

EXPERIMENT No-1

Standardize the Given Solution Of NaOH By Volumetric Method.

Principle:

It is an acid-base titration HCl is a strong acid and can be titrated with a base.

Standard Solution: 0.1 M HCl

Indicator: Phenolphthalein

End Point: Just Colourless

Equation: $\text{HCl} + \text{NaOH} \longrightarrow \text{NaCl} + \text{H}_2\text{O}$

Mole Ratio: 1 : 1

Procedure:

Take the given HCl solution in burette with the help of funnel and note the initial reading. Pipette out 10.0cm^3 of NaOH in conical flask. Add 1-2 drops of phenolphthalein as an indicator. The solution becomes pink. Titrate this solution against HCl solution taken in burette. The end point is just colourless. Note the final reading. Take at least three concordant readings to calculate the exact volume of acid used.

Observations and Calculations:

- Vol. of NaOH taken in conical flask for each titration = 10.0cm^3 .
- Vol. of HCl used from burette for each titration.

No. of Obs.	Initial Reading	Final Reading	Vol. of HCl used
1.	0.0	10.0	10.0cm^3
2.	10.0	20.0	10.0cm^3
3.	20.0	30.0	10.0cm^3

Concordant Reading = 10.0cm^3

$$\begin{array}{ccc} \text{NaOH} & & \text{HCl} \\ \frac{M_1 V_1}{n_1} & = & \frac{M_2 V_2}{n_2} \\ \frac{M_1 \times 10.0}{1} & = & \frac{0.1 \times 10.0}{1} \end{array}$$

$$M_1 = \frac{0.1 \times 10.0}{10.0} = 0.1 \text{ M NaOH}$$

Result:

Given solution of NaOH is 0.1 mol/dm^3

Exercise:

Standardize the given solution of H_2SO_4 by volumetric method.

Experiment No-2

Standardize The Given Solution Of HCl By Volumetric Method.
Calculate The Volume Of This Solution Required To Make 500cm³ Of 0.01 M HCl.

Principle:

It is an acid-base titration. HCl is a strong acid and can be titrated with a strong base NaOH.

Standard Solution: 0.1 M NaOH

Indicator: Phenolphthalein

End Point: Just Colourless

Equation: $\text{HCl} + \text{NaOH} \longrightarrow \text{NaCl} + \text{H}_2\text{O}$

Mole Ratio: 1 : 1

Procedure:

Take the given HCl solution in burette with the help of funnel and note the initial reading. Pipette out 10.0cm³ of NaOH in conical flask. Add 1-2 drops of phenolphthalein as an indicator. The solution becomes pink. Titrate this solution against HCl solution taken in burette. The end point is just colourless. Note the final reading. Take at least three concordant readings to calculate the exact volume of acid used.

Observations and Calculations:

- (i) Vol. of NaOH taken in conical flask for each titration = 10.0cm³.
- (ii) Vol. of HCl used from burette for each titration.

No. of Obs.	Initial Reading	Final Reading	Vol. of HCl used
1.	0.0	10.0	10.0cm ³
2.	10.0	20.0	10.0cm ³
3.	20.0	30.0	10.0cm ³

Concordant Reading = 10.0 cm³

$$\begin{array}{rcl}
 \text{HCl} & & \text{NaOH} \\
 \frac{M_1 V_1}{n_1} & = & \frac{M_2 V_2}{n_2} \\
 \frac{M \times 10}{1} & = & \frac{0.1 \times 10}{1} \\
 M_1 & = & \frac{0.1 \times 10}{10} = 0.1 \text{ mol/dm}^3 \text{ HCl}
 \end{array}$$

Calculation for volume to make 500 cm³ of 0.01 M HCl:
(Dilution method)

Known concentration = conc. to be prepared

$$\begin{array}{rcl}
 M_1 V_1 & = & M_2 V_2 \\
 0.1 \times V_1 & = & 0.01 \times 500 \\
 V_1 & = & \frac{0.01 \times 500}{0.1} \\
 V_1 & = & 50 \text{ cm}^3 \text{ of HCl}
 \end{array}$$

Result:

The given HCl solution is 0.1M and 50cm³ of this solution is mixed with 450cm³ of water to make 500cm³ of 0.01 M HCl solution.

Exercise:

- Standardize the given solution of HCl by volumetric method. calculate the volume of this solution required to make 250cm³ of 0.05 M HCl.
- Standardize the given solution of H₂SO₄ by volumetric method. calculate the volume of this solution required to make 100cm³ of 0.05 M H₂SO₄.

MIXTURE ANALYSIS

Experiment No-3

The Given Solution Contains 5 Grams Of A Mixture Of NaOH And Na_2SO_4 Dissolved Per 500cm^3 . Determine Volumetrically Percentage Of Each In The Mixture.

Principle:

It is an acid-base titration. In the mixture NaOH is reactive against standard solution of HCl.

Standard Solution: 0.05 M HCl

Indicator: Phenolphthalein

End Point: Just Colourless

Equation: $\text{HCl} + \text{NaOH} \longrightarrow \text{NaCl} + \text{H}_2\text{O}$

Mole Ratio: 1 : 1



Procedure:

Take the given HCl solution in burette with the help of funnel and note the initial reading. Pipette out 10.0cm^3 of NaOH and Na_2SO_4 mixture in conical flask. Add 1-2 drops of phenolphthalein as an indicator. The solution becomes pink. Titrate this solution against HCl. The end point is just colourless. Note the final reading. Take at least three concordant readings to calculate the exact volume of acid used.

Observations and Calculations:

- Vol. of mixture taken in conical flask for each titration = 10.0cm^3 .
- Vol. of HCl used from burette for each titration.

No. of Obs.	Initial Reading	Final Reading	Vol. of HCl used
1.	0.0	10.0	10.0cm^3
2.	10.0	20.0	10.0cm^3
3.	20.0	30.0	10.0cm^3

Concordant Reading = 10.0cm^3

$$\frac{M_1 V_1}{n_1} = \frac{M_2 V_2}{n_2}$$

$$\frac{M_1 \times 10.0}{1} = \frac{0.05 \times 10}{1}$$

$$M_1 = 0.05 \text{ mol/dm}^3 \text{ of NaOH}$$

$$\begin{aligned} \text{Amount in g/dm}^3 &= \text{molarity} \times \text{mol. mass of NaOH} \\ &= 0.05 \times 40 \\ &= 2 \text{ g/dm}^3 \end{aligned}$$

$$500\text{cm}^3 \text{ solution contain mixture} = 5\text{g}$$

$$1000\text{cm}^3 \text{ solution contain mixture} = \frac{5}{500} \times 1000$$

$$= 10 \text{ g/dm}^3$$

$$\% \text{age of NaOH} = \frac{2}{10} \times 100 = 20\%$$

$$\% \text{age of Na}_2\text{SO}_4 = 100 - 20 = 80\%$$

Result:

The given mixture contains 20% NaOH and 80% Na_2SO_4 .



EXPERIMENT No-4

The Given Solution Contains 2.5g Of A Mixture Of Oxalic acid and Sodium Oxalate Per 250cm³. Find Out % age Composition Of Mixture.

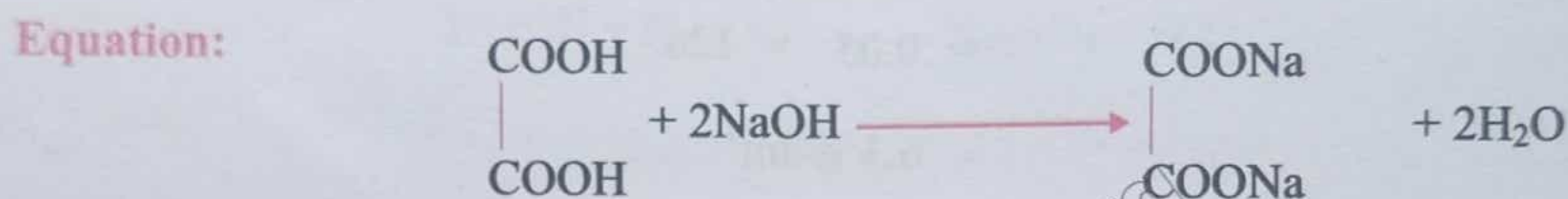
Principle:

It is an acid-base titration. In the mixture, oxalic acid will react with a standard base.

Standard Solution: 0.1 M NaOH

Indicator: Phenolphthalein

End Point: Just Colourless



Mole Ratio: 1 : 2

Procedure:

Take the given mixture of solution in burette with the help of funnel and note the initial reading. Pipette out 10.0cm³ of NaOH in conical flask. Add 1-2 drops of phenolphthalein as an indicator. The solution becomes pink. Titrate this solution against acidic mixture taken in burette. The end point is just colourless. Note the final reading. Take at least three concordant readings to calculate the exact volume of acid used.

Observations and Calculations:

- (i) Vol. of NaOH used for each titration = 10.0cm³.
 (ii) Vol. of acid used for each titration.

No. of Obs.	Initial Reading	Final Reading	Vol. of Oxalic acid used
1.	0.0	10.0	10.0cm ³
2.	10.0	20.0	10.0cm ³
3.	20.0	30.0	10.0cm ³

Concordant Reading = 10.0 cm³

$$\begin{array}{ccc} \text{Oxalic acid} & & \text{NaOH} \\ \frac{M_1 V_1}{n_1} & = & \frac{M_2 V_2}{n_2} \\ \frac{M_1 \times 10.0}{1} & = & \frac{0.1 \times 10}{2} \end{array}$$

$$M_1 = 0.05 \text{ M oxalic acid}$$

$$250\text{cm}^3 \text{ solution contain mixture} = 2.5\text{g}$$

$$\begin{aligned} 1000\text{cm}^3 \text{ solution contain mixture} &= \frac{2.5}{250} \times 1000 \\ &= 10.0 \text{ g} \end{aligned}$$

$$\begin{aligned} \text{Amount per dm}^3 \text{ of oxalic acid} &= \text{molarity} \times \text{mol. mass} \\ &= 0.05 \times 126 \\ &= 6.3 \text{ g/dm}^3 \end{aligned}$$

$$10.0 \text{ g mixture contain oxalic acid} = 6.3 \text{ g}$$

$$100 \text{ g mixture contain oxalic acid} = \frac{6.3}{10} \times 100 = 63\text{g}$$

$$\% \text{ age of } \text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O} = 63\%$$

$$\% \text{ age of } \text{Na}_2\text{C}_2\text{O}_4 = 100 - 63 = 37\%$$

Result:

The given mixture contains 63% oxalic acid and 37% sodium oxalate.

Exercise:

- (i) The given solution contains 8g mixture of KOH and K_2SO_4 dissolved /dm³. Calculate the % age of KOH volumetrically.
- (ii) The given solution contains 2.5g mixture of HCl and NaCl dissolved/250cm³. Calculate % age composition of each volumetrically.

Experiment No-5

The Given Solution Contains 10g Mixture Of H_2SO_4 and Na_2SO_4 dissolved Per dm^3 .
Determine % age composition of the Mixture.

Principle:

It is an acid-base titration. In the mixture H_2SO_4 is reactive against standard NaOH Solution.

Standard Solution: 0.1 M NaOH

Indicator: Phenolphthalein

End Point: Just colourless

Equation: $2\text{NaOH} + \text{H}_2\text{SO}_4 \longrightarrow \text{Na}_2\text{SO}_4 + \text{H}_2\text{O}$

Mole Ratio: 2 : 1

Procedure:

Take the given mixture of acid solution in burette with the help of funnel and note the initial reading. Pipette out 10.0cm^3 of NaOH in conical flask. Add 1-2 drops of phenolphthalein as an indicator. The solution becomes pink. Titrate this solution against mixture taken in burette. The end point is just colourless. Note the final reading. Take at least three concordant readings to calculate the exact volume of H_2SO_4 used.

Observations and Calculations:

- (i) Vol. of NaOH taken for each titration = 10.0cm^3 .
- (ii) Vol. of H_2SO_4 used for each titration.

No. of Obs.	Initial Reading	Final Reading	Vol. of H_2SO_4 used
1.	0.0	10.0	10.0cm^3
2.	10.0	20.0	10.0cm^3
3.	20.0	30.0	10.0cm^3

Concordant Reading = 10.0cm^3

$$\begin{aligned}
 \frac{H_2SO_4}{\frac{M_1 V_1}{n_1}} &= \frac{NaOH}{\frac{M_2 V_2}{n_2}} \\
 \frac{M_1 \times 10.0}{1} &= \frac{0.1 \times 10.0}{2} \\
 M_1 &= \frac{0.1 \times 10.0}{2} \times \frac{1}{10.0} = 0.05 \text{ M of } H_2SO_4
 \end{aligned}$$

$$\begin{aligned}
 \text{Amount in g/dm}^3 \text{ of } H_2SO_4 &= \text{Molarity} \times \text{mol. mass} \\
 &= 0.05 \times 98 \\
 &= 4.9 \text{ g/dm}^3
 \end{aligned}$$

$$\begin{aligned}
 \% \text{ age of } H_2SO_4 &= \frac{4.9}{10} \times 100 = 49\%
 \end{aligned}$$

$$\begin{aligned}
 \% \text{ age of } Na_2SO_4 &= 100 - 49 = 51\%
 \end{aligned}$$

Result:

The given mixture contains 49% H_2SO_4 and 51% of Na_2SO_4 .



DETERMINATION OF MOLECULAR AND ATOMIC MASSES

Experiment No-6



The Given Solution Contain 4.0g of a Metal Hydroxide MOH Dissolved Per dm^3 . determine The Atomic Mass of the Metal 'M'.

Principle:

It is an acid-base titration. MOH is strong base and can be titrated with a strong acid.

Standard Solution: 0.05 M H_2SO_4

Indicator: Phenolphthalein

End Point: Just colourless

Equation: $2\text{MOH} + \text{H}_2\text{SO}_4 \longrightarrow \text{M}_2\text{SO}_4 + 2\text{H}_2\text{O}$

Mole Ratio: 2 : 1

Procedure:

Take the given H_2SO_4 solution in burette with the help of funnel and note the initial reading. Pipette out 10.0cm^3 of MOH solution in conical flask. Add 1-2 drops of phenolphthalein as an indicator. The solution becomes pink. Titrate this solution against standard solution taken in burette. The end point is just colourless. Note the final reading. Take at least three concordant readings to calculate the exact volume of acid used.

Observations and Calculations:

- (i) Vol. of MOH taken for each titration = 10.0cm^3
- (ii) Vol. of H_2SO_4 used from burette for each titration.

No. of Obs.	Initial Reading	Final Reading	Vol. of H_2SO_4 used
1.	0.0	10.0	10.0cm^3
2.	10.0	20.0	10.0cm^3
3.	20.0	30.0	10.0cm^3

Concordant Reading = 10.0cm^3



$$\frac{M_1 \times 10.0}{2} = \frac{0.05 \times 10.0}{1}$$

$$M_1 = \frac{0.05 \times 10.0}{1} \times \frac{2}{10.0} = 0.1 \text{ M}$$

$$= 0.1 \text{ mol/dm}^3 \text{ MOH}$$

$$\text{Amount in g/dm}^3 \text{ of MOH} = \text{molarity} \times \text{mol. mass of MOH}$$

$$4.0 = 0.1 \times \text{mol. mass of MOH}$$

$$\text{Mol. mass of MOH} = \frac{4.0}{0.1} = 40.0 \text{ g}$$

$$\text{At mass of M} = \text{mol mass of MOH} - \text{Formula mass of OH}^-$$

$$= 40.0 - 17$$

$$= 23 \text{ g/mol.}$$

Result:

The atomic mass of metal 'M' is 23 so the metal is sodium Na (Natrium).



Experiment No-7

The given solution contains 5.6g of an alkali metal hydroxide MOH per dm^3 . Find out atomic mass of the metal and also the name of the metal.

Principle:

It is an acid-base titration. The alkali metal hydroxide can be titrated against an acid.

Standard Solution: 0.1 M HCl

Indicator: Phenolphthalein

End Point: Just colourless

Equation: $\text{MOH} + \text{HCl} \longrightarrow \text{MCl} + \text{H}_2\text{O}$

Mole Ratio: 1 : 1

Procedure:

Take the given HCl solution in burette with the help of funnel and note the initial reading. Pipette out 10.0cm^3 of MOH solution in conical flask. Add 1-2 drops of indicator. The solution becomes pink. Titrate this solution against standard solution taken in burette. The end point is just colourless. Note the final reading. Take at least three concordant readings to calculate the accurate volume of acid used.

Observations and Calculations:

- (i) Vol. of MOH taken for each titration = 10.0cm^3 .
 (ii) Vol. of acid used for each titration.

No. of Obs.	Initial Reading	Final Reading	Vol. of HCl used
1.	0.0	10.0	10.0cm^3
2.	10.0	20.0	10.0cm^3
3.	20.0	30.0	10.0cm^3

Concordant Reading = 10.0 cm^3

$$\frac{\text{MOH}}{\frac{M_1 V_1}{n_1}} = \frac{\text{HCl}}{\frac{M_2 V_2}{n_2}}$$

$$\frac{M_1 \times 10.0}{1} = \frac{0.1 \times 10.0}{1}$$

$$M_1 = 0.1 \text{ mol/dm}^3 \text{ of MOH}$$

$$\begin{aligned} \text{Amount of MOH in g/dm}^3 &= \text{Molarity} \times \text{mol. mass of MOH} \\ 5.6 &= 0.1 \times \text{mol. mass of MOH} \end{aligned}$$

$$(i) \text{ Mol. mass of MOH} = \frac{5.6}{0.1} = 56\text{g}$$

$$\begin{aligned} (ii) \text{ At mass of M} &= \text{mol mass of MOH} - \text{Formula mass of OH}^- \\ &= 56 - 17 \\ &= 39 \text{ g/mol.} \end{aligned}$$

Result:

The molecular mass of MOH is 56 and the atomic mass of metal 'M' is 39. So the given metal hydroxide is KOH. The metal is kalium K (Potassium).

Exercise:

The given solution contains 0.4g of MOH dissolved per 100cm³. Determine the equivalent weight of MOH.



EXPERIMENT No-8

The given solution contains 10 g dm^{-3} of caustic soda (NaOH). Find the % purity of the sample.

Solution:

Standard reagent	= 0.1 M HCl
Indicator	= Phenolphthalein
Principle of titration	= Acid – Base neutralization
Equation	= $\text{NaOH} + \text{HCl} \longrightarrow \text{NaCl} + \text{H}_2\text{O}$
End point	= Just colourless
Mole ratio	= 1 : 1

Procedure:

Take HCl in the burette and 10 cm^3 of caustic soda solution in the titration flask with the help of pipette. Add one or two drops of phenolphthalein as an indicator. The solution turned pink. Now titrate it against HCl from the burette drop wise till colourless end point is obtained. Take three concordant readings.

Observations and Calculations:

No.	Initial Reading	Final Reading	Volume of HCl Used
1	0.0	10.0	10.0 cm^3
2	10.0	20.0	10.0 cm^3
3	20.0	30.0	10.0 cm^3

C.R = 10.0 cm^3

NaOH

HCl

$$\frac{M_1 V_1}{n_1} = \frac{M_2 V_2}{n_2}$$

$$\frac{M_1 \times 10}{1} = \frac{0.1 \times 10}{1}$$

$$M_1 = 0.1$$

$$\begin{aligned} \text{Amount / dm}^3 \text{ of NaOH} &= \text{Molarity} \times \text{Molar mass} \\ &= 0.1 \times 40 \\ &= 4.0 \text{ g dm}^{-3} \end{aligned}$$

10 grams of the solution gives pure NaOH = 4 g

1 gram of the solution gives pure NaOH = $\frac{4}{10}$

100 grams of the solution gives pure NaOH = $\frac{4}{10} \times 100 = 40\%$

∴

% purity = 40%

% impurity = $100 - 40 = 60\%$

Result:

% purity = 40%

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EXPERIMENT No-9

6.3g Of Organic Dibasic Acid Have Been dissolved Per dm^3 .
Calculate Relative Molecular Mass Of Organic Dibasic Acid.

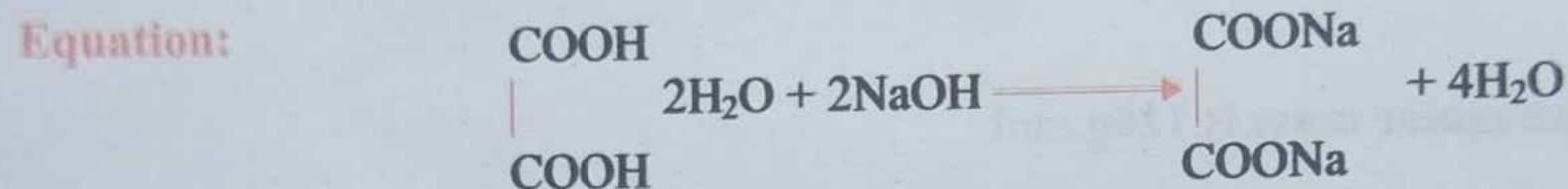
Principle:

It is an acid-base titration. Oxalic acid is a weak organic dibasic acid as it furnishes two protons its aqueous solution.

Standard Solution: 0.1 M NaOH

Indicator: Phenolphthalein

End Point: Just colourless



Mole Ratio: 1 : 2

Procedure:

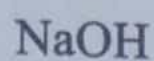
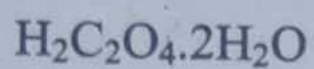
Take the given acid in burette and note the initial reading. Pipette out 10.0cm^3 of NaOH in conical flask. Add 1-2 drops of indicator in it. Solution becomes pink. Titrate this solution against acid taken in burette. The end point is just colourless. Take at least three concordant readings to calculate the accurate volume of acid used.

Observations and Calculations:

- (i) Vol. of NaOH used for each titration = 10.0cm^3 .
- (ii) Vol. of oxalic acid used for each titration.

No. of Obs.	Initial Reading	Final Reading	Vol. of Oxalic acid used
1.	0.0	10.0	10.0cm^3
2.	10.0	20.0	10.0cm^3
3.	20.0	30.0	10.0cm^3

Concordant Reading = 10.0cm^3



$$\frac{M_1 V_1}{n_1}$$

$$= \frac{M_2 V_2}{n_2}$$

$$\frac{M_1 \times 10.0}{1}$$

$$= \frac{0.1 \times 10.0}{2}$$

$$M_1 = \frac{0.1 \times 10.0}{2} \times \frac{1}{10.0}$$

$$M_1 = 0.05 \text{ M of } \text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$$

$$\text{Amount in g/dm}^3 \text{ of } \text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O} = \text{molarity} \times \text{relative mol. mass}$$

$$6.3 = 0.05 \times \text{relative mol. mass}$$

$$\text{Relative molar mass} = \frac{6.3}{0.05} = 126 \text{ g.mol}^{-1}$$

Result:

The relative molar mass is 126 g.mol^{-1}



DETERMINATION OF WATER OF CRYSTALLIZATION

Experiment No-10

The Given Solution Contains 6.3g Of $\begin{array}{c} \text{COOH} \\ | \\ \text{COOH} \end{array} \cdot x\text{H}_2\text{O}$ dissolved Per dm^3 . Find Out The Value Of 'x'.

Principle:

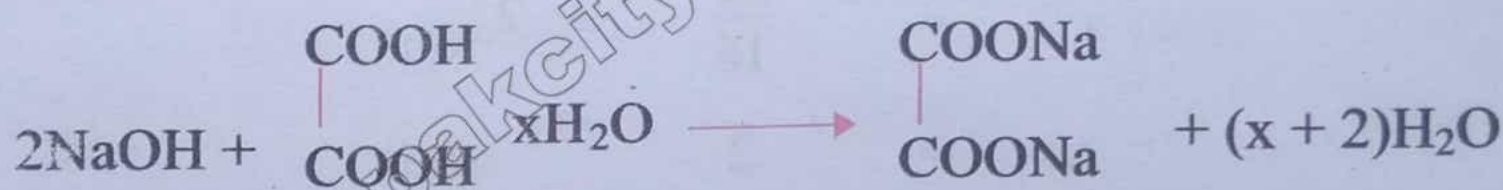
It is an acid-base titration. Oxalic acid is a weak organic dibasic acid. It can be titrated with a strong base such as NaOH.

Standard Solution: 0.1 M NaOH

Indicator: Phenolphthalein

End Point: Just colourless

Equation:



Mole Ratio:

2 : 1

Procedure:

Take the given oxalic acid solution in burette with the help of funnel and note the initial reading. Pipette out 10.0cm^3 of NaOH in conical flask. Add 1-2 drops of phenolphthalein as an indicator. The Solution becomes pink. Titrate this solution against acid solution taken in burette. The end point is just colourless. Note the final reading. Take at least three concordant readings to get the exact volume used.

Observations and Calculations:

- (i) Vol. of NaOH taken for each titration = 10.0cm^3 .
- (ii) Vol. of $\text{H}_2\text{C}_2\text{O}_4 \cdot x\text{H}_2\text{O}$ used for each titration.

No. of Obs.	Initial Reading	Final Reading	Vol. of Oxalic acid used
1.	0.0	10.0	10.0cm^3
2.	10.0	20.0	10.0cm^3
3.	20.0	30.0	10.0cm^3

Concordant Reading = 10.0cm^3

Oxalic acid

NaOH

$$\frac{M_1 V_1}{n_1} =$$

$$\frac{M_2 V_2}{n_2}$$

$$\frac{M_1 \times 10.0}{1} =$$

$$\frac{0.1 \times 10.0}{2}$$

$$M_1 = \frac{0.1 \times 10.0}{2} \times \frac{1}{10.0}$$

$$M_1 = 0.05 \text{ M}$$

$$\text{Amount in g/dm}^3 = \text{molarity} \times \text{relative molecular}$$

$$6.3 = 0.05 \times (90 + 18x)$$

$$\frac{6.3}{0.05} = 90 + 18x$$

$$126 = 90 + 18x$$

$$126 - 90 = 18x$$

$$36 = 18x$$

$$x = \frac{36}{18} = 2$$

$$x = 2$$

Result:**Water of crystallization in hydrated oxalic acid is = 2**

DETERMINATION OF SOLUBILITY

Experiment No-11

Determine The Solubility Of Oxalic Acid Volumetrically At Room Temperature.

Principle:

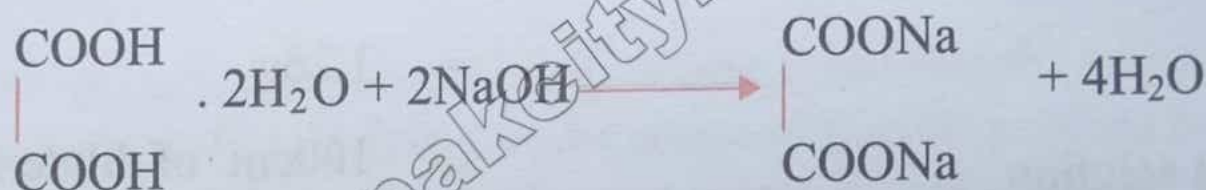
It is an acid-base titration. Oxalic acid is a weak acid and can be titrated with a base.

Standard Solution: 0.1 M NaOH

Indicator: Phenolphthalein

End Point: Just colourless

Equation:



Mole Ratio:

1 : 2

Procedure:

Prepare a saturated solution of oxalic acid at room temperature. Take 10.0cm³ of this saturated solution and dilute it to 100cm³. Take this dilute solution in the burette with the help of funnel and note the initial reading. Pipette out 10.0cm³ of NaOH in conical flask. Add 1-2 drops of indicator in it. The Solution becomes pink. Titrate this solution against acid taken in burette. The end point is just colourless. Take at least three concordant readings to get the exact volume of acid used.

Observations and Calculations:

- (i) Vol. of NaOH taken for each titration = 10.0cm³.
- (ii) Vol. of oxalic acid used for each titration.

No. of Obs.	Initial Reading	Final Reading	Vol. of Oxalic acid used
1.	0.0	5.0	5.0cm ³
2.	5.0	10.0	5.0cm ³
3.	10.0	15.0	5.0cm ³

Concordant Reading = 5.0 cm³

Oxalic acid NaOH

$$\frac{M_1 V_1}{n_1} = \frac{M_2 V_2}{n_2}$$

$$\frac{M_1 \times 5.0}{1} = \frac{0.1 \times 10.0}{2}$$

$$M_1 = \frac{0.1 \times 10.0}{2} \times \frac{1}{5.0}$$

$$M_1 = 0.1 \text{ mol/dm}^3 \text{ of oxalic acid}$$

$$\text{Amount in } \text{H}_2\text{C}_2\text{O}_4 \text{ in g/dm}^3 = \text{Molarity} \times \text{mol. mass}$$

$$= 0.1 \times 126$$

$$= 12.6 \text{ g/dm}^3$$

$$1000\text{cm}^3 \text{ solution contain } \text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O} = 12.6\text{g}$$

$$100\text{cm}^3 \text{ dilute solution contain } \text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O} = \frac{12.6}{1000} \times 100$$

$$= 1.26\text{g}$$

$$10\text{cm}^3 \text{ of saturated solution} = 100\text{cm}^3 \text{ of dilute solution}$$

$$10\text{g of saturated solution contain oxalic acid} = 1.26\text{g (d} = 1\text{g/cm}^3\text{)}$$

$$100\text{g of saturated solution contain oxalic acid} = \frac{1.26}{10} \times 100 = 12.6\text{g}$$

Result:

The solubility of oxalic acid at room temperature is = 12.6g

Experiment No-12

The Given Solution Contain 5g Of Soap Dissolved Per 500cm³ Solution.
Determine The Percentage Of Free Alkali In Soap.

Principle:

Soap is formed by the reaction of oil and caustic soda. Washing soap contains NaOH as free Alkali. The soap solution may be titrated against a standard solution of HCl in presence of phenolphthalein as an indicator.

Standard Solution:	0.1 MHCl
Indicator:	Phenolphthalein
End point:	Just colourless
Equation:	$\text{NaOH} + \text{HCl} \rightarrow \text{NaCl} + \text{H}_2\text{O}$
Mole ratio:	1 : 1

Procedure:

Take the given HCl in burette with the help of funnel and note the initial reading. Weigh 5g of toilet soap pieces and put them in hot water. Dissolve the soap and convert solution into 500cm³ measuring flask. Make up the volume upto mark. Take 50cm³ of soap solution in conical flask with the help of pipette. Add 1-2 drops of indicator in it. Titrate this solution against standard acid in burette. The end point is just colourless. Note the final reading. Take at least three concordant readings to calculate the exact volume of acid used.

Observations and Calculations:

- (i) Vol. of soap solution taken for each titration = 50.0cm³.
(ii) Vol. of HCl used for each titration

No. of Obs.	Initial Reading	Final Reading	Vol. of HCl used
1.	0.0	8.0	8.0cm ³
2.	8.0	16.0	8.0cm ³
3.	16.0	24.0	8.0cm ³

Concordant reading = 8.0cm³

$$\frac{\text{NaOH}}{\frac{M_1 V_1}{n_1}} = \frac{\text{HCl}}{\frac{M_2 V_2}{n_2}}$$

$$\frac{M_1 \times 50.0}{1} = \frac{0.1 \times 8.0}{1}$$

$$M_1 = 0.016M$$

$$\text{Amount in g/dm}^3 \text{ of NaOH} = \text{Molarity} \times \text{Mol. mass}$$

$$= 0.016 \times 40$$

$$= 0.64 \text{ g/dm}^3$$

$$500\text{cm}^3 \text{ solution contain soap} = 5\text{g.}$$

$$1000\text{cm}^3 \text{ solution contain soap} = \frac{5}{500} \times 1000 = 10\text{g.}$$

$$10\text{g soap contain free alkali} = 0.64\text{g.}$$

$$100\text{g soap contain free alkali} = \frac{0.64}{10} \times 100 = 6.4\%$$

Result:

The given soap solution contain 6.4% free alkali.



Experiment No-13

The Given Solution Contains 40g Of Vinegar Per 200 cm³ Of Solution. Calculate The % age Of Acetic Acid (CH₃COOH) In This Vinegar Sample.

Principle:

Vinegar is a mixture containing 3-6% CH₃COOH, Ethyl acetate, Ethyl formate and a number of fermentation products. The amount of acetic acid can be determined by titrating it against some base. So, it is an acid base titration.

Standard Solution: 0.1 M NaOH

Indicator: Phenolphthalein

End point: Just colourless

Equation: $\text{NaOH} + \text{CH}_3\text{COOH} \longrightarrow \text{CH}_3\text{COONa} + \text{H}_2\text{O}$

Mole ratio: 1 : 1

Procedure:

Take the given vinegar solution in burette with the help of funnel and note the initial reading. Only CH₃COOH in vinegar will react with NaOH. Pipette out 10.0 cm³ of NaOH in conical flask. Add 1-2 drops of indicator in it.

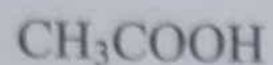
The solution becomes pink. Titrate this solution against the acid taken in burette. The end point is just colourless. Note the final reading. Take at least three concordant readings to get the exact volume of acid used.

Observations and Calculations:

- (i) Vol. of NaOH taken for each titration = 10.0 cm³
- (ii) Vol. of CH₃COOH used for each titration.

No. of Obs.	Initial Reading	Final Reading	Vol. of Acetic acid used
1.	0.0	10.0	10.0 cm ³
2.	10.0	20.0	10.0 cm ³
3.	20.0	30.0	10.0 cm ³

Concordant Reading = 10.0 cm³



$$\frac{M_1 V_1}{n_1}$$

$$\frac{M_2 V_2}{n_2}$$

$$\frac{M_1 \times 10.0}{1}$$

$$\frac{0.1 \times 10.0}{1}$$

$$M_1 = 0.1 \text{ mol/dm}^3 \text{ of } \text{CH}_3\text{COOH}$$

$$\text{Amounting g/dm}^3 \text{ of } \text{CH}_3\text{COOH} = \text{Molarity} \times \text{Molecular mass}$$

$$= 0.1 \times 60$$

$$= 6.0 \text{ g/dm}^3$$

$$200\text{cm}^3 \text{ solution contain vinegar} = 40\text{g}$$

$$1000\text{cm}^3 \text{ solution contain vinegar} = \frac{40}{200} \times 1000$$

$$= 200\text{g/dm}^3$$

$$200\text{g vinegar contain } \text{CH}_3\text{COOH} = 6\text{g}$$

$$100\text{g vinegar contain } \text{CH}_3\text{COOH} = \frac{6}{200} \times 100 = 3\%$$

$$\% \text{ age of } \text{CH}_3\text{COOH} = 3\%$$

Result:

The given vinegar sample contains 3% CH_3COOH



Experiment No-14

The Given Solution Contain 16g Of Na_2CO_3 And NaCl Dissolved $/\text{dm}^3$. Calculate the Composition Of each in 80g Of Mixture Volumetrically.

Principle:

It is an acid-base titration. In this mixture Na_2CO_3 is reactive against standard acid like HCl .

Standard Solution: 0.1 M HCl

Indicator: Methyl Orange

End Point: Just light pink / orange red

Equation: $\text{Na}_2\text{CO}_3 + 2\text{HCl} \longrightarrow 2\text{NaCl} + \text{H}_2\text{O} + \text{CO}_2$

Mole Ratio: 1 : 2

Procedure:

Take the given HCl solution in burette and note the initial reading. Pipette out 10.0cm^3 of basic mixture in conical flask. Add 1-2 drops of methyl orange as an indicator. The solution becomes yellow. Titrate this solution against HCl solution taken in burette. The end point is just light pink/orange red. Note the final reading. Take at least three concordant readings to calculate the exact volume of acid used.

Observations and Calculations:

- Vol. of mixture taken for each titration = 10.0cm^3 .
- Vol. of acid used from burette for each titration.

No. of Obs.	Initial Reading	Final Reading	Vol. of HCl used
1.	0.0	10.0	10.0cm^3
2.	10.0	20.0	10.0cm^3
3.	20.0	30.0	10.0cm^3

Concordant Reading = 10.0cm^3

$$\frac{\text{Na}_2\text{CO}_3}{\frac{M_1 V_1}{n_1}} = \frac{\text{HCl}}{\frac{M_2 V_2}{n_2}}$$

$$\frac{M_1 \times 10.0}{1} = \frac{0.1 \times 10.0}{2}$$

$$M_1 = 0.05 \text{ mol/dm}^3 \text{ of Na}_2\text{CO}_3$$

$$\text{Amount per dm}^3 \text{ of Na}_2\text{CO}_3 = \text{molarity} \times \text{mol. mass}$$

$$= 0.05 \times 106$$

$$= 5.3 \text{ g/dm}^3$$

$$16 \text{ g mixture contain Na}_2\text{CO}_3 = 5.3 \text{ g}$$

$$80 \text{ g mixture contain Na}_2\text{CO}_3 = \frac{5.3 \text{ g}}{16} \times 80 = 26.5 \text{ g}$$

$$\text{Amount in NaCl} = 80 - 26.5$$

$$= 53.5 \text{ g}$$

Result:

The given 80 g mixture contains 26.5g of Na_2CO_3 and 53.5g of NaCl.

Exercise:

- (i) The given solution contains 15g of a mixture of NaOH and Na_2SO_4 dissolved per dm^3 . Calculate the amount of NaOH in 50g of the mixture.
- (ii) The given solution contains 2.0g of HCl and NaCl dissolved in 500 cm^3 . Calculate % age of NaCl.



Experiment No-15

The Given Solution Contains 0.84g Of Alkali Metal Bicarbonate dissolved Per 100cm³ Of Solution. Calculate Atomic Mass Of Metal 'M'.

Principle:

It is an acid-base titration. MHCO_3 is a weak base. It can be titrated with a strong acid.

Standard Solution: 0.1 M HCl

Indicator: Methyl Orange

End Point: Just light pink / orange red

Equation: $\text{MHCO}_3 + \text{HCl} \longrightarrow \text{MCl} + \text{H}_2\text{O} + \text{CO}_2$

Mole Ratio: 1 : 1

Procedure:

Take the given HCl solution in burette with the help of funnel and note the initial reading. Pipette out 10.0cm³ of MHCO_3 in conical flask. Add 1-2 drops of methyl orange in it. The solution becomes yellow. Titrate this solution against HCl taken in burette. The end point is just light pink/orange red. Note the final reading. Take at least three concordant readings to calculate the accurate volume of acid used.

Observations and Calculations:

- (i) Vol. of MHCO_3 taken for each titration = 10.0cm³.
- (ii) Vol. of HCl used from burette for each titration.

No. of Obs.	Initial Reading	Final Reading	Vol. of HCl used
1.	0.0	10.0	10.0cm ³
2.	10.0	20.0	10.0cm ³
3.	20.0	30.0	10.0cm ³

Concordant Reading = 10.0 cm³

$$\frac{M_1 V_1}{n_1} = \frac{M_2 V_2}{n_2}$$

$$\frac{M_1 \times 10.0}{1} = \frac{0.1 \times 10.0}{1}$$

$$M_1 = 0.1 \text{ mol/dm}^3 \text{ of MHCO}_3$$

$$100 \text{ cm}^3 \text{ solution contain MHCO}_3 = 0.84 \text{ g}$$

$$1000 \text{ cm}^3 \text{ solution contain MHCO}_3 = \frac{0.84}{100} \times 1000$$

$$= 8.4 \text{ g/dm}^3$$

$$\text{Amount of MHCO}_3 \text{ in g/dm}^3 = \text{molarity} \times \text{mol. mass of MHCO}_3$$

$$8.4 = 0.1 \times \text{mol. mass of MHCO}_3$$

$$\text{Mol. mass of MHCO}_3 = \frac{8.4}{0.1} = 84$$

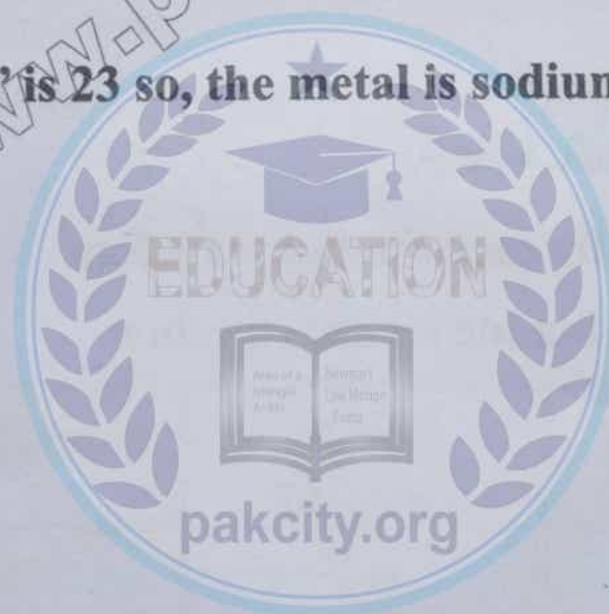
$$\text{Atomic mass of M} = \text{mol mass of MHCO}_3 - \text{Formula mass of HCO}_3^-$$

$$= 84 - 61$$

$$\text{Atomic mass of M} = 23$$

Result:

The atomic mass of metal 'M' is 23 so, the metal is sodium Na (Natrium).



Experiment No-16

The Given Solution Contains 2.5g Of Impure Baking Soda (NaHCO_3) dissolved per 250cm^3 . Calculate The %age Purity Of Sample Volumetrically:

Principle:



It is an acid-base titration. Baking soda NaHCO_3 being weak Base can be titrated against a strong acid.

Standard Solution: 0.1 M HCl

Indicator: Methyl orange

End point: Just light pink / orange red

Equation: $\text{NaHCO}_3 + \text{HCl} \longrightarrow \text{NaCl} + \text{H}_2\text{O} + \text{CO}_2$

Mole ratio: 1 : 1

Procedure:

Take the given acid in the burette with the help of funnel and note the initial reading. Pipette out 10.0cm^3 of baking soda sample in conical flask. Add 1-2 drops of indicator in it. The solution becomes yellow. Titrate this solution against the solution taken in burette. The end point is just light pink/orange red. Take at least three concordant readings to calculate the exact volume of acid used.

Observations and Calculations:

- (i) Vol of NaHCO_3 taken for each titration = 10.0cm^3
- (ii) Vol. of Acid used for each titration.

No. of Obs.	Initial Reading	Final Reading	Vol. of HCl used
1.	0.0	10.0	10.0cm^3
2.	10.0	20.0	10.0cm^3
3.	20.0	30.0	10.0cm^3

Concordant reading = 10.0cm^3

$$\frac{\text{NaHCO}_3}{\frac{M_1 V_1}{n_1}} = \frac{\text{HCl}}{\frac{M_2 V_2}{n_2}}$$

$$\frac{M_1 \times 10.0}{1} = \frac{0.1 \times 10.0}{1}$$

$$M_1 = 0.1 \text{ mol/dm}^3 \text{ of NaHCO}_3$$

Amount of NaHCO₃ (Pure) in g/dm³ = Molarity × Mol. mass

$$= 0.1 \times 84$$

$$= 8.4 \text{ g/dm}^3$$

$$250 \text{ cm}^3 \text{ solution contains impure sample} = 2.5 \text{ g.}$$

$$1000 \text{ cm}^3 \text{ solution contain impure sample} = \frac{2.5}{250} \times 1000$$

$$= 10.0 \text{ g.}$$

$$10.0 \text{ g baking soda contain pure NaHCO}_3 = 8.4 \text{ g}$$

$$100.0 \text{ g backing soda contain pure NaHCO}_3 =$$

$$= \frac{8.4}{10} \times 100$$

$$= 84\%$$

$$\% \text{ age purity} = 84\%$$

Result:

The given impure sample of baking soda contains pure NaHCO₃ = 84%

Exercise:

The given soln contains 7.5g of impure baking soda NaHCO₃ dissolved per 500 cm³. Calculate % purity of the sample.

Experiment No-17

The Given Solution Contains 8.0g Of Impure Na_2CO_3 (soda Ash) dissolved per dm^3 .
Calculate The % age Of Pure Na_2CO_3 Volumetrically.

Principle:

It is an acid base titration. Na_2CO_3 being a weak base can be titrated with a strong acid.

Standard Solution: 0.05M H_2SO_4

Indicator : Methyl orange

End point : • Just light pink / orange red

Equation : $\text{Na}_2\text{CO}_3 + \text{H}_2\text{SO}_4 \longrightarrow \text{Na}_2\text{SO}_4 + \text{CO}_2 + \text{H}_2\text{O}$

Mole ratio: 1 : 1

Procedure:

Take the given H_2SO_4 in the burette with the help of funnel and note the initial reading.

Pipette out 10.0cm^3 of Na_2CO_3 in the conical flask. Add 1-2 drops of Methyl orange as an indicator in conical flask. The solution becomes yellow. Titrate this solution against acid taken in burette. The end point is just light pink/orange red colour. Note the final reading. Take at least three concordant readings to calculate the exact volume of acid used.

Observations and Calculations:

- (i) Vol. of Na_2CO_3 taken for each titration = 10.0cm^3 .
(ii) Vol. of Acid used for each titration.

No. of Obs.	Initial Reading	Final Reading	Vol. of H_2SO_4 used
1.	0.0	10.0	10.0cm^3
2.	10.0	20.0	10.0cm^3
3.	20.0	30.0	10.0cm^3

Concordant reading = 10.0cm^3

$$\begin{aligned} \frac{\text{Na}_2\text{CO}_3}{\frac{M_1 V_1}{n_1}} &= \frac{\text{H}_2\text{SO}_4}{\frac{M_2 V_2}{n_2}} \\ \frac{M_1 \times 10.0}{1} &= \frac{0.05 \times 10.0}{1} \\ M_1 &= 0.05\text{M Na}_2\text{CO}_3 \end{aligned}$$

$$\begin{aligned} \text{Amount of Na}_2\text{CO}_3 \text{ in sample} &= \text{Molarity} \times \text{Mol. mass} \\ &= 0.05 \times 106 \\ &= 5.3\text{g/dm}^3 \end{aligned}$$

$$8\text{g impure sample contain Na}_2\text{CO}_3 \text{ (Pure)} = 5.3\text{g}$$

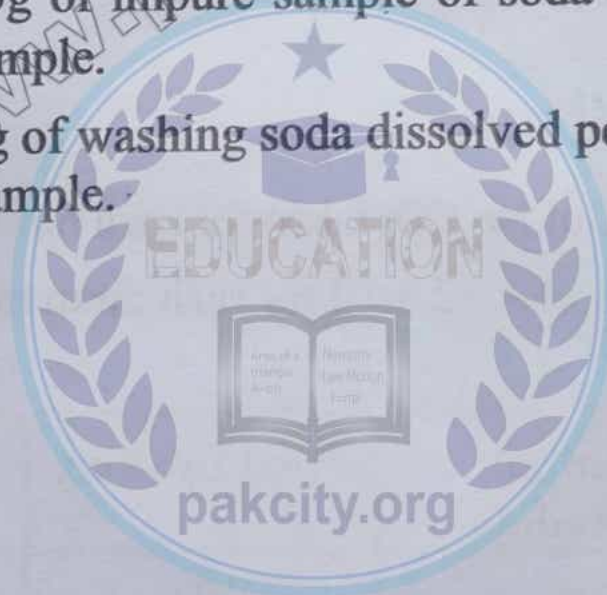
$$\begin{aligned} 100\text{g impure sample contain Na}_2\text{CO}_3 \text{ (Pure)} &= \\ &= \frac{5.3}{8} \times 100 \\ &= 66.25\% \end{aligned}$$

Result:

The given impure sample of soda ash contain 66.25% pure Na_2CO_3 .

Exercise:

- (i) The given solution contains 5g of impure sample of soda ash Na_2CO_3 dissolved per 500cm^3 . Calculate the %age purity of sample.
- (ii) The given solution contains 2g of washing soda dissolved per 250cm^3 of solution. Calculate the %age purity of Na_2CO_3 in the sample.



SECTION-II

REDOX (KMnO₄ Titration)

Redox Reaction:

A reaction in which both oxidation and reduction reactions occur simultaneously is called redox reaction.

Oxidation:



Oxidation may be defined in a number of ways as if the reactant.

- (1) Gains oxygen.
- (2) Losses electrons.
- (3) Losses hydrogen.
- (4) Increase in oxidation number, then the process of oxidation occurs.

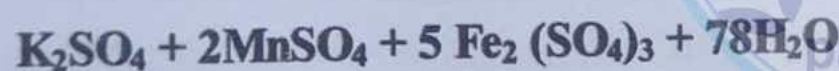
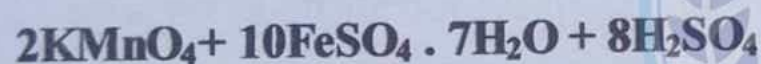
Reduction:

Reduction is the opposite of oxidation. In this reaction, if the reactant.

- (1) Gains hydrogen.
- (2) Gains electrons.
- (3) Losses oxygen.
- (4) There is a decrease in oxidation number.

The process of oxidation and reduction are opposite to each other. They take place simultaneously. No reaction occurs alone.

Consider The Following Reaction:



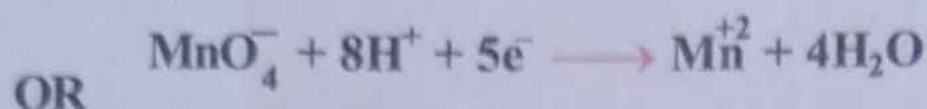
Since FeSO₄ is converted into Fe₂(SO₄)₃ there is a loss of electrons.

We can calculate it by the following method.

FeSO ₄	Fe ₂ (SO ₄) ₃
Fe + (+6) + 4(-2) = 0	2Fe + 3(+6) + 3(-8) = 0
Fe + 6 - 8 = 0	2Fe + 18 - 24 = 0
 Fe - 2 = 0	 2Fe - 6 = 0
Fe = +2	2Fe = +6
	Fe = +6/2
	Fe = +3
$\text{Fe}^{+2} \rightarrow \text{Fe}^{+3} + 1\text{e}^-$	

Since there is loss of e⁻, So oxidation take place in the above reaction.

Similarly

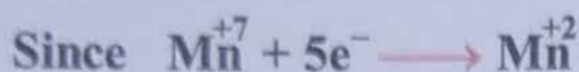


$(+1) + \text{Mn} + 4(-2) = 0$

$\text{Mn} + 1 - 8 = 0$

$\text{Mn} - 7 = 0$

$\text{Mn} = +7$



$\text{Mn} + (+6) + 4(-2) = 0$

$\text{Mn} + 6 - 8 = 0$

$\text{Mn} - 2 = 0$

$\text{Mn} = +2$

There is a gain of electrons so reduction take place.

The branch of volumetric analysis in which an oxidizing agent is titrated against a reducing agent or vice versa is called Redox titration.

A substance that gains electrons during a chemical reaction is called oxidizing agent e.g. KMnO_4 . The positive charge of an oxidizing agent is reduced during a chemical reaction. Oxidizing agent is always reduced in the reaction.

A substance that losses or donates electrons in a chemical reaction is called a reducing agent e.g. $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$. The positive charge of reducing agent is increased during the chemical reaction. Reducing agent is always oxidized in a chemical reaction.

List of Oxidizing Agents:

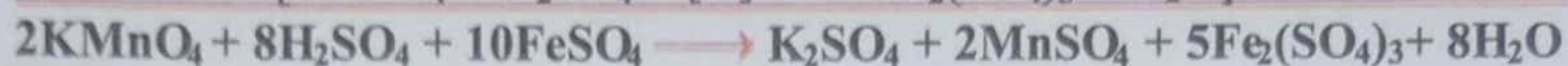
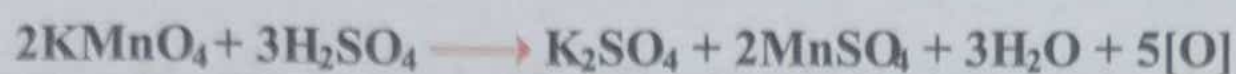
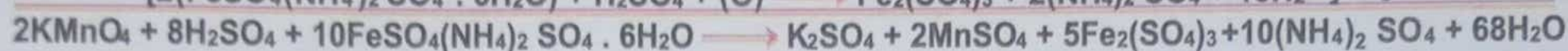
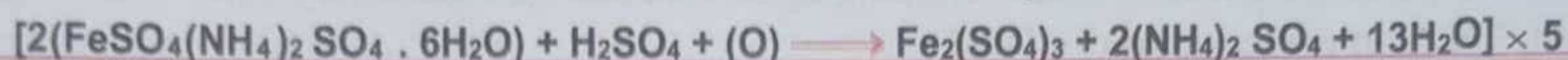
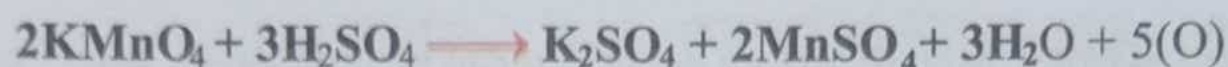
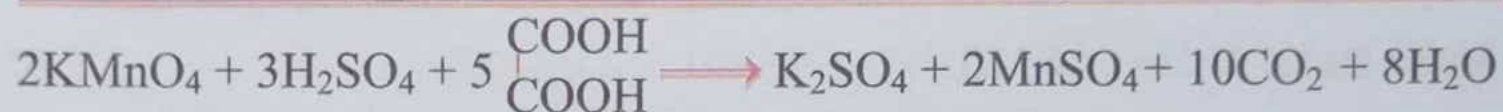
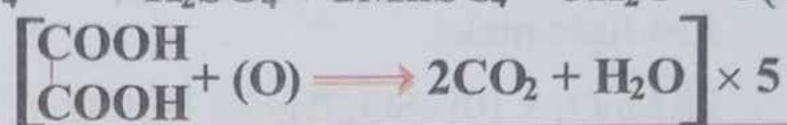
- (1) KMnO_4
- (2) $\text{K}_2\text{Cr}_2\text{O}_7$
- (3) Conc. HNO_3

List of Reducing Agents:

- (1) $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$
- (2) $\text{FeSO}_4 \cdot (\text{NH}_4)_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$ (Mohr's Salt)
- (3) $\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$
- (4) $\text{Na}_2\text{C}_2\text{O}_4$
- (5) $\text{K}_2\text{C}_2\text{O}_4$
- (6) $(\text{NH}_4)_2\text{C}_2\text{O}_4 \cdot \text{H}_2\text{O}$

Indicator:

KMnO_4 itself acts as an indicator in these reaction because it is a colour substance. Oxidation-reduction reaction is a colourless reaction. At the end point one drop of KMnO_4 indicates the end point by changing the colour of solution pink.

Reaction of KMnO_4 with $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$.**Reduction of KMnO_4 with Mohr's Salt:****Reaction of KMnO_4 with Oxalic Acid:****Reaction of KMnO_4 with Salts of Oxalic Acid:****GENERAL INSTRUCTIONS FOR KMnO_4 TITRATIONS:**

- (1) Always take KMnO_4 in the burette KMnO_4 being a coloured liquid, its upper meniscus is read.
- (2) KMnO_4 itself acts as an indicator so no other indicator is used in KMnO_4 titration.
- (3) As indicated in the above equations, all redox reactions take place in presence of dilute H_2SO_4 , Therefore always add half test tube of dilute H_2SO_4 in conical flask.
- (4) When titrations with oxalic acid are carried out, 60 - 70°C temperature is needed.
- (5) If the temperature falls below 60°C, brown ppt must appear which tells about incomplete reaction, so always titrate hot solution while carrying out titration with oxalic acid.
- (6) In case of Ferrous ions, heating is not necessary because on heating Fe^{+2} are easily converted into Fe^{3+} ions, by atmospheric oxygen.
- (7) Sometimes a brownish black colour or brown precipitates are obtained at the end point which may be due to the following reasons.
 - (i) Due to abrupt addition of KMnO_4 solution in form of continuous stream.
 - (ii) Due to insufficient amount of dil. H_2SO_4 added.
 - (iii) Due to incomplete reactions MnO_2 ppt settle down.
- (8) The burette should not be filled upto zero mark because upper meniscus is to be read in the reaction.
- (9) Due to green colour of iron salts solution, during their volume measurement, upper meniscus must be read.

EXPERIMENT No-18

Standardize The Given Solution Of KMnO_4 By Volumetric Method.

Principle:

It is a redox titration. KMnO_4 is an oxidizing agent and can be reduced by some reducing agent e.g $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ in presence of dil. H_2SO_4 .

Standard Solution: $0.1\text{M FeSO}_4 \cdot 7\text{H}_2\text{O}$

Indicator: KMnO_4 (itself)

End point: Just light pink

Equation: $2\text{KMnO}_4 + 10\text{FeSO}_4 \cdot 7\text{H}_2\text{O} + 8\text{H}_2\text{SO}_4 \rightarrow \text{K}_2\text{SO}_4 + 2\text{MnSO}_4 + 5\text{Fe}_2(\text{SO}_4)_3 + 78\text{H}_2\text{O}$

Mole Ratio: 2 : 10

Procedure:

Take KMnO_4 solution in the burette with the help of funnel and remove the funnel. Note the initial reading. Pipette out 10.0cm^3 of $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ in conical flask. Add half test tube of dil H_2SO_4 in it. Titrate this solution against KMnO_4 solution taken in burette. End point is just light pink. Take at least three concordant readings to get the exact volume of KMnO_4 used.

Observation and Calculations:

- Vol. of $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ solution taken in conical flask for each titration = 10.0cm^3 .
- Vol. of KMnO_4 used from burette for each titration

No. of Obs.	Initial Reading	Final Reading	Vol. of KMnO_4 used
1.	0.0	10.0	10.0cm^3
2.	10.0	20.0	10.0cm^3
3.	20.0	30.0	10.0cm^3

Concordant reading = 10.0 cm^3

KMnO_4 $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$

$$\frac{M_1 V_1}{n_1} = \frac{M_2 V_2}{n_2}$$

$$\frac{M_1 \times 10.0}{2} = \frac{0.1 \times 10.0}{10}$$

$$M_1 = \frac{0.1 \times 10.0}{10} \times \frac{2}{10.0} = 0.02\text{M}$$

$$\text{Amount in g/dm}^3 = \text{Molarity} \times \text{Mol mass of } \text{KMnO}_4$$

$$= 0.02 \times 158$$

$$= 3.16\text{g}$$

Result:

The given KMnO_4 solution is 0.02M having 3.16 g/dm^3 .

Experiment No-19

Standardize The Given Solution Of KMnO_4 . Also Calculate The Volume Of KMnO_4 Required To Prepare 400cm^3 Of 0.005M KMnO_4 .

Principle:

It is a redox-titration KMnO_4 is an oxidizing agent and can be reduced with some reducing agent.

Standard Solution: 0.1M Mohr's salt

Indicator: KMnO_4 (itself)

End point: Just light pink

Equation: $2\text{KMnO}_4 + 10\text{FeSO}_4(\text{NH}_4)_2\text{SO}_4 \cdot 6\text{H}_2\text{O} + 8\text{H}_2\text{SO}_4$

↓

$\text{K}_2\text{SO}_4 + 2\text{MnSO}_4 + 5\text{Fe}_2(\text{SO}_4)_3 + 10(\text{NH}_4)_2\text{SO}_4 + 68\text{H}_2\text{O}$

Mole Ratio:

KMnO_4 : Mohr's salt
2 : 10

Procedure:

Take given KMnO_4 solution in the burette with the help of funnel, then remove the funnel and note the initial reading. Take 10.0cm^3 of Mohr's salt in conical flask with the help of pipette. Add half test tube of dil H_2SO_4 in it. Titrate this solution against KMnO_4 taken in burette. The end point is just light pink colour.

Note the final reading. Take at least three concordant readings to calculate the exact volume of KMnO_4 used.

Observations and Calculations:

- (i) Vol. of Mohr's salt soln taken for each titration = 10.0cm^3
(ii) Vol. of KMnO_4 used for each titration.

No. of Obs.	Initial Reading	Final Reading	Vol. of KMnO_4 used
1.	0.0	10.0	10.0cm^3
2.	10.0	20.0	10.0cm^3
3.	20.0	30.0	10.0cm^3

Concordant reading = 10.0cm^3

KMnO₄

Mohr's salt

$$\frac{M_1 V_1}{n_1}$$

=

$$\frac{M_2 V_2}{n_2}$$

$$\frac{M_1 \times 10.0}{2}$$

=

$$\frac{0.1 \times 10.0}{10}$$

M₁

=

$$\frac{0.1 \times 10.0}{10} \times \frac{2}{10.0}$$

=

0.02M

M₁

=

0.02 mol/dm³ of KMnO₄**Dilution Formula:**M₁V₁

=

M₂V₂Given KMnO₄

=

Required KMnO₄M₁V₁

=

M₂V₂

$$0.02 \times V_1$$

=

$$0.005M \times 400$$

V₁

=

$$\frac{0.005M \times 400}{0.02}$$

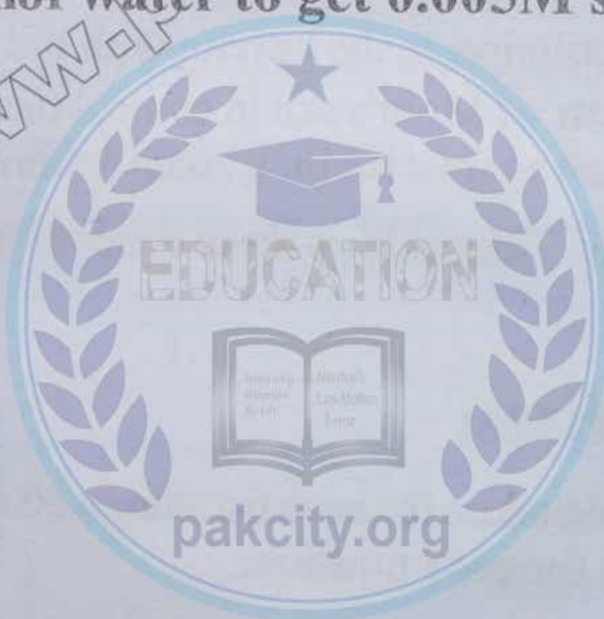
V₁

=

$$100\text{cm}^3$$

Result:

Molarity of given KMnO₄ soln is 0.02 mol/dm³. 100cm³ of this solution is required to mix with 300cm³ of water to get 0.005M soln of 400cm³ volume.



MIXTURE ANALYSIS

Experiment No-20

The Given Solution Contain 8.0 Grams Of A Mixture Of KMnO_4 And K_2SO_4 dissolved Per dm^3 . Calculate The Amount Of K_2SO_4 In The Mixture Solution.

Principle:

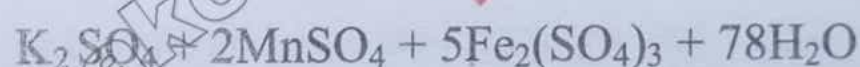
It is a redox titration. KMnO_4 is an oxidizing agent and can be titrated against reducing agent like $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ in the presence of dil H_2SO_4 . In the give mixture, only KMnO_4 is reactive.

Standard Solution : 0.1M $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$

Indicator : KMnO_4 (itself)

End Point : Just light pink

Equation: $2\text{KMnO}_4 + 10\text{FeSO}_4 \cdot 7\text{H}_2\text{O} + 8\text{H}_2\text{SO}_4$



Mole Ratio :



Procedure:

Take mixture solution in the burette and note the initial reading. Pipette out 10.0cm^3 of $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ solution in conical flask. Then add half test take of dil. H_2SO_4 in it. Titrate this solution against mixture taken in burette. The end point is just light pink. Note the final reading. Take at least three concordant reading to calculate the exact volume of KMnO_4 used.

Observations and Calculations:

- (i) Vol. of $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ soln taken for each titration = 10.0cm^3 .
- (ii) Vol. of KMnO_4 used for each titration.

No. of Obs.	Initial Reading	Final Reading	Vol. of KMnO_4 used
1.	0.0	10.0	10.0cm^3
2.	10.0	20.0	10.0cm^3
3.	20.0	30.0	10.0cm^3

Cancordant reading = 10.0 cm^3

$$\begin{aligned}
 \text{KMnO}_4 & \qquad \qquad \text{FeSO}_4 \cdot 7\text{H}_2\text{O} \\
 \frac{M_1 V_1}{n_1} & = \frac{M_2 V_2}{n_2} \\
 \frac{M_1 \times 10.0}{2} & = \frac{0.1 \times 10.0}{10} \\
 M_1 & = \frac{0.1 \times 10.0}{10} \times \frac{2}{10} = 0.02\text{M}
 \end{aligned}$$

$$\begin{aligned}
 \text{Amount of KMnO}_4 \text{ in g/dm}^3 & = \text{Molarity} \times \text{Mol. mass} \\
 & = 0.02 \times 158 \\
 & = 3.16 \text{ g/dm}^3
 \end{aligned}$$

$$8.0\text{g mixture contain KMnO}_4 = 3.16\text{g}$$

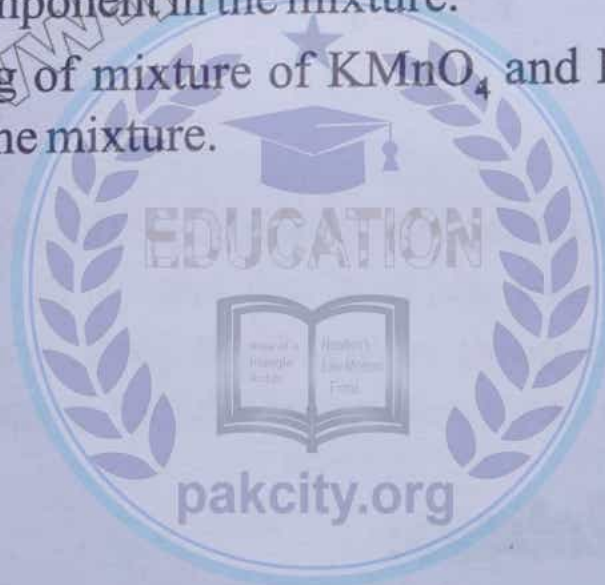
$$\begin{aligned}
 \text{Amount of K}_2\text{SO}_4 & = 8 - 3.16 \\
 & = 4.84\text{g}
 \end{aligned}$$

Result:

In the given mixture of KMnO_4 and K_2SO_4 , the amount of K_2SO_4 is = 4.84g

Exercise:

- (i) The given solution contains 5.0g of a mixture of KMnO_4 and K_2SO_4 dissolved per 500cm^3 soln. Determine the % age of each component in the mixture.
- (ii) The given solution contain 8.0g of mixture of KMnO_4 and K_2SO_4 dissolved per dm^3 . Find out composition of each in 200g of the mixture.



Experiment No-21

The Given Solution Contains 6.0g Of Hydrated Oxalic Acid And Sulphuric Acid dissolved per 500 cm³ Of Solution. Find The % age Composition Of each.

Principle:

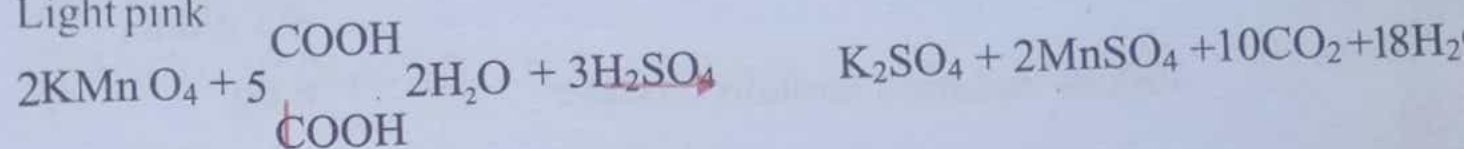
It is a redox titration. In this mixture oxalic acid reacts with KMnO₄ in the presence of dil. H₂SO₄.

Standard Solution: 0.02M KMnO₄

Indicator: KMnO₄ (itself)

End Point: Light pink

Equation:



Mole Ratio:

KMnO₄ : Oxalic acid
2 : 5

Procedure:

Take given KMnO₄ solution in the burette and note the initial reading. Pipette out given mixture of oxalic acid and sulphuric acid in the conical flask and then add half test tube of dil. H₂SO₄ in it. Heat the solution upto 60-70°C and then titrate this hot solution against KMnO₄. The end point is just light pink. Note the final reading. Take at least three concordant readings to calculate the exact volume of KMnO₄ used.

Observations and Calculations:

- (i) Vol. of mixture taken for each titration = 10.0 cm³
- (ii) Vol. of KMnO₄ used for each titration.

No. of Obs.	Initial Reading	Final Reading	Vol. of KMnO ₄ used
1.	0.0	10.0	10.0 cm ³
2.	10.0	20.0	10.0 cm ³
3.	20.0	30.0	10.0 cm ³

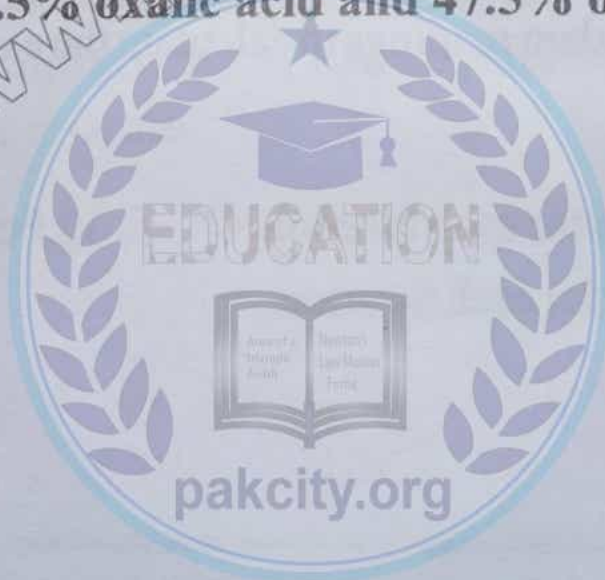
Concordant reading = 10.0 cm³

$$\begin{aligned}
 \text{Oxalic acid} & \quad \text{KMnO}_4 \\
 \frac{M_1 V_1}{n_1} &= \frac{M_2 V_2}{n_2} \\
 \frac{M_1 \times 10.0}{5} &= \frac{0.02 \times 10.0}{2} \\
 M_1 &= \frac{0.02 \times 10.0}{2} \times \frac{5}{10.0} \\
 M_1 &= 0.05\text{M oxalic acid}
 \end{aligned}$$

$$\begin{aligned}
 \text{Amount is g/dm}^3 \text{ of oxalic acid} &= \text{Molarity} \times \text{Molar mass} \\
 &= 0.05 \times 126 \\
 &= 6.3 \text{ g/dm}^3 \\
 500\text{cm}^3 \text{ solution contain mixture} &= 6.0\text{g} \\
 1000\text{cm}^3 \text{ solution contain mixture} &= \frac{6}{500} \times 1000 = 12\text{g} \\
 12\text{g mixture contain oxalic acid} &= 6.3\text{g} \\
 100\text{g mixture contain oxalic acid} &= \frac{6.3}{12} \times 100 = 52.5\% \\
 \% \text{ age of H}_2\text{SO}_4 &= 100 - 52.5 = 47.5\%
 \end{aligned}$$

Result:

The given mixture contains 52.5% oxalic acid and 47.5% of H₂SO₄.



EXPERIMENT No-22

The Given Solution Contain 10 Grams Of A Mixture Of Ammonium Oxalate And Ammonium Sulphate dissolved Per dm^3 . Find Out % age Of each By Volumetric Method.



Principle:

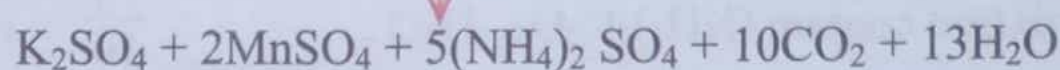
It is a redox titration. In the given mixture, Ammonium oxalate contain $\text{C}_2\text{O}_4^{2-}$ ions and can be titrated against oxidizing agent in the presence of dil. H_2SO_4 .

Standard Solution: 0.02M KMnO_4

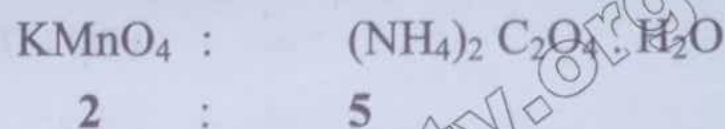
Indicator: KMnO_4 (itself)

End point: Just light pink

Equation: $2\text{KMnO}_4 + 5(\text{NH}_4)_2\text{C}_2\text{O}_4 \cdot \text{H}_2\text{O} + 8\text{H}_2\text{SO}_4$



Mole Ratio:



Procedure:

Take KMnO_4 solution in the burette and note the initial reading. Pipette out 10.0cm^3 of mixture in the conical flask and add half test tube of dil. H_2SO_4 in it. Heat the solution of conical flask upto $60-70^\circ\text{C}$. Now titrate this hot solution against KMnO_4 . The end point is just light pink. Note the final reading. Take at least three concordant readings to get the exact volume of KMnO_4 used.

Observations and Calculations:

- (i) Vol. of Mixture, taken for each titration = 10.0cm^3
- (ii) Vol. of KMnO_4 used for each titration.

No. of Obs.	Initial Reading	Final Reading	Vol. of KMnO_4 used
1.	0.0	10.0	10.0cm^3
2.	10.0	20.0	10.0cm^3
3.	20.0	30.0	10.0cm^3

Candordant reading = 10.0 cm^3

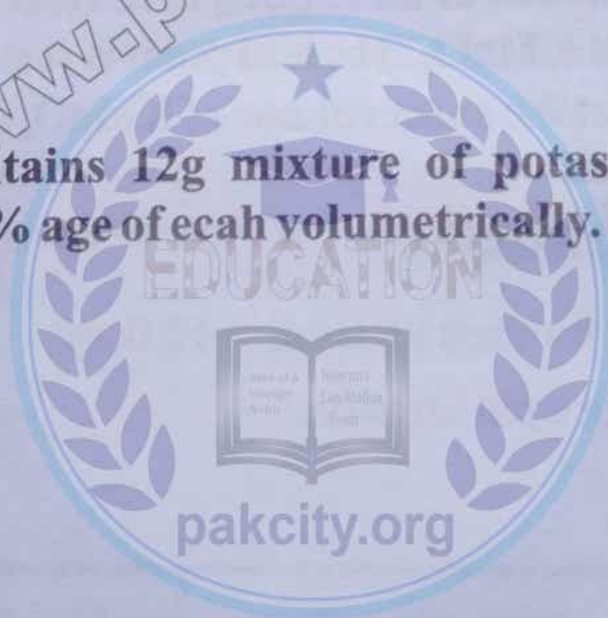
$$\begin{aligned}
 & \text{(NH}_4\text{)}_2\text{C}_2\text{O}_4 \cdot \text{H}_2\text{O} & \text{KMnO}_4 \\
 & \frac{M_1 V_1}{n_1} = \frac{M_2 V_2}{n_2} \\
 & \frac{M_1 \times 10.0}{5} = \frac{0.02 \times 10.0}{2} \\
 & M_1 = \frac{0.02 \times 10.0}{2} \times \frac{5}{10.0} \\
 & & = 0.05\text{M Amm. Oxalate.} \\
 & \text{Amount in g/dm}^3 \text{ of (NH}_4\text{)}_2\text{C}_2\text{O}_4 \cdot \text{H}_2\text{O} & = \text{Molarity} \times \text{Mol. mass} \\
 & & = 0.05 \times 142 \\
 & & = 7.1 \text{ g/dm}^3 \\
 & 10\text{g mixture contain (NH}_4\text{)}_2\text{C}_2\text{O}_4 \cdot \text{H}_2\text{O} & = 7.1\text{g} \\
 & 100\text{g mixture contain (NH}_4\text{)}_2\text{C}_2\text{O}_4 \cdot \text{H}_2\text{O} & = \frac{7.1}{10} \times 100 \\
 & & = 71\% \\
 & \% \text{ age of (NH}_4\text{)}_2\text{SO}_4 & = 100 - 71 \\
 & & = 29\%
 \end{aligned}$$

Result:

In the given mixture 71% $(\text{NH}_4)_2\text{C}_2\text{O}_4 \cdot \text{H}_2\text{O}$ and 29% $(\text{NH}_4)_2\text{SO}_4$ is present.

Exercise:

The given solution contains 12g mixture of potassium oxalate and potassium sulphate dissolved per dm^3 . Find out % age of each volumetrically.



EXPERIMENT No-23

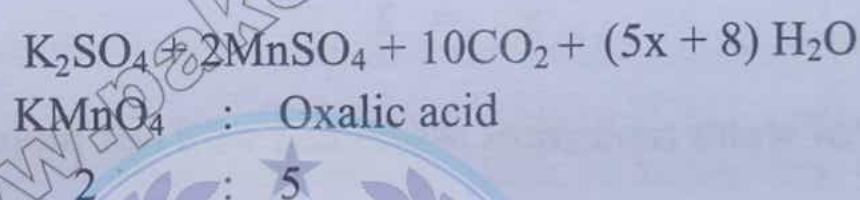
The Given Solution Contains 6.3g Of Hydrated Oxalic Acid $\begin{array}{c} \text{COOH} \\ | \\ \text{COOH} \end{array} \times \text{H}_2\text{O}$ dissolved Per dm^3 . Find Out Value Of 'x'.

Principle:

It is a redox titration. Oxalic acid is a reducing agent and can be oxidized to CO_2 by an oxidizing agent such as KMnO_4 in the presence of dil. H_2SO_4 at $60-70^\circ\text{C}$.

Standard Solution: 0.02M KMnO_4
Indicator: KMnO_4 (itself)
End Point: Just light pink
Equation: $2\text{KMnO}_4 + 5 \begin{array}{c} \text{COOH} \\ | \\ \text{COOH} \end{array} \cdot x\text{H}_2\text{O} + 3\text{H}_2\text{SO}_4$

Mole Ratio:



Procedure:

Take given KMnO_4 solution in the burette with the help of funnel and then remove the funnel. Note the initial reading. Pipette out 10.0cm^3 of oxalic acid in conical flask.

Add half test tube of dil. H_2SO_4 in it. Heat the solution upto $60-70^\circ\text{C}$ and then titrate this hot solution against standard KMnO_4 solution. End point is just light pink. Note the final reading. Take at least three concordant readings to calculate the exact volume of KMnO_4 used.

Observations and Calculations:

- (i) Vol. of oxalic acid taken for each titration = 10.0cm^3
 (ii) Vol. of KMnO_4 used for each titration.

No. of Obs.	Initial Reading	Final Reading	Vol. of KMnO_4 used
1.	0.0	10.0	10.0cm^3
2.	10.0	20.0	10.0cm^3
3.	20.0	30.0	10.0cm^3

Concordant Reading = 10.0cm^3

Oxalic acid

KMnO₄

$$\frac{M_1 V_1}{n_1} = \frac{M_2 V_2}{n_2}$$

$$\frac{M_1 \times 10.0}{5} = \frac{0.02 \times 10.0}{2}$$

$$M_1 = \frac{0.02 \times 10.0}{2} \times \frac{5}{10.0}$$

$$M_1 = 0.05M \text{ oxalic acid}$$

$$\text{Mol. mass of } H_2C_2O_4 \cdot xH_2O = 90 + 18x.$$

$$\text{Amount in g/dm}^3 \text{ of oxalic acid} = \text{Molarity} \times \text{Mol. mass}$$

$$6.3 = 0.05 \times (90 + 18x)$$

$$\frac{6.3}{0.05} = (90 + 18x)$$

$$126 = (90 + 18x)$$

$$126 - 90 = 18x$$

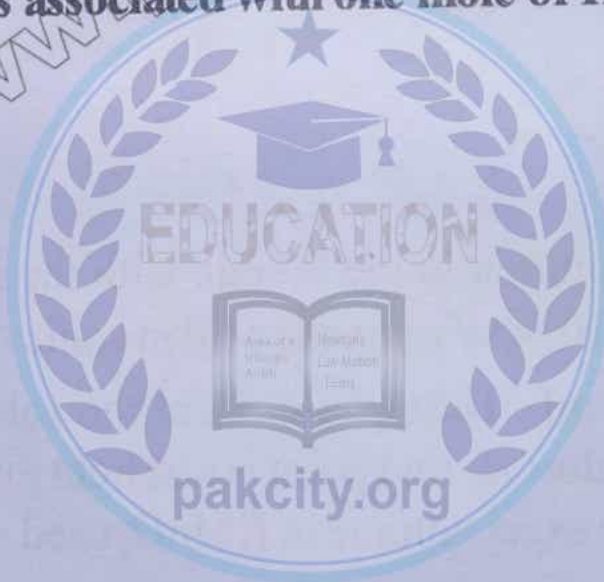
$$36 = 18x$$

$$x = \frac{36}{18} = 2$$

$$x = 2$$

Result:

The number of water molecules associated with one mole of $H_2C_2O_4$ is = 2



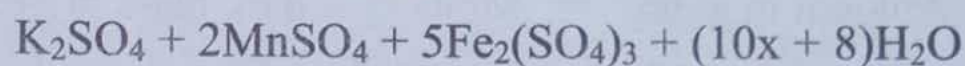
EXPERIMENT No-24

The Given Solution Contains 13.9g Of $\text{FeSO}_4 \cdot x\text{H}_2\text{O}$ dissolved Per 500cm^3 Solution. Find Out Value Of 'x' By Volumetric Method.

Principle:

It is a redox titration. FeSO_4 is a reducing agent and can be titrated against standard KMnO_4 solution in the presence of dil. H_2SO_4 .

Standard Solution	:	0.02M KMnO_4
Indicator	:	KMnO_4 (itself)
End Point	:	Just light pink
Equation	:	$2\text{KMnO}_4 + 10\text{FeSO}_4 \cdot x\text{H}_2\text{O} + 8\text{H}_2\text{SO}_4$



Mole Ratio:		KMnO_4	:	$\text{FeSO}_4 \cdot x\text{H}_2\text{O}$
		2	:	10

Procedure:

Take given KMnO_4 solution in the burette and note the initial reading. Pipette out 10.0cm^3 of $\text{FeSO}_4 \cdot x\text{H}_2\text{O}$ solution in conical flask. Then add half test tube of dilute H_2SO_4 in it. Titrate this solution against KMnO_4 solution taken in burette. The end point is just light pink. Note the final reading. Take at least three concordant readings to get the exact volume of KMnO_4 used.

Observations and Calculations:

- (i) Vol. of $\text{FeSO}_4 \cdot x\text{H}_2\text{O}$ taken for each titration = 10.0cm^3 .
- (ii) Vol. of KMnO_4 used for each titration =

No. of Obs.	Initial Reading	Final Reading	Vol. of KMnO_4 used
1.	0.0	10.0	10.0cm^3
2.	10.0	20.0	10.0cm^3
3.	20.0	30.0	10.0cm^3

Concordant Reading = 10.0cm^3

$$\begin{aligned}
 \text{FeSO}_4 \cdot x\text{H}_2\text{O} & \quad \text{KMnO}_4 \\
 \frac{M_1 V_1}{n_1} & = \frac{M_2 V_2}{n_2} \\
 \frac{M_1 \times 10.0}{10} & = \frac{0.02 \times 10.0}{2} \\
 M_1 & = \frac{0.02 \times 10.0}{2} \times \frac{10}{10.0} \\
 M_1 & = 0.1 \text{ mol/dm}^3
 \end{aligned}$$

500cm³ solution contain FeSO₄ · xH₂O = 13.9g.

$$\begin{aligned}
 1000\text{cm}^3 \text{ solution contain FeSO}_4 \cdot x\text{H}_2\text{O} &= \frac{13.9}{500} \times 1000 \\
 &= 27.8 \text{ g/dm}^3
 \end{aligned}$$

Amount in g/dm³ = Molarity × mol. mass of FeSO₄ · xH₂O.

$$27.8 = 0.1 \times (152 + 18x)$$

$$\frac{27.8}{0.1} = 152 + 18x$$

$$278 = 152 + 18x$$

$$278 - 152 = 18x$$

$$126 = 18x$$

$$x = \frac{126}{18}$$

$$x = 7$$

Result:

No. of water molecule in hydrated FeSO₄ is = 7



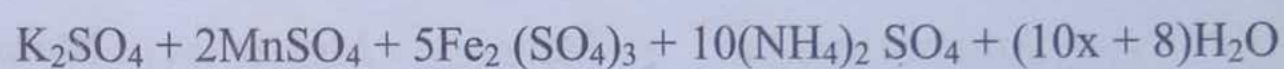
Experiment No-25

The Given Solution Contains 3.92g Of $\text{FeSO}_4 \cdot (\text{NH}_4)_2 \text{SO}_4 \cdot x\text{H}_2\text{O}$ dissolved Per 100cm^3 Of Solution. Determine Value Of 'x' By Volumetric Method:

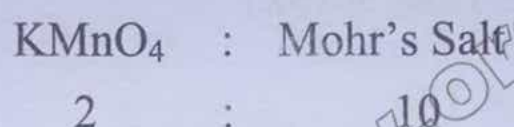
Principle:

It is a redox titration. Mohr's salt is a reducing agent and can be titrated with some oxidizing agent like KMnO_4 .

Standard Solution	:	0.02M KMnO_4
Indicator	:	KMnO_4 (itself)
End Point	:	Just light pink
Equation	:	$2\text{KMnO}_4 + 10\text{FeSO}_4 \cdot (\text{NH}_4)_2 \text{SO}_4 \cdot x\text{H}_2\text{O} + 8\text{H}_2\text{SO}_4$



Mole Ratio:



Procedure:

Take the given KMnO_4 solution in burette and note the initial reading. Pipette out 10.0cm^3 of Mohr's salt solution in the conical flask and then add half test tube of dil. H_2SO_4 in it. Titrate this solution against standard solution taken in burette. The end point is just light pink. Note the final reading. Take at least three concordant readings to calculate the exact volume of KMnO_4 used.

Observations and Calculations:

- (i) Vol. of Mohr's salt taken for each titration = 10.0cm^3
- (ii) Vol. of KMnO_4 used for each titration.

No. of Obs.	Initial Reading	Final Reading	Vol. of KMnO_4 used
1.	0.0	10.0	10.0cm^3
2.	10.0	20.0	10.0cm^3
3.	20.0	30.0	10.0cm^3

Concordant reading = 10.0cm^3

$$\begin{aligned}
 \text{Mohr's Salt} & \quad \text{KMnO}_4 \\
 \frac{M_1 V_1}{n_1} & = \frac{M_2 V_2}{n_2} \\
 \frac{M_1 \times 10.0}{10} & = \frac{0.02 \times 10.0}{2} \\
 M_1 & = \frac{0.02 \times 10.0}{2} \times \frac{10}{10.0} \\
 M_1 & = 0.1M
 \end{aligned}$$

$$100\text{cm}^3 \text{ solution contain Mohr's salt} = 3.92$$

$$\begin{aligned}
 1000\text{cm}^3 \text{ solution contain Mohr's salt} & = \frac{3.92}{100} \times 1000 \\
 & = 39.2 \text{ g/dm}^3
 \end{aligned}$$

$$\text{Mol. mass of } \text{FeSO}_4 \cdot (\text{NH}_4)_2 \text{SO}_4 \cdot x\text{H}_2\text{O} = 284 + 18x.$$

$$\text{Amount in g/dm}^3 = \text{Molarity} \times \text{Mol. mass of Mohr's salt.}$$

$$39.2 = 0.1 \times (284 + 18x)$$

$$\frac{39.2}{0.1} = 284 + 18x$$

$$392 = 284 + 18x$$

$$392 - 284 = 18x$$

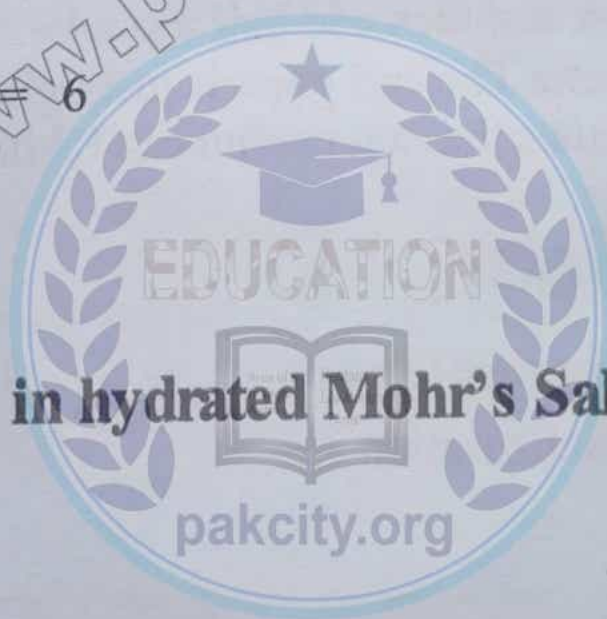
$$108 = 18x$$

$$x = \frac{108}{18} = 6$$

$$x = 6$$

Result:

No. of water molecules in hydrated Mohr's Salt is = 6



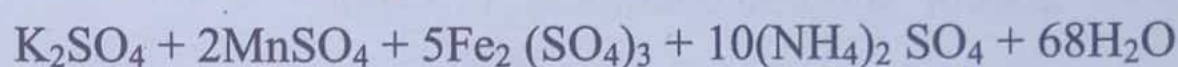
EXPERIMENT No-26

To determine The Solubility Of Mohr's Salt At Room Remperature:

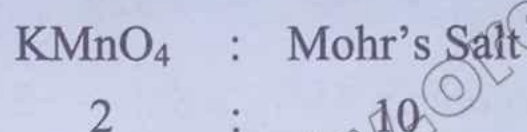
Principle:

It is a redox-titration. Mohr's salt is a reducing agent and can be titrated with standard oxidizing agent e.g KMnO_4 in the presence of dil. H_2SO_4 .

Standard Soln	:	0.02M KMnO_4
Indicator	:	KMnO_4 (itself)
End Point	:	Just light pink
Equation	:	$2\text{KMnO}_4 + 10\text{FeSO}_4(\text{NH}_4)_2\text{SO}_4 \cdot 6\text{H}_2\text{O} + 8\text{H}_2\text{SO}_4$



Mole Ratio:



Procedure:

Take the given KMnO_4 solution in burette and note the initial reading. Prepare a saturated soln of Mohr's Salt at room temperature. Now take 10.0cm^3 of this saturated solution and dilute it upto 200cm^3 of solution. Now pipette out 10.0cm^3 of this dilute solution in conical flask. Then add half test tube of dil. H_2SO_4 in it. Titrate this solution against KMnO_4 . The end point is just light pink. Note the final reading. Take at least three concordant readings to calculate the exact volume of KMnO_4 used.

Observations and Calculations:

- (i) Vol. of Mohr's Salt taken for each titration = 10.0cm^3 .
- (ii) Vol. of KMnO_4 used for each titration =

No. of Obs.	Initial Reading	Final Reading	Vol. of KMnO_4 used
1.	0.0	5.0	5.0cm^3
2.	5.0	10.0	5.0cm^3
3	10.0	15.0	5.0cm^3

Concordant Reading = 5.0cm^3

Mohr's Salt

KMnO₄

$$\frac{M_1 V_1}{n_1} =$$

$$\frac{M_2 V_2}{n_2}$$

$$\frac{M_1 \times 10.0}{10} =$$

$$\frac{0.02 \times 5.0}{2}$$

$$M_1 =$$

$$\frac{0.02 \times 5.0}{2} \times \frac{10}{10.0}$$

$$M_1 =$$

$$0.05 \text{ mol/dm}^3$$

$$\text{Amount in g/dm}^3 =$$

$$\text{Molarity} \times \text{Mol. mass of Mohr's Salt}$$

$$=$$

$$0.05 \times 392$$

$$=$$

$$19.6 \text{ g/dm}^3$$

$$1000\text{cm}^3 \text{ solution contain Mohr's Salt} = 19.6\text{g}$$

$$200\text{cm}^3 \text{ solution contain Mohr's Salt} =$$

$$= \frac{19.6}{1000} \times 200 = 3.92\text{g}$$

$$200\text{cm}^3 \text{ dilute soln contain Mohr's Salt} = 3.92\text{g}$$

$$10\text{cm}^3 \text{ of water} = 10\text{g of water}$$

$$200\text{cm}^3 \text{ of dilute soln} = 10\text{cm}^3 \text{ of saturated solution.}$$

$$10\text{cm}^3 \text{ of saturated solution contain Mohr's Salt} = 3.92\text{g.}$$

$$100\text{cm}^3 \text{ of saturated solution contain Mohr's Salt} = \frac{3.92}{10} \times 100$$

$$= 39.2 \text{ g/100g}$$

$$\text{Solubility of Mohr's Salt} = 39.2\text{g/100g of H}_2\text{O.}$$

Result:

The solubility of Mohr's Salt at room temperature is = 39.2g

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EXPERIMENT No-27

Determine The Solubility Of Oxalic acid at room temperature.

Principle:

It is a redox titration. Oxalic acid is a reducing agent and can be titrated with some oxidizing agent like KMnO_4 at $60-70^\circ\text{C}$.

Standard Solution : 0.02M KMnO_4
Indicator : KMnO_4 (itself)
End Point : Just light pink
Equation : $2\text{KMnO}_4 + 5\text{H}_2\text{C}_2\text{O}_4 \xrightarrow{\Delta} 2\text{K}_2\text{SO}_4 + 2\text{MnSO}_4 + 10\text{CO}_2 + 18\text{H}_2\text{O}$

Mole Ratio:

KMnO_4 : Oxalic acid
 2 : 5

Procedure:

Take the given KMnO_4 solution in the burette and Note the initial reading. Prepare a saturated solution of oxalic acid at room temperature. Take 10.0cm^3 of this saturated solution and dilute it upto 250cm^3 in a measuring flask. Take 10.0cm^3 of this dilute oxalic acid solution in conical flask and then add half test tube of dil. H_2SO_4 in it. Heat the solution of conical flask upto $60-70^\circ\text{C}$. Titrate this hot solution against KMnO_4 . The end point is just light pink. Note the final reading. Take at least three concordant readings to calculate the exact volume of KMnO_4 used.

Observations and Calculations:

- (i) Vol. of oxalic acid taken for each titration = 10.0cm^3 .
 (ii) Vol. of KMnO_4 used for each titration =

No. of Obs.	Initial Reading	Final Reading	Vol. of KMnO_4 used
1.	0.0	8.0	8.0cm^3
2.	8.0	16.0	8.0cm^3
3.	16.0	24.0	8.0cm^3

concordant reading = 8.0cm^3

Oxalic acid KMnO_4

$$\frac{M_1 V_1}{n_1} = \frac{M_2 V_2}{n_2}$$

$$\frac{M_1 \times 10.0}{5} = \frac{0.02 \times 8.0}{2}$$

$$M_1 = \frac{0.02 \times 8.0}{2} \times \frac{5}{10.0}$$

$$M_1 = 0.04\text{M}$$

$$\begin{aligned}\text{Amount in g/dm}^3 &= \text{Molarity} \times \text{Mol. mass} \\ &= 0.04 \times 126 \\ &= 5.04 \text{ g/dm}^3\end{aligned}$$

$$1000\text{cm}^3 \text{ solution contain oxalic acid} = 5.04$$

$$\begin{aligned}250\text{cm}^3 \text{ solution contain oxalic acid} &= \frac{5.04}{1000} \times 250 \\ &= 1.26\text{g}\end{aligned}$$

$$250\text{cm}^3 \text{ dilute solution contain oxalic acid} = 1.26\text{g.}$$

$$\therefore 10\text{cm}^3 \text{ of water} = 10\text{g of water}$$

$$250\text{cm}^3 \text{ of dilute solution} = 10\text{cm}^3 \text{ of saturated solution.}$$

$$10.0\text{cm}^3 \text{ saturated solution contain oxalic acid} = 1.26\text{g.}$$

$$100\text{cm}^3 \text{ of saturated solution contain oxalic acid} = \frac{1.26}{10} \times 100$$

$$= 12.6 \text{ g/100g of H}_2\text{O}$$

$$\text{Solubility of H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O} = 12.6\text{g/100g of H}_2\text{O.}$$

Result:

Hence the solubility of oxalic acid at room temperature is = 12.6 g

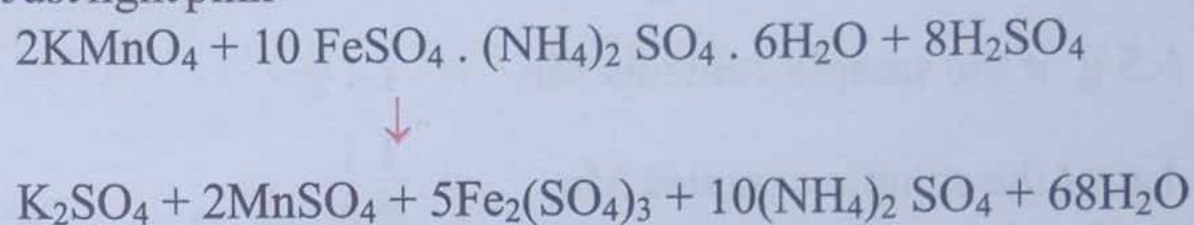
Experiment No-28

6.5g Of An Impure Sample Of KMnO_4 Is dissolved Per dm^3 . Determine %age Of Mn Present In The Given Solution:

Principle:

It is a redox titration. KMnO_4 is an oxidizing agent and can be reduced to Mn^{2+} ions by a suitable reducing agent such as Mohr's Salt.

Standard Solution : 0.1M Mohr's Salt
Indicator : KMnO_4 (itself)
End Point : Just light pink
Equation :



Mole Ratio:

KMnO_4 : Mohr's Salt
 2 : 10

Procedure:

Take the given KMnO_4 solution in burette and Note the initial reading. Pipette out 10.0cm^3 of Mohr's Salt in conical flask and add half test tube of dilute H_2SO_4 in it. Titrate this solution against KMnO_4 . The end point is just light pink. Note the final reading. Take at least three concordant Reading. to calculate the exact volume of KMnO_4 used.

Observations and Calculations:

- (i) Vol. of Mohr's salt taken for each titration = 10.0cm^3
 (ii) Vol. of KMnO_4 used for each titration.

No. of Obs.	Initial Reading	Final Reading	Vol. of KMnO_4 used
1.	0.0	10.0	10.0cm^3
2.	10.0	20.0	10.0cm^3
3.	20.0	30.0	10.0cm^3

Concordant Reading = 10.0cm^3

KMnO_4		Mohr's Salt
$\frac{M_1 V_1}{n_1}$	=	$\frac{M_2 V_2}{n_2}$
$\frac{M_1 \times 10.0}{2}$	=	$\frac{0.1 \times 10.0}{10}$
M_1	=	$\frac{0.1 \times 10.0}{10} \times \frac{2}{10.0} = 0.02\text{M}$

Amount in $\text{g/dm}^3 = \text{Molarity} \times \text{relative Atomic mass of Mn.}$

$$= 0.02 \times 55$$

$$= 1.1 \text{ g/dm}^3$$

$$6.5 \text{ g of the sample contains Mn} = 1.1 \text{ g}$$

$$1 \text{ g of the sample contains Mn} = \frac{1.1}{6.5}$$

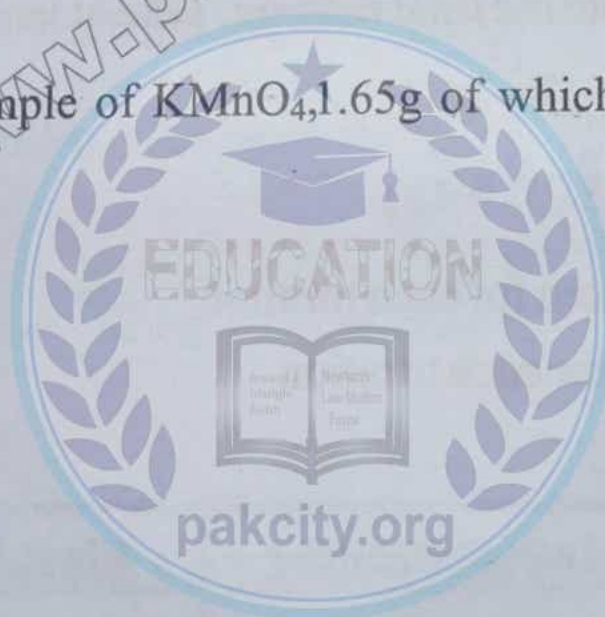
$$100 \text{ g of the sample contains Mn} = \frac{1.1}{6.5} \times 100 = 16.92\%$$

Result:

The given sample of KMnO_4 contain 16.92% Mn.

Exercise:

Find out the % age of Mn in the given sample of KMnO_4 , 1.65g of which has been dissolved per 500c

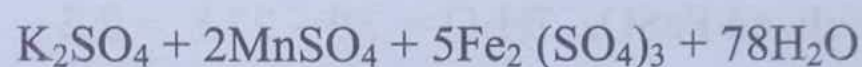
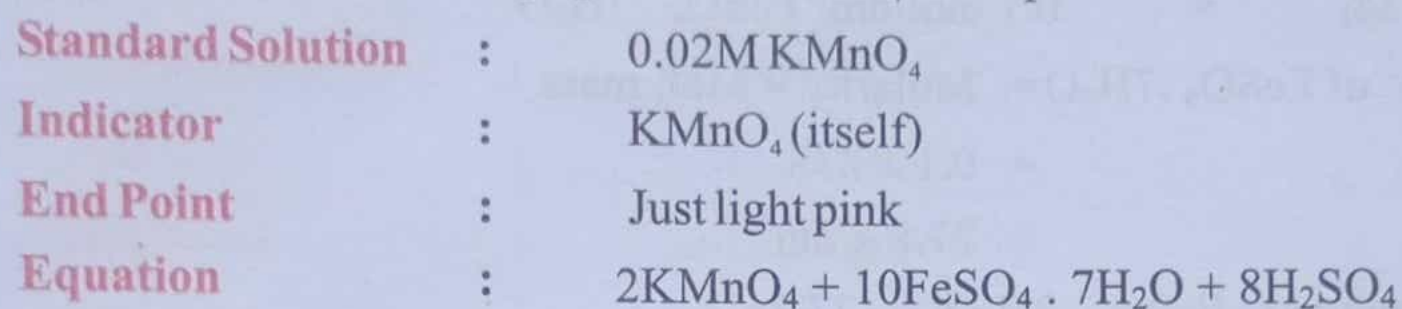


EXPERIMENT No-29

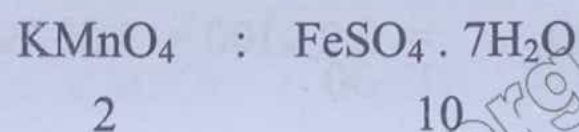
The Given Solution Contain 30.0g Per dm^3 Of A partially Oxidized Ferrous Sulphate
Calculate The Percentage Oxidation By Volumetric Method:

Principle:

It is a redox titration. FeSO_4 is a reducing agent and get oxidized easily in atmosphere. It can be titrated against some standard oxidizing agent like KMnO_4 in the presence of dil. H_2SO_4 .



Mole Ratio:



Procedure:

Take the given KMnO_4 solution in the burette and note the initial reading. Pipette out 10.0cm^3 of FeSO_4 (Partially Oxidized) in conical flask and then add half test tube of dil. H_2SO_4 in it. Titrate this solution against KMnO_4 . The end point is just light pink.

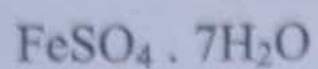
Note the final reading. Take at least three concordant readings to calculate the exact volume of KMnO_4 used.

Observations and Calculations:

- (i) Vol. of FeSO_4 taken for each titration = 10.0cm^3 .
 (ii) Vol. of KMnO_4 used for each titration =

No. of Obs.	Initial Reading	Final Reading	Vol. of KMnO_4 used
1.	0.0	10.0	10.0cm^3
2.	10.0	20.0	10.0cm^3
3.	20.0	30.0	10.0cm^3

Concordant Reading = 10.0cm^3



$$\frac{M_1 V_1}{n_1} =$$

$$\frac{M_2 V_2}{n_2}$$

$$\frac{M_1 \times 10.0}{10} =$$

$$\frac{0.02 \times 10.0}{2}$$

$$M_1 = \frac{0.02 \times 10.0}{2} \times \frac{10}{10.0} =$$

$$M_1 = 0.1 \text{ mol/dm}^3 \text{ FeSO}_4 \cdot 7\text{H}_2\text{O}$$

$$\text{Amount in g/dm}^3 \text{ of FeSO}_4 \cdot 7\text{H}_2\text{O} = \text{Molarity} \times \text{Mol. mass}$$

$$= 0.1 \times 278$$

$$= 27.8 \text{ g/dm}^3$$

$$30\text{g sample contain pure FeSO}_4 \cdot 7\text{H}_2\text{O} = 27.8\text{g}$$

$$\text{Amount of oxidized FeSO}_4 \cdot 7\text{H}_2\text{O} = 30 - 27.8 = 2.2$$

$$\% \text{ of partially oxidised FeSO}_4 = \frac{2.2}{30} \times 100 = 7.33 \%$$

Result:

The given impure sample contains 7.33% partially oxidized $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$.



Experiment No-30

The Given Solution Contains 27.8g Of $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ Dissolved per dm^3 .
Find The Amount Of Iron In The Given Sample By Volumetric Method:

Principle:

It is redox titration. $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ is a reducing agent and can be titrated against KMnO_4 in the presence of dil. H_2SO_4 .

Standard Solution	:	0.02M KMnO_4
Indicator	:	KMnO_4 (itself)
End Point	:	Just light pink
Equation	:	$2\text{KMnO}_4 + 10\text{FeSO}_4 \cdot 7\text{H}_2\text{O} + 8\text{H}_2\text{SO}_4$ \downarrow $\text{K}_2\text{SO}_4 + 2\text{MnSO}_4 + 5\text{Fe}_2(\text{SO}_4)_3 + 78\text{H}_2\text{O}$
Mole Ratio:		$\text{KMnO}_4 : \text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ $2 : 10$

Procedure:

Take the given KMnO_4 in the burette and Note the initial reading. Pipette out 10.0cm^3 of $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ solution in the conical flask. Then add half test tube of dil. H_2SO_4 in the flask. Titrate this solution against KMnO_4 in the burette. The end point is just light pink. Note the final reading. Take at least three concordant readings to calculate the exact volume of KMnO_4 used.

Observations and Calculations:

- (i) Vol. of $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ solution taken = 10.0cm^3
 (ii) Vol. of KMnO_4 used for each titration.

No. of Obs.	Initial Reading	Final Reading	Vol. of KMnO_4 used
1.	0.0	10.0	10.0cm^3
2.	10.0	20.0	10.0cm^3
3.	20.0	30.0	10.0cm^3

Concordant Reading = 10.0cm^3

$$\begin{aligned}
 \text{FeSO}_4 \cdot 7\text{H}_2\text{O} & \qquad \qquad \text{KMnO}_4 \\
 \frac{M_1 V_1}{n_1} & = \frac{M_2 V_2}{n_2} \\
 \frac{M_1 \times 10.0}{10} & = \frac{0.02 \times 10.0}{2} \\
 M_1 & = \frac{0.02 \times 10.0}{2} \times \frac{10}{10.0} \\
 M_1 & = 0.1\text{M FeSO}_4 \cdot 7\text{H}_2\text{O} \\
 \text{Amount of Fe in g/dm}^3 & = \text{Molarity} \times \text{Atomic mass of Fe} \\
 & = 0.1 \times 56 \\
 & = 5.6 \text{ g/dm}^3
 \end{aligned}$$

Result:

The given solution of $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ contain 5.6g iron per dm^3 .



SECTION-III

IODINE TITRATION (REDOX TITRATIONS)

IODINE TITRATION:

Iodine titration is the type of redox titration. Iodine acts as an oxidizing agent and can be titrated against reducing agent like $\text{Na}_2\text{S}_2\text{O}_3$.

OXIDIZING AGENT:

Iodine (I_2) itself acts as an oxidizing agent and in the reaction itself reduced.

REDUCING AGENT:

$\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$ (sodium thiosulphate) acts as a reducing agent and in the reaction itself oxidized.

INDICATOR:

Mostly starch is used as an indicator in Iodimetry. Although Iodine can be used as an indicator because it has an intense yellow to brown colour. But during Titration it is difficult to detect the disappearance of yellow colour, so starch is used near the end point. Starch produces a deep blue complex with iodine. The complex is visible at low concentration of iodine. It gives water insoluble complex with iodine, so that is why we use indicator near to the end point.

Types of Iodine Titrations:

There are two types of Iodine titration.

- (1) Iodimetry (2) Iodometry

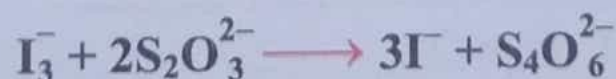
(1) Iodimetry (Direct Titration):

Iodine is an oxidizing agent. Its standard solution is directly titrated with sodium thiosulphate, which is a reducing agent.



In this iodine solution is taken in iodine flask. (stopper conical flask). Iodine is slightly soluble in water but when some KI is added, its solubility increase due to formation of I_3^- .

Volatility of iodine also decreases by KI due to formation of I_3^- .



(2) Iodometry (Indirect Titration):

In this titration some oxidizing agent liberate iodine from KI and this liberated I_2 is titrated against standard solution of reducing agent i.e $\text{Na}_2\text{S}_2\text{O}_3$. The amount of I_2 liberated from KI is equivalent to the quantity of oxidizing agent present. Some oxidizing agents are $\text{K}_2\text{Cr}_2\text{O}_7$, CuSO_4 , KMnO_4 , H_2O_2 , Ferric ions, MnO_2 , bromine and chlorine.

- (I) $2\text{CuSO}_4 + 4\text{KI} \longrightarrow \text{Cu}_2\text{I}_2 + 2\text{K}_2\text{SO}_4 + \text{I}_2$
- (ii) $\text{K}_2\text{Cr}_2\text{O}_7 + 6\text{KI} + 7\text{H}_2\text{SO}_4 \longrightarrow 4\text{K}_2\text{SO}_4 + \text{Cr}_2(\text{SO}_4)_3 + 3\text{I}_2 + 7\text{H}_2\text{O}$
- (iii) $2\text{KMnO}_4 + 10\text{KI} + 8\text{H}_2\text{SO}_4$



In above reactions, liberated iodine is titrated against standard $\text{Na}_2\text{S}_2\text{O}_3$ solution.



GENERAL INSTRUCTIONS FOR IODINE TITRATIONS:

- (1) Always add sodium thiosulphate solution in burette.
- (2) In iodometry titration; add oxidizing agent in the conical flask or iodine flask.
- (3) The medium of solution should be acidic.
- (4) Add KI solution in excess because volatility of I_2 decreases.
- (5) In iodimetry make solution of I_2 in potassium iodide.
- (6) Add indicator near the end point when colour of solution is light yellow.
- (7) Always use fresh solutions of starch indicator and sodium thiosulphate. Prepare solution of $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$ with recently boiled water because CO_2 present in water and bacteria decompose the solution.
- (8) Do not expose the solution of $\text{Na}_2\text{S}_2\text{O}_3$ to light for long time.
- (9) Perform this titration in iodine flask or stopper flask.
- (10) Use sucker pipette to transfer iodine solution into iodine flask. Do not use ordinary pipette.

EXPERIMENT No-31

Standardize The Given Solution Of Iodine. You Are Provided With 0.1M $\text{Na}_2\text{S}_2\text{O}_3$ Solution:

Principle:

It is redox titration. I_2 is an oxidizing agent and can be titrated against some reducing agent like $\text{Na}_2\text{S}_2\text{O}_3$. (Iodimetry)

Standard Solution	:	0.1M $\text{Na}_2\text{S}_2\text{O}_3$
Indicator	:	Starch solution
End Point	:	Blue to colourless
Equation	:	$\text{I}_2 + 2\text{Na}_2\text{S}_2\text{O}_3 \longrightarrow \text{Na}_2\text{S}_4\text{O}_6 + 2\text{NaI}$
Mole Ratio	:	1 : 2

Procedure:

Take $\text{Na}_2\text{S}_2\text{O}_3$ solution in burette with the help of funnel and then remove the funnel. Note the initial reading. Pipette out 10.0cm^3 of I_2 solution in a conical flask with the help of pipette sucker. Add 20cm^3 of distilled water in flask. Titrate this I_2 solution against standard $\text{Na}_2\text{S}_2\text{O}_3$ solution. When the solution becomes pale yellow, add 1-2 drops of starch as an indicator. The solution becomes blue. Now titrate further till the blue colour disappears. This is the end point. Note the final reading. Take at least three concordant reading to calculate the exact volume of $\text{Na}_2\text{S}_2\text{O}_3$ used.

Observations and Calculations:

- (i) Vol. of I_2 solution taken for each titration = 10.0cm^3 .
- (ii) Vol. of $\text{Na}_2\text{S}_2\text{O}_3$ soln used for each titration

No.	Initial Reading	Final Reading	Volume of $\text{Na}_2\text{S}_2\text{O}_3$
1.	0.0	10.0	10.0cm^3
2.	10.0	20.0	10.0cm^3
3.	20.0	30.0	10.0cm^3

Concordant Reading = 10.0cm^3

$$\begin{aligned}
 \text{I}_2 & \qquad \qquad \text{Na}_2\text{S}_2\text{O}_3 \\
 \frac{M_1 V_1}{n_1} &= \frac{M_2 V_2}{n_2} \\
 \frac{M_1 \times 10.0}{1} &= \frac{0.1 \times 10.0}{2} \\
 M_1 &= \frac{0.1 \times 10.0}{2} \times \frac{1}{10} \\
 M_1 &= 0.05\text{M}
 \end{aligned}$$

$$\begin{aligned}
 \text{Amount in g/dm}^3 \text{ of I}_2 &= \text{Molarity} \times \text{Molecular mass} \\
 &= 0.05 \times 254 \\
 &= 12.7 \text{ g/dm}^3
 \end{aligned}$$

Result:

The given I_2 solution is 0.05M having 12.7 g/dm^3 strength.

Exercise:

Standardize the given solution of I_2 you are provided with 0.05M $\text{Na}_2\text{S}_2\text{O}_3$ solution.



EXPERIMENT No-32

Standardize The Given Solution Of I_2 And Find Out Volume Of This Iodine Solution Required To Prepare 400cm^3 Of 0.025M I_2 Solution:

Principle:

It is redox titration. I_2 is an oxidizing agent and can be titrated with some standard reducing agent like $\text{Na}_2\text{S}_2\text{O}_3$ directly. (Iodimetry).

Standard Solution	:	$0.1\text{M Na}_2\text{S}_2\text{O}_3$
Indicator	:	Starch solution
End Point	:	Blue to colourless
Equation	:	$I_2 + 2\text{Na}_2\text{S}_2\text{O}_3 \longrightarrow \text{Na}_2\text{S}_4\text{O}_6 + 2\text{NaI}$
Mole Ratio	:	1 : 2

Procedure:

Take the given $\text{Na}_2\text{S}_2\text{O}_3$ solution in burette and note the initial reading. Pipette out 10.0cm^3 of I_2 solution in conical flask with pipette sucker. Add 20cm^3 of water in it. Titrate this solution against $\text{Na}_2\text{S}_2\text{O}_3$ solution in burette. When the solution becomes pale yellow, add 1-2 drops of indicator in it. The solution becomes blue. Further titrate the solution till the blue colour disappears. This is the end point. Note the final reading. Take at least three concordant readings to calculate the exact volume of $\text{Na}_2\text{S}_2\text{O}_3$ used

Observations and Calculations:

- (i) Vol. of I_2 taken for each titration = 10.0cm^3 .
- (ii) Vol. of $\text{Na}_2\text{S}_2\text{O}_3$ used for each titration.

No. of Obs.	Initial Reading	Final Reading	Vol. of $\text{Na}_2\text{S}_2\text{O}_3$ used
1.	0.0	10.0	10.0cm^3
2.	10.0	20.0	10.0cm^3
3.	20.0	30.0	10.0cm^3

Concordant Reading = 10.0cm^3

$$\begin{aligned}
 \frac{I_2}{\frac{M_1 V_1}{n_1}} &= \frac{Na_2S_2O_3}{\frac{M_2 V_2}{n_2}} \\
 \frac{M_1 \times 10.0}{1} &= \frac{0.1 \times 10.0}{2} \\
 M_1 &= \frac{0.1 \times 10.0}{2} \times \frac{1}{10.0} \\
 M_1 &= 0.05M
 \end{aligned}$$

Dilution Formula:

$$\begin{aligned}
 I_2 \text{ Soln given} &= I_2 \text{ soln required} \\
 M_1 V_1 &= M_2 V_2 \\
 0.05 \times V_1 &= 0.025 \times 400 \\
 V_1 &= \frac{0.025 \times 400}{0.05} \\
 V_1 &= 200\text{cm}^3
 \end{aligned}$$

Result:

The given I_2 solution is 0.05M and the volume required to prepare 400cm^3 of 0.025 MI_2 solution is 200cm^3 mixed with 200cm^3 water.

Exercise:

Standardize the given solution of I_2 and calculate the volume of this solution required to make 500cm^3 of 0.025 MI_2 solution. Given 0.1M $Na_2S_2O_3$ solution.

EXPERIMENT No-33

24.8g Sample Of Alkali Metal Thiosulphate $M_2S_2O_3 \cdot 5H_2O$ Have Been Dissolved Per dm^3 Of Solution. Calculate The Atomic Mass Of Metal 'M' By Volumetric Method.

Principle:

It is a redox titration. I_2 is an oxidizing agent and can be titrated with some reducing agent like $Na_2S_2O_3$ (Iodimetry).

Standard Solution	:	0.05 M I_2 solution
Indicator	:	Starch solution
End Point	:	Blue to colourless
Equation	:	$I_2 + 2M_2S_2O_3 \longrightarrow 2MI + M_2S_4O_6$

Procedure:

Take $M_2S_2O_3$ solution in burette and note the initial reading. Pipette out $10.0cm^3$ of I_2 solution in conical flask with pipette sucker. Add $20cm^3$ of water in it. Titrate this solution against solution in burette. When the solution becomes pale yellow, add 1-2 drops of indicator in it. The solution becomes blue. Further titrate the solution till the blue colour disappears. It is the end point Note the Final reading. Take at least three concordant readings to calculate the exact volume of $M_2S_2O_3$ used.

Observations and Calculations:

- (i) Vol. of I_2 taken for each titration = $10.0cm^3$.
- (ii) Vol. of $M_2S_2O_3$ used for each titration.

No. of Obs.	Initial Reading	Final Reading	Vol. of $M_2S_2O_3$ used
1.	0.0	10.0	$10.0cm^3$
2.	10.0	20.0	$10.0cm^3$
3.	20.0	30.0	$10.0cm^3$

Concordant reading = $10.0cm^3$

$$\begin{aligned}
 \frac{M_2 S_2 O_3}{n_1} &= \frac{I_2}{n_2} \\
 \frac{M_1 \times 10.0}{2} &= \frac{0.05 \times 10.0}{1} \\
 M_1 &= \frac{0.05 \times 10.0}{1} \times \frac{2}{10.0} \\
 M_1 &= 0.1M M_2 S_2 O_3
 \end{aligned}$$

$$\text{Molar mass of } M_2 S_2 O_3 \cdot 5H_2O = M_2 + 202$$

$$\text{Amount in g/dm}^3 \text{ of } M_2 S_2 O_3 = \text{Molarity} \times \text{Mol. mass}$$

$$24.8 = 0.1 \times (2M + 202)$$

$$\frac{24.8}{0.1} = 2M + 202$$

$$248 = 2M + 202$$

$$2M = 248 - 202$$

$$2M = 46$$

$$M = \frac{46}{2} = 23$$

$$M = 23 \text{ g/mol}$$

Result:

So the atomic mass of metal M in $M_2 S_2 O_3 \cdot 5H_2O$ is 23g/mol which is sodium Na (Natrium).

Exercise:

12.4g of $M_2 S_2 O_3 \cdot 5H_2O$ have been dissolved per 500m³ of solution. Find out the atomic mass of 'M' by volumetric method.

EXPERIMENT No-34

Calculate The Percentage Purity Of Given Sample Of Hypo, 7g Of Which Have Been dissolved Per 250cm³ Of Solution:

Principle:

It is redox titration. Hypo ($\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$) is a reducing agent and can be titrated with I_2 solution directly (Iodimetry).

Standard Solution	:	0.05M I_2 solution
Indicator	:	Starch solution
End Point	:	Blue to colourless
Equation	:	$\text{I}_2 + 2\text{Na}_2\text{S}_2\text{O}_3 \longrightarrow 2\text{NaI} + \text{Na}_2\text{S}_4\text{O}_6$
Mole Ratio	:	1 : 2

Procedure:

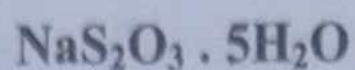
Take hypo solution in burette and note the initial reading. Take 10.0cm³ of I_2 solution in conical flask with pipette sucker. Add 20cm³ of distilled water in it. Titrate this solution against the solution in burette. When the solution becomes pale yellow, add 1-2 drops of starch solution it. The solution becomes blue in colour. Further titrate the solution till the blue colour disappears. This is the end point. Note the final reading. Take at least three concordant readings to calculate the exact volume of hypo used.

Observations and Calculations:

- (i) Vol. of I_2 taken for each titration = 10.0cm³
- (ii) Vol. of hypo used for each titration.

No. of Obs.	Initial Reading	Final Reading	Vol. of $\text{Na}_2\text{S}_2\text{O}_3$ used
1.	0.0	10.0	10.0cm ³
2.	10.0	20.0	10.0cm ³
3.	20.0	30.0	10.0cm ³

Concordant Reading = 10.0cm³



$$\frac{M_1 V_1}{n_1}$$

=

$$\frac{M_2 V_2}{n_2}$$

$$\frac{M_1 \times 10.0}{2}$$

=

$$\frac{0.05 \times 10.0}{1}$$

$$M_1$$

=

$$\frac{0.05 \times 10.0}{1} \times \frac{2}{10.0}$$

$$M_1$$

=

$$0.1\text{M}$$

$$\text{Amount in g/dm}^3 = \text{Molarity} \times \text{Mol. mass of hypo}$$

$$= 0.1 \times 248$$

$$= 24.8 \text{ g/dm}^3$$

$$250\text{cm}^3 \text{ solution contain hypo} = 7.0\text{g}$$

$$1000\text{cm}^3 \text{ solution contain hypo} = \frac{7}{250} \times 1000$$

=

$$28$$

$$28\text{g impure sample contain pure Na}_2\text{S}_2\text{O}_3 \Rightarrow 24.8\text{g}$$

$$100\text{g of impure sample contain pure Na}_2\text{S}_2\text{O}_3 =$$

$$= \frac{24.8}{28} \times 100$$

$$= 88.75\%$$

$$\% \text{ age purity} = 88.75\%$$

Result:

The given impure sample of hypo contains 88.75% pure $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$.

EXPERIMENT No-35

20g Of $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$ Have Been dissolved per dm^3 Of Solution. Find Out The %age Of Sulphur In The Sample By Volumetric Method:

Principle:

It is a redox titration. I_2 is an oxidizing agent and can be titrated with a reducing agent like $\text{Na}_2\text{S}_2\text{O}_3$. (Iodimetry).

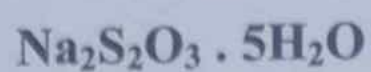
Standard Solution	:	0.05 M I_2 solution
Indicator	:	Starch solution
End Point	:	Blue to colourless
Equation	:	$\text{I}_2 + 2\text{Na}_2\text{S}_2\text{O}_3 \longrightarrow 2\text{NaI} + \text{Na}_2\text{S}_4\text{O}_6$
Mole Ratio	:	1 : 2

Procedure:

Take hypo solution in burette and note the initial reading. Take 10.0cm^3 of I_2 solution in conical flask with pipette sucker. Add 20cm^3 of distilled water in it. Titrate this solution against the solution in burette. When the solution becomes pale yellow, add 1-2 drops of starch solution it. The solution becomes blue in colour. Further titrate the solution till the blue colour disappears. This is the end point. Note the final reading. Take at least three concordant readings to calculate the exact vol.

No. of Obs.	Initial Reading	Final Reading	Vol. of $\text{Na}_2\text{S}_2\text{O}_3$ used
1.	0.0	10.0	10.0cm^3
2.	10.0	20.0	10.0cm^3
3.	20.0	30.0	10.0cm^3

Concordant Reading = 10.0cm^3



$$\frac{M_1 V_1}{n_1}$$

$$\frac{M_1 \times 10.0}{2}$$

$$M_1$$

$$M_1$$



$$\frac{M_2 V_2}{n_2}$$

$$\frac{0.05 \times 10.0}{1}$$

$$\frac{0.05 \times 10.0}{1} \times \frac{2}{10.0}$$

$$0.1 \text{ mol/dm}^3 \text{ of } \text{Na}_2\text{S}_2\text{O}_3$$

Amount in g/dm^3 of sulphur

20g sample contain sulphur(S)

100g sample contain sulphur(S)

% age of S

Molarity \times atomic mass

$$0.1 \times (32 \times 2)$$

$$6.4 \text{ g/dm}^3$$

$$6.4 \text{ g}$$

$$\frac{6.4}{20} \times 100$$

$$32\%$$

$$32\%$$

Result:

The given sample of $\text{Na}_2\text{S}_2\text{O}_3$ contain 32% sulphur (S).



EXPERIMENT No-36

24.8g Of $\text{Na}_2\text{S}_2\text{O}_3 \cdot x\text{H}_2\text{O}$ Have Been dissolved Per Dm^3 Of Solution. Find Out Value Of 'x'.

Principle:

It is a redox titration I_2 is an oxidizing agent and can be titrated against some reducing agent like sodium thiosulphate directly (Iodimetry).

Standard Solution	:	0.05M I_2
Indicator	:	Starch solution
End Point	:	Blue to colourless
Equation	:	$\text{I}_2 + 2\text{Na}_2\text{S}_2\text{O}_3 \cdot x\text{H}_2\text{O} \longrightarrow 2\text{NaI} + \text{Na}_2\text{S}_4\text{O}_6 \cdot 2x\text{H}_2\text{O}$
Mole Ratio	:	1 : 2

Procedure:

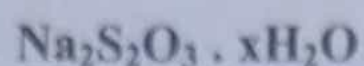
Take the given $\text{Na}_2\text{S}_2\text{O}_3$ solution in burette and note the initial reading. Pipette out 10.0cm^3 of I_2 solution in conical flask and then add 20cm^3 of distilled water in it. Titrate this solution against solution in burette. When the solution becomes pale yellow, add 1-2 drops of indicator in it. The solution becomes blue. Further titrate the solution till the blue colour just disappear. This is the end point. Note the final reading. Take at least three concordant readings to calculate the exact volume of $\text{Na}_2\text{S}_2\text{O}_3$ used.

Observations and Calculations:

- (i) Vol. of I_2 taken for each titration = 10.0cm^3 .
- (ii) Vol. of $\text{Na}_2\text{S}_2\text{O}_3$ used for each titration.

No. of Obs.	Initial Reading	Final Reading	Vol. of $\text{Na}_2\text{S}_2\text{O}_3$ used
1.	0.0	10.0	10.0cm^3
2.	10.0	20.0	10.0cm^3
3.	20.0	30.0	10.0cm^3

Concordant Reading = 10.0cm^3



$$\frac{M_1 V_1}{n_1}$$

=

$$\frac{M_2 V_2}{n_2}$$

$$\frac{M_1 \times 10.0}{2}$$

=

$$\frac{0.05 \times 10.0}{1}$$

$$M_1$$

=

$$\frac{0.05 \times 10.0}{1} \times \frac{2}{10.0}$$

$$M_1$$

=

$$0.1\text{M}$$

Molecular mass of $\text{Na}_2\text{S}_2\text{O}_3 \cdot x\text{H}_2\text{O}$

=

$$158 + 18x$$

Amount in g/dm^3

=

Molarity \times Mol. mass

$$24.8$$

=

$$0.1 \times (158 + 18x)$$

$$\frac{24.8}{0.1}$$

=

$$158 + 18x$$

$$248$$

=

$$158 + 18x$$

$$248 - 158$$

=

$$18x$$

$$90$$

=

$$18x$$

$$x$$

=

$$\frac{90}{18}$$

$$x$$

=

$$5$$

Result:

No. of water of crystallization in $\text{Na}_2\text{S}_2\text{O}_3$ is = 5

Exercise:

2.48g of $\text{Na}_2\text{S}_2\text{O}_3 \cdot x\text{H}_2\text{O}$ have been dissolved per 100cm^3 of solution calculate the value of 'x'.

