



GCE A LEVEL MARKING SCHEME

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

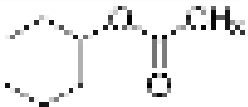
The following may be used in marking schemes or in the marking of scripts to indicate reasons for the marks awarded.

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

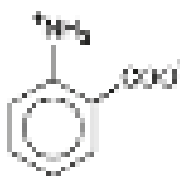
Credit should be awarded for correct and relevant alternative responses which are not recorded in the mark scheme.

Section A

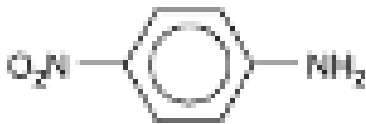

Question				Marking details	Marks available											
					AO1	AO2	AO3	Total	Maths	Prac						
1.				<table><tr><td>Reagent</td><td>Observation</td></tr><tr><td>iron(III) chloride</td><td>purple coloration / solution</td></tr><tr><td>sodium hydroxide</td><td>no observation / change</td></tr></table>	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 ₆ H ₈ O ₃		1		1								
3.				<div></div> + Na ₂ CO ₃ accept C ₆ H ₅ ONa + NaHCO ₃		1		1								
4.				sodium tetrahydridoborate(III) / sodium borohydride / NaBH ₄	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								

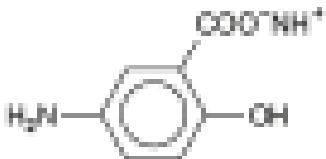

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
7.						1		1		
8.				A nitric(III) acid / HNO_2 / sodium nitrate(III) and hydrochloric acid / NaNO_2 and HCl (1) B acidified dichromate / $\text{Cr}_2\text{O}_7^{2-}$ and H^+ (1)	2					2
				Section A total	5	5	0	10	1	5


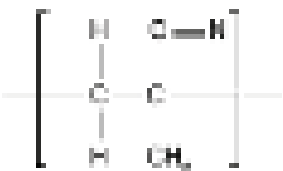
Section B

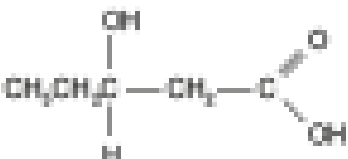

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
9.	(a)	(i)		sulfur oxide dichloride / thionyl chloride / SOCl_2 phosphorus(III) chloride / PCl_3 phosphorus(V) chloride PCl_5	1			1		1
		(ii)		it does not absorb in the visible region	1			1		
		(iii)		loss of $191 - 91 / 100$ (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)		2.0×10^{-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
				Question 9 total	3	4	7	14	1	8

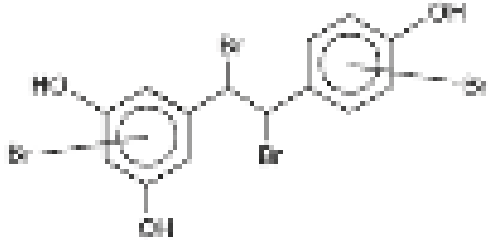
Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
10.	(a)	(i)		  (1)		2		2		
		(ii)		the wavelength of the light absorbed increases as the pH increases; in the visible spectrum, violet has the shortest wavelength and this increases as the colour moves towards red			1	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	1

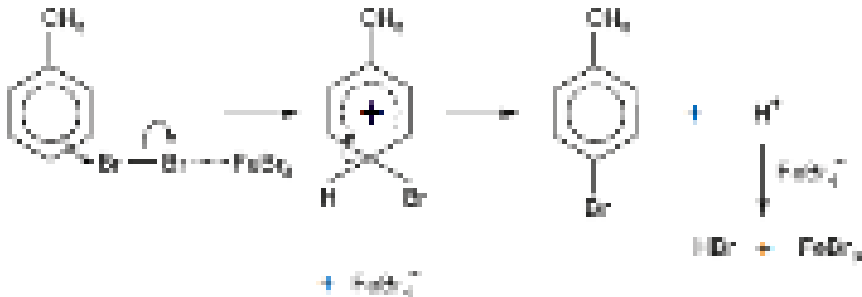
Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(b)	(i)		tin (or iron) and concentrated hydrochloric acid	1			1		1
		(ii)		<p>there are two signals of equal size / area (1)</p> <p>the 4 aromatic protons are in identical environments and give singlet / no splitting (1)</p> <p>the 4 NH₂ protons are in identical environments and give singlet / no splitting (1)</p>			3	3		
		(iii)				1		1		
		(iv)				1		1		
				Question 10 total	2	8	4	14	4	1

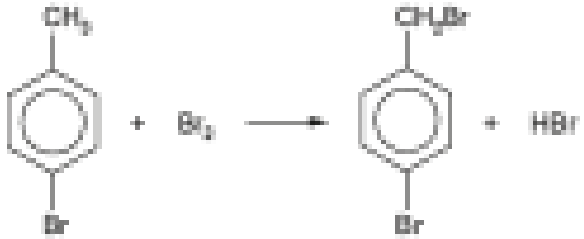
Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
11.	(a)	(i)		 <p>nucleophilic addition (1) curly arrows (1) partial / full charges (1)</p>	3			3		
		(ii)		<p>incomplete extraction by ethoxyethane (1)</p> <p>incomplete distillation / decomposition of product (1)</p>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

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

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
12.	(a)		<p>Indicative content 65.2 % of carbon and M_r 184 ‘M_r’ of the carbon content is $65.2 \times 184 / 100 = 120$ therefore must be 10 carbon atoms</p> <p>26.1 % of oxygen and M_r 184 ‘M_r’ of the oxygen content is $26.1 \times 184 / 100 = 48$ therefore must be 3 oxygen atoms</p> <p>remaining mass 16 therefore must be 16 hydrogen atoms</p> <p>\Rightarrow molecular formula is C₁₀H₁₆O₃</p> <p>straight chain, double bond between carbons 2 and 3 and an <i>E</i>-isomer</p> <div style="text-align: center;"> </div> <p>2,4-DNP derivative, but no silver mirror therefore must be a ketone</p> <p>gives the triiodomethane test therefore must contain CH₃C=O group; these must be carbon atoms 9 and 10</p> <p>effervescence therefore must be a carboxylic acid; not branched, therefore carbon 1 must be the carboxylic acid group</p> <p>formula must be</p> <div style="text-align: center;"> </div>						
					2	4	6		3

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		
				Question 12 total	3	4	5	12	0	5

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
13.	(a)	(i)		<p>it is compound N (1)</p> <p>singlet for the —CH₃ 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 CH₃ protons (5.7δ) (1)</p> <p>the other —CH₃ 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 L, M and N but unaffected by bromocyclobutane</p>		1		1		1
			II	<p>bromocyclobutane would only give three ¹³C signals (1)</p> <p>L, M and N 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 L, M and N 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 $0.150 \times 159.8 = 23.97 \text{ g}$ (1)</p>		2		2		
		(ii)		potassium cyanide / sodium cyanide	1					1
		(iii)		dilute sulfuric acid / hydrochloric acid	1					1
				Question 13 total	5	5	4	14	0	3

UNIT 4: ORGANIC CHEMISTRY AND ANALYSIS

SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

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