Prepare a Solution of Ferrous Ammonium Sulphate (Mohr's salt) Containing Exactly 17.0 g of the Salt in one litre. With the help of this Solution, Determine the Molarity & the Concentration of $KMnO_4$ in the Given Solution

Chemical Equations

Molecular equations

$$2KMnO_4 + 3H_2SO_4 \longrightarrow K_2SO_4 + 2MnSO_4 + 3H_2O + 5[O]$$

$$2FeSO_4(NH_4)_2SO_4.6H_2O + H_2SO_4 + [O] \longrightarrow Fe_2(SO_4)_3 + 2(NH_4)_2SO_4 + 13H_2O] \times 5$$

$$2KMnO_4 + 8H_2SO_4 + 10FeSO_4(NH_4)_2.SO_4.6H_2O \longrightarrow K_2SO_4 + 2MnSO_4 + 5Fe_2(SO_4)_3 + 10(NH_4)_2SO_4 + 68H_2O$$

Ionic equations

$$MnO_4^- + 8H^+ + 5e^- \longrightarrow Mn^{2+} + 4H_2O$$

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

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

Indicator

$KMnO_4$ is a self-indicator.

End Point

Colourless to permanent pink colour ($KMnO_4$ in burette).

Procedure

1. Weigh exactly 4.250 g of Mohr's salt on a watch glass and dissolve in water to prepare exactly 250 ml of solution with the help of a 250 ml measuring flask. Rinse the pipette with the prepared Mohr's salt solution and pipette out 20.0 ml of it in a washed titration flask.
2. Rinse and fill the burette with the given $KMnO_4$ solution.
3. Add one test-tube (~ 20 ml) full of dilute sulphuric acid (~ 2 M) to the solution in titration flask.
4. Note the initial reading of the burette.
5. Now add $KMnO_4$ solution from the burette till a permanent light pink colour is imparted to the solution in the titration flask on addition of last single drop of $KMnO_4$ solution.
6. Note the final reading of the burette.
7. Repeat the above steps 4-5 times to get a set of three concordant readings.

Observations

Weight of watch glass =……. g
Weight of watch glass + Mohr's salt =……..g
Weight of Mohr's salt = 4.250 g
Volume of Mohr's salt solution prepared = 250 ml
Volume of Mohr's salt solution taken for each titration = 20.0 ml

S. No.	*Initial reading of the burette*	*Final reading of the burette*	*Volume of the $KMnO_4$ solution used*
1.	—	—	— ml
2.	—	—	— ml
3.	—	—	— ml
4.	—	—	— ml

Concordant volume = x ml (say).

Calculations

Concentration of Mohr's salt, ferrous ammonium sulphate, $FeSO_4.(NH_4)_2\ SO_4.6H_20$ in the prepared solution = 17.0 g/litre.

Molecular mass of Mohr's salt, $FeSO_4.(NH_4)_2SO_4.6H_2O = 392$

Molarity of Mohr's salt solution $= \frac{\text{Strength (g/litre)}}{\text{Mol. mass}} = \frac{17.0}{392}$

Calculation of molarity of $KMnO_4$ solution

From the overall balanced chemical equation, it is clear that 2 moles of $KMnO_4$ react with 10 moles of Mohr's salt.

$$\therefore \quad \frac{M_{KMnO_4} \times V_{KMnO_4}}{M_{\text{Mohr's salt}} \times V_{\text{Mohr's salt}}} = \frac{2}{10}$$

where, M_{KMnO_4} = Molarity of $KMnO_4$ solution

V_{KMnO_4} = Volume of $KMnO_4$ solution

$M_{\text{Mohr's salt}}$ = Molarity of Mohr's salt solution

$V_{\text{Mohr's salt}}$ = Volume of Mohr's salt solution

$$\frac{M_{KMnO_4} \times x}{17/392 \times 20} = \frac{2}{10}$$

From this equation, molarity of $KMnO_4$ solution can be calculated.

Calculation of strength of $KMnO_4$ solution

Strength (in g/litre) = Molarity × Molar mass

$= M_{KMnO_4} \times 158.$

Instructions for the Preparation of Solutions:

Provide the following:

1. Mohr's salt
2. M/100 $KMnO_4$ solution (1.58 g/litre)
3. 4N H_2SO_4.