Anderson Junior College 2009 H1 Chemistry Preliminary Examinations Paper 2 Mark Scheme

- **1** (a) Empirical formula is the simplest formula that shows the relative number of atoms of each element present in a compound.
 - **(b)** (i) CH₂

(ii)
$$C_n H_{2n} + \frac{3}{2} n O_2 \rightarrow n CO_2 + n H_2O_2$$

Volume of $H_2O = 40 \text{ cm}^3$

Mole ratio of $H_2O : C_nH_{2n} = n : 1 = 40 : 10$ Hence n = 4

Molecular formula of **A** is $\underline{C_4H_8}$.

(c)

2



A (or B), C and D are structural isomers.

A and B are cis-trans isomers.



(a) (i) Let the rate equation be rate = k $[CH_3COCH_3]^x [I_2]^y [H^+]^z$

As observed from the graph, rate of reaction remains constant when [I₂] changes => rate of reaction is independent of [I₂] => zero order wrt [I₂], **y** = **0**

Using the 1st graph, when [H⁺] doubled while [CH₃COCH₃] is constant,

$$\frac{\frac{0.006}{240}}{\frac{0.006}{120}} = (\frac{0.10}{0.20})^{z}$$

$$z = 1$$

Using the 2^{nd} graph, when [CH₃COCH₃] increased by 1.5 times while [H⁺] is constant,

$$\frac{\frac{0.006}{240}}{\frac{0.006}{160}} = (\frac{0.10}{0.15})^{x}$$

x = 1

(ii) rate = k $[CH_3COCH_3] [H^+]$

 $\frac{0.006}{120} = k (0.10)(0.20) \implies k = 2.50 \text{ X } 10^{-3} \text{ mol}^{-1} \text{ dm}^3 \text{ min}^{-1}$



Hydrogen ions speed up the rate of the reaction by providing a different reaction path which has lower activation energy.

As shown on the diagram, the number of reactant molecules with energy greater than or equal to the activation energy (E_a) will increase. This results in an increase in the frequency of effective collisions. Hence, the rate of reaction increases.

(b)

) : I_2 molecule

Simple molecular lattice structure with weak van der Waals forces of attraction between I_2 molecules.

(c) NaOH(aq), warm

Yellow precipitate observed for propanone but not propanal

- (a) • Silicon has the highest melting point, followed by magnesium, then sulfur.
 - Magnesium has a giant metallic structure with strong electrostatic attraction between magnesium ions and delocalized electrons.
 - Silicon has a giant macromolecular structure with strong and extensive covalent bonds between silicon atoms.
 - Sulfur has a simple molecular structure with weak van der waals' forces of attraction between the molecules.
 - **(b)** (i)

Maximum temp reached = $54.5^{\circ}C$

Mg + 2HC $l \rightarrow$ MgC l_2 + H₂ (ii)

 $n_{Mg} = \frac{0.25}{24.3} = 0.0103 \text{ mol}$ $n_{HCl} = 0.04 \text{ mol}$

Mg is the limiting agent. Heat evolved = Heat absorbed by solution= 40 X 4.2 X (54.5 - 28.0) = 4452 J

$$\Delta H = -\frac{4.452}{0.0103} = -432 \text{ kJ mol}^{-1} \qquad (\text{no mark if no -ve sign})$$

(iv) Using Hess' Law,

$$-432 + (-286) = -600 + \Delta H_1$$

 $\Delta H_1 = -118 \text{ kJ mol}^{-1}$

3

- **4 (a)** sp²
 - (b)
 - (c) (i) Brown solution turns colourless.

 $CH_2 = CH - CH = CH_2 + 2Br_2 \rightarrow CH_2BrCH(Br)CH(Br)CH_2Br$

(ii) Purple solution turns colourless with black solid formed.

 $CH_2=CH-CH=CH_2 + 2[O] + 2H_2O \rightarrow CH_2(OH) CH(OH)CH(OH)CH_2OH$

- (d) (i) $H_2C_2O_4 \rightarrow 2CO_2 + 2H^+ + 2e$ $5H_2C_2O_4 + 2MnO_4^- + 6H^+ \rightarrow 10CO_2 + 2Mn^{2+} + 8H_2O$
 - (ii)

No. of moles of $MnO_4^- = 0.0200 \times (20.0 / 1000) = 4 \times 10^{-4} \text{ mol}$ No. of moles of $H_2C_2O_4 = 4 \times 10^{-4} \times 5/2 = 1.00 \times 10^{-3} \text{ mol}$ Concentration of $H_2C_2O_4 = 1.00 \times 10^{-3}/(25.0/1000) = 0.0400 \text{ mol dm}^{-3}$

(iii) The removal of the 2^{nd} electron from CI^{t} is easier due to the inter–electronic repulsion between the paired electrons in the 3p orbital, hence 2^{nd} IE of CI is less than that of S.

- (b) (i) As the $[H_2O_2]$ increases by 3 times $(\frac{0.30}{0.10})$, the time taken for 100 cm³ of O_2 to be produced decreases by about $\frac{1}{3}(\frac{13}{40})$ => rate of decomposition of H_2O_2 is directly proportional to $[H_2O_2]$ => order of reaction wrt $[H_2O_2]$ is 1
 - (ii) When equal volumes of H_2O_2 and water are mixed, the $[H_2O_2]$ will be <u>halved</u> as volume doubled. hence <u>rate of reaction will be halved</u>. (time taken will be doubled).

- (iii) $\Delta H_6 = \Delta H_1 (\Delta H_2 + \Delta H_3 + \Delta H_4 + \Delta H_5)$ = - 414 - (214 + 248 + 988 + 657) = - 2521 kJ mol⁻¹
- (iv) Na⁺ has a smaller charge and larger ionic radius, hence the electrostatic forces of attraction between Na⁺ and O²⁻ will be weaker. Therefore melting point of Na₂O is lower than that of AI_2O_3 .

(v)
$$Al + NaOH + 3H_2O \longrightarrow NaAl(OH)_4 + \frac{3}{2}H_2$$

(vi)

nH₂ evolved =
$$\frac{75}{24000}$$
 = 3.125 x 10⁻³ mol
nA*l* present = $\frac{3.125 \times 10^{-3}}{3/2}$ = 2.083 x 10⁻³ mol
mass of A*l* present = 2.083 x 10⁻³ x 27.0 = 0.05625 g
% purity of A*l* sample = $\frac{0.05625}{0.10}$ x100% = **56.3** %

6. **(a)** (i)

Bond Angle: 109.5°

- (ii) Aluminium is **electron deficient** which can accept a **lone pair of electrons** from chlorine to attain an **octet structure**.
- (iii) $A/Cl_3 + 6H_2O \rightarrow [AI(H_2O)_5(OH)]^{2+} + H_3O^+ + 3Cl^-$
- (iv) Effervescence is observed and the zinc sheet dissolves. $2H^+ + Zn \rightarrow H_2 + Zn^{2+}$
- (b) (i) The salt form is **soluble** and is more easily absorbed in the body.
 - (ii) The **C***I*⁺ is electron deficient and it attacks the electron rich benzene ring.
 - (iii) Substitution

 Add 2,4–DNPH to the two drugs separately and warm. Naprofen: No orange precipitate Ketoprofen: Orange precipitate

(c) (i) The forward reaction is **endothermic**, **heat is absorbed**. For the equilibrium position to be shifted to the **right hand side**, the reaction must be **heated to absorb the external heat** supplied.

(ii)

$$K_{c} = \frac{[PCl_{3}][Cl_{2}]}{[PCl_{5}]}$$

$$[PCl_{3}]_{eqm} = [Cl_{2}]_{eqm} = \frac{0.30}{2} = 0.15 \text{ mol dm}^{-3}$$

$$[PCl_{5}]_{eqm} = \frac{(0.40 - 0.30)}{2} = 0.05 \text{ mol dm}^{-3}$$

$$K_{c} = \frac{0.15X0.15}{0.05} = 0.45 \text{ mol dm}^{-3}$$

7 (a) (i)
$$[H^+] = 10^{-1.93} = 0.0117 \text{ mol } \text{dm}^{-3} < 0.20 \text{ mol } \text{dm}^{-3}$$

Citric acid undergoes partial dissociation in water to give H⁺, hence it is a **weak acid**.

(ii)
$$K_a = \frac{[C_5 H_7 O_4 COO^-][H^+]}{[C_5 H_7 O_4 COOH]}$$

(iii)

	C ₅ H ₇ O ₄ COOH	$<-> C_5 H_7 O_4 COO^-$	+ H ⁺
Initial	0.20	0	0
Change	- 0.0117	+ 0.0117	+ 0.0117
Equilibrium	0.1833	0.0117	0.0117
			0

 $K_a = [H^+][C_5H_7COO^-]/[C_5H_7O_4COOH] = 7.27 \times 10^{-4} \text{ mol dm}^{-3}$

 $[OH^{-}] = 0.100 \text{ mol } dm^{-3}$ pOH = 1 pH = 14 - pOH = 13 (ii)

No. of moles of sodium hydroxide = $0.100 \times (20.00 / 1000) = 0.002 \text{ mol}$

No. of moles of sodium hydroxide = No. of moles of citric acid = 0.002 mol

Volume of citric acid needed for complete neutralization = $0.002/0.20 = 10.00 \times 10^{-3} \text{ dm}^3 = 10.00 \text{ cm}^3$

(iii)

Indicator to be used is **phenol red** since the pH range at which the indicator changes colour lies within the range of rapid pH change during this weak acid – strong alkali titration.

(iv)

 $C_5H_7O_4COO^- + H^+ \rightarrow C_5H_7O_4COOH$ When a small amount of acid is added, $C_5H_7O_4COO^-$ removes the H⁺.

 $C_5H_7O_4COOH + OH^- \rightarrow C_5H_7O_4COO^- + H_2O$ When a small amount of alkali is added, the citric acid helps to remove the OH⁻. Hence pH remains relatively constant.

(v) When $[C_5H_7COO^-] = [C_5H_7O_4COOH]$, $K_a = [H^+][C_5H_7COO^-]/[C_5H_7O_4COOH]$ $K_a = [H^+]$ $pH = -lg (7.29 \times 10^{-4}) = 3.14$

1	2	3	4	5
В	А	D	A	D
6	7	8	9	10
D	А	В	D	С
11	12	13	14	15
А	А	В	С	D
16	17	18	19	20
А	С	С	В	С
21	22	23	24	25
В	А	D	С	В
26	27	28	29	30
A	С	В	В	С

2009 H1 Chemistry Prelim Exam Paper 1 Answers