A.M

TANZANIA HEADS OF ISLAMIC SCHOOL COUNCIL

FORM SIX INTER ISLAMIC MOCK EXAMINATION 2025

CHEMISTRY-2 MARKING SCHEME

132/2

5(a)(i) $P_H = 4.4$

(ii) $P_H = 4.26$

5(b) $K_{sp} = 1.4 \times 10^{-3}\ M^{-3}$

6(a)(i) $PbBr_2(s) \rightleftharpoons Pb^{2+}(aq) + Br^-(aq)$ Has no effect on its solubility

(ii) $Cu(OH)_2(s) \rightleftharpoons Cu^{2+}(aq) + 2OH^-(aq)$

$OH^-(aq) + H_3O^+ \rightarrow 2H_2O$

Addition of strong acid will cause an increase in its solubility

(iii) $FeS(s) \rightleftharpoons Fe^{2+}(aq) + S^{2-}(aq)$

$S^{2-}(aq) + H_3O^+ \rightarrow H_2S + H_2O$

Addition of acid will cause increase in solubility

1 (a) i) small size of Fe and Al have higher polarizing power - hence are decomposed as they are formed (2 marks)

ii) Insoluble $CaCO_3$ is formed and turn Lime water milky

$$Ca(OH)_{(aq)} + CO_{2(g)} \longrightarrow CaCO_{3(s)} + H_2O_{(l)}$$ (2 marks)

iii) Due to formation of CO_2 gas

$$NaHCO_3 + CuSO_4 \longrightarrow CuCO_{3(s)} + Na_2SO_{4(aq)} + CO_{2(g)} + H_2O_{(l)}$$ (2 marks)

iv) Addition of excess NaOH results in excess O-H ions - which Leads to the formation of colourless soluble tetra hydroxo Lead (II) complex

$$Pb(OH)_2 + 2O\text{-}H \longrightarrow [Pb(OH)_4]^{2-}$$ (2 marks)

(b) i) $CuCl_2$ can be prepared by reacting hydrochloric acid with either

- $CuCO_3$

$$CuCO_{3(s)} + 2HCl \longrightarrow CuCl_{2(s)} + 2H_2O + CO_{2(g)}$$

1 (b) i- $Cu(OH)_2$

$Cu(OH)_2 + 2HCl \rightarrow CuCl_2 + 2H_2O$
(s)

- $Cu(NO_3)_2$

$Cu(NO_3)_2 + HCl \rightarrow CuCl_2 + 2HNO_3$ (2 marks)

attempt 2 point, 1 mark each

ii) Zinc oxide is amphoteric oxide it reacts with both acid and base (01 marks).

$ZnO + HCl \rightarrow ZnCl_2 + H_2O$ 01/2 marks — 01/2
(s) (aq)

$ZnO + NaOH \rightarrow Na_2ZnO_2 + H_2O$ (01 marks) — 01/2

iii) - Direct method of preparing metal oxide:
By direct reaction or ~~oxygen~~ combination between metallic element and oxygen

Example $Cu_{(s)} + O_{2(g)} \rightarrow CuO$ (01 1/2 marks)

eqn — 01/2 is important (01/2)

- Indirect method
Thermal decomposition of metallic carbonate.

Example $CuCO_{3(s)} \xrightarrow{\Delta} CuO_{(s)} + CO_{2(g)}$ (01 1/2 marks)

eqn — 01/2 is important (01/2)

1 c) i) chlorine is a strong oxidizing agent hence it will oxidise iron straight (directly) to iron (III) chloride

$$2Fe_{(s)} + 3Cl_{2(g)} \longrightarrow 2FeCl_{3(s)}$$ (02 marks)

ii) Cl^- ion may react with Fe^{3+} as a titration product to form $FeCl_2$ which is red in colour, this makes difficult to identify changes in MnO_4^{4-} colour. (02 marks)

2 a) i) Thermoplastic polymer is the polymer which become soft on heating and become hards on cooling Example nylon 6,6 polyethylene (01 marks)

defn - 00½
example - 00½

ii) Thermosetting polymers, polymers which hard on heating and can be soften by cooling. Example Bakelite (01 marks)

defn - 00½
example - 00½

iii) Condensation polymers, polymers formed by combination of mo nomers with with elimination of simple molecules such as H_2O - or CH_3OH Example polyster (01 marks)

defn - 00½
example - 00½

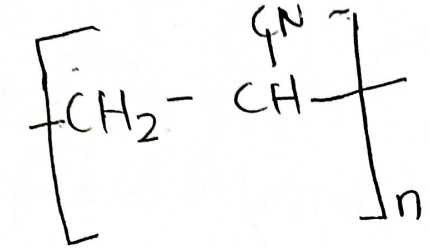
b) i) $-CH_2-\underset{Cl}{CH}-$ (01 marks)

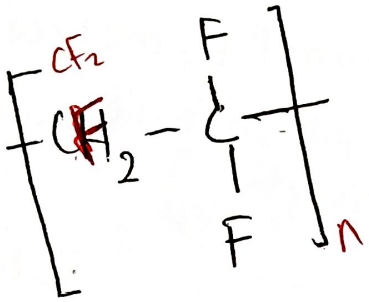
ii) $-\underset{F}{\overset{F}{C}}-\underset{F}{\overset{F}{C}}-$ (01 marks)

03

iii) $-CO(CH_2)_4CONH(CH_2)_6NH-$ (01 marks)

2 (c)

c(i)  (02 marks)

ii)  (02 marks)

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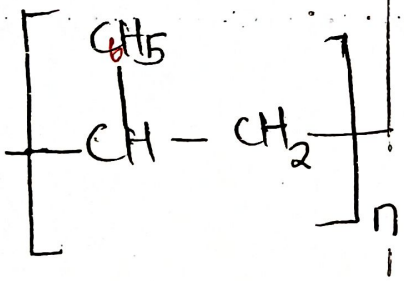
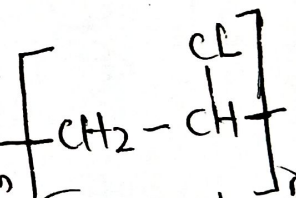
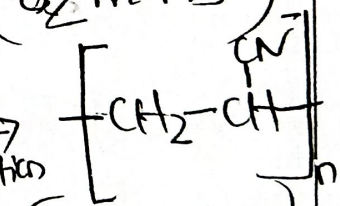
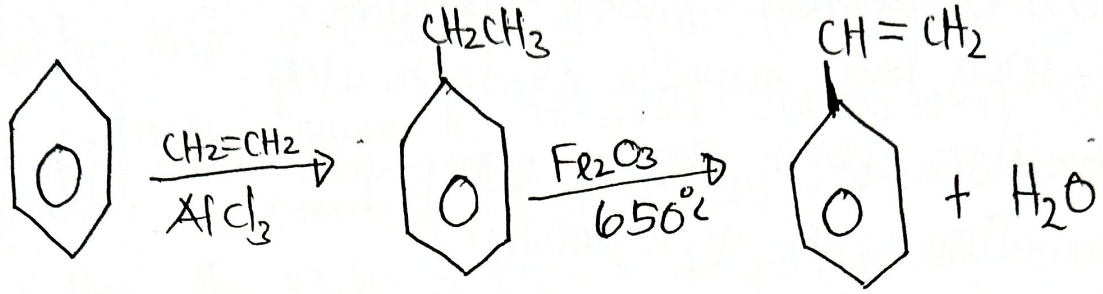
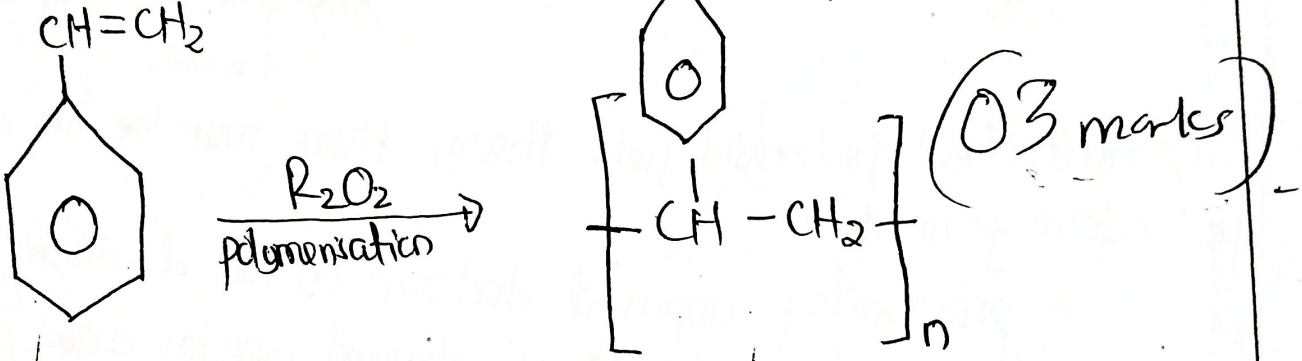
iii  (02 marks)

d) i) $HC \equiv CH \xrightarrow[HgCl_2]{HCl} H_2C=CH-Cl \xrightarrow[\text{polymerisation}]{R_2O_2}$  (02 marks)

ii) $HC \equiv CH \xrightarrow[Ba(CN)_2]{HCN} CH_2=CH-CN \xrightarrow[\text{polymerisation}]{R_2O_2}$  (03 marks)

2 (iii)





(03 marks)

3 (a)i
- They form coloured compounds
- They have variable oxidation state
- They form complex compounds with ligands
- They act as a catalyst
- They have magnetic property.

Any four point (4 marks) 1 each.

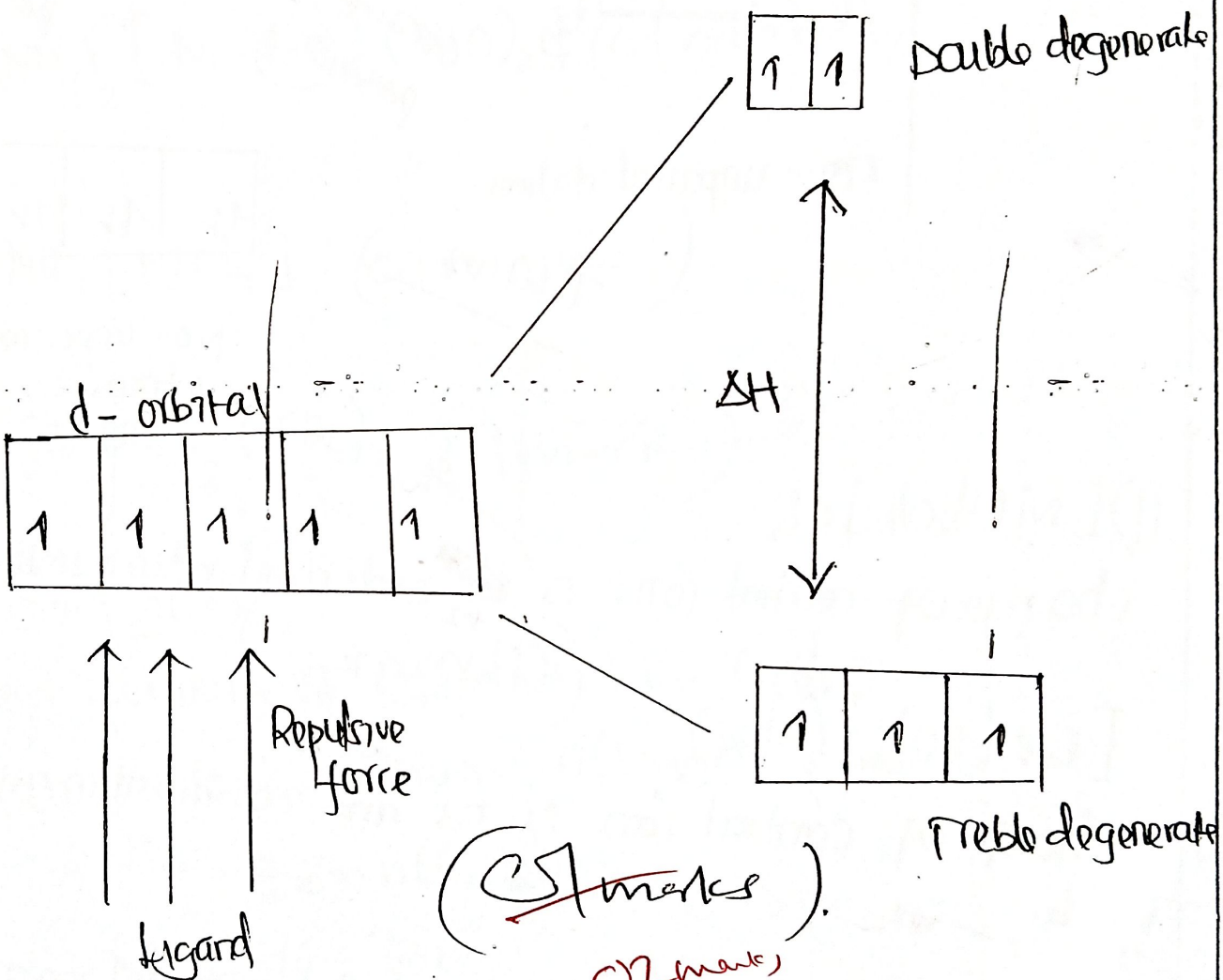
ii) According to crystal field theory there must be two conditions for colour formation.
- presence of unpaired electrons in the d-orbital
- presence of negatively charged species called ligands (01 marks)

The process starts when the ligand approaches d-orbital containing unpaired electrons which exert repulsive effect causing the splitting of d-orbital into two parts which are double degenerate and treble degenerate (01 marks)

Double degenerate has raised energy hence found on upper part while treble degenerate has lower energy and found on the lower part. The gap separation will depend on the nature of ligand. For weak field ligand the gap separation between double and treble degenerate is very small, thus normal radiant energy can excite electron from treble to double degenerate making it to be unstable. To maintain (01 marks)

explain 03 explain

3(a) Stability the electron has to fall from higher energy level (double degenerate) to lower energy level (treble degenerate) by emitting radiant energy whose wavelength are within the visible part of hydrogen spectrum hence can be visible to human eyes. (01 mark)



(05 marks)

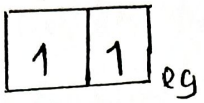
02 marks

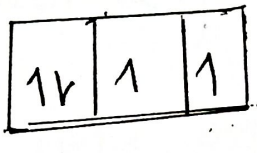
04

Total 05

3(b) i)

$[Fe(H_2O)_6]^{2+}$



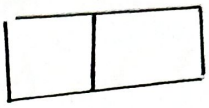


(01½ marks)

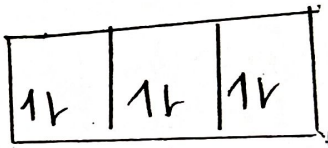
potential energy

Four unpaired electrons

$[Fe(CN)_6]^{-4}$



(01½ marks)



No- unpaired electrons

ii) $[Ni(H_2O)_6]Cl_2$

charge of central ions is +2 and coordination number is 6

(01 mark)

$[Cr(en)_3](ClO_4)_3$

charge of central ion is +3 and coordination number is 6

c i) Dichlorobis(ethylenediamine)platinum(IV) chloride (01 mark)

ii) Diaminesilver(I) dicyanoargentate(I) (01 mark)

3 (d) i) $(NH_4)_2[CuCl_4]$ (01 mark)

ii) $[Pt(NH_3)_5Cl]Br_3$ (01 mark)

iii) $(NH_4)_2[Ni(C_2O_4)_2(H_2O)_2]$ (01 mark)

iv) $Na_2[NiCl_4]$ (01 mark)

v) $[Co(en)_3]_2(SO_4)_3$ (01 mark)

4 a) i) Data given

Empirical formula of compound M is C_4H_8O

from, Molecular mass = n(Empirical formula)

$72 = n(C_4H_8O)$

$\frac{72}{72} = \frac{72n}{72}$

$n = 1$ (01 mark)

From molecula formula = n(Empirical formula)

Molecular formula = $(C_4H_8O) \times 1$

Molecular formula = C_4H_8O (01 marks)

4 (a)(ii) possible structures of M

- $CH_3CH_2CH_2\overset{\overset{O}{\|}}{C}-H$ (01 mark)
- $CH_3CH_2\overset{\overset{O}{\|}}{C}-CH_3$ (01 marks)
- $CH_3-\underset{CH_3}{\underset{|}{CH}}-\overset{\overset{O}{\|}}{C}-H$ (01 mark)

b(i) Test A - Test for Alcohol (01 mark)

Test B - Test for unsaturated hydrocarbon (double / triple bonds) (01 mark)

Test C - Test for aldehyde and ketone (01 marks)

Test D - Test for aldehyde (01 marks)

Test E - Test for ketone, aldehyde or alcohol with terminal methyl group (01 marks)

ii) structure of Liquid M is

$CH_3CH_2-\overset{\overset{O}{\|}}{C}-CH_3$ (01 marks).

4 c) i) $CH_3CH_2-\underset{\underset{CH_3}{|}}{C}=N-NH_2$ and H_2O (01½ marks) (04)

ii) $CH_3CH_2-\overset{\overset{O}{||}}{C}-ONa + CHI_3 + NaI + H_2O$ (01½ marks) (04)

d) i) Aldo condensation is the combination between molecules of aldehydes themselves with minimal loss of water molecules

OR

Aldo is the chemical reaction between two aldehydes with α-hydrogen in alkaline medium to form large aldehyde molecule with hydroxyl group at β-carbon. (03marks) 02

ii) $CH_3-\underset{\underset{CH_3}{|}}{CH}-\overset{\overset{O}{||}}{C}-H$ can undergo aldo condensation due to the presence of replaceable hydrogen WHERE As $(CH_3)_3-C-CHO$ and $(CH_3)_3-CHO$ can not undergo aldo condensation due to absence of repleceable hydrogen at α-carbon in all two groups

(03marks) 04

5 (a) (i) Ionization of HCNO (cyanic acid)

$$HCNO \rightleftharpoons H^+ + CNO^-$$
(aq) (aq)

$$K_a = \frac{[H^+][CNO^-]}{[HCNO]}$$ (01 marks)

$$2.0 \times 10^{-4} = \frac{[H^+][CNO^-]}{[HCNO]}$$

$$HCNO = \frac{0.1 \text{ mol}}{0.10 \text{ Litre}} = 0.2 M \ (\text{mol dm}^{-3})$$ (01 marks)

$HCNO \rightleftharpoons$	H^+	$+ CNO^-$	
0.2	0	1.0	at $t = 0$
$-x$	$+x$	$+x$	at $t = t$
$0.2 - x$	x	1	

$+x$ at equillibrium (01 mark)

But $1.0 + x \approx 1.0$ M and $0.2 - x \simeq 0.2$ M

5(a) i $K_a = \frac{x \times 1.0}{0.2}$

$2.0 \times 10^{-4} = \frac{xM^2}{0.2}$ ($\frac{01}{2}$ mark)

$x = 4.6 \times 10^{-5} M$

$[H^+] = 4.0 \times 10^{-5} M$

$pH = -\log [H^+]$

$= -\log (4.0 \times 10^{-5})$

$pH = 4.4$ ($\frac{01}{2}$ mark)

6(a) (i) 4
(ii) 6

ii)

$[HCl] = \frac{0.030 mol}{0.5L} = 0.060 mol L^{-1}$

$[HCl] = 0.060 mol L^{-1}$ (01 mark)

then

$HCNO \rightleftharpoons H^+ + CNO^-$

5 a)ii) $HCNO \rightleftharpoons H^+ + CNO^-$ (01 mark).

0·2	0	1·0	at t=0
+0·06	0·00	−0·06	
−x	+x	+x	
0·260−x	x	0·94+x	(01 mark)

Assume $0.260 - x = 0.260M$ and $0.94 + x = 0.94$

then

$$K_a = \frac{[H^+][CNO^-]}{[HCNO]} \quad (01\ mark)$$

$$= \frac{x \times 0.94}{0.26}$$

$$2.0 \times 10^{-4} = \frac{0.94x}{0.26}$$

$$X = \frac{0.26 \times 2.0 \times 10^{-4}}{0.94}$$

$$X = .55 \times 10^{-5} M = [H^+] \quad (02 mark)$$

5 a(ii). $pH = -\log[H^+]$

$-\log(5.5 \times 10^{-5})$

$pH = 4.26$ (01 marks).

(b) Molar solubility of $MnF_2 = \frac{6.609/L}{92.99/L} = 0.071044$ (01 mark)

Molar solubility $= 0.071044\ mol/L^{-1}$

$MnF_{2(aq)} \rightleftharpoons Mn^{2+}_{(aq)} + 2F^-_{(aq)}$ (01 marks)

$K_{sp} = [Mn^{2+}][2F^-]^2$

$[Mn^{2+}] = 0.071044M$

$[F^-] = 0.14209M$ (01 marks)

$K_{sp} = [0.071044][0.14209]^2$

$K_{sp} = 1.4 \times 10^{-3} M^3$ (01 marks).

5 (i) $PbBr_2(s) \rightleftharpoons Pb^{2+}(aq) + Br^-(aq)$

Br^- Is the anion of HBr as strong acid so it does not react with H_3O^+. Has no effects on its solubility (02marks).

ii) $Cu(OH)_2(s) \rightleftharpoons Cu^{2+}(aq) + 2OH^-(aq)$

OH is the anion of H_2O It react with H_3O^+

$O-H(aq) + H_3O^+ \rightarrow 2H_2O(l)$. Addition of strong acid will cause an increase on solubility (02marks)

iii) $FeS(s) \rightleftharpoons Fe^{2+}(aq) + S^{2-}(aq)$

S^{2-} Is the anion of HS^- Is weak acid and strong base, it will react completely with water to form HS^- and O-H. both of these ions will react with added H_3O^+

$HS^- + H_3O^+ \rightarrow H_2S + H_2O$

$O-H + H_3O^+ \rightarrow H_2O$ (02marks)

so addition of strong acid will cause an increase in solubility

6 (a) i) Overall $Cr_2O_7^{2-}$ + $3HNO_2$ → $3NO_3^-$ + $2Cr^{3+}$ + $4H_2O$
(aq) (aq) (aq) (aq) (l)

(02 marks) step 1 award 1

ii) Balanced equation in basic medium

$Cl^- + PbO_2 + OH^- \rightarrow ClO^- + [Pb(OH)_3]^-$

(02 marks) step 1 award 1

b(i) the cathodic reaction in the electrolytic cell containing $AgNO_3$ solution is

$Ag^+_{(aq)} + e^- \rightarrow Ag$

from the equation 1mole of Ag^+ requires 1mole of electrons which is equivalent to 1F for complete reduction. The equivalent weight to Ag^+ is = Atomic weight of silver / valence of silver

$= \frac{108g}{1}$

$= 108g$

Thus the equivalent weight of silver is 108g. If 108g of Ag^+ is equivalent to 1F, then Xg of silver is equivalent to ~~0.5x~~ 0.5F

108g → 1F

x ← 0.5

$x = \frac{0.5F \times 108g}{1F} = 54g$

(01 marks / 2)

01

The obtained mass of silver can be used to calculate the masses of other metals deposited if the equivalent weight are known. The equivalent weight of copper and iron are obtained as follows

cathodic reaction for $CuSO_4$ and $FeCl_3$ in their respective cells are

$$Cu^{2+}_{(aq)} + 2e^- \rightarrow Cu_{(s)}$$

$$Fe^{3+}_{(aq)} + 3e^- \rightarrow Fe_{(s)}$$

Equivalent weight of Cu. $= \frac{63.5g}{2} = 31.75g$ (01 mark)

Equivalent weight of Fe $= \frac{56g}{3} = 18.67g$ (01 marks)

from Faradays law of electrolysis,

$$\frac{\text{Mass of silver deposited}}{\text{Mass of copper deposited}} = \frac{\text{Equivalent weight of silver}}{\text{Equivalent weight of copper}}$$

$$\frac{54g}{x} = \frac{108g}{31.75}$$

$$\text{Mass of Cu} = \frac{54g \times 31.75g}{108g} = 15.88g$$

Mass of Cu = 15.88g (01 marks)

6 b(i) $\frac{\text{Mass of Ag}}{\text{Mass of Fe}} = \frac{E_{Ag}}{E_{Fe}}$

$= \frac{54g}{M \text{ of Fe}} = \frac{108g}{18.67g}$

$M_{Fe} = \frac{54g \times 18.67g}{108g}$

$M_{Fe} = 9.33g$ (01 marks)

ii) $\Lambda_m^\circ = 3.88 \times 10^{-2} Sm^2 mol^{-1}$

$\Lambda_m = 5.2 \times 10^{-4} Sm^2 mol^{-1}$

$\alpha = \frac{\Lambda_m}{\Lambda_m^\circ} = \frac{5.2 \times 10^{-4} Sm^2 mol^{-1}}{3.88 \times 10^{-2} Sm^2 mol^{-1}} = 0.013$

α of CH_2COOH is 0.013 or 1.3%
(02 marks).

6 c) solution.

Zn^{2+} is oxidized species

Cu^{2+} is reduced species

number of electrons involved in the reaction $n = 2$

$$E^{\circ}_{cell} = E^{\circ}_{Cu^{2+}/Cu} - E^{\circ}_{Zn/Zn^{2+}}$$

$$E^{\circ}_{cell} = 0.34V - (-0.76V) = 1.1V \quad (01 \text{ marks})$$

from Nernst equation

$$E_{cell} = \Delta E^{\circ} + \frac{0.0591}{n} \log\left(\frac{[\text{reduced species}]}{[\text{oxidized species}]}\right) \quad (01 \text{ marks})$$

$$E_{cell} = 1.10V + \left[\frac{0.0591}{2} \log\left(\frac{5M}{0.05M}\right)\right] V$$

$$E_{cell} = 1.10V + \left|\frac{0.0591}{2} \log 100\right| \quad (01 \text{ marks})$$

$$E_{cell} = 1.10V + 0.0591V = 1.16V$$

$$E_{cell} = 1.16V \quad (01 \text{ marks})$$

6 d) the intermediate species is NO_3 (01 marks)

ii) $R_{1(forward)} = K_1[NO][O_2]$

$R_{(reverse)} = K_{-1}[NO_3]$ (01 marks) (01/2 marks)

$R_2 = K_2[NO_3][NO]$ (01 marks) (01/2 marks)

At equillibrium

$R_1 = R_2$

$K_1[NO][O_2] = K_{-1}[NO_3]$ (01 marks)

make $[NO_3]$ the subject

$$[NO_3] = \frac{K_1[NO][O_2]}{K_{-1}}$$ (01 marks)

substitute the $[NO_3]$ to R_2 but $R_2 = K_2[NO_3][NO]$

$$R_2 = \frac{K_2 K_1}{K_{-1}}[NO][O_2][NO]$$ (00 1/2 marks)

$R_2 = K[NO]^2[O_2]$ (00 1/2 marks)

The proposed mechanism is consistent with the rate law

6 (a) (i) $Cr_2O_7^{2-}_{(aq)} + 3HNO_{2(aq)} + 5H^+ \rightarrow 3NO_{3(aq)}^- + 2Cr^{3+}_{(aq)} + 4H_2O_{(l)}$ —(02 marks)

(ii) $Cl^- + PbO_2 + OH^- + H_2O^+ \rightarrow ClO^- + [Pb(OH)_3]^-$ —(02 marks)

(b) $M_{Ag} = 54g$ —(01)

$M_{Cu} = 15.88g$ —(01)

$M_{Fe} = 9.33g$ (01)

eqn = $Cu^{2+}_{(aq)} + 2e^- \rightarrow Cu_{(s)}$ —(01)

$Fe^{3+}_{(aq)} + 3e^- \rightarrow Fe_{(s)}$

(ii) $\alpha = 0.013$ or 1.3% —(02)

$\alpha = \frac{\Lambda_m}{\Lambda_m^\infty}$

(c) $E^\circ_{cell} = 1.1V$ —(01)

eqn = 01

entering = 01

$E_{cell} = 1.16V$ (01)

(d) (i) Intermediate species = NO_3 (01 mark)

(ii) R_1 (forward) = $K_1[NO][O_2]$ —(01 mark)

(iii) $R_{(reverse)} = K_{-1}[NO_3]$ —(00½

$R_2 = K_2[NO_3][NO]$ —(00½ mark)

$K_1[NO][O_2] = K_{-1}[NO_3]$ —(01)

$[NO_3] = \frac{K_1[NO][O_2]}{K_{-1}}$ —(01)

$R_2 = \frac{K_2K_1[[NO][O_2]][NO]}{K_{-1}}$ —00½

$R_2 = K[NO]^2[O_2]$ —00½

Yes, the power is constant