Class	Reg Number

Candidate Name _____

Meridian Junior College
2009 JC 2 Preliminary Examination Answers
H2 Chemistry 9746

14 September 2009 **2 hours**

Paper 3

Free Response

Additional Materials
Data Booklet
Writing paper

INSTRUCTION TO CANDIDATES

Write your name, class and register number in the spaces provided at the top of this page.

Answer *any* 4 out of 5 questions.

Begin each question on a fresh page of writing paper.

Fasten the writing papers behind the given **Cover Page for Questions 1 & 2** and **Cover Page for Questions 3, 4 & 5** respectively.

Hand in Questions 1 & 2 and 3, 4 & 5 separately.

You are advised to spend about **30 min** per question **only**.

INFORMATION FOR CANDIDATES

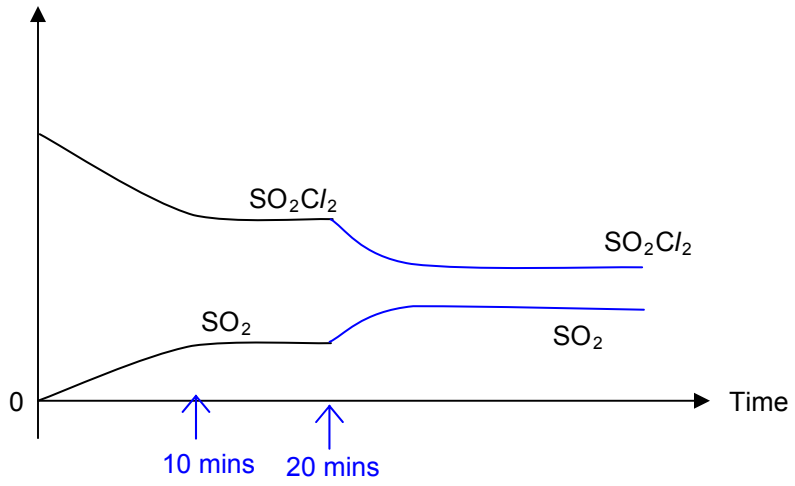
The number of marks is given in brackets [ ] at the end of each question or part question.

You are reminded of the need for good English and clear presentation in your answers.

This question paper consists of 15 printed pages

1 (a) $$K_p = \frac{(P_{SO_2})(P_{Cl_2})}{(P_{SO_2Cl_2})} = \frac{1.958 \text{ x } 0.625}{4.042}$$ = **<u>0.303 atm</u>**

(b) The equilibrium position will shift right towards the endothermic reaction to absorb heat.



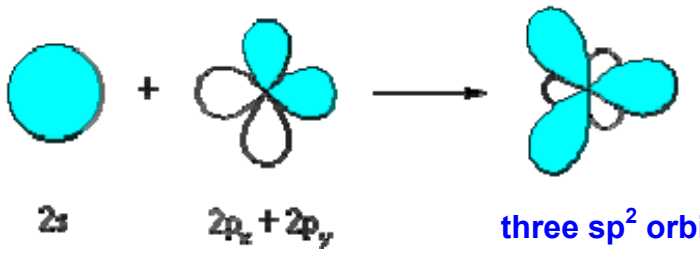
(c)

$SOCl_2 + H_2O \longrightarrow SO_2 + 2HCl$

$SO_2Cl_2 + 2H_2O \longrightarrow H_2SO_4 + 2HCl$

- SO_2Cl_2 in water yields 3 mol of strong acid in comparison to 2 mole strong acid for $SOCl_2$hence pH is lower.

(di) sp^2 hydrisation



(ii) Homolytic fission is the breaking of a covalent bond such that each atom retains only one of the shared electrons.

$HO\bullet + SO_2Cl_2 \rightarrow HOCl + SO_2 + Cl\bullet$

(iii) $CH_2{=}CHCH_2Cl \xrightarrow{\text{step 1}} CH_2(Cl)CH(OH)CH_2Cl \xrightarrow{\text{step 2}} CH_2(CN)CH(OH)CH_2CN$

step 3 ↓

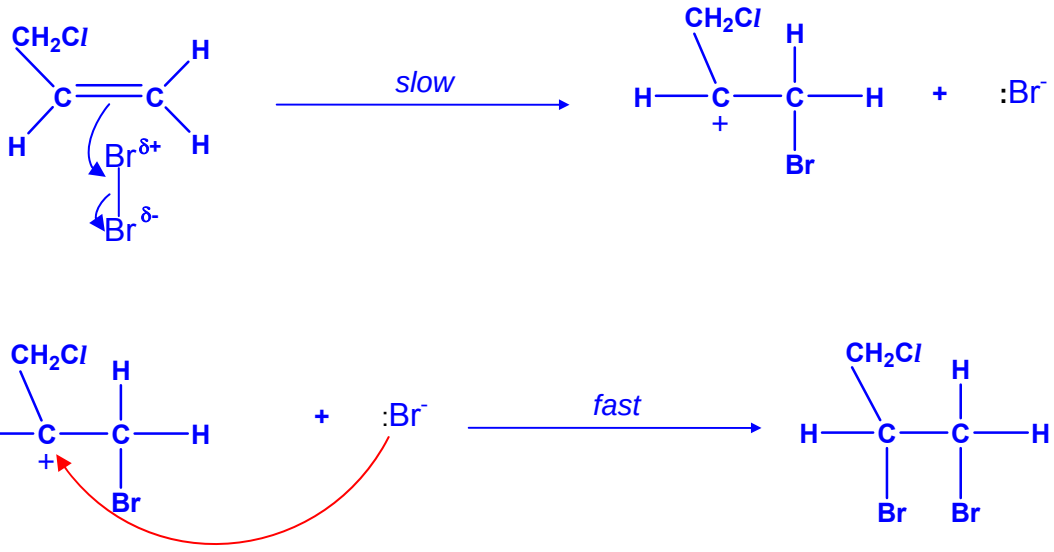
$CH_2(COOH)CH(OH)CH_2COOH$

Step 1: aqueous Br_2 or Cl_2

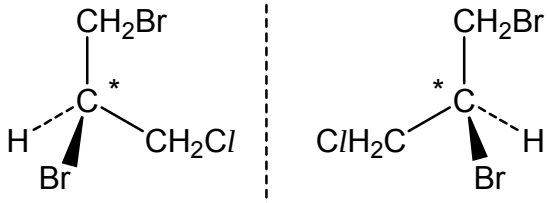
Step 2: alcoholic KCN, heat

Step 3: aq HCl or H_2SO_4, heat

(iv) ***1*** Outline the mechanism that occurs for the formation of either **B** or **C.**



2 Concept : A racemic mixture is formed due to equal probability of attack from either plane



[1] **[1]**

2a(i) Gas liberated - Chlorine gas

$ClO^-(aq) + Cl^-(aq) + H_2O(l) \longrightarrow Cl_2(g) + 2OH^-(aq)$

(ii) Chlorine is only slightly/ moderately soluble in water as the VDW of attraction is not compatible to the hydrogen bonding between the water molecules

(iii) Concentrated H_2SO_4 is only able to oxidize HI to I_2 or Br^- to Br_2

$NaCl + H_2SO_4 \rightarrow HCl + NaHSO_4$

$NaBr + H_2SO_4 \longrightarrow HBr + NaHSO_4$

$2\,HBr + H_2SO_4 \longrightarrow Br_2 + SO_2 + 2\,H_2O$

or

$NaI + H_2SO_4 \longrightarrow HI + NaHSO_4$

$8\,HI + H_2SO_4 \longrightarrow 4\,I_2 + H_2S + 4\,H_2O$

(iv) Thermal stability decreases from HBr to HAt as the covalent bond strength decreases down the group resulting in the decrease of the bond dissociation energy

BE of HI (+299 kJ mol^{-1}) < BE of HBr (+366 kJ mol^{-1})

(bi) E^{θ}cell for Rxn 1 = **0.36 V**

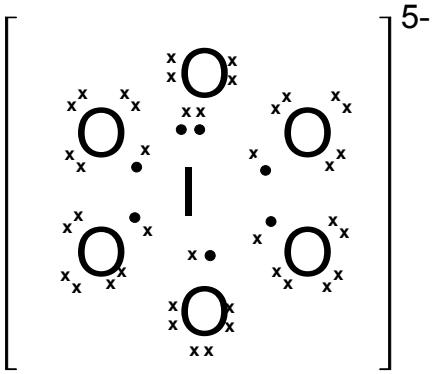
E^{θ}cell for Rxn 2 = **0.30 V**

E^{θ}cell for Reaction I > E^{θ}cell for Reaction II, hence reaction I is more feasible.

(ii) Reagent -$HClO_3$ or $KClO_3$ or $NaClO_3$ eg

(ci) Iodine has a large enough atomic size to accommodate the number of O atoms surrounding it in IO_5^{3-} and IO_6^{5-} . *Or use steric hinderance factor to explain*

(ii) Dot and cross diagram for IO_6^{5-}



(iii) $5Ba(IO_3)_2 \longrightarrow Ba_5(IO_6)_2 + 4I_2 + 9O_2$

Ionic size hence charge density hence polarising power of of Ca^{2+} > Ba^{2+}

Hence, Ca^{2+} has greater ability to distort the anion IO_3^- charge/electron cloud

Hence, thermal stability of $Ca(IO_3)_2$ > $Ba(IO_3)_2$.

(iv) Overall equation : $IO_6^{5-} + 7I^- + 12H^+ \longrightarrow 4I_2 + 6H_2O$

No of mol IO_6^{5-} = 1/8 (2.20×10^{-3}) = 2.75×10^{-4}

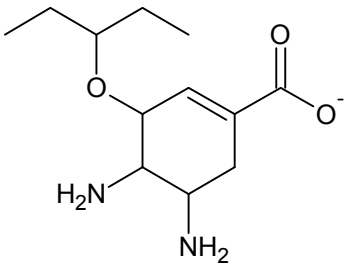
Mass of sodium iodate (VII) = 2.75×10^{-4} x x 338 = 0.09295g

Percentage by mass = 0.09295/0.200 = **46.5%**

3(a) alkene, ester,amine ,amide, ether-*any 4 out of 5*

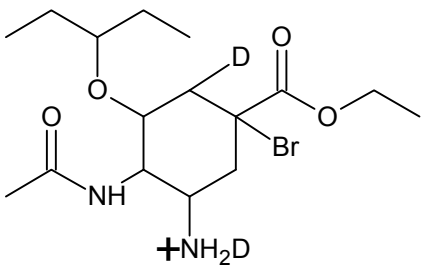
(b) The phosphate salt is more soluble in water hence more easily absorbed.

(c)

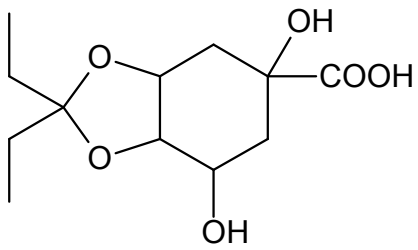


CH_3COO^- CH_3CH_2OH

(d)

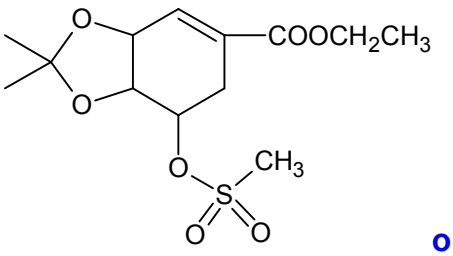


(e)



(fi) Nucleophilic substitution

(ii)



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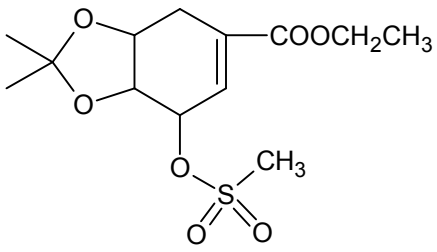
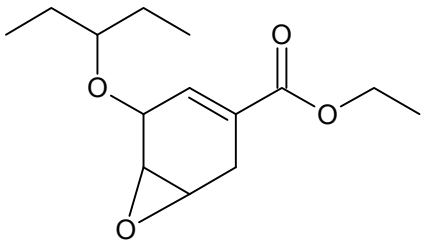
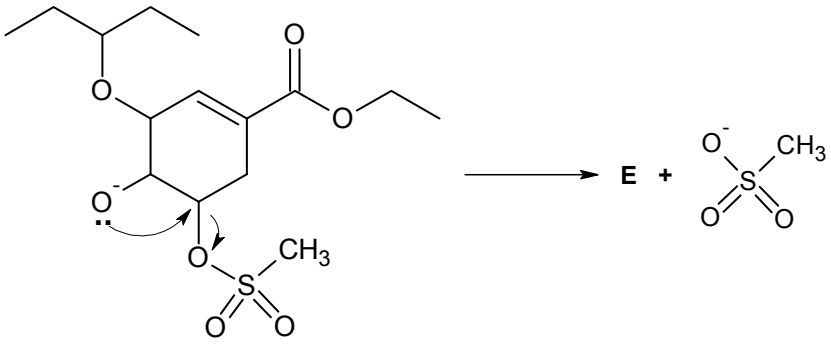


(gi)



(ii)



(h) Unusual : The alkene group would have been expected to undergo reduction.

(i) CH_3Br , heat under high pressure

Compound **G** would be more basic due to the electron-donating group which increases the electron density on the lone pair of the N atom hence making the lone pair more available to accept a proton.

(j) Quantity of heat absorbed by water = 70 x 4.18 x 8.4(temp change) = 2457.84 J

$\Delta H_{neutralisation}$ = - 2457.84 / 0.045 = **-54.6 kJ mol^{-1}**

Since the $\Delta H_{neutralisation}$ is less exothermic than that between strong acid and strong base, can deduce that *Tamiflu* is a weak base. Some of the energy evolved from the neutralisation process is used to further dissociate the weak base *completely.*

4(ai) Ka_1 and Ka_2 are the acid dissociation constant of the carboxylic acid group and phenolic group respectively. Ka_1 is smaller Ka_2 because carboxylic acid group is more acidic than the phenolic group.

(ii) H^+ from the 2nd dissociation is negligible and can be ignored.

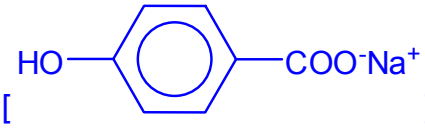
$$[H^+] = \sqrt{cK_a}$$
$$= \sqrt{0.05 \times 6.31 \text{ x } 10^{-5}}$$

Hence, pH = **2.75**

(iii) For acidic buffer

$$\text{pH} = -\lg 6.31 \text{ x } 10^{-5} + \lg \frac{[6.25 \times 10^{-4}/0.03125]}{[6.25 \times 10^{-4}/0.03125]}$$
$$= \mathbf{4.20}$$

Salt hydrolysis



[ ] = 1.25 x10^{-3} / 0.0375 = 3.33 x 10^{-2} mol dm^{-3}

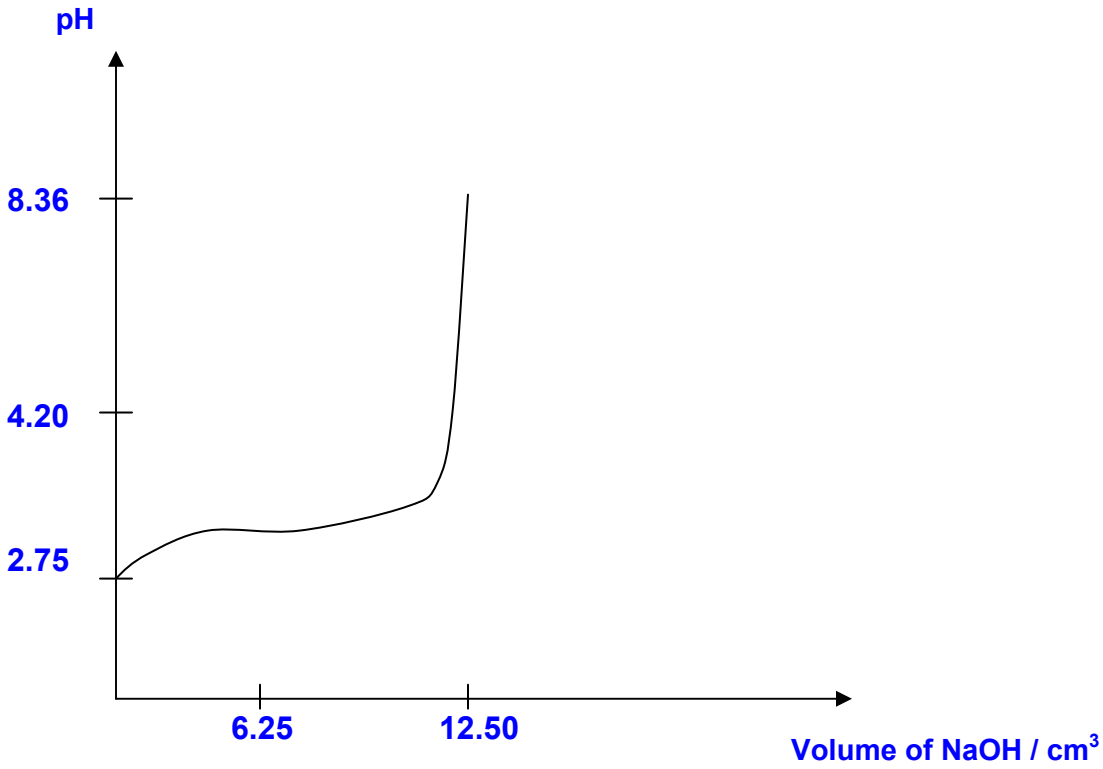
$$K_{b1} = \frac{K_w}{K_{a1}} = \frac{1\times10^{-14}}{6.31\times10^{-5}} = 1.58\times10^{-10} \text{ mol dm}^{-3}$$

$$[OH^-] = \sqrt{cK_b}$$
$$= \sqrt{3.33\times10^{-2}\times1.58\times10^{-10}}$$
$$= 2.29\times10^{-6} \text{ mol dm}^{-3}$$

pOH = -lg 2.29 x 10^{-5}

Hence, pH = 14 – 5.63 = **8.36**

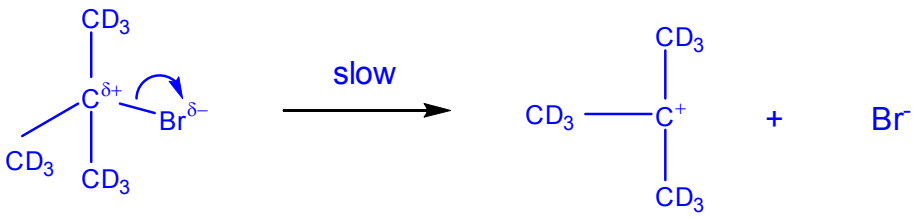
(iv)



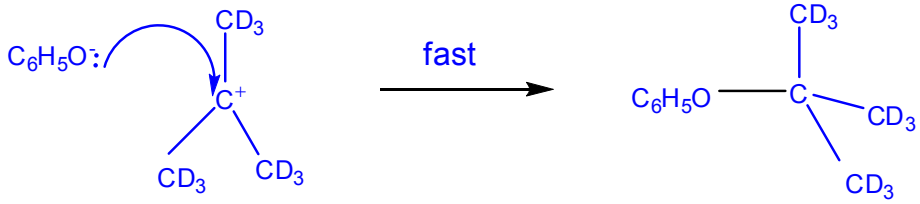
(bi) . Rate = k[$(CD_3)_3CBr$]

(ii) Nucleophilic substitution mechanism

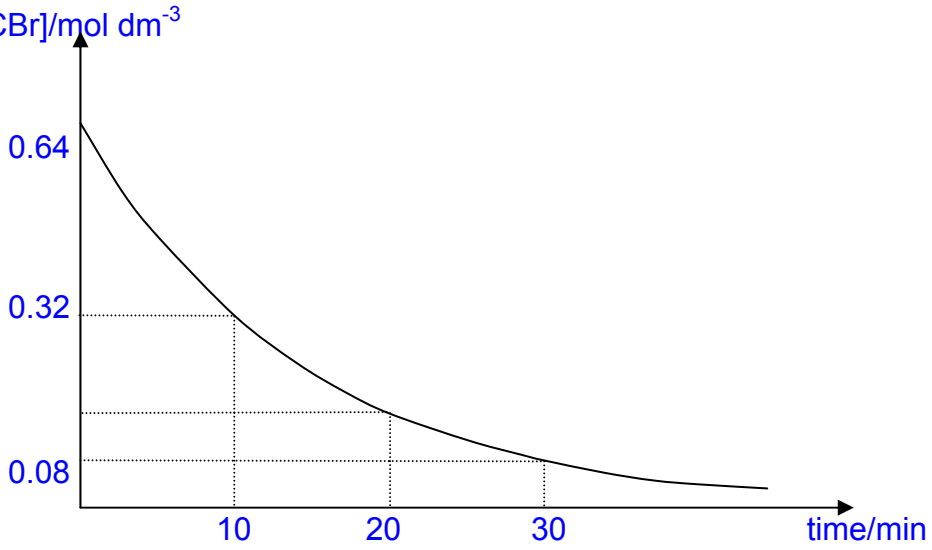
Step 1



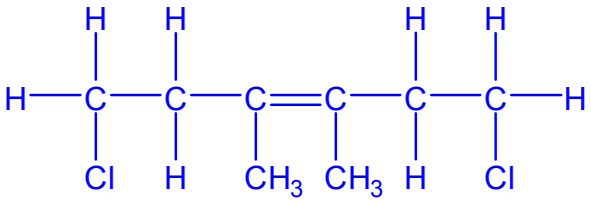
Step 2



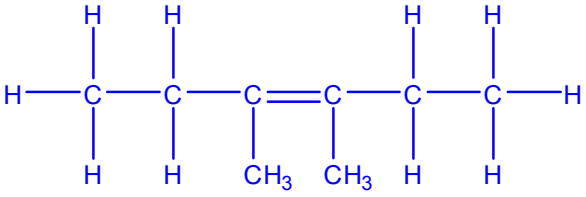
(iii)



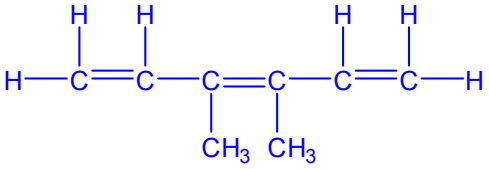
(ci) **X** can be : *(accept other logical answers)*



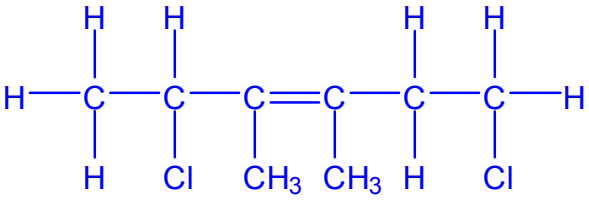
W :



Y :



(cii)



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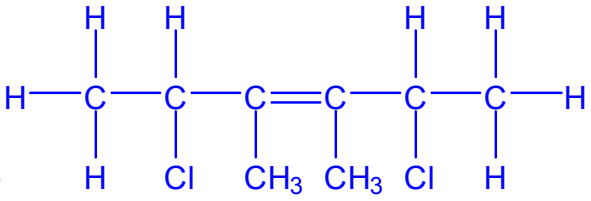
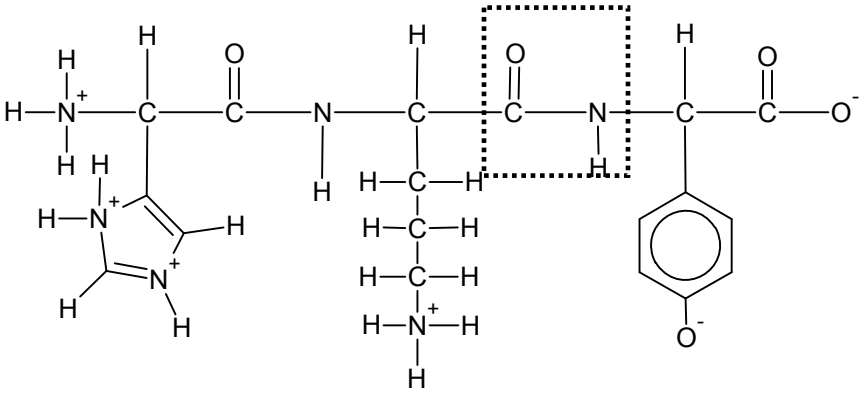


(ciii) There is 1 alkene double bond that is capable of exhibiting cis-trans isomerism as there are 2 different groups attached to each C atom; no of stereoisomers= **2**.

5(a) *Primary Structure* – amide / peptide linkage ; *Secondary Structure* – hydrogen bonds between C=O & N-H groups ;*Tertiary Structure* – R group interactions (e.g. ionic, disulphide linkages, hydrogen bonding);*Quaternary Structure* – Van der Waal's forces eg

(bi) **peptide linkage**



(ii) $H^+ + {}^+NH_3CHCH_3COO^- \rightarrow {}^+NH_3CHCH_3COOH$ **similar format for the other*

(ci) Disulphide bonds

(ii) The R groups are deprotonated which affect the electrostatic interactions causing unfolding of the protein chain hence denaturation occurs.

(iii) Pipette the 25.0 cm^3 Fe^{2+} solution into a conical flask and add about 10 cm^3 of sulphuric acid, including few drops of phosphoric acid.

Titrate with the $KMnO_4$ solution from a burette until the solution in conical flask turns from pale green to permanent pink. Repeat titration to get consistent results.

$$8H^+ + MnO_4^- + 5Fe^{2+} \rightarrow Mn^{2+} + 5Fe^{3+} + 4H_2O$$

(iv) *Consider reaction between $KMnO_4$ and Cl^-*

E^{θ}_{cell} = 1.52 – 1.36 = **+ 0.16 V**

Since $E^{\theta}_{cell} > 0$, reaction is feasible

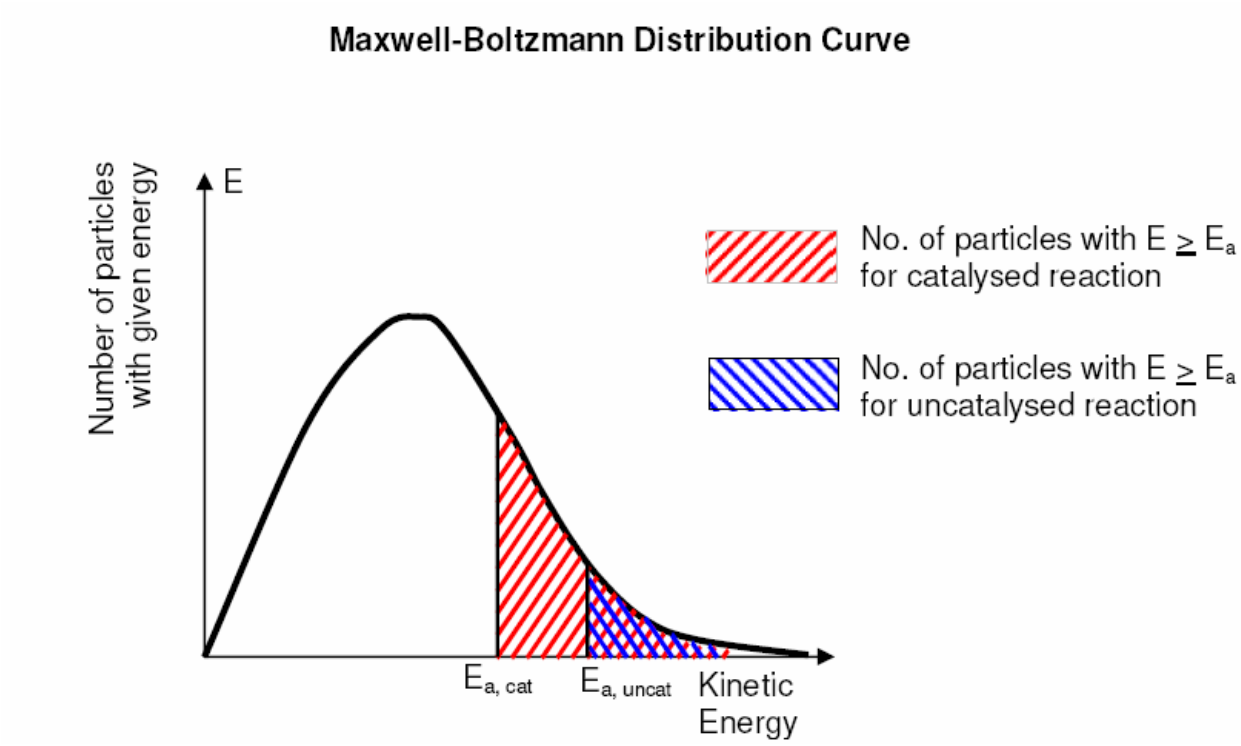
Conclusion : The oxidising agent will oxidise HCl as well inaccurate experimental titration values would be obtained

Consider reaction between Fe^{2+} and NO_3^-

Calculate correct E_{cell} for any case with NO_3^- *-there are 3 cases for this from Data Booklet*

Conclusion : HNO_3 is likely to oxidise Fe^{2+} in the solution to Fe^{3+}hence inaccurate experimental titration values would be obtained

(v)



E_a is lowered due to an alternative reaction pathway. Number of reactant particles with E ≥ Ea increases. Hence, number of effective collisions per unit time increases**.** Hence, rate of reaction increases which causes an increase in iron overload in the liver,This aggravates the patient's condition.