Experiment-4: Redox Titrations. Potassium Permanganate.

Introduction

Redox titration, also known as an oxidation-reduction reaction, is a method used to determine the concentration of an unknown solution from the equivalence point. In this type of titration, the chemical reaction involves the transfer of electrons between the reacting ions in aqueous solutions. Redox titrations are named based on the reagent used, including :

- Permanganate Titrations.
- Dichromate Titrations.
- Iodometric Titrations.

Permanganate Titrations

- In this titration, potassium permanganate acts as an oxidizing agent.
- Permanganate titrations must be performed in a strongly acidic solution, typically using sulfuric acid.
- A solution with $\mathbf{MnO_4^-}$ ions is purple, while a solution containing $\mathbf{Mn^{2+}}$ ions is colorless. Thus, when permanganate is added to a solution with a reducing agent, its color changes.
- Commercial potassium permanganate is considered impure due to contamination with $\mathbf{MnO_2}$, making $\mathbf{KMnO_4}$ solution unsuitable as primary standards. Therefore, calibration is essential to accurately determine its concentration before use. This can be achieved using one of the following substances : oxalic acid ($\mathbf{H_2C_2O_4}$), sodium oxalate ($\mathbf{Na_2C_2O_4}$), or potassium hexacyanoferrate ($\mathbf{K_4[Fe(CN)_6]}$).

Objective of the experiment

Step one: Determine the concentration of the potassium permanganate ($\mathbf{KMnO_4}$) solution through the process of titration with the oxalic acid ($H_2C_2O_4$) solution.

Step two: Use the calibrated potassium permanganate ($KMnO_4$) solution to determine the concentration of iron sulphate ($FeSO_4$) solution.

Materials

- Burette with stand and clamp.
- Graduated cylinder
- Erlenmeyer flask

Chemicals

- Potassium permanganate ($KMnO_4$) solution of unknown concentration
- Iron sulfate ($FeSO_4$) solution of unknown concentration
- 0.1 M oxalic acid ($H_2C_2O_4$) solution
- 0.1 M sulfuric acid (H_2SO_4) solution
- Distilled water

Procedure

Step 1 : A titration will be performed using an oxalic acid (**$H_2C_2O_4$**) solution to determine the concentration of the unknown (**$KMnO_4$**) solution.

1. Always rinse the materials with distilled water before using.
2. Fill the burette with a $KMnO_4$ solution of unknown concentration and set it to zero.
3. Using a graduated cylinder, take 10 ml of a 0.1 M solution of oxalic acid ($H_2C_2O_4$)
4. Put it into a 250 Erlenmeyer flask.
5. Add 20 ml of a 0.1 M solution of sulfuric acid (H_2SO_4).
6. Incorporate 10 ml of heated distilled water (60 – 90°C).
7. Transfer 0.5 ml of the liquid from the burette into the Erlenmeyer flask.
8. Apply heat to the mixture until the violet color dissipates, indicating the presence of Mn^{2+} ions, no further heating is required beyond this point.
9. Proceed with the titration by adding one drop at a time while shaking until neutralization is reached, indicated by the appearance of a brown color.
10. Note the measured volume V_{KMnO4} that was added.
11. Repeat the experience twice.

Step 2: We will use the **$KMnO_4$** solution, for which the concentration was determined in first part, to titrate an unknown **$FeSO_4$** solution.

1. Refill the burette with a solution of $KMnO_4$ and adjust it to a zero.
2. Using a graduated cylinder, take 10 ml of a 0.1 M solution of $FeSO_4$.
3. Put it into a 250 Erlenmeyer flask.
4. Add 20 ml of a 0.1 M solution of H_2SO_4.
5. Incorporate 10 ml of distilled water.
6. Proceed with the titration by adding one drop at a time while shaking until neutralization is reached, indicated by the appearance of red color.
7. Note the measured volume V_{KMnO4} that was added.
8. Repeat the experience twice.