New Specification

Rewarding Learning

ADVANCED
General Certificate of Education
2018

Chemistry

Assessment Unit A2 1

assessing

Further Physical and Organic Chemistry

[ACH12]

TUESDAY 5 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 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. What is 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 C	
2 C	
3 D	
4 D	
5 C	
6 D	
7 C	
8 D	
9 B	
10 A	
[1] for each correct answer [10]	10
Section A	**10**

Section B

AVAILABLE MARKS

11 **(a)** **(i)** **(**Enthalpy of) atomisation (of barium) [1]

(ii) 1st and 2nd ionisation energies (of barium) [1]

(iii) Bond enthalpy (of chlorine)/twice the enthalpy of atomisation (of chlorine) [1]

(iv) (First) electron affinity (of chlorine) [1] [4]

(b) The enthalpy change when 1 mole of an ionic compound is converted to gaseous ions
([–1] for each error) [2]

(c) $\Delta H = 175 + 1500 + 242 - (2 \times 364) - (-855)$
$= 2044\ kJ\ mol^{-1}$
([–1] for each error) [2]

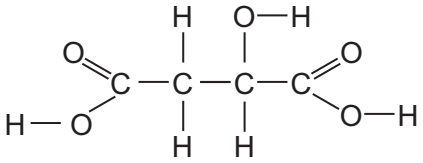
(d) Born-Haber (cycle) [1]

(e) $\Delta H_{soln} = 2044 - 1309 - 2\ (378)$
$= -21.0\ kJ\ mol^{-1}$ [2]

Enthalpy of solution is negative [1] [3] 12

AVAILABLE MARKS

12 **(a)** **(i)**



[1]

(ii) (2-)hydroxybutane-1,4-dioic acid/(2-)hydroxybutanedioic acid
([–1] for each error) [2]

(b) **(i)** $ClOCCH_2CHClCOCl$ [1]
$HOCH_2CH_2CHOHCH_2OH$ [1]
$(CH_3)_2CHOOCCH_2CHOHCOOCH(CH_3)_2$
([–1] for each error) [4]

(ii) Butane-1,2,4-triol [1] [1]

(c) **(i)** The melting point is high due to hydrogen bonding [1]
between the –COOH and the –OH/COOH groups in adjacent molecules [1] [2]
(2nd mark dependent on the first mark)

(ii) Moles malic acid = 558/134 = 4.16 mol dm^{-3}
([–1] for each error) [2]

(d) **(i)** A molecule which rotates the plane [1]
of plane polarised light [1] [2]

(ii) HOOC–(CHOH)–CH_2–COOH [1]

(iii) A racemic mixture [1]

(iv) Equal amounts/moles of both optically active isomers are formed [1]

17

AVAILABLE MARKS

13 (a)
- Record the pH
- Calculate the concentration of OH^-
- Plot a graph of concentration of OH^- against time
- Take tangents from graph and find the gradient at different times
- Plot gradient (rate) against concentration of sodium hydroxide
- Shape of graph indicates order

Band	Response	Mark
A	Candidates must use appropriate specialist terms to describe the methodology using 5–6 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 to describe the methodology using 3–4 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 describe the methodology using 1–2 points of indicative content. They use limited correct spelling, punctuation and grammar and the form and style is of a basic standard.	**[1]–[2]**
D	Not worthy of credit.	**[0]**

[6]

(b) (i) Rate = $k[CH_3COOC_2H_5][OH^-]$ [2]

(ii) $1.13 \times 10^{-2} = k\ (0.152)(0.038)$
$k = 1.13 \times 10^{-2}/(0.152)(0.038) = 1.96$ [1]
Unit = $mol^{-1}\ dm^3\ s^{-1}$ [1] [2]

(iii) The rate of the reaction will increase (but concentrations will remain the same) [1]
Therefore the rate constant is increased [1] [2]

(c) (i)

	CH_3COOH	C_4H_9OH	$CH_3COOC_4H_9$	H_2O
Initial moles	0.75	X	0	2.78
Final moles	0.25	X – 0.50	0.5	3.28

$3 = (0.5)(3.28)/(0.25)(X - 0.5)$

$(X - 0.5) = \dfrac{1.64}{(3 \times 0.25)} = 2.187$

$X = 2.687$
$X = 2.687$ mole
$2.687 \times 74 = 198.84\,g = 200\,g$ or $2.0 \times 10^2\,g$ or $0.20\,kg$
(unit essential, [–1] for each error) [4]

(ii) The equilibrium will move to the left [1] (reducing the concentration of the products)
To remove the heat [1] [2]

(iii) There are equal numbers of molecules/moles on both sides of the equation [1]
or K = concentration/concentration, hence no units

AVAILABLE MARKS

(d) **(i)**

$$\begin{array}{l} H_2C - O - CO(CH_2)_{16}CH_3 \\ \quad | \\ HC - O - CO(CH_2)_{16}CH_3 \\ \quad | \\ H_2C - O - CO(CH_2)_7CHCH(CH_2)_7CH_3 \end{array}$$

[2]

(must have two stearic and one oleic, any order. [–1] for each error)

(ii) (A reaction where) the alkyl group of an ester is exchanged with the alkyl group of an alcohol [2]

(iii) Biodiesel
Margarine/spreads [2] 25

AVAILABLE MARKS

14 (a) Butane-2,3-dione [1]

(b) (i) $CH_3CH(OH)CH(OH)CH_3 + 2[O] \rightarrow CH_3COCOCH_3 + 2H_2O$ [2]

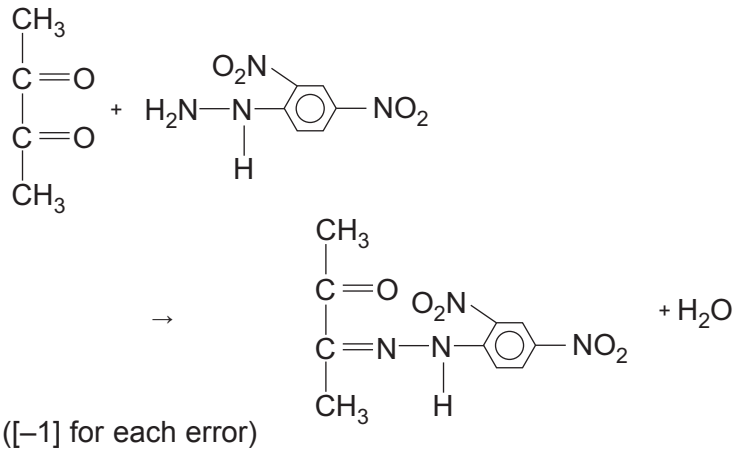
(ii) Acidified sodium/potassium dichromate(VI)/H_2SO_4 and $K_2Cr_2O_7$ [1]
Heat [1] [2]

(iii)
- Distil at a range of 88–90 °C
- Collect sample in named container
- Add anhydrous calcium chloride/sodium sulfate/ magnesium sulfate
- Swirl until clear/no longer cloudy
- Compare spectrum with pure diacetyl
- They should be the same

Band	Response	Mark
A	Candidates must use appropriate specialist terms to describe the methodology using 5–6 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 to describe the methodology using 3–4 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 describe the methodology using 1–2 points of indicative content. They use limited correct spelling, punctuation and grammar and the form and style is of a basic standard.	**[1]–[2]**
D	Not worthy of credit.	**[0]**

[6]

(c) (i)

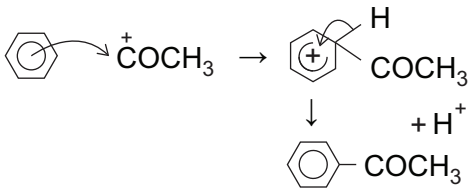


([–1] for each error) [2]

(ii) Yellow/orange crystals/solid [1]

(iii) The melting point would be lower with one molecule [1]
Smaller RMM of product [1] [2]
or vice versa

16

					AVAILABLE MARKS
15	**(a)**	**(i)**	An ion or molecule which attacks regions of high electron density	[2]	
		(ii)	A hydrogen atom on the benzene is replaced by an acyl group	[1]	
	(b)	**(i)**	$CH_3COOH + PCl_5 \rightarrow CH_3COCl + POCl_3 + HCl$	[1]	
		(ii)	PCl_5/CH_3COCl reacts with water	[1]	
		(iii)	$CH_3COCl + AlCl_3 \rightarrow CH_3CO^+ + AlCl_4^-$	[1]	
		(iv)			
			$H^+ + AlCl_4^- \rightarrow AlCl_3 + HCl$	[4]	10
			(curly arrows [1])		

				AVAILABLE MARKS
16	**(a)**	**(i)**	+7 [1]	
		(ii)	acidic [1] It is the salt of a strong acid and a weak base [1] [2]	
	(b)	**(i)**	$4NH_4ClO_4 \rightarrow 2N_2 + 4HCl + 5O_2 + 6H_2O$ **([1] for all formulae correct, [1] for balancing – conditional on the correct formulae.)** [2]	
		(ii)	Mole of NH_4ClO_4 = 11.75/117.5 = 0.1 mole 4 moles NH_4ClO_4 = 17 moles of gas 0.1 mole NH_4ClO_4 = 0.425 moles of gas Volume of gas = 0.425 × 42 = 17.85 $dm^3 \rightarrow 18\,dm^3$ **([–1] for each error, unit essential)** [3]	
	(c)	**(i)**	A solution which resist changes in pH on addition of small amounts of acid or alkali [2]	
		(ii)	H^+ removed by NH_3 [1] $H^+ + NH_3 \rightarrow NH_4^+$ [1] OH^- ions removed by NH_4^+ [1] $OH^- + NH_4^+ \rightarrow NH_3 + H_2O$ [1] [4]	
	(d)	**(i)**	$192 + 3(131) = 2(193) + \Delta S$ $\Delta S = 386–585 = –199\,J\,mol^{-1}\,K^{-1}$ [1]	
		(ii)	$\Delta G = \Delta H – T\Delta S$ $= 2(–46.2) – (298 \times –0.199)$ $= –92.4 + 59.3 = –33.1\,kJ\,mol^{-1}$ **(unit essential, [–1] for each error)** [2]	
		(iii)	$\Delta G = 0$ $0 = –92.4 + 0.199T$ $T = 92.4/0.199 = 464\,K$ (unit essential, [–1] for each error) [2]	
		(iv)	The activation energy [1]	20
			Section B	**100**
			Total	**110**