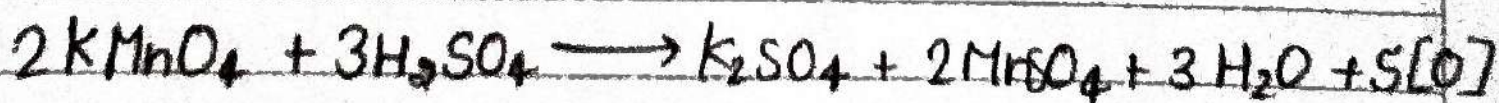


Experiment - 6

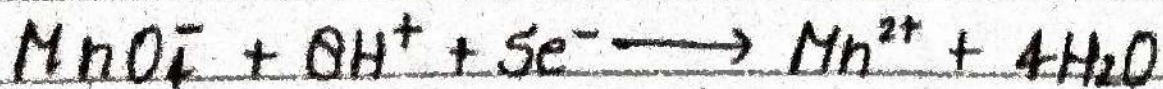
Aim - Determination of water of crystallization in Mohr's salt by titrating with KMnO_4

Objective - To determine the water of crystallization in a given sample solution of Mohr's salt, $\text{FeSO}_4 \cdot (\text{NH}_4)_2\text{SO}_4 \cdot x\text{H}_2\text{O}$, by titrating it against a 0.01N Potassium permanganate (KMnO_4) solution acting as an oxidizing agent via redox titration.

Theory - Potassium permanganate (KMnO_4) acts as a powerful oxidizing agent in an acidic medium. Each molecule of KMnO_4 yields five atoms of nascent oxygen $[\text{O}]$ according to the following molecular equation:



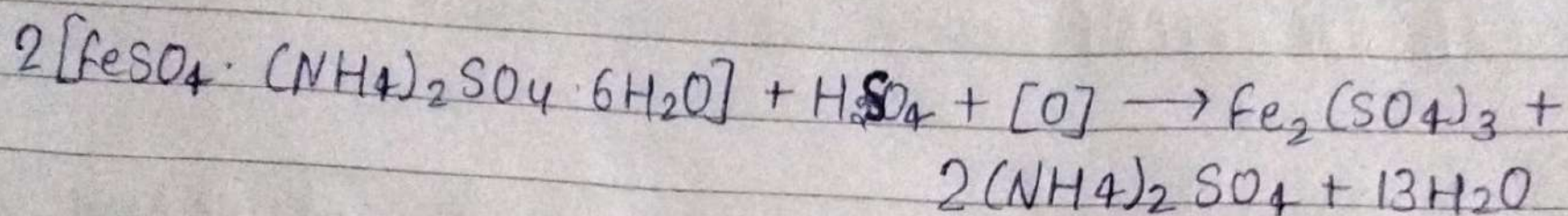
The ionic representation of this reduction half-reaction is:



When the acidic KMnO_4 is added to a standard solution of ferrous ammonium sulfate (Mohr's salt), the FeSO_4 component is oxidized

Teacher's Signature

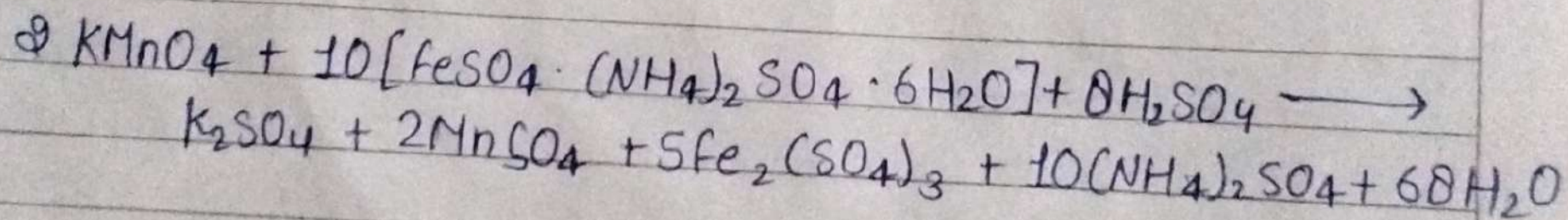
While the ammonium sulfate remains unchanged, the following reaction takes place: molecular reaction.



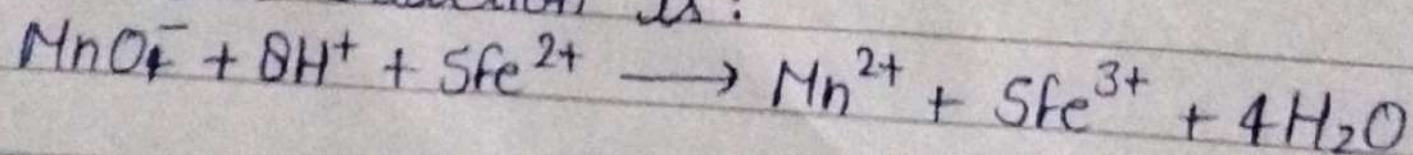
Ionically, the oxidation half-reaction is written as:

$$[\text{Fe}^{2+} \longrightarrow \text{Fe}^{3+} + \text{e}^-] \times 5$$

the overall molecular reaction is:



the overall ionic reaction is:



Theory & Principle.

This titration is based on an oxidation-reduction (redox) reaction. When ferrous ammonium sulphate (Mohr's salt) solution is titrated against potassium permanganate (KMnO_4) in an acidic medium provided by dilute sulphuric acid (H_2SO_4), KMnO_4 acts as a self indicator.

Consequently, this process is known as a permanganate titration. The end point is detected by a distinct colour change in the conical flask, where the solution shifts from colourless to a permanent light pink.

Experimental Setup -

- Apparatus: Burette, Pipette, conical flask, beaker, funnel, dropper.

Chemicals Required.

- Standard 0.01 N Potassium Permanganate (KMnO_4) Solution.
- Unknown Sample Solution of Iron ore (Mohr's salt)
- Dilute Sulfuric Acid (H_2SO_4)

Indicator

- KMnO_4 Solution (acts as a self indicator)

Experimental Procedure.

1. Pipette out 10 ml of the iron ore Sample Solution into a clean conical flask and add half a test tube of dilute H_2SO_4 to it.
2. Fill the burette with the standard 0.01 N potassium permanganate (KMnO_4) Solution up to the zero mark.

Observation.

S.No.	Volume of Sample Solution taken (ml)	Burette reading		Volume of 0.01N $KMnO_4$ Consumed.
		Initial	Final	
1.	10 ml	0	10.3 ml	10.2 ml
2.	10 ml	0	10.2 ml	
3	10 ml	0	10.2 ml	

3. Titrate by adding the KMnO_4 solution from the burette into the conical flask drop by drop swirling constantly, until the colourless solution turns a persistent light pink. This indicates the end point of the titration.
4. Repeat the procedure until two concordant readings are obtained.

Calculations.

Let N_1 and V_1 be the normality and volume of the Mohr's salt solution.

Let N_2 and V_2 be the normality and volume of the potassium permanganate (KMnO_4) solution.

Using the normality equation at the end point:

Normality of Mohr's salt ($N_1 V_1$) = Normality of potassium permanganate ($N_2 V_2$)

$$N_1 \times V_1 = N_2 \times V_2$$

Given values from the experiment:

$$V_1 = 10 \text{ ml}$$

$$N_2 = 0.01 \text{ N}$$

$$V_2 = 10.2 \text{ ml}$$

Substitution and Calculation: $N_1 \times 10 = 0.01 \times 10.2$

$$N_1 = 0.0102 \text{ N}$$

1. Strength of Fe^{2+} Solution.

$$\begin{aligned}\text{Strength (in g/L)} &= \text{Normality} \times \text{Equivalent weight of } \text{Fe}^{2+} \\ &= 0.01 \times 55.85 \\ &= 0.5585 \text{ g/L}\end{aligned}$$

2. Amount of Fe^{2+} in 100 ml (i.e., in 0.40 g of Mohr's salt)
- 1000 ml of Solution Contains = 0.5585 g
 - 100 ml of Solution Contains

$$\text{Amount of } \text{Fe}^{2+} = \frac{0.5585 \times 100}{1000} = 0.05585 \text{ g}$$

3. Percentage of Iron (Fe) in 0.40 g of Mohr's salt

$$\text{Percentage of Fe} = \frac{\text{Weight of } \text{Fe}^{2+}}{\text{Weight of Mohr's salt sample}} \times 100$$

$$= \frac{0.05585}{0.40} \times 100 = 13.96 \%$$

this value corresponds to 6 moles of H_2O of crystallization)

Result - The percentage of iron (Fe) in the 0.40 g sample of Mohr's salt is found to be 13.96% which corresponds to 6 moles of water of crystallization.

Teacher's Signature

Precaution.

1. Wash the glass apparatus properly before the start of the experiment.
2. KMnO_4 acts as an oxidizing agent in an acidic Medium.
3. KMnO_4 acts as a Self indicator.
4. Readings should be taken carefully.
5. The end point should be noted carefully.