GCE A LEVEL MARKING SCHEME

SUMMER 2018

A LEVEL (NEW)
CHEMISTRY - UNIT 4
1410U40-1

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 4: ORGANIC CHEMISTRY AND ANALYSIS

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.

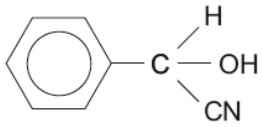
Marking abbreviations

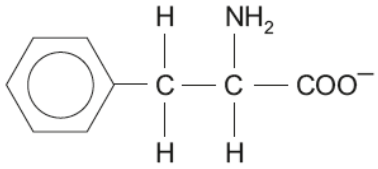
The following may be used in marking schemes or in the marking of scripts to indicate reasons for the marks awarded.

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

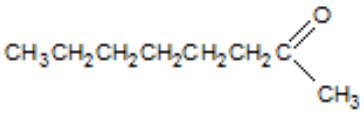
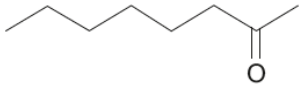
Credit should be awarded for correct and relevant alternative responses which are not recorded in the mark scheme.

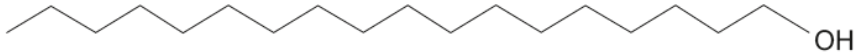
Section A

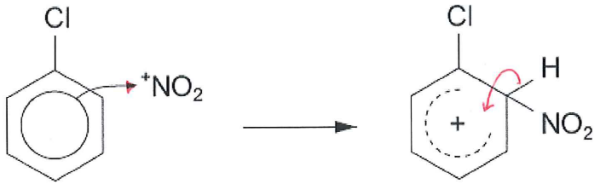
Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
1.	*(a)*					1		1		
	(b)			$^{-}$CN accept CN^{-}	1			1		
2.				butanoic acid accept methylpropanoic acid / pentanedioic acid		1		1		
3.				2 mol NH_3 from 1 mol amide **T** 0.060 mol from 0.030 mol amide **T** M_r of the amide 3.90/0.030 = 130 (1) M_r 'R' = 130 – 88 = 42 therefore C_3H_6 / $CH_2CH_2CH_2$ (1)		1	 1	 2	1	

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
4.	*(a)*					1		1		
	(b)			2-aminopropanoic acid exists as zwitterions / $CH_3CHNH_3^+COO^-$ (1) it has strong ionic character therefore much stronger forces between molecules than the other acids (1)		2		2		
5.				275.4 dm^3 gaseous material from 222 g RDX (1) therefore 1 m^3 from 222 × 1000 / 275.4 = 806 answer must be given to 3 sig figs (1)		1	1	2	2	
				Section A total	**1**	**7**	**2**	**10**	**3**	**0**

Section B

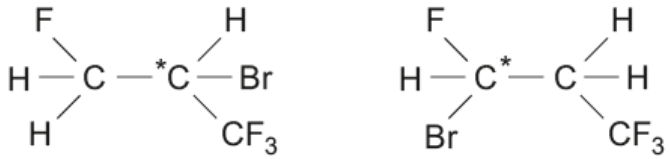
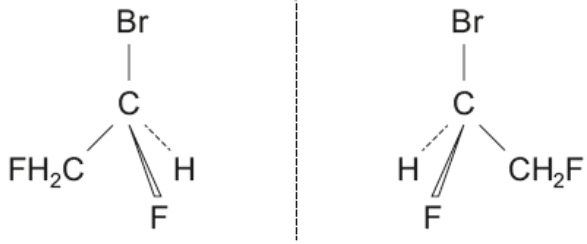
Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
6.	*(a)*	(i)		$C_8H_{16}O$	1			1		
		(ii)		NaOH(aq) / $^-$OH(aq) (1) nucleophilic substitution (1)	 2			 2		1
		(iii)		accept any of following acidified dichromate(VI) acidified potassium dichromate(VI) H^+, $Cr_2O_7^{2-}$ acidified manganate(VII) acidified potassium manganate(VII) acidified permanganate H^+, MnO_4^-	1			1		1
	(b)	(i)		CHI_3	1			1		1
		(ii)		possible formulae   accept an unsaturated methyl secondary alcohol e.g. $CH_3CH_2CH_2CH{=}CHCH_2CH(OH)CH_3$ (1) methylketone / $CH_3C{=}O$ (1) or $CH(OH)CH_3$ (that can be oxidised to $CH_3C{=}O$)		1	1	2		

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(c)	(i)		accept any of following sodium tetrahydridoborate(III) sodium borohydride $NaBH_4$ lithium tetrahydridoaluminate(III) lithium aluminium hydride $LiAlH_4$		1		1		1
		(ii)		by following the disappearance of the colour using a colorimeter			1	1		1
	(d)			e.g. 99 → $CH_3CH_2CH_2CH_2CH_2CO^+$ / $C_5H_{11}CO^+$ / $CH_3COCOCH_2CH_2^+$ 71 → CH_3COCO^+ 43 → CH_3CO^+ / $C_3H_7^+$ award (2) for all three correct award (1) for any one/two correct			2	2		
	(e)	(i)		 award (1) for correct chain length award (1) for terminal primary alcohol		2		2		
		(ii)		accept any of following lithium tetrahydridoaluminate(III) lithium aluminium hydride $LiAlH_4$	1			1		1
				Question 6 total	**6**	**4**	**4**	**14**	**0**	**6**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
7.	*(a)*	(i)		 both curly arrows needed (1) correct structure of intermediate (1)	 1	 1		 2		
		(ii)		electrophilic substitution	1			1		
	(b)			lone pair of electrons on the nitrogen atom(s)	1			1		
	(c)	(i)		orange / red solid	1			1		
		(ii)		the derivatives formed using 2,4-DNPH have suitable melting temperatures for identification / precise melting temperatures			1	1		1
	(d)			dissolve the (impure) oxime in a minimum volume (1) hot methanol / warm methanol (1) water bath / electrical heater (1) allow to cool (1) filter off oxime and dry (1)	 1 1	 1 1 	 1 	 5		 5

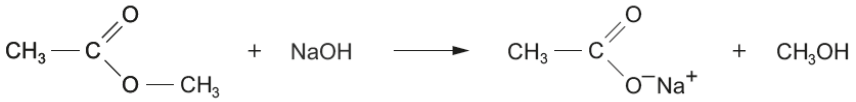
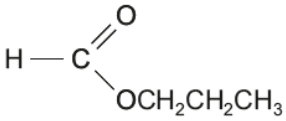
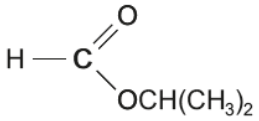
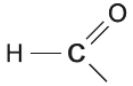
Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(e)			(broad) peak at 3200-3550 cm^{-1} due to O—H bond present in the oxime and not in the amide (1) peak at 1650-1750 cm^{-1} due C=O bond present in the amide and not in the oxime (1) peak at 3300-3500 cm^{-1} due to N—H bond present in the amide and not in the oxime (1)		3		3		
				Question 7 total	**6**	**6**	**2**	**14**	**0**	**6**

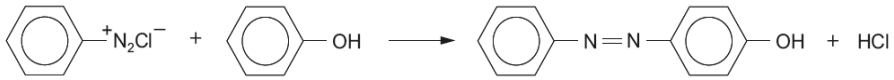
Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
8.	*(a)*			$F_3CCl \rightarrow F_3C\bullet + Cl\bullet$		1		1		
	(b)	(i)		the higher the ratio of HF:CH_2Cl_2 the higher the yield of CH_2F_2			1	1		
		(ii)		$n(CH_2F_2) = 0.0356$ (1) mass of $CH_2F_2 = 0.0356 \times 52.02 = 1.85$ (1) ecf possible from incorrect M_r		2		2	1	
	(c)	(i)		high pressure because there are more (gaseous) moles on the left than on the right	1			1		
		(ii)		high temperature as the endothermic reaction needs heat for the position of equilibrium to move to the right	1			1		
		(iii)		separation can be achieved by (fractional) distillation (1) reduce the temperature of the mixture to below –30°C and let the mixture warm up slowly (1,1,1,2-tetrafluoroethane will distil off first and can be condensed in a cold trap) (1)			2	2		2

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(d)	(i)		each end of the C=C double bond has two different groups bonded to it	1			1		
		(ii)	I	electrophilic addition	1			1		
			II	(intermediate) carbocations / carbonium ions have similar stabilities / similar reactivities / similar activation energies / are formed at similar rates			1	1		
		(iii)		 correct formulae (1) chiral centres correctly shown on both compounds (1) award (1) for one correct formula and chiral centre		2		2		
		(iv)				1		1		
				Question 8 total	**4**	**6**	**4**	**14**	**1**	**2**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
9.	*(a)*			**Indicative content** • percentage of chlorine in this compound is 32.1% which is consistent with that of 2,4-D • colourless gas with $NaHCO_3$ indicates compound is a carboxylic acid • n(NaOH) is 1.85×10^{-3} mol • mole ratio is 1:1 therefore only one COOH group • number of moles of compound in 25.0 cm^3 is also 1.85×10^{-3} mol therefore 1.85×10^{-2} in 250 cm^3 • M_r of compound is 221 which is consistent with that of 2,4-D test results consistent with structure of 2,4-D • no chloride ions on reflux with NaOH therefore chlorine atoms are bonded directly to the ring, not in alkyl side-chains • no white precipitate with aqueous bromine therefore not a phenol • aqueous bromine not decolourised therefore no C=C double bonds spectral data consistent with that of 2,4-D • ^1H NMR spectrum of this compound would show three peaks; aromatic (area of 3), —CH_2— (area 2), O—H (area 1) • ^{13}C NMR of this compound would show eight peaks as it has 8 different carbon environments					2	
				• take its melting temperature and compare to a book value • mix a sample with some actual 2,4-D, and take its melting temperature – see if the value is unchanged	2	2	2	6		4

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
				5-6 marks All information has been used and interpreted correctly, good account of melting temperature determination *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** Most of the information has been used and interpreted correctly *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** Some of the information has been used correctly *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.*						

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(b)	(i)				1		1		
		(ii)	I	88		1		1	1	
			II	 or  (1) ester must contain  group for it to reduce Tollens reagent (1)		1	1	2		
		(iii)	I	60		1		1	1	
			II	if relative molecular masses are different, the number of moles present in the chromatogram is not directly related to the mass of each component			1	1		
		(iv)		**A** has weaker intermolecular forces therefore (less energy is needed to overcome these forces and) it has a lower boiling temperature			1	1		
		(v)		2-methylbut-1-ene			1	1		
				Question 9 total	**2**	**6**	**6**	**14**	**4**	**4**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
10.	*(a)*			<table><tr><th>Stage</th><th>Reagent used</th><th>Structural formula of product</th></tr><tr><td>1</td><td>KBr / H_2SO_4 or $SOCl_2$ / PCl_5</td><td>$CH_3CH_2CH_2Br$ $CH_3CH_2CH_2Cl$</td></tr><tr><td>2</td><td>KCN</td><td>$CH_3CH_2CH_2CN$</td></tr><tr><td>3</td><td>$LiAlH_4$</td><td></td></tr></table> award (1) for each correct row	1	2		3		
	(b)	(i)		sodium nitrate(III) / nitrite and acid e.g. HCl	1			1		1
		(ii)		 accept other correct alternative equations		1		1		
	(c)			the statement is true as HCl will be removed as it is formed, moving the position of equilibrium to the right accept other valid reasons			1	1		

<table>
<tr><th colspan="4" rowspan="2">Question</th><th rowspan="2">Marking details</th><th colspan="6">Marks available</th></tr>
<tr><th>AO1</th><th>AO2</th><th>AO3</th><th>Total</th><th>Maths</th><th>Prac</th></tr>
<tr><td></td><td>(d)</td><td></td><td></td><td>7.87 g of the amino acid gives 1470 cm^3 of N_2 gas (1)
$n(N_2) = 1470 / 24.5 \times 1000 = 0.060$
therefore 0.060 mol of the amino acid
molar mass of the amino acid = 7.87 / 0.060 = 131 (1)
$R—CH(NH_2)COOH \rightarrow 131$ and $CH(NH_2)COOH \rightarrow 74$
therefore $R \rightarrow 131 - 74 = 57$ (1)
it is a straight chain compound so R is $CH_3CH_2CH_2CH_2$
therefore amino acid must be $CH_3(CH_2)_3CH(NH_2)COOH$ (1)</td><td></td><td>2</td><td>2</td><td>4</td><td>2</td><td></td></tr>
<tr><td></td><td>(e)</td><td>(i)</td><td></td><td>2-methylpropane-1,3-dioic acid
accept 2-methylpropanedioic acid</td><td>1</td><td></td><td></td><td>1</td><td></td><td></td></tr>
<tr><td></td><td></td><td>(ii)</td><td></td><td><table><tr><th>Protons</th><th>Splitting pattern</th><th>Relative peak area</th></tr><tr><td>$-CH_2-CH_2-$</td><td>singlet / no splitting</td><td>4</td></tr><tr><td>−C−H−</td><td>quartet</td><td>1</td></tr><tr><td>$-CH_3$</td><td>doublet</td><td>3</td></tr></table>award (1) for each correct row</td><td></td><td>3</td><td></td><td>3</td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td>Question 10 total</td><td>3</td><td>8</td><td>3</td><td>14</td><td>2</td><td>1</td></tr>
</table>

UNIT 4: ORGANIC CHEMISTRY AND ANALYSIS

SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	Total	Maths	Prac
Section A	1	7	2	10	3	0
6.	6	4	4	14	0	6
7.	6	6	2	14	0	6
8.	4	6	4	14	1	2
9.	2	6	6	14	4	4
10.	3	8	3	14	2	1
Totals	22	37	21	80	10	19