SRM VALLIAMMAI ENGINEERING COLLEGE

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

DEPARTMENT OF CHEMISTRY

1901108-CHEMISTRY LAB MANUAL

(2022-23)

1901108 **PHYSICS AND CHEMISTRY LABORATORY** **L T P C**
0 0 4 2

(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 viscometery.
- 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 Na_2CO_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

Table. 1 Titre values and different alkalinities

S. No.	Value of [P] & [M]	Alkalinity due to			Nature of alkalinity
		OH^-	CO_3^{2-}	HCO_3^-	
1.	$P = 0$	0	0	M	Only HCO_3^- ions present
2.	$P = 1/2\ M$	0	2P	0	Only CO_3^{2-} ions present
3.	$P = M$	$P = M$	0	0	Only OH^- ions present
4.	$P < ½\ M$	0	2P	M-2P	HCO_3^-, CO_3^{2-} ions present
5.	$P > ½\ M$	2P-M	$2M - 2P$	0	Only OH^-, CO_3^{2-} 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					

Calculation

If the data satisfies the condition $P > ½\ M$

(i) Volume of HCl required for OH^- Alkalinity $= 2P - M =$ _____ ml

(ii) Volume of HCl required for CO_3^{2-} Alkalinity $= 2M - 2P =$ ______ ml

(iii) HCO_3^- absent

Calculation of OH^- 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

$$V_1N_1 = V_2N_2$$

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

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 (OH^-)
- Carbonates only (CO_3^{2-})
- Bicarbonates only (HCO_3^-)
- Hydroxides and carbonates ($OH^- + CO_3^{2-}$)
- Carbonate and bicarbonates ($CO_3^{2-} + HCO_3^-$)

The possibility of all the three ions existing together is ruled out because the hydroxides and bicarbonate ions combine together to form CO_3^{2-} ions

$$OH^- + HCO_3^- \longrightarrow CO_3^{2-} + H_2O$$

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.

(a) $OH^- + H^+ \longrightarrow H_2O$ ... (1)

(b) $CO_3^{2-} + H^+ \longrightarrow HCO_3^-$ ... (2)

(c) $HCO_3^- + H^+ \longrightarrow H_2CO_3 \longrightarrow H_2O + CO_2$ ... (3)

Amount of OH^- present in 1 litre of water

sample in terms of $CaCO_3$ equivalent = Strength of water sample × Eq.wt of $CaCO_3$

i.e OH^- alkalinity of $CaCO_3$ equivalent $= \_\_\_\_ N \times 50 \times 10^3$ ppm

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

Calculation of 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

$$V_1N_1 = V_2N_2$$

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

Amount of CO_3^{2-} present in 1 litre of water

sample in terms of $CaCO_3$ equivalent = Strength of water sample × Eq.wt of $CaCO_3$

i.e CO_3^{2-} alkalinity in terms of $CaCO_3$ equivalent $= \_\_\_\_ N \times 50 \times 10^3$ ppm

Alkalinity due to 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 > ½ M

(iv) Volume of HCl required for CO_3^{2-} Alkalinity $= 2P = \_\_\_\_\_$ ml

(v) Volume of HCl required for HCO_3^- Alkalinity $= M - 2P = ______$ml

(vi) OH^- ion absent

The volume of acid used upto phenolphthalein end point corresponds to the reaction (1) and (2), i.e, complete neutralization of OH^- ions and neutralization of CO_3^{2-} ions up to 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 OH^-, CO_3^{2-} and 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 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

$$V_1N_1 = V_2N_2$$

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

Amount of CO_3^{2-} present in 1 litre of water sample in terms of $CaCO_3$ equivalent = Strength of water sample × Eq.wt of $CaCO_3$

i.e CO_3^{2-} alkalinity in terms of $CaCO_3$ equivalent $= \_\_\_\_\ N \times 50 \times 10^3$ ppm

Alkalinity due to CO_3^{2-} ion = ______ ppm

Calculation of HCO_3^- 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

$$V_1N_1 = V_2N_2$$

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

Amount of HCO_3^- present in 1 litre of water sample in terms of $CaCO_3$ equivalent = Strength of water sample × Eq.wt of $CaCO_3$

i.e HCO_3^- alkalinity in terms of $CaCO_3$ equivalent $= \_\_\_\_\ N \times 50 \times 10^3$ ppm

Alkalinity due to HCO_3^- ion **=** ______ 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

Standardization of sodium thiosulphate

Titration I:

Standard dichromate Vs Sodium thiosulphate

Sl.No.	Volume of Potassium dichromate (ml)	Burette readings (ml)		Volume of sodium thiosulphate (ml)	Concordant Value (ml)	Indicator
		Initial	Final			
1	20	0				Starch
2	20	0				

Volume of Potassium dichromate (V_1) = 20 ml

Strength of Potassium dichromate (N_1) = 0.1 N

Volume of Sodium thiosulphate (V_2) = ––– ml

Strength of Sodium thiosulphate (N_2) = ––– N

According to volumetric formula, $V_1N_1 = V_2N_2$

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

Strength of Sodium thiosulphate (N_2) = ––– N

2. Estimation of copper content of the given solution by iodometry

AIM:

Estimate the amount of copper in the given solution by iodometric method. You are provided with a standard solution of potassium dichromate of strength 0.1N and sodium thiosulphatesolution as link.

CHEMICALS REQUIRED:

1. Potassium dichromate
2. Sodium thiosulphate
3. Potassium iodide
4. Starch
5. Sulphuric acid
6. Ammonia
7. Acetic acid
8. Ammonium thiocyanate.

PRINCIPLE:

The strength of copper sulphate solution is determined by iodometric method. When potassium iodide is added to a solution of copper sulphate, a white cuprous iodide (Cu_2I_2) is precipitated and an equivalent amount of iodine is liberated. The free iodine is titrated against standard solution of sodium thiosulphate using starch as an indicator,

As soon as all the liberated iodine is reduced to iodide (NaI), the blue colour of the iodo- starch complex will disappear. The colour of precipate in the conical flask will be white, Cu_2I_2. This indicates the end point. The reactions involved are:

$$2CuSO_4 + 4KI \longrightarrow Cu_2I_2 + 2K_2SO_4 + I_2$$

$$2Na_2S_2O_3 + I_2 \longrightarrow Na_2S_4O_6 + 2NaI$$

From the titre values, the strength of copper sulphate solution and the amount of copper are calculated.

$$K_2Cr_2O_7 + 7\,H_2SO_4 + 6\,KI \longrightarrow 4K_2SO_4 + Cr_2(SO_4)_3 + 3I_2 + 7H_2O$$

The liberated iodine is titrated against sodium thiosulphate using starch as indicator. The end point is the appearance of green colour. From the equations, it is clear that the equivalent weight of crystalline copper sulphate ($CuSO_4.5H_2O$) is its molecular weight. i.e., 249.54 and that of copper is its own atomic weight. i.e., 63.54.

Estimation of copper

Titration 2:

Sodium thiosulphate Vs Copper sulphate

Sl.No.	**Volume of $CuSO_4$ (ml)**	**Burette readings (ml)**		**Volume of $Na_2S_2O_3$ (ml)**	**Concordant Value (ml)**	**Indicator**
		Initial	**Final**			
1	20	0				Starch
2	20	0				

Volume of Sodium thiosulphate (V_1) = ml

Strength of Sodium thiosulphate (N_1) = N

Volume of Copper sulphate (V_2) = 20 ml

Strength of Copper sulphate (N_2) = ––– N

According to volumetric formula, $V_1N_1 = V_2N_2$

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

Strength of Copper sulphate (N_2) = ––– N

Equivalent weight of Copper = 63.54

The amount of copper present in 1 L = Normality x Equivalent weight

= N_2 x 63.54

= .... g

PROCEDURE:

Titration 1:

Standardization of sodium thiosulphate

The burette is washed and rinsed with sodium thiosulphate solution. Then the burette is filled with this sodium thiosulphate solution up to zero mark without any air bubbles. 20 ml of 0.1N potassium dichromate solution is pipetted out by means of clean and rinsed 20ml pipette into a clean conical flask.

About 10ml 10% potassium iodide solution is added. The liberated iodine is titrated at once against sodium thiosulphate solution taken in the burette. When the solution in the conical flask becomes straw yellow colour, 1ml of freshly prepared starch solution is added as indicator and the titration is continued. The end point is the disappearance of blue colour and the appearance of pale green colour. Titre value is noted Titrations are repeated for concordant values.

Titration 2:

Estimation of copper

20 ml of the given copper sulphate solution is pipetted out by means of a clean and rinsed 20 ml pipette into a clean conical flask. Ammonium hydroxide is added drop by drop till a permanent precipitate s formed. The precipitate is re dissolved by adding drop by drop acetic acid.

About 5 ml of 10% solution of potassium iodide is added. The liberated iodine is titrated against sodium thiosulphate solution taken in the burette. 1 ml of freshly prepared starch solution is added as indicator towards the end point. The end point is the disappearance of blue colour. The titration is repeated till concordant values are obtained.

From the titre values, the strength of copper sulphate and the weight of copper in the whole of the given solution can be calculated. The equivalent weight of copper is 63.54.

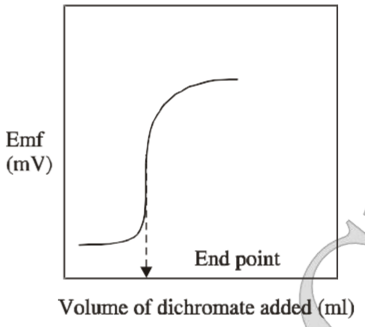
RESULT:

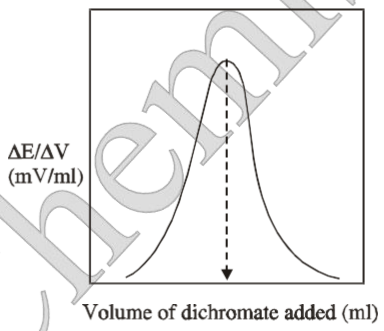
The strength of copper sulphate solution =.................. N

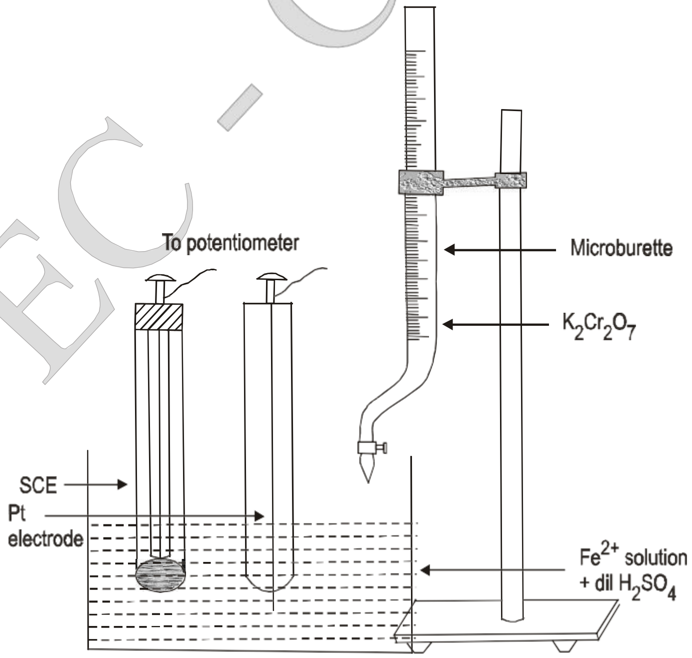
The amount of copper present in the given solution =.......................... g

Table 1
$K_2Cr_2O_7$ Vs Iron solution

S.No.	Volume of $K_2Cr_2O_7$ added (ml)	Emf (m Volts)







3.ESTIMATION OF FERROUS ION BY POTENTIOMETRIC REDOX TITRATION

Expt. No.	

Date			

AIM:

To estimate the weight of 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 $K_2Cr_2O_7$ solution, given ferrous solution.

PRINCIPLE:

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

$$Pt/Fe^{2+}, Fe^{3+}$$

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

$$Pt/Fe^{2+}, Fe^{3+} \ // \ SCE$$

The potential of the cell depends on the ratio (Fe^{3+}/Fe^{2+}). Initially, during the addition of $K_2Cr_2O_7$ 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 $K_2Cr_2O_7$ 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 H_2SO_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 $K_2Cr_2O_7$ solution is taken in the burette.

Titration 1

A preliminary titration is carried out by adding Std. $K_2Cr_2O_7$ solution in 1 ml portions and the emf of the cell is measured each time after the addition. The addition of $K_2Cr_2O_7$ 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 $K_2Cr_2O_7$ against emf (graph 1).

Table 2

$K_2Cr_2O_7$ Vs Iron solution

S. No	Volume of $K_2Cr_2O_7$ (ml)	Emf (mV)	ΔE (mV)	ΔV (ml)	ΔE/ΔV 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

$$N_1 = V_2N_2/V_1 = V_2 \times 0.2/10$$

Strength of ferrous ion solution $(N_1) =$ _______ N

Amount of ferrous ion present in 1000 ml of the given solution = strength of ferrous ion × 55.85

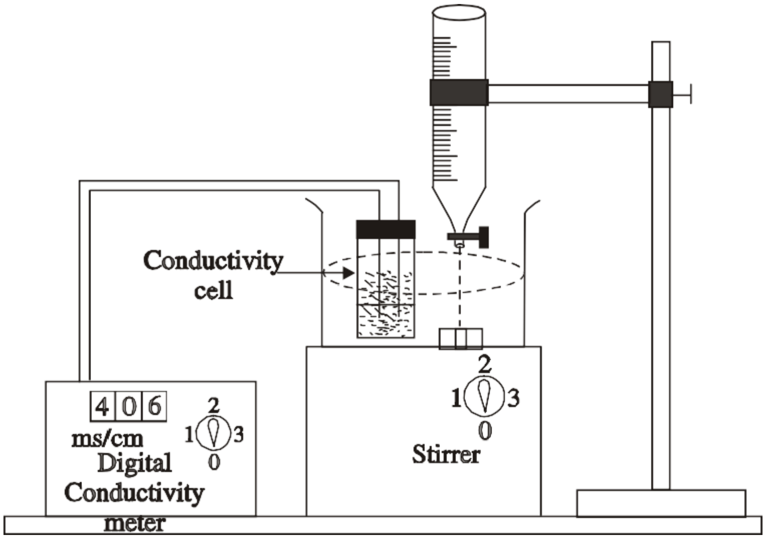
= _______ g/l

Titration 2

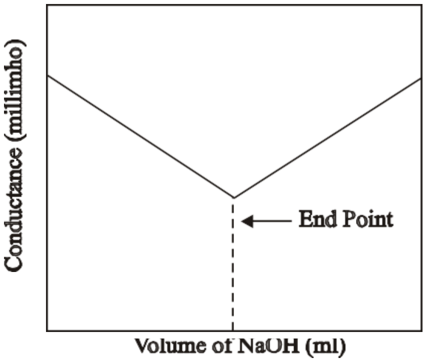
Fair titration is carried out by adding std. $K_2Cr_2O_7$ solution in portions of 0.2 ml near the end point and the emf of the cell is measured after each addition. The addition of $K_2Cr_2O_7$ is continued even after the end point for further 3-4 ml. The accurate end point is determined by plotting $\Delta E/\Delta V$ 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



Determination of Conductance



HCl Vs NaOH

4. 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 in to 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.

$$\mathrm{HCl} + \mathrm{NaOH} \longrightarrow \mathrm{NaCl} + \mathrm{H_2O}$$

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 H^+ ions are progressively replaced by slow moving 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 OH^- ion.

$$\mathrm{NaOH} \longrightarrow \mathrm{Na^+} + \mathrm{OH^-}$$

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 in to a clean 100 ml beaker. The conductivity cell is placed in it and then diluted to 50 ml 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 additionof 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)

Strengthof NaOH $N_1 =$ _N

Volume of HCl $V_2 = 20$ ml

Strength of HCl $N_2 = ?$

By volumetric principle $V_1 N_1 = V_2 N_2$

$$N_2 = \frac{V_1 \times N_1}{20} = \underline{\qquad} N$$

$\therefore$ Strength of HCl $N_2 =$ _N

Step - 2: Calculation of amount of HCl

$$\left.\begin{array}{l}\text{The amount of HCl present in the}\\ \text{whole of the given solution}\end{array}\right\} = N_2 \times \text{Eq} \cdot \text{wt. of HCl}$$

$= N_2 \times 36.45$

$=$ __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.

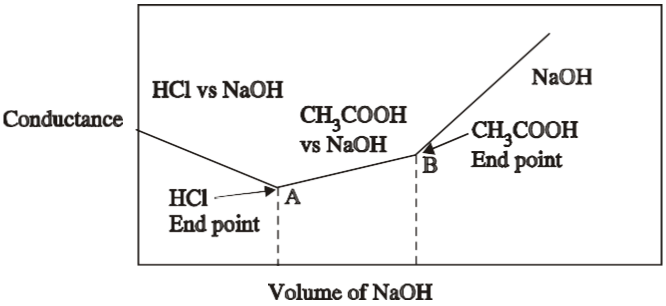
RESULT

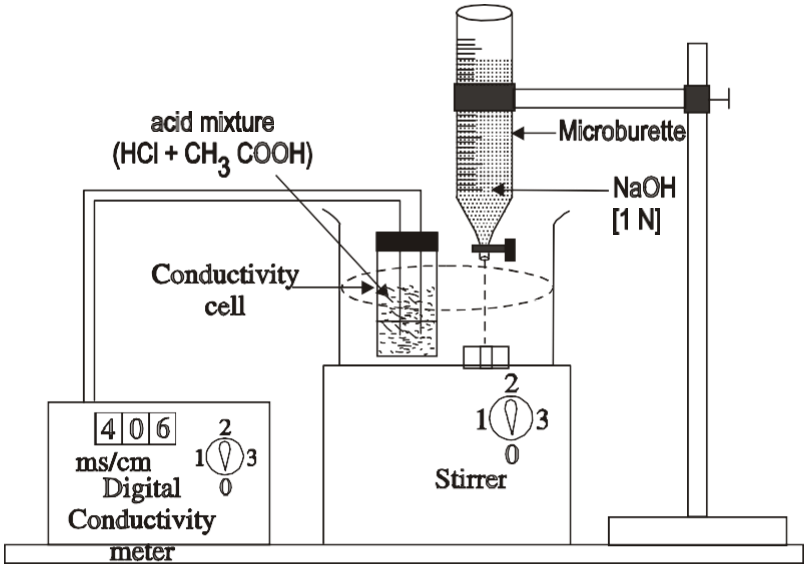
Amount of the HCl present in the given acid =___g/lit

Table 1
Titration of mixture of acids vs NaOH

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

Model graph





5. CONDUCTOMETRIC TITRATION OF MIXTURE OF ACIDS

Expt. No.	

Date			

AIM:

To estimate the amount of hydrochloric (HCl) and acetic acids (CH_3COOH) 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^+ ions are removed as water. Hence the conductanceof the solution decreases.

$$\underset{\text{acid}}{H^+} + \underset{\text{base}}{OH^-} \longrightarrow H_2O$$

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^- ionin 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_3COOH 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) $N_1 =$ _?

Volume of NaOH $V_2 =$ _(A) ml (1st titre value)

Strength of NaOH $N_2 = 0.5$ N

$N_1 = V_2N_2/V_1 = V_2 \times 0.5/20$

Strength of HCl $N_1 =$ _N

Theamount of HCl present in

1 litre of the given solution = Strength of HCl × Eq.wt. of HCl

=___N × 36.5

=___g/l

Calculation of strength of CH_3COOH

Volume of mixture (CH_3COOH) $V_1 = 20$ ml

Strength of mixture (CH_3COOH) $N_1 =$_?

Volume of NaOH (B − A) $V_2 =$ _ml

Strength of NaOH $N_2 = 0.5$ N

$N_1 = V_2N_2/V_1 = V_2 \times 0.5/20$

Strength of CH_3COOH N_1=___N

The amount of CH_3COOH present in

1 litre of the given solution = Strength of CH_3COOH× Eq.wt. of CH_3COOH

= _ N × 60

= _ 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_3COOH present in 1 litre of the mixture is calculated from the end points A and B respectively.

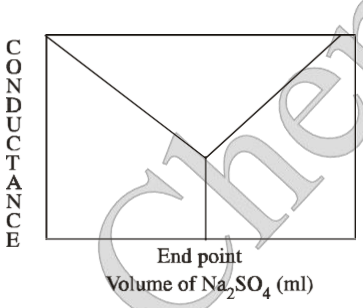
RESULT

1. The amount of HCl present in 1 litre of the given solution = __g/l
2. The amount of CH_3COOH present in 1 litre of the given solution =___g/l

Titration of mixture of $BaCl_2$ Vs Na_2SO_4

S.No.	Volume of Na_2SO_4 added (ml)	Conductance (mho)

Model Graph



Calculation of strength of $BaCl_2$

Volume of $BaCl_2$, V_1 ml = 20 ml

Strength of $BaCl_2$, N_1 = ________ ? N

Volume of Na_2SO_4 , V_2 = ______ ml (titre value)

Strength of Na_2SO_4 , N_2 = 0.5 N

Strength of $BaCl_2$ $N_1 = V_2N_2/V_1 = V_2 \times 0.5/20$

Strength of $BaCl_2(N_1)$ = ______ N

The amount of $BaCl_2$ present in

1 litre of the given solution = Strength of $BaCl_2$ × Equivalent weight of $BaCl_2$

= ______ N × 122.14

= __________ g/l

6. CONDUCTOMETRIC PRECIPITATION TITRATION

(Barium chloride Vs Sodium sulphate)

Expt. No.	

Date			

AIM

To estimate the amount of $BaCl_2$ present in the given solution. You are provided with a standard solution of Na_2SO_4 of strength 0.5 N.

MATERIALS REQUIRED

Conductivity meter, conductivity cell, microburette, pipette, Std. 0.5 N Na_2SO_4, $BaCl_2$ solution.

PRINCIPLE

Conductivity of the solution depends upon number of ions in solution. During the addition of Na_2SO_4 to $BaCl_2$ taken in the beaker, Ba^{2+} ions are removed as $BaSO_4$ precipitate (which produce negligible amount of ions).

$$Ba^{2+} + SO_4^{2-} \longrightarrow BaSO_4$$

Hence the conductance decreases sharply. When all the Ba^{2+} ions are removed as $BaSO_4$, further addition of Na_2SO_4 produces $2Na^+$ and SO_4^{2-} ions. Hence, conductivity starts increasing sharply. The intersection point corresponds to the end point of the titration.

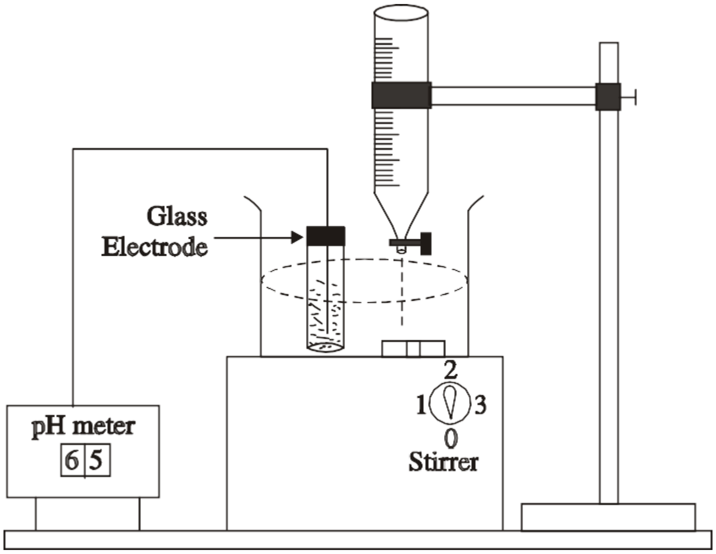
PROCEDURE

Sodium sulphate is taken in the burette. 20 ml of the given $BaCl_2$ solution is pipetted out into a clean beaker. Conductivity cell is placed in it and diluted with conductivity water. 1 ml of Na_2SO_4 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_2SO_4.

A graph is plotted between the volume of Na_2SO_4 and conductance. From the graph, end point is noted and the amount of $BaCl_2$ present in 1 liter of the solution is calculated.

RESULT

The amount of $BaCl_2$ present in 1 liter of the given solution = __________ g/l.



Determination of pH

Table 1
Titration of HCl vs NaOH

S.No	Volume of NaOH (ml)	pH

7. 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

PRINCIPLE

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

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

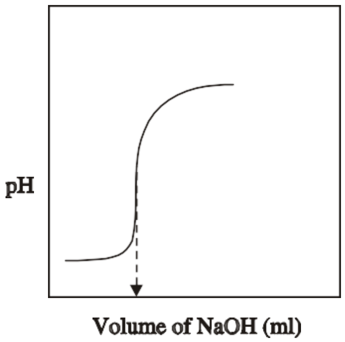
The concentration of H^+ ions in the solution is determined by measuring the pH of the solution.

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.

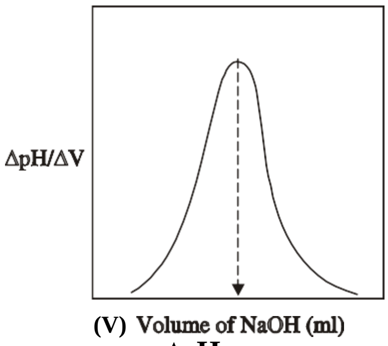
$$HCl + NaOH \longrightarrow NaCl + H_2O$$

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



Plot of pH Vs V



$\frac{\Delta pH}{\Delta V}$ Vs V

Table 2
Titration of HCl vs NaOH

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

Calculation

Volume of HCl V_1 = 20 ml

Strength of HCl N_1 = _ ?

Volume of NaOH V_2 = _ ml

Strength of NaOH N_2 = 0.1 N

Strength of HCl $N_1 = V_2N_2/V_1 = V_2 \times 0.1/20$

Weight of HCl in 1 litre of the given solution = N_1 × eq.wt of HCl g

= N_1 × 36.5 gm/l

Weight of HCl in 100 ml of the given solution = N_1 × 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