Rewarding Learning

ADVANCED
General Certificate of Education
2018

Chemistry

Assessment Unit A2 1

assessing

Periodic Trends and Further Organic, Physical and Inorganic Chemistry

[AC212]

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.

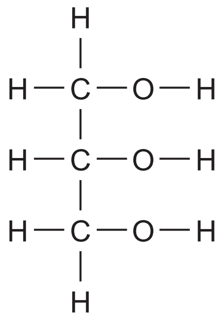
It is important to recognise that in some cases there may well be other correct responses which are equally acceptable to those published: the mark scheme can only cover those responses which emerged in the examination. There may also be instances where certain judgements may have to be left to the experience 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	B	
4	C	
5	C	
6	C	
7	D	
8	B	
9	A	
10	B	
[2] for each correct answer	[20]	20
	Section A	**20**

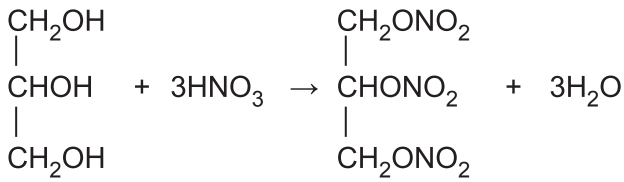
AVAILABLE MARKS

11 **(a)** **(i)**



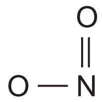
[2]

(ii)



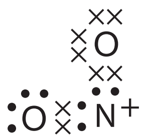
[2]

(iii)



[1]

(iv)



[1]

(b) **(i)** $2C_3H_5N_3O_9(l) \rightarrow 5H_2O(g) + 3N_2(g) + 6CO_2(g) + \frac{1}{2}O_2(g)$ [2]

(ii) RFM nitroglycerine = 227

Number of moles nitroglycerine = (50/227)

Ratio 1: 4.75 (note water will be liquid at 20 °C)

Number of moles gas = (475/454)

Volume gas = 25.11 dm^3 [2]

(c) **(i)** $2NO + O_2 \rightarrow 2NO_2$ [1]

(ii) High temperature in engines [1]
Allows reaction between nitrogen and oxygen [1] [2]

(d) **(i)** 2 [1]

(ii) 1 [1]

(iii) rate = $k[NO]^2[H_2]$ [1]

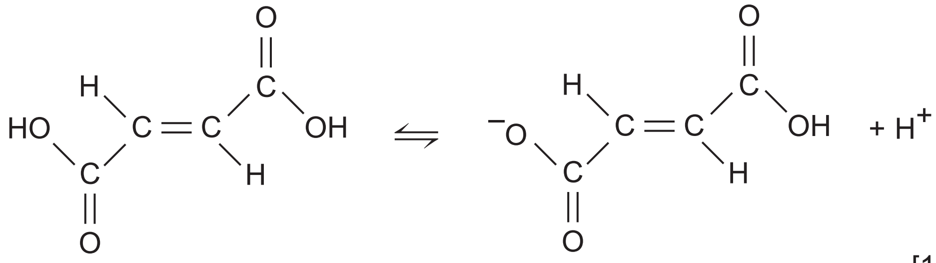
(iv) 1.23 $mol^{-2} dm^6 s^{-1}$ [2]

(e) **(i)** all particles are moving, so no particles have zero energy [1]

(ii) no upper limit to energy [1] 20

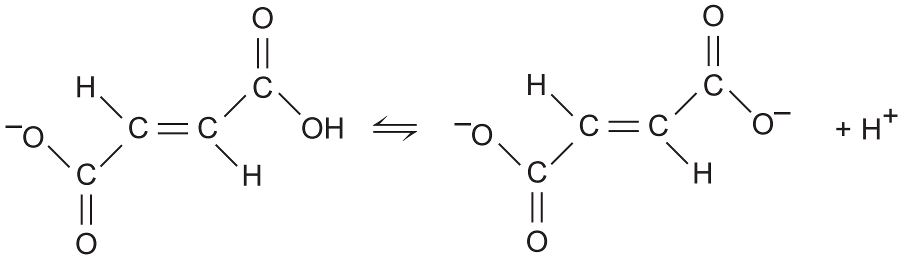
12 **(a)** E butenedioic acid [2]

(b) **(i)**



[1]

(ii)



[1]

(iii) $8.85 \times 10^{-4} = \frac{[H^+]^2}{[HA]}$

$(8.85 \times 10^{-4})(0.05) = [H^+]^2$

$0.00004425 = [H^+]^2$

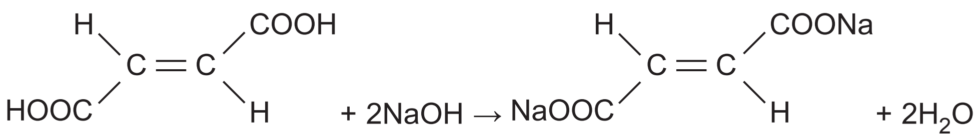
$0.00665206734 = [H^+]$

pH = 2.18 [3]

(iv) Presence of protons from the first dissociation shifts equilibrium of second dissociation to the left
or
Second value for Ka is much smaller than the first [1]

(c) **(i)** $C_2H_2(COOH)_2 + 2NaOH \rightarrow C_2H_2(COONa)_2 + 2H_2O$

or



[2]

(ii) H^+ reacts with the $-COO^-$ part of the fumarate [1]
Removing the H^+ /Therefore the H^+ concentration stays constant [1] [2]

(iii) mol NaOH 0.04

mol acid 0.09

mol acid remaining = 0.09 – 0.04 = 0.05

mol salt = 0.04

$[H^+] = 1.8 \times 10^{-5} \times 0.05/0.04 = 2.25 \times 10^{-5}$

pH = 4.64 [3]

AVAILABLE MARKS

AVAILABLE MARKS

(d) (i) yield increases [1] equilibrium shifts right to remove methanol [1] [2]

(ii) Rate increases as acid acts as a catalyst

Catalyst provides a route of lower activation energy

Yield increases

Concentrated sulfuric acid removes water shifting equilibrium right [4]

(iii) $$Kc = \frac{[C_2H_4(COOCH_3)_2][H_2O]^2}{[C_2H_4(COOH)_2][CH_3OH]^2}$$ [2]

(iv)

	$C_2H_4(COOH)_2$	CH_3OH	$C_2H_2(COOCH_3)_2$	H_2O
start	0.5	0.7	0	0
equilibrium	0.5–x	0.7–2x	x	2x
	0.24	0.18	0.26	0.52

$$Kc = \frac{0.26\ (0.52)^2}{0.24(0.18)^2}$$

Kc = 9.04 no units [4]

(v) volumes cancel in the equilibrium expression [1] 28

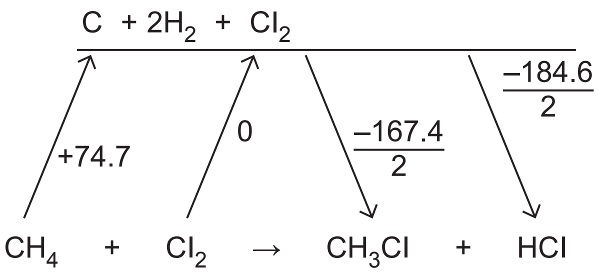
AVAILABLE MARKS

13 **(a)** Ozone is also an element but not in its standard state (which is O_2) [1]

(b) 3(205) – 2(239) = 137 $JK^{-1} mol^{-1}$ [1]

(c) the enthalpy of reaction is negative. The entropy of reaction is positive
The free energy change therefore must be negative at all temperatures [2]

(d) **(i)**

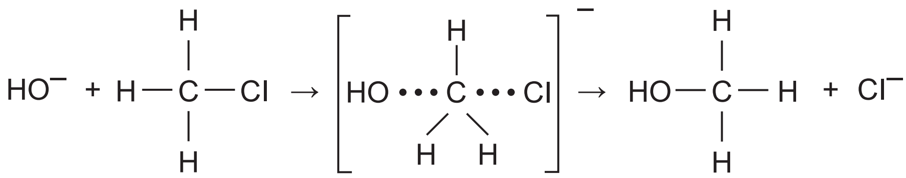


$$74.7 + \frac{-167.4}{2} + \frac{-184.6}{2} = -101.3\ kJ\,mol^{-1}$$

or

$\frac{1}{2}H_2 + \frac{1}{2}Cl_2$	→	HCl	$-1846/2\ kJ\,mol^{-1}$
$C + H_2 + \frac{1}{2}Cl_2$	→	CH_3Cl	$-167.4/2\ kJ\,mol^{-1}$
CH_4	→	$C + 2H_2$	$+74.7\ kJ\,mol^{-1}$
$CH_4 + Cl_2$	→	$CH_3Cl + HCl$	$-101.3\ kJ\,mol^{-1}$ [2]

(ii)



[3]

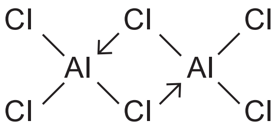
(iii) Rate = $k[CH_3Cl][OH^-]$ 2nd order [2] 11

14 **(a)** **(i)** Mg^{2+} has a higher charge density than Na^{+} [1]
Mg^{2+} will attract O^{2-} more strongly [1] [2]

(ii) Silicon dioxide has a giant covalent structure [1]
Large amount of energy to break many strong covalent bonds [1]
Phosphorus(V) oxide and sulfur trioxide are molecular structures [1]
P_4O_{10} has more electrons and therefore more van der Waals' [1]
Max [3]

(b) **(i)** $Al_2Cl_3.6H_2O \rightarrow Al(OH)_3 + 3HCl + 3H_2O$ [2]

(ii)



[2]

(iii) Breaking up of molecules by reaction with water [1]

(iv) $Al_2Cl_6 + 3H_2O \rightarrow Al_2O_3 + 6HCl$

or

$Al_2Cl_6 + 6H_2O \rightarrow 2Al(OH)_3 + 6HCl$ [2]

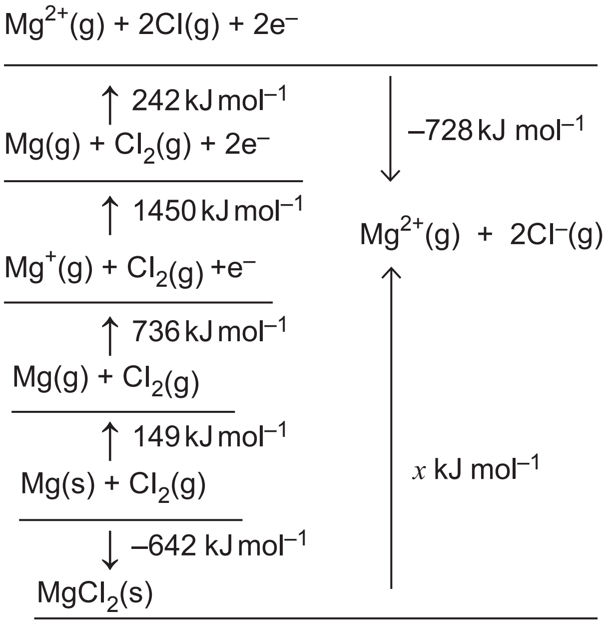
AVAILABLE MARKS

12

15 (a) (i) $2NH_3 \rightleftharpoons N_2 + 3H_2$ [1]

Accept non-equilibrium arrow drawn in correct direction

(ii)



[4]

(iii) –642 = 149 + 736 + 1450 + 242 – 728 – x

x = 2491 kJ mol^{-1} [1]

(b) (i) (Ability to) absorb infrared radiation [1]

(Atmospheric) concentration [1] [2]

(ii) Any **two** from:

reforestation

Using more public transport

Burning less fossil fuels

Using alternative fuel sources

(2 x [1]) [2]

(c) $Mg(NH_3)_6Cl_2$ = 24 + 6 × 17 + 2 × 35.5

= 24 + 102 + 71

= 197

Moles of compound = $100 \times 10^3 \times 10^3/197 = 5.076 \times 10^5$

Ratio of compound : H_2 1:9

Moles of H_2 = $5.076 \times 10^5 \times 9 = 4.5684 \times 10^6$

Mass of H_2 = $4.5684 \times 10^6 \times 2$ g

= 9.1368×10^6 g

= 9.137 tonnes [3]

AVAILABLE MARKS

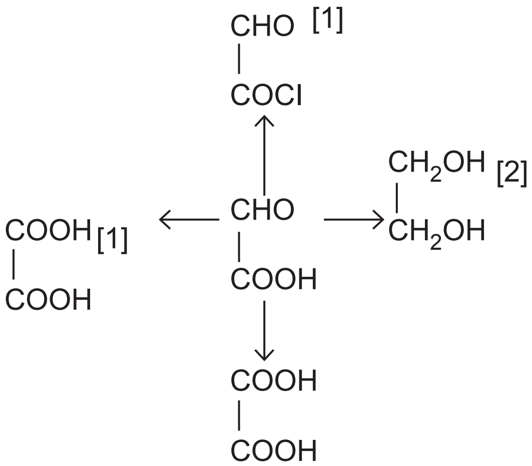
13

16 (a) contains two functional groups [1] aldehyde and carboxylic acid [1] [2]

(b) Place (approximately 5 cm^3) of 2,4-dinitrophenylhydrazine solution in a suitable container
Add a few drops of the test liquid (or the solid dissolved in ethanol)
Cool the mixture in iced water
Filter off the crystals
Measure the melting point
Compare melting points to table of known values [4]

Quality of written communication [2]

(c)



Single functional group reduced using
L_1AlH_4 = [1] [5]

(d) Glyoxylic acid has a higher boiling point [1]

The carboxylic acid has hydrogen bonds between molecules. The ester has van der Waals/dipole-dipole forces between molecules [1]

Hydrogen bonds are stronger [1] [3]

	AVAILABLE MARKS
	16
Section B	**100**
Total	**120**