Rewarding Learning

ADVANCED
General Certificate of Education
2025

Chemistry

Assessment Unit A2 2

assessing

Analytical, Transition Metals, Electrochemistry and Further Organic Chemistry

[ACH24]

WEDNESDAY 11 JUNE, AFTERNOON

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.

Where one response is required to gain a mark, candidates will not gain credit if a correct response is given alongside one or more incorrect responses. This is referred to as listing.

AVAILABLE MARKS

Section A

1 A

2 C

3 D

4 C

5 A

6 B

7 C

8 D

9 D

10 B

[1] for each correct answer [10] 10

Section A **10**

Section B

AVAILABLE MARKS

11 (a) (i) $Cu(OH)_2$ **or** $[Cu(H_2O)_4(OH)_2]$ [1]
blue [1] [2]

(ii) $Cu(OH)_2 + 4NH_3 + 2H_2O \rightarrow [Cu(NH_3)_4(H_2O)_2]^{2+} + 2OH^-$
or $[Cu(H_2O)_4(OH)_2] + 4NH_3 \rightarrow [Cu(NH_3)_4(H_2O)_2]^{2+} + 2H_2O + 2OH^-$ [2]
deep blue/dark blue [1] [3]

(b) (i) $[Cu(H_2O)_6]^{2+} + 4Cl^- \rightarrow [CuCl_4]^{2-} + 6H_2O$ [2]

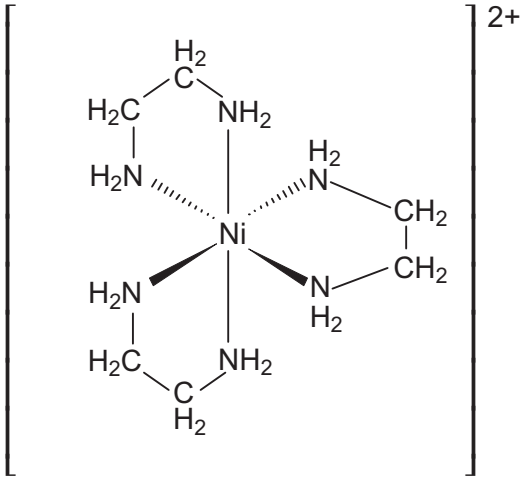
(ii) blue to yellow/green [1]

(c)

Complex ion	Co-ordination number	Shape
$[Co(H_2O)_6]^{2+}$	6	octahedral
$[CoCl_4]^{2-}$	4	tetrahedral

[1] per row [2]

(d) green [1]
structure:



[2] [3]

(e) (i)

Atom	Electronic Configuration	Ion	Electronic Configuration
V	[Ar] $3d^3\ 4s^2$	V^{3+}	[Ar] $3d^2$
Cr	[Ar] $3d^5\ 4s^1$	Cr^{3+}	[Ar] $3d^3$
Cu	[Ar] $3d^{10}\ 4s^1$	Cu^{2+}	[Ar] $3d^9$
Zn	[Ar] $3d^{10}\ 4s^2$	Zn^{2+}	[Ar] $3d^{10}$

[1] per row [4]

(ii) an element which forms at least one stable ion with a partially filled d-subshell [1]

18

AVAILABLE MARKS

12 (a) Indicative content

- pipette 25.0 cm^3 of the solution containing iron(II) ions into a conical flask
- add excess sulfuric acid to the conical flask
- fill burette with standard solution of potassium manganate(VII)
- add potassium manganate(VII) solution from burette into conical flask
- until colour changes from colourless to pink
- titrate dropwise near end point
- swirl the flask

Band	Response	Mark
A	Candidates must use appropriate specialist terms including a minimum of 6 points of indicative content. They use good spelling, punctuation and grammar and the form and style are of a high standard.	[5]–[6]
B	Candidates must use appropriate specialist terms including a minimum of 4 points of indicative content. They use satisfactory spelling, punctuation and grammar and the form and style are of a satisfactory standard.	[3]–[4]
C	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]
D	A response not worthy of credit	[0]

[6]

(b) (i) a solution of known concentration [1]

(ii) moles of hydrated oxalic acid = $\frac{3.30}{126}$ = 0.02619

$0.02619 \times 4 = 0.105$ (mol dm^{-3}) [2]

(iii) half equation:

$MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$ [1]

redox equation:

$2MnO_4^- + 6H^+ + 5H_2C_2O_4 \rightarrow 2Mn^{2+} + 8H_2O + 10CO_2$ [1] [2]

(iv) moles of $H_2C_2O_4$ = $\frac{20.0 \times 0.105}{1000}$ = 0.0021

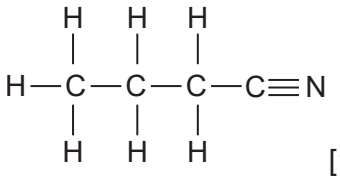
moles of $KMnO_4$ = $\frac{0.0021}{5} \times 2 = 8.4 \times 10^{-4}$

concentration of $KMnO_4$ = $\frac{8.4 \times 10^{-4} \times 1000}{16.0}$ = 0.0525 (mol dm^{-3}) [3] 14

AVAILABLE MARKS

13 **(a)** **(i)** potassium cyanide [1]
substitution [1] [2]

(ii)



[1]

butanenitrile [1] [2]

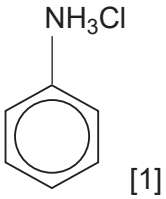
(iii) lithium tetrahydridoaluminate(III)/lithal/$LiAlH_4$ [1]
reduction [1] [2]

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

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

(iii) reduction [1]

(iv)



[1]

name: phenylammonium chloride [1] [2]

(v) to liberate the free amine/remove H^+ [1]

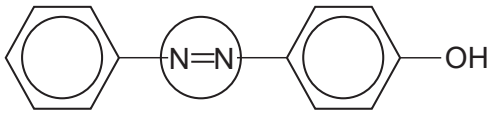
(c) **(i)** sodium nitrate(III) [1]

(ii) $NaNO_2 + HCl \rightarrow HNO_2 + NaCl$ [1]

(iii) $CH_3CH_2CH_2CH_2NH_2 + HNO_2 \rightarrow CH_3CH_2CH_2CH_2OH + N_2 + H_2O$ [1]

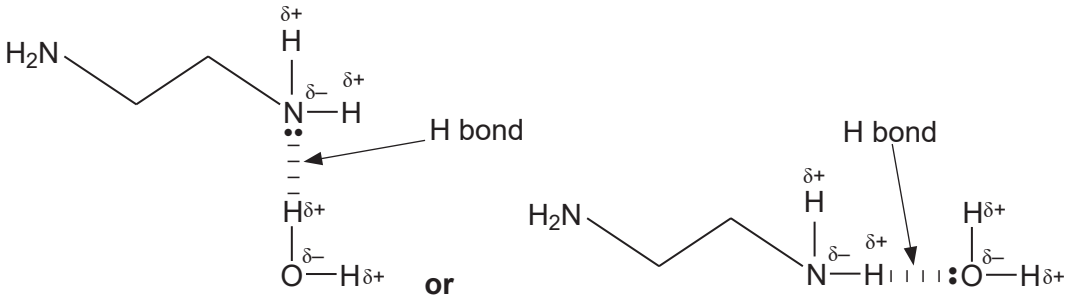
(iv) benzenediazonium chloride [1]

(v)



[1] for structure
[1] for circle
[1] for azo [3]

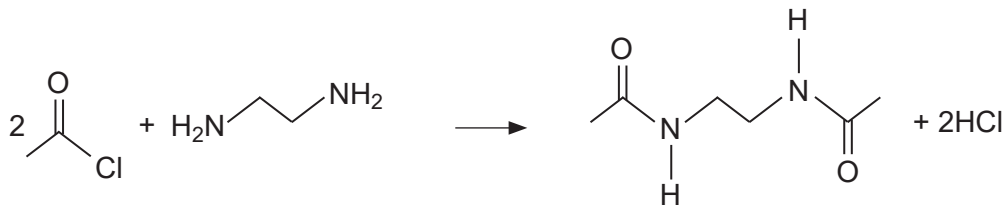
(d) (i)



[2]

(ii) $H_2NCH_2CH_2NH_2 + 2HNO_3 \rightarrow H_3NCH_2CH_2NH_3(NO_3)_2$ [1]

(iii)



[2]

AVAILABLE MARKS

25

AVAILABLE MARKS

14 (a) (i) the potential difference measured when a half-cell is connected to a standard hydrogen electrode under standard conditions [1]

(ii) $Zn(s) \mid Zn^{2+}(aq) \mid\mid VO_2^{+}(aq), H^{+}(aq), VO^{2+}(aq) \mid Pt(s)$ [2]

(iii) + 1.00 V [1]

(b) (i) $Zn + 2VO_2^{+} + 4H^{+} \rightarrow Zn^{2+} + 2VO^{2+} + 2H_2O$ [1]

(ii) VO_2^{+} [1]

(iii) $VO_2^{+}(aq)$ yellow [1]
$VO^{2+}(aq)$ blue [1] [2]

(c) indicative content

- $2H^{+} + 2e^{-} \rightleftharpoons H_2$
- state symbols for above $2H^{+}(aq) + 2e^{-} \rightleftharpoons H_2(g)$
- $E^{\ominus} = 0.00$ V
- hydrogen gas at 100 kPa/1atm
- 1 mol dm^{-3} $H^{+}(aq)$
- platinum electrode
- 298 K/25°C

Band	Response	Mark
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D	A response not worthy of credit	[0]

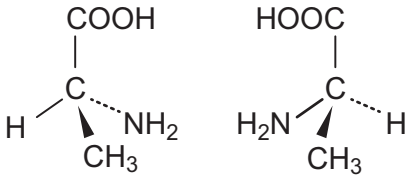
[6]

14

15 **(a)** **(i)** 2-aminopropanoic acid [1]

(ii) it does not contain an asymmetric centre/chiral centre [1]

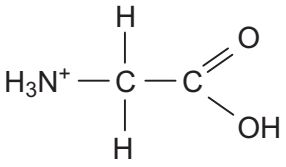
(iii)



[2]

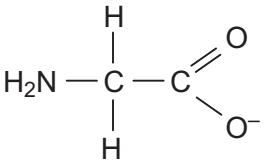
(b) glycine exists as dipolar ions/zwitterions [1]
held together by strong ionic bonding [1]
ionic bonding is stronger than the hydrogen bonds between propanoic acid molecules [1] [3]

(c) pH 1



[1]

pH 12



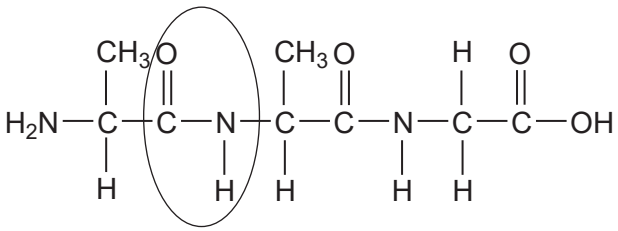
[1]

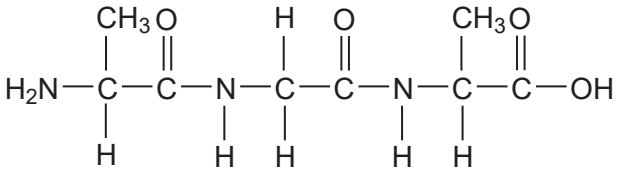
[2]

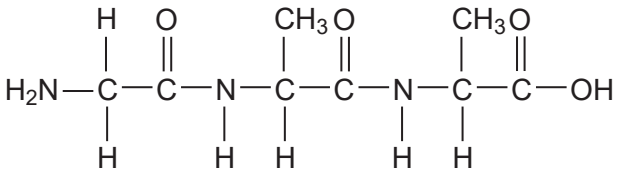
(d) **(i)** structural isomers [1]

(ii) condensation [1]

(iii) any **one** of the following peptides





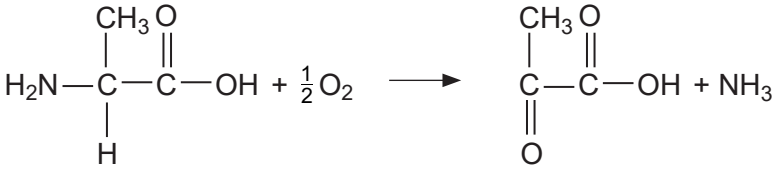


[2] for correct tripeptide structure
[1] for any peptide link circled [3]

(iv) hydrolysis [1]

AVAILABLE MARKS

(e) **(i)**



[2]

(ii)

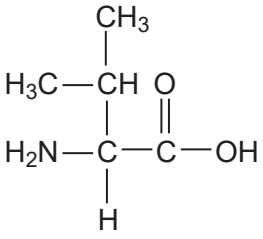
mass spectrum data	
m/z value of molecular ion peak	116 [1]
nmr spectroscopy data	
number of environments of chemically equivalent hydrogen atoms	3 [1]
peak integration ratio (from highest chemical shift to lowest)	1 : 1 : 6 [1] for correct ratio [1] for correct order

[4]

(iii) doublet: 2 × CH_3 groups [1] split by CH [1]
singlet: COOH group [1] no H atoms bonded to adjacent carbon atoms [1] [4]

(iv) 43: $(CH_3)_2CH^+$ [1]
45: $COOH^+$ [1] [2]

(v)



[1]

2-amino-3-methylbutanoic acid [1] [2]

	AVAILABLE MARKS
	29
Section B	**100**
Total	**110**