GCE A LEVEL MARKING SCHEME

SUMMER 2019

A LEVEL
CHEMISTRY - UNIT 4
1410U40-1

INTRODUCTION

This marking scheme was used by WJEC for the 2019 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

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.

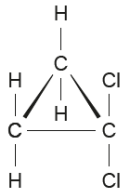
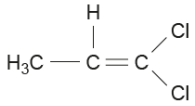
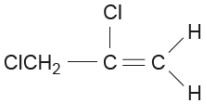
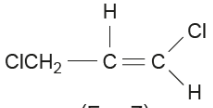
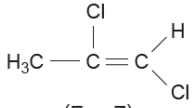
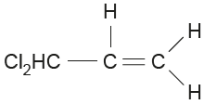
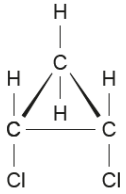
Section A

<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>$C_9H_{18}O_6$</td><td></td><td>1</td><td></td><td>1</td><td></td><td></td></tr>
<tr><td>2</td><td></td><td></td><td></td><td>butanoic acid

accept methylpropanoic acid / pentanedioic acid</td><td>1</td><td></td><td></td><td>1</td><td></td><td>1</td></tr>
<tr><td>3</td><td></td><td></td><td></td><td><table><tr><th>Proton(s)</th><th>Splitting pattern</th><th>Relative peak area ratio</th></tr><tr><td>a</td><td>singlet</td><td>1</td></tr><tr><td>b</td><td>singlet</td><td>2</td></tr></table></td><td></td><td>2</td><td></td><td>2</td><td></td><td></td></tr>
<tr><td>4</td><td></td><td></td><td></td><td>least acidic B C A most acidic</td><td></td><td>1</td><td></td><td>1</td><td></td><td></td></tr>
<tr><td>5</td><td></td><td></td><td></td><td>C - (despite the lack of a solvent front measurement) the spots will ascend in order of their R_f values</td><td>1</td><td></td><td></td><td>1</td><td></td><td></td></tr>
<tr><td>6</td><td></td><td></td><td></td><td>NaOH / I_2 or NaOCl / KI

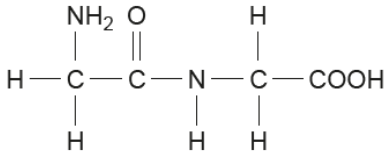
pentan-2-one gives a yellow solid / precipitate and no observable change with 1-phenylbutanone</td><td></td><td>1

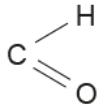
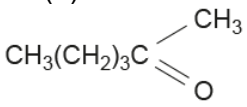
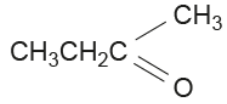
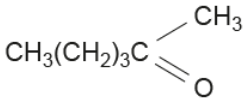
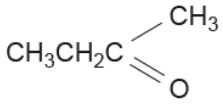
1</td><td></td><td>2</td><td></td><td>2</td></tr>
</table>

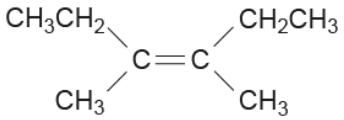
Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
7	*(a)*			award (1) for any of following     (E or Z)  (E or Z) 		1		1		
	(b)						1	1		
				Section A total	**2**	**7**	**1**	**10**	**0**	**3**

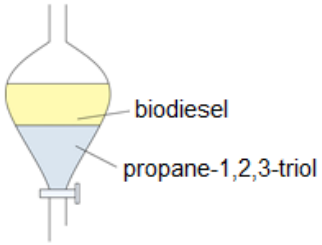
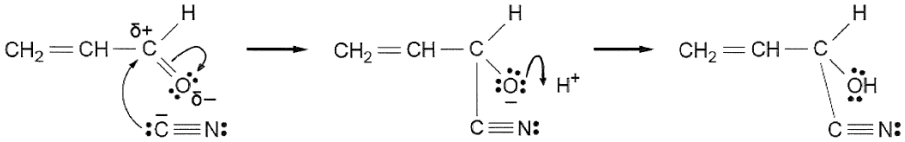
Section B

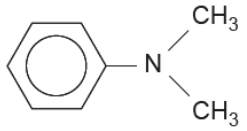
Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
8	*(a)*	(i)		•CH_2COOH			1	1		
		(ii)	I	$CH_3COOH \rightarrow ClCH_2COOH$ 60.0 → 94.5 89.0 → 140.2 (1) increase in mass 140.2 – 89.0 = 51.2 g (1) accept 51 g		1	1	2		
			II	$CH_3COOH \rightarrow CH_2(NH_2)COOH$ 60.0 → 75.0 89.0 → 111.3 (1) percentage yield = $\frac{49.2 \times 100}{111.3}$ = 44.3 (1) answer **must** be to 3 significant figures		1 1		2	1	
			III	it exists as zwitterions / ionic compound (1) accept correctly drawn correct formula of zwitterion ionic compounds are not (generally) soluble in covalent solvents (1)	1		1	2		
	(b)			it does not contain a chiral centre / asymmetric carbon atom	1			1		

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(c)			 accept zwitterion version		1		1		
	(d)			stoichiometric ratio is 1:1 (1) using pV = nRT volume = $\frac{0.300 \times 8.31 \times 373}{9.8 \times 10^4}$ (1) 9.49 dm^3 (1) must be given in dm^3	1	2		3	2	
	(e)			the (sodium) salt of the acid is formed		1		1		1
				Question 8 total	**3**	**7**	**3**	**13**	**3**	**1**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
9	*(a)*	(i)		award (1) for either of following • the groups bonded to each carbon atom of the C=C must be the same • it must be a symmetrical alkene			1	1		
		(ii)		orange / red / yellow	1			1		1
		(iii)	I	award (1) for any of following • it does not contain a  group • it is not an aldehyde			1	1		
			II	it is not an aldehyde, therefore cannot be $CH_3(CH_2)_3CHO$ or $CH_3(CH_2)_2CHO$ (1) accept it must be  or  melting temperature cannot be higher than the literature value therefore it cannot be  (1) compound **U** must be  (1) ecf possible	1 1	1		3		

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
		(iv)		 (1) accept *E*- or *Z*- isomer 3,4-dimethylhex-3-ene (*E*- or *Z*- as structure given) (1) ecf possible from *(a)*(iii)II		1	1	2		
	(b)	(i)		award (1) for any of following • renewable source • does not use fossil fuels • method 2 gives two products (or biodiesel and propan-1,2,3-triol) • availability of raw materials	1			1		
		(ii)		award (1) each for any **two** of following • temperature conditions • pressure used • yield • rate • separation of products	2			2		2

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
		(iii)		award (1) for diagram **and** biodiesel labelled as top layer  award (1) for name of separating funnel	1		1	2		2
		(iv)		 partial / complete charges (1) curly arrows (1)		2		2		
				Question 9 total	**7**	**4**	**4**	**15**	**0**	**5**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
10	*(a)*	(i)		award (1) for either of following • sodium nitrite / nitrate(III) / $NaNO_2$ and HCl / hydrochloric acid • nitrous acid / nitric(III) acid / HNO_2 / HONO	1			1		1
		(ii)				1		1		
		(iii)		$f = \frac{c}{\lambda}$ (1) 7.32×10^{14} Hz (1)	1	1		2	2	
	(b)	(i)		number of moles = $\frac{0.0075 \times 250}{1000}$ = 1.875×10^{-3} (1) mass required = $272 \times 1.875 \times 10^{-3} = 0.51$ g (1)		2		2	1	
		(ii)		$\frac{1.44}{1.03} = \frac{k \times 0.0096}{k \times c}$ (1) $c = \frac{0.0096 \times 1.03}{1.44}$ = 6.87×10^{-3} / 0.00687 / 0.0069 mol dm^{-3} (1) accept alternative method $k = 150$ (1) c = 6.87×10^{-3} / 0.00687 / 0.0069 mol dm^{-3} (1)		2		2	2	

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(c)	(i)		$CH_3COOH + NH_2CONH_2 \rightarrow CH_3CONH_2 + CO_2 + NH_3$		1		1		
		(ii)		it contains a <u>nitrogen</u> atom that has a lone pair of electrons / is a proton acceptor		1		1		
		(iii)		the C=O absorption at 1650-1750 cm^{-1} decreases / the N—H absorption at 3300-3500 cm^{-1} decreases (1) the C≡N absorption at 2100-2250 cm^{-1} increases (1)		2		2		
		(iv)		award (1) for any of following • the benzene ring / negative electron cloud is not (easily) susceptible to attack by nucleophiles • the benzene ring / negative electron cloud is usually attacked by electrophiles • the C—Cl bond in chlorobenzene is stronger than the C—Cl aliphatic bond			1	1		
				Question 10 total	**2**	**10**	**1**	**13**	**5**	**1**

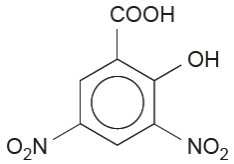
Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
11	*(a)*	(i)		**Indicative content** • flasks or beakers - suitable sizes • use of a fume cupboard • use of a thermometer and method of maintaining 60 °C temperature • stirring • filtration • filtered crystals washed with water • until filtrate is colourless (AO3) • reaction flask washed with water and contents added to filtering • apparatus • crystals removed and dried in a warm oven / at room temperature / below the melting temperature of the product (AO3)	4		2	6		6

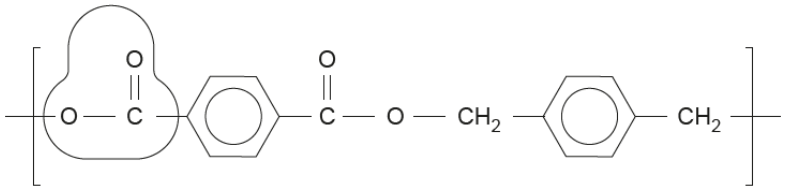
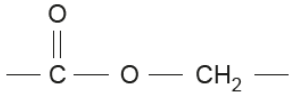
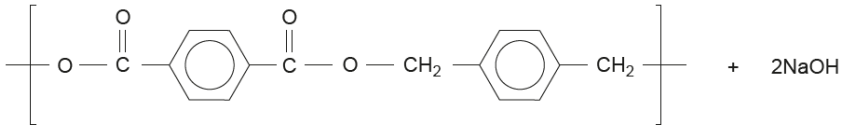
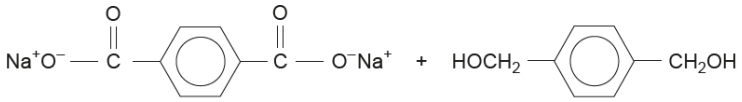
5-6 marks
Specific detail from the question has been used; reference to apparatus sizes, use of a fume cupboard for the reaction and washing the filtered crystals
The candidate constructs a relevant, coherent and logically structured account including key elements of the indicative content. A sustained and substantiated line of reasoning is evident and scientific conventions and vocabulary is used accurately throughout.

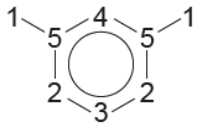
3-4 marks
Mainly generic description; use of a fume cupboard
The candidate constructs a coherent account including many of the key elements of the indicative content. Some reasoning is evident in the linking of key points and use of scientific conventions and vocabulary is generally sound.

1-2 marks
Reference to reaction and filtration stages
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
		(ii)		mole ratio 1:1 moles of 2-hydroxybenzoic acid used = $\frac{4.00}{138.06}$ = 0.0290 (1) theoretical moles of nitroacid = 0.290 theoretical mass of nitroacid = 5.306 / 5.31 g (1) percentage yield is 41 therefore mass obtained = $\frac{5.31 \times 41}{100}$ = 2.18 g (1)		3		3	2	
		(iii)		relative mass of compound **J** without two X groups ($C_7H_6O_3$) = 136 relative mass of two X groups is 228 – 136 = 92 each X group has mass of 46 (1) award (1) for either of following • X must contain 2 oxygen atoms (as 7 in total) atoms therefore remainder is 14 - other atom must be nitrogen and X is NO_2 • structure of compound **J** 			2	2		
		(iv)		lower temperature / lower concentration HNO_3 / lower volume of aqueous HNO_3 / less heating time			1	1		
	(b)			2-hydroxybenzenecarboxylic acid will react with $NaHCO_3$ / Na_2CO_3 to give effervescence	1			1		1
				Question 11 total	**5**	**3**	**5**	**13**	**2**	**7**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
12	*(a)*	(i)		 accept  circled	1			1		
		(ii)		  award (1) for correct formulae award (1) for balancing only if formulae are correct			2	2		
		(iii)		in condensation polymerisation a small molecule / H_2O / HCl is eliminated but no elimination in addition polymerisation	1			1		

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
		(iv)		5 environments correctly identified from the ^{13}C NMR spectrum and indicated on drawn structure of 1,3-dimethylbenzene (1) signals at 126-136 δ identified as aromatic (1) signal at 20 δ identified as aliphatic / CH_3 (1) 	1		2	3		
		(v)		must be an aromatic compound so at least 6 carbon atoms (1) molecular formula therefore likely to be $C_8H_6O_2$ (1) there are 2 additional carbon atoms therefore likely to be a dialdehyde **or** cannot be acid-aldehyde or alcohol-aldehyde or acid-alcohol as molecular formula does not fit (1) made by partial oxidation (of each methyl group) (1) formula is  (1)		2	3	5		

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(b)	(i)		award (1) for any of following • phosphorus(III) chloride / phosphorus trichloride / PCl_3 • phosphorus(V) chloride / phosphorus pentachloride / PCl_5 • sulfur dichloride oxide / thionyl chloride / $SOCl_2$	1			1		1
		(ii)		71g chlorine in 239.1 g decanedioyl dichloride (1) 0.977g chlorine in $\frac{239.1}{71} \times 0.977$ = 3.29 g dichloride percentage purity = $\frac{3.29}{3.50} \times 100$ = 94.0 (1)		1	1	2	2	
		(iii)		moisture/water gained entry to the bottle and hydrolysed the decanedioyl dichloride when it was previously opened			1	1		1
				Question 12 total	**4**	**3**	**9**	**16**	**2**	**2**

UNIT 4: ORGANIC CHEMISTRY AND ANALYSIS

SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	Total	Maths	Prac
Section A	2	7	1	10	0	3
8	3	7	3	13	3	1
9	7	4	4	15	0	5
10	2	10	1	13	5	1
11	5	3	5	13	2	7
12	4	3	9	16	2	2
Totals	23	34	23	80	12	19