Rewarding Learning

ADVANCED
General Certificate of Education
2023

Chemistry

Assessment Unit A2 1

assessing

Further Physical and Organic Chemistry

[ACH14]

TUESDAY 30 MAY, 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 the 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 the 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 D	
2 C	
3 A	
4 B	
5 D	
6 A	
7 D	
8 D	
9 D	
10 B	
[1] for each correct answer [10]	10
Section A	**10**

Section B

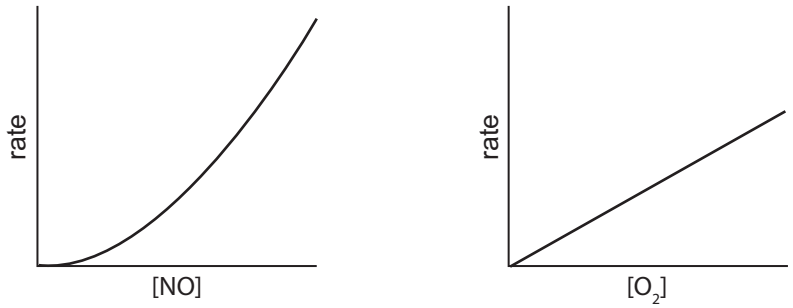
AVAILABLE MARKS

11 (a) (i) second/2 [1]

(ii) first/1 [1]

(iii) rate = $k[NO]^2[O_2]$ [1]

(iv)



[2]

(v) the proportionality constant which links the rate of reaction to the concentrations in the rate equation [1]

(vi) $k = \frac{0.048}{(0.015)^3} = 14\,000\ mol^{-2}\ dm^6\ s^{-1}$ [3]

(b) (i) a measure of disorder (randomness) [1]

(ii) $2(240.0) - (2(210.5) + 205.2) = -146.2\ (J\ K^{-1}\ mol^{-1})$ [1]

(c) (i) $\Delta G = \Delta H - T\Delta S$ [2]
$\Delta G = -57 - (400 \times -0.176)$
$\Delta G = +13.4\ kJ\,mol^{-1}$

(ii) reaction not feasible as ΔG is positive [1]

(iii) $0 = -57 - T(-0.176)$
$T = 324\ K$ [2]

(d) (i) $K_c = \frac{[NO_2]^2}{[NO]^2[O_2]}$ [1]

(ii) $[NO_2]^2 = 8.54 \times (0.42)^2 \times 1.70 = 2.561$
$[NO_2] = 1.60\ mol\ dm^{-3}$ [2] 19

AVAILABLE MARKS

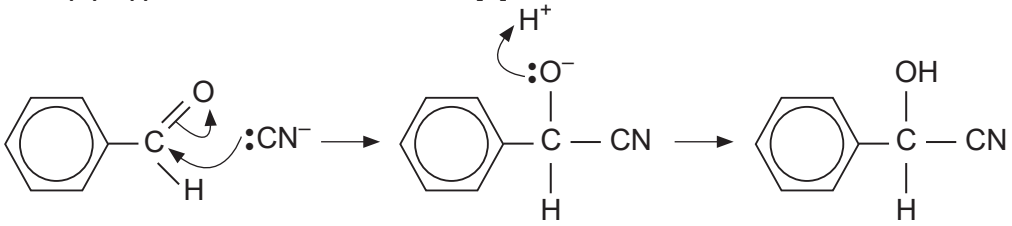
12 (a) Indicative content

- add benzaldehyde to (1cm^3 of) freshly prepared Tollens' reagent in a clean test tube
- add the benzaldehyde to acidified potassium dichromate(VI) solution
- warm both reactions in a hot water bath
- silver mirror observed with Tollens' reagent
- orange to green colour with acidified potassium dichromate(VI) solution
- $C_6H_5CHO + [O] \rightarrow C_6H_5COOH$
- $Ag^+ + e^- \rightarrow Ag$
- $Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$

Band	Response	Mark
A	Candidates must use appropriate specialist terms using a minimum of 7 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 a minimum of 5 points of indicative content. They must use appropriate spelling, punctuation and grammar and the form and style are of a good standard.	[3]–[4]
C	Candidates must use a minimum of 3 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]

(b) (i) $HCN \rightleftharpoons H^+ + CN^-$ [1]



[3]

[4]

(ii) fewer CN^-/CN^- protonated [1]

(iii) racemic mixture/isomers are formed in equal amounts [1]
rotates the plane of plane polarised light equally and opposite so the effect cancels out [1] [2]

(c) (i) $C_6H_5CH(OH)COOH + NaOH \rightarrow C_6H_5CH(OH)COONa + H_2O$ [1]

(ii) a solution which resists changes in pH on addition of small amounts of acid or alkali [1]

(iii) moles of $C_6H_5CH(OH)COOH = \frac{35 \times 0.125}{1000} = 4.375 \times 10^{-3}$

moles of $NaOH = \frac{15 \times 0.175}{1000} = 2.625 \times 10^{-3}$

moles of $C_6H_5CH(OH)COOH$ remaining $= 1.75 \times 10^{-3}$

moles of $C_6H_5CH(OH)COO^-$ formed $= 2.625 \times 10^{-3}$

$[H^+] = \frac{3.88 \times 10^{-4} \times 1.75 \times 10^{-3}}{2.625 \times 10^{-3}} = 2.587 \times 10^{-4}$

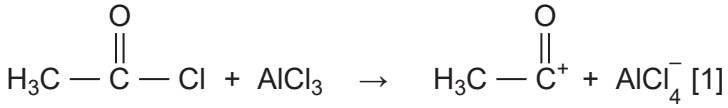
$pH = -\log_{10}(2.587 \times 10^{-4}) = 3.59$ [4]

AVAILABLE MARKS

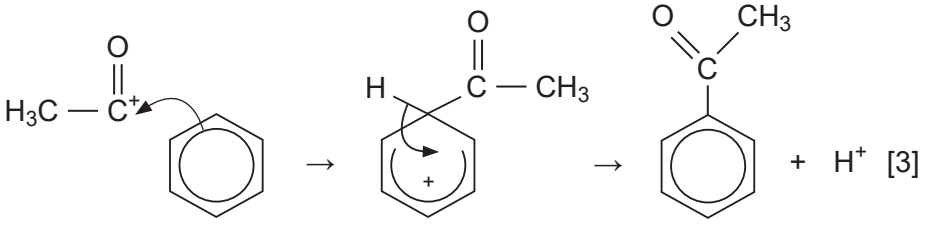
19

AVAILABLE MARKS

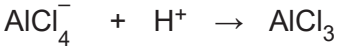
13 (a) (i)



[1]



[3]

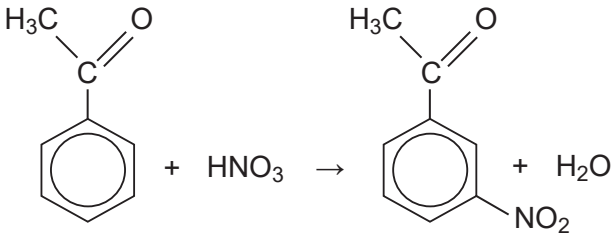


[1] [5]

(ii) an ion or molecule that attacks regions of high electron density [1]

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

(ii) $CH_3COC_6H_5 + HNO_3 \rightarrow CH_3COC_6H_4NO_2 + H_2O$
(or $CH_3COC_6H_5 + NO_2^+ \rightarrow CH_3COC_6H_4NO_2 + H^+$)



[1]

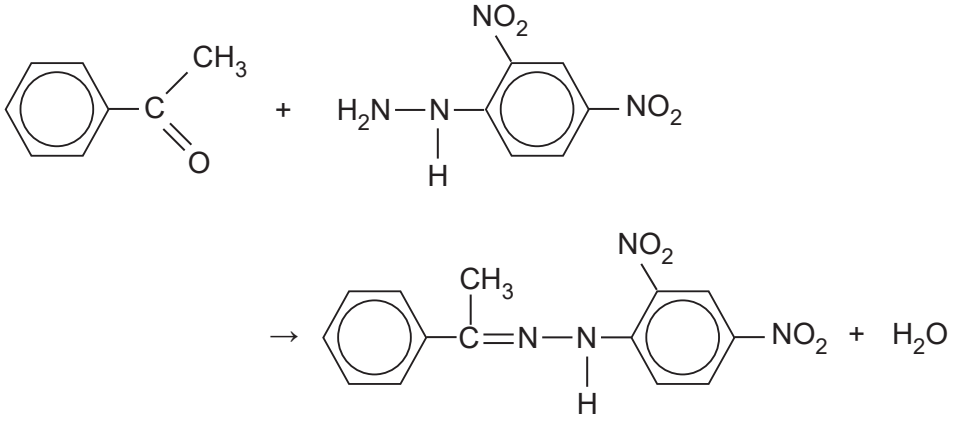
(iii) Indicative content

- place a small amount of solid in a capillary tube sealed at one end
- heat slowly (using melting point apparatus)
- record temperature at which melting starts and finishes
- repeat and average the temperatures
- solid will melt at a lower temperature if impurities are present
- solid will melt over a broader temperature range if impurities are present

Band	Response	Mark
A	Candidates must use appropriate specialist terms using a minimum of 5 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 a minimum of 3 points of indicative content. They must use appropriate spelling, punctuation and grammar and the form and style are of a good standard.	[3]–[4]
C	Candidates must use a minimum of 1 point of indicative content. They must 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) RMM of 2,4-dinitrophenylhydrazone derivative = 300

moles of derivative = $\frac{5.00}{300}$ = 0.0167

100% would be $\frac{0.0167}{0.9}$ = 0.0185

moles of phenylethanone = 0.0185

mass of phenylethanone = 0.0185 × 120 = 2.22 g

volume of phenylethanone = $\frac{2.22}{1.03}$ = 2.16 cm^3 [4]

(iii) assume RMM of ketone = x

RMM of oxime = x + 15

moles of ketone = moles of oxime

$\frac{0.8764}{x} = \frac{1.103}{x + 15}$

$0.8764(x + 15) = 1.103x$

$13.146 = 0.2266x$

$x = \frac{13.146}{0.2266}$ = 58

or

difference in mass = 0.2266 g

RMM of difference in structure = 15

moles of difference = moles of ketone = $\frac{0.2266}{15}$ = 0.01511

mass of ketone = $\frac{0.8764}{0.01511}$ = 58 [2]

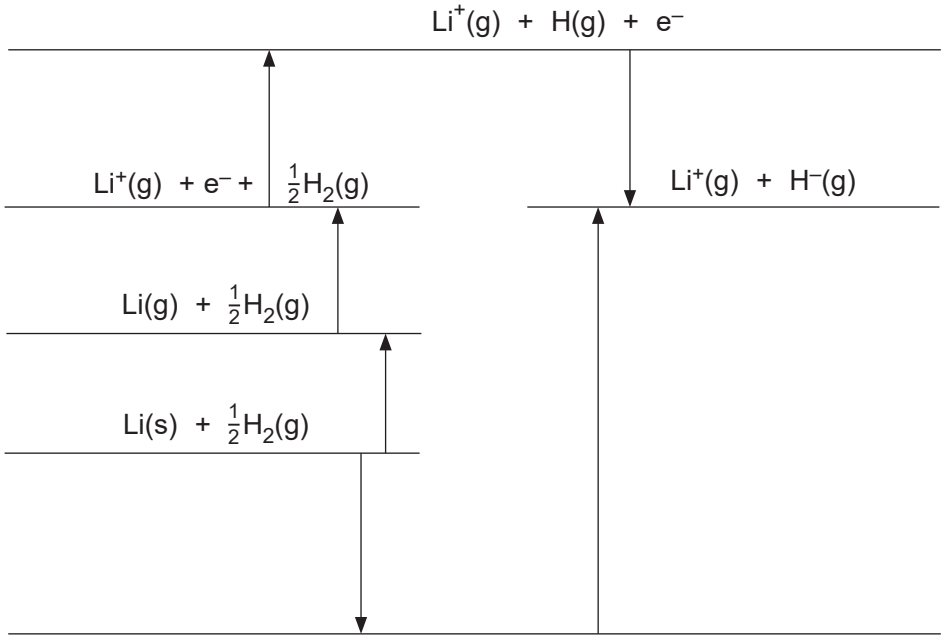
AVAILABLE MARKS

23

				AVAILABLE MARKS
14	**(a)**	**(i)**	molecules which have the same molecular formula but a different structural formula [1]	
		(ii)	pentanoic acid is a straight chain isomer/close packing/more points of contact [1] stronger van der Waals' forces between molecules [1] [2]	
	(b)	**(i)**	$CH_3(CH_2)_3COOCH_3 + H_2O \rightleftharpoons CH_3(CH_2)_3COOH + CH_3OH$ [1]	
		(ii)	sodium pentanoate [1] reaction goes to completion/reaction not reversible [1] [2]	
	(c)	**(i)**	sodium hydroxide [1] aqueous solution/heat under reflux [1] [2]	
		(ii)	oxidation [1]	
		(iii)	$CH_3CH_2CH(CH_3)COOH + 4[H] \rightarrow CH_3CH_2CH(CH_3)CH_2OH + H_2O$ [2]	
	(d)	**(i)**	$(CH_3)_3CCOOH + PCl_5 \rightarrow (CH_3)_3CCOCl + POCl_3 + HCl$ [1]	
		(ii)	misty fumes/steamy fumes [1] solid disappears [1] mixture warms up [1] max [2]	14
15	**(a)**	**(i)**	$C_{51}H_{98}O_6 + 72½O_2 \rightarrow 51CO_2 + 49H_2O$ [2]	
		(ii)	saturated as contains no C=C/fatty acid follows $C_nH_{2n+1}COOH$ [1]	
	(b)	**(i)**	propane-1,2,3-triol [1]	
		(ii)	transesterification [1]	
		(iii)	biodiesel [1]	
		(iv)	ethyl hexadecanoate [1]	
		(v)	moles of fat = $\frac{125}{806} = 0.155$ moles of ethanol = $\frac{30}{46} = 0.652$ ethanol in excess moles of **B** = 0.155 × 3 = 0.465 mass of **B** = 0.465 × 284 = 132.1 (g) [4]	
	(c)	**(i)**	(finely divided) nickel [1]	
		(ii)	to become saturated/reaction with C=C /changes liquid to a solid [1] [1]	13

16 **(a)** $LiH + AlH_3 \rightarrow LiAlH_4$ [1]

(b) **(i)**



[5]

(ii) $+916 = -(-91) + (+159) + (+520) + \frac{1}{2}\Delta_{BDE}H\ (H_2) + (-72)$

$\frac{1}{2}\Delta_{BDE}H\ (H_2) = 218$

$\Delta_{BDE}H\ (H_2) = 436\ (kJ\ mol^{-1})$ [3]

(c) **(i)** $H^- + H_2O \rightarrow OH^- + H_2$ [1]

(ii) H_2O acts as an acid [1]

donates H^+(proton) to H^- [1] [2]

AVAILABLE MARKS	
	12
Section B	**100**
Total	**110**