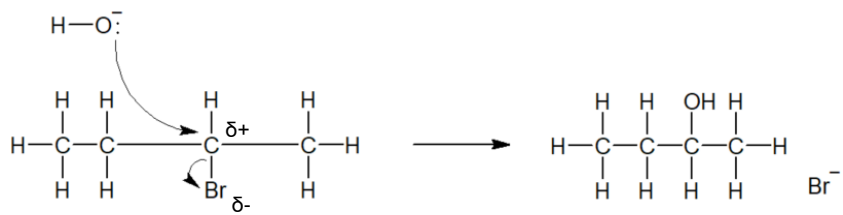
cao	=	correct answer only
ecf	=	error carried forward
bod	=	benefit of doubt

Section A

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
1.	(a)	(i)		orange to colourless	1			1		1
		(ii)		$\begin{array}{c} \text{H}_3\text{C}-\text{CH}-\text{CH}_2 \\ \quad \\ \text{Br} \quad \text{Br} \end{array}$ accept any correct structure for 1,2-dibromopropane accept bromo-hydroxy compound		1		1		
	(b)			(alkaline) potassium manganate(VII) (1) accept potassium permanganate	1			1		1
2.	(a)				1			1		
	(b)			π -bond	1			1		

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
3.				add sodium carbonate / sodium hydrogencarbonate solution (1) fizzing/effervescence is observed (1) OR add magnesium / calcium (1) fizzing/effervescence is observed (1) OR add universal indicator (1) change colour (from green) to red (1)	2			2		2
4.				$\left[\begin{array}{cc} \text{W} & \text{X} \\ & \\ -\text{C} & -\text{C}- \\ & \\ \text{Y} & \text{Z} \end{array} \right]_n$		1		1		
5.				enthalpy change that happens when 1 mol of a substance/compound is formed (1) from it's constituent elements in their standard states under standard conditions (1)	2			2		
				Section A Total	8	2	0	10	0	4

Section B

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
6.	(a)	(i)		 do not accept HBr fully circled	1			1		
		(ii)		heterolytic	1			1		
	(b)	(i)		 award (1) for curly arrows award (1) for partial charges		2		2		
		(ii)		aqueous sodium hydroxide (1) reflux / heating / boiling (1) must have 'hydroxide' as reagent to award this mark	2			2		2
		(iii)		secondary	1			1		
	(c)	(i)		oxidising (agent)	1			1		

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
		(ii)		butan-2-ol has hydrogen bonding but butanone does not (1) therefore butanone has a lower <u>boiling</u> temperature (than butan-2-ol) (1) neutral answer – different boiling temperatures		2		2		
	(d)	(i)		product is lost at the end of each step (so two steps will mean a greater loss) accept references to percentage yield for both steps neutral answer – any reference to atom economy			1	1		
		(ii)	I	dehydration accept elimination do not accept condensation	1			1		
			II	$\begin{array}{c} \text{H} & & \text{CH}_2\text{CH}_3 \\ & \diagdown & / \\ & \text{C}=\text{C} \\ & / & \diagdown \\ \text{H} & & \text{H} \end{array}$ but-1-ene $\begin{array}{c} \text{CH}_3 & & \text{CH}_3 \\ & \diagdown & / \\ & \text{C}=\text{C} \\ & / & \diagdown \\ \text{H} & & \text{H} \end{array}$ (Z)-but-2-ene $\begin{array}{c} \text{CH}_3 & & \text{H} \\ & \diagdown & / \\ & \text{C}=\text{C} \\ & / & \diagdown \\ \text{H} & & \text{CH}_3 \end{array}$ (E)-but-2-ene award (3) for all structures and names correct award (2) for any four correct structures/names award (1) for any two correct structures/names do not accept correct name for an incorrect structure except in the case of methylpropene award maximum (2) if no mention of E/Z		3		3		
				Question 6 total	7	7	1	15	0	2

Question				Marking details	Marks available																													
					AO1	AO2	AO3	Total	Maths	Prac																								
7.	(a)	(i)		compounds with the same molecular formula but a different structure / structural formula	1			1																										
		(ii)		<table><tr><th>Name</th><th>Shortened structural formula</th><th>Skeletal formula</th><th>Boiling temperature / °C</th></tr><tr><td>hexane</td><td>CH₃CH₂CH₂CH₂CH₂CH₃</td><td></td><td>69</td></tr><tr><td>2-methylpentane</td><td>CH₃CH(CH₃)CH₂CH₂CH₃</td><td></td><td>62</td></tr><tr><td>3-methylpentane</td><td>CH₃CH₂CH(CH₃)CH₂CH₃</td><td></td><td>63</td></tr><tr><td>2,3-dimethylbutane</td><td>(CH₃)₂CHCH(CH₃)₂</td><td></td><td>58</td></tr><tr><td>2,2-dimethylbutane</td><td>CH₃C(CH₃)₂CH₂CH₃</td><td></td><td>50</td></tr></table> award (1) for each correct answer accept (CH₃)₂CHCH₂CH₂CH₃ for 2-methylpentane	Name	Shortened structural formula	Skeletal formula	Boiling temperature / °C	hexane	CH ₃ CH ₂ CH ₂ CH ₂ CH ₂ CH ₃		69	2-methylpentane	CH ₃ CH(CH ₃)CH ₂ CH ₂ CH ₃		62	3-methylpentane	CH ₃ CH ₂ CH(CH ₃)CH ₂ CH ₃		63	2,3-dimethylbutane	(CH ₃) ₂ CHCH(CH ₃) ₂		58	2,2-dimethylbutane	CH ₃ C(CH ₃) ₂ CH ₂ CH ₃		50		3		3		
Name	Shortened structural formula	Skeletal formula	Boiling temperature / °C																															
hexane	CH ₃ CH ₂ CH ₂ CH ₂ CH ₂ CH ₃		69																															
2-methylpentane	CH ₃ CH(CH ₃)CH ₂ CH ₂ CH ₃		62																															
3-methylpentane	CH ₃ CH ₂ CH(CH ₃)CH ₂ CH ₃		63																															
2,3-dimethylbutane	(CH ₃) ₂ CHCH(CH ₃) ₂		58																															
2,2-dimethylbutane	CH ₃ C(CH ₃) ₂ CH ₂ CH ₃		50																															

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
		(iii)		as the main carbon chain length increases, the boiling temperature increases (or converse) (1) award (1) for either of following lengthening the chain increases the Van der Waals forces between molecules more heat energy is required to overcome the increased forces (or converse)		1	1	2		
	(b)	(i)		$\text{C}_6\text{H}_{14} + 9\frac{1}{2}\text{O}_2 \rightarrow 6\text{CO}_2 + 7\text{H}_2\text{O}$ accept $2\text{C}_6\text{H}_{14} + 19\text{O}_2 \rightarrow 12\text{CO}_2 + 14\text{H}_2\text{O}$ formulae (1) balancing (1) – only awarded if all formulae are correct		2		2		
		(ii)		the number and types of bond are the same (1) the energy absorbed by breaking bonds and the energy released by forming bonds will be similar (1)		2		2		
		(iii)		it has the lowest boiling point / is the most volatile / vaporises most quickly accept explanation of lower boiling point		1		1		
		(iv)	I	energy absorbed = $(5 \times 348) + (14 \times 413) + (6.5 \times 495) = 10739.5$ (1) energy released = $(6 \times 1072) + (14 \times 464) = 12928$ (1) enthalpy change = $10739.5 - 12928 = -2188.5$ (1)		3		3	2	

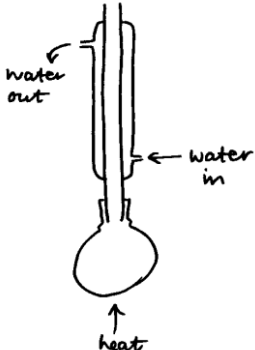
Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
			II	award (2) for quantitative comparison e.g. about twice as much energy is released (with excess oxygen) / additional 1971.5 kJ mol ⁻¹ released (with excess oxygen) award (1) for simple statement e.g. the fuel releases more energy (with excess oxygen) ecf possible from part I			2	2		
			III	award (1) for any reference to CO/carbon monoxide	1			1		
				Question 7 total	2	12	3	17	2	0

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
8.				award (1) each for up to 9 of following white precipitate indicates the unknown halogen is chlorine (1) $n(\text{C}) = 3.25$ $n(\text{H}) = 3.22$ $n(\text{Cl}) = 1.63$ (1) for all three ratio of C:H:Cl is 2:2:1 therefore empirical formula is $\text{C}_2\text{H}_2\text{Cl}$ (1) molecular ion peak at 122 therefore molecular formula is $\text{C}_4\text{H}_4\text{Cl}_2$ (1) $n(\text{Br}_2) = 2 \text{ mol}$ (1) $n(\text{A}) = 1 \text{ mol}$ (1) bromine reacts with A suggests a C=C double bond (1) 1 mol of A reacts with 2 mol of $\text{Br}_2 \Rightarrow$ two double bonds (1) 1 peak in ^1H NMR spectrum $\Rightarrow$ one hydrogen environment (1) 2 peaks in ^{13}C NMR spectrum $\Rightarrow$ two carbon environments (1) IR peak at approx. 650 cm^{-1} is C—Cl IR peak at approx. 1650 cm^{-1} is C=C (1) for either mass spec peak at 87 is $\text{C}_4\text{H}_4\text{Cl}^+$ mass spec peak at 52 is C_4H_4^+ peaks in ratio of 9:6:1 around 122 indicates two Cl atoms (1) for any of three award (1) for identification of correct compound 2,3-dichlorobuta-1,3-diene (accept correct structure)	3	3	4	10	3	2
				Question 8 total	3	3	4	10	3	2

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
9.	(a)			colorimetry	1			1		1
	(b)	(i)		Cu^{2+} (1) absorbance reaches 0.1 in the shortest time / curve has the steepest gradient (1) neutral answer – has the highest rate			2	2		
		(ii)		change in absorbance in first ten seconds = 0.39 (1) 0.039 s^{-1} (1) accept 0.038-0.040			2	2	1	
		(iii)		$1 \times 10^{-4} \text{ mol}$		1		1		
	(c)			Indicative content <u>Temperature</u> Boltzmann distribution has a curve to indicate a higher temperature (curve drawn with peak lower and to the right) increasing temperature increases the (kinetic) energy of the particles more particles have energy greater than or equal to the activation energy more successful collisions per second / increased chance of successful collisions <u>Catalyst</u> Boltzmann distribution showing lower activation energy for reaction with catalyst [line for $E_a(\text{cat})$ drawn to the left of uncatalysed E_a] catalyst provides alternative reaction pathway / provides a surface for particles to adsorb to this lowers the activation energy more particles have energy greater than or equal to the activation energy	6			6		

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
				5-6 marks Detailed description of both factors <i>There is a sustained line of reasoning which is coherent, relevant, substantiated and logically structured. The information included in the response is relevant to the argument.</i> 3-4 marks Detailed description of one factor OR incomplete description of both factors <i>There is a line of reasoning which is partially coherent, largely relevant, supported by some evidence and with some structure. Mainly relevant information is included in the response but there may be some minor errors or the inclusion of some information not relevant to the argument.</i> 1-2 marks Incomplete description of one factor OR correct Boltzmann distributions with no written explanation <i>There is a basic line of reasoning which is not coherent, supported by limited evidence and with very little structure. There may be significant errors or the inclusion of information not relevant to the argument.</i> 0 marks No attempt made or no response worthy of credit.						
				Question 9 total	7	1	4	12	1	1

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
10.	(a)	(i)		appropriate scales (1) all points plotted correctly (1) (tolerance ± 1 square)		2		2	2	2
		(ii)		straight line extrapolating back to y-axis (1) $\Delta T = 44 - 17 = 27$ (1) where vertical scale covers 0-40 extrapolation back to y-axis is not possible so mark as follows line of best fit drawn (1) $\Delta T = 41 - 17 = 24$ (1)			2	2	2	1
		(iii)		mass of solution = 380g (1) $q = -mc\Delta T = 380 \times 4.18 \times 27 = -42\,886.8 \text{ J}$ (1) $n(\text{CH}_3\text{COONa} \cdot 3\text{H}_2\text{O}) = \frac{320}{136.09} = 2.35 \text{ mol}$ (1) $\Delta H = \frac{-42.9}{2.35} = -18.26 \text{ kJ mol}^{-1}$ (1) ECF possible $\Delta H = -16.22$ using $\Delta T = 24$ from part (ii)		4		4	2	1
		(iv)		heat is lost to the surroundings / sodium ethanoate does not fully crystallise			1	1		1
	(b)			award (1) for each reactant $\text{CH}_3\text{COOH} + \text{NaHCO}_3 \rightarrow \text{CH}_3\text{COONa} + \text{CO}_2 + \text{H}_2\text{O}$ award (2) for correct equation using Na_2CO_3 $2\text{CH}_3\text{COOH} + \text{Na}_2\text{CO}_3 \rightarrow 2\text{CH}_3\text{COONa} + \text{CO}_2 + \text{H}_2\text{O}$		2		2		

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(c)	(i)		ethanol / ethanal and acidified potassium dichromate (1) colour change from orange to green (1) OR ethanol / ethanal and acidified potassium manganate(VII) (1) colour change from purple/light pink to colourless (1)		2		2		2
		(ii)		 condenser with water in at bottom and out at top (1) condenser attached upright to top of reaction vessel (1) source of heat (with upright condenser drawn) (1) if distillation apparatus drawn – (1) max for water in / water out			3	3		3
				Question 10 total	0	10	6	16	8	9

UNIT 2

SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	TOTAL MARK	MATHS	PRAC
Section A	8	2	0	10	0	4
6	7	7	1	15	0	2
7	2	12	3	17	2	0
8	3	3	4	10	3	2
9	7	1	4	12	1	1
10	0	10	6	16	8	9
Total	29	35	16	80	14	16