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# **GCE A LEVEL MARKING SCHEME**

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**SUMMER 2017**

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

## **INTRODUCTION**

This marking scheme was used by WJEC for the 2017 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.

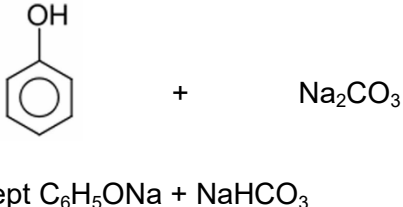
##### Marking abbreviations

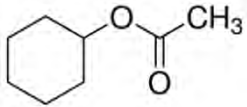
The following may be used in marking schemes or in the marking of scripts to indicate reasons for the marks awarded.

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

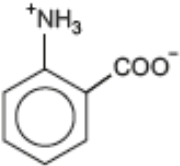
Credit should be awarded for correct and relevant alternative responses which are not recorded in the mark scheme.

## Section A


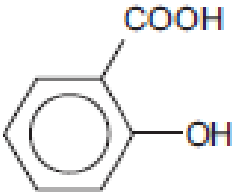
Question				Marking details		Marks available											
						AO1	AO2	AO3	Total	Maths	Prac						
1.				<table border="1"> <thead> <tr> <th>Reagent</th> <th>Observation</th> </tr> </thead> <tbody> <tr> <td>iron(III) chloride</td> <td>purple coloration / solution</td> </tr> <tr> <td>sodium hydroxide</td> <td>no observation / change</td> </tr> </tbody> </table>		Reagent	Observation	iron(III) chloride	purple coloration / solution	sodium hydroxide	no observation / change	2			2		2
Reagent	Observation																
iron(III) chloride	purple coloration / solution																
sodium hydroxide	no observation / change																
2.				C <sub>6</sub> H <sub>8</sub> O <sub>3</sub>			1		1								
3.							1		1								
4.				sodium tetrahydridoborate(III) / sodium borohydride / NaBH <sub>4</sub>		1			1		1						
5.				total relative peak area = 36 + 18 + 13 = 67 % 1,3-dimethylbenzene = 18 × 100 / 67 = 26.87 = 27			1		1	1							
6.				1-propyl ethanoate (accept propyl ethanoate)			1		1								

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
7.						1		1		
8.				<p><b>A</b> nitric(III) acid / <math>\text{HNO}_2</math> / sodium nitrate(III) and hydrochloric acid / <math>\text{NaNO}_2</math> and <math>\text{HCl}</math> (1)</p> <p><b>B</b> acidified dichromate / <math>\text{Cr}_2\text{O}_7^{2-}</math> and <math>\text{H}^+</math> (1)</p>	2					2
				<b>Section A total</b>	<b>5</b>	<b>5</b>	<b>0</b>	<b>10</b>	<b>1</b>	<b>5</b>

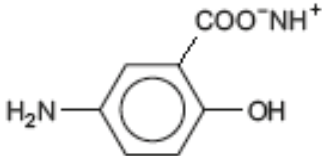
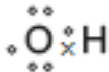
## Section B

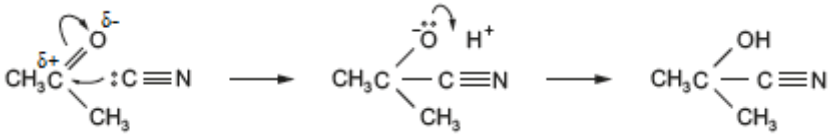
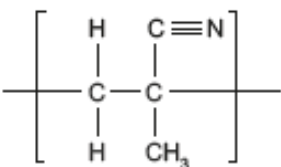
Question			Marking details	Marks available						
				AO1	AO2	AO3	Total	Maths	Prac	
9.	(a)	(i)	sulfur oxide dichloride / thionyl chloride / $\text{SOCl}_2$ phosphorus(III) chloride / $\text{PCl}_3$ phosphorus(V) chloride $\text{PCl}_5$	1			1		1	
		(ii)	it does not absorb in the visible region	1			1			
		(iii)	loss of $191 - 91 / 100$ (1)  could be $(\text{C}_2\text{H}_5)_2\text{N}-\text{C}=\text{O}$ which has $M_r$ of $29 + 29 + 14 + 28 = 100$ (1)  accept $\text{C}_5\text{H}_{10}\text{NO}$			2	2			
(b)	(i)	alkaline potassium manganate(VII) solution / $\text{MnO}_4^- + \text{OH}^-$	1			1		1		
	(ii)	as the reaction is carried out in alkaline solution the salt of the acid rather than the acid itself is produced			1	1		1		
(c)	(i)				1		1			
			(ii)	the ester contains a basic $-\text{NH}_2$ group which can accept a proton		1		1		
			(iii)	I water is produced as during the esterification reaction / an aqueous solution of sodium carbonate has been added		1		1		1
		II electrically heated / hot water bath			1	1		1		

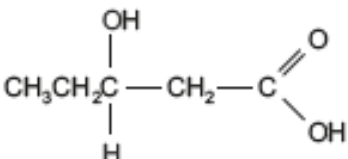
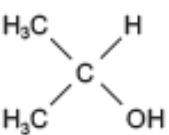
Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
	(d)	(i)	$2.0 \times 10^{-5}$		1		1	1	
		(ii)	<p>as BA is produced it dissolves preferentially in the hexane (1)</p> <p>this removes BA from the reaction and moves the position of equilibrium to the right (1)</p> <p>2-aminobenzoic acid remains largely in the aqueous alcohol mixture (1)</p>			3	3		3
			<b>Question 9 total</b>	<b>3</b>	<b>4</b>	<b>7</b>	<b>14</b>	<b>1</b>	<b>8</b>

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
10.	(a)	(i)	  (1)						
		(ii)	the wavelength of the light absorbed increases as the pH increases; in the visible spectrum, violet has the shortest wavelength and this increases as the colour moves towards red			1	1		
		(iii)	$f = c / \lambda$ $f = 3.00 \times 10^8 / 385 \times 10^{-9}$ (1) $f = 7.79 \times 10^{14}$ (1)	1	1		2	2	
		(iv)	$E = hf$ $E = 6.63 \times 10^{-34} \times 7.79 \times 10^{14}$ (1) $E = 5.16 \times 10^{-19}$ (1) $E = 5.16 \times 10^{-19} \times 6.02 \times 10^{23} = 310684 \text{ J mol}^{-1} = 310.68 \text{ kJ mol}^{-1}$ 311 (1) ecf from part (ii)		3		3	1	

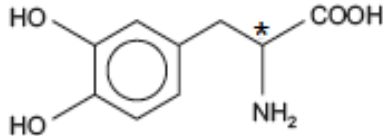
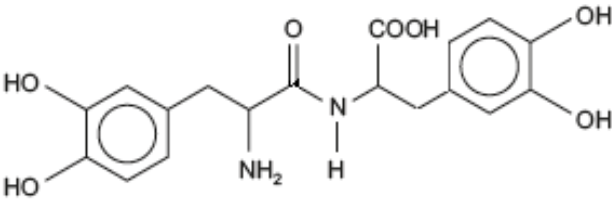


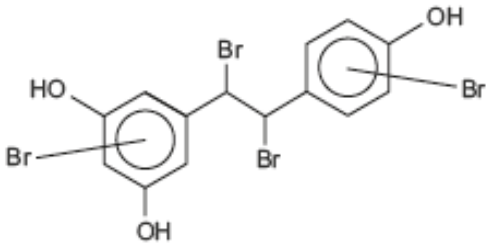
Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
(b)	(i)		tin (or iron) and concentrated hydrochloric acid	1			1		1
	(ii)		there are two signals of equal size / area (1)  the 4 aromatic protons are in identical environments and give singlet / no splitting (1)  the 4 NH <sub>2</sub> protons are in identical environments and give singlet / no splitting (1)			3	3		
	(iii)				1		1		
	(iv)				1		1		
			<b>Question 10 total</b>	<b>2</b>	<b>8</b>	<b>4</b>	<b>14</b>	<b>4</b>	<b>1</b>

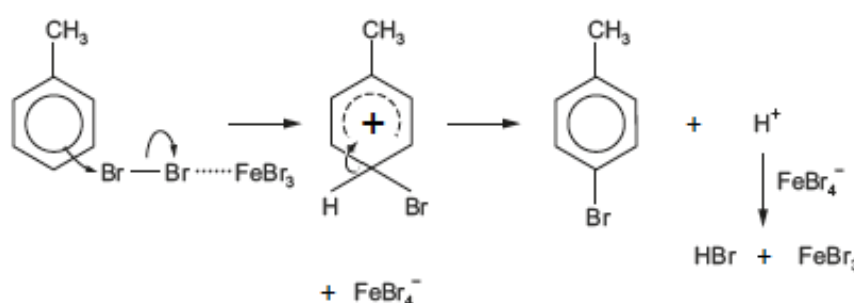
Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
11.	(a)	(i)	 <p>nucleophilic addition (1) curly arrows (1) partial / full charges (1)</p>	3			3		
		(ii)	<p>incomplete extraction by ethoxyethane (1)</p> <p>incomplete distillation / decomposition of product (1)</p>			2	2		2
		(iii)	<p>moles of propanone used = <math>17.4 / 58.06 = 0.300</math> (1)</p> <p>1:1 molar ratio <math>\Rightarrow</math> 0.300 mol of 2-hydroxy-2-methylpropanenitrile</p> <p>mass of 2-hydroxy-2-methylpropanenitrile = <math>0.300 \times 85.07 = 25.5</math> g (1)</p> <p>percentage yield = <math>18.6 \times 100 / 25.5 = 73\%</math> (1)</p>			3	3	2	
		(iv)			1		1		

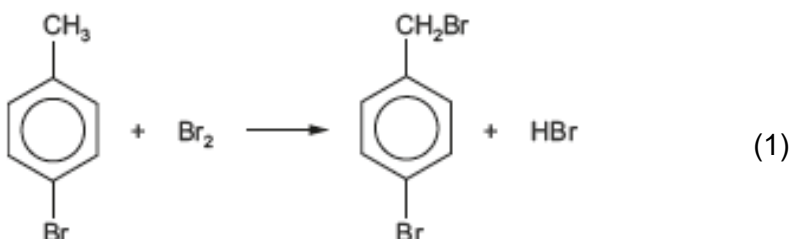
Question		Marking details		Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
	(b)		 <p>(1)</p> <p>balancing i.e. n monomer units <b>and</b> nH<sub>2</sub>O molecules on product side (1)</p>			1	2		
	(c)		<p>in condensation polymerisation a small molecule e.g. water is lost; this does not occur with addition polymerisation</p> <p>accept alternatives e.g. different numbers of monomer types, functional groups, atom economy</p> <p>must refer to both types of polymerisation</p>	1			1		
	(d)	(i)	surround the flask with a cold water bath	1			1		1
		(ii)	<p>1 mol <math>\equiv</math> 24500 cm<sup>3</sup> of hydrogen from 2 mol of the alcohol</p> <p>184 cm<sup>3</sup> from <math>184 \times 2 / 24500 = 0.015</math> mol of the alcohol (1)</p> <p><math>M_r = 0.900 / 0.015 = 60</math> (1)</p>			2	2	1	2
		(iii)	 <p>e/c possible from incorrect <math>M_r</math> in part (ii)</p>			1	1		1
			<b>Question 11 total</b>	<b>5</b>	<b>8</b>	<b>3</b>	<b>16</b>	<b>3</b>	<b>6</b>



			<p><b>5-6 marks</b> Correct structure given; reference to all information provided <i>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 are used accurately throughout.</i></p> <p><b>3-4 marks</b> Molecular formula obtained but insufficient chemical deductions to obtain the correct structure <i>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.</i></p> <p><b>1-2 marks</b> Some use of analytical results and / or chemical deductions but insufficient to suggest a structure <i>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.</i></p> <p><b>0 marks</b> <i>The candidate does not make any attempt or give an answer worthy of credit.</i></p>						
(b)	(i)			1		1			
	(ii)	<p>one isomer rotates the plane to the left and the other to the right (1)</p> <p>isomers present in equimolar amounts therefore the effect of rotation is cancelled out (1)</p>	2			2		2	
	(iii)			1		1			

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
	(c)	(i)	benzene compounds are very resistant to addition reactions and this would destroy the stable ring system of electrons / needs too much energy	1			1		
		(ii)	 <p>at least one Br needed on both rings (any position)</p>			1	1		
			<b>Question 12 total</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>12</b>	<b>0</b>	<b>5</b>

Question			Marking details	Marks available						
				AO1	AO2	AO3	Total	Maths	Prac	
13.	(a)	(i)	<p>it is compound <b>N</b> (1)</p> <p>singlet for the —CH<sub>3</sub> group bonded to the carbon atom of the double bond that is also bonded to the bromine atom (2.2δ) (1)</p> <p>the CH proton is as a quartet – split by the adjacent CH<sub>3</sub> protons (5.7δ) (1)</p> <p>the other —CH<sub>3</sub> group is a doublet, split by the adjacent CH proton (1.7δ) (1)</p>			4	4			
		(ii)	I	<p>add aqueous bromine / aqueous acidified manganate(VII) – this is decolourised by <b>L</b>, <b>M</b> and <b>N</b> but unaffected by bromocyclobutane</p>		1		1		1
			II	<p>bromocyclobutane would only give three <sup>13</sup>C signals (1)</p> <p><b>L</b>, <b>M</b> and <b>N</b> would each give four signals as each carbon atom is in a different environment for these alkenes (1)</p> <p>accept answer based on C=C at δ 90 to 150 present in <b>L</b>, <b>M</b> and <b>N</b> but not in bromocyclobutane</p>		2		2		
	(b)		 <p>curly arrows (1)</p> <p>partial / full charges (1)</p> <p>regeneration of catalyst (1)</p>	3			3			

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
(c)	(i)		 <p>1:1 molar ratio  <math>0.150 \times 159.8 = 23.97 \text{ g}</math> (1)</p>		2		2		
	(ii)		potassium cyanide / sodium cyanide	1					1
	(iii)		dilute sulfuric acid / hydrochloric acid	1					1
			<b>Question 13 total</b>	<b>5</b>	<b>5</b>	<b>4</b>	<b>14</b>	<b>0</b>	<b>3</b>



## UNIT 4: ORGANIC CHEMISTRY AND ANALYSIS

### SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	Total	Maths	Prac
<b>Section A</b>	<b>5</b>	<b>5</b>	<b>0</b>	<b>10</b>	<b>1</b>	<b>5</b>
<b>9.</b>	<b>3</b>	<b>4</b>	<b>7</b>	<b>14</b>	<b>1</b>	<b>8</b>
<b>10.</b>	<b>2</b>	<b>8</b>	<b>4</b>	<b>14</b>	<b>4</b>	<b>1</b>
<b>11.</b>	<b>5</b>	<b>8</b>	<b>3</b>	<b>16</b>	<b>3</b>	<b>6</b>
<b>12.</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>12</b>	<b>0</b>	<b>5</b>
<b>13.</b>	<b>5</b>	<b>5</b>	<b>4</b>	<b>14</b>	<b>0</b>	<b>3</b>
<b>Totals</b>	<b>23</b>	<b>34</b>	<b>23</b>	<b>80</b>	<b>9</b>	<b>28</b>

WJEC GCE A Level Chemistry Unit 4 MS (New) Summer 2017/ED