



**SRM VALLIAMMAI ENGINEERING COLLEGE**

(An Autonomous Institution)  
SRM Nagar, Kattankulathur - 603 203



**DEPARTMENT OF CHEMISTRY**

# *1901108-Chemistry Lab Manual*

## *(2021-22)*

SRMVEC-Dept of Chemistry

(Common to all branches of B.E., / B.Tech., Programmes)

### CHEMISTRY LABORATORY: (Any five experiments to be conducted)

#### OBJECTIVES

- To make the student to acquire practical skills in the determination of water quality parameters through volumetric and instrumental analysis.
- To acquaint the students with the determination of molecular weight of a polymer by viscometry.
- To make the student conversant with the corrosion defects experimentally.
- To develop and understand the basic concepts of acidic and basic nature using pH.
- To make the student familiar with the properties and nature of alloys experimentally.

#### List of Experiments

1. Estimation of HCl using  $\text{Na}_2\text{CO}_3$  as primary standard and determination of alkalinity in water sample.
2. Estimation of copper content of the given solution by iodometry.
3. Determination of strength of given hydrochloric acid using pH meter.
4. Determination of strength of acids in a mixture of acids using conductivity meter.
5. Estimation of iron content of the given solution using potentiometer.
6. Determination of molecular weight of polyvinyl alcohol using Ostwald viscometer.
7. Pseudo first order kinetics-ester hydrolysis.
8. Corrosion experiment-weight loss method.
9. Conductometric titration of strong acid vs strong base.

#### OUTCOMES

##### The students should be able to:

- Obtain the hands-on knowledge in the quantitative chemical analysis of water quality related parameters.
- Understand the experimental concepts in the mixture of acids and bases.
- Appreciate the need of iodometry in the estimation of metals.
- Explore the drawbacks of corrosion by weight loss method.
- Design and carry out the scientific experiments related to boiler troubles.

#### TEXT BOOKS

G.H. Jeffery, J. Bassett, J. Mendham and R.C. Denney, "Vogel's Textbook of Quantitative Chemical Analysis", John Wiley & Sons Inc, 2014.

## CONTENTS

<b>EX.NO.</b>	<b>NAME OF THE EXPERIMENTS</b>	<b>PAGE NO.</b>
1	Estimation of Alkalinity of Water	2
2	Determination of Copper in samples using EDTA	8
3	Estimation of Ferrous Ion by Potentiometric Redox Titration	12
4	Conductometric Precipitation Titration (Barium chloride Vs Sodium sulphate)	16
5	Conductometric Titration of Strong Acid with Strong Base	18
6	pH Metry – Determination of Strength of HCl	22
7	Conductometric Titration of Mixture of Acids	26

**Table. 1** Titre values and different alkalinities

S. No.	Value of [P] & [M]	Alkalinity due to			Nature of alkalinity
		OH <sup>-</sup>	CO <sub>3</sub> <sup>2-</sup>	HCO <sub>3</sub> <sup>-</sup>	
1.	P = 0	0	0	M	Only HCO <sub>3</sub> <sup>-</sup> ions present
2.	P = 1/2 M	0	2P	0	Only CO <sub>3</sub> <sup>2-</sup> ions present
3.	P = M	P = M	0	0	Only OH <sup>-</sup> ions present
4.	P < 1/2 M	0	2P	M - 2P	HCO <sub>3</sub> <sup>-</sup> , CO <sub>3</sub> <sup>2-</sup> ions present
5.	P > 1/2 M	2P - M	2M - 2P	0	Only OH <sup>-</sup> , CO <sub>3</sub> <sup>2-</sup> ions present

**Table. 2** Water sample 1 vs standard acid

S.No	Volume of the water sample(ml)	Burette reading (ml)			Volume of the acid (ml)	
		Initial	[P]	[M]	[P]	[M]
1.	20					
2.	20					

SRMVEC-Dept of Chemistry

**Calculation**

If the data satisfies the condition  $P > \frac{1}{2} M$

(i) Volume of HCl required for OH<sup>-</sup> Alkalinity =  $2P - M = \text{_____ ml}$

(ii) Volume of HCl required for CO<sub>3</sub><sup>2-</sup> Alkalinity =  $2M - 2P = \text{_____ ml}$

(iii) HCO<sub>3</sub><sup>-</sup> absent

**Calculation of OH<sup>-</sup> alkalinity**

Volume of HCl (V<sub>1</sub>) = \_\_\_\_\_ ml

Strength of HCl (N<sub>1</sub>) = 0.1 N

Volume of sample water (V<sub>2</sub>) = 20 ml

Strength of sample water (N<sub>2</sub>) = ?

According to volumetric formula

$$V_1 N_1 = V_2 N_2$$

$$N_2 = \frac{\text{_____ ml} \times 0.1 \text{ N}}{20} = \text{_____ N}$$

## 1. ESTIMATION OF ALKALINITY OF WATER

Expt. No.	
-----------	--

Date			
------	--	--	--

### AIM

To determine the type and amount of alkalinity present in the given water sample. You are provided with standard solution of Hydrochloric acid of strength of 0.1N.

### CHEMICALS REQUIRED

0.1 N HCl, phenolphthalein and methyl orange

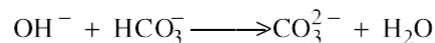
### PRINCIPLE

- The alkalinity of water is normally due to the presence of bicarbonates, carbonates and hydroxides of sodium, potassium, calcium and magnesium. The knowledge of alkalinity is important in calculating the amounts of reagents required in water softening and in internal conditioning of boiler feed waters.

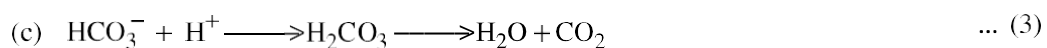
The alkalinity in water can be present due to the presence of the above mentioned ions present alone or in combination as

- Hydroxide only ( $\text{OH}^-$ )
- Carbonates only ( $\text{CO}_3^{2-}$ )
- Bicarbonates only ( $\text{HCO}_3^-$ )
- Hydroxides and carbonates ( $\text{OH}^- + \text{CO}_3^{2-}$ )
- Carbonate and bicarbonates ( $\text{CO}_3^{2-} + \text{HCO}_3^-$ )

The possibility of all the three ions existing together is ruled out because the hydroxides and bicarbonate ions combine together to form  $\text{CO}_3^{2-}$  ions



The alkalinity of the water sample is determined by titrating against the standard acid using phenolphthalein and methyl orange indicators. The following reactions take place.



Amount of  $\text{OH}^-$  present in 1 litre of water

sample in terms of  $\text{CaCO}_3$  equivalent = Strength of water sample  $\times$  Eq.wt of  $\text{CaCO}_3$

i.e  $\text{OH}^-$  alkalinity of  $\text{CaCO}_3$  equivalent = \_\_\_\_ N  $\times 50 \times 10^3$  ppm

Alkalinity due to  $\text{OH}^-$  ion = \_\_\_\_ ppm

### Calculation of $\text{CO}_3^{2-}$ alkalinity

Volume of HCl ( $V_1$ ) = \_\_\_\_ ml

Strength of HCl ( $N_1$ ) = 0.1 N

Volume of sample water ( $V_2$ ) = 20 ml

Strength of sample water ( $N_2$ ) = ?

According to volumetric formula

$$V_1 N_1 = V_2 N_2$$

$$N_2 = \frac{V_1 \times 0.1 \text{ N}}{20} = \text{____ N}$$

Amount of  $\text{CO}_3^{2-}$  present in 1 litre of water

sample in terms of  $\text{CaCO}_3$  equivalent = Strength of water sample  $\times$  Eq.wt of  $\text{CaCO}_3$

i.e  $\text{CO}_3^{2-}$  alkalinity in terms of  $\text{CaCO}_3$  equivalent = \_\_\_\_ N  $\times 50 \times 10^3$  ppm

Alkalinity due to  $\text{CO}_3^{2-}$  ion = \_\_\_\_ ppm

**Table. 3 Water sample 2 vs standard acid**

S. No	Volume of the water sample (ml)	Burette reading (ml)			Volume of the acid (ml)	
		Initial	[P]	[M]	[P]	[M]
1.	20					
2.	20					

If the data satisfies the condition  $P < 1/2 M$

If the data satisfies the condition  $P > 1/2 M$

(iv) Volume of HCl required for  $\text{CO}_3^{2-}$  Alkalinity =  $2P =$  \_\_\_\_ ml

(v) Volume of HCl required for  $\text{HCO}_3^-$  Alkalinity =  $M - 2P =$  \_\_\_\_ ml

(vi)  $\text{OH}^-$  ion absent

The volume of acid used upto phenolphthalein end point corresponds to the reaction (1) and (2), i.e, complete neutralization of  $\text{OH}^-$  ions and neutralization of  $\text{CO}_3^{2-}$  ions up to  $\text{HCO}_3^-$  stage.

The total volume of the acid used upto methylorange end point corresponds to all the reactions (1), (2) and (3), i.e a complete neutralization of  $\text{OH}^-$ ,  $\text{CO}_3^{2-}$  and  $\text{HCO}_3^-$  ions.

Thus from the respective volumes of acid used the strength of various ions can be determined.

## **PROCEDURE**

### **For water sample 1**

#### **Titration I: Phenolphthalein indicator**

The burette is washed, rinsed and filled with the given std. hydrochloric acid. 20 ml of the water sample (1) is pipetted into a clean conical flask. 2 – 3 drops of phenolphthalein indicator is added. Pink color is observed. This is titrated against the standard acid until the pink colour disappears. This titre value is noted which corresponds to the phenolphthalein end point. (P)

#### **Titration-II: Methylorange indicator**

Few drops of methylorange indicator is added to the same solution after the phenolphthalein end point. The solution turns yellow in colour. The titration is continued until the yellow colour changes to reddish orange colour. The titre value corresponds to methyl orange end point (M). The titration is repeated for concordant values. Using the titre values the type and amount of alkalinity is calculated.

### **For water sample 2**

The given water sample (2) is made up in a 100 ml standard flask with distilled water. 20 ml of the made up solution is pipetted out in to a clean conical flask. The titration is repeated as above by adding phenolphthalein indicator followed by methyl orange indicator. From the titre value the alkalinity is found out.

### Calculation of $\text{CO}_3^{2-}$ alkalinity

Volume of HCl  $(V_1) = \underline{\hspace{1cm}}$  ml

Strength of HCl  $(N_1) = 0.1 \text{ N}$

Volume of sample water  $(V_2) = 20 \text{ ml}$

Strength of sample water  $(N_2) = ?$

According to volumetric formula

$$V_1 N_1 = V_2 N_2$$

$$N_2 = \frac{V_1 \times 0.1 \text{ N}}{20} = \underline{\hspace{1cm}} \text{ N}$$

Amount of  $\text{CO}_3^{2-}$  present in 1 litre of water sample in terms of  $\text{CaCO}_3$  equivalent =  
Strength of water sample  $\times$  Eq.wt of  $\text{CaCO}_3$

i.e  $\text{CO}_3^{2-}$  alkalinity in terms of  $\text{CaCO}_3$  equivalent =  $\underline{\hspace{1cm}} \text{ N} \times 50 \times 10^3 \text{ ppm}$

Alkalinity due to  $\text{CO}_3^{2-}$  ion =  $\underline{\hspace{1cm}} \text{ ppm}$

SRMVEC-Dept of Chemistry

### Calculation of $\text{HCO}_3^-$ alkalinity

Volume of HCl  $(V_1) = \underline{\hspace{1cm}}$  ml

Strength of HCl  $(N_1) = 0.1 \text{ N}$

Volume of sample water  $(V_2) = 20 \text{ ml}$

Strength of sample water  $(N_2) = ?$

According to volumetric formula

$$V_1 N_1 = V_2 N_2$$

$$N_2 = \frac{V_1 \times 0.1 \text{ N}}{20} = \underline{\hspace{1cm}} \text{ N}$$

Amount of  $\text{HCO}_3^-$  present in 1 litre of water sample in terms of  $\text{CaCO}_3$  equivalent =  
Strength of water sample  $\times$  Eq.wt of  $\text{CaCO}_3$

i.e  $\text{HCO}_3^-$  alkalinity in terms of  $\text{CaCO}_3$  equivalent =  $\underline{\hspace{1cm}} \text{ N} \times 50 \times 10^3 \text{ ppm}$

Alkalinity due to  $\text{HCO}_3^-$  ion =  $\underline{\hspace{1cm}} \text{ ppm}$



## Result

The given water sample (1) contains

1. Hydroxide alkalinity = \_\_\_\_\_ ppm
2. Carbonate alkalinity = \_\_\_\_\_ ppm
3. Bicarbonate alkalinity = \_\_\_\_\_ ppm

The given water sample (2) contains

1. Carbonate alkalinity = \_\_\_\_\_ ppm
2. Bicarbonate alkalinity = \_\_\_\_\_ ppm
3. Hydroxide alkalinity = \_\_\_\_\_ ppm

### 1. Standardisation of EDTA

S. No	Volume of CuSO <sub>4</sub> (ml)	Burette reading (ml)		Volume of	Concordant	Indicator
1.	20	0				FSB
2.	20	0				
3.	20	0				

Volume of CuSO<sub>4</sub> (V<sub>1</sub>) = \_\_\_\_\_ ml

Strength of CuSO<sub>4</sub> (N<sub>1</sub>) = 0.01 N

Volume of EDTA (V<sub>2</sub>) = \_\_\_ ml

Strength of EDTA (N<sub>2</sub>) = ?

According to volumetric formula

$$V_1 N_1 = V_2 N_2$$

$$N_2 = \frac{V_1 N_1}{V_2}$$

$$N_2 = \frac{V_1 \times 0.1 \text{ N}}{20} = \underline{\underline{Z}}$$

## 2. DETERMINATION OF COPPER IN SAMPLES USING EDTA

Expt. No.	
-----------	--

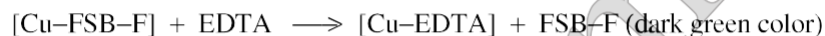
Date			
------	--	--	--

### Aim

To estimate the weight of copper present in the whole of the given solution. You are provided with EDTA solution and 0.01N copper sulphate solution.

### Principle

The EDTA solution is standardized using copper sulphate solution using fast sulphone black-F indicator.



### PROCEDURE

#### 1. Preparation of EDTA (0.01M).

Dissolve 3.72 gm of EDTA in a 1000 mL distilled water to get 0.01 M EDTA

#### 2. Preparation of known copper solution.

Place 0.63 g of pure Copper sulphate, dissolve in distilled water containing a little dil. sulphuric acid and made up to 1000 mL in standard volumetric flask to get 0.01M solution.

#### 3. Preparation of unknown copper solution.

Weigh 0.5 to 0.6 grams of Copper sulphate into a 1000 mL vol. flask. Add 30 mL of dil. sulphuric acid. Dilute to the mark.

#### 4. Titration with EDTA - murexide indicator.

Do this step for 4 samples of known and 4 samples of unknown.

### KNOWN

Pipette out 20 mL of Copper solution (known solution) Add 10ml of ammonia buffer drop-wise until the solution turns completely blue and 4 drops of FSB indicator. Then solution turns purple in color. This is titrated with EDTA until color changes to dark green. Repeat for concordant values.

## 2. Standardisation of unknown copper sulphate solution

S. No	Volume of CuSO <sub>4</sub> (ml)	Burette reading (ml)		Volume of	Concordant	Indicator
1.	20	0				FSB
2.	20	0				
3.	20	0				

Volume of EDTA (V<sub>1</sub>) = \_\_\_\_\_ ml

Strength of EDTA (N<sub>1</sub>) =

Volume of CuSO<sub>4</sub> (V<sub>2</sub>) = \_\_\_ ml

Strength of CuSO<sub>4</sub> (N<sub>2</sub>) = ?

According to volumetric formula

$$V_1 N_1 = V_2 N_2$$

$$N_2 = \frac{V_1 N_1}{V_2}$$

$$N_2 = \frac{\text{ml} \times ZN}{20} = Y N$$

### CALCULATION

Calculation of the weight of copper = strength of copper sulphate × 63.54/litre

### UNKNOWN

Pipette out 20 mL of Copper solution (known solution) Add 10ml of ammonia buffer drop-wise until the solution turns completely blue and 4 drops of FSB indicator. Then solution turns purple in color. This is titrated with EDTA until color changes to dark green. Repeat for concordant values.

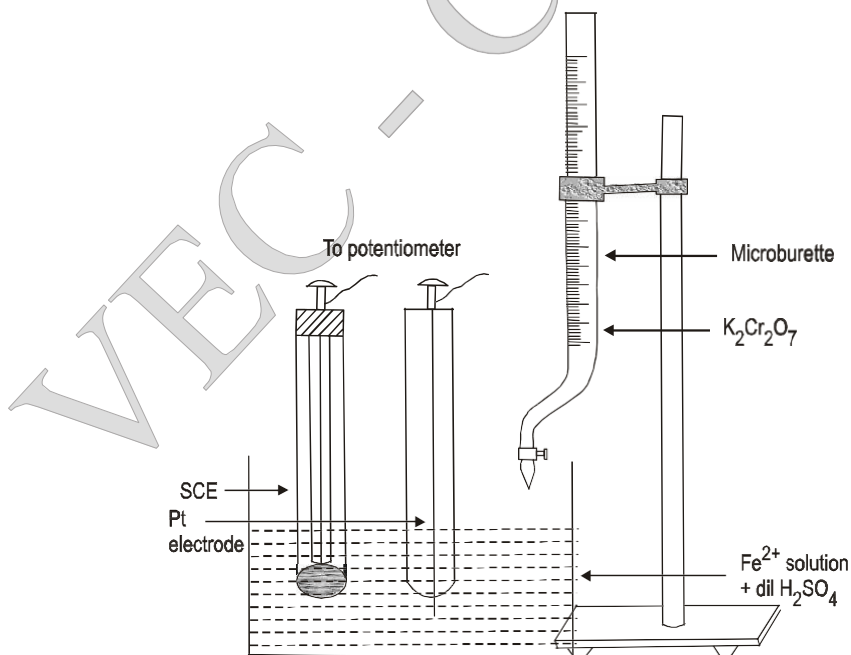
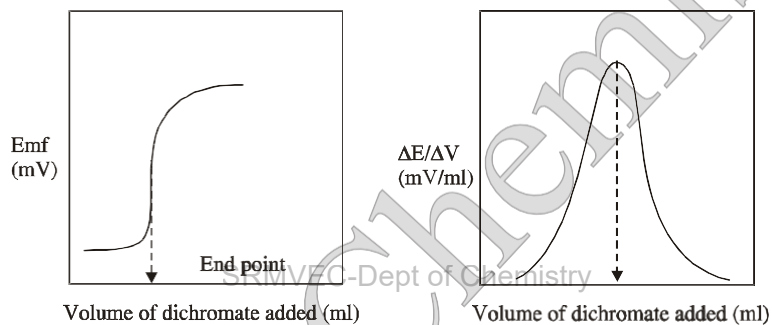
Equivalent weight of  $\text{Cu}^{2+}$  is 63.54

### RESULT

The amount of copper present in the whole of the given solution is = ..... gm.

**Table 1**  
**K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub> Vs Iron solution**

S.No.	Volume of K <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub> added (ml)	Emf (m Volts)



### 3. ESTIMATION OF FERROUS ION BY POTENTIOMETRIC REDOX TITRATION

Expt. No.	
-----------	--

Date			
------	--	--	--

#### AIM:

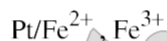
To estimate the weight of  $\text{Fe}^{2+}$  ion present in the given solution. You are provided with 0.2 N solution of dichromate.

#### MATERIALS REQUIRED:

Potentiometer, platinum electrode, std. calomel electrode, std  $\text{K}_2\text{Cr}_2\text{O}_7$  solution, given ferrous solution.

#### PRINCIPLE:

Potassium dichromate oxidizes  $\text{Fe}^{2+}$  ion to  $\text{Fe}^{3+}$  ion and hence the following electrode is formed;



When this is coupled with std. calomel electrode the following cell is obtained.



The potential of the cell depends on the ratio ( $\text{Fe}^{3+}/\text{Fe}^{2+}$ ). Initially, during the addition of  $\text{K}_2\text{Cr}_2\text{O}_7$  this ratio does not change appreciably. At the end point the ratio increases suddenly leading to a large increase in the potential measured. The addition of  $\text{K}_2\text{Cr}_2\text{O}_7$  after this end point does not change this ratio and hence the potential of the cell remains almost constant.

#### PROCEDURE

10 ml of the given ferrous solution is pipetted out in a clean 250 ml beaker. To this, 10 ml of  $\text{H}_2\text{SO}_4$  and 80 ml of conductivity water were added. Platinum electrode and saturated calomel electrode are dipped to form a cell. It is then connected to a digital potentiometer. The std  $\text{K}_2\text{Cr}_2\text{O}_7$  solution is taken in the burette.

#### Titration 1

A preliminary titration is carried out by adding Std.  $\text{K}_2\text{Cr}_2\text{O}_7$  solution in 1 ml portions and the emf of the cell is measured each time after the addition. The addition of  $\text{K}_2\text{Cr}_2\text{O}_7$  is continued even after the end point. The volume at which there is a sharp increase in emf is the end point. The range at which the end point lies is found out by plotting volume of  $\text{K}_2\text{Cr}_2\text{O}_7$  against emf (graph 1).

Table 2

$K_2Cr_2O_7$  Vs Iron solution

S. No	Volume of $K_2Cr_2O_7$ (ml)	Emf (mV)	$\Delta E$ (mV)	$\Delta V$ (ml)	$\Delta E/\Delta V$ mV/ml	$V = (V_1 + V_2)/2$

Calculation of amount of  $Fe^{2+}$  ion solution

Volume of ferrous ion solution  $V_1 = 10$  ml

Strength of ferrous ion solution,  $N_1 =$  \_\_\_\_\_ N

Volume of  $K_2Cr_2O_7$   $V_2 =$  \_\_\_\_\_ ml (titre value)

Strength of  $K_2Cr_2O_7$   $N_2 = 0.2$  N

$$N_1 = V_2 N_2 / V_1 = V_2 \times 0.2 / 10$$

Strength of ferrous ion solution ( $N_1$ ) = \_\_\_\_\_ N

Amount of ferrous ion present in 1000 ml of the given solution = strength of ferrous ion  $\times 55.85$   
 = \_\_\_\_\_ g/l



### Titration 2

Fair titration is carried out by adding std.  $K_2Cr_2O_7$  solution in portions of 0.2 ml near the end point and the emf of the cell is measured after each addition. The addition of  $K_2Cr_2O_7$  is continued even after the end point for further 3-4 ml. The accurate end point is determined by plotting  $\Delta E/\Delta V$  vs volume of  $K_2Cr_2O_7$  added (graph 2). From the end point the strength of ferrous ion in the solution is calculated and the amount of  $Fe^{2+}$  ion is determined.

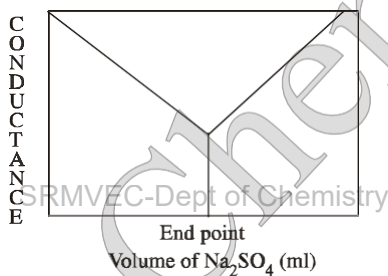
### RESULT

Amount of ferrous ion present in 1000 ml of the given solution = \_\_\_\_\_ g/l

**Titration of mixture of BaCl<sub>2</sub> Vs Na<sub>2</sub>SO<sub>4</sub>**

S.No.	Volume of Na <sub>2</sub> SO <sub>4</sub> added (ml)	Conductance (mho)

**Model Graph**



**Calculation of strength of BaCl<sub>2</sub>**

Volume of BaCl<sub>2</sub>, V<sub>1</sub> ml = 20 ml

Strength of BaCl<sub>2</sub>, N<sub>1</sub> = \_\_\_\_\_ ? N

Volume of Na<sub>2</sub>SO<sub>4</sub>, V<sub>2</sub> = \_\_\_\_\_ ml (titre value)

Strength of Na<sub>2</sub>SO<sub>4</sub>, N<sub>2</sub> = 0.5 N

Strength of BaCl<sub>2</sub> N<sub>1</sub> = V<sub>2</sub>N<sub>2</sub>/V<sub>1</sub> = V<sub>2</sub> × 0.5/20

Strength of BaCl<sub>2</sub> (N<sub>1</sub>) = \_\_\_\_\_ N

The amount of BaCl<sub>2</sub> present in

1 litre of the given solution = Strength of BaCl<sub>2</sub> × Equivalent weight of BaCl<sub>2</sub>

= \_\_\_\_\_ N × 122.14

= \_\_\_\_\_ g/l

## 4. CONDUCTOMETRIC PRECIPITATION TITRATION (Barium chloride Vs Sodium sulphate)

Expt. No.	
-----------	--

Date			
------	--	--	--

### AIM

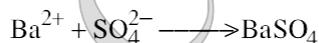
To estimate the amount of BaCl<sub>2</sub> present in the given solution. You are provided with a standard solution of Na<sub>2</sub>SO<sub>4</sub> of strength 0.5 N.

### MATERIALS REQUIRED

Conductivity meter, conductivity cell, microburette, pipette, Std. 0.5 N Na<sub>2</sub>SO<sub>4</sub>, BaCl<sub>2</sub> solution.

### PRINCIPLE

Conductivity of the solution depends upon number of ions in solution. During the addition of Na<sub>2</sub>SO<sub>4</sub> to BaCl<sub>2</sub> taken in the beaker, Ba<sup>2+</sup> ions are removed as BaSO<sub>4</sub> precipitate (which produce negligible amount of ions).



Hence the conductance decreases sharply. When all the Ba<sup>2+</sup> ions are removed as BaSO<sub>4</sub>, further addition of Na<sub>2</sub>SO<sub>4</sub> produces 2Na<sup>+</sup> and SO<sub>4</sub><sup>2-</sup> ions. Hence, conductivity starts increasing sharply. The intersection point corresponds to the end point of the titration.

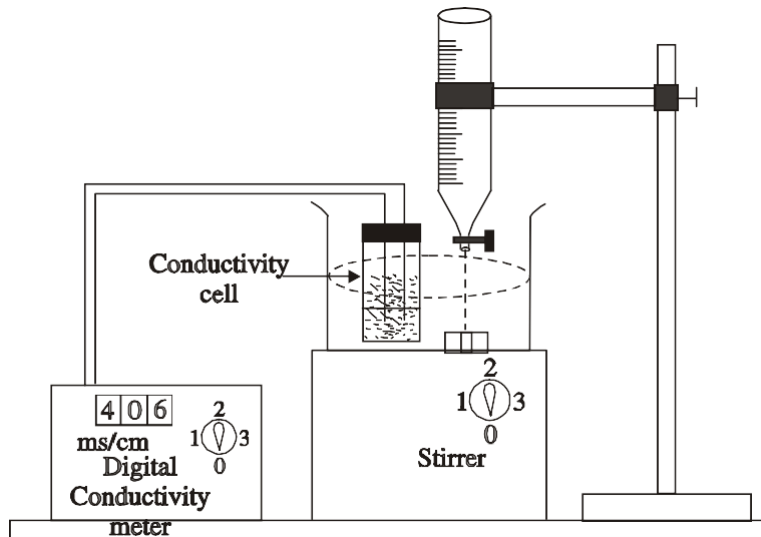
### PROCEDURE

Sodium sulphate is taken in the burette. 20 ml of the given BaCl<sub>2</sub> solution is pipetted out into a clean beaker. Conductivity cell is placed in it and diluted with conductivity water. 1 ml of Na<sub>2</sub>SO<sub>4</sub> solution is added to the solution, stirred and then conductance is measured. This is continued up to the end point. The conductance decreases up to the end point. After the end point, the conductance increases due to the addition of excess of Na<sub>2</sub>SO<sub>4</sub>.

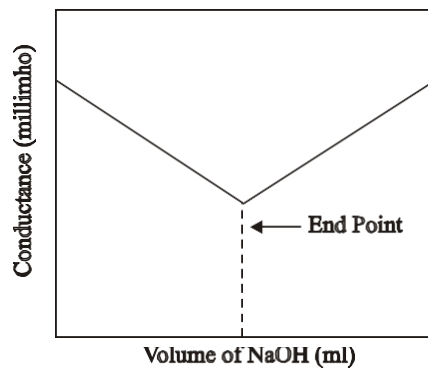
A graph is plotted between the volume of Na<sub>2</sub>SO<sub>4</sub> and conductance. From the graph, end point is noted and the amount of BaCl<sub>2</sub> present in 1 liter of the solution is calculated.

### RESULT

The amount of BaCl<sub>2</sub> present in 1 liter of the given solution = \_\_\_\_\_ g/l.



**Determination of Conductance**  
SRMVEC-Dept of Chemistry



**HCl Vs NaOH**

## 5. CONDUCTOMETRIC TITRATION OF STRONG ACID WITH STRONG BASE

Expt. No.	
-----------	--

Date			
------	--	--	--

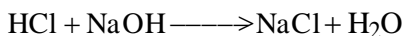
### Aim

To determine the amount of strong acid (HCl) present in the given sample by conductometric titration. You are provided with NaOH solution of strength 0.2N.

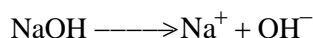
### Principle

A solution of an electrolyte conducts electricity due to its dissociation into ions which depends on their number and mobility. Since specific conductance of a solution is proportional to the concentration of ions in it, conductance of the solution is measured during titration.

A reaction between strong acid and strong base, leading to the following neutralization.



This reaction is followed conductometrically in a conductivity bridge using a conductivity cell. When a strong base of NaOH is added slowly from the burette to the solution of HCl, the fast moving  $\text{H}^+$  ions are progressively replaced by slow moving  $\text{Na}^+$  ions. As a result conductance of the solution decreases. This decrease in conductance will take place until the end point is reached. Further addition of NaOH increases the conductance sharply as there is an excess of fast moving  $\text{OH}^-$  ion.



A plot is made between volume of NaOH added and the conductance of solutions. The end point is intersection of the two lines.

### Procedure

The microburette is filled with standard NaOH solution. 20 ml of the given HCl is pipetted out into a clean 100 ml beaker. The conductivity cell is placed in it and then diluted to 50ml by adding conductivity water. The two terminals of the cell are connected to conductivity bridge. Initial conductance is read in the instrument for the acid alone without the addition of NaOH.

Now 0.05 ml of NaOH solution from the burette is added to the solution taken in the beaker, stirred and then conductivity is measured. The process is continued up to the end point. After the end point, further NaOH is gradually added and few more readings are noted.

**Table**

Sl.No.	Volume of NaOH added (ml)	Conductance (millimho)
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		

**Calculation:**

**Step - 1: Calculation of normality of HCl:**

Volume of NaOH  $V_1 =$  \_\_\_\_\_ ml (titre value)

Strength of NaOH  $N_1 =$  \_\_\_\_\_ N

Volume of HCl  $V_2 = 10$  ml

Strength of HCl  $N_2 = ?$

By volumetric principle  $V_1 N_1 = V_2 N_2$

$$= 20 \times N_2$$

$$N_2 = \frac{V_1 \times N_1}{10} = \text{_____ N}$$

$\therefore$  Strength of HCl  $N_2 =$  \_\_\_\_\_ N

**Step - 2: Calculation of amount of HCl**

The amount of HCl present in the }  $= N_2 \times \text{Eq. wt. of HCl}$   
whole of the given solution }  $2$

$$= N_2 \times 36.45$$

$$= \text{_____ g/lit}$$

A graph is plotted between the volume of NaOH and conductance and the end point is noted. It is the intersection of the two lines as in the figure. The amount of HCl present in the given solution is calculated.

**RESULT**

Amount of the HCl present in the given acid = \_\_\_\_\_g/lit





## 6. pH METRY – DETERMINATION OF STRENGTH OF HCl

Expt. No.	
-----------	--

Date			
------	--	--	--

### AIM :

To determine the strength of given hydrochloric acid by pH metry. You are provided with a standard solution of 0.1N sodium hydroxide.

### MATERIALS REQUIRED

Hydrochloric acid, sodium hydroxide, pH meter, glass electrode

SRMVEC-Dept of Chemistry

### PRINCIPLE

pH of the solution is related to the  $H_3O^+$  ion concentration of the solution by the expression

$$pH = -\log [H_3O^+]$$

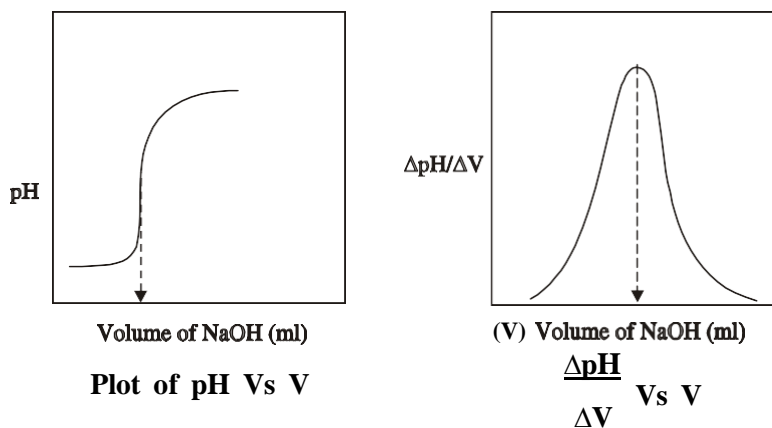
The concentration of  $H^+$  ions in the solution is determined by measuring the pH of the solution.

When NaOH is added slowly from the burette to the solution of HCl,  $H^+$  ions are neutralized by  $OH^-$  ions. As a result, pH of the solution increases.



The increase in pH takes place until all the  $H^+$  ions are completely neutralized. After the endpoint, further addition of NaOH increases the pH sharply as there is an excess of  $OH^-$  ions.

### Model Graph



**Table 2**  
**Titration of HCl vs NaOH**

S.No	Volume of NaOH (ml)	pH	$\Delta pH$	$\Delta V$ (ml)	$\Delta pH/\Delta V$	$V = (V_1 + V_2)/2$

### Calculation

Volume of HCl  $V_1 = 20$  ml

Strength of HCl  $N_1 = \underline{\hspace{2cm}} ?$

Volume of NaOH  $V_2 = \underline{\hspace{2cm}}$  ml

Strength of NaOH  $N_2 = 0.1$  N

Strength of HCl  $N_1 = V_2 N_2 / V_1 = V_2 \times 0.1 / 20$

Weight of HCl in 1 litre of the given solution =  $\underline{\hspace{2cm}}$   $N_1 \times \text{eq. wt of HCl g}$   
 $= N_1 \times 36.5$  gm/l

Weight of HCl in 100 ml of the given solution =  $N_1 \times 36.5 / 10$  gm.

**PROCEDURE:**

The burette is filled with standard NaOH solution. 20ml of HCl solution is pipetted out into a clean beaker. It is diluted to 100ml with distilled water. The glass electrode is dipped into the solution and connected to the pH meter.

The NaOH solution is gradually added from the burette to the HCl solution in the beaker. pH is noted after each addition. The observed pH values are plotted against the volume of NaOH added. From the graph the end point is determined.

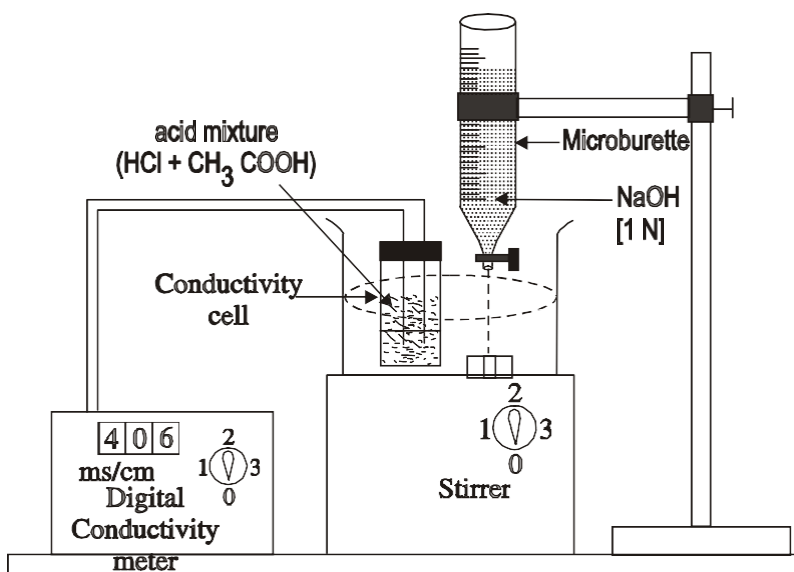
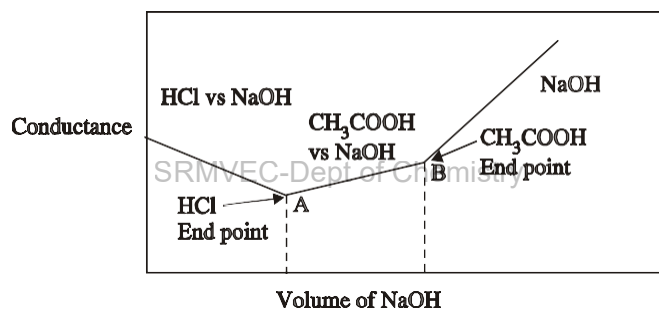
**RESULT:**

The amount of HCl present in the given solution is = ..... g.

**Table 1**  
**Titration of mixture of acids vs NaOH**

S.No.	Volume of NaOH added (ml)	Conductance (mho)

**Model graph**



## 7. CONDUCTOMETRIC TITRATION OF MIXTURE OF ACIDS

<b>Expt. No.</b>	
------------------	--

<b>Date</b>			
-------------	--	--	--

### AIM:

To estimate the amount of hydrochloric (HCl) and acetic acids (CH<sub>3</sub>COOH) present in the given mixture. You are provided with a standard solution of NaOH of strength 0.5 N.

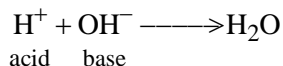
### MATERIALS REQUIRED:

Conductivity meter, conductivity cell, microburette, pipette, Std. 0.5N NaOH.

### PRINCIPLE:

Conductivity of a solution depends upon the number and nature of ions in solution. During the addition of base to acid solution, the H<sup>+</sup> ions are removed as water. Hence the conductance of the solution decreases.

SRMVEC-Dept of Chemistry



In a mixture of strong acid and weak acid, strong acid reacts with the base initially. The decrease in conductivity is sharp. After the neutralization of strong acid, weak acid reacts with the added base. Acetic acid being weakly ionized, the decrease in conductivity is slow. At the end point, when all the acids are neutralized, the addition of base increases the OH<sup>-</sup> ion in solution. Hence there is a sharp increase in conductivity.

### PROCEDURE:

The burette is filled with sodium hydroxide (NaOH) solution up to the zero mark. 10ml of HCl and 10ml of CH<sub>3</sub>COOH are taken in a 250ml beaker. The conductivity cell is placed in it and then diluted to 100ml with distilled water. It is then connected with the conductivity meter.

Then 0.5 ml of alkali is added from the burette to the solution. The solution is stirred carefully and then conductance is measured after each addition of alkali.

### Calculation of strength of HCl

Volume of mixture (HCl)  $V_1 = 20$  ml  
Strength of mixture (HCl)  $N_1 = \text{_____}?$   
Volume of NaOH  $V_2 = \text{____}(A)$  ml (1<sup>st</sup> titre value)  
Strength of NaOH  $N_2 = 0.5$  N  
 $N_1 = V_2 N_2 / V_1 = V_2 \times 0.5 / 20$

Strength of HCl  $N_1 = \text{_____}N$

The amount of HCl present in

1 litre of the given solution = Strength of HCl  $\times$  Eq.wt. of HCl  
=  $\text{_____}N \times 36.5$   
=  $\text{_____}g/l$

SRMVEC-Dept of Chemistry

### Calculation of strength of CH<sub>3</sub>COOH

Volume of mixture (CH<sub>3</sub>COOH)  $V_1 = 20$  ml  
Strength of mixture (CH<sub>3</sub>COOH)  $N_1 = \text{_____}?$   
Volume of NaOH (B - A)  $V_2 = \text{_____}ml$   
Strength of NaOH  $N_2 = 0.5$  N  
 $N_1 = V_2 N_2 / V_1 = V_2 \times 0.5 / 20$

Strength of CH<sub>3</sub>COOH  $N_1 = \text{_____}N$

The amount of CH<sub>3</sub>COOH present in

1 litre of the given solution = Strength of CH<sub>3</sub>COOH  $\times$  Eq.wt. of CH<sub>3</sub>COOH  
=  $\text{_____}N \times 60$   
=  $\text{_____}g/l$

A graph is drawn between conductance and volume of NaOH. From the graph, the first end point A and the second end point B are noted. The amount of HCl and CH<sub>3</sub>COOH present in 1 litre of the mixture is calculated from the end points A and B respectively.

**RESULT**

1. The amount of HCl present in 1 litre of the given solution = \_\_\_\_\_g/l
2. The amount of CH<sub>3</sub>COOH present in 1 litre of the given solution = \_\_\_\_\_g/l