Rewarding Learning

ADVANCED
General Certificate of Education
2015

Chemistry

Assessment Unit A2 2

assessing

Analytical, Transition Metals, Electrochemistry and Further Organic Chemistry

[AC222]

TUESDAY 2 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. What is 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

	AVAILABLE MARKS
1 A	
2 B	
3 A	
4 C	
5 D	
6 A	
7 C	
8 B	
9 C	
10 C	
[2] for each correct answer [20]	20
Section A	**20**

Section B

AVAILABLE MARKS

11 (a) An element which forms (at least one stable) ion with a partially filled d-subshell/An element which has an atom with a partially filled d-subshell [1]

(b) (i) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^3$ [1]

(ii)

ion	oxidation number	colour
	+2	Violet
$VO_2^+(aq)$	+5	
	+4	Blue
	+3	Green

(error [–1]) [4]

(c) (i) It is in a different (physical) state to the reactants [1]

(ii) Reactants adsorbed onto the surface [1]
Reactant bonds weakened [1]
Orientation of molecules [1] [3]
(Do not accept comments on catalytic action)

(iii) $SO_2 + V_2O_5 \rightarrow SO_3 + V_2O_4$ [1]
$2V_2O_4 + O_2 \rightarrow 2V_2O_5$ [1] [2]
Accept VO_2 instead of V_2O_4

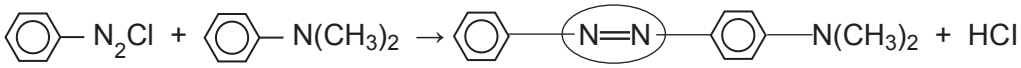
(iv)

industrial process	catalyst
	iron
	platinum + rhodium

[2] 14

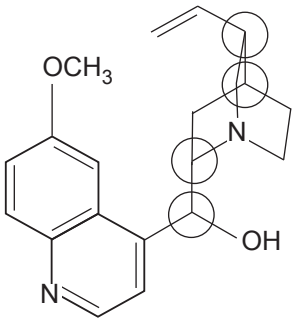
12 (a) Tin and concentrated hydrochloric acid [1]
(Free amine produced by reaction with) NaOH/KOH solution [1] [2]

(b) (Dilute) hydrochloric acid and sodium nitrite [1]
Below 10 °C [1] [2]

(c) 

(Equation [2], azo group [1]) [3]

(d) (i) Frequency has decreased [1]

(ii)


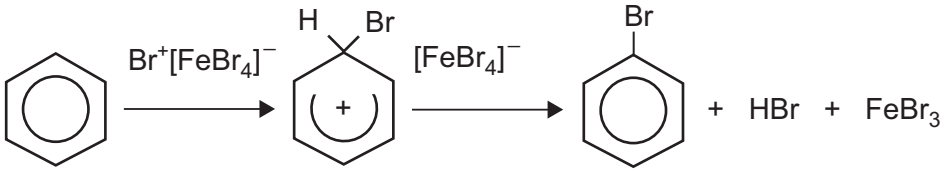
[2]

3/4 = [2] 2 = [1] 1 = [0]

10

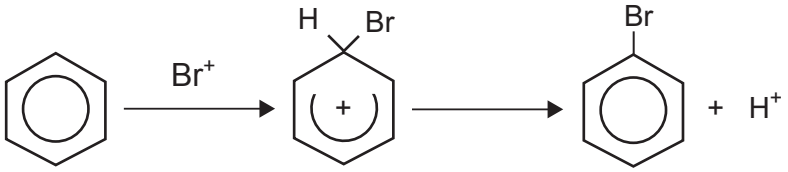
13 (a) (i) Electrophilic addition [1]

(ii) Iron/iron(III) bromide catalyst [1]

(iii)


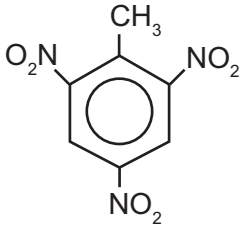
or

$Br_2 + FeBr_3 \rightarrow Br^+ [FeBr_4]^-$



([–1] for each mistake) [3]

(iv) Electrophilic substitution [1]

(b) (i)


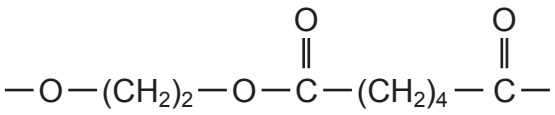
[1]

(ii) Concentrated nitric acid
Concentrated sulfuric acid } [1]
$HNO_3 + 2H_2SO_4 \rightarrow NO_2^+ + 2HSO_4^- + H_3O^+$ [1] [2]

9

14 (a) (i) Condensation [1]

(ii)



([–1] for each mistake) [2]

(b) —N=C=O [1]

(c) Carbon monoxide forms a stable complex with haemoglobin [1]
preventing it from carrying oxygen [1] [2]

(d) The amide group can be hydrolysed [1] 7

15 (a) (i) 1,4-diaminobutane or butane-1,4-diamine [1]

(ii) The amino group(s) can form hydrogen bonds with water [1]

(b) (i) $H_2N(CH_2)_4NH_2 + 2HNO_2 \rightarrow HO(CH_2)_4OH + 2H_2O + 2N_2$
(2 marks, [–1] for each mistake) [2]

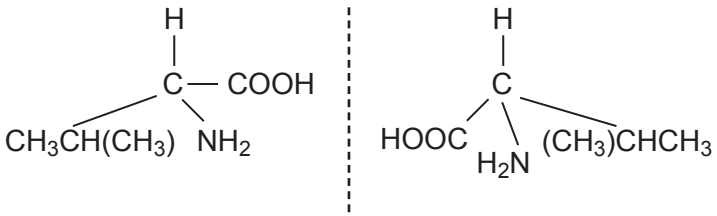
(ii) $H_2N(CH_2)_4NH_2 + 2CH_3COCl \rightarrow H_3CCOHN(CH_2)_4NHOCCH_3 + 2HCl$
(2 marks, [–1] for each error) [2]

(iii) Find the melting point of the solid [1]
Compare with data book/actual melting point [1] [2]

(c) (i) Molecule or ion which has a permanent positive and negative charge but which is neutral overall/ion which has permanent $–NH_3^+$ and $–CO_2^-$ and is neutral overall [2]

(ii) $CH_3CH(CH_3)CH(NH_3^+)COO^-$ [1]

(iii)



([–1] for each mistake) [2]

(d) Primary: sequence of amino acids in the chain [1]
Secondary: the twisting/coiling of the chain to form a β-pleated sheet/ α-helix by (intramolecular) hydrogen bonding [1]
Tertiary: the bending/folding of the secondary structure to give a 3D shape held together by hydrogen bonding/disulfide bridges/ionic interactions [1] [3]

(e) (i) Enzymes have an active site [1]
which provides a path of lower activation energy [1] [2]

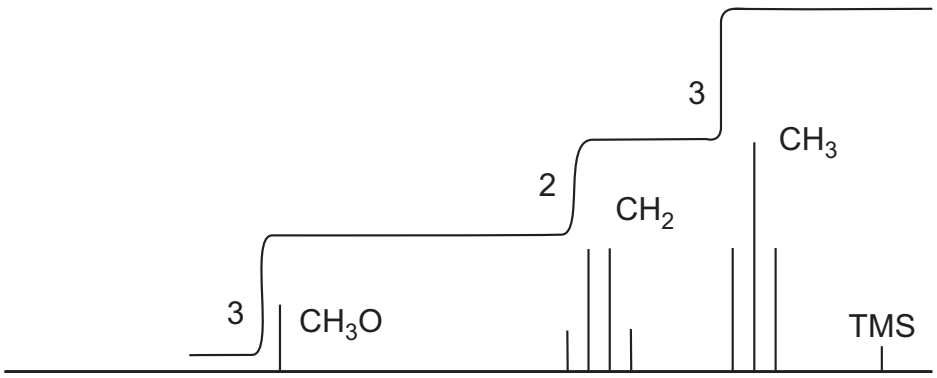
(ii) Intramolecular forces are disrupted/broken [1]
The enzymes will be denatured/structure disrupted by higher temperatures/the active site will no longer be effective [1] [2] 20

AVAILABLE MARKS

16 (a) (i) Tetramethylsilane [1]

(ii) All the hydrogen atoms are equivalent [1]
the signal is outside the usual range [1]
TMS is inert/unreactive [1]
to a maximum of [2] [2]

(b)



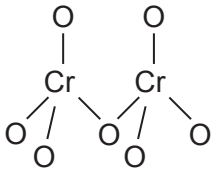
Splitting of peaks [1]
Each set of peaks [3] – correct heights, shift and label
Integration curve above [1] [5]

(c) (i) 29 [1]

(ii) CH_3O^+ [1]
$CH_3CH_2CO^+$ [1]
(penalise no charge once) [2]

(iii) The presence of a carbon-13 atom [1] 12

AVAILABLE MARKS

				AVAILABLE MARKS
17	**(a)**	**(i)**	$2Cr + 2Na_2CO_3 + 3O_2 \rightarrow 2Na_2CrO_4 + 2CO_2$ [2]	
		(ii)	$Na_2Cr_2O_7 + 3C \rightarrow Na_2Cr_2O_4 + 3CO$ [1]	
		(iii)	$Cr_2O_3 + 2Al \rightarrow 2Cr + Al_2O_3$ [1]	
	(b)		Yellow [1] to orange [1] [2]	
	(c)			
			([–1] for each mistake) [2]	
	(d)	**(i)**	$Cr_2O_7^{2-} + 14H^+ + 6Fe^{2+} \rightarrow 2Cr^{3+} + 7H_2O + 6Fe^{3+}$ [1]	
		(ii)	Moles of $Cr_2O_7^{2-}$ in 25 cm^3 = (0.01 × 23.5)/1000 = 2.35×10^{-4} Moles of Fe^{2+} in 25 cm^3 = $(2.35 \times 10^{-4}) \times 6 = 1.41 \times 10^{-3}$ Moles of Fe^{2+} in 250 cm^3 = $1.41 \times 10^{-2} = 0.0141$ Mass of $FeSO_4$ in 250 cm^3 = 0.0141 × 152 = 2.143 Mass of $FeSO_4$ in one tablet = 2.143/5 = 0.429 g ([–1] for each mistake; [–1] if no mass unit) [4]	
	(e)	**(i)**	An **ion or molecule** with a **lone pair of electrons** which forms a **coordinate bond** with a (central) **metal atom/ion in a complex** [2]	
		(ii)	Cl has a higher priority than N i.e. atomic number Cl > N [1] Isomer 1 has Cl on opposite sides [1] Isomer 1 is E [1] [3]	
	(f)	**(i)**	Polydentate/chelate/hexadentate [1]	
		(ii)	$[Cr(H_2O)_6]^{3+} + edta^{4-} \rightarrow [Cr(edta)]^- + 6H_2O$ [1]	
		(iii)	More molecules/species on the right hand side [1] increases the entropy/disorder [1] [2]	
	(g)		Cool a solution of potassium dichromate (Slowly) add concentrated sulfuric acid Add ethanol (slowly)(with stirring) Keep the temperature below 60 °C Leave to crystallise (and filter off crystals) [4]	
			Quality of written communication [2]	28
			Section B	**100**
			Total	**120**