Experiment-5

Experiment - To determine the amount of Fe^{2+} and Fe^{3+} ions by permanganometry.

Apparatus - Pipette, burette, beakers, conical flask, burette stand and clamp.

Chemicals - Mohr's salt solⁿ, $FeSO_4(NH_4)_2SO_4 \cdot 6H_2O$, permanganate ($KMnO_4$) & sulphuric acid ($H_2SO_4$).

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

Indicator - $KMnO_4$ acts as self indicator

Observation - 1. Standardization of $KMnO_4$ solⁿ.

volume of 0.1N FAS(N_1) solⁿ take for each titration = 10 ml

S.No.	Burette reading (ml)		Vol of $KMnO_4$ used (ml)
	Initial	Final	
1.	0	10.3	10.3
2	0	10.3	10.3
3	0	10.3	10.3

Mean volume (V_1) = 10.5 ml

Experiment:- To determine the amount of Fe^{2+} & Fe^{3+} ions by permanganometry.

Apparatus: Pipette, burette, beakers, conical flask, burette stand & clamps

Chemicals: Mohr's Salt solⁿ (Ferrous ammonium sulphate) $FeSO_4 \cdot (NH_4)_2SO_4 \cdot 6H_2O$, Permanganate ($KMnO_4$) and sulphuric acid H_2SO_4

Theory: Mn^{7+} oxidises Fe^{2+} in acidic medium to Fe^{3+} and itself gets reduced to divalent chromium (Mn^{2+})

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

$KMnO_4$ acts as a self indicator. If Fe^{3+} is present in the original solⁿ, it can be reduced by boiling the soln with zinc pieces in acidic medium and can be titrated with standard $KMnO_4$. The endpoint in this case corresponds to presence of both Fe^{2+} and Fe^{3+} ions in the solⁿ.

Procedure: 1. Standardisation of $KMnO_4$ -

1. Transfer 10 ml of the standard 0.1 N ferrous ammonium sulphate (FAS) solⁿ to a clean conical flask using a pipette.

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2. Determination of Fe^{2+}

Vol of given sample taken for each titration = 10 ml

S.NO	Burette Reading (ml)		Volume of $KMnO_4$ used (ml)
	Initial	Final	
1	0	10·3	10·3
2	0	10·3	10·3
3	0	10·3	10·3

Mean vol (V_2) = 10·3 ml

3. Determination of Fe^{2+} & Fe^{3+} (total iron content)

volume of given sample taken for each titration = 10 ml.

S.No	Burette Reading (ml)		Vol. of $KMnO_4$ used (ml)
	Initial	Final	
1	0	14·3	14·3
2	0	14·3	14·3
3.	0	14·3	14·3

Mean vol (V_3) = 14·3 ml

(ii) Add 5 ml of 4 N sulphuric acid.

(iii) Titrate the solⁿ against $KMnO_4$ solⁿ taken in a burette. The colour of the solⁿ changes from colorless to pink.

(iv) Note the volume of the solⁿ used and repeat the titration atleast 5 times and take the mean of closely related readings (V_1)

2. Determination of Fe^{2+}

(i) Pepette out 10 ml of the given substance in a titration conical flask.

(ii) Add 5 ml of 4 N sulphuric acid

(iii) ~~Titrate~~ Titrate the solⁿ against $KMnO_4$ solⁿ taken in burette the color of the substance changes from colorless to pink

(iv) Note the volume of the solⁿ used and repeat the titration atleast 5 times and take the mean of closely related reading (V_2)

3. Determination of Fe^{2+} and Fe^{3+} (Total iron content)

(i) Pipette ~~out~~ out 10 ml of aq solⁿ into the conical

Calculations :- 1. Normality of $KMnO_4$ sol^n

$(KMnO_4)\ N_1V_1 = N_2V_2\ (FAS) = 0.1N \times 10ml$

Normality of $KMnO_4 (N_1) = \frac{0.1 \times 10}{V_1} = \frac{0.1 \times 10}{10.3} = S(N) = 0.097N$

2. Determination of Fe^{2+}

Vol of sol^n taken = 10 ml

Vol of $KMnO_4$ sol^n used $(V_2) = 10.3$ ml

Normality of $KMnO_4\ (N_1) = 0.097N$

Normality of $Fe^{2+} = N = V_2 \times S = 10.3 \times 0.097 \simeq 0.1$

Strength of $Fe^{2+} = 56 \times N = 56 \times 0.1 = 5.6$ gm/L

3. Determination of Fe^{+3} in a mixed Fe^{2+} & Fe^{3+}

Vol of sol taken used = 10 ml

Vol. of $KMnO_4$ used $(V_3) = 14.3$ ml

Normality of $KMnO_4\ (N_1) = 0.097N$

Normality of total Fe | $N_1 = \frac{V_3 \times S}{10} = \frac{0.097 \times 14.3}{10} \simeq 0.138N$

Strength of total Fe = $N_1 \times$ Eq wt = $0.138 \times 56 = 7.728$ gm/L

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flask (The given solⁿ has already been boiled with 2-3 g of zinc pieces and 5 ml of dilute H_2SO_4 to reduce the Fe^{3+} to Fe^{2+})

(ii) Add 5 ml of 4 N H_2SO_4.

(iii) Titrate it with standard $KMnO_4$ solⁿ till the colour changes from colourless to pink.

(iv) Note the volume of the solⁿ used and repeat the titration at least 5 times and take the mean of the closely related reading (V_3)

<u>General calculation:</u>

1. Normality of $KMnO_4$ solⁿ

Applying the normality solⁿ

$$N_1 V_1 (KMnO_4) = N_2 V_2 (FAS) = 0.1 N \times 10 ml$$

$$\text{Normality of } KMnO_4 \quad N_1 = \frac{0.1 \times 10}{V_1} = s (N)$$

2. Determination of Fe^{2+}

vol of solⁿ taken = 10 ml.

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Strength of Fe^{3+} ions = Normality of Eq wt

$$\frac{(V_3 - V_2) \times 8 \times 56}{10} = 2.1 \text{ gm/L}$$

Result - The amount of Fe^{2+} = 5.6 gm/L

The amount of Fe^{3+} = 2.1 gm/L

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Vol. of $KMnO_4$ soln used $= V_2$ ml

Normality of $KMnO_4$ = $\frac{1}{8}$ N

Normality of Fe^{2+} $N_1 = \frac{V_2 \times 5}{10}$

Strength = $N_1 \times$ Eq wt = $N_1 \times 56$ gm/L

7. Determination of Fe^{3+} in a mixture of Fe^{2+} and Fe^{3+}

Volume of solⁿ taken = 10 ml

Volume of $KMnO_4$ soln used = V_3 ml

Normality of $KMnO_4$ = $\frac{1}{8}$ N

Normality of total Fe = $N_1 = V_3 \times \frac{8}{10}$

Strength of total Fe = $N_1 \times$ Eq wt = $N_1 \times 56$ gm/L

Strength of Fe^{3+} ions = Normality × Eq wt.

$= (V_3 - V_2) \times 8 \times \frac{56}{10}$

Result - The amount of Fe^{2+} = 5.6 gm/L

The amount of Fe^{3+} = 2.1 gm/L

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