GCE A LEVEL MARKING SCHEME

A LEVEL
CHEMISTRY
1410U30 – 1

About this marking scheme

The purpose of this marking scheme is to provide teachers, learners, and other interested parties, with an understanding of the assessment criteria used to assess this specific assessment.

This marking scheme reflects the criteria by which this assessment was marked in a live series and was finalised following detailed discussion at an examiners' conference. A team of qualified examiners were trained specifically in the application of this marking scheme. The aim of the conference was to ensure that the marking scheme was interpreted and applied in the same way by all examiners. It may not be possible, or appropriate, to capture every variation that a candidate may present in their responses within this marking scheme. However, during the training conference, examiners were guided in using their professional judgement to credit alternative valid responses as instructed by the document, and through reviewing exemplar responses.

Without the benefit of participation in the examiners' conference, teachers, learners and other users, may have different views on certain matters of detail or interpretation. Therefore, it is strongly recommended that this marking scheme is used alongside other guidance, such as published exemplar materials or Guidance for Teaching. This marking scheme is final and will not be changed, unless in the event that a clear error is identified, as it reflects the criteria used to assess candidate responses during the live series.

WJEC GCE A LEVEL CHEMISTRY

PHYSICAL AND ORGANIC CHEMISTRY

GENERAL INSTRUCTIONS

Recording of marks

Examiners must mark in red ink.

One tick must equate to one mark (apart from the 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.

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.

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

Extended response question

A level of response mark scheme is used. Before applying the mark scheme please read through the whole answer from start to finish. Firstly, decide which level descriptor matches best with the candidate's response: remember that you should be considering the overall quality of the response. Then decide which mark to award within the level. Award the higher mark in the level if there is a good match with both the content statements and the communication statement. Award the middle mark in the level if most of the content statements are given and the communication statement is partially met. Award the lower mark if only the content statements are matched.

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

AVAILABLE MARKS

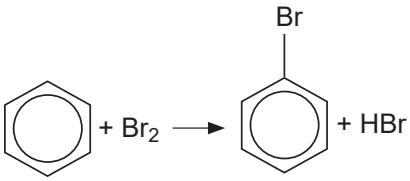
1 **(a)** **(i)**

Reaction of benzene	Name of organic product	Name of catalyst
with bromine	bromobenzene	iron/iron(III) bromide/ aluminium bromide [1]
with ethanoyl chloride	phenylethanone [1]	iron(III) chloride/ aluminium chloride [1]

[3]

(ii) $C_6H_6 + Br_2 \rightarrow C_6H_5Br + HBr$ [1]

or



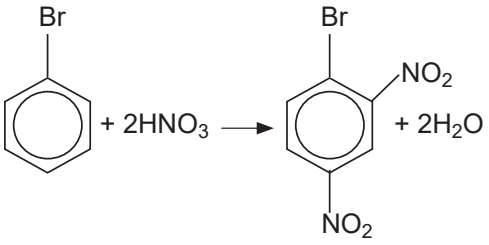
(iii) electrophilic substitution [1]

(b) **(i)** concentrated sulfuric acid [1]
concentrated nitric acid [1] [2]

(ii) $2H_2SO_4 + HNO_3 \rightarrow NO_2^+ + H_3O^+ + 2HSO_4^-$ [2]

(iii) $C_6H_5Br + 2HNO_3 \rightarrow C_6H_3(NO_2)_2Br + 2H_2O$

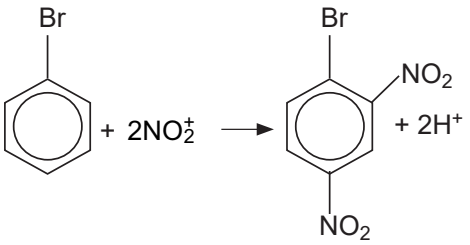
or



or

$C_6H_5Br + 2NO_2^+ \rightarrow C_6H_3(NO_2)_2Br + 2H^+$

or



[1]

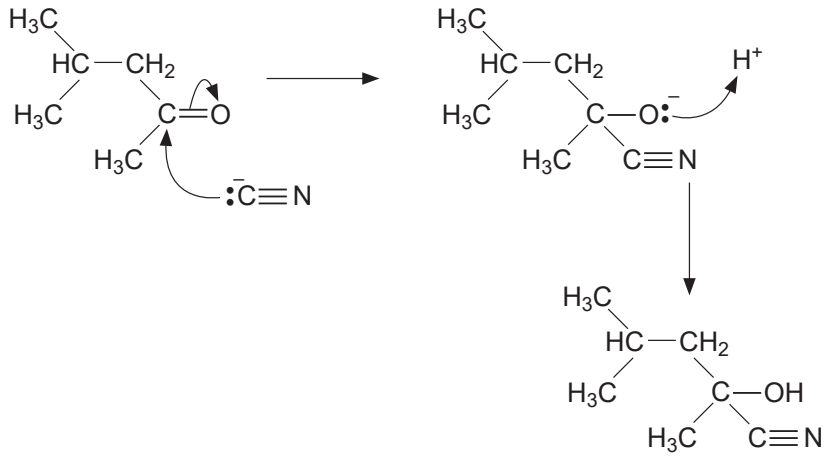
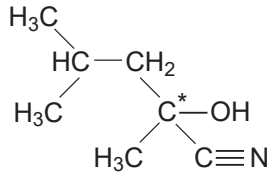
AVAILABLE MARKS

(e) **(i)** $LiAlH_4$ [1]

(ii) reduction [1]

(iii) $HOOCCH_2COOH + 8[H] \rightarrow HOCH_2CH_2CH_2OH + 2H_2O$ [2]

14

				AVAILABLE MARKS
2	**(a)**	**(i)**		
			3 curly arrows correct [1] correct charges on ^{-}CN, O^{-}, H^{+} [1] lone pairs on C of ^{-}CN and O^{-} of intermediate [1] [3]	
		(ii)	nucleophilic addition [1]	
		(iii)	4-methylpentan-2-one [1]	
	(b)	**(i)**	an atom which has four different atoms or groups attached [1]	
		(ii)	 [1]	
		(iii)	CN^{-} attack equally probable from top or bottom/racemic mixture/equal concentrations of both optical isomers formed [1]	
	(c)	**(i)**	2-hydroxy-2,4-dimethylpentanoic acid [2]	
		(ii)	ammonia [1]	
		(iii)	ethanal [1]	12
			Section B	**100**
			Total	**110**

3

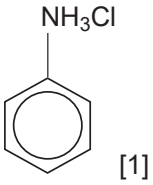
AVAILABLE MARKS

(b) **(i)** nitrobenzene [1]

(ii) tin [1]
concentrated hydrochloric acid [1] [2]

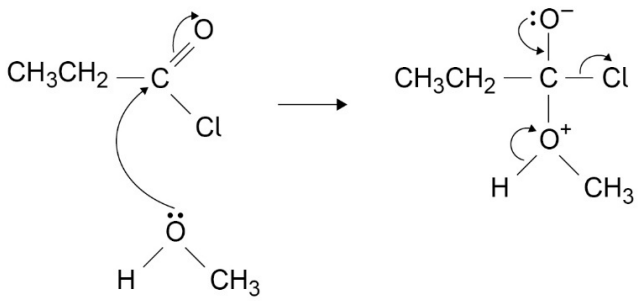
(iii) reduction [1]

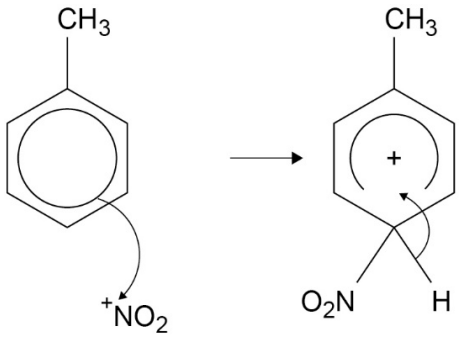
(iv)

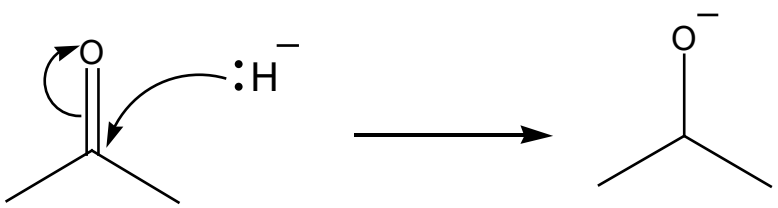


[1]

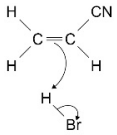
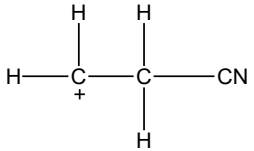
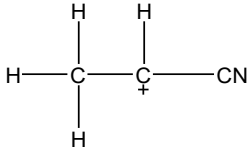
name: phenylammonium chloride [1] [2]

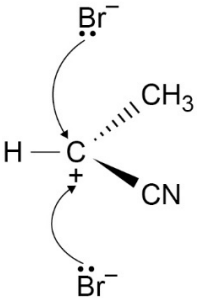
Question	Answers	Additional Comments/Guidelines	Mark
4 .1		M1 Structures of reactant species M2 Arrow from lp on O to C M3 Arrow from C=O bond to O M4 3 curly arrows and lp on intermediate Allow full marks for candidates who draw a second intermediate formed after formation of C=O and loss of Cl^- then loss of H^+ Ignore any attempt to show the final products	4 (4 x AO1)

Question	Answers	Additional Comments/Guidelines	Mark
4 .2	 M4 Electrophilic substitution	M1 Structures of reactant species including + on N of $^+NO_2$ M2 Arrow from ring (inside hexagon) to N or + on N M3 Arrow from C-H bond into hexagon Apply list principle	4 (4 x AO1)

Question	Answers	Additional Comments/Guidelines	Mark
4 .3	 M4 Nucleophilic addition	M1 Arrow from lp on hydride to C M2 Arrow from C=O to O M3 Intermediate structure / Allow displayed or abbreviated structures Ignore any attempt to show further steps if correct Penalise further incorrect steps Apply list principle	4 (4 x AO1)

Question	Answers	Additional Comments/Guidelines	Mark
5 .1	3-bromopropan<u>e</u>nitrile	Allow 3-bromopropan<u>e</u>-1-nitrile	1 (AO1)

<table>
<tr><th>Question</th><th colspan="2">Answers</th><th>Additional Comments/Guidelines</th><th>Mark</th></tr>
<tr><td rowspan="5">5 .2</td><td colspan="2">This question is marked using Levels of Response. Refer to the Mark Scheme Instructions for Examiners for guidance.</td><td rowspan="5">Indicative Chemistry content
Stage 1 Types of Isomers formed
1a $CH_3CHBrCN$
1b Exists as two Optical isomers / enantiomers
Stage 2 Mechanism
2a 2 curly arrows
 
2b Intermediate structure primary carbocation OR
 
2c Alternative Intermediate structure secondary carbocation OR
  </td><td rowspan="5">6
(3 x AO1,
3 x AO3)</td></tr>
<tr><td>Level 3
5–6 marks</td><td>All stages are covered and each stage is generally correct and virtually complete.
Answer is communicated coherently and shows a logical progression from Stage 1 to Stages 2 and 3.</td></tr>
<tr><td>Level 2
3–4 marks</td><td>All stages are covered but stage(s) may be incomplete or may contain inaccuracies
OR two stages are covered and are generally correct and virtually complete.
Answer is communicated mainly coherently and shows a logical progression from Stage 1 to Stages 2 and 3.</td></tr>
<tr><td>Level 1
1–2 marks</td><td>Two stages are covered but stage(s) may be incomplete or may contain inaccuracies OR only one stage is covered but is generally correct and virtually complete.
Answer includes isolated statements but these are not presented in a logical order.</td></tr>
<tr><td>0 mark</td><td>Insufficient correct chemistry to gain a mark.</td></tr>
</table>

		Stage 3 Optical isomerism 3a 2-bromo isomer has chiral carbon / C with four different groups / non superimposable mirror images OR  3b Optical because (secondary) C^+ planar 3c So can be attacked from above or below  	

Question	Answers	Additional Comments/Guidelines	Mark
5 4.3	M1 KCN or NaCN M2 Aqueous AND ethanol (alcohol)	Penalise acid in M1	2 (2 x AO1)

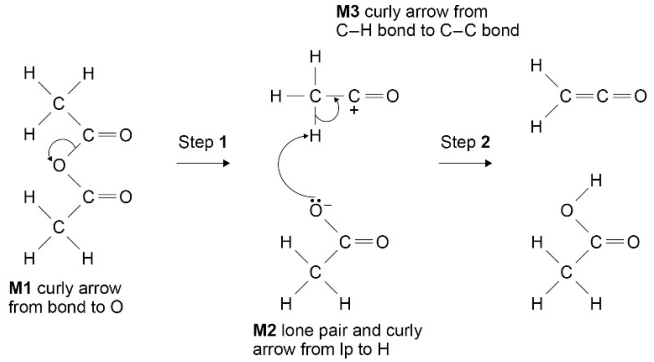
Question	Answers	Additional Comments/Guidelines	Mark
5 4.4	M1 H_2 and Ni/Pt/Pd M2 $NCCH_2CH_2CN + 4H_2 \rightarrow H_2N(CH_2)_4NH_2$	Allow $LiAlH_4$ and (Dry) ether BUT <u>not</u> $NaBH_4$ (ignore heat and pressure) Allow with 8[H]	2 (1 x AO1, 1 x AO2)

Question	Answers	Additional Comments/Guidelines	Mark
06.1	Use H_2SO_4	Allow HCl / H_3PO_4 Ignore conc / dilute	1 (AO1)

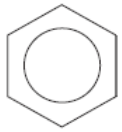
Question	Answers	Additional Comments/Guidelines	Mark
06.2	M1 Cool test 2 warm (water bath) M2 Gas is tested with lighted splint in test 3 Bubble into limewater	 Allow heat / hot Allow no test on gas needed	2 (2 x AO3)

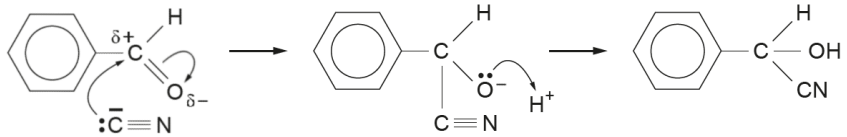
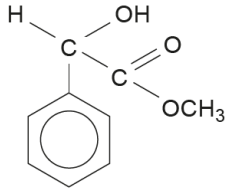
Question	Answers	Additional Comments/Guidelines	Mark
06.3	M1 J and M M2 Test 1 (Orange solution goes) green M3 M M4 Test 2 (Blue solution gives a brick) red precipitate M5 J and L M6 Test 3 (Colourless gas that turns) limewater cloudy M7 K M8 Test 4 (Orange solution goes) colourless	 Allow (Brown-red/orange/orange-red) Allow M6 Test 3 fizz / effervescence Allow (Brown/Brown-red/yellow/yellow-orange) Allow decolorises bromine	8 (8 x AO3)

Question	Answers	Additional Comments/Guidelines	Mark
7 1	$C_nH_{2n-2}O$	Allow $C_nH_{2n}CO$ or $(CH_2)_nCO$ or $C_nH_{2(n-1)}O$	1 (AO2)

Question	Answers	Additional Comments/Guidelines	Mark
7 2		Allow other C-O bond breaking for M1	3 (3 x AO2)

8

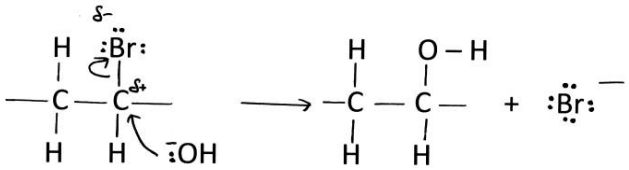
Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
8	(c)	(i)		$LiAlH_4$	1			1		
		(ii)			1			1		
		(iii)		dehydration accept elimination			1	1		
	(d)			add $NaHCO_3$ / Na_2CO_3 (1) effervescence with the most acidic (1)		2		2		2
				Question 7 total	**5**	**6**	**4**	**15**	**1**	**5**

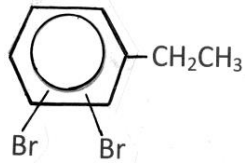
Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
9	(a)	(i)	I	 award (1) each for up to **three** of following curly arrows and addition of ^{-}CN capture of H^{+} partial and full charges dissociation of HCN into H^{+} and ^{-}CN		3		3		
			II	nucleophilic addition	1			1		
		(iii)		it is a racemic mixture / an equimolar mixture of the two enantiomers			1	1		
		(iv)		it does not contain a chiral centre / no asymmetric carbon atom		1		1		
		(v)	I	it acts as a carboxylic acid 		1	1	2		
			II	it acts as an alcohol (giving an ester)		1		1		

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(b)	(i)		orange to green (accept colourless to green)	1			1		1
		(ii)		**Indicative content** • distillate placed in a separating funnel • add water to the distillate • add ethoxyethane to the funnel • equal volume of ethoxyethane as distillate • (stopper) and shake • allow to separate • run off lower aqueous layer • treat ethoxyethane layer with anhydrous magnesium sulfate • remove magnesium sulfate (by filtration/decanting) • remove ethoxyethane by distillation • use of heating mantle		3	3	6		6
				5-6 marks All the essential steps described in logical order to ensure a dry sample of pentan-2-one *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 correct steps described (although order may not be correct); safe method involving no naked flames *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 correct steps in separation method *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)		no peak seen at 3200-3500 cm^{-1} (due to the OH group in the alcohol) accept no peak seen at 1000-1300 cm^{-1} (due to the C—O group in the alcohol)		1		1		
		(iv)		alkaline iodine / KI and NaOCl (1) yellow precipitate / solid forms (1) do **not** accept 2,4-DNPH test		2		2		2
				Question 10 total	**3**	**12**	**5**	**20**	**0**	**9**

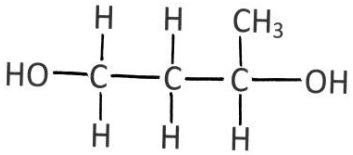
Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
10	(a)	(i)		(deep) blue Fehling's solution (1) gives a red / brown precipitate (1)	2			2		2
		(ii)		award (1) for name/formula of any aliphatic aldehyde e.g. propanal / CH_3CH_2CHO do not accept benzaldehyde / C_6H_5CHO		1		1		
	(b)	(i)		nucleophilic addition	1			1		
		(ii)		decomposition by water / dilute acid	1			1		
	(c)			award (1) each for any **two** of following loss of (volatile) ethanal incomplete oxidation / further oxidation side reactions			2	2		2
	(d)			moles of NaOH = $0.200 \times \frac{40.0}{1000}$ = 0.0080 mol (1) moles of lactic acid reacted = 0.0080 mol mass of lactic acid reacted = 0.0080 × 90.06 = 0.72 g (1) volume of lactic acid = $\frac{0.72}{1.2}$ = 0.60 cm^3 percentage = $\frac{0.60}{75} \times 100$ = 0.8% (1)		2	1	3	1	

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
11		(iii)	I	H^+ / $H^{\delta+}$		1		1		
			II	 curly arrows (1) partial charges (1)		1	1	2		
			III	if not present in excess the added sodium hydroxide will simply neutralise the two COOH groups present			1	1		1
			IV	the bromine atom has higher electronegativity and attracts both electrons from the C—Br bond (resulting in heterolytic fission)		1		1		
				Question 7 total	**7**	**7**	**3**	**17**	**0**	**4**

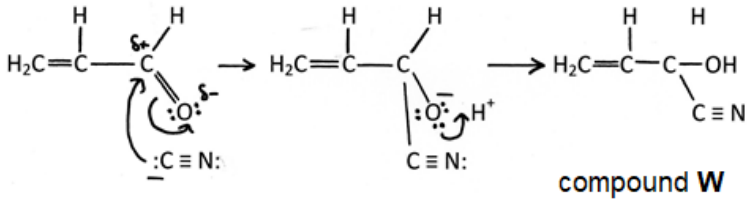
Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
12	(a)	(i)		bromine and iron(III) bromide / Br_2 and $FeBr_3$		1		1		1
		(ii)		17	1			1		1
		(iii)	I	award (1) for both of following structures 		1				
				substitution can occur elsewhere in the ring (1)	1			2		
			II			1		1		
	(b)			alcoholic sodium hydroxide solution (1)		1				
				a small molecule / HBr is removed (1)	1			2		2
	(c)			add aqueous bromine dropwise (1)		1				
				bromine decolourised (1)	1			2		2

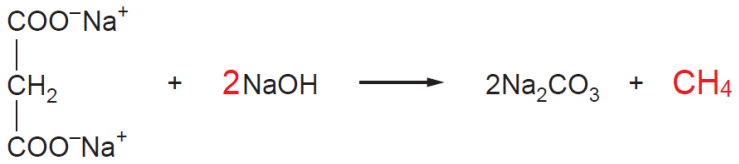
Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(d)	(i)		to react with benzoic acid (1) to give water soluble sodium benzoate (1) (other possible correct answers to discussed at the examiners' conference)			2	2		
		(ii)		the density of trichloromethane is greater than the density of the aqueous layer		1		1		1
		(iii)		moles of phenylethene = $\frac{3.00}{104}$ = 0.289 mol (1) moles of phenyloxirane = $\frac{2.50}{120}$ = 0.208 mol (1) mole ratio is 1:1 percentage yield = $\frac{0.208}{0.289}$ × 100 = 71.9% (1)		3		3	2	
	(e)			a peak would be seen between 1650 and 1750 cm^{-1} (1) indicating the presence of the C=O group (1)	2			2		

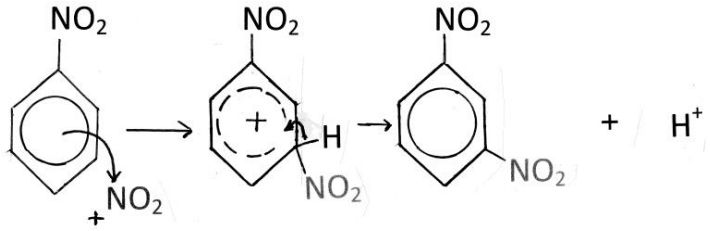
<table>
<tr><th colspan="4" rowspan="2">Question</th><th rowspan="2">Marking details</th><th colspan="6">Marks available</th></tr>
<tr><th>AO1</th><th>AO2</th><th>AO3</th><th>Total</th><th>Maths</th><th>Prac</th></tr>
<tr><td></td><td>(f)</td><td></td><td></td><td>
<table>
<tr><th>Test</th><th>phenylethanal
$C_6H_5CH_2CHO$</th><th>phenylethanone
$C_6H_5C(O)CH_3$</th></tr>
<tr><td>alkaline iodine</td><td>no observable reaction</td><td>yellow precipitate formed</td></tr>
<tr><td>Tollens' reagent</td><td>silver mirror formed</td><td>no observable reaction</td></tr>
<tr><td>warming with acidified potassium dichromate</td><td>solution turns from orange to green</td><td>no observable reaction</td></tr>
</table>
award (3) for all correct
award (2) for any four or five correct
award (1) for any two or three correct
</td><td></td><td>3</td><td></td><td>3</td><td></td><td>3</td></tr>
<tr><td></td><td></td><td></td><td></td><td>Question 8 total</td><td>6</td><td>12</td><td>2</td><td>20</td><td>2</td><td>10</td></tr>
</table>

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
13	(f)						1	1		
				Question 9 total	**2**	**7**	**9**	**18**	**1**	**1**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
14	(b)	(i)	I	$ClCH_2(CH_2)_2CH_2Cl + 2KCN \rightarrow NC(CH_2)_4CN + 2KCl$		1		1		
			II	^{-}CN	1			1		
			III	award (1) for any of following lithium tetrahydridoaluminate(III) / $LiAlH_4$ hydrogen with Ni catalyst sodium and ethanol	1			1		1

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
15		(v)	I	 compound **W** award (1) for appropriate charges award (1) for curly arrows		2		2		
			II	initial attack is by the nucleophile $^{-}$CN (1) HCN adds across the C=O bond (1)	2			2		

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(b)	(i)		lithium tetrahydridoaluminate(III) / $LiAlH_4$ (1) hydrogen is added / oxygen is lost (1)	2			2		
		(ii)		benzene-1,4-dioic acid accept terephthalic acid		1		1		
	(c)	(i)				2		2		
		(ii)		sodium hydrogencarbonate / $NaHCO_3$ (1) accept sodium carbonate / Na_2CO_3 reaction complete when no more effervescence seen (1) phenol does not react with sodium hydrogencarbonate (to give carbon dioxide) (1)		3		3		3
		(iii)		no purple coloration seen			1	1		1
				Question 11 total	**5**	**12**	**1**	**18**	**1**	**4**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
16	(b)	(i)				2		2		
		(ii)	I	Fe / Sn and hydrochloric acid	1			1		1
			II	NaOH / sodium hydroxide	1			1		1
		(iii)		HNO_2 / $NaNO_2$, HCl / nitric(III) acid / sodium nitrate(III) and hydrochloric acid 0-10°C	2			2		2
		(iv)		amine group in the azo dye has a lone pair of electrons on the nitrogen atom and acts as an electron pair donor / proton acceptor			1	1		

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