GCE A LEVEL MARKING SCHEME

SUMMER 2018

A LEVEL
CHEMISTRY - COMPONENT 2
A410U20-1

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.

COMPONENT 2: 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.

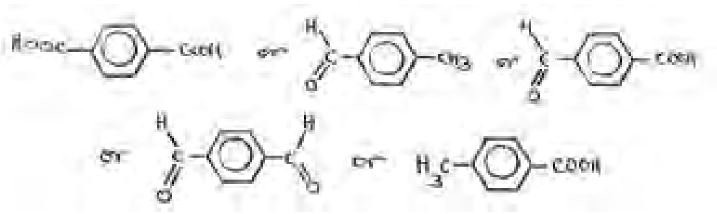
Marking abbreviations

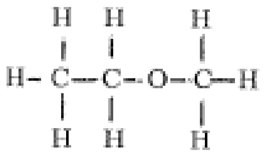
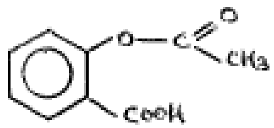
The following may be used in marking schemes or in the marking of scripts to indicate reasons for the marks awarded.

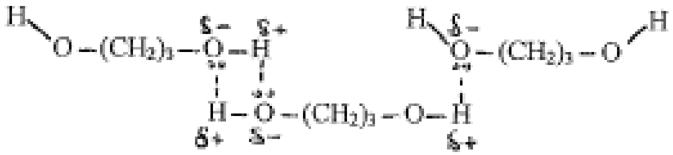
cao	=	correct answer only
ecf	=	error carried forward
bod	=	benefit of doubt

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

Section A

<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>1</td><td></td><td></td><td></td><td>1,1-dichloroethene</td><td>1</td><td></td><td></td><td>1</td><td></td><td></td></tr>
<tr><td>2</td><td></td><td></td><td></td><td></td><td></td><td>1</td><td></td><td>1</td><td></td><td></td></tr>
<tr><td>3</td><td></td><td></td><td></td><td>the compound shown is a ketone and these are reduced to secondary alcohols</td><td>1</td><td></td><td></td><td>1</td><td></td><td></td></tr>
<tr><td>4</td><td></td><td></td><td></td><td><table><tr><td>Compound</td><td>Number of peaks</td><td>Relative peak area ratio</td></tr><tr><td>mesitylene</td><td>2</td><td>3:1 or 1:3</td></tr><tr><td>TNT</td><td>2</td><td>3:2 or 2:3</td></tr></table>
award (1) for each correct row</td><td></td><td>2</td><td></td><td>2</td><td></td><td></td></tr>
</table>

Question				Marking details	AO1	AO2	AO3	Total	Maths	Prac
5				 (1)		1				
				it has a C—O bond (at 1000-1300 cm^{-1}) but no O—H bond (at 2500-3550 cm^{-1}) so it cannot be an alcohol (1)	1			2		
6	(a)				1			1		
	(b)			add (aqueous) bromine (1) decolourised **and** white precipitate (1) or add (aqueous) iron(III) chloride (1) purple colour (1)	2			2		2
7				decarboxylation (1) benzene (1)		2		2		

Question				Marking details	AO1	AO2	AO3	Total	Maths	Prac
					Marks available					
8				only compound **N** contains an O—H group that can <u>hydrogen bond</u> to other molecules (hence stronger intermolecular forces, more energy needed, hence higher boiling temperature) (1) e.g.  (1)	1	1		2		
9				award (1) for any of following $H_2N–CH_2–CH_2–NH_2$ $H_3C–N(H)–N(H)–CH_3$ $(CH_3)_2N–NH_2$		1		1		
				Section A total	**7**	**8**	**0**	**15**	**0**	**2**

Section B

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
10	(a)			orange / brown precipitate (1) given by an aldehyde / CHO group (1)	2			2		2
	(b)	(i)		0.075 mol of ethanoic anhydride (1) there are 5 alcohol groups in glucose (and they react in a 1:1 ratio with ethanoic anhydride) (1)		2		2		
		(ii)		steam / boiling water bath / heating mantle / should be used to heat the mixture (1) condenser should be attached vertically to the flask so that the cold water jacket condenses the vapours and returns them to the flask (1)		2		2		2
		(iii)		the compound is <u>precipitated</u> when the mixture is poured into a large excess of water	1			1		1
		(iv)		so that the maximum amount of glucose pentaethanoate can crystallise out on cooling		1		1		1
		(v)		a lower value indicates that the compound is impure (1) award (1) for any of following • it could be contaminated with glucose / damp • some ethanoic anhydride may remain		1	1	2		1

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(c)			0.200 mol of glucose gives 0.400 mol of ethanol (1) 0.400 mol ethanol in 2.03 dm^3 18.4 g in 2.03 dm^3 (1) therefore concentration of glucose is 9.06 g dm^{-3} (1)		3		3	1 1	
	(d)	(i)		percentage of compound **A** decreases rapidly at the start but then is removed more slowly as the reaction proceeds			1	1		
		(ii)		proportion of compound **B** shows a steady rise as time increases but the proportion of compound **C** remains very small / rises very slowly			1	1		
		(iii)		$\frac{0.18 \times 100}{0.20} = 90$		1		1		
		(iv)		compound **C** (1) as $E = hf$ and $c = f\lambda$ or $E = hc/\lambda$ etc (1)		2		2	1	
		(v)		award (1) for either of following • does not use a toxic solvent • solvent does not harm the environment		1		1		
				Question 10 total	**3**	**13**	**3**	**19**	**3**	**7**

<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>11</td><td>(a)</td><td></td><td></td><td>Indicative content

Mass spectroscopy
each compound has its own mass spectrum
although the molecular ion will be the same (at 114) the fragmentation pattern of each compound will be different

Gas-liquid chromatography
the retention times for both compounds are the same

Boiling temperature
the boiling temperatures of the two compounds must be different

Chemical analysis
since both compounds have the same molecular formula, $C_7H_{14}O$, the elemental analysis for each compound will be the same

Reaction with alkaline iodine
only methyl ketones will give a positive test, hence only heptan-2-one will react in this way.

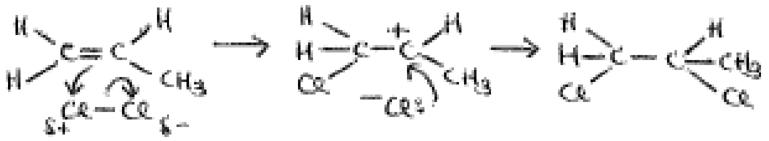
Reaction with 2,4-dinitrophenylhydrazine
the derivatives formed must have different melting temperatures, if they are.to be distinguished in this way / the derivatives must have melting temperatures that are very close to each other

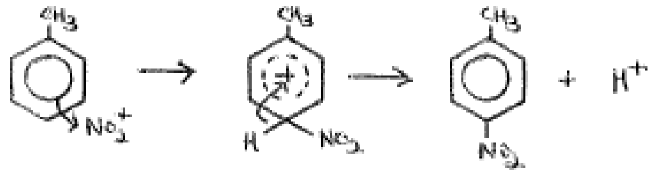
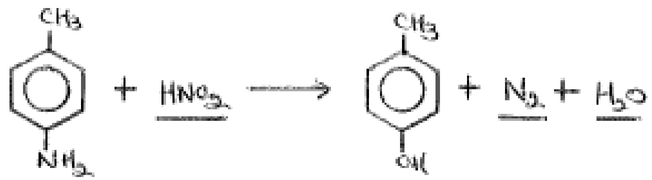
Warmed with Tollens reagent
neither compound is an aldehyde, so no silver mirror is seen</td><td>1</td><td>2</td><td>3</td><td>6</td><td></td><td>5</td></tr>
</table>

				5-6 marks Full explanation of the responses for all methods *The candidate constructs a relevant, coherent and logically structured account including all key elements of the indicative content. A sustained and substantiated line of reasoning is evident and scientific conventions and vocabulary are used accurately throughout.* **3-4 marks** A number of correct points relating to most responses but they lack some relevant detail *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** Attempt to explain some responses but there is a significant lack of detail *The candidate attempts to link at least two relevant points from the indicative material. Coherence is limited by omission and/or inclusion of irrelevant materials. 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.*

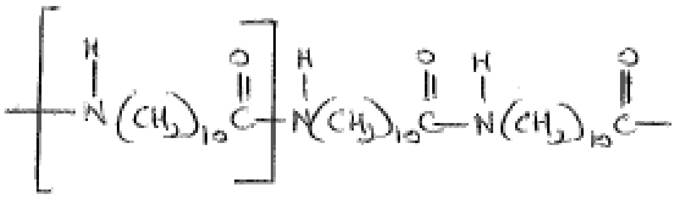
Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(b)	(i)			1			1		
		(ii)		the acid acts as a dehydrating agent (1) water can be eliminated from either side of the —CH(OH)— group (1)	1	1		2		1
		(iii)		nickel / platinum (1) catalyst and reactants / products in <u>different physical states</u> (1)	2			2		
		(iv)		fractional distillation	1			1		1

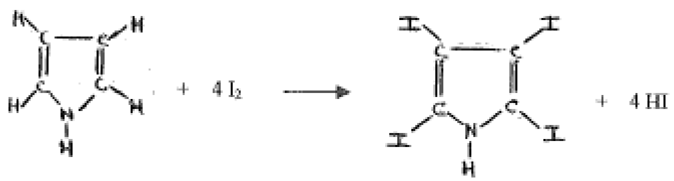
Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
		(v)		award (1) each for up to FOUR of following • as the chain length increases so does the boiling temperature • as the isomers become more branched the boiling temperatures decrease • the rise in boiling temperature is due to increased intermolecular forces • more energy is needed to separate the molecules [or converse] • the branched isomers have weaker intermolecular bonding	1	2	1	4		
		(vi)	I				1	1		
			II	award (1) for any of following • octane • 2,3-dimethylhexane • 3-methylheptane accept a correct unambiguous formula			1	1		
				Question 11 total	**7**	**5**	**6**	**18**	**0**	**7**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
12	(a)			 partial **and** full charges (1) curly arrows **and** lone pair on chloride ion (1)		2		2		
	(b)			add bromine / aqueous bromine (1) alkene decolourised and alkane unaffected (1) OR add acidified $KMnO_4$ (1) alkene decolourised and alkane unaffected (1) allow use of neutral / alkaline $KMnO_4$ with appropriate answers	2			2		2
	(c)	(i)		^{-}OH	1			1		
		(ii)		award (1) each for any TWO of following • percentage yield • availability of starting material / catalyst • atom economy • cost of starting material / catalyst • suggestion of an economic way of running the reaction at a high temperature • isolation of product from starting materials / catalyst			2	2		

Question				Marking details	Marks available					
					AO1	**AO2**	**AO3**	**Total**	**Maths**	**Prac**
	(d)	(i)	I	 charges (1) curly arrows (1) (concentrated) nitric acid and sulfuric acid (1) electrophilic substitution (1)	2	2		4		1
			II	tin / iron and <u>concentrated</u> hydrochloric acid	1			1		1
			III	 HNO_2 (accept $NaNO_2$ / HCl) (1) correct equation (1)	1	1		2		1
		(ii)	I	add $NaHCO_3$ / Na_2CO_3 (1) ethanoic acid produces effervescence / gives of carbon dioxide, phenol does not (1)	2			2		2
			II	the anion formed is more stable than the phenoxide ion / the O—H bond is weakened by the presence of the NO_2 electron withdrawing group			1	1		
				Question 12 total	**9**	**5**	**3**	**17**	**0**	**7**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
13	(a)			they contain both an acidic and alkaline functional groups	1			1		
	(b)	(i)		award (1) for any of following • the burette had been rinsed with water and this was not replaced entirely with sodium hydroxide • inadequate shaking • rough titration / overshot end point	1			1		1
		(ii)		concordant titres chosen - 35.90, 36.00 and 36.10 cm^3 (1) mean titre = 36.00 cm^3 (1) $n(NaOH) = \frac{\underline{36.00 \times 0.105}}{1000} = 0.00378$ (1) 1:1 ratio therefore number of moles of the amino acid is also 0.00378 250 cm^3 contain 0.0378 mol (1) M_r of the amino acid = $\frac{4.95}{0.0378} = 131$ (1)		5		5	1 1	
		(iii)		—$CH(NH_2)COOH$ 'M_r' = 74 (1) 'M_r' of chain is 131-74 = 57 so must be C_4H_9 ecf possible from part (ii) formula must be $CH_3CH_2CH_2CH_2CH(NH_2)COOH$ (1)			2	2		

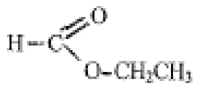
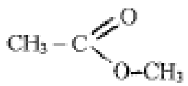
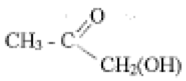
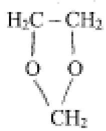
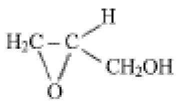
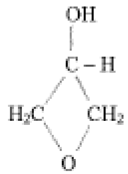
Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(c)	(i)		compound **T** as this is the only one that contains a chiral centre / asymmetric carbon atom		1		1		
		(ii)		only compound **T** would show an N—H stretching frequency at 3300-3500 cm^{-1}		1		1		
		(iii)		compound **S** could only form one dipeptide via its COOH group, as it does not contain an N—H bond			1	1		
	(d)	(i)		the reaction proceeds via secondary carbocations which are more stable / have lower activation energies accept explanation using Markovnikov's rule			1	1		
		(ii)	I	bromine is more electronegative than carbon / has greater electron attracting power than carbon (so is δ–) accept converse argument	1			1		
			II	it acts as a base / nucleophile	1			1		
		(iii)		e.g. 		1		1		
				Question 13 total	**4**	**8**	**4**	**16**	**2**	**1**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
14	(a)	(i)		award (1) for up to FOUR of following • benzene exists as a six membered (planar) ring • it has a molecular formula C_6H_6 • it has a delocalised electron structure / π cloud • stability is lost if addition occurs, hence substitution is the usual reaction	4			4		
		(ii)	I	65.(0) (2) if answer incorrect award (1) for M_r values of butan-1,4-dial [86.06], pyrrole [67.05] and ammonia [17.03] ecf possible from incorrect M_r values		2		2	1	
			II				1	1		
	(b)	(i)		14.8 (2) if answer incorrect award (1) for mass of methylbenzene = 92.1 × 0.430 = 39.6 g ecf possible from incorrect mass of methylbenzene			2	2	1	

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
		(ii)		**Indicative content** methylbenzene reacts with chlorine in the presence of UV light by a radical reaction $C_6H_5CH_3 + Cl_2 \rightarrow C_6H_5CH_2Cl + HCl$ $C_6H_5CH_2Cl + KCN \rightarrow C_6H_5CH_2CN + KCl$ nucleophilic substitution hydrolysis of the nitrile using aqueous acid $C_6H_5CH_2CN \rightarrow C_6H_5CH_2CONH_2 \rightarrow C_6H_5CH_2COOH$		3	3	6		
				5-6 marks The details for each stage have been provided completely and correctly *The candidate constructs a relevant, coherent and logically structured account including all key elements of the indicative content. A sustained and substantiated line of reasoning is evident and scientific conventions and vocabulary are used accurately throughout.* **3-4 marks** Most of the stages have detailed answers but some points are missing *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** There is some attempt to explain each stage but a number of points are missing *The candidate attempts to link at least two relevant points from the indicative material. Coherence is limited by omission and/or inclusion of irrelevant materials. 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
		(iii)		38.0		1		1		
		(iv)	I	the acid chloride may react preferentially with the water present rather than the amine			1	1		1
			II	so that the hydrogen chloride was neutralised by the excess diethylamine			1	1		1
			III	use of vacuum distillation reduces the boiling temperature to avoid decomposition at the higher temperature needed for ordinary distillation			1	1		1
				Question 14 total	**4**	**6**	**9**	**19**	**2**	**3**

Question				Marking details	AO1	AO2	AO3	Total	Maths	Prac
					Marks available					
15	(a)	(i)		award (1) for each of following • add compound **W** to aqueous sodium hydroxide (in the presence of a co-solvent) and warm • acidify the mixture with (aqueous) nitric acid • add silver nitrate • white precipitate (of AgCl) is seen (precipitate dissolves in aqueous ammonia)	2	2		4		4
		(ii)		M_r is 141 (2) if answer incorrect award (1) for mass of chlorine in compound = 3.19 g ecf possible from incorrect mass of chlorine		2		2	1	
		(iii)		there are no protons bonded to the central carbon atom in either compound and therefore the splitting pattern will not be affected by the chlorination			1	1		
		(iv)		use of the Data Booklet to identify protons next to C=O at 2.0 to 3.0 and protons at 0.1 to 2.0 (1) the spectrum consists of a quartet (CH_2) and a triplet (CH_3) (1) these are like to be ethyl groups and the ketone is probably $CH_3CH_2C(O)CH_2CH_3$ (1)		1	2	3		

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
	(b)	(i)	using $pV = nRT$ $9.50 \times 10^4 \times 111 / 10^6 = n \times 8.31 \times 423$ $n = 0.00300$ (1) $M_r = 0.222 / 0.00300 = 74$ (1)		2		2	2	
		(ii)	it did not give CO_2 with $NaHCO_3$ so it is not a carboxylic acid / no COOH group present (1) two oxygen atoms per molecule suggests an ester (1) possibilities are  1 or  2 (1) not 1 since this would give ethanol on hydrolysis but could be 2 (1) other non-ester structures are possible for up to 3 marks in total e.g.    		2	2	4		1
			Question 15 total	**2**	**9**	**5**	**16**	**3**	**5**

COMPONENT 2: ORGANIC CHEMISTRY AND ANALYSIS

SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	Total	Maths	Prac
Section A	7	8	0	15	0	2
10	3	13	3	19	3	7
11	7	7	3	17	0	7
12	9	5	3	17	0	7
13	4	8	4	16	2	1
14	4	6	9	19	2	3
15	2	9	5	16	3	5
Totals	36	56	30	120	10	32