

A.M

TANZANIA HEADS OF ISLAMIC SCHOOL COUNCIL

FORM SIX INTER ISLAMIC MOCK EXAMINATION 2023

CHEMISTRY-2 MARKING SCHEME

132/2

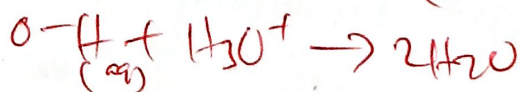
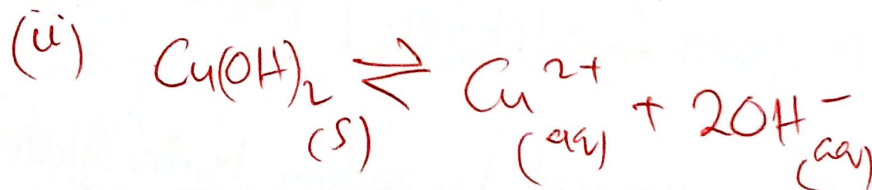
5(a)(i) $pH = 4.4$

(ii) $pH = 4.26$

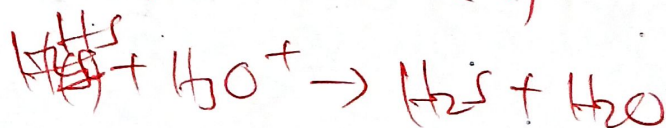
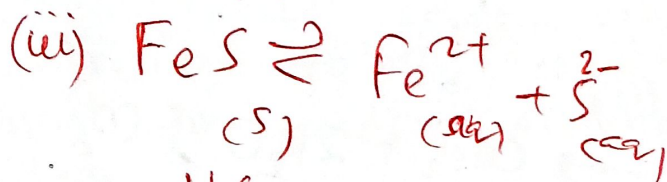
5(b) $K_{sp} = 1.4 \times 10^{-3} M^{-3}$



Has no effect on its solubility



Addition of strong acid will cause an increase in its solubility

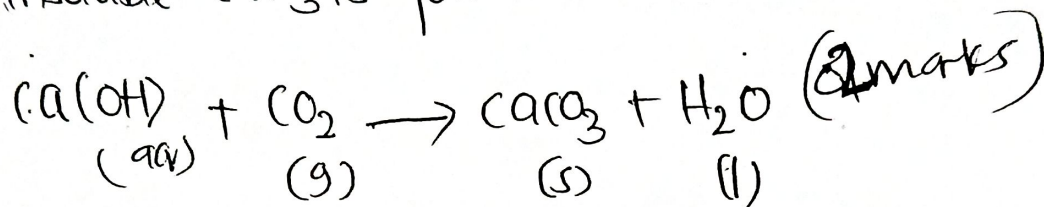


Addition of acid will cause increase in solubility

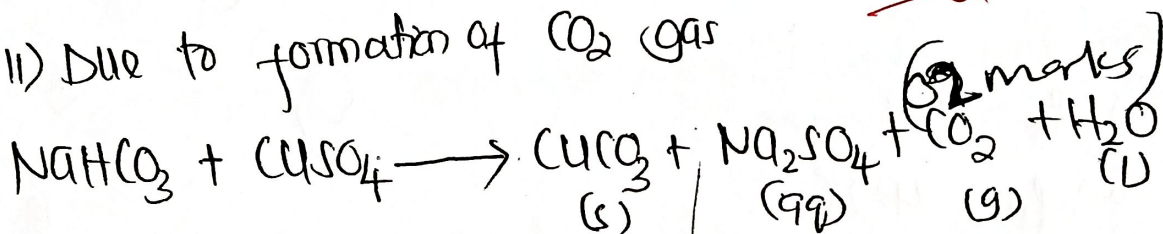
5(a)(i) 1x
 (ii) 6
 5(b) 4 @ 1
 (c) 6 @ 2

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

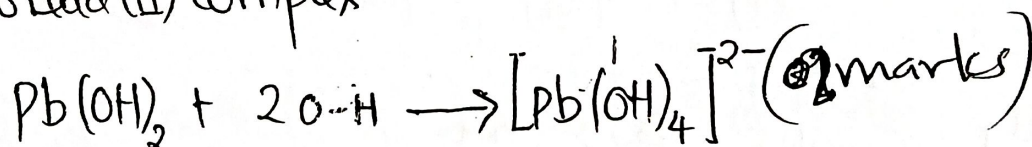
~~ii) Insoluble CaCO_3 is formed and turns lime water milky~~



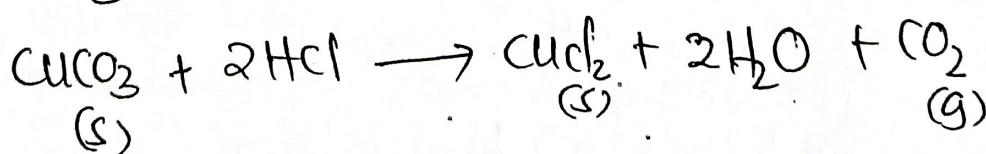
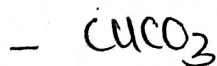
iii) Due to formation of CO_2 gas



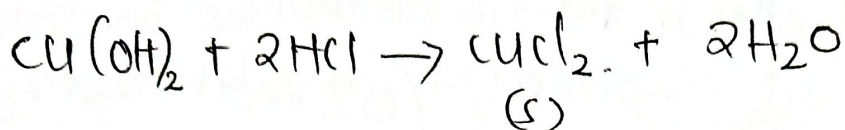
iv) Addition of excess NaOH results in excess OH^- ions - which leads to the formation of colourless soluble tetrahydroxo Lead (II) complex



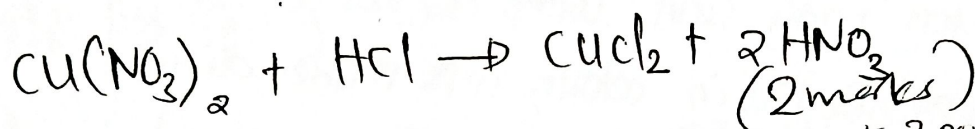
(b) i) CuCl_2 can be prepared by reacting hydrochloric acid with either



1. (b) i - $\text{Cu}(\text{OH})_2$

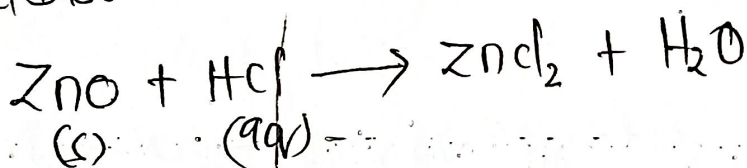


- $\text{Cu}(\text{NO}_3)_2$

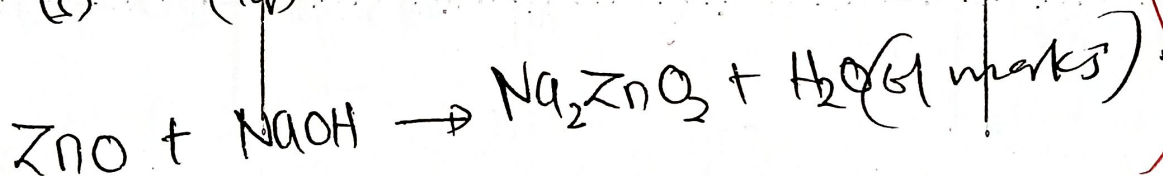


at least 2 points 1 mark each

ii) Zinc oxide is amphoteric oxide. It reacts with both acid and base (1 mark)

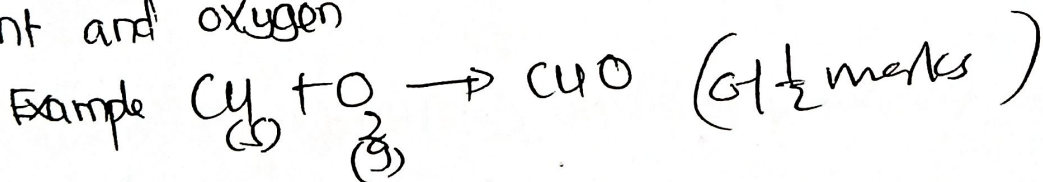


1 mark



iii) - Direct method of preparing metal oxide

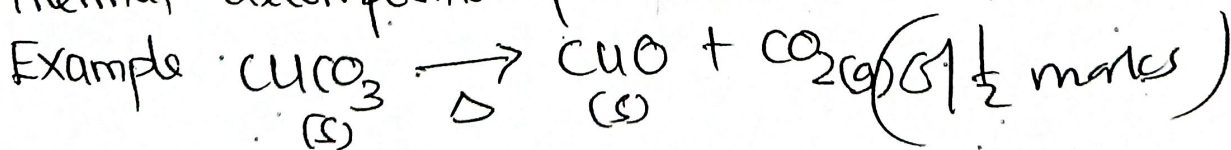
By direct reaction or oxygen combination between metallic element and oxygen



eqn is important (1/2)

- Indirect method

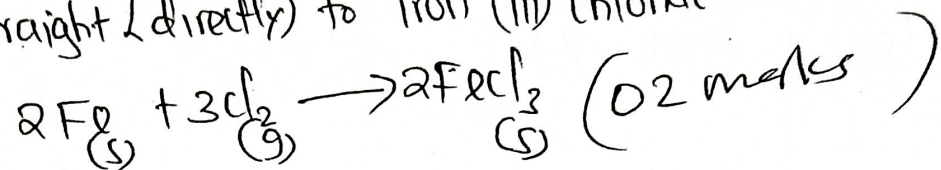
Thermal decomposition of metallic carbonate.



eqn is important (1/2)

1

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



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 hard on cooling. Examples: nylon 6,6, polyethylene (01 marks)

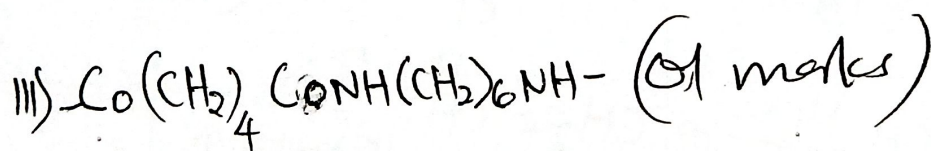
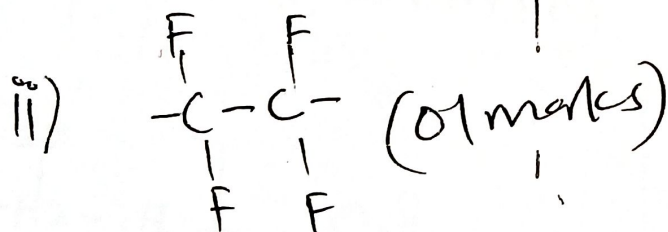
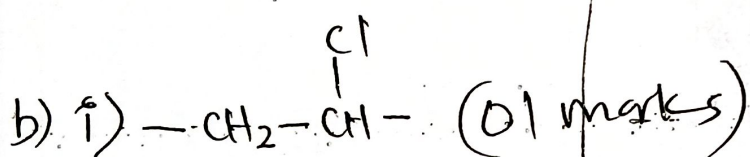
defn - soft
example - soft

ii) Thermosetting polymers, polymers which harden on heating and can be softened by cooling. Example: Bakelite (01 marks)

defn - soft
example - soft

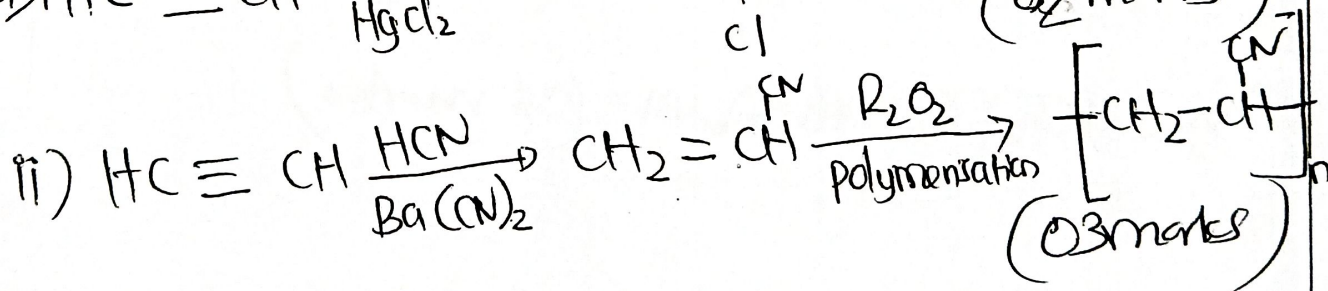
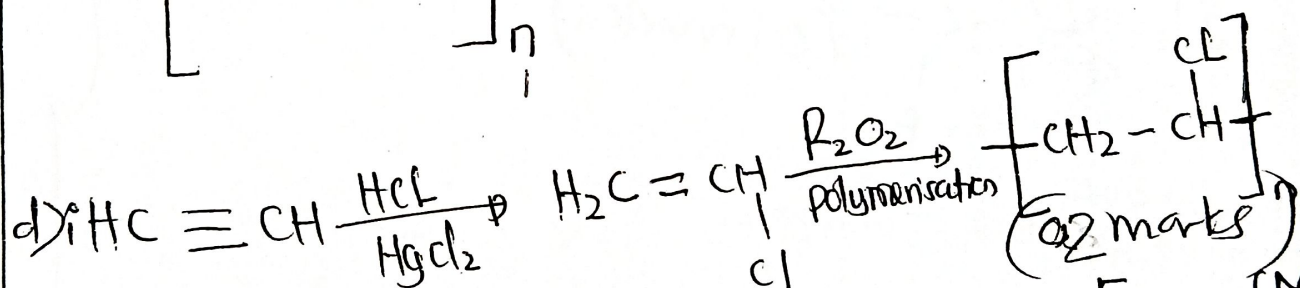
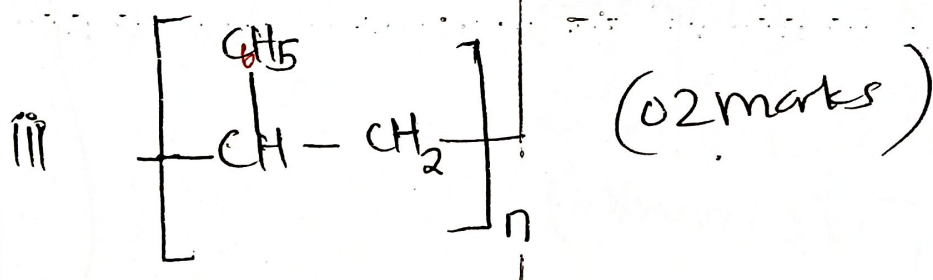
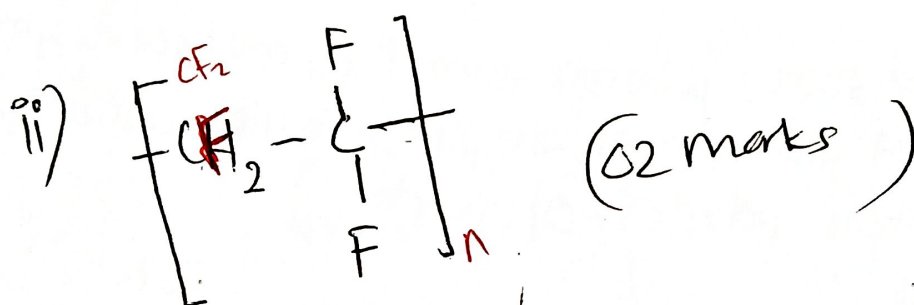
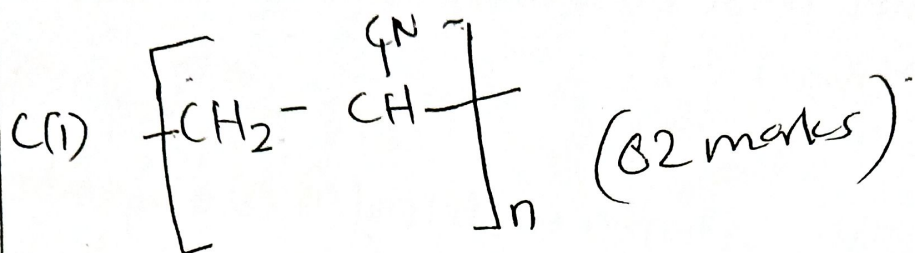
iii) Condensation polymer, polymers formed by combination of monomers with elimination of simple molecules such as H_2O or CH_3OH . Example: polyester (01 marks)

defn - soft
example - soft

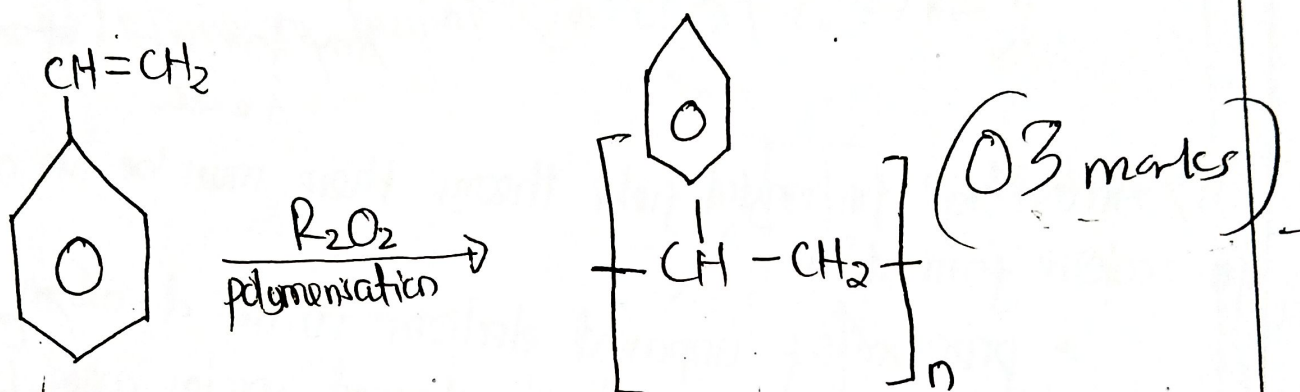
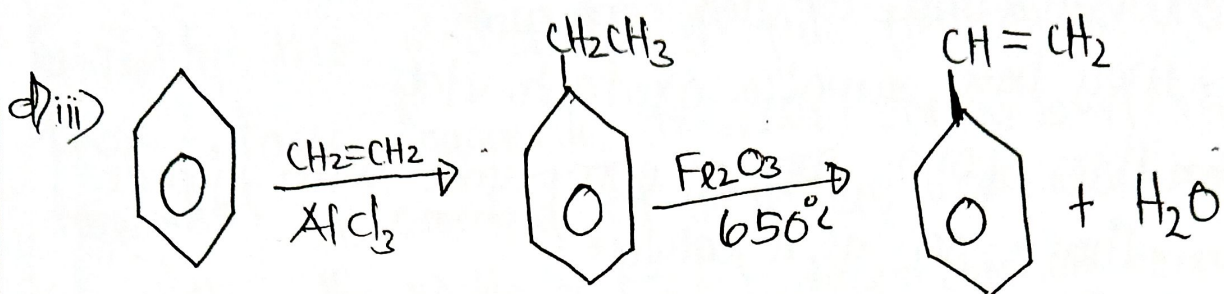


03

2 (c)



2



3

- (a):
- 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.

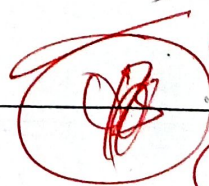
ii) According to crystal field theory there must be two conditions for colour formation.

- presence of unpaired electrons in the d-orbital (01 mark)
- presence of negatively charged species called ligands

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 mark)

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 mark)

(07)



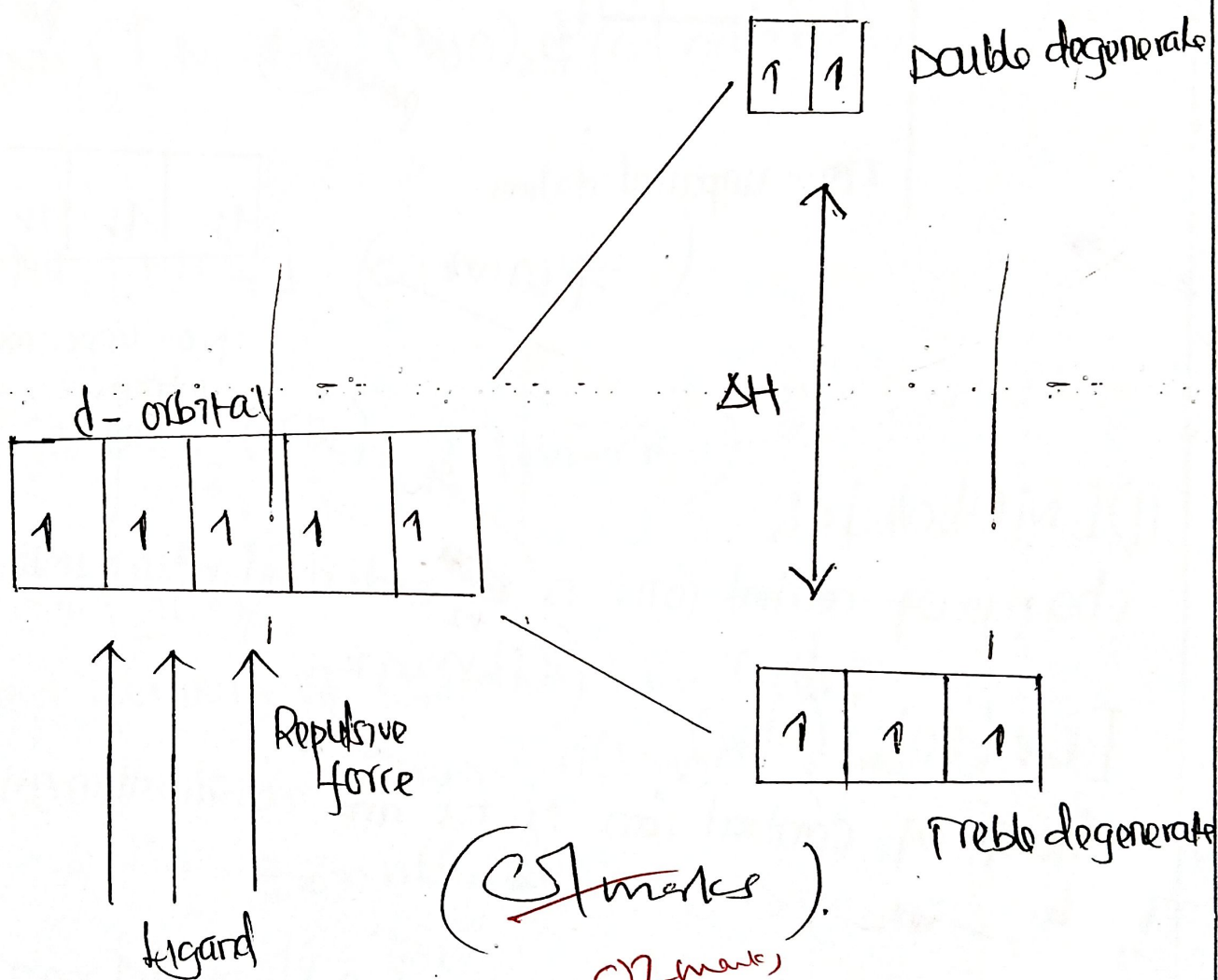
explan

03

explan

3(a)

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

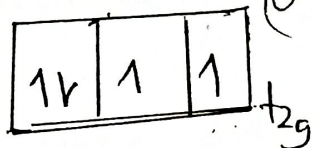
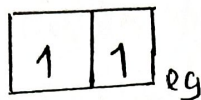
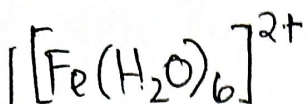


Total 05

08

04

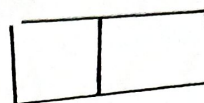
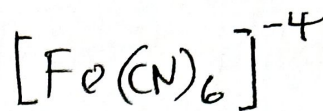
3(b) 1)



potential energy

Four unpaired electrons

Total 02

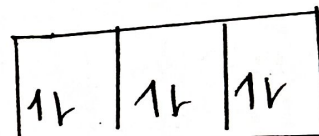


e_g

(0.5 mark)

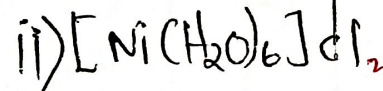
drawing 0.5 mark
product 0.5

drawing 0.5
product 0.5

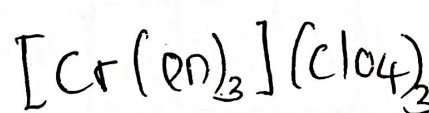


t_{2g}

No unpaired electrons



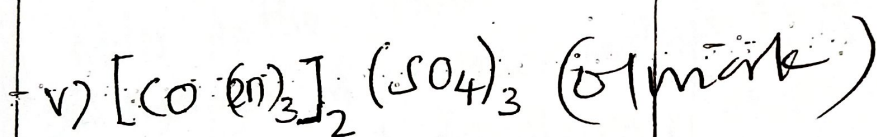
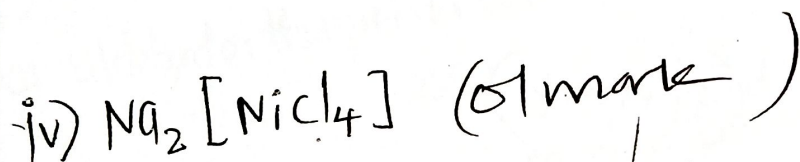
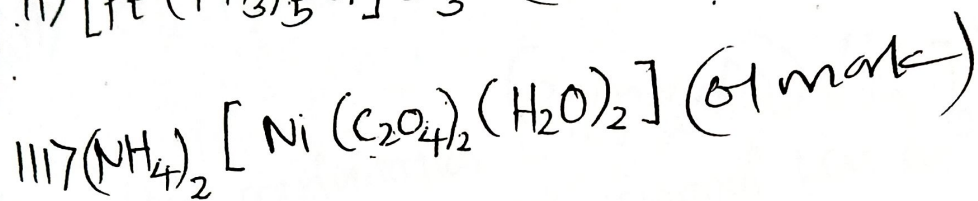
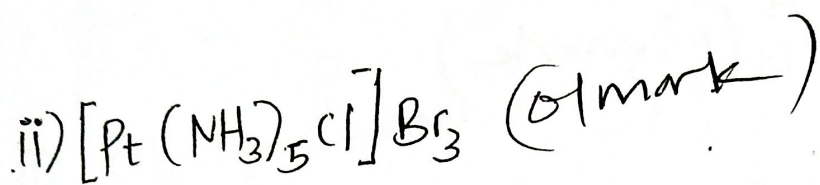
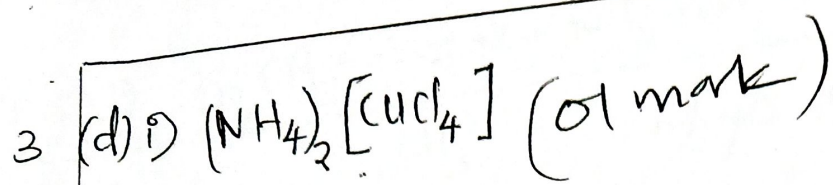
charge of central ions is ~~2~~ ⁺² and coordination number is 6
(0.1 mark)



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

c i) Dichlorobis(ethylenediamine)platinum(IV) chloride (0.1 mark)

ii) Diamine silver(I) dicyanoargentate(I) (0.1 mark)



4 a) i) Data given

Empirical formula of compound M is $\text{C}_4\text{H}_8\text{O}$
 from, Molecular mass = $n(\text{Empirical formula})$

$$72 = n(\text{C}_4\text{H}_8\text{O})$$

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

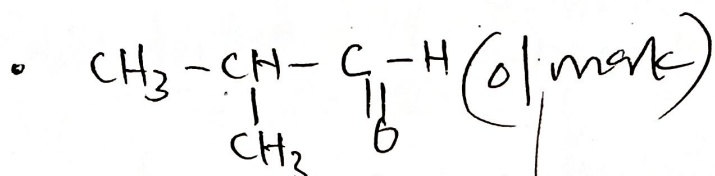
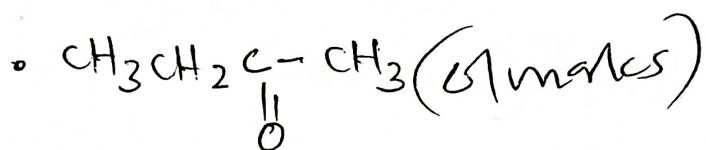
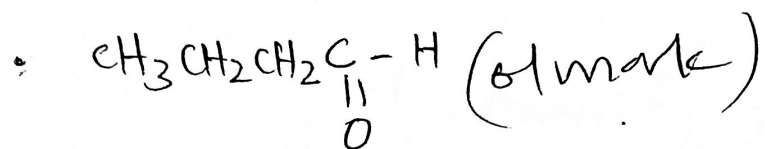
$$n = 1 \text{ (01 mark)}$$

From molecular formula = $n(\text{Empirical formula})$

$$\text{Molecular formula} = (\text{C}_4\text{H}_8\text{O}) \times 1$$

$$\text{Molecular formula} = \text{C}_4\text{H}_8\text{O} \text{ (01 marks)}$$

4 (a)(ii) possible structures of M



b(i) Test A - Test for Alcohol (1 mark)

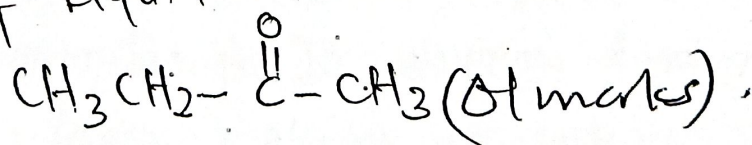
Test B - Test for unsaturated hydrocarbon (double/triple bond) (1 mark)

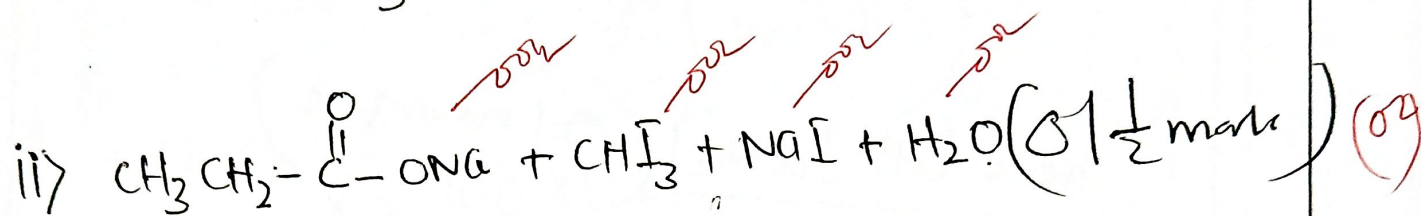
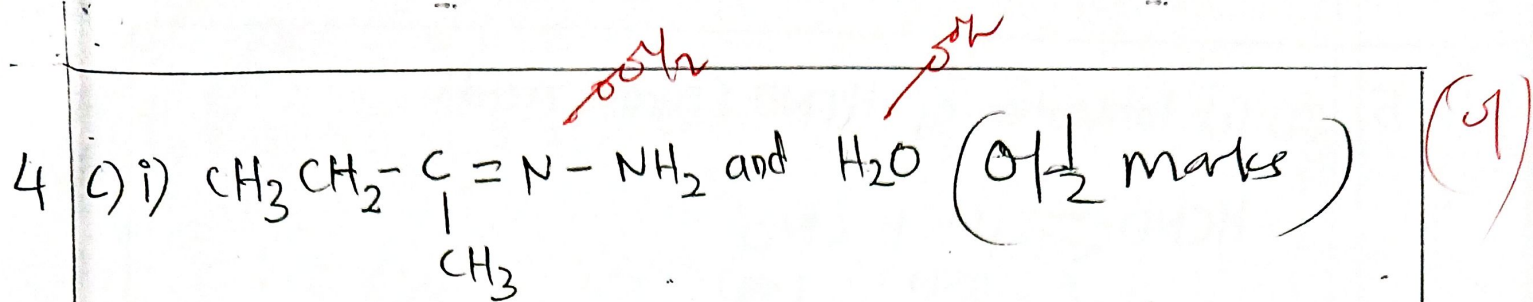
Test C - Test for aldehyde and ketone (1 mark)

Test D - Test for aldehyde (1 mark)

Test E - Test for ketone, aldehyde or alcohol with terminal methyl group (1 mark)

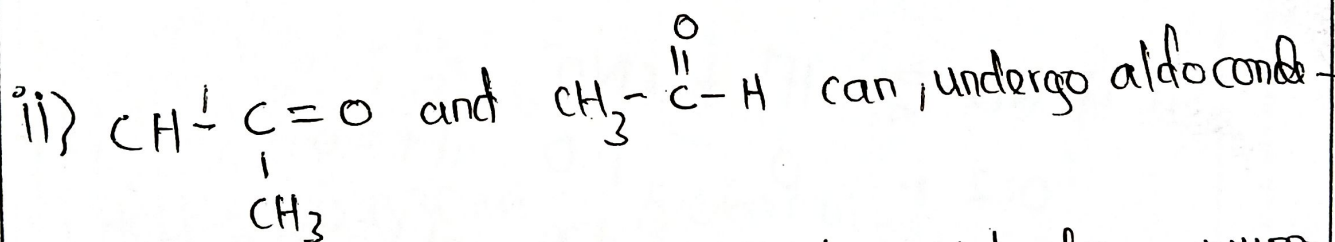
ii) structure of Liquid M is





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

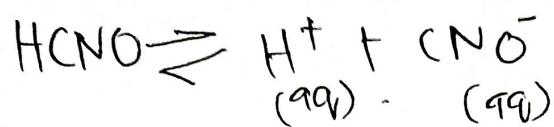
Aldo is the chemical reaction between two aldehydes with α -hydrogen in alkaline medium to form large aldehyde-molecule with hydroxyl group at β -carbon. (03 marks) (02)



due to the presence of replaceable hydrogen where. As $(\text{CH}_3)_2-\text{C}-\text{CHO}$ and $(\text{CH}_3)_3-\text{CHO}$ can not undergo aldo condensation due to absence of replaceable hydrogen at α -carbon in all two groups.

(03 marks) (04)

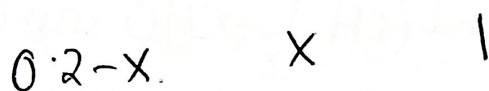
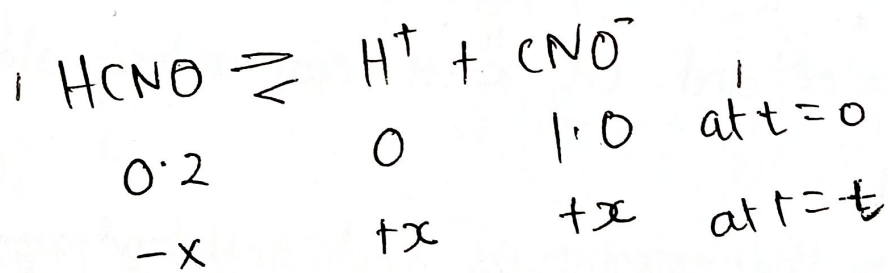
5 (a) (i) Ionization of HCN (cyanic acid)



$$K_a = \frac{[\text{H}^+][\text{CNO}^-]}{[\text{HCNO}]} \quad (0 \text{ marks})$$

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

$$\text{HCNO} = \frac{0.1 \text{ mol}}{0.50 \text{ litre}} = 0.2 \text{ M (mol dm}^{-3}\text{)} \quad (0 \text{ marks})$$



+x at equilibrium (0 mark)

But $1.0 + x \approx 1.0 \text{ M}$ and $0.2 - x \approx 0.2 \text{ M}$

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

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

$$2.0 \times 10^{-4} = \frac{x^2}{0.2} \quad \left(\frac{0.5}{2} \text{ mark} \right)$$

$$x = 4.0 \times 10^{-5} \text{ M}$$

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

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

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

$$pH = 4.4$$

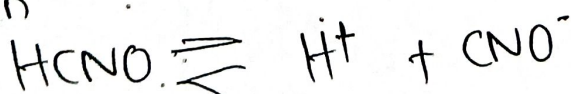
$\left(\frac{0.5}{2} \text{ mark} \right)$

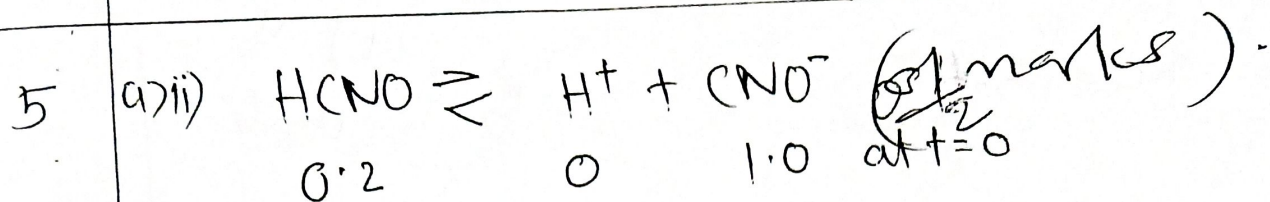
ii)

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

$$[HCl] = 0.060 \text{ mol L}^{-1} \quad (0.5 \text{ mark})$$

then





+0.06	0.60	-0.06
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-x	+x	+x
----	----	----

0.260-x	x	0.94+x	(0.5 marks)
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Assume $0.260 - x = 0.260 \text{ M}$ and $0.94 + x = 0.94$

then

$$K_a = \frac{[\text{H}^+][\text{CNO}^-]}{[\text{HCNO}]}$$

(0.1 mark)

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

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

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

$$x = 5.5 \times 10^{-5} \text{ M} = [\text{H}^+] \quad (0.2 \text{ mark})$$

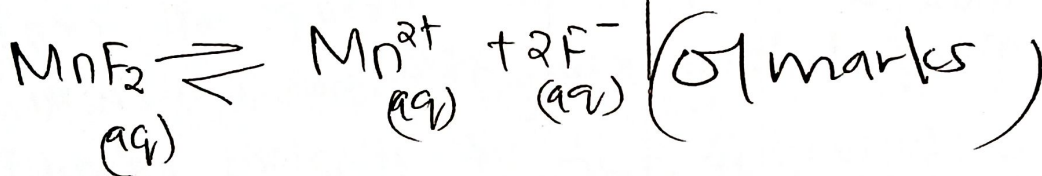
5 a(ii), $\text{pH} = -\text{Log}[\text{H}^+]$

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

$$\text{pH} = 4.26 \text{ (01 marks)}$$

(b) molar solubility of $\text{MnF}_2 = \frac{6.60 \text{ g/L}}{92.9 \text{ g/L}} = 0.071044$
(01 mark)

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



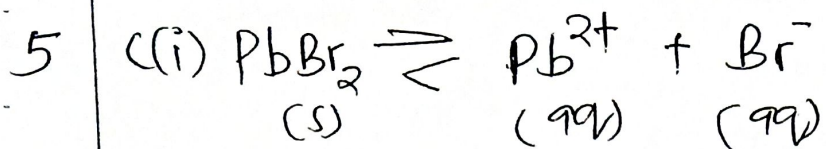
$$K_{sp} = [\text{Mn}^{2+}] [\text{F}^-]^2$$

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

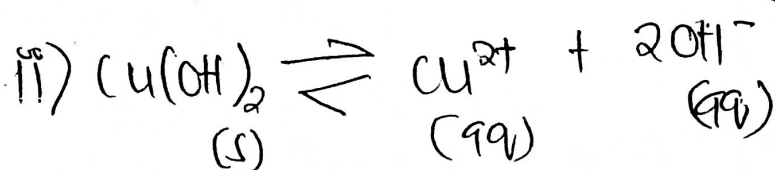
$$[\text{F}^-] = 0.14209 \text{ M (01 marks)}$$

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

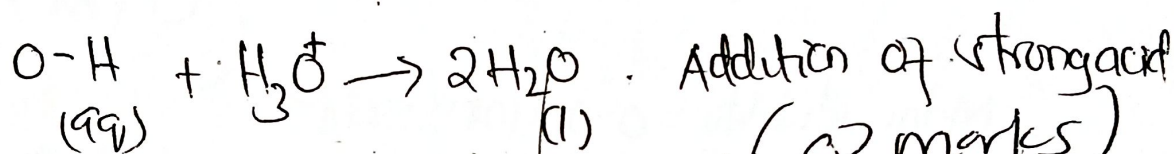
$$K_{sp} = 1.4 \times 10^{-3} \text{ M}^3 \text{ (01 marks)}$$



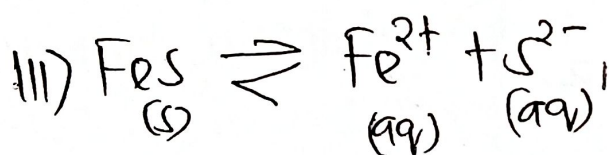
Br^- is the anion of HBr a strong acid so it does not react with H_3O^+ . Has no effects on its solubility
 (02 marks)



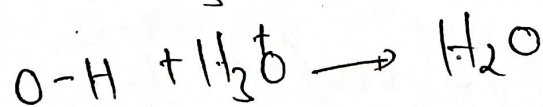
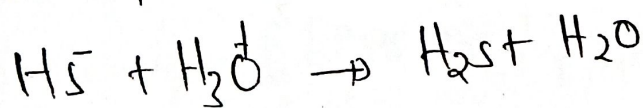
OH^- is the anion of H_2O it reacts with H_3O^+



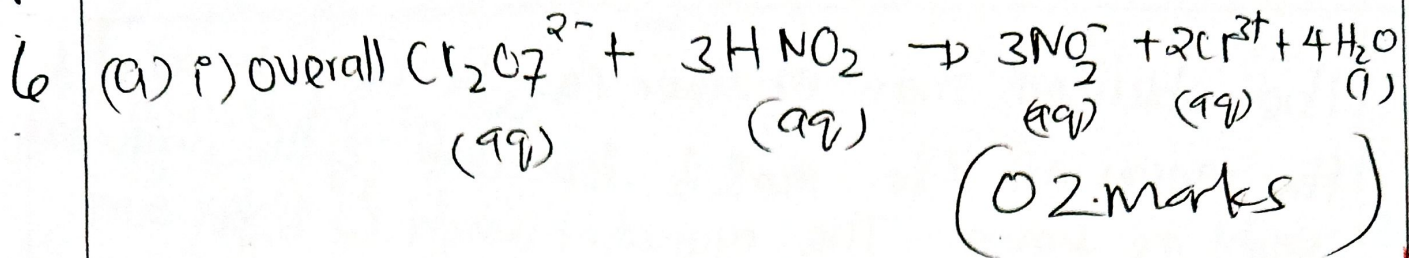
will cause an increase in solubility.



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^+



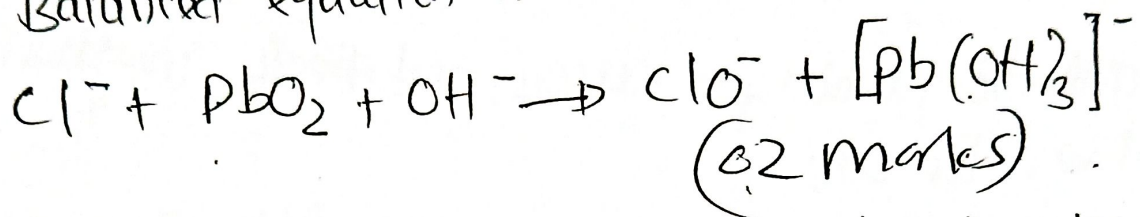
(02 marks)
 so addition of strong acid will cause an increase in solubility



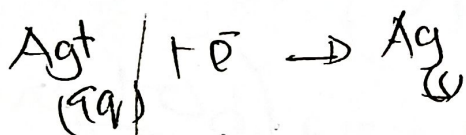
Step 1
 mark 1

Step 1
 mark 1

ii) Balanced equation in basic media



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



from the equation 1 mole of Ag^+ requires 1 mole of electrons which is equivalent to 1F for complete reduction. The equivalent weight of Ag^+ is $= \frac{\text{Atomic weight of silver}}{\text{Valence of silver}}$

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

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

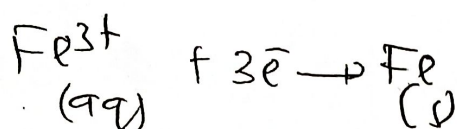
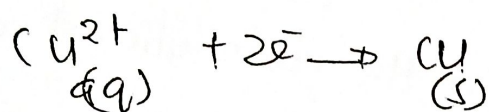
$x = \frac{0.5\text{F} \times 108\text{g}}{1\text{F}} = 54\text{g}$
 (001 marks)

(17)

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



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

Equivalent weight of Fe = $\frac{56}{2} = 28$ (3 marks)

from Faradays law of electrolysis,

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

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

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

Mass of Cu = 15.88g (01 mark)

(18)

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

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

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

$$\text{M Fe} = 9.33\text{g} \text{ (01 marks)}$$

$$\text{ii) } \Lambda_m^\infty = 3.88 \times 10^2 \text{ S m}^2 \text{ mol}^{-1}$$

$$\Lambda_m = 5.2 \times 10^4 \text{ S m}^2 \text{ mol}^{-1}$$

$$\alpha = \frac{\Lambda_m}{\Lambda_m^\infty} = \frac{5.2 \times 10^4 \text{ S m}^2 \text{ mol}^{-1}}{3.88 \times 10^2 \text{ S m}^2 \text{ mol}^{-1}} = 0.13$$

$$\alpha \text{ of } \text{CH}_2\text{COOH} \text{ is } 0.13 \text{ or } 13\% \text{ (02 marks)}$$

6 c) solution.

Zn^{2+} is oxidised species

Cu^{2+} is reduced species

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

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

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

from Nernst equation

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

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

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

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

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

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

$$R_{\text{forward}} = k_1 [\text{NO}] [\text{O}_2] \quad (01 \text{ marks})$$

$$R_{\text{reverse}} = k_{-1} [\text{NO}_3] \quad (00 \frac{1}{2} \text{ marks})$$

$$R_2 = k_2 [\text{NO}_3] [\text{NO}] \quad (01 \text{ marks})$$

At equilibrium

$$R_1 = R_2$$

$$k_1 [\text{NO}] [\text{O}_2] = k_{-1} [\text{NO}_3] \quad (01 \text{ marks})$$

make $[\text{NO}_3]$ the subject

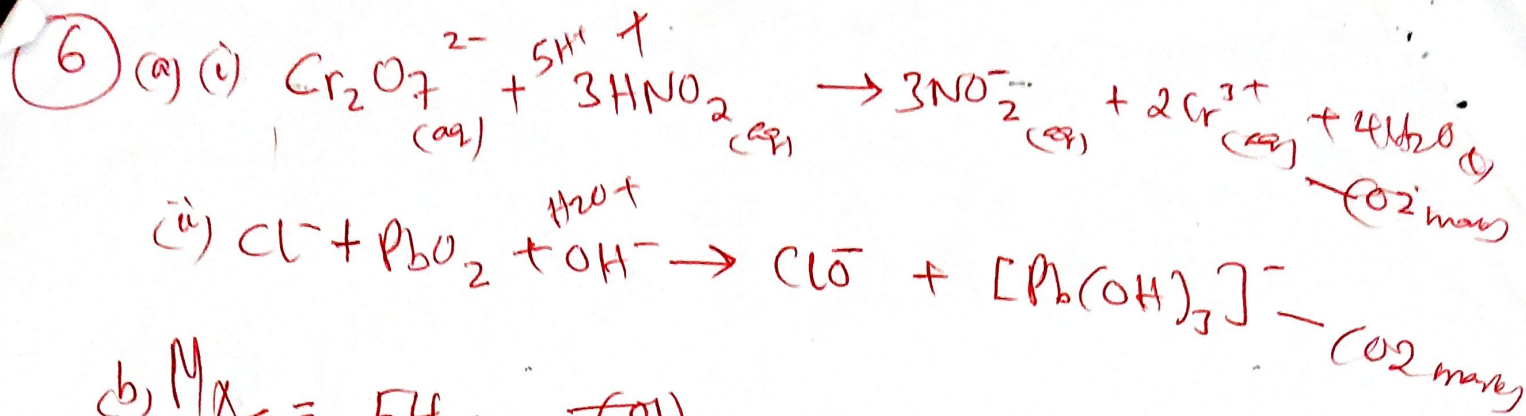
$$[\text{NO}_3] = \frac{k_1 [\text{NO}] [\text{O}_2]}{k_{-1}} \quad (01 \text{ marks})$$

substitute the $[\text{NO}_3]$ to R_2 but $R_2 = k_2 [\text{NO}_3] [\text{NO}]$

$$R_2 = \frac{k_2 k_1 [\text{NO}] [\text{O}_2] [\text{NO}]}{k_{-1}} \quad (00 \frac{1}{2} \text{ marks})$$

$$R_2 = k [\text{NO}]^2 [\text{O}_2] \quad (00 \frac{1}{2} \text{ marks})$$

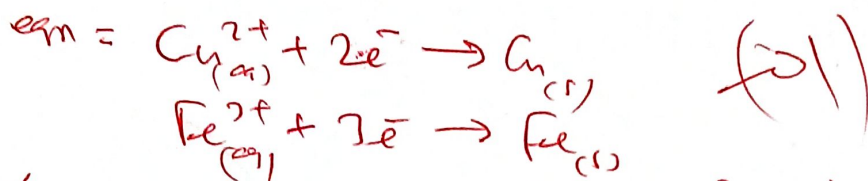
The proposed mechanism is consistent with the rate law.



b) $M_{\text{Ag}} = 54 \text{ g}$ (01)

$M_{\text{Cu}} = 15.88 \text{ g}$ (01)

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



(ii) $\alpha = 0.013$ or 1.3% (02)

$\alpha = \frac{\Delta m}{\Delta m}$

(c) $E_{\text{cell}} = 1.1 \text{ V}$ (01)

eqn = 01
entering = 01

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

d) (i) Intermediate species = NO_2 (01 marks)

(ii) $R_1 (\text{forward}) = k_1 [\text{NO}][\text{O}_2]$ (01 marks)

(iii) $R_{\text{reverse}} = k_{-1} [\text{NO}_2]$ (01 marks)

$R_2 = k_2 [\text{NO}_2][\text{NO}]$ (01 marks)

$k_1 [\text{NO}][\text{O}_2] = k_{-1} [\text{NO}_2]$ (01)

$[\text{NO}_2] = \frac{k_1 [\text{NO}][\text{O}_2]}{k_{-1}}$ (01)

$R_2 = k_2 k_1 \frac{[\text{NO}][\text{O}_2]}{k_{-1}} [\text{NO}]$ (01 marks)

$R_2 = k [\text{NO}]^2 [\text{O}_2]$ (01 marks)
Yes, the rate is constant