GCE AS MARKING SCHEME

SUMMER 2023

AS
CHEMISTRY – COMPONENT 2
B410U20-1

INTRODUCTION

This marking scheme was used by WJEC for the 2023 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 2023 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.

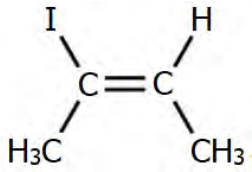
Marking abbreviations

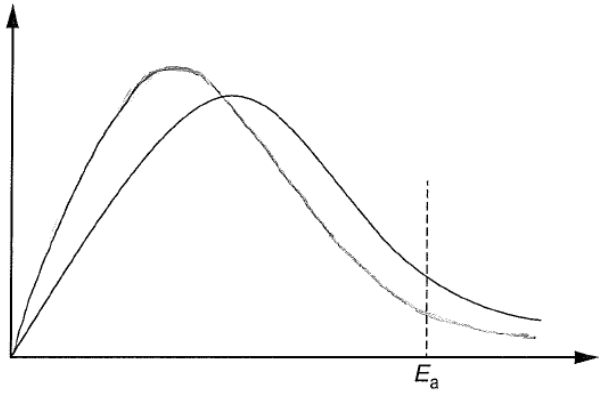
The following may be used in marking schemes or in the marking of scripts to indicate reasons for the marks awarded.

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.

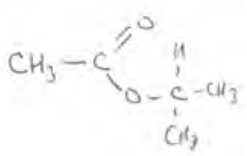
SECTION A

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
1				2-chloro-3-methylpentane		1		1		
2				$C_{10}H_{18}O$		1		1		
3				(when a bond is broken and) each of the bonded atoms receives one of the of the bonding pair of electrons	1			1		
4				C—F bonds are too strong to be broken by UV radiation (1) so no radicals form (1) award 1 max if answered in terms of no C—Cl bond	2			2		
5				 correct structure (1) do not award this mark if C atom bonded to H_3 *E* isomer (1)		2		2		

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
6	(a)			 curve peak should be higher than **and** to the left of original peak	1			1		
	(b)			only molecules with an energy equal to or greater than the activation energy are able to react (1) **diagram shows** that at 20°C, many more molecules have the required activation energy so the rate increases (1)	2			2		
				Section A total	**6**	**4**	**0**	**10**	**0**	**0**

SECTION B

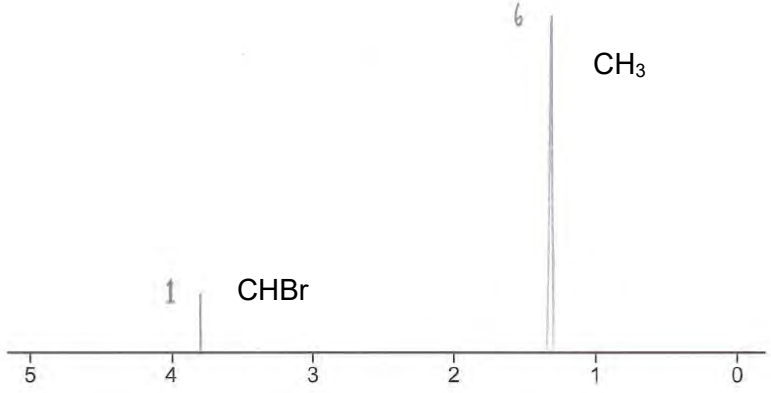
Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
7	(a)	(i)		(a molecule) where an —OH group is joined to a carbon atom which is bonded to two carbon atoms/one hydrogen atom	1			1		
		(ii)		award (1) for either of following $CH_3CH(OH)CH_3 + 4½O_2 \rightarrow 3CO_2 + 4H_2O$ $C_3H_7OH + 4½O_2 \rightarrow 3CO_2 + 4H_2O$		1		1		
		(iii)		$\Delta H = -\frac{mc\Delta T}{n}$ (1) ΔT = 25.4°C, m = 100 g, n = 6.025×10^{-3} (1) $\Delta H = -1762191$ J mol^{-1} (1) $\Delta H = -1762$ kJ mol^{-1} (1) accept –1760	1	3		4	3	
		(iv)		$\frac{-2006-(-1762)}{-2006} \times 100 = 12.2\%$ ecf possible			1	1		
		(v)		incomplete combustion do not accept poor technique			1	1		1

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(b)	(i)		bonds broken (C=C) + (C—C) + 6(C—H) + 4½(O=O) 612 + 348 + 2472 + 4½(O=O) (1) bonds formed 6(C=O) + 6(O—H) = 4830 + 2778 = 7608 (1) 3432 + 4½(O=O) – 7608 = –2058 (1) (O=O) = $\frac{2118}{4½}$ = 471 kJ mol^{-1} (1)		4		4	3	
		(ii)		propene is a gas / not a liquid			1	1		1
	(c)	(i)		$CH_3CH(OH)CH_3$ + CH_3COOH ⇌  + H_2O ester structure (1) balanced equation (1)		2		2		
		(ii)		boiling temperature of ester is lower (than alcohol and acid) (1) alcohols and acids form hydrogen bonds between molecules (which are stronger than van der Waals forces between ester molecules) / esters do not form hydrogen bonds between molecules (1)	2			2		

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
		(iii)	I	removing ester decreases its concentration so equilibrium position moves to the right to form more ester	1			1		
			II	dehydrating agent so removes water so equilibrium position moves to the right (to form more water and more ester)			1	1		
				Question 7 total	**5**	**10**	**4**	**19**	**6**	**2**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
8	(a)	(i)		award (1) for any sensible answer e.g. • available at all times / widely available • type of fuel can be matched with its use • releases large amount of energy	1			1		
		(ii)		carbon / soot	1			1		
		(iii)		award (1) for any of following • alkenes have a region of high electron density so easily react with electrophiles • alkenes have electrons in a π orbital so easily react with electrophiles • alkenes have double bond, one of which is easily broken award (1) for either of following • alkanes only contain single bonds / σ-bonds • alkanes contain no double bonds	2			2		
		(iv)		$C_{10}H_{22} \rightarrow C_5H_{12} + C_2H_4 + C_3H_6$		1		1		

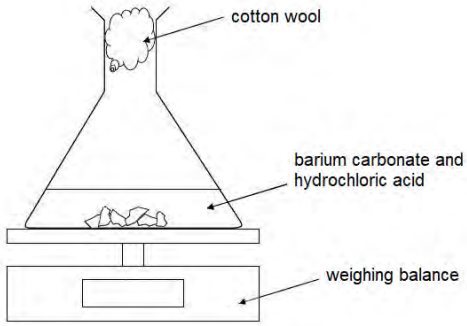
Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(b)	(i)		C H Br $\frac{29.2}{12}$ $\frac{5.80}{1.01}$ $\frac{65.0}{79.9}$ 2.43 5.74 0.814 (1)		1				
				simplest whole number ratio is 3 : 7 : 1 ⇨ empirical formula is C_3H_7Br (1)		1				
				award (1) for either of following • M_r of empirical formula is 122 ⇨ molecular formula is C_3H_7Br • mass spectrum peak at 122 due to $C_3H_7{}^{79}Br$ / at 124 due to $C_3H_7{}^{81}Br$			1	5	1	
				award (1) for either of following • ^{13}C NMR peak at 30 ppm due to CH_3 and at 45 ppm due to CHBr • only two peaks / carbon environments			1 1			
				X is 2-bromopropane (1)			1			

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
		(ii)		 chemical shift (1) peak area / height (1) ecf possible from part (i)			2	2		
				Question 8 total	**4**	**3**	**5**	**12**	**1**	**0**

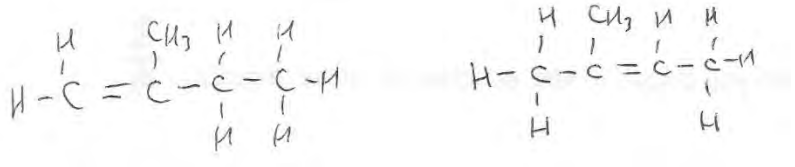
Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
9	(a)			**Indicative content** • add aqueous sodium hydroxide and heat add nitric acid followed by aqueous silver nitrate white precipitate forms with 1-chloropropane only $C_3H_7Cl + OH^- \rightarrow C_3H_7OH + Cl^-$ $Ag^+ + Cl^- \rightarrow AgCl$ • add bromine water and shake well changes from orange to colourless with hex-1-ene only $C_6H_{12} + Br_2 \rightarrow C_6H_{12}Br_2$ • add suitable carbonate e.g. Na_2CO_3 effervescence with propanoic acid only $2C_2H_5COOH + Na_2CO_3 \rightarrow 2C_2H_5COONa + CO_2 + H_2O$	4	2		6		4
				5-6 marks Good description of all three tests and observations; good attempt at equations *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** Basic description of two tests and observations; attempt at an equation *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 of one or two tests; reference to one observation *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-chloropropane = $\frac{8.93}{78.6}$ = 0.114 mol (1) theoretical mass propylamine = 0.114 × 59.1 = 6.74 g (1) mass propylamine = 6.74 × 0.345 = 2.33 g (1) final answer **must** be given to 3 sig figs		3		3	2	
				Question 9 total	**4**	**5**	**0**	**9**	**2**	**4**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
10	(a)			award (1) for moles of both $BaCO_3$ = 7.61 × 10^{-3} mol HCl = 1.20 ×10^{-2} mol since ratio $BaCO_3$: HCl is 1:2 only 6.0 × 10^{-3} mol $BaCO_3$ needed ⇨ $BaCO_3$ is in excess (1)		1	1	2	1	
	(b)	(i)		rate = $\frac{0.26}{270}$ = 9.63 × 10^{-4} g s^{-1} accept any time in the range 260-270 s		1		1	1	
		(ii)		award (1) for tangent drawn at t = 0 sec rate = 2.25 × 10^{-3} g s^{-1} (1) accept any value in range 2.0 × 10^{-3} to 3.0 × 10^{-3}		1	1	2	2	2
	(c)	(i)		award (1) for either of following • rate decreases and reaches zero after 270 s • reaction slows down and stops after 270 s	1			1		
		(ii)		concentration of hydrochloric acid decreases (as reaction proceeds) / fewer moles of hydrochloric acid to react (as reaction proceeds) (1) so fewer successful collisions per unit time (1)	2			2		

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(d)			award (1) for apparatus – diagram or description  cotton wool plug in a conical flask containing hydrochloric acid (30 cm^3) and barium carbonate (1.50g) set on a weighing balance total mass recorded before barium carbonate is added to the acid and a stopwatch started at the same time (1) mass is recorded every 30s for 5 minutes (1) accept any time interval from 10-30s / use of data logger no marks awarded for gas syringe method	3			3		3
	(e)			gas syringe	1			1		1
	(f)			moles CO_2 formed = $\frac{0.26}{44}$ = 5.91×10^{-3} (1) volume CO_2 formed = 145 cm^3 (1)		2		2	1	

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(g)			carbonate would still be in excess (since number of moles of $CaCO_3$ would be greater) / HCl is the limiting factor (1) so same volume of CO_2 would be formed (since only 0.006 mol of $CaCO_3$ would react) and student <u>incorrect</u> (1) ecf possible from part (a)			2	2		
				Question 10 total	**7**	**5**	**4**	**16**	**5**	**6**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
11	(a)			award (1) for each correct structure  do not credit both the *E* and the *Z* isomer of the same structure		2		2		
	(b)	(i)		**B** must be a bromoalkane since **A** is an alkene and addition of HBr gives a bromoalkene (1) B must be a secondary bromoalkene because a secondary carbocation is more stable (1) bromoalkanes undergo substitution reactions with aqueous sodium hydroxide therefore **C** is an alcohol (1) **C** must be a secondary alcohol (1) award (1) for either of following • **C** is not a primary alcohol since when completely oxidised by acidified dichromate(VI) a primary alcohol forms a carboxylic acid which reacts with aqueous sodium carbonate • **C** is not tertiary alcohol because it cannot be oxidised by acidified dichromate(VI) **D** must be a ketone since it does not react with aqueous sodium carbonate / because it forms from a secondary alcohol (1) **D** is not an aldehyde because complete oxidation would form a carboxylic acid (1)		6		6		

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
				E must be an alkene since alcohols are dehydrated to alkenes (1) award up to **six** of possible eight marks but all compounds must be correct for full marks credit named compounds instead of homologous series						
		(ii)		colour change from orange to green	1			1		
		(iii)		NaOH in ethanol	1			1		
		(iv)	I	pent-1-ene is incorrect as it would form 2-bromopentane as the only major product with HBr (which would then form pentan-2-ol) (1) alkene **E** formed on dehydration of pentan-2-ol would be pent-2-ene but this has *E*-*Z* isomers (1)			2	2		
			II	**A** cannot be 2-methylbut-1-ene or 2-methylbut-2-ene because a tertiary bromoalkane would be formed as the major product on addition of HBr (1) after the substitution reaction, this bromoalkane would become a tertiary alcohol / an alcohol which cannot be oxidised by acidified dichromate(VI) (1)			2	2		
				Question 11 total	**2**	**8**	**4**	**14**	**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	6	4	0	10	0	0
7	5	10	4	19	6	2
8	4	3	5	12	1	0
9	4	5	0	9	2	4
10	7	5	4	16	5	6
11	2	8	4	14	0	0
Totals	28	35	17	80	14	12