Experiment 5: Permanganate Titrations

Introduction

The redox titration is also known as an oxidation-reduction reaction. This method is used to determine the concentration of unknown solution from the **equivalence point**. In this type of titration, the chemical reaction takes place with a transfer of electrons in the reacting ions of aqueous solutions. The titrations are named after the reagent that is used in are as follows;

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

Permanganate Titrations

- In this titration, the potassium permanganate is used as an oxidizing agent.
- Titrations with Permanganate must be carried out in strong acid solution. Sulfuric acid is generally used for this purpose because Nitric acid and Hydrochloric acid can participate in competing oxidation-reduction reactions, reducing the accuracy of the titration.
- The solution containing MnO_4^- ions is purple in colour, while the solution containing Mn^{2+} ions is colourless and hence permanganate solution is decolourised when added to a solution of a reducing agent. When $KMnO_4$ react with a reducing agent it works as self indicator .
- This titration cannot be carried out in the presence of acids like nitric acid or hydrochloric acid because itself is an oxidising agent. So hydrochloric acid chemically reacts with $KMnO_4$ solution forming chlorine which is also an oxidising agent.
- Commercial $KMnO_4$ is deemed impure due to contamination with MnO_2, rendering potassium permanganate solutions unsuitable as standard materials. Hence, it is imperative to calibrate them in order to precisely ascertain their concentration prior to utilization. This can be achieved by utilizing one of the subsequent substances : oxalic acid ($H_2C_2O_4$), sodium oxalate ($Na_2C_2O_4$), or potassium cyanide ($K_4[Fe(CN)_6]$).The solution of potassium permanganate is always standardized before it is used.

Objective of the experiment

Step one: Establish the concentration of the potassium permanganate ($KMnO_4$) solution through the process of titration using the oxalic acid ($H_2C_2O_4$) solution.
Step two: Utilizing a pre-calibrated solution of potassium permanganate ($KMnO_4$) to establish the concentration of iron sulphate ($FeSO_4$) solution.

Materials and Chemicals

Materials	Chemicals
• Burette with burette stand and clamp. • Graduated cylinder • Cronical flask • Funnel	• $KMnO_4$ solution with unknown concentration • $FeSO_4$ solution with unknown concentration • 0.1 mol/L $H_2C_2O_4$ solution • 0.1 mol/L H_2SO_4 solution • Distilled water

Procedure of the experiment

Step 1 : Titration of $KMnO_4$ solution against standard $H_2C_2O_4$ 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 conical 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 volumetric 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 use the solution of $KMnO_4$ to determine the concentration of $FeSO_4$ 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 conical 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.

Answer the questions

1. What is the definition of redox titration?
2. What is the definition of endpoint?
1. Why we add sulfuric acid?
2. Why we did not use a color indicator?