Rewarding Learning

ADVANCED
General Certificate of Education
January 2014

Chemistry

Assessment Unit A2 1

assessing

Periodic Trends and Further Organic, Physical and Inorganic Chemistry

[AC212]

MONDAY 13 JANUARY, AFTERNOON

MARK SCHEME

8830.01 F

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

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

Section B

					AVAILABLE MARKS
11	**(a)**	Born–Haber cycle		[1]	
	(b)	Step 1: Enthalpy of formation (of magnesium chloride) Step 2: Enthalpy of atomisation (of magnesium) Step 3: electron affinity (of chlorine)	[1] [1] [1]	[3]	
	(c)	$-642 + \Delta H_{lat} = 149 + 2240 + (2 \times 121) + (2 \times (-364))$ $\Delta H = +2545\ kJ\ mol^{-1}$ ([–1] for each mistake)		[3]	7
12	**(a)**	Restricted rotation about the double bond Different group/atoms on each C atom of the double bond	[1] [1]	[2]	
	(b)	**(i)** $HOOCCHCHCOOH + 2C_2H_5OH \rightleftharpoons H_5C_2OOCCHCHCOOC_2H_5 + 2H_2O$		[2]	
		(ii) Heat/reflux/warm		[1]	
		(iii) concentrated sulfuric acid		[1]	
	(c)	Mix each with Fehling's solution and warm The solution will remain blue/no change – with fumaric acid Isomer will form a red precipitate	[1] [1] [1]	[3]	9

13 (a) P_4O_{10}/P_2O_5 [1]
Cl_2O_7 [1] [2]

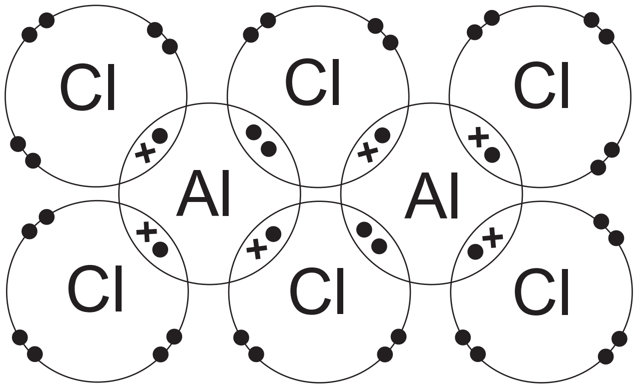
(b) (i) Reacts with acids and alkalis/bases [1]

(ii) $Al_2O_3 + 2NaOH + 3H_2O \rightarrow 2NaAl(OH)_4$ [2]
or $Al_2O_3 + 2NaOH \rightarrow 2NaAlO_2 + H_2O$

(iii) $Al_2O_3 + 6HCl \rightarrow 2AlCl_3 + 3H_2O$ [1]

(c) (i) Two molecules joined together (to form a single molecule) [1]

(ii) Dot and cross correctly used and bonding correct [1]
Dative bonds correct [1] [2]



(d) (i) Sodium chloride: 7 [1]
Phosphorus(V) chloride: 0–2 [1] [2]

(ii) Both NaCl equations [2]
Or [1] for either equation and [1] for explanation:
Salt of strong acid and strong base
$NaCl(s) + H_2O \rightarrow Na^+ (aq) + Cl^- (aq)$
$NaOH + HCl \rightarrow NaCl + H_2O$
$[H^+] = [OH^-]$ [2]

Both PCl_5 equations [2]
Or [1] for either equation and [1] for explanation:
$PCl_5 + 4H_2O \rightarrow H_3PO_4 + 5HCl$
$PCl_5 + H_2O \rightarrow POCl_3 + 2HCl$
Reacts to produce strong acids/fully dissociated/named acids [2] [4] 15

14 **(a)** C_5H_8O [1]

(b) **(i)** Mass of iodine in grams [1]
which reacts with 100 g of the fatty acid [1] [2]

(ii) Weigh accurately (about 1 g) of LTB4
Dissolve in a suitable solvent
Add (5 cm^3 of) Wij's solution
Allow to stand in the dark (for 30 minutes)
Add excess KI (solution)
Titrate (the liberated iodine) against standard sodium thiosulfate solution
Repeat using a blank titration (without the LTB4)
(To a maximum of [6]) [6]

Quality of written communication [2]

(iii) $C_{20}H_{32}O_4$ = 336
1 mole LTB4 : 4 moles I_2
(4 × 254/336) × 100 = 302.4
([–1] for each mistake) [3]

(c) Mass of KOH in mg [1] required to completely hydrolyse 1 g of the fat [1] [2]

(d) **(i)**

```
C15H31COOCH2
           |
C15H31COOCH
           |
C13H27COOCH2
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(**or** correct alternative order of acid groups, [–1] for each mistake) [2]

(ii) $C_{49}H_{94}O_6$ = 49 × 12 + 94 × 1 + 6 × 16
= 588 + 94 + 96
= 778
1 mole fat: 3 moles KOH, i.e. 3 × 56 = 168
168/778 = 0.216 = 216 mg = 216
([–1] for each mistake) [3] 21

15 (a) (i) It is an element [1]

(ii) $\Delta H = -393.5 + 110.5 + 241.8$
$= -41.2$ kJ mol^{-1} [2]

(iii) $\Delta S = 213.6 + 114.6 - 197.9 - 188.7$
$= -58.4$ J K^{-1} mol^{-1} [2]

(iv) $\Delta G = \Delta H - T\Delta S$
Therefore $T = \Delta H/\Delta S = 41.2/0.0584$
= 705.5 K/706 K/433 °C [2]

(b) (i) $K_p = (p_{NH_3})^2(p_{N_2})(p_{H_2})^3$ [1]

(ii) $N_2 + 3H_2 \rightleftharpoons 2NH_3$

	N_2	$3H_2$	$2NH_3$
at the start	1	3	0
at equilibrium	0.2	0.6	1.6
mol fractions	$\frac{0.2}{2.4}$	$\frac{0.6}{2.4}$	$\frac{1.6}{2.4}$
	= 0.083	= 0.25	= 0.67

partial pressures N_2: 8.3×10^5 Pa
H_2: 2.5×10^6 Pa
NH_3: 6.7×10^6 Pa

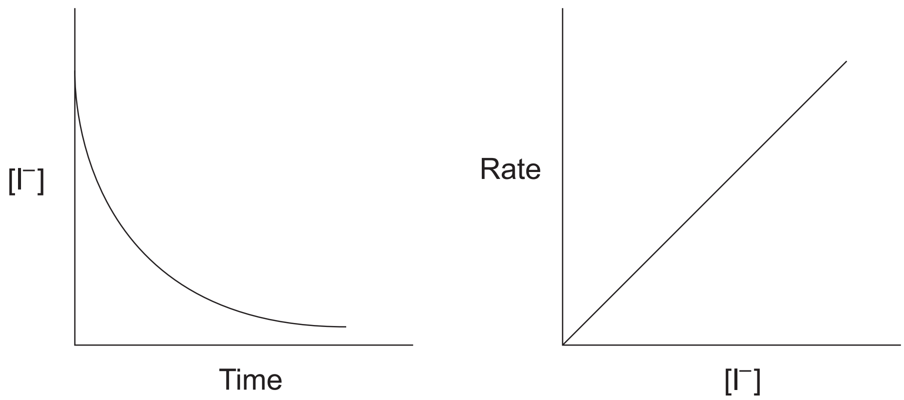
$$K_p = \frac{(6.6 \times 10^6)^2}{(8.3 \times 10^5)(2.5 \times 10^6)^3}$$

$$(6.7 \times 10^6)^2 = 44.89 \times 10^{12}$$
$$(2.5 \times 10^6)^3 = 15.6 \times 10^{18}$$
$$K_p = \frac{44.89 \times 10^{12}}{8.3 \times 10^5 \times 15.6 \times 10^{18}} = \frac{4.5 \times 10^{13}}{129 \times 10^{23}}$$
$$= 0.035 \times 10^{-10}$$
$$= 3.5 \times 10^{-12} \text{ Pa}^{-2}$$ [4] 12

error ([–1])

16 (a) Starch [1]
goes blue-black [1] [2]

(b) (i)



[2]

(ii) H_2O_2 = 1st [1]
H^+ = zero [1] [2]

(iii) Rate = $k[H_2O_2][I^-][H^+]^0$ or Rate = $k[H_2O_2][I^-]$ [1]

(iv) $k = (2.1 \times 10^{-6})/(0.00075)(0.1)$
$= 0.028$ [2]
$mol^{-1}\ dm^3\ s^{-1}$ [1] [3]

(c) (i) Slowest step (in the reaction mechanism) [1]

(ii) $2H^+ + I^- + IO^- \rightarrow I_2 + H_2O$ [2] 13

17 (a) (i) Fizzing/effervescence (**not** a gas given off) [1]
$2HCOOH + Na_2CO_3 \rightarrow 2HCOONa + H_2O + CO_2$ [1] [2]

(ii) $HCOOH \rightarrow H_2O + CO$ [1]

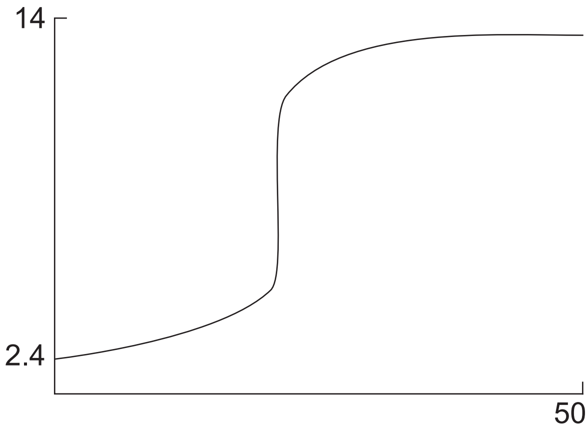
(b) (i) (Mix Tollen's reagent with methanoic acid)
warm/heat [1]
a silver mirror will form/silver is formed [1] [2]

(ii) $Ag^+ + e^- \rightarrow Ag$ [1]

(c) (i) $HCOO^-$ [1]

(ii) $[H^+]^2 = K_a[HCOOH]$
$= (1.6 \times 10^{-4})(0.1) = 1.6 \times 10^{-5}$
$[H^+] = 4 \times 10^{-3}$
pH = 2.4
([–1] for each mistake) [2]

(d) Correct shape



Begins at approximately 2.4 (does not need to be marked)
Rises sharply at 25 cm^3
Levels off at approximately 13
([–1] for each mistake) [3]

(e) (i) A solution which resists changes in pH [1]
on addition of small amounts of acid or alkali [1] [2]

(ii) On addition of alkali/OH^- methanoic acid reacts to remove OH^- [1]
$HCOOH + OH^- \rightarrow HCO_2^- + H_2O$ [1]
On addition of acid/H^+ methanoate ions combine with the H^+ ions to form methanoic acid molecules [1]
$HCOO^- + H^+ \rightarrow HCOOH$ [1] [4]

(iii) Moles of NaOH = 2/40 = 0.05
Moles HCOONa in 500 cm^3 = 0.05
[HCOONa] = 0.1 mol dm^{-3}
Moles HCOOH in 500 cm^3 = 0.15
Moles HCOOH in buffer = 0.15 – 0.05 = 0.10
[HCOOH] = 0.2 mol dm^{-3}
$[H^+] = K_a[HCOOH]/[HCOONa] = 1.6 \times 10^{-4}(0.2/0.1) = 3.2 \times 10^{-4}$
pH = 3.49
([–1] for each mistake) [5] 23

Section B	**100**
Total	**120**