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

## Paper 2



(ii)  $\Delta H = 180 - 282 = -102 \text{ kJ mol}^{-1}$ 

(iii) The activation energy will decrease.

(iv) 
$$\Delta H = 150 - \frac{1}{2} (496) = -98 \text{ kJ mol}^{-1}$$

(v) Bond energy is an estimated value / average value only.

(b) (i) Amount of unreacted iodine 
$$=\frac{23.60}{1000} \times 0.02 \times \frac{1}{2}$$
  
= 2.36 x 10<sup>-4</sup> mol

(ii) Amount of iodine reacted with sulfur dioxide =  $\frac{40}{1000} \times 0.01 - 2.36 \times 10^{-4}$ = 1.64 x 10<sup>-4</sup> mol

(iii)  $I_2 + 2e \rightarrow 2I^-$ SO<sub>2</sub> + 2H<sub>2</sub>O  $\rightarrow$  SO<sub>4</sub><sup>2-</sup> + 4H<sup>+</sup> + 2e Balanced equation: SO<sub>2</sub> + I<sub>2</sub> + 2H<sub>2</sub>O  $\rightarrow$  2I<sup>-</sup> + SO<sub>4</sub><sup>2-</sup> + 4H<sup>+</sup> Amount of SO<sub>2</sub> present in wine = 1.64 x 10<sup>-4</sup> mol

(iv) Concentration of SO<sub>2</sub> =  $\frac{1.64 \times 10^{-4}}{\frac{50}{1000}}$  = 3.28 x 10<sup>-3</sup> mol dm<sup>-3</sup>

[Total: 12]

- 2(a) (i) The first ionisation energy of an element is defined as the amount of energy required to remove one electron from each atom in <u>a mole of gaseous atoms</u> producing one mole of gaseous ions with one positive charge.
  - (ii)  $Be(g) \rightarrow Be^+(g) + e$
  - **(b)** N  $1s^2 2s^2 2p_x^{1} 2p_y^{1} 2p_z^{1}$  O  $1s^2 2s^2 2p_x^{2} 2p_y^{1} 2p_z^{1}$

**Less** energy is required to remove a paired 2p electron in O since **repulsion** is experienced between the paired electrons.



(d) (i) SiO<sub>2</sub> is <u>giant</u> covalent that requires a lot of energy to break the <u>strong covalent</u> <u>bonds</u> between atoms during melting.

SiCl<sub>4</sub> is <u>simple</u> covalent that requires little energy to break the <u>weak Van der</u> <u>Waals' forces</u> between molecules during melting.

(ii) SiCl<sub>4</sub> + 2H<sub>2</sub>O  $\rightarrow$  SiO<sub>2</sub> + 4HCl pH = 2 (3 is also accepted)

[Total: 10]

8872 / CJC JC 2 CHEMISTRY Promotional Exam 09 ANSWERS



E: HCN, trace amount of NaOH, (10 – 20 °C)

F: HCl (aq), reflux

 (b) Test: Add Tollen's reagent to J, K and L and warm. Observation: Only Y gives silver precipitate, the others will not.
 OR Add 2,4-DNPH and warm, only Y gives orange precipitate, the others will not.

Test: Add  $Br_2$  in  $CCl_4$  or aqueous to **J** and **L**. Observation: Only **J** decolourises the reddish-brown  $Br_2$ . **L** will not.

Test: Add  $I_2$ , NaOH (aq) and warm L. Observation: L gives yellow precipitate Add PCI<sub>5</sub> to L, white fumes (HCI) is evolved.

**OR** Add PCI<sub>5</sub> to L, white fumes (HCI) is evolved. Answers of the correct logic or sequence will be given marks.

(c)



[Total: 12]

4(a) The sailors ate fruits / vegetables.





(c) Starch

(d) Amt of triiodide solution = Amt of vit C in 25.0 cm<sup>3</sup> sample =  $\frac{22.60}{1000} \times 0.031 = 7.006 \times 10^{-4}$ Amt of vit C in 100 cm<sup>3</sup> sample =  $\frac{100}{25.0} \times 7.006 \times 10^{-4} = 2.80 \times 10^{-3}$ Mass of vit C in tablet =  $2.80 \times 10^{-3} \times 176 = 0.493g = 493mg$ 

OR

Common dose of vitamin C is likely to be 500 mg.

[Total: 6]

**5(a)** (i) It is the enthalpy change when <u>one mole of water</u> is formed in the neutralisation of an acid and alkali, the reaction being carried out in aqueous solution under standard conditions, at <u>25 °C, 1 atm</u>.

(ii) Amt of 
$$CH_3CO_2H = \frac{40}{1000} \times 3 = 0.012 \text{ mol}$$
  
Amt of  $KOH = \frac{60}{1000} \times 1.4 = 0.084 \text{ mol} \text{ (limiting)} = \text{Amt of } H_2O \text{ formed} = 0.084 \text{ mol}$   
Heat absorbed by water =  $(40 + 60) \times 4.2 \times 10.5 = 4410 \text{ J}$   
 $\Delta H_n = -\frac{4410}{0.084} = -52500 \text{ J mol}^{-1} = -52.5 \text{ kJ mol}^{-1}$ 

- (iii) The value in a(ii) is less exothermic/ less negative/ differs from that of the reaction between a strong acid and alkali because the enthalpy change due to the conversion of  $CH_3CO_2H$  into ions has to be considered.
- (b) (i) Le Chatelier's Principle states that if a change is made to a <u>system in equilibrium</u>, the system reacts in such a way as to tend to <u>oppose the change</u>, and a *new equilibrium* is formed.
  - (ii) <u>Low temperature</u>, so that equilibrium will lie to the left which is the backward <u>exothermic reaction</u>.
     <u>Good air flow</u>, so that equilibrium will lie to the left to <u>decrease the amount of</u> <u>oxygen gas</u>.
  - (iii) There will be an <u>increase</u> in the production of SO<sub>3</sub>. Equilibrium will lie to the right to decrease the amount of oxygen gas when there is good air flow and the low temperature favours the forward exothermic reaction.

(iv) 
$$K_{c} = \frac{[SO_{3}]^{2}}{[SO_{2}]^{2}[O_{2}]}$$

(v) I C

F

2SO <sub>2</sub> (g)	+ O <sub>2</sub> (g) <b>≓</b>	2SO <sub>3</sub> (g)
2	1	0
-1.9	-0.95	+1.9
0.1	0.05	1.9

Equilibrium concentration of SO<sub>2</sub> =  $\frac{0.1}{2}$  = 0.05 mol dm<sup>-3</sup> (Recall vol is 2 dm<sup>3</sup>.) Equilibrium concentration of O<sub>2</sub> =  $\frac{0.05}{2}$  = 0.025 mol dm<sup>-3</sup>

$$K_{c} = \frac{\left[SO_{3}\right]^{2}}{\left[SO_{2}\right]^{2}\left[O_{2}\right]} = \frac{0.95^{2}}{0.05^{2}\left(0.025\right)} = 14440 \text{ mol}^{-1} \text{ dm}^{3}$$

- (c) (i) Substitution.
  - (ii) Compound Y has a high boiling point because it is <u>giant</u>
     <u>ionic</u> and requires a lot of energy to break the <u>strong</u> electrostatic forces of attraction between the oppositely charged ion.
     Compound Y is soluble in water because it can form <u>ion-dipole interaction</u> with the molecules of water.

[Total: 20]



Equation:

- A has a benzene ring as C:H ratio is almost 1:1.
- A neutral liquid **A**,  $C_{10}H_{12}O_2$  when heated with aqueous hydrochloric acid gave two products, **B** and **C**.

 $\rightarrow$  A undergoes <u>acid hydrolysis</u> to form **B** and **C**.

- B gave a yellow precipitate when warmed with aqueous alkaline iodine.
   → B has <u>-CH<sub>3</sub>CH(OH)</u> structure.
- When heated with acidified sodium dichoromate (VI), B gave D, C<sub>8</sub>H<sub>8</sub>O.
   → B undergoes <u>oxidation</u> to form a ketone, D.
- D reacts with 2,4-dinitrophenylhydrazine to give orange crystals, E.
  - $\rightarrow$  **D** is a <u>ketone</u>.
- (b) (i)  $S_2O_8^{2-}$  and I<sup>-</sup> will repel each other/ No catalyst is added.
  - (ii) Using experiments 1 and 3, When the concentration of  $I^{-}$  increased by 1.5 times, the rate increased by 1.5 times.  $1^{st}$  order with respect to  $I^{-}$ .

Using experiments 2 and 3, When concentration of  $S_2O_8^{2-}$  is halved, the rate is halved. 1<sup>st</sup> order with respect to  $S_2O_8^{2-}$ .

(iii) Rate  $k[I^{-}][S_2O_8^{2^-}]$ 

(c) Al<sup>3+</sup> has a high charge density, hence when AlCl<sub>3</sub> dissolves in water, the surrounding water molecules in the hydrated Al<sup>3+</sup> ion is polarised. <u>The O-H bond in water is polarised</u> and H<sup>+</sup> is easily liberated.

 $AICI_{3}(s) + 6H_{2}O \rightarrow [AI(H_{2}O)_{5}(OH)]^{2+}(aq) + H^{+}(aq) + 3CI^{-}(aq)$ 

(Equation without Cl<sup>-</sup> is accepted.)

PCI<sub>3</sub> is covalent and it **dissolves vigorously** in water to give an acidic solution with the **evolution of HCI gas**.

 $PCI_3 + 3H_2O \rightarrow H_3PO_3 + 3HCI$ 

- (d) (i) Acidic. (Se is below S in the periodic table so SeO<sub>2</sub> is expected to behave similarly to SO<sub>2</sub>, which is acidic.)
  - (ii)  $SeO_2 + 2OH^- \rightarrow SeO_3^{2-} + H_2O$
  - (iii) Bent / V-shaped / non-linear

[Total: 20]



(ii) 
$$\bigcirc$$
 CH=CHC  $\_$  O  $\_$  CH<sub>3</sub>

- (iii) sp<sup>3</sup>
- (iv)  $C_6H_5CH_2CH_2CH_2OH < C_6H_5CH_2CH_2CO_2H < X$  (or  $C_6H_5CH_2CHCICO_2H$

**X** is more acidic due to the presence of <u>electron-withdrawing Cl</u> in **X** [1]. This caused the O-H bond in **X** to be more <u>polarised</u>. The O-H bond is <u>weakened</u>, hence the <u>H+</u> is <u>lost</u> easier.

(v) Test: Add NaOH(aq) to **X** and **Y** and heat. Then cool the products. Acidify the products with  $HNO_3(aq)$ . Add  $AgNO_3(aq)$ .

Observation: **X** will give a white precipitate (AgCI) and **Y** will give a yellow precipitate (or **Y** will not give a white precipitate).

- **(b)** (i)  $K_w = [H^+ (aq)] [OH^- (aq)] mol^2 dm^{-6}$ 
  - (ii) Neutralisation
  - (iii) **Exothermic** because **bonds are formed** when water is formed.
  - (iv) Because  $[H^+]$  and  $[OH^-]$  are still equal.
  - (v) pH at 62°C = 6.54. So,  $[H^+] = 10^{-6.54} = 2.88 \times 10^{-7} \text{ mol dm}^{-3}$ .  $K_w = [H^+ (aq)] [OH^- (aq)] = (2.88 \times 10^{-7})^2 = 8.32 \times 10^{-14}$
  - (vi) Total  $[H^+] = 2.88 \times 10^{-7} + 1 \times 10^{-8} = 2.98 \times 10^{-7}$ pH = -lg (2.98 x 10<sup>-7</sup>) = 6.53
- (c) "Free"  $H^+$  ions in an aqueous environment form  $H_3O^+$  with water molecules.





[Total: 20]