GCE AS MARKING SCHEME

SUMMER 2022

AS
CHEMISTRY – COMPONENT 2
B410U20-1

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 AS CHEMISTRY

COMPONENT 2: ENERGY, RATE AND CHEMISTRY OF CARBON COMPOUNDS

SUMMER 2022 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.

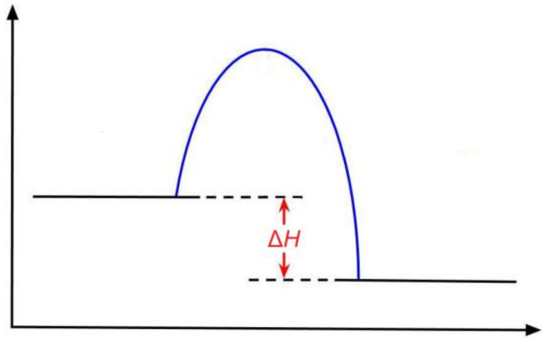
Marking abbreviations

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

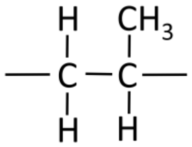
Credit should be awarded for correct and relevant alternative responses which are not recorded in the mark scheme.

Section A

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
1				2,2-dimethylpropane		1		1		
2				when a bond is broken and one of the bonded atoms receives both electrons (from the covalent bond)	1			1		
3				only propanoic acid forms hydrogen bonds / propanoic acid forms hydrogen bonds but propane does not (1) with water (1)	2			2		
4				$2C_2H_5COOH + Mg \rightarrow (C_2H_5COO)_2Mg + H_2$		1		1		
5	(a)				1			1		
	(b)			136		1		1		

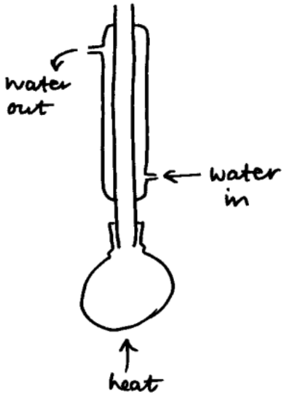
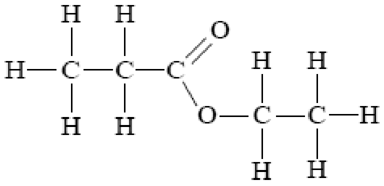
Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
6				moles $C_3H_8 = \frac{9000}{44.08} = 204$ (1) molecules $C_3H_8 = 204 \times 6.02 \times 10^{23} = 1.23 \times 10^{26}$ (1)		2		2	1	
7				3		1		1		
				Section A total	**4**	**6**	**0**	**10**	**1**	**0**

Section B

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
8	(a)			award (1) each for any two of following • σ bonds formed between C and H / between one C and C • σ and π bonds formed between one C and C • π bond formed by sideways overlap of p orbitals π bond gives region of high electron density (and weaker) (1) so react by electrophilic addition (1)	4			4		
	(b)					1		1		
	(c)	(i)		radical substitution	1			1		
		(ii)		initiation $Cl_2 \rightarrow 2Cl\bullet$ (1) propagation $Cl\bullet + C_3H_8 \rightarrow \bullet C_3H_7 + HCl$ (1) $\bullet C_3H_7 + Cl_2 \rightarrow C_3H_7Cl + Cl\bullet$ (1) termination - award (1) for either of following $\bullet C_3H_7 + Cl\bullet \rightarrow C_3H_7Cl$ $\bullet C_3H_7 + \bullet C_3H_7 \rightarrow C_6H_{14}$	4			4		

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(d)			C : H ratio $\frac{88.1}{12}$: $\frac{11.9}{1.01}$ ⇨ 7.34 : 11.8 (1) 1 : 1.6 ⇨ 5 : 8 ⇨ empirical formula C_5H_8 (1) molecular formula $C_{10}H_{16}$ (1) alternative method e.g. $\frac{11.9}{100} \times 136 = 16.2$ 136 – 16.2 = 119.8 (1) mass of hydrogen equates to 16 atoms mass of carbon equates to 10 atoms ⇨ molecular formula $C_{10}H_{16}$ (1) empirical formula C_5H_8 (1)		3		3	2	
				Question 8 total	**9**	**4**	**0**	**13**	**2**	**0**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
9	(a)	(i)		phosphoric acid	1			1		
		(ii)		energy in to break bonds (4 × 413) + (1 × 612) + (2 × 463) = 3190 (1) energy out as new bonds form (5 × 413) + (C—C) + (1 × 360) + (1 × 463) = 2888 + (C—C) –46 = 3190 – [2888 + (C—C)] (1) (C—C) = 348 (1) ecf possible		2	1	3	2	
	(b)	(i)		enthalpy change when 1 mol of substance is burned (1) completely / in excess oxygen under standard conditions (1)	2			2		
		(ii)		mass ethanol = 0.350 × 1000 × 0.789 = 276.15 g (1) moles ethanol = $\frac{276.15}{46.06}$ = 5.995 (1) heat energy released = 5.995 × 1370 = 8210 (1) **must** be given to 3 sig figs ignore minus sign if included		3		3	2	

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(c)	(i)		 flask with vertical condenser (1) direction of water flow (1) clear indication that flask and condenser are two different pieces of apparatus (1)	3			3		3
		(ii)		vapour / mixture being heated is condensed and returns to the flask (1) award (1) for any of following yield would be reduced / product would be lost reactants would be lost solvent would be lost neutral answer – vapour is flammable			2	2		2
		(iii)				1		1		
				Question 9 total	**6**	**6**	**3**	**15**	**4**	**5**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
10	(a)			**Indicative content** **Method** • Equal amounts of halogenoalkane in each tube • Add ethanol as a solvent • Add $AgNO_3$(aq) to each tube • Heat mixture to same temperature • Measure time taken for each precipitate to form **Results** • C_4H_9I produces yellow precipitate quickly • C_4H_9Br takes longer to produce a cream precipitate • C_4H_9Cl takes a very long time to produce a white precipitate **Use of Results** • Trend is 1-iodobutane > 1-bromobutane > 1-chlorobutane • Bond enthalpy C – Cl > C – Br > C – I	1	2	3	6		4
				5-6 marks Description of method with reference to time; correct order of precipitate formation and trend; reference to relevant bond strengths *The candidate constructs a relevant, coherent and logically structured method 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** Attempt at description of method with reference to $AgNO_3$; attempt at order of precipitate formation with corresponding trend or explanation in terms of bond strengths *The candidate constructs a coherent account including most 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 are generally sound.* **1-2 marks** Attempt at description or results/trend/explanation *The candidate attempts to link at least two 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				Marking details	Marks available					
					AO1	**AO2**	**AO3**	**Total**	**Maths**	**Prac**
	(b)			moles 1-chlorobutane = $\frac{37.6}{92.59}$ = 0.406 (1) moles but-1-ene = 0.406 × 0.25 = 0.1015 moles 2-iodobutane = 0.1015 × 0.92 = 0.0934 (1) mass 2-iodobutane = 0.0934 × 184.09 = 17.2 g (1)		1 1	1	3	2	
	(c)			CFCs produce chlorine radicals / Cl• (1) these destroy the ozone layer (1) in HFCs C—F / C—H / C—C bonds are too strong to be broken by UV radiation (1) to form radicals (1)	4			4		
				Question 10 total	**5**	**4**	**4**	**13**	**2**	**4**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
11	(a)	(i)		award (1) for either of following to allow CO_2 to escape but stop any acid from spraying out to allow only CO_2 to escape			1	1		1
		(ii)		use a gas syringe / upside down burette to measure volume of CO_2 formed (1) over time (1)	2			2		2
		(iii)		award (2) for all points plotted correctly - tolerance ±½ small square award (1) for any 8 or 9 points plotted correctly best fit curve (1)		3		3	1	
		(iv)		tangent drawn at t = 1 minute (1) rate = 0.13 (g min^{-1}) (1) accept any value in range 0.115-0.145 tangent must be drawn to access second mark		1	1	2	2	2
		(v)		moles $CaCO_3$ = 0.015 moles CO_2 = 0.015 (1) mass CO_2 = 0.66 g (1)		2		2	1	
		(vi)		curve drawn is steeper than the original (1) because there is an increase in surface area so there are more successful collisions per unit time (1) levels off at 170.84 g (since 0.66 g max mass CO_2 / reaction has finished) (1)	1	1	1	3		1

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(b)	(i)		$q = 50 \times 4.18 \times 2.1 = 438.9$ J (1) $\Delta H = \frac{-438.9}{0.025} = -17556$ J mol^{-1} (1) $\Delta H = -17.6$ kJ mol^{-1} (1)		3		3	2	
		(ii)		$\frac{0.2}{2.1} \times 100 = 9.5\%$		1		1	1	
		(iii)		4.2°C since ΔH / q constant and mass of solution is halved accept reference to temperature change doubling in place of value			1	1		
		(iv)		2.1°C since both acids are strong / same number of moles of H^+ accept reference to temperature change being the same in place of value			1	1		
				Question 11 total	**3**	**11**	**5**	**19**	**7**	**6**

Question				**Marking details**	**Marks available**					
					AO1	**AO2**	**AO3**	**Total**	**Maths**	**Prac**
12	(a)			award (1) for each compound identified and (1) for each relevant point in reasoning (up to maximum of 4) e.g. **K** ⇨ ^{1}H NMR peak area 6 so must have two CH_3 groups attached to same carbon / must have branched chain (1) **L** ⇨ hydrocarbon with M_r of 56 so must be C_4H_8 and must have branched chain (1) **L** ⇨ 2-methylpropene (1) **M** ⇨ formed by addition of H_2 to alkene **L** (1) **M** ⇨ 2-methylpropane (1) **K** ⇨ undergoes nucleophilic substitution to form (primary) alcohol **N** (1) **K** ⇨ 1-chloro-2-methylpropane (or 1-bromo-2-methylpropane or 1-iodo-2-methylpropane) (1) **N** ⇨ 2-methylpropan-1-ol (1) accept correct structures for **K**, **L**, **M** and **N** credit any other relevant points in reasoning e.g. **N** ⇨ ^{13}C NMR has only 3 peaks meaning carbons in 3 environments so must be branched chain (1) if **L** identified as but-1-ene award maximum (6) if **L** identified as but-2-ene award maximum (5)		4	4	8		
	(b)			aldehyde	1			1		
	(c)			KOH in ethanol (+ heat)	1			1		
				Question 12 total	**2**	**4**	**4**	**10**	**0**	**0**

COMPONENT 2: ENERGY, RATE AND CHEMISTRY OF CARBON COMPOUNDS

SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	Total	Maths	Prac
Section A	**4**	**6**	**0**	**10**	**1**	**0**
8	**9**	**4**	**0**	**13**	**2**	**0**
9	**6**	**6**	**3**	**15**	**4**	**5**
10	**5**	**4**	**4**	**13**	**2**	**4**
11	**3**	**11**	**5**	**19**	**7**	**6**
12	**2**	**4**	**4**	**10**	**0**	**0**
Totals	**29**	**35**	**16**	**80**	**16**	**15**