VIRUDHUNAGAR S.VELLAICHAMY NADAR POLYTECHNIC COLLEGE

(Affiliated to Directorate of Technical Education, Chennai 600 025)

Virudhunagar - 626 001

MISSION

"Our Mission is to Produce Disciplined and Quality Technocrats through Academic Programme of Noted Excellence to Serve the Society"

VISION

"To be an Institute of Excellence in Technical Education and Training of individuals , Focusing on the needs of the Nation and Society in tune with Technological Developments"

COURSE MATERIAL	
SCHEME	N1
PROGRAMME	BASIC SCIENCE
TERM	I
COURSE	ENGINEERING CHEMISTRY – I PRACTICAL
PREPARED BY	❖ M. Selvambigai, Lecturer / Chemistry ❖ K. Nagarajan, Lecturer / Chemistry ❖ S. Nagaraj, Lecturer / Chemistry ❖ S.Sountharya, Lecturer / Chemistry
VERIFIED BY	

DEPARTMENT OF BASIC SCIENCE

INDEX

Sl. No.	Title of the Experiment	Date	Marks	Staff sign (with date)
ACIDIMETRY & ALKALIMETRY				
1.	Estimation of Sulphuric acid			
2.	Estimation of Sodium hydroxide			
PERMANGANOMETRY				
3.	Estimation of Mohr's salt (Ferrous ammonium sulphate)			
4.	Estimation of Ferrous ion			
5.	Comparison of strength of two Potassium permanganate solutions			
WATER ANALYSIS				
6.	Estimation of total hardness of the sample by using EDTA method			
7.	Water quality testing – determination of pH, TDS & calculation of $[H^+]$			
8.	Water analysis for dissolved chlorine			
NANO SCIENCE (Beyond the syllabus)				
9.	Synthesis of Lead Nano materials by chemical reduction method			
10.	Synthesis of Chromium Nano materials by chemical reduction method			

ENGINEERING CHEMISTRY – I PRACTICAL

SYLLABUS

Course	Instructions		Examination			
	Hours / Week	Hours / Term	Marks			Duration
			Internal Assessment	End Examination	Total	
ENGINEERING CHEMISTRY- I PRACTICAL	2 Hrs.	30 Hrs.	25	75	100	3 Hrs.

Objectives:

1. At the end of the program the student will have knowledge about volumetric analysis in acidimetric, alkalimetric and permanganometric titration and their applications.
2. To get knowledge of estimation of total hardness, temporary and permanent hardness in the hard water sample.
3. To get knowledge about measurement of TDS, pH and to calculate Hydrogen ion concentration in a solution.
4. To get knowledge of estimation of dissolved chlorine in a water sample.
5. To get knowledge of synthesis of Nano materials.

Intellectual Skills:

1. Carrying out Volumetric titrations and calculation of masses.
2. Knowing units for Concentrations of solutions.

Motor Skills:

1. Measure quantities accurately.
2. Observe chemical reactions.
3. Handle the apparatus carefully.

CONTENTS

i) Acidimetry and Alkalimetry:

1. Estimate the amount of sulphuric acid present in ……. ml of a given solution using Standard solution of HCl of strength……..N and an approximately decinormal solution of NaOH.
2. Estimate the amount of NaOH present in …….ml the given solution using a standard solution of KOH of strength ……N and approximately decinormal solution of H_2SO_4.

ii) Permanganometry:

3. Estimation of the amount of Mohr salt present in…….ml of the given solution using a standard solution of ferrous sulphate of strength ……N and an an approximately decinormal solution of $KMnO_4$.
4. Estimation of the amount of of Fe^{2+} present in…….ml of the given solution using a standard solution of ferrous ammonium sulphate of strength ……N and an an approximately decinormal solution of $KMnO_4$.
5. Compare of strength of two given $KMnO_4$ solution and estimate the stronger/weaker solution present in …….ml using a standard solution of ferrous ammonium sulphate of strength ……N.

iii) Water Analysis:

6. Estimation of total hardness of a sample by using EDTA method.
7. Water quality testing, pH, TDS (3 sample) Determination of pH using a pH meter and calculation of hydrogen ion Concentrations in the solutions and TDS using TDS meter (For three given samples). **(This question may be given to any two students per batch).**
8. water analysis for dissolved chlorine.

DETAILED ALLOCATION OF MARKS

End Practical Examination: 75 Marks

Volumetric analysis			Determination of pH & TDS	
Contents	**Marks Allotted**		**Contents**	**Marks allotted**
Short Procedure	05		Answer for short questions on pH & TDS	07
Titration – I	25		Determination of pH (3 x 8)	24
Titration – II	25		Calculation of $[H^+]$ (3 x 5)	15
Calculation (3 x 5)	15		Determination of TDS (3 x 8)	24
Viva – Voce	05		Viva – Voce	05
Total Marks	75		Total Marks	75

Guide lines for Evaluation

Titration value accuracy for Titration – I and II			pH value accuracy	TDS value accuracy	Marks
Accuracy	**Marks**				
± 0.2 ml	25		± 0.2	± 2	8
above ± 0.2 ml to ± 0.4 ml	21		Above ± 0.2 to ± 0.4	above ± 2 to ± 4	6
above ± 0.4 ml to ± 0.6 ml	17		above ± 0.4	above ± 4	4
above ± 0.6 ml	5				

Internal Assessment: 25 Marks

Contents	Marks Allotted
Observation / Record	**10**
Model examination	**10**
Attendance	**5**
Total Marks	**25**

VOLUMETRIC ANALYSIS

The method to determine the exact amount of the substance in a given sample is termed as quantitative analysis. Volumetric analysis is a branch of quantitative analysis involving accurate measurement of volumes of reacting solutions. The volumetric analysis is very much in use due to simplicity, rapidity, accuracy and wide applicability.

The reacting substances are taken in the form of solutions and made to react. The concentration of one solution is determined using another suitable solution whose concentration is accurately known. A known volume of one solution is measured with a pipette and taken in a conical flask. The other solution is taken in a burette and run into the first solution till the chemical reaction is just complete. The volume of the second solution is read from the burette and the two volumes are compared.

Various terms used in volumetric analysis are given below:

Titration:

The process of adding one solution from the burette to another in the conical flask in order to complete the chemical reaction is termed titration.

End point:

It is the exact stage at which chemical reaction involved in the titration is just complete.

Indicator:

It is a substance which will show the end point of the reaction by change of colour. For example, phenolphthalein and methyl orange are indicators used in acid-alkali titrations. Potassium permanganate itself acts as an indicator in potassium permanganate titrations.

Acidimetry and alkalimetry Titration:

Acidimetry refers to the titration of alkali with a standard acid and alkalimetry refers to the titration of an acid with a standard alkali.

Permanganometric Titration:

The titration involving $KMnO_4$ is called permanganometric titration. In the presence of dilute H_2SO_4, $KMnO_4$ oxidises ferrous sulphate and ferrous ammonium sulphate to ferric sulphate and oxidizes oxalic acid to CO_2 and H_2O.

Iodometric Titration:

The amount of dissolved chlorine can be determined by titrating a known volume of water sample against thio solution using starch indicator. The estimation based on the iodometric titration.

Normality:

The strength of a solution is expressed in terms of normality. Normality is the number of gram equivalents of solute present in 1000 ml (1 litre) of the solution. It is represented by the symbol N.

Decinormal solution:

A solution of having the strength (Normality) of 0.1 N is called a decinormal solution.

Law of volumetric analysis:

Whenever two substances react together, they react in the ratio of their equivalent mass. One litre of a normal solution of a substance will react exactly with the same volume of a normal solution of another substance. In other words, equal normal solutions will exactly react with each other. This result is stated in the form of law of volumetric analysis.

If V_1 ml of a solution of strength N_1 is required for complete reaction by V_2 ml of the second solution of strength N_2, then $\mathbf{V_1N_1 = V_2N_2}$ If any three factors (V_1, V_2 and N_1) are known, the fourth factor N_2 can be calculated. The following formula is the important formula used in all volumetric estimations.

Mass of solute per litre of the solution = Equivalent mass x Normality

Equivalent mass of some important compounds:

Name of the compounds	Equivalent mass
Hydrochloric acid	36.5
Sulphuric acid	49
Oxalic acid	63
Sodium carbonate	53
Sodium hydroxide	40
Potassium hydroxide	56.1
Potassium permanganate	31.6
Ferrous sulphate	278
Ferrous ammonium sulphate	392
Potassium dichromate	49.04
Copper sulphate	249.54
EDTA (Disodium salt)	372
Iron	55.85
Chlorine (Molecular mass)	70.90

TITRATION – I

Hydrochloric acid solution Vs Sodium hydroxide solution

Sl. No.	Volume of Sodium hydroxide solution (V_2 ml)	Burette Reading		Volume of Hydrochloric acid solution (V_1 ml)	Indicator
		Initial (ml)	Final (ml)		
1.	20	0			Phenolphthalein
2.	20	0			
3.					
				Concordant value = ml	

Calculation:

Volume of Hydrochloric acid solution (V_1) = ml

Normality of Hydrochloric acid solution (N_1) = N

Volume of Sodium hydroxide solution (V_2) = ml

Normality of Sodium hydroxide solution (N_2) = ? N

By the principle of Volumetric Analysis,

$$\mathbf{V_1N_1 = V_2N_2}$$

$$\mathbf{N_2 = \frac{V_1N_1}{V_2}}$$

$$N_2 = \frac{X}{\quad}$$

Normality of Sodium hydroxide solution (N_2) = N

Expt. No. : 01 Date :	ESTIMATION OF SULPHURIC ACID

Aim:

To estimate the amount of sulphuric acid present in 100 ml of the given solution using a standard solution of hydrochloric acid solution of normality 0.1025 N and an approximately decinormal solution of sodium hydroxide.

Apparatus required:

50 ml Burette, 20 ml Pipette, 250 ml Conical flask, 100 ml SMF, Tiles, Burette stand, Wash bottle, Required reagents & solutions.

Principle:

The titration is based on the neutralization reaction between hydrochloric acid and sodium hydroxide in titration – I and sulphuric acid and sodium hydroxide in titration – II.

By the principle of Volumetric Analysis,

$$V_1N_1 = V_2N_2$$

Pre Experiment questions:

1. Titration – I occurs between which solution?

   Sodium hydroxide solution (in pipette) & Hydrochloric acid solution (in burette)

2. Titration – II occurs between which solution?

   Sodium hydroxide solution (in pipette) & Sulphuric acid solution (in burette)

3. Which indicator is used in this experiment?

   Phenolphthalein

4. Which type of reaction takes place in this experiment?

   Neutralization reaction

5. Which is the standard solution in this experiment?

   Hydrochloric acid solution

TITRATION – II

Sulphuric acid solution Vs Sodium hydroxide solution

Sl. No.	Volume of Sodium hydroxide solution (V_1 ml)	Burette Reading		Volume of Sulphuric acid solution (V_2 ml)	Indicator
		Initial (ml)	Final (ml)		
1.	20	0			Phenolphthalein
2.	20	0			
3.					
				Concordant value = ml	

Calculation:

Volume of Sodium hydroxide solution (V_1) = ml

Normality of Sodium hydroxide solution (N_1) = N

Volume of Sulphuric acid solution (V_2) = ml

Normality of Sulphuric acid solution (N_2) = ? N

By the principle of Volumetric Analysis,

$$\mathbf{V_1N_1 = V_2N_2}$$

$$\mathbf{N_2 = \frac{V_1N_1}{V_2}}$$

$$N_2 = \frac{X}{\quad}$$

Normality of Sulphuric acid solution (N_2) = N

The amount of Sulphuric acid present in the whole of the given solution,

$$= \frac{\text{Equivent mass of sulphuric acid X Normality of sulphuric acid solution}}{10}$$

Short procedure:

Description	Titration – I	Titration – II
Burette solution	Hydrochloric acid solution	Sulphuric acid solution
Pipette solution	Sodium hydroxide solution	Sodium hydroxide solution
Indicator	Phenolphthalein	Phenolphthalein
End point	Disappearance of pale pink colour	Disappearance of pale pink colour
Equivalent mass of sulphuric acid = 49		

Procedure:

A.) Titration – I: (Standardization of Sodium hydroxide solution)

- The burette is washed with water, rinsed with distilled water and then with the given hydrochloric acid solution.
- It is filled with same acid up to zero mark. The initial reading of the burette is noted.
- A 20 ml pipette is washed with water, rinsed with distilled water and then with the given sodium hydroxide solution.
- 20 ml of sodium hydroxide solution is pipetted out into a clean conical flask.
- Two drops of phenolphthalein indicator is added into the flask. The solution turns pale pink in colour.
- The solution is titrated against hydrochloric acid taken in the burette.
- The end point of the titration is the disappearance of pale pink colour to give colourless solution.
- The titration is repeated to get the concordant value.
- From the titre value, the normality of sodium hydroxide solution is calculated.

B.) Titration – II: (Standardization of Sulphuric acid solution)

- The given sulphuric acid solution is made up to 100 ml in a 100 ml standard flask. The solution is thoroughly shaken to get a uniformly concentrated solution.
- A 20 ml pipette is washed with water, rinsed with distilled water and then with the given sodium hydroxide solution.
- 20 ml of sodium hydroxide solution is pipetted out into a clean conical flask.
- Two drops of phenolphthalein indicator is added into the flask. The solution turns pale pink in colour.

- The solution is titrated against sulphuric acid solution taken in the burette. The end point of the titration is the change in colour from pale pink to colourless.
- The titration is repeated to get the concordant value.
- From the titre value, the normality of sulphuric acid solution is calculated.
- From the normality of sulphuric acid solution, the amount of sulphuric acid present in whole of the given solution is calculated.

Result:

1. The Normality of Sodium hydroxide solution = N
2. The Normality of Sulphuric acid solution = N
3. The amount of Sulphuric acid present in the whole of the given solution = g

Post Experiment questions:

1. What is the end point of this titration?

   Disappearance of pale pink colour

2. What is the equivalent mass of sulphuric acid?

   49

3. Give the formula used to find out the amount of sulphuric acid in given solution?

$$\frac{\text{Equivent mass of sulphuric acid X Normality of sulphuric acid solution}}{10}$$

TITRATION – I

Sulphuric acid solution Vs Potassium hydroxide solution

Sl. No.	Volume of Potassium hydroxide solution (V_1 ml)	Burette Reading		Volume of Sulphuric acid solution (V_2 ml)	Indicator
		Initial (ml)	Final (ml)		
1.	20	0			Phenolphthalein
2.	20	0			
3.					
				Concordant value = ml	

Calculation:

Volume of Potassium hydroxide solution (V_1) = ml

Normality of Potassium hydroxide solution (N_1) = N

Volume of Sulphuric acid solution (V_2) = ml

Normality of Sulphuric acid solution (N_2) = ? N

By the principle of Volumetric Analysis,

$$\mathbf{V_1N_1 = V_2N_2}$$

$$\mathbf{N_2 = \frac{V_1N_1}{V_2}}$$

$$N_2 = \frac{X}{\qquad}$$

Normality of Sulphuric acid solution (N_2) = N

Expt. No. : 02 Date :	ESTIMATION OF SODIUM HYDROXIDE

Aim:

To estimate the amount of sodium hydroxide present in 100 ml of the given solution using a standard solution of potassium hydroxide solution of normality 0.1010 N and an approximately decinormal solution of sulphuric acid.

Apparatus required:

50 ml Burette, 20 ml Pipette, 250 ml Conical flask, 100 ml SMF, Tiles, Burette stand, Wash bottle, Required reagents & solutions.

Principle:

The titration is based on the neutralization reaction between sulphuric acid and potassium hydroxide in titration – I and sulphuric acid and sodium hydroxide in titration – II.

By the principle of Volumetric Analysis,

$$V_1N_1 = V_2N_2$$

Pre Experiment questions:

1. Titration – I occurs between which solution?

   Potassium hydroxide solution (in pipette) & Sulphuric acid solution (in burette)

2. Titration – II occurs between which solution?

   Sodium hydroxide solution (in pipette) & Sulphuric acid solution (in burette)

3. Which indicator is used in this experiment?

   Phenolphthalein

4. Which type of reaction takes place in this experiment?

   Neutralization reaction

5. Which is the standard solution in this experiment?

   Potassium hydroxide solution

TITRATION – II

Sulphuric acid solution Vs Sodium hydroxide solution

Sl. No.	Volume of Sodium hydroxide solution (V_2 ml)	Burette Reading		Volume of Sulphuric acid solution (V_1 ml)	Indicator
		Initial (ml)	Final (ml)		
1.	20	0			Phenolphthalein
2.	20	0			
3.					
				Concordant value = ml	

Calculation:

Volume of Sulphuric acid solution (V_1) = ml

Normality of Sulphuric acid solution (N_1) = N

Volume of Sodium hydroxide solution (V_2) = ml

Normality of Sodium hydroxide solution (N_2) = ? N

By the principle of Volumetric Analysis,

$$\mathbf{V_1N_1 = V_2N_2}$$

$$\mathbf{N_2 = \frac{V_1N_1}{V_2}}$$

$$N_2 = \frac{X}{\quad}$$

Normality of Sodium hydroxide solution (N_2) = N

The amount of Sodium hydroxide present in the whole of the given solution,

$$= \frac{\text{Equivent mass of Sodium hydroxide X Normality of Sodium hydroxide solution}}{10}$$

$$= \frac{X}{10} = \quad g$$

Short procedure:

Description	Titration – I	Titration – II
Burette solution	Sulphuric acid solution	Sulphuric acid solution
Pipette solution	Potassium hydroxide solution	Sodium hydroxide solution
Indicator	Phenolphthalein	Phenolphthalein
End point	Disappearance of pale pink colour	Disappearance of pale pink colour
Equivalent mass of sodium hydroxide = 40		

Procedure:

A.) Titration – I: (Standardization of Potassium hydroxide solution)

- The burette is washed with water, rinsed with distilled water and then with the given Sulphuric acid solution. It is filled with same acid up to zero mark. The initial reading of the burette is noted.
- A 20 ml pipette is washed with water, rinsed with distilled water and then with the given Potassium hydroxide solution.
- 20 ml of Potassium hydroxide solution is pipetted out into a clean conical flask.
- Two drops of phenolphthalein indicator is added into the flask. The solution turns pale pink in colour.
- The solution is titrated against Sulphuric acid taken in the burette.
- The end point of the titration is the disappearance of pale pink colour to give colourless solution.
- The titration is repeated to get the concordant value.
- From the titre value, the normality of sulphuric acid solution is calculated.

B.) Titration – II: (Standardization of Sodium hydroxide solution)

- The given sodium hydroxide solution is made up to 100 ml in a 100 ml standard flask. The solution is thoroughly shaken to get a uniformly concentrated solution.
- A 20 ml pipette is washed with water, rinsed with distilled water and then with the given sodium hydroxide solution.
- 20 ml of sodium hydroxide solution is pipetted out into a clean conical flask.
- Two drops of phenolphthalein indicator is added into the flask. The solution turns pale pink in colour.
- The solution is titrated against sulphuric acid solution taken in the burette.

- The end point of the titration is the change in colour from pale pink to colourless solution. The titration is repeated to get the concordant value.
- From the titre value, the normality of sodium hydroxide solution is calculated.
- From the normality of sulphuric acid solution, the amount of sulphuric acid present in whole of the given solution is calculated.

Result:

1. The Normality of Sulphuric acid solution = N
2. The Normality of Sodium hydroxide solution = N
3. The amount of Sodium hydroxide present in the whole of the given solution = g

Post Experiment questions:

1. What is the end point of this titration?

   Disappearance of pale pink colour

2. What is the equivalent mass of sodium hydroxide?

   40

3. Give the formula used to find out the amount of sodium hydroxide in given solution?

$$\frac{\text{Equivent mass of sodium hydroxide X Normality of sodium hydroxide solution}}{10}$$

TITRATION – I

Potassium permanganate solution Vs Ferrous sulphate solution

Sl. No.	Volume of Ferrous sulphate solution (V_1 ml)	Burette Reading		Volume of Potassium permanganate solution (V_2 ml)	Indicator
		Initial (ml)	Final (ml)		
1.	20	0			Self ($KMnO_4$)
2.	20	0			
3.					
				Concordant value =	ml

Calculation:

Volume of Ferrous sulphate solution (V_1) = ml

Normality of Ferrous sulphate solution (N_1) = N

Volume of Potassium permanganate solution (V_2) = ml

Normality of Potassium permanganate solution (N_2) = ? N

By the principle of Volumetric Analysis,

$$\mathbf{V_1N_1 = V_2N_2}$$

$$\mathbf{N_2 = \frac{V_1N_1}{V_2}}$$

$$N_2 = \frac{X}{\quad}$$

Normality of Potassium permanganate solution (N_2) = N

Expt. No. : 03 Date :	ESTIMATION OF MOHR'S SALT (FERROUS AMMONIUM SULPHATE)

Aim:

To estimate the amount of crystalline ferrous ammonium sulphate (Mohr's salt) present in whole of the given solution using a standard solution of ferrous sulphate of normality 0.1013 N and an approximately decinormal solution of potassium permanganate.

Apparatus required:

50 ml Burette, 20 ml Pipette, 250 ml Conical flask, 100 ml SMF, Tiles, Burette stand, Wash bottle, Required reagents & solutions.

Principle:

The titration is based on the oxidation and reduction reaction. The oxidising agent, potassium permanganate oxidizes the reducing agent, ferrous sulphate and ferrous ammonium sulphate in acidic medium to ferric sulphate.

By the principle of Volumetric Analysis,

$$V_1N_1 = V_2N_2$$

Pre Experiment questions:

1. Titration – I occurs between which solution?

   Ferrous sulphate solution (in pipette) & Potassium permanganate solution (in burette)

2. Titration – II occurs between which solution?

   Ferrous ammonium sulphate solution (in pipette) & Potassium permanganate solution (in burette)

3. Which indicator is used in this experiment?

   Self (Potassium permanganate or $KMnO_4$)

4. Which type of reaction takes place in this experiment?

   Redox reaction

5. Which is the standard solution in this experiment?

   Ferrous sulphate solution

6. What are the reagents added in this titration?

   20 ml of dilute sulphuric acid

TITRATION – II

Potassium permanganate solution Vs Ferrous ammonium sulphate solution

Sl. No.	Volume of Ferrous ammonium sulphate solution (V_2 ml)	Burette Reading		Volume of Potassium permanganate solution (V_1 ml)	Indicator
		Initial (ml)	Final (ml)		
1.	20	0			Self ($KMnO_4$)
2.	20	0			
3.					
				Concordant value =	ml

Calculation:

Volume of Potassium permanganate solution (V_1) = ml

Normality of Potassium permanganate solution (N_1) = N

Volume of Ferrous ammonium sulphate solution (V_2) = ml

Normality of Ferrous ammonium sulphate solution (N_2) = ? N

By the principle of Volumetric Analysis,

$$\boxed{V_1N_1 = V_2N_2}$$

$$N_2 = \frac{V_1N_1}{V_2}$$

$$N_2 = \frac{X}{\quad}$$

Normality of Ferrous ammonium sulphate solution (N_2) = N

The amount of Ferrous ammonium sulphate present in the whole of the given solution,

$$= \frac{\text{Equivent mass of Ferrous ammonium sulphate X Normality of Sodium hydroxide solution}}{10}$$

$$= \frac{X}{10} = \quad g$$

Short procedure:

Description	Titration – I	Titration – II
Burette solution	Potassium permanganate solution	Potassium permanganate solution
Pipette solution	Ferrous sulphate solution	Ferrous ammonium sulphate solution
Reagents added	20 ml of dilute Sulphuric acid	20 ml of dilute Sulphuric acid
Indicator	Self ($KMnO_4$)	Self ($KMnO_4$)
End point	Appearance of pale permanent pink colour	Appearance of pale permanent pink colour
Equivalent mass of Ferrous ammonium sulphate = 392		

Procedure:

A.) Titration – I: (Standardization of Potassium permanganate solution)

- The burette is washed with water, rinsed with distilled water and then with the given Potassium permanganate solution.
- It is filled with same solution up to zero mark. The initial reading of the burette is noted.
- A 20 ml pipette is washed with water, rinsed with distilled water and then with the given ferrous sulphate solution.
- 20 ml of ferrous sulphate solution is pipetted out into a clean conical flask. One test tube of sulphuric acid (20 ml) is added into the flask.
- The solution is titrated against Potassium permanganate taken in the burette. Potassium permanganate acts as the self-indicator.
- The end point of the titration is the appearance of pale permanent pink colour.
- The titration is repeated to get the concordant value.
- From the titre value, the normality of Potassium permanganate solution is calculated.

B.) Titration – II: (Standardization of Ferrous ammonium sulphate solution)

- The given ferrous ammonium sulphate (Mohr's salt) solution is made up to 100 ml in a 100 ml standard flask. The solution is thoroughly shaken to get a uniformly concentrated solution.
- A 20 ml pipette is washed with water, rinsed with distilled water and then with the given ferrous ammonium sulphate solution.
- 20 ml of ferrous ammonium sulphate solution is pipetted out into a clean conical flask. One test tube of sulphuric acid (20 ml) is added into the flask.

- The solution is titrated against standardized Potassium permanganate taken in the burette. Potassium permanganate acts as the self-indicator.
- The end point of the titration is the appearance of pale permanent pink colour.
- The titration is repeated to get the concordant value.
- From the titre value, the normality of ferrous ammonium sulphate solution is calculated.
- From the normality of ferrous ammonium sulphate solution, the amount of ferrous ammonium sulphate present in whole of the given solution is calculated.

Result:

1. The Normality of Potassium permanganate solution = N
2. The Normality of Ferrous ammonium sulphate solution = N
3. The amount of Ferrous ammonium sulphate present in the whole of the given solution = g

Post Experiment questions:

1. What is the end point of this titration?

   Appearance of pale permanent pink colour

2. What is the equivalent mass of Ferrous ammonium sulphate?

   392

3. Give the formula used to find out the amount of Ferrous ammonium sulphate in given solution?

$$\frac{\text{Equivent mass of Ferrous ammonium sulphate X Normality of Ferrous ammonium sulphate solution}}{10}$$

TITRATION – I

Potassium permanganate solution Vs Ferrous ammonium sulphate solution

Sl. No.	Volume of Ferrous ammonium sulphate solution (V_1 ml)	Burette Reading		Volume of Potassium permanganate solution (V_2 ml)	Indicator
		Initial (ml)	Final (ml)		
1.	20	0			Self ($KMnO_4$)
2.	20	0			
3.					
				Concordant value =	ml

Calculation:

Volume of Ferrous ammonium sulphate solution (V_1) = ml

Normality of Ferrous ammonium sulphate solution (N_1) = N

Volume of Potassium permanganate solution (V_2) = ml

Normality of Potassium permanganate solution (N_2) = ? N

By the principle of Volumetric Analysis,

$$\mathbf{V_1N_1 = V_2N_2}$$

$$\mathbf{N_2 = \frac{V_1N_1}{V_2}}$$

$$N_2 = \frac{X}{\quad}$$

Normality of Potassium permanganate solution (N_2) = N

Expt. No. : 04 Date :	ESTIMATION OF FERROUS ION

Aim:

To estimate the amount of iron present in whole of the given ferrous sulphate solution using a standard solution of ferrous ammonium sulphate of normality 0.0950 N and an approximately decinormal solution of potassium permanganate.

Apparatus required:

50 ml Burette, 20 ml Pipette, 250 ml Conical flask, 100 ml SMF, Tiles, Burette stand, Wash bottle, Required reagents & solutions.

Principle:

The titration is based on the oxidation and reduction reaction. The oxidising agent, potassium permanganate oxidizes the reducing agent, ferrous sulphate and ferrous ammonium sulphate in acidic medium to ferric sulphate.

By the principle of Volumetric Analysis,

$$V_1N_1 = V_2N_2$$

Pre Experiment questions:

1. Titration – I occurs between which solution?

   Ferrous ammonium sulphate solution (in pipette) & Potassium permanganate solution (in burette)

2. Titration – II occurs between which solution?

   Ferrous sulphate solution (in pipette) & Potassium permanganate solution (in burette)

3. Which indicator is used in this experiment?

   Self (Potassium permanganate or $KMnO_4$)

4. Which type of reaction takes place in this experiment?

   Redox reaction

5. Which is the standard solution in this experiment?

   Ferrous ammonium sulphate solution

6. What are the reagents added in this titration?

   20 ml of dilute sulphuric acid

TITRATION – II

Ferrous sulphate solution Vs Potassium permanganate solution

Sl. No.	Volume of Ferrous sulphate solution (V_2 ml)	Burette Reading		Volume of Potassium permanganate solution (V_1 ml)	Indicator
		Initial (ml)	Final (ml)		
1.	20	0			Self ($KMnO_4$)
2.	20	0			
3.					
				Concordant value =	ml

Calculation:

Volume of Potassium permanganate solution (V_1) = ml

Normality of Potassium permanganate solution (N_1) = N

Volume of Ferrous sulphate solution (V_2) = ml

Normality of Ferrous sulphate solution (N_2) = ? N

By the principle of Volumetric Analysis,

$$\boxed{V_1N_1 = V_2N_2}$$

$$N_2 = \frac{V_1N_1}{V_2}$$

$$N_2 = \frac{X}{\quad}$$

Normality of Ferrous sulphate solution (N_2) = N

The amount of Iron present in whole of the given Ferrous sulphate solution,

$$= \frac{\text{Equivent mass of Iron X Normality of Ferrous sulphate solution}}{10}$$

$$= \frac{X}{10} = \quad g$$

Short procedure:

Description	Titration – I	Titration – II
Burette solution	Potassium permanganate solution	Potassium permanganate solution
Pipette solution	Ferrous ammonium sulphate solution	Ferrous sulphate solution
Reagents added	20 ml of dil. Sulphuric acid	20 ml of dilute Sulphuric acid
Indicator	Self ($KMnO_4$)	Self ($KMnO_4$)
End point	Appearance of pale permanent pink colour	Appearance of pale permanent pink colour
Equivalent mass of Iron = 55.85		

Procedure:

A.) Titration – I: (Standardization of Potassium permanganate solution)

- The burette is washed with water, rinsed with distilled water and then with the given Potassium permanganate solution.
- It is filled with same solution up to zero mark. The initial reading of the burette is noted.
- A 20 ml pipette is washed with water, rinsed with distilled water and then with the given ferrous ammonium sulphate solution.
- 20 ml of ferrous ammonium sulphate solution is pipetted out into a clean conical flask. One test tube of sulphuric acid (20 ml) is added into the flask.
- The solution is titrated against Potassium permanganate taken in the burette. Potassium permanganate acts as the self-indicator.
- The end point of the titration is the appearance of pale permanent pink colour.
- The titration is repeated to get the concordant value.
- From the titre value, the normality of Potassium permanganate solution is calculated.

B.) Titration – II: (Standardization of Ferrous sulphate solution)

- The given ferrous sulphate solution is made up to 100 ml in a 100 ml standard flask. The solution is thoroughly shaken to get a uniformly concentrated solution.
- A 20 ml pipette is washed with water, rinsed with distilled water and then with the given ferrous sulphate solution.
- 20 ml of ferrous sulphate solution is pipetted out into a clean conical flask. One test tube of sulphuric acid (20 ml) is added into the flask.

- The solution is titrated against standardized Potassium permanganate taken in the burette. Potassium permanganate acts as the self-indicator.
- The end point of the titration is the appearance of pale permanent pink colour.
- The titration is repeated to get the concordant value.
- From the titre value, the normality of ferrous sulphate solution is calculated.
- From the normality of ferrous sulphate solution, the amount of iron present in whole of the given ferrous sulphate solution is calculated.

Result:

1. The Normality of Potassium permanganate solution = N
2. The Normality of Ferrous sulphate solution = N
3. The amount of Iron present in whole of the given Ferrous sulphate solution = g

Post Experiment questions:

1. What is the end point of this titration?

   Appearance of pale permanent pink colour

2. What is the equivalent mass of Iron?

   55.85

3. Give the formula used to find out the amount of Ferrous in given solution?

$$\frac{\text{Equivent mass of Iron X Normality of Ferrous sulphate solution}}{10}$$

TITRATION – I

Potassium permanganate (B) solution Vs Ferrous sulphate solution

Sl. No.	Volume of Ferrous sulphate solution (V_1 ml)	Burette Reading		Volume of Potassium permanganate (B) solution (V_2 ml)	Indicator
		Initial (ml)	Final (ml)		
1.	20	0			Self ($KMnO_4$)
2.	20	0			
3.					
				Concordant value =	ml

Calculation:

Volume of Ferrous sulphate solution (V_1) = ml

Normality of Ferrous sulphate solution (N_1) = N

Volume of Potassium permanganate (B) solution (V_2) = ml

Normality of Potassium permanganate (B) solution (N_2) = ? N

By the principle of Volumetric Analysis,

$$\boxed{V_1N_1 = V_2N_2}$$

$$N_2 = \frac{V_1N_1}{V_2}$$

$$N_2 = \frac{X}{\quad}$$

Normality of Potassium permanganate (B) solution (N_2) = N

Expt. No. : 05 Date :	COMPARISON OF STRENGTH OF TWO POTASSIUM PERMANGANATE SOLUTIONS

Aim:

To compare the strength of two potassium permanganate solutions in bottles B and A and estimate the amount of potassium permanganate present in 750 ml of the given weaker solution using a standard solution of ferrous sulphate of normality 0.1055 N.

Apparatus required:

50 ml Burette, 20 ml Pipette, 250 ml Conical flask, Tiles, Burette stand, Wash bottle, Required reagents & solutions.

Principle:

The titration is based on the oxidation and reduction reaction. The oxidising agent, potassium permanganate oxidizes the reducing agent, ferrous sulphate in acidic medium to ferric sulphate.

By the principle of Volumetric Analysis,

$$V_1N_1 = V_2N_2$$

Pre Experiment questions:

1. Titration – I occurs between which solution?

   Ferrous sulphate solution (in pipette) & Potassium permanganate - B solution (in burette)

2. Titration – II occurs between which solution?

   Ferrous sulphate solution (in pipette) & Potassium permanganate – A solution (in burette)

3. Which indicator is used in this experiment?

   Self (Potassium permanganate or $KMnO_4$)

4. Which type of reaction takes place in this experiment?

   Redox reaction

5. Which is the standard solution in this experiment?

   Ferrous sulphate solution

6. What are the reagents added in this titration?

   20 ml of dilute sulphuric acid

TITRATION – II

Potassium permanganate (A) solution Vs Ferrous sulphate solution

Sl. No.	Volume of Ferrous sulphate solution (V_1 ml)	Burette Reading		Volume of Potassium permanganate (A) solution (V_2 ml)	Indicator
		Initial (ml)	Final (ml)		
1.	20	0			Self ($KMnO_4$)
2.	20	0			
3.					
				Concordant value =	ml

Calculation:

Volume of Ferrous sulphate solution (V_1) = ml

Normality of Ferrous sulphate solution (N_1) = N

Volume of Potassium permanganate (A) solution (V_2) = ml

Normality of Potassium permanganate (A) solution (N_2) = ? N

By the principle of Volumetric Analysis,

$$\mathbf{V_1N_1 = V_2N_2}$$

$$\mathbf{N_2 = \frac{V_1N_1}{V_2}}$$

$$N_2 = \frac{X}{\quad}$$

Normality of Potassium permanganate (A) solution (N_2) = N

Potassium permanganate ( ) solution is weaker than Potassium permanganate ( ) solution

The amount of Potassium permanganate present in 750 ml of the given weaker solution,

$$= \frac{\text{Equivent mass of Potassium permanganate X Normality of Potassium permanganate solution X 750}}{1000}$$

$$= \frac{X \quad X\ 750}{1000} = \quad g$$

Short procedure:

Description	Titration – I	Titration – II
Burette solution	Potassium permanganate (B) solution	Potassium permanganate (A) solution
Pipette solution	Ferrous sulphate solution	Ferrous sulphate solution
Reagents added	20 ml of dil. Sulphuric acid	20 ml of dilute Sulphuric acid
Indicator	Self ($KMnO_4$)	Self ($KMnO_4$)
End point	Appearance of pale permanent pink colour	Appearance of pale permanent pink colour
Equivalent mass of Potassium permanganate = 31.6		

Procedure:

A.) Titration – I: (Standardization of Potassium permanganate - B solution)

- The burette is washed with water, rinsed with distilled water and then with the given Potassium permanganate (B) solution.
- It is filled with same solution up to zero mark. The initial reading of the burette is noted.
- A 20 ml pipette is washed with water, rinsed with distilled water and then with the given ferrous sulphate solution.
- 20 ml of ferrous sulphate solution is pipetted out into a clean conical flask. One test tube of sulphuric acid (20 ml) is added into the flask.
- The solution is titrated against Potassium permanganate (B) taken in the burette. Potassium permanganate (B) acts as the self-indicator.
- The end point of the titration is the appearance of pale permanent pink colour.
- The titration is repeated to get the concordant value.
- From the titre value, the normality of Potassium permanganate (B) solution is calculated.

B.) Titration – I: (Standardization of Potassium permanganate - A solution)

- The burette is washed with water, rinsed with distilled water and then with the given Potassium permanganate (A) solution.
- It is filled with same solution up to zero mark. The initial reading of the burette is noted.
- A 20 ml pipette is washed with water, rinsed with distilled water and then with the given ferrous sulphate solution.

- 20 ml of ferrous sulphate solution is pipetted out into a clean conical flask. One test tube of sulphuric acid (20 ml) is added into the flask.
- The solution is titrated against Potassium permanganate (A) taken in the burette. Potassium permanganate (A) acts as the self-indicator.
- The end point of the titration is the appearance of pale permanent pink colour.
- The titration is repeated to get the concordant value.
- From the titre value, the normality of Potassium permanganate (A) solution is calculated.
- The normalities of two potassium permanganate solutions are compared and then the amount of potassium permanganate present in 750 ml of the given weaker solution is calculated.

Result:

1. The Normality of Potassium permanganate (B) solution = N
2. The Normality of Potassium permanganate (A) solution = N
3. Potassium permanganate ( ) solution is weaker than Potassium permanganate ( ) solution
4. The amount of Potassium permanganate present in 750 ml of the given weaker solution } = g

Post Experiment questions:

1. What is the end point of this titration?

   Appearance of pale permanent pink colour

2. What is the equivalent mass of Potassium permanganate?

   31.6

3. Give the formula used to find out the amount of Potassium permanganate in given solution?

$$\frac{\text{Equivent mass ofPotassium permanganate X Normality of Potassium permanganate solution X 750}}{1000}$$

TITRATION – I

EDTA solution Vs Calcium chloride solution

Sl. No.	Volume of Calcium chloride solution (V_1 ml)	Burette Reading		Volume of EDTA solution (V_2 ml)	Indicator
		Initial (ml)	Final (ml)		
1.	20	0			EBT
2.	20	0			
3.					
				Concordant value =	ml

Calculation:

Volume of Calcium chloride solution (V_1) = ml

Molarity of Calcium chloride solution (M_1) = M

Volume of EDTA solution (V_2) = ml

Molarity of EDTA solution (M_2) = ? M

By the principle of Volumetric Analysis,

$$\mathbf{V_1M_1 = V_2M_2}$$

$$\mathbf{M_2 = \frac{V_1M_1}{V_2}}$$

$$M_2 = \frac{X}{\qquad}$$

Molarity of EDTA solution (M_2) = M

Expt. No. : 06 Date :	ESTIMATION OF TOTAL HARDNESS OF THE SAMPLE BY USING EDTA METHOD

Aim:

To estimate the total hardness of the given sample of water by EDTA titration using a standard calcium chloride solution of molarity 0.0101 M and an approximately decimolar solution of EDTA.

Apparatus required:

50 ml Burette, 20 ml Pipette, 250 ml Conical flask, Tiles, Burette stand, Wash bottle, Required reagents & solutions.

Principle:

The total hardness of water can be determined by titrating a known volume of hard water against EDTA solution using Eriochrome Black – T indicator. The estimation is based on the complexometric titration.

By the principle of Volumetric Analysis,

$$V_1M_1 = V_2M_2$$

Pre Experiment questions:

1. Titration – I occurs between which solution?

   Calcium chloride solution (in pipette) & EDTA solution (in burette)

2. Titration – II occurs between which solution?

   Water sample (in pipette) & EDTA solution (in burette)

3. Which indicator is used in this experiment?

   Eriochrome Black – T

4. Which type of reaction takes place in this experiment?

   Formation of complexes (Complexometric titration)

5. Which is the standard solution in this experiment?

   Calcium chloride solution

6. What are the reagents added in this titration?

   10 ml of ammonia buffer solution

TITRATION – II

EDTA solution Vs Water sample

Sl. No.	Volume of Water sample (V_2 ml)	Burette Reading		Volume of EDTA solution (V_1 ml)	Indicator
		Initial (ml)	Final (ml)		
1.	20	0			EBT
2.	20	0			
3.					
				Concordant value =	ml

Calculation:

Volume of EDTA solution (V_1) = ml

Molarity of EDTA solution (M_1) = M

Volume of Water sample (V_2) = ml

$$\textbf{Total hardness of water sample} = \frac{V_1 M_1}{V_2} \times 10^6$$

$$= \frac{x}{\quad} \times 10^6$$

= ppm

Short procedure:

Description	Titration – I	Titration – II
Burette solution	EDTA solution	EDTA solution
Pipette solution	Calcium chloride solution	Water sample
Reagents added	10 ml of ammonia buffer solution	10 ml of ammonia buffer solution
Indicator	Eriochrome Black – T (or) EBT	Eriochrome Black – T (or) EBT
End point	Change in colour from wine red to steel blue	Change in colour from wine red to steel blue

Procedure:

A.) Titration – I: (Standardization of EDTA solution)

- The burette is washed with water, rinsed with distilled water and then with the given EDTA solution.
- It is filled with same solution up to zero mark. The initial reading of the burette is noted.
- A 20 ml pipette is washed with water, rinsed with distilled water and then with the given standard calcium chloride solution.
- 20 ml of standard calcium chloride solution is pipetted out into a clean conical flask.
- Half a test tube of ammonia buffer solution (10 ml) is added into the flask.
- A pinch of EBT indicator is added into the flask. The solution turns wine red in colour.
- The solution is titrated against EDTA solution taken in the burette.
- The end point of the titration is the change in colour from wine red to steel blue.
- The titration is repeated to get the concordant value.
- From the titre value, the molarity of EDTA solution is calculated.

B.) Titration – II: (Standardization of Water sample)

- A 20 ml pipette is washed with water, rinsed with distilled water and then with the given water sample.
- 20 ml of water sample is pipetted out into a clean conical flask.
- Half a test tube of ammonia buffer solution (10 ml) is added into the flask.
- A pinch of EBT indicator is added into the flask. The solution turns wine red in colour.
- The solution is titrated against EDTA solution taken in the burette.
- The end point of the titration is the change in colour from wine red to steel blue.
- The titration is repeated to get the concordant value.

- From the titre value, the hardness of the given water sample is calculated in ppm.

Result:

1. The Molarity of EDTA solution = M
2. The total hardness of the given water sample = ppm

Post Experiment questions:

1. What is the end point of this titration?

   Change in colour from wine red to steel blue

2. What stands for ppm?

   Parts per million

3. What is one ppm?

   1 mg per particles dissolved per litre is called as 1 ppm

Determination of pH, TDS & calculation of $[H^+]$

Sl. No.	Sample solution	pH	$[H^+]$ (g ions / litre)	TDS (ppm)
1.	A			
2.	B			
3.	C			

Calculation:

I.) Sample – A:

pH =

pH = - $\log_{10}[H^+]$

$[H^+]$ = Antilog (-pH)

= Antilog (-)

= g ions / litre

II.) Sample – B:

pH =

pH = - $\log_{10}[H^+]$

$[H^+]$ = Antilog (-pH)

= Antilog (-)

= g ions / litre

III.) Sample – C:

pH =

pH = - $\log_{10}[H^+]$

$[H^+]$ = Antilog (-pH)

= Antilog (-)

= g ions / litre

Expt. No. : 07 Date :	WATER QUALITY TESTING – DETERMINATION OF pH, TDS & CALCULATION OF $[H^+]$

Aim:

To find out,

1) The pH and TDS of the given solutions in bottles – A, B & C.
2) To calculate the hydrogen ion concentrations of the above solutions.

Apparatus required:

pH & TDS meter with electrode, Buffer solutions, 100 ml beaker, Wash bottle.

Principle:

The pH of the solution can be directly measured using a pH meter. Acids give hydrogen ions in solution. The acidic nature of the solution depends on the hydrogen ion concentration which is expressed as grams ions per litre. The pH of the solution varies with the concentration of ions.

The TDS of the solution can be directly measured using a TDS meter.

$$\boxed{pH = -\log_{10}[H^+]}$$

Pre Experiment questions:

1. Which buffer is used for calibrate the pH meter?

   pH @ 7 and pH @ 4

2. Which buffer is used for calibrate the TDS meter?

   342 ppm standard buffer

3. Which electrode is used in this pH meter?

   Calomel electrode

4. Which electrode is used in this TDS meter?

   Platinum electrode

5. Which is the standard solution in this experiment?

   Calcium chloride solution

6. Before the electrodes are immersed in next solution the electrodes are washed with which type of water?

   Distilled water

Procedure:

- Exactly 50 ml of the given three sample solutions are taken in three 100 ml beakers and labeled as A, B & C

A.) Determination of pH using pH meter:

- The pH meter is standardized using a known buffer solution.
- The electrodes are then washed with distilled water and then immersed in the solution taken in the beaker.
- The pH reading is noted. The pH of the other solutions is determined similarly.
- The electrodes are washed well with distilled water before the electrodes are immersed in next solution.
- The amount of hydrogen ions present in the solution is then calculated from the pH.

B.) Determination of TDS using TDS meter:

- The TDS meter is standardized using a known buffer solution.
- The electrodes are then washed with distilled water and then immersed in the solution taken in the beaker.
- The TDS reading is noted. The TDS of the other solutions is determined similarly.
- The electrodes are washed well with distilled water before the electrodes are immersed in next solution.

Result:

Sl. No.	Sample solution	Ph	$[H^+]$ (g ions / litre)	TDS (ppm)
1.	A			
2.	B			
3.	C			

Post Experiment questions:

1. What stands for TDS?

   Total Dissolved Solids.

2. What stands for ppm?

   Parts per million.

3. Which formula is used to find out the hydrogen ion concentration of the given solution?

   $pH = -\log_{10}[H^+]$

   $[H^+] = \text{Antilog}(-pH)$

TITRATION – I

Thio solution Vs Potassium dichromate solution

Sl. No.	Volume of Potassium dichromate solution (V_1 ml)	Burette Reading		Volume of Thio solution (V_2 ml)	Indicator
		Initial (ml)	Final (ml)		
1.	20	0			Starch
2.	20	0			
3.					
				Concordant value = ml	

Calculation:

Volume of Potassium dichromate solution (V_1) = ml

Molarity of Potassium dichromate solution (M_1) = M

Volume of Thio solution (V_2) = ml

Molarity of Thio solution (M_2) = ? M

By the principle of Volumetric Analysis,

$$\mathbf{V_1M_1 = V_2M_2}$$

$$\mathbf{M_2 = \frac{V_1M_1}{V_2}}$$

$$M_2 = \frac{X}{\quad}$$

Molarity of Thio solution (M_2) = M

Expt. No. : 08 Date :	WATER ANALYSIS FOR DISSOLVED CHLORINE

Aim:

To estimate the amount of chlorine dissolved in the given sample of water by Iodometric method using a standard potassium dichromate solution of molarity 0.0499 M and an approximately decimolar solution of thio.

Apparatus required:

50 ml Burette, 20 ml Pipette, 250 ml Iodometric flask, Tiles, Burette stand, Wash bottle, Required reagents & solutions.

Principle:

The amount of dissolved chlorine can be determined by titrating a known volume of water sample against thio solution using starch indicator. The estimation based on the iodometric titration.

$$Cr_2O_7^{2-} + 14H^+ + 6S_2O_3^{2-} \rightarrow 2Cr_3^{3+} + 3S_4O_6^{2-} + 7H_2O$$

$$2\,Na_2S_2O_3 + Cl_2 + 2KI \rightarrow Na_2S_4O_6 + 2NaI + 2KCl$$

By the principle of Volumetric Analysis,

$$V_1M_1 = V_2M_2$$

Pre Experiment questions:

1. Titration – I occurs between which solution?

   Potassium dichromate solution (in pipette) & Thio solution (in burette)

2. Titration – II occurs between which solution?

   Water sample (in pipette) & Thio solution (in burette)

3. Which indicator is used in this experiment?

   Starch

4. Which type of reaction takes place in this experiment?

   Determination of oxidizing agent during liberation reaction

5. Which is the standard solution in this experiment?

   Potassium dichromate solution

6. What are the reagents added in this titration?

   20 ml of dilute sulphuric acid + 10 ml of 10% KI solution

TITRATION – II

Thio solution Vs Water sample

Sl. No.	Volume of Water sample (V_2 ml)	Burette Reading		Volume of Thio solution (V_1 ml)	Indicator
		Initial (ml)	Final (ml)		
1.	20	0			Starch
2.	20	0			
3.					
				Concordant value = ml	

Calculation:

Volume of Thio solution (V_1) = ml

Molarity of Thio solution (M_1) = M

Volume of Water sample (V_2) = ml

Molarity of Water sample (M_2) = ? M

By the principle of Volumetric Analysis,

$$\mathbf{V_1M_1 = 2V_2M_2}$$

$$\mathbf{M_2 = \frac{V_1M_1}{2V_2}}$$

$$M_2 = \frac{X}{2 \quad X}$$

Molarity of Water sample (M_2) = M

The amount of chlorine present in 20 ml of water sample,

= Molarity of water sample X Molar mass of Chlorine

= X = g

The amount of chlorine present in 100 ml of water sample = X 5 g

= g

Short procedure:

Description	Titration – I	Titration – II
Burette solution	Thio solution	Thio solution
Pipette solution	Potassium dichromate solution	Water sample
Reagents added	20 ml of dilute Sulphuric acid + 10 ml of 10 % KI solution	20 ml of dilute Sulphuric acid + 10 ml of 10 % KI solution
Titration until	Get yellowish green colour	Get yellowish green colour
Indicator	Starch	Starch
End point	Change in colour from blue to green	Change in colour from blue to green
Molecular mass of chlorine = 70.90		

Procedure:

A.) Titration – I: (Standardization of Thio solution)

- The burette is washed with water, rinsed with distilled water and then with the given thio solution.
- It is filled with same solution up to zero mark. The initial reading of the burette is noted.
- A 20 ml of pipette is washed with water, rinsed with distilled water and then with the given standard potassium dichromate solution.
- 20 ml of standard potassium dichromate solution is pipetted out into a clean iodometric flask.
- 20 ml of dilute sulphuric acid 10 ml of 10% KI solution is added in to the Iodomeric flask.
- The flask was constantly shaken well. It is allowed to stand for some times and the liberated iodine was titrated against thio solution.
- When the solution was yellowish green colour, 1ml of starch was added as an indicator and the titration was continued to get the end point.
- The end point was the disappearance of blue to green color.
- From the titre value, the molarity of thio solution is calculated.

B.) Titration – II: (Standardization of Water sample)

- A 20 ml of pipette is washed with water, rinsed with distilled water and then with the given water sample.
- 20 ml of water sample is pipetted out into a clean iodometric flask.
- 20 ml of dilute sulphuric acid 10 ml of 10% KI solution is added in to the Iodomeric flask.

- The flask was constantly shaken well. It is allowed to stand for some times and the liberated iodine was titrated against thio solution.
- When the solution was yellowish green colour, 1ml of starch was added as an indicator and the titration was continued to get the end point.
- The end point was the disappearance of blue to green color.
- From the titre value, the amount of chlorine present in the given sample of water is calculated.

Result:

1. The Molarity of Thio solution = M
2. The amount of chlorine present in 100 ml of water sample = g

Post Experiment questions:

1. What is the end point of this titration?

   Change in colour from blue to green

2. What is the molar mass of Chlorine?

   70.90

3. Give the formula used to find out the amount of Chlorine in given water sample?

   Molarity of Water sample X Molar mass of chlorine

Calculation:

Weight of empty filter paper (W_1)	=	g
Weight of empty filter paper + Lead nano materials (W_2)	=	g
Weight of Lead nano materials ($W_2 – W_1$)	=	g

Expt. No. : 09 Date :	SYNTHESIS OF LEAD NANO MATERIALS BY CHEMICAL REDUCTION METHOD

Aim:

To synthesis a Lead Nano materials by a chemical reduction method.

Principle:

Reduction is a chemical reaction that involves the gaining of electrons by one of the atoms involved in the reaction between two chemicals. The term refers to the element that accepts electrons, as the oxidation state of the element that gains electrons is lowered.

Apparatus & chemicals required:

Lead sulphate, Sodium borohydride, distilled water, beaker, Measuring cylinder, spatula, digital balance, magnetic stirrer and magnetic pellet.

Pre Experiment questions:

1. What are the size of nano particles?

   10^{-9} m sized particles

2. How will you prepare the solution for the preparation of lead Nano materials?

   1 g of Lead sulphate is dissolved in 30 ml of water

3. Which reducing agent is used in this experiment?

   Sodium borohydride

4. Which method lead nano materials is prepared?

   Chemical reduction method

5. What are the duration of stirring of a reaction mixture?

   1 hour at RT

Short Procedure:

Preparation of solution	1 g of Lead sulphate in 30 ml water
Duration of stirring	1 hour at room temperature
Addition of reducing agent	0.5 g sodium borohydride (slowly added)
Filtration	Using Whatmann No-42 filter paper
Drying	Dried in hot air-oven at 110° C for 30 minutes
Yield	Weighed and then collected

Procedure:

- About weighed lead sulphate (1g) accurately and then transferred it into 30 ml of water taken in a 250 ml beaker.
- Then stirred the above solution in a magnetic stirrer at room temperature, and slow addition of sodium borohydride (0.5g) takes place in the stirring solution. Here, exothermic reaction takes place.
- \The reaction mixture was stirred about 1 hour.
- After the completion of the reaction the synthesized lead nano materials is filtered using Whatmann No-42 filter paper and dried at hot air-oven at 110° C for 30 minutes.
- Finally, the synthesized lead nano materials was collected and weighed.

Result:

Yield of Lead nano materials are = g

Post Experiment questions:

1. What is the drying process of formed lead nano materials?

   Dried at hot air-oven @ 110° C for 30 minutes

2. Which filter paper is used for filtration?

   Whatmann No – 42 filter paper

3. How will you find out the yield of lead nano materials?

   Weight of empty filter paper (W_1) = g

   Weight of empty filter paper + Lead nano materials (W_2) = g

   Weight of Lead nano materials (W_2-W_1) = g

Calculation:

Weight of empty filter paper (W_1)	=	g
Weight of empty filter paper + Chromium nano materials (W_2)	=	g
Weight of Chromium nano materials ($W_2 – W_1$)	=	g

Expt. No. : 10 Date :	SYNTHESIS OF CHROMIUM NANO MATERIALS BY CHEMICAL REDUCTION METHOD

Aim:

To synthesis a Chromium Nano materials by a chemical reduction method.

Principle:

Reduction is a chemical reaction that involves the gaining of electrons by one of the atoms involved in the reaction between two chemicals. The term refers to the element that accepts electrons, as the oxidation state of the element that gains electrons is lowered.

Apparatus & chemicals required:

Potassium dichromate, Sodium borohydride, distilled water, beaker, Measuring cylinder, spatula, digital balance, magnetic stirrer and magnetic pellet.

Pre Experiment questions:

1. What are the size of nano particles?

   10^{-9} m sized particles

2. How will you prepare the solution for the preparation of chromium Nano materials?

   1 g of Potassium dichromate is dissolved in 30 ml of water

3. Which reducing agent is used in this experiment?

   Sodium borohydride

4. Which method lead nano materials is prepared?

   Chemical reduction method

5. What are the duration of stirring of a reaction mixture?

   1 hour at RT

Short Procedure:

Preparation of solution	1 g of Potassium dichromate in 30 ml water
Duration of stirring	1 hour at room temperature
Addition of reducing agent	2 g sodium borohydride (slowly added)
Filtration	Using Whatmann No-42 filter paper
Drying	Dried in hot air-oven at 110° C for 30 minutes
Yield	Weighed and then collected

Procedure:

- About weighed Potassium dichromate (1g) accurately and then transferred it into 30 ml of water taken in a 250 ml beaker.
- Then stirred the above solution in a magnetic stirrer at room temperature, and slow addition of sodium borohydride (2g) takes place in the stirring solution. Here, exothermic reaction takes place.
- The reaction mixture was stirred about 1 hour.
- After the completion of the reaction the synthesized Chromium nano materials is filtered using Whatmann No-42 filter paper and dried at hot air-oven at 110° C for 30 minutes.Finally, the synthesized Chromium nano materials was collected and weighed.

Result:

Yield of Chromium nano materials are = g

Post Experiment questions:

1. Which reaction is takes place during addition of reducing agent?

   Exothermic reaction

2. Which filter paper is used for filtration?

   Whatmann No – 42 filter paper

3. How will you find out the yield of Chromium Nano materials?

   Weight of empty filter paper (W_1) = g

   Weight of empty filter paper + Chromium Nano materials (W_2) = g

   Weight of Chromium Nano materials (W_2-W_1) = g

MODEL QUESTIONS

Max. Marks: 75 Time: 03 hrs.

1) To **ESTIMATE** the amount of **SULPHURIC ACID** (in SMF) present in 100 ml of the given solution using a standard solution of Hydrochloric acid (in Bottle-B) of normality 0.1025 N of and an approximately decinormal sodium hydroxide solution (in Bottle-C).
2) To **ESTIMATE** the amount of **SODIUM HYDROXIDE** (in SMF) present in 100 ml of the given solution using a standard solution of potassium hydroxide (in Bottle-B) of normality 0.1010 N of and an approximately decinormal sulphuric acid solution (in Bottle-C).
3) To **ESTIMATE** the amount of **FERROUS AMMONIUM SULPHATE - MOHR'S SALT**(in SMF) present in 100 ml of the given solution using a standard solution of ferrous sulphate (in Bottle-B) of normality 0.1013 N of and an approximately decinormal Potassium permanganate solution (in Bottle-C).
4) To **ESTIMATE** the amount of **FERROUS ION** PRESNT IN FERROUS SULPHATE SOLUTION (in SMF) present in 100 ml of the given solution using a standard solution of ferrous ammonium sulphate (in Bottle-B) of normality 0.0950 N of and an approximately decinormal Potassium permanganate solution (in Bottle-C).
5) To **COMPARE** the **STRENGTH OF TWO POTASSIUM PERMANGANATE SOLUTION** (in Bottle-A & Bottle-B) and to estimate the amount of POTASSIUM PERMANGANATE present in 750 ml of the WEAKER SOLUTION using a standard solution of ferrous sulphate (in Bottle-C) of normality 0.1055 N.
6) To **ESTIMATE** the **TOTAL HARDNESS OF THE GIVEN WATER SAMPLE** (in Bottle-A) using a standard solution of calcium chloride (in Bottle-B) of molarity 0.0101 M and an approximately decimolar EDTA solution (in Bottle-C).
7) **WATER QUALITY TESTING -** DETERMINE the **pH & TDS** of three given samples using pH meter and CALCULATE THE HYDROGEN ION CONCENTRATION of the samples.
8) To **ESTIMATE** the **DISSOLVED CHLORINE OF THE GIVEN WATER SAMPLE** (in Bottle-A) using a standard solution of Potassium dichromate (in Bottle-B) of molarity 0.0499 M and an approximately decimolar thio solution (in Bottle-C).