GCE AS MARKING SCHEME

SUMMER 2018

AS (NEW)
CHEMISTRY - UNIT 2
2410U20-1

INTRODUCTION

This marking scheme was used by WJEC for the 2018 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.

UNIT 2: ENERGY, RATE AND CHEMISTRY OF CARBON COMPOUNDS

MARK SCHEME SUMMER 2018

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.

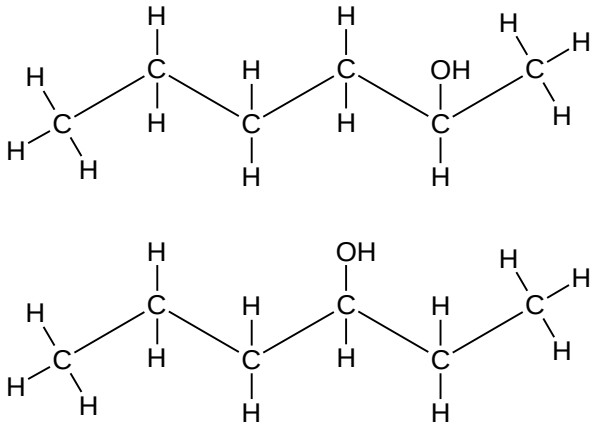
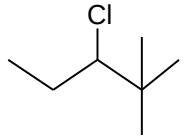
Marking abbreviations

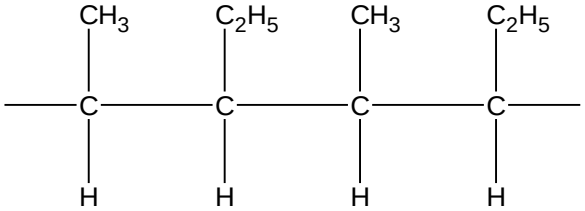
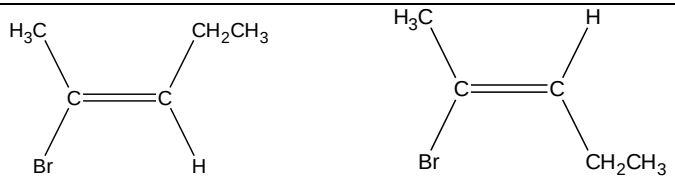
The following may be used in marking schemes or in the marking of scripts to indicate reasons for the marks awarded.

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

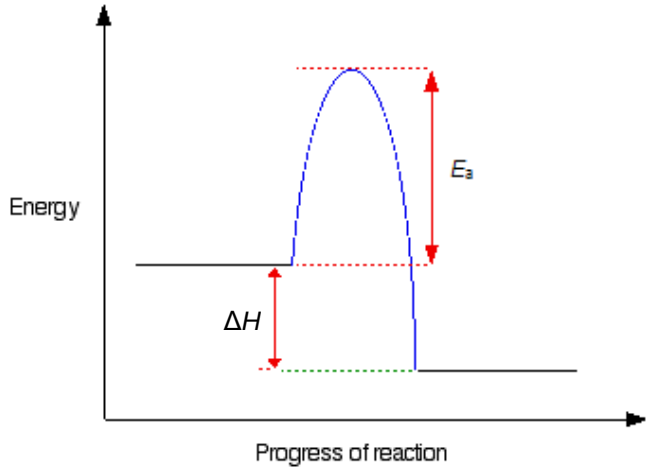
Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
1.				any secondary alcohol containing six carbon atoms e.g.  		1		1		
2.						1		1		
3.				only ethanol forms hydrogen bonds / ethane does not form hydrogen bonds but ethanol does (1) with water (1)	2			2		

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
4.				π orbital above and below plane of molecule 	1			1		
5.	(a)			$2C_2H_5OH + 2CO_2$ ignore state symbols	1			1		
	(b)			yeast / zymase	1			1		1
6.						1		1		
7.				 ***E*** ***Z*** correct formulae (1) ***E*** and ***Z*** labelled correctly (1) award (1) for one correct formula with correct label		2		2		
				Section A total	**5**	**5**	**0**	**10**	**0**	**1**

Section B

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
8.	(a)			use of IR spectroscopy (1) peak at 650 to 800 (cm^{-1}) (1) **OR** use of mass spectrometry (1) peak at m/z 64/66 (allow 64.5) (1)		2				
	(b)			(mechanism involves) radical / homolytic fission (1) initiation $Cl_2 \rightarrow 2Cl\bullet$ (1) propagation e.g. $C_2H_6 + Cl\bullet \rightarrow \bullet CH_2CH_3 + HCl$ (1) termination e.g. $\bullet CH_2CH_3 + Cl\bullet \rightarrow CH_2ClCH_3$ (1) for **both** propagation and termination mark to be awarded chloroethane **must** be a product allow appropriate second propagation step in place of termination	4			4		
	(c)			2.0 g ethane = 0.067 mol (1) produces 0.067 mol of chloroethane with mass of 4.3 g (1) percentage yield = $\frac{1.0}{4.3} \times 100 = 23$ (1) ecf possible		3		3	1 1	

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(d)			**two** possible products e.g. CH_2ClCH_2Cl, $CH_3CH_2CH_2CH_3$ (1) with relevant explanation/equation e.g. two ethyl radicals combine / $\bullet CH_2CH_3 + \bullet CH_2CH_3 \rightarrow CH_3CH_2CH_2CH_3$ (1) allow appropriate propagation step award (1) for one product and one explanation		2		2		
				Question 8 total	**4**	**7**	**0**	**11**	**2**	**0**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
9.	(a)	(i)		(average) energy required to break / released by making (1) 1 mol of bonds (1)	2			2		
		(ii)		bonds broken C≡C + 2(H−H) = 839 + 2(436) = 1711 (1) bonds formed (C−C) + 4(C−H) = 348 + 4(413) = 2000 (1) ΔH = 1711 – 2000 = −289 kJmol^{-1} (1) ecf possible		3		3	1	
		(iii)		 products at lower energy than reactants (1) ecf possible from part (ii) ΔH and E_a labelled (1)	2			2		

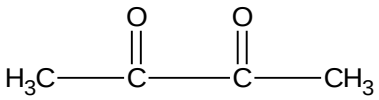
Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(b)			Hess' cycle drawn with all arrows in correct direction / ΔH = ΔH reactants – ΔH products (1) correct values −1300, −572 and −1600 on arrows / ΔH = [−1300 + (−572)] − (−1600) (1) ΔH = −272 kJmol^{-1} (1)		3		3	1 1	
	(c)			bond enthalpy terms are averages / same bond in different environment will have slightly different bond enthalpy			1	1		
	(d)			(electrophilic) addition / hydrogenation	1			1		
				Question 9 total	**5**	**6**	**1**	**12**	**3**	**0**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
10.	(a)	(i)		**Indicative content** $RX + OH^- \rightarrow ROH + X^-$ (any halogenopropane / NaOH) mechanism is nucleophilic substitution C—halogen bond must be broken for the reaction to take place based on electronegativity, carbon atom in the chlorocompound is the most $\delta+$ suggests that chlorocompound would react fastest based on bond enthalpies, the C—I bond is the weakest suggests that iodocompound would react fastest iodocompound does in fact react fastest so effect of bond strength effect is more significant than effect of polarity	1	1	4	6		6

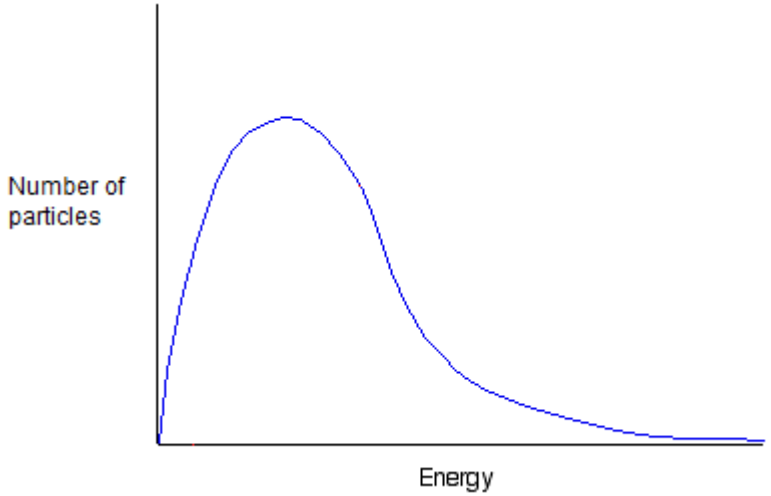
Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
				5-6 marks Equation and nucleophilic substitution included; both bond strength and polarity considered and effects compared *The candidate constructs a relevant, coherent and logically structured account including key 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** Equation or nucleophilic substitution included; some reference to both bond strength and polarity *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** Reference to the reaction type or to the data given *The candidate attempts to link 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.*						
		(ii)		$Ag^+(aq) + X^-(aq) \rightarrow AgX(s)$ accept any halide		1		1		
		(iii)		look down through solution / put a cross on paper underneath flask (1) record time taken for cross to be obscured (1) **OR** colorimeter (1) record time taken to reach set absorbance (1)		2		2		2
		(iv)		two layers formed / they would not have mixed / precipitate only formed at interface			1	1		1

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(b)	(i)		CFCs produce chlorine radicals / Cl• (1) these destroy the ozone layer (1) the ozone layer protects us from UV radiation (1) UV radiation causes (skin) cancer / mutations (1) ignore all references to global warming	4			4		
		(ii)		C—F / C—H / C—C bonds would need to be broken to form radicals (1) these are too strong to be broken by UV radiation (1)		2		2		
				Question 10 total	**5**	**6**	**5**	**16**	**0**	**9**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
11.	(a)			**Empirical formula** percentage oxygen = 35.6 C : H : O = $\frac{53.3}{12}$: $\frac{11.1}{1}$: $\frac{35.6}{16}$ (1)		1			1	
				= 4.44 : 11.1 : 2.22						
				= 4 : 10 : 2 $\Rightarrow$ C_2H_5O (1)		1				
				Mass spectrum M_r = 90 (1)		1				
				molecular formula $C_4H_{10}O_2$ (1)		1				
				any fragment linked to m/z (1)		1				
				IR O—H peak at 3200-3550 (1)	1					
				NMR 3 hydrogen **environments** (1)		1				
				Potassium dichromate(VI) **X** is 1^o alcohol, 2^o alcohol or aldehyde (1)		1				1
				Sodium carbonate (carboxylic) acid not formed so **X** must be 2^o alcohol / oxidised to ketone (1)			1			1
				X is butane-2,3-diol / unambiguous formula (1)			1	10		

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(b)	(i)		redox / oxidation	1			1		1
		(ii)		 ecf possible from part (a) e.g. if 1° alcohol given			1	1		
				Question 11 total	**2**	**7**	**3**	**12**	**1**	**3**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
12.	(a)	(i)		<table><tr><th>[I^-]</th><th>Rate</th></tr><tr><td>0.1</td><td>18</td></tr><tr><td>0.2</td><td>50</td></tr><tr><td>0.3</td><td>56</td></tr><tr><td>0.4</td><td>83</td></tr><tr><td>0.5</td><td>100</td></tr></table>		1		1	1	1
		(ii)		axes – labelled **and** minimum half of both axes used (1) points plotted correctly – tolerance ±½ square (1) straight line of best fit clearly missing point at 0.2 (1)		1 1	1	3	3	3
		(iii)		rate proportional to concentration of I^- accept first order			1	1	1	
		(iv)		rate read from graph – in the range 28-32 × 10^{-3} s^{-1} (1) time = 33 s accept range 31.25-35.7 (1)		2		2	1	
		(v)		reaction is faster at start / slows as it proceeds (1) concentrations of reactants higher at start / average rate is measured (1)			2	2		2

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(b)	(i)		 axes labelled (1) curve – start at origin, hump, does not touch x-axis (1)	2			2		
		(ii)		activation energy E_a is lower with a catalyst / E_a with catalyst and without catalyst marked on diagram (1) more particles / collisions exceed E_a with catalyst (1)		2		2		
				Question 12 total	**2**	**7**	**4**	**13**	**6**	**6**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
13.	(a)			when fuel from renewable / biological source (burns) (1) no net change in atmospheric carbon dioxide levels (1) carbon dioxide released is that absorbed by photosynthesis as the plant grew (1)	3			3		
	(b)	(i)		carbon dioxide $10x$ water $5y$ **both** needed			1	1	1	
		(ii)		$10x + 5y - [10(1 + x + \frac{y}{4})] = 20$ (1) $y = 12$ (1)			2	2	2	
				Question 13 total	**3**	**0**	**3**	**6**	**3**	**0**

UNIT 2: ENERGY, RATE AND CHEMISTRY OF CARBON COMPOUNDS

SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	Total	Maths	Prac
Section A	5	5	0	10	0	1
8.	4	7	0	11	2	0
9.	5	6	1	12	3	0
10.	5	6	5	16	0	9
11.	2	7	3	12	1	3
12.	2	7	4	13	6	6
13.	3	0	3	6	3	0
Totals	26	38	16	80	15	19