Experiment Name: Standardization of Potassium Permanganate solution with Standard Sodium Oxalate Solution.

Theory: In this experiment, potassium permanganate solution is standardizing with the help of standard sodium oxalate solution. The reaction that occurs here is oxidation and reduction reaction. An oxidation-reduction reaction (redox) is a reaction in which electrons are transferred between species or in which atoms change oxidation numbers. Oxidation is the half reaction in which there is loss of electrons by a species (or increase of oxidation number of an atom). Reduction is the half reaction in which there is a gain of electrons by a species (or decrease of oxidation number of an atom).
Reaction involved in this reaction is:

MW of $Na_2C_2O_4$ = 134

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

$$2KMnO_4 + 5Na_2C_2O_4 + 8H_2SO_4 \rightarrow K_2SO_4 + 2MnSO_4 + 5Na_2SO_4 + 10CO_2 + 8H_2O$$

In this reaction, MnO^{4-} is reduced to Mn^{+2} and $Na_2C_2O_4$ is oxidized to CO_2.

The following equation is used to calculate the strength to Potassium Permanganate:

$$V_A \times S_A \times e_A = V_B \times S_B \times e_B$$

here,

V_A = Volume of Potassium Permanganate ($KMnO_4$)

S_A = Strength of Potassium Permanganate ($KMnO_4$)

e_A = equivalent of Potassium Permanganate ($KMnO_4$)

V_B = Volume of Sodium Oxalate ($Na_2C_2O_4$)

S_B = Strength of Sodium Oxalate ($Na_2C_2O_4$)

e_B = equivalent of Sodium Oxalate ($Na_2C_2O_4$)

The direction reaction is slow as one can see in a titration. The first few drops of permanganate added to the acidified oxalate solution

are not decolorized immediately.

Mn^{+2} ions produced in the reaction acts as a catalyst.

They react with permanganate to form intermediate oxidation states of manganese. These states, in turn, react rapidly with oxalate to give the products. So, $KMnO_4$ acts as an auto catalyst in this reaction. This is the advantage of $KMnO_4$ is that it serves as its own indicator, the pink color being distinguishable even if the solution is very dilute. Therefore, no indicator is used in this reaction.

Apparatus:

Potassium Permanganate Solution ($KMnO_4$), Standard Sodium Oxalate Solution ($Na_2C_2O_4$), Sulfuric Acid (H_2SO_4), Volumetric Flask, Burette, Pipette, Conical Flask, Beakers, Distilled Water, Bunsen Burner.

Data table:

Number of Observation	Volume of $Na_2C_2O_4$ (ml)	Burette Reading (ml)			Average (ml)	Strength of $KMnO_4$
		initial Reading	final Reading	Difference		
1	10	0	10	10	10	0.02M
2	10	10	19	9		
3	10	19	30	11		

Calculation:

Preparation of 0.05M Sodium Oxalate Solution ($Na_2C_2O_4$)

$$V_A \times S_A \times e_A = V_B \times S_B \times e_B$$

here,

Volume of acid, $V_A = 10$ ml

strength of acid, $S_A = 0.05M$

equivalent number of acid, $e_A = 2$

Volume of base, $V_B = 10$ ml

Strength of base ($KMnO_4$), $S_B = ?$

equivalent number of $KMnO_4$, $e_B = 5$

Now,

$$10 \times 0.05 \times 2 = 10 \times S_B \times 5$$

$$\therefore S_B = 0.02\ M$$

Result:

The Determined Strength of Potassium Permanganate ($KMnO_4$) solution is: S_{KMnO_4} =

Error:

Given strength of $KMnO_4$ =

$$\text{Percentage of error} = \frac{(\text{known value} - \text{observe value})}{\text{known value}} \times 100\%$$

Discussion:

1. All the apparatus were handled carefully and according to the rules.
2. The reaction between $KMnO_4$ and $Na_2C_2O_4$ involves $KMnO_4$ being reduced and $Na_2C_2O_4$ being oxidized.
3. Mn^{2+} ions speed up the reaction, improving titration accuracy.
4. Heating the solution to 60-70°C speeds up the reaction.
5. Glassware was cleaned and rinsed, and the conical flask was placed on white paper to see the color change clearly.