



*Rewarding Learning*

**ADVANCED**  
**General Certificate of Education**  
**2024**

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## **Chemistry**

**Assessment Unit A2 2**

*assessing*

Analytical, Transition Metals, Electrochemistry  
and Further Organic Chemistry

**[ACH24]**

**MONDAY 10 JUNE, AFTERNOON**

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**MARK  
SCHEME**

## General Marking Instructions

### Introduction

Mark schemes are published to assist teachers and students in their preparation for examinations. Through the mark schemes, teachers and students will be able to see what examiners are looking for in response to questions and exactly where the marks have been awarded. The publishing of the mark schemes may help to show that examiners are not concerned about finding out what a student does not know but rather, with rewarding students for what they do know.

### The Purpose of Mark Schemes

Examination papers are set and revised by teams of examiners and revisers appointed by the Council. The teams of examiners and revisers include experienced teachers who are familiar with the level and standards expected of students in schools and colleges.

The job of the examiners is to set the questions and the mark schemes; and the job of the revisers is to review the questions and mark schemes commenting on a large range of issues about which they must be satisfied before the question papers and mark schemes are finalised.

The questions and the mark schemes are developed in association with each other so that the issues of differentiation and positive achievement can be addressed right from the start. Mark schemes, therefore, are regarded as part of an integral process which begins with the setting of questions and ends with the marking of the examination.

The main purpose of the mark scheme is to provide a uniform basis for the marking process so that all the markers are following exactly the same instructions and making the same judgements in so far as this is possible. Before marking begins, a standardising meeting is held where all the markers are briefed using the mark scheme and samples of the students' work in the form of scripts. Consideration is also given at this stage to any comments on the operational papers received from teachers and their organisations. During this meeting, and up to and including the end of the marking, there is provision for amendments to be made to the mark scheme. The document published represents this final form of the mark scheme.

It is important to recognise that in some cases there may well be other correct responses which are equally acceptable to those published: the mark scheme can only cover those responses which emerged in the examination. There may also be instances where certain judgements may have to be left to the experience of the examiner, for example, where there is no absolute correct response – all teachers will be familiar with making such judgements.

**Section A**

- 1 D
- 2 D
- 3 D
- 4 D
- 5 C
- 6 B
- 7 A
- 8 D
- 9 B
- 10 C

[1] for each correct answer

[10]

**Section A**

**AVAILABLE  
MARKS**

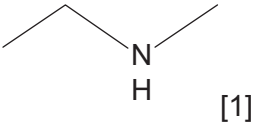
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**10**

## Section B

AVAILABLE  
MARKS

11 (a) (i)

Skeletal formula	Molecular formula	Classification
		Primary [1]
	$C_6H_{15}N$ [1]	
 [1]		
	$C_4H_{11}N$ [1]	Secondary [1]

[5]

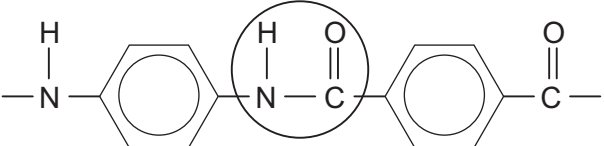
- (ii) filter(crude) solids (separately) [1]  
 recrystallise each from hot solvent/ethanol [1]  
 determine melting point of each purified solid [1]  
 compare with book values to identify amines [1] [4]

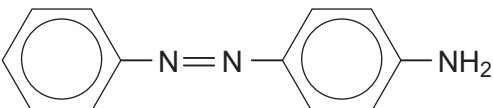
- (iii) two alkyl groups so lone pair of electrons more available from protonation [1]

- (b) (i) same molecular formula but different structures/structural formulae [1]

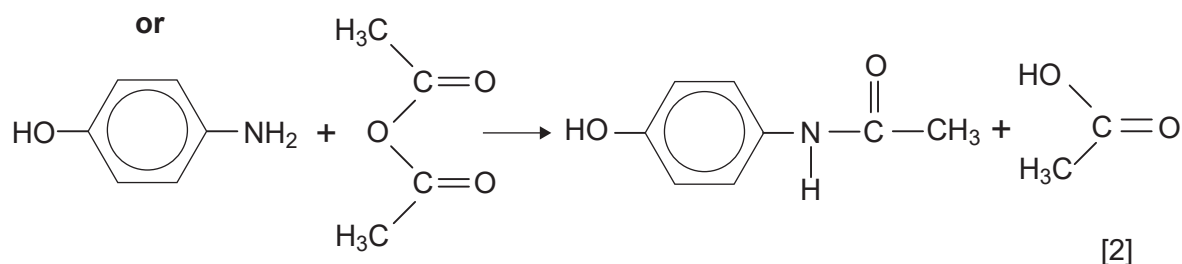
- (ii) benzene-1,4-diamine/1,4-diaminobenzene [1]  
 terephthalic acid/benzene-1,4-dicarboxylic acid [1] [2]

- (iii) 4-aminobenzoic acid [1]

- (iv)  [1]

- (c) (i)  [2]
- (ii) extended delocalised system [1]  
energy levels closer together [1]  
absorbs light in the visible region/colour removed [1] [3]

- 12 (a) hydrolysis [1]  
hydrochloric acid/any named dilute acid [1] [2]
- (b) carbon dioxide [1]
- (c)  $C_6H_5OH + HNO_3 \rightarrow C_6H_4(OH)NO_2 + H_2O$   
(or  $C_6H_5OH + NO_2^+ \rightarrow C_6H_4(OH)NO_2 + H^+$ ) [2]
- (d) (i) the tin is not regenerated/tin is not unchanged/tin is oxidised/tin is the reducing agent [1]
- (ii) concentrated hydrochloric acid [1]  
sodium hydroxide solution [1] [2]
- (e)  $HOC_6H_4NH_2 + (CH_3CO)_2O \rightarrow HOC_6H_4NHCOCH_3 + CH_3COOH$



- 13 (a) (i) a peak produced by an ion formed by the removal of one electron from a molecule [1]
- (ii) compound D has the highest RMM [1]
- (b) (i) base peak [1]
- (ii) **A** [1] **B** [1]
- $CH_3CH_2CH_2^+$  [1]  $CH_3CH(CH_3)^+$  [1] [2]
- (iii)  $^+CH_2CHO$  [1]
- (c) (i) **A** 4 [1]  
**B** 3 [1] [2]
- (ii) hydrogen in the aldehyde functional group/-CHO [1]
- (iii) in compound **A**, there are two hydrogen atoms bonded to an adjacent carbon atom [1]  
In compound **B**, there is one hydrogen atom bonded to an adjacent carbon atom [1] [2]

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- (d) (i) tetramethylsilane (TMS) [1]  
any **two** from:  
used as a standard for comparison/all hydrogen atoms are chemically equivalent to give a strong (singlet) signal/hydrogen atoms more shielded than those in organic compounds [2] [3]

(ii) **Similarities**

- both spectra contain three sets of peaks
- integration ratio is 3:3:2 in both spectra
- both have singlet, triplet, quartet/same spin-spin splitting pattern
- both have triplet as lowest chemical shift
- both have singlet at  $\delta = 2.0$  ppm

**Difference**

- quartet lower shift for compound **C**
- quartet at higher chemical shift for compound D due to proximity to extra oxygen atom

Band	Response	Mark
<b>A</b>	Candidates must use appropriate specialist terms including a minimum of 5 points of indicative content. They use good spelling, punctuation and grammar and the form and style are of a high standard.	[5]–[6]
<b>B</b>	Candidates must use appropriate specialist terms including a minimum of 3 points of indicative content. They use satisfactory spelling, punctuation and grammar and the form and style are of a satisfactory standard.	[3]–[4]
<b>C</b>	Candidates' brief and partial response includes a minimum of 2 points of indicative content. They use limited spelling, punctuation and grammar and they have made little use of specialist terms. The form and style are of a limited standard.	[1]–[2]
<b>D</b>	Response not worthy of credit.	[0]

[6]

20

- 14 (a) the potential difference measured when a half-cell is connected to the standard hydrogen electrode under standard conditions [2]
- (b) (i)  $2\text{H}_2\text{O}_2 \rightarrow 2\text{H}_2\text{O} + \text{O}_2$  [1]
- (ii) the potential difference measured when two half-cells are connected [1]
- (iii)  $\text{emf} = 1.77 - 0.68 = +1.09 \text{ V}$  [1]  
cell emf is positive [1] [2]
- (iv) high activation energy [1]
- (c) (i)  $2\text{MnO}_4^- + 16\text{H}^+ + 10\text{Cl}^- \rightarrow 2\text{Mn}^{2+} + 5\text{Cl}_2 + 8\text{H}_2\text{O}$  [2]  
chloride ions can reduce manganate(VII) ions/manganate(VII) ions can oxidise chloride ions/emf = +0.15V [1] [3]
- (ii)  $\text{Pt(s)}|\text{Cl}^-(\text{aq})|\text{Cl}_2(\text{g})||\text{Ce}^{4+}(\text{aq}),\text{Ce}^{3+}(\text{aq})|\text{Pt(s)}$  [3]

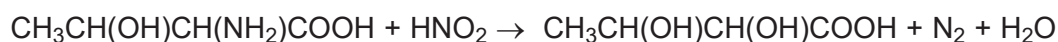
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- 15 (a)**  $2\text{Cr}_2\text{O}_3 + 4\text{Na}_2\text{CO}_3 + 3\text{O}_2 \rightarrow 4\text{Na}_2\text{CrO}_4 + 4\text{CO}_2$  [2]
- (b) (i)**  $\text{Cr}_2\text{O}_7^{2-} + 14\text{H}^+ + 6\text{e}^- \rightarrow 2\text{Cr}^{3+} + 7\text{H}_2\text{O}$  [1]
- (ii)**  $2\text{I}^- \rightarrow \text{I}_2 + 2\text{e}^-$  [1]
- (iii)**  $\text{Cr}_2\text{O}_7^{2-} + 14\text{H}^+ + 6\text{I}^- \rightarrow 2\text{Cr}^{3+} + 3\text{I}_2 + 7\text{H}_2\text{O}$  [1]
- (iv)**  $\text{Cr}^{3+}$  is coloured/green [1]
- (v)** iodine forms insoluble/irreversible complex with starch/adsorbs on surface of starch [1]
- (vi)** moles  $\text{S}_2\text{O}_3^{2-} = \frac{20.0 \times 0.100}{1000} = 0.002$   
 moles  $\text{I}_2 = \frac{0.002}{2} = 0.001$  in  $25 \text{ cm}^3$   
 moles of  $\text{I}_2 = 0.01$  in  $250 \text{ cm}^3$   
 moles  $\text{Cr}_2\text{O}_7^{2-} = \frac{0.01}{3} = 0.00333$   
 mass  $\text{Na}_2\text{Cr}_2\text{O}_7 = 0.00333 \times 262 = 0.872 \text{ g}$   
 % purity =  $\frac{0.872}{1} \times 100 = 87.2 \%$  [5]
- (c) (i)** hexaaquachromium(III) [1]
- (ii)** green-blue [1]
- (iii)** removal of a hydrogen ion or proton [1]
- (iv)**  $[\text{Cr}(\text{H}_2\text{O})_3(\text{OH})_3] + 6\text{NH}_3 \rightarrow [\text{Cr}(\text{NH}_3)_6]^{3+} + 3\text{H}_2\text{O} + 3\text{OH}^-$   
 or  $\text{Cr}(\text{OH})_3 + 6\text{NH}_3 \rightarrow [\text{Cr}(\text{NH}_3)_6]^{3+} + 3\text{OH}^-$  [2]
- 16 (a)** 2-amino-3-hydroxybutanoic acid [2]
- (b)**  $\text{C}_4\text{H}_9\text{NO}_3$  [1]
- (c)** 2 [1]
- (d)** exists as a zwitterion/dipolar ion [1]  
 strong ionic bonding/electrostatic forces [1] [2]
- (e) (i)** A = lithium tetrahydridoaluminate(III)/lithal [1]  
 B = hydrochloric acid/any dilute acid [1] [2]
- (ii)** nitric(III) acid [1]
- (iii)** sodium nitrite/sodium nitrate(III) [1]  
 hydrochloric acid [1] [2]

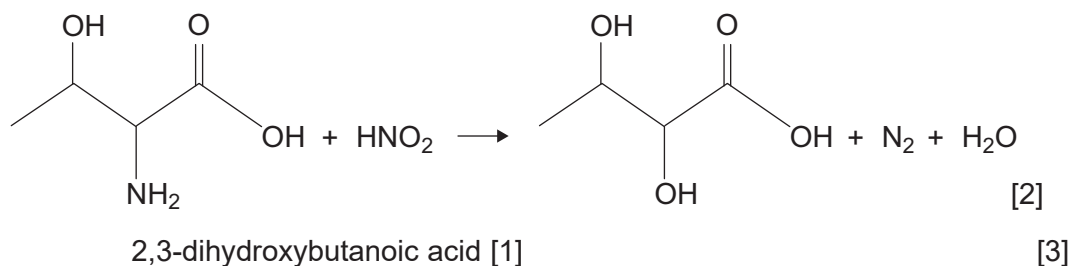
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MARKS

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(iv)



or



(f) **Indicative content**

- primary structure is the sequence of amino acids in a chain
- primary structure held together by amide/peptide links
- secondary structure is formed from coiling/twisting of amino acid chain
- secondary structure composed of  $\alpha$ -helix
- secondary structure composed of  $\beta$ -pleated sheet
- secondary structure held together by intramolecular hydrogen bonding
- tertiary structure final folding/bending of the structure
- tertiary structure held together by hydrogen bonding/disulfide bridges/van der Waals' forces/ionic interactions

Band	Response	Mark
<b>A</b>	Candidates must use appropriate specialist terms including a minimum of 7 points of indicative content. They use good spelling, punctuation and grammar and the form and style are of a high standard.	[5]–[6]
<b>B</b>	Candidates must use appropriate specialist terms including a minimum of 5 points of indicative content. They use satisfactory spelling, punctuation and grammar and the form and style are of a satisfactory standard.	[3]–[4]
<b>C</b>	Candidates' brief and partial response includes a minimum of 2 points of indicative content. They use limited spelling, punctuation and grammar and they have made little use of specialist terms. The form and style are of a limited standard.	[1]–[2]
<b>D</b>	Response not worthy of credit.	[0]

[6]

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**Section B**

**100**

**Total**

**110**