Rewarding Learning

ADVANCED
General Certificate of Education
2022

Chemistry

Assessment Unit A2 2

assessing

Analytical, Transition Metals, Electrochemistry and Further Organic Chemistry

[ACH24]

TUESDAY 14 JUNE, MORNING

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.

COVID-19 Context

Given the unprecedented circumstances presented by the COVID-19 public health crisis, senior examiners, under the instruction of CCEA awarding organisation, are required to train assistant examiners to apply the mark scheme in case of disrupted learning and lost teaching time. The interpretation and intended application of the mark scheme for this examination series will be communicated through the standardising meeting by the Chief or Principal Examiner and will be monitored through the supervision period. This paragraph will apply to examination series in 2021–2022 only.

Section A

	AVAILABLE MARKS
1 B	
2 A	
3 C	
4 B	
5 B	
6 D	
7 D	
8 C	
9 D	
10 B	
[1] for each correct answer [10]	10
Section A	**10**

Section B

AVAILABLE MARKS

11 **(a)** a bidentate ligand is an ion or molecule which uses two lone pairs of electrons to form two co-ordinate bonds (with the central metal atom or ion in a complex) [1] [2]

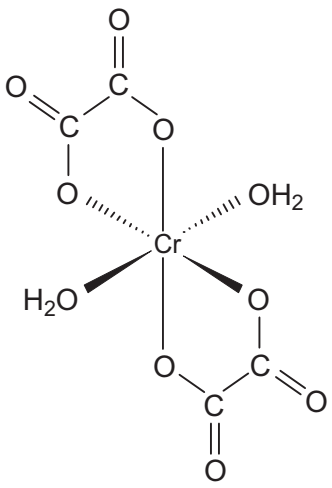
(b) **(i)** same number and type of bonds broken and formed [2]

(ii) increase in entropy [1]
4 species on left and 7 on right [1] [2]

(iii) co-ordination number = 6 [1]
oxidation state of Ni = +2 [1]
shape = octahedral [1] [3]

(c) **(i)** $[Cr(H_2O)_6]^{3+} + 2C_2O_4^{2-} \rightarrow [Cr(C_2O_4)_2(H_2O)_2]^{-} + 4H_2O$ [2]

(ii)



[1]

(d) **(i)** Fe oxidised from +2 to +3 [1]
Mn reduced from +7 to +2 [1]
C oxidised from +3 to +4 [1]
redox is oxidation and reduction occurring in the same reaction [1] [4]

(ii) $Fe^{2+} \rightarrow Fe^{3+} + e^{-}$ [1]
$C_2O_4^{2-} \rightarrow 2CO_2 + 2e^{-}$ [1]
$MnO_4^{-} + 8H^{+} + 5e^{-} \rightarrow Mn^{2+} + 4H_2O$ [1] [3]

(iii) colourless to pink [1]

(iv) moles of $MnO_4^{-} = \frac{12.45 \times 0.0150}{1000} = 1.8675 \times 10^{-4}$

moles of $FeC_2O_4 = \frac{1.8675 \times 10^{-4}}{6} \times 10 = 3.1125 \times 10^{-4}$

concentration of $FeC_2O_4 = 3.1125 \times 10^{-4} \times 40 = 0.0125$ mol dm^{-3} [4]
(to 3 sig fig)

(v) moles of FeC_2O_4 in 250 $cm^3 = \frac{0.0125}{4} = 3.125 \times 10^{-3}$

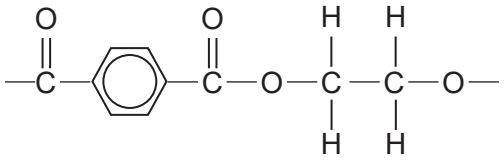
M_r of $FeC_2O_4.xH_2O = \frac{0.561}{3.125 \times 10^{-3}} = 180$

M_r of $xH_2O = 180 - 144 = 36$

$x = \frac{36}{18} = 2$ [3]

27

12 (a) (i) polyethylene terephthalate [1]

(ii)  [1]

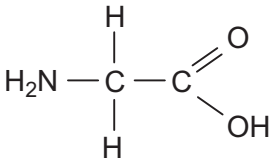
(b) (i) hydrogen bonds [1]

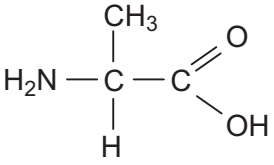
(ii) strong (hydrogen) bonds between molecules need substantial energy to break [1]

(c) amide and ester groups are hydrolysed [1]
by the action of microorganisms [1] [2]

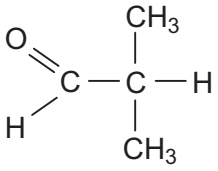
AVAILABLE MARKS

6

13 (a) glycine  [1]

alanine  [1] [2]

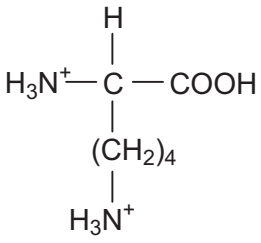
(b) (i) 2-amino-2-methylpropanoic acid [2]

(ii)  [1]

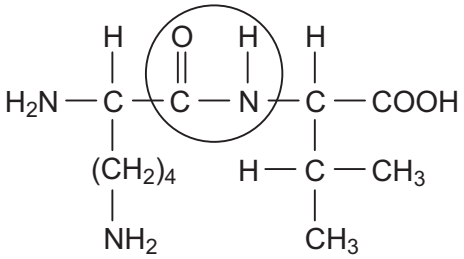
(2-)methylpropanal [1] [2]

(iii) $CH_3CHO + NH_3 + HCN \rightarrow CH_3CH(NH_2)CN + H_2O$ [1]

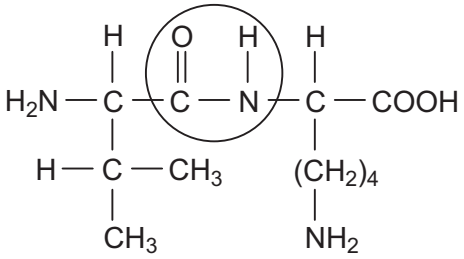
(iv) $CH_3CH(NH_2)CN + HCl + 2H_2O \rightarrow CH_3CH(NH_2)COOH + NH_4Cl$ [2]

(c) (i)  [1]

(ii)



[1]



[1]

peptide link circled in one structure [1] [3]

(d) twisting/coiling of the chain [1]
to form α-helix/β-pleated sheet [1]
held by intramolecular hydrogen bonding [1] [3]

(e) **(i)** draw base line(s) using a pencil close to bottom of the paper [1]
spot mixture onto the paper and allow to dry [1]
place the paper in a tank allow to run in first solvent [1]
mark the solvent front and allow to dry [1]
rotate the paper by 90° and run in the second solvent [1] [5]

(ii) locate spots with UV light/ninhydrin/iodine [1]
measure distance travelled by spots and solvents [1]
calculate R_f values [1]
compare with known R_f values to identify lysine and valine [1] [4]

(iii) improves separation/greater separation between spots [1]

26

14 **(a)** an element which has a partially filled d-subshell or forms at least one stable ion with a partially filled d-subshell
V^{2+} [Ar] $3d^3$/V^{3+} [Ar] $3d^2$/ V[Ar] $3d^3\ 4s^2$ [2]

(b)

Reduction reaction	Half Equation	Colour Change
VO_2^+ to VO^{2+}	$VO_2^+ + 2H^+ + e^- \rightarrow VO^{2+} + H_2O$ [1]	yellow to blue [1]
VO^{2+} to V^{3+}	$VO^{2+} + 2H^+ + e^- \rightarrow V^{3+} + H_2O$ [1]	blue to green [1]
V^{3+} to V^{2+}		green to violet [1]

[5]

(c) **(i)** $4V^{2+} + O_2 + 4H^+ \rightarrow 4V^{3+} + 2H_2O$ [2]

(ii) $Pt(s)|V^{2+}(aq),V^{3+}(aq)||O_2(g)|H^+(aq),H_2O(l)|Pt(s)$ [2]

(iii) oxidation occurs/loss of electrons [1] V^{2+},V^{3+} half cell [1] [2]

(iv) +1.23 – (–0.26) = +1.49 V [1]

(d) Indicative content

- platinum in 1.00 mol dm^{-3} H^+
- H_2 gas passed over platinum at 100 kPa pressure
- 298 K/25 °C
- vanadium mixture in **another** beaker with platinum electrode
- vanadium ion solutions both have concentration 1.00 mol dm^{-3}
- connect solutions via a salt bridge
- external circuit with a high resistance voltmeter

Band	Response	Mark
A	Candidates must use appropriate specialist terms using at least 6 points of indicative content. They must use good spelling, punctuation and grammar and the form and style are of an excellent standard.	[5]–[6]
B	Candidates must use appropriate specialist terms using at least 4 points of indicative content. They must use satisfactory spelling, punctuation and grammar and the form and style are of a good standard.	[3]-[4]
C	Candidates use at least 2 points of indicative content. They use limited correct spelling, punctuation and grammar and the form and style are of a basic standard.	[1]-[2]
D	Response not worthy of credit.	[0]

[6]

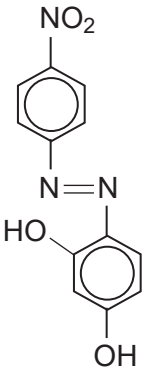
AVAILABLE MARKS

20

15 (a) (i) sodium nitrite [1]
hydrochloric acid [1]
low temperature/<10 °C [1] [3]

(ii) benzene-1,3-diol accept 3-hydroxyphenol/1,3-dihydroxybenzene [2]

(iii)



[2]

(iv) extended delocalised system [1]
energy levels closer together [1]
absorbs light in visible region of the electromagnetic spectrum [1] [3]

(b) (i) ethanoyl chloride [1]

(ii) $C_8H_8O_3N_2$ [1]

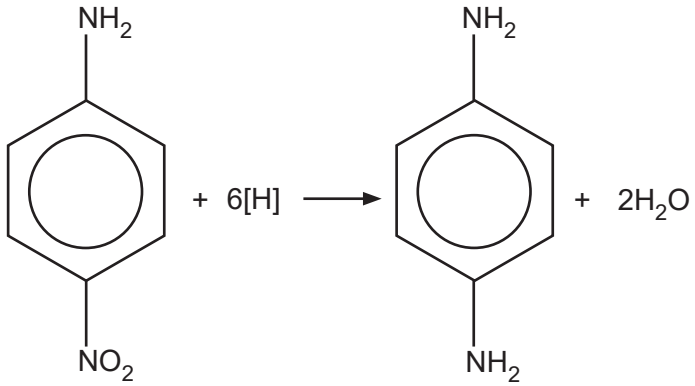
(iii) Indicative content

- dissolve in a minimum volume of hot solvent
- filter whilst hot (through fluted filter paper)
- allow to cool and crystallise
- suction filter the solid
- stated method of drying
- determine melting point
- sharp/narrow range/similar to data book value

Band	Response	Mark
A	Candidates must use appropriate specialist terms using at least 6 points of indicative content. They must use good spelling, punctuation and grammar and the form and style are of an excellent standard.	[5]–[6]
B	Candidates must use appropriate specialist terms using at least 4 points of indicative content. They must use satisfactory spelling, punctuation and grammar and the form and style are of a good standard.	[3]-[4]
C	Candidates use at least 2 points of indicative content. They use limited correct spelling, punctuation and grammar and the form and style are of a basic standard.	[1]-[2]
D	Response not worthy of credit.	[0]

[6]

(c) (i)



[2]

(ii) to liberate the free amine [1]

21

Section B **100**

Total **110**

AVAILABLE MARKS