You Are Provided With a Partially Oxidised Sample Of Ferrous Sulphate ($FeSO_4.7H_20$) Crystals. Prepare a Solution By Dissolving 14.0 g Of these Crystals Per litre & Determine the Percentage Oxidation Of the given Sample. Given M/100 $KMnO_4$ Solution

Chemical Equations

Molecular Equation

$$2KMnO_4 + 3H_2SO_4 \longrightarrow K_2SO_4 + 2MnSO_4 + 3H_2O + 5[O]$$
$$2FeSO_4 + H_2SO_4 + [O] \longrightarrow Fe_2(SO_4)_3 + H_2O\ ] \times 5$$

$$2KMnO_4 + 10FeSO_4 + 8H_2SO_4 \longrightarrow K_2SO_4 + 2MnSO_4 + 8H_2O + Fe_2(SO_4)_3$$

Ionic equation

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

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

Theory

Since the given sample contains partially oxidized ferrous sulphate, it contains both ferrous ions, Fe^{2+}(unoxidised) and ferric ions Fe^{3+} (oxidised). The strength of partially oxidised sample is known. The solution of partially oxidised $FeSO_4$ of known strength is titrated against standard $KMnO_4$ solution to determine the molarity and strength of the unoxidised ferrous sulphate. From this the percentage oxidation of the sample can be calculated.

Indicator

$KMnO_4$ is a self-indicator.

End Point

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

Procedure

1. Weigh exactly 3.50 g of the given sample of ferrous sulphate on a watch glass and dissolve in water to prepare exactly 250 ml of solution using a 250 ml measuring flask. Rinse and fill the pipette with prepared ferrous sulphate solution and pipette out 20.0 ml of it in a washed titration flask.
2. Rinse and fill the burette with the M/100 $KMnO_4$ 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 a 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 three concordant reading.

Observations

Weight of watch glass =……. g
Weight of watch glass + Mohr's salt =…….g
Weight of mixture = 3.50 g
Volume of solution prepared = 250 ml
Molarity of $KMnO_4$ solution =M/100
Volume of oxalate 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

Molarity of the standard $KMnO_4$ solution = M/100

Volume of $\frac{M}{100}$ $KMnO_4$ solution required for the oxidation of 20.0 ml of the given ferrous sulphate solution = x ml.

From the chemical equations, it is clear that 2 moles of $KMnO_4$ react with 10 moles of ferrous sulphate.

$$\therefore \quad \frac{M_{KMnO_4} \times V_{KMnO_4}}{M_{FeSO_4} \times V_{FeSO_4}} = \frac{2}{10}$$

$$\frac{\frac{1}{100} \times x}{M_{FeSO_4} \times 20.0} = \frac{2}{10}$$

$$M_{FeSO_4} = \frac{1 \times x \times 10}{100 \times 20.0 \times 2} = \frac{x}{400}$$

$\therefore$ Molarity of unoxidized ferrous sulphate = $\frac{x}{400}$

Strength of unoxidized ferrous sulphate

= Molarity × Molecular mass of $FeSO_4 .7H_2O$

$= \frac{x}{400} \times 278 = y$ g/litre

Total strength of partially oxidised sample = 14 g/litre

$\therefore$ Strength of oxidised ferrous sulphate = $(14 - y)$ g/litre

% Oxidation = $\frac{14 - y}{14} \times 100.$

Instructions for the Preparation of Solutions

Provide the following :

1. $KMnO_4$ solution (1.58 g/litre)
2. $FeSO_4.7H_2O$
3. 4N H_2SO_4.