

Experiment No. → 1

DATE 11/4/23
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AIM

To determine the percentage composition of a given mixture of NaCl and NaOH, 10g of which is dissolved per liter of the solution.

CHEMICALS REQUIRED

0.1 N HCl solution, phenolphthalein solution.

APPARATUS

Burette, Pipette, beakers, titration flask, stand.

THEORY

For the titration of a solution of NaOH and NaCl the other solution needed is HCl solution. NaOH will react with acid solution whereas NaCl will remain as such.



The mixture solution and the acid solution will be titrated and in this way we can determine the normality of NaOH and hence its strength. By subtracting the strength of NaOH from the total strength of solution we can find out strength of NaCl and hence find percentage composition.

End Point

Pink to Colourless.

• OBSERVATIONS

Normality of HCl solution = 0.1 N

Volume of mixture taken for each titration = 10 mL

S.No.	Volume of the soln taken in the titration flasks (mL)	Burette Readings		Volume of titrant used (F-I) mL
		Initial (I) Reading (mL)	Final (F) Reading (mL)	
1.	10	0.0	13.6	13.6
2.	10	13.6	26.4	12.8
3.	10	26.4	39.2	12.8

Vacid used = 12.8 mL

• CALCULATIONS

Acid Mixture

$$N_1 V_1 = N_2 V_2$$

$$= N_2 \times 10$$

$$= N_2 / 100$$

$$(V_1 = V_{\text{acid used}} = 12.8 \text{ mL})$$

$$N_2 = \frac{12.8}{100} = 0.128 \text{ N}$$

$$\text{Strength} = \text{Normality} \times \text{Eq. wt.} = N_2 \times 40 = 0.128 \times 40 \Rightarrow 5.128 \text{ g/L}$$

(Eq. wt. of NaOH = 40 g)



• PROCEDURE

1. Rinse the burette with the given HCl solution.
2. Take HCl in burette and note initial reading.
3. Pipette out 10ml of unknown solution in titration flask.
4. Add a drop of phenolphthalein to the solution.
5. Run the acid solution into mixture from burette till the solution changes from pink to colourless.
6. Repeat to get three concordant readings.

• RESULT

The percentage of NaOH present in given mixture =
51.2%

And the percentage of NaCl present in given mixture =
48.8%

• PRECAUTIONS

1. Wash apparatus first with water and then detergent followed by plenty of water.
2. Rinse the burette & pipette with respective solutions to be taken in.
3. Do not rinse the conical flask with the solution to be taken in it.

The amount of NaOH in mixture = 5.12 g/L

$$\text{Amount of NaCl in mixture} = (10 - 5.12) \text{ g/L} \\ \Rightarrow 4.88 \text{ g/L}$$

Now, percentage of NaOH = $\left(\frac{5.12}{10} \times 100\right)\% \rightarrow 51.2\%$

$$\& \text{Percentage of NaCl} = \left(\frac{4.88}{10} \times 100\right)\% \\ = 48.8\%$$

✓
11/04/2023

AIM

To determine the amount of oxalic acid and sulphuric acid in 1 litre of solution, given NaOH solution and KMnO₄ solution.

CHEMICALS REQUIRED

NaOH solution, KMnO₄ solution, Oxalic acid solution, sulphuric acid solution, phenolphthalein.

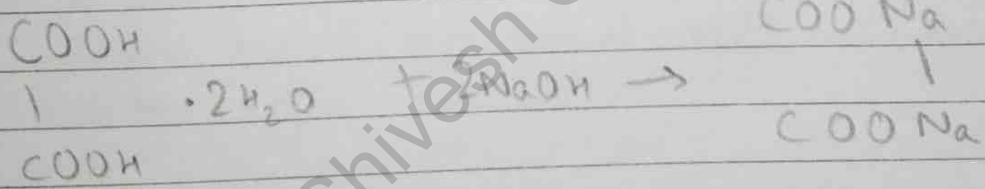
APPARATUS

Burette, Pipette, 2 beakers, titration flask, stand.

THEORY

This involves double titration.

~~1st Titration: NaOH reacts with oxalic acid as well as H₂SO₄ according to the following equations:~~

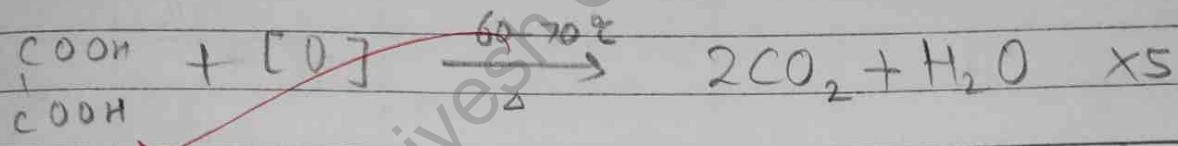
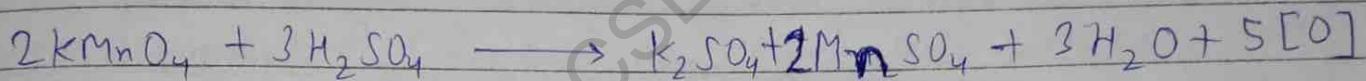


~~By titrating NaOH against the given mixture of oxalic acid and sulphuric acid, the total normality of oxalic acid and H₂SO₄ can be found out.~~



(After titration)

2nd Titration: The mixture solution is titrated with KMnO_4 solution which will react with oxalic acid (redox titration) in the presence of H_2SO_4 .



Thus, from second titration, normality of oxalic acid alone can be found out and hence its strength is determined. From the normality of the solution obtained in the first titration, the normality of oxalic acid is subtracted and hence the normality of H_2SO_4 and its strength can be found out.

The reaction of oxalic acid with KMnO_4 is very slow therefore the oxalic acid solution is heated to 60 - 70°C initially. Once the reaction has started, its rate automatically increases due to formation of Mn^{2+} ions which catalyze the reaction (auto-catalysis).

* INDICATOR USED

Phenolphthalein (1st Titration)

KMnO_4 is self-indicator (2nd Titration)

OBSERVATION TABLE 1

NaOH versus mixture

S. No.	Volume of solution taken in titration flasks (mL)	Burette Readings		Volume of titrant used (Final - Initial) (mL)
		Initial Reading (mL)	Final Reading (mL)	
1	10	0.0	18.9	18.9
2	10	18.9	37.8	18.9
3	10	4.7	23.6	18.9

$$V_2 = 18.9 \text{ mL}$$

CALCULATION 1

$$\frac{N_1 V_1}{(\text{NaOH, oxalic acid})} = \frac{N_2 V_2}{(\text{NaOH})}$$

$$N_1 = \frac{(N_2 \times V_2)}{10} = \frac{0.1 \times 18.9}{10} \rightarrow 0.189 \text{ N}$$

15/04/2023

$$\text{Normality of oxalic acid} + H_2SO_4 = N_1 = 0.189 \text{ N}$$



END POINT

Colorless to pink (1st Titration)

Colorless to pink (2nd Titration)

PROCEDURE

1st Titration:

1. Rinse the apparatus thoroughly. Take NaOH in the burette and pipette out 10 ml of mixture in the titration flask.
2. Add a drop of phenolphthalein and run NaOH from the burette.
3. Titrate till end point is achieved and note down the volume of NaOH used ..
4. Repeat to get 3 concordant readings

2nd Titration :

1. Rinse the apparatus thoroughly. Take KMnO₄ in the burette. Since it is a colored solution we note the upper meniscus for taking the initial reading.
2. Pipette out 10 ml of mixture in the titration flask. Add half a test tube (almost 100 ml) of H₂SO₄ and then heat the conical flask slowly until the moisture appears on neck of the flask or it is unbearable to touch (60 - 70 °C).
3. Titrate to achieve the end point & note volume of KMnO₄ used.
4. Repeat to get 3 concordant readings

~~OBSERVATION~~ TABLE 2

KMnO_4 vs mixture (only oxalic acid reacts)

S No.	Volume of solution taken in titration flask (mL)	Burette Readings		Volume of titrant used (Final-Initial) (mL)
		Initial Reading (mL)	Final Reading (mL)	
1.	10 mL	0.0	11.2	11.2
2.	10 mL	11.2	22.4	11.2
3.	10 mL	22.4	33.6	11.2

$$\text{N}_3 \text{V}_3 = \text{N}_4 \text{V}_4 \\ (\text{oxalic acid}) \quad (\text{KMnO}_4)$$

$$\text{N}_3 = \frac{0.1 \times \text{V}_4}{\text{V}_3} \Rightarrow$$

Normality of Oxalic acid = $\frac{N}{2}$ or $0.5 N$

Strength of oxalic acids $\text{N}_3 \times \text{Eq wt}$

$$= 0.112 \text{ N} \times 63.9\text{ cm}$$

= 7.056

$$\text{Normality of H}_2\text{SO}_4 = (N_1 - N_3) = (0.189 - 0.112) \text{ N} \\ = 0.077 \text{ N}$$

$$\text{Strength of H}_2\text{SO}_4 = 0.077 \times 49 \text{ g/L} = \cancel{3.773}$$



Result

Amount of oxalic acid in the given mixture = 7.056 g/L

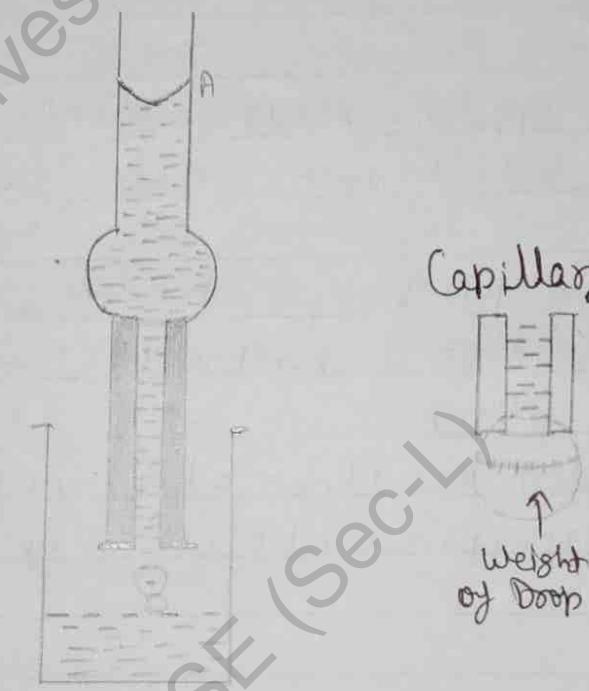
Amount of H_2SO_4 present in the given mixture = 3.773 g/L

Precautions

1. All the apparatus should be washed before use.
2. Rinse the burette with $KMnO_4$ and pipette with given solution.
3. Never use a pinch cock burette as $KMnO_4$ attacks rubber.
4. Always use freshly prepared $KMnO_4$ solution. Sulfuric acid should be added.
5. Sulfuric acid should be added in excess otherwise a brown precipitate of MnO_2 may form.

16/09/2023

Diagram



Capillary Tube

Surface Tension
acts along the
circumference

Stalagmometer



• AIM

Determine the surface tension of a given liquid by drop number method.

• APPARATUS

Stalagmometer, beaker, pinch cock.

Stalagmometer is essentially a pipette with a capillary at the lower end and a bulb in the middle. The end is flattened and ground carefully so that there is a large dropping surface. There are two marks A and B, above and below the bulb respectively. These marks define the volume to be delivered for counting the drops. In case the rate of flow is rapid leading to rapid drop formation, a piece of rubber tubing with a pinch cock is attached to top of stalagmometer and rate of flow is adjusted to not more than 15 drops per minute.

• THEORY

When a liquid is allowed to flow through a capillary tube, a drop is formed at its lower end. It increases to a certain size and falls off. The size of drop depends on the radius of capillary and the surface tension of the liquid. The surface tension acting along the circumferences of the capillary tube supports the drop in upward direction.

Observation Table

S. No.	Water		Sample A		Sample B	
	No. of Drop	Mean	No. of Drop	Mean	No. of Drop	Mean
1)	60		46		51	
2)	50	52.6	45	46.33	46	47.66
3)	48		48		46	

$$\gamma_{L1} = \frac{1.2}{4} \times \frac{52.6}{46.33} \times 72 = 98.09 \text{ dyne/cm}$$

Surface Tension of Sample A = 98.09 dyne/cm

$$\gamma_{L2} = \frac{1.3}{1} \times \frac{52.6}{47.66} \times 72 = 103.30 \text{ dyne/cm}$$

Surface Tension of Sample B = 103.30 dyne/cm



The measurement of surface tension of liquid is based on the fact that the drop of liquid at lower end of capillary falls down when weight of drop becomes just equal to the surface tension.

1. Now the force of gravity exerted on the drop is given by $v \cdot d \cdot g$. where v is the volume of the drop, d is density and g is gravity. The force of gravity will pull down the drop.
2. The force tending to uphold the drop is given by $2\pi\gamma r$ where $2\pi r$ is circumference of the capillary of radius r .

When the two forces are balanced,

$$2\pi\gamma r = v \cdot d \cdot g \quad \text{--- (1)}$$

If n is the number of drops in volumes V of liquid then volume of each drop will $v = V/n$, From equation 1, we have $2\pi\gamma r = (V \cdot d \cdot g)/n \quad \text{--- (2)}$

Consider two liquids of densities d_1 & d_2 having surface tension γ_1 & γ_2 . Let no. of drops counted for the same volume V of two liquids be n_1 & n_2 respectively. Then,

$$2\pi\gamma_1 r = (V/n_1) d_1 g \text{ for 1st liquid} \quad \text{--- (3)}$$

$$2\pi\gamma_2 r = (V/n_2) d_2 g \text{ for 2nd liquid} \quad \text{--- (4)}$$



Dividing equation (3) by (4), we have

$$\gamma_1 / \gamma_2 = (n_2 / n_1) / (d_1 / d_2)$$

where γ_1 & γ_2 are surface tensions of two individual liquids & d_1 & d_2 are their densities, respectively. Thus, for determination of surface tension of any liquid, the number of drops produced from equal volume of two liquids and their densities must be known. Knowing the surface tension of reference liquid (eg water) the surface tension of given liquid can be determined.

• PROCEDURE

1. Immerse the lower end of stalagmometer in a beaker containing distilled water. Suck the water until it rises above mark A.
2. Now let water flow out and start counting the number of drops when water meniscus just reaches the mark A, and counting is stopped when water meniscus passes the lower mark B. Let number of drops be n_w .
3. Repeat to get three readings.
4. Clean the stalagmometer and dry it. Fill it with liquid until it rises above mark A and count number of drops when a fixed volume of liquid flows between mark A & B,



as before. Let the no. of drops be n .

RESULT

The surface tension of given liquid is _____ dynes cm^{-1}
at _____ $^{\circ}\text{C}$.

PRECAUTIONS

1. Stalagmometer should be thoroughly cleaned.
2. It should be in vertical position throughout counting process.
3. Drop formation should be adjusted to a slower rate and should not exceed 15 drops per minute.

**AIM**

Determination of alkalinity in a given sample of water.

APPARATUS

Burette, Pipette, Conical flask, measuring flask.

Chemicals

Standard HCl solution & phenolphthalein, methyl orange.

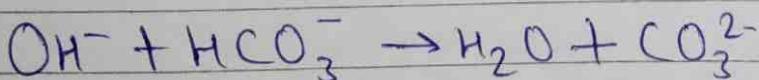
Theory

In water sample alkalinity may be present due to following three ions, i.e., OH^- , CO_3^{2-} and HCO_3^- .

Thus on the basis of above three ions, possible combination of ions causing alkalinity of water are:

1. OH^-
2. CO_3^{2-}
3. HCO_3^-
4. OH^- and CO_3^{2-}
5. CO_3^{2-} and HCO_3^-

The presence of OH^- and HCO_3^- ions together is not possible since they combine together & form CO_3^{2-} ions.



Thus, the extent of alkalinity in the given water sample may be determined by titrating the water sample with a

OBSERVATIONS

Indicator

→ Phenolphthalein and methyl orange

End Point

→ Pink to colorless and yellow to Red respectively

Volume of water sample →

S. No	Sample in titration flask (ml)	Initial burette reading (ml)	Phenolphthalein add Burette reading Hl end point (ml)	Volume of titrant used Phenolphthalein use (ml)	Methyl orange add Burette reading till end point (ml)	Methyl orange in use (ml) Volume of titrant used (ml)
1.	10	0	1.9	1.9	8.0	8.0
2.	10	9.9	11.9	2	17.7	7.8
3.	10	17.6	19.6	2	25.4	7.8

$$V_1 = 2 \text{ ml}$$

$$V_1' = 7.8 \text{ ml}$$

CALCULATIONS

② Phenolphthalein alkalinity in terms of CO_3^{2-} equivalents

$$N_1 V_1 = N_2 V_2 \\ (\text{HCl}) \quad (\text{Water sample})$$

$$10 \times V_1 = N_2 \times 10$$

$$N_2 = \frac{V_1}{100} = \frac{2}{100} = 0.02 \text{ N}$$

Strength in g/L in terms of $\text{CaCO}_3 = (0.02 \times 50) \text{ g/L} = 1 \text{ g/L}$

③ Methyl Orange Alkalinity

$$N_1' V_1' = N_2' V_2'$$

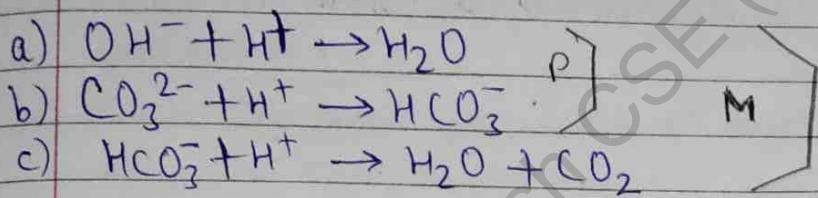
$$(\text{HCl}) \quad (\text{Water sample})$$

$$\frac{1}{10} \times V_1' = N_2' \times 10$$

$$N_2' = \frac{V_1'}{100} = \frac{7.8}{100} = 0.078 \text{ N}$$



standard acid using phenolphthalein and methyl orange indicators according to the pH of water sample.



The volume of acid used up to phenolphthalein end point corresponds to the reaction (a) & (b) i.e. complete neutralization of OH^- ions and neutralization of CO_3^{2-} ions upto HCO_3^- stage (half neutralization).

The volume of acid used up to methyl orange end point corresponds to reaction (a), (b) & (c) i.e. complete neutralization of OH^- , CO_3^{2-} & HCO_3^- ions.

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

• Procedure

- a) Pipette out 20 ml of water sample in to conical flask and add 2 drops of phenolphthalein indicator. Pink color appears.
- b) Rinse and fill the burette with 1M HCl.
- c) Titrate the water sample with HCl from burette with constant shaking till the pink color just disappears.
- d) Note this reading this corresponds to phenolphthalein end point (P).
- e) Now add 2-3 drops of methyl orange indicator in the same solution.

Strength in g/L in terms of $\text{CaCO}_3 = (0.078 \times 50) \text{ g/L}$

$$\Rightarrow 3.9 \text{ g/L}$$



and continue the titration until a sharp color change from yellow to pink takes place.

- (f) Note this reading, it corresponds to methyl orange end point (M).
- (g) Repeat the same procedure at least three times to get the concordant readings.

- Result

Water is alkaline due to presence of CO_3^{2-} ion/ion. Alkalinity due to the presence of CO_3^{2-} ion is 39.00 mg/L.

- Precautions

1. Apparatus should be thoroughly cleaned.
2. Rinse the burette with the solution to be taken in it.
3. Always read the lower meniscus in case of colorless solution.
4. There should be no burette bubble or bubble in pipette during the measurement.

_____ X _____

• AIM

To determine the strength of Cu^{2+} in the CuSO_4 solution, provided hypo solution.

• Chemicals Required :

Hypo solution, copper sulphate solution, starch, dilute acetic acid, Na_2CO_3 solution, KI.

• Apparatus

Burette, Pipette, beakers, titration flask and stand.

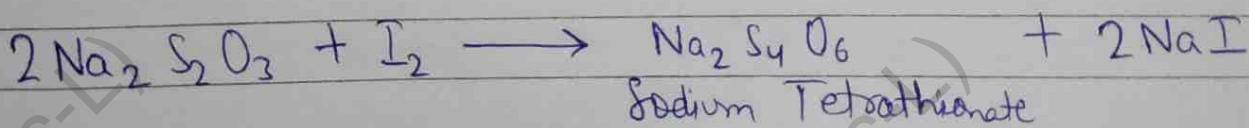
• Theory

This experiment comes under the category of iodometry which is used widely in the analysis of ores, alloys, etc.

When an excess of KI is added to the solution containing Cu^{2+} in neutral or slightly acidic medium, quantitative liberation of iodine takes place.

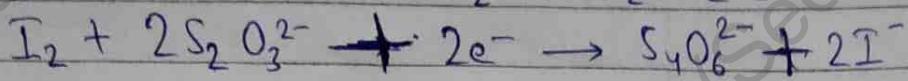
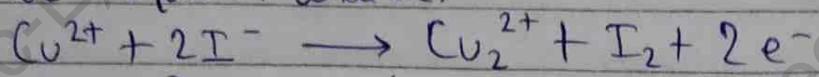


This liberated iodine is then titrated against standard $\text{Na}_2\text{S}_2\text{O}_3$ solution using starch solution as indicator near the end point.





Ionic equation will be:



From the above equation it is evident,

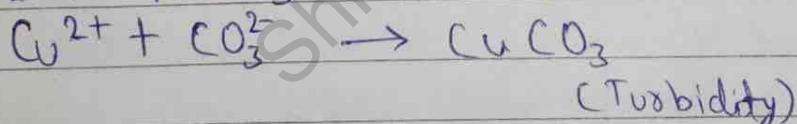
$$2\text{Cu}^{2+} \equiv \text{I}_2 \equiv \text{S}_2\text{O}_3^{2-} \equiv 2\text{e}^-$$

The equivalent weight of Cu^{2+} will be one half of twice the molecular weight since the reaction involves two electrons per two moles of Cu^{2+} .

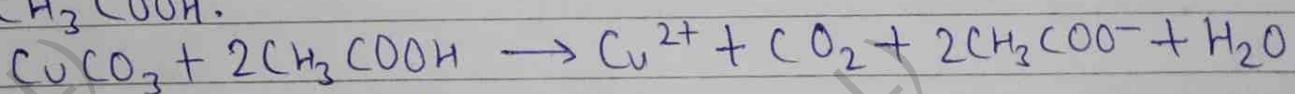
$$\text{Eq. Wt of Cu}^{2+} = \frac{2 \times 63.5}{2} = 63.5$$

From the normality equation, normality of Cu^{2+} and hence the strength of Cu^{2+} in hydrated CuSO_4 crystals is determined.

The titration fails when any mineral acid is present in the solution and therefore, before commencing the titration the acid should be neutralized. This is done by drop wise addition of a solution of Na_2CO_3 until a slight precipitate or turbidity appears.



The turbidity is removed by drop wise addition of dilute CH_3COOH .

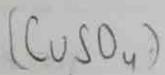


OBSERVATIONS

S. No.	Volume of solution taken in titration flask (mL)	Burette Readings	Volume of the titrant used (Final - Initial Reading)(mL)
		Initial Reading (mL) Final Reading (mL)	
1.	10	0 11	11
2.	10	11 22.2	11.2
3.	10	22.2 33.2	11

$$V_2 = \underline{11 \text{ mL}}$$

CALCULATIONS



$$N_1 V_1$$

$$N_1 \times 10$$

$$N_1 (\omega^{2+}) = \rightarrow 0.11 N$$

$$\therefore \text{Strength of } \omega^{2+} = (0.11 \times 63.5) \text{ g/L}$$

$$\Rightarrow 6.985 \text{ g/L}$$



Moreover, the precipitate of Cu_2I_2 absorbs I_2 from solution and releases it slowly making the detection of sharp end point difficult so a small amount of NH_4CNS is added near the end point to displace the absorbed iodine from Cu_2I_2 precipitate.

- End Point

Blue to colourless.

- Procedure

1. Rinse and fill burette with $\text{Na}_2\text{S}_2\text{O}_3$ solution.
2. Measure 10 mL of CuSO_4 solution into a conical flask.
3. Neutralize any free acid present by adding Na_2CO_3 solution drop by drop till a faint permanent precipitate remains even on shaking.
4. Add dilute acetic acid drop wise until the precipitate just dissolves.
5. Add 1g of solid KI , cover the mouth of conical flask by filter paper and allow the mixture to stand for 2-5 minutes in the dark. The solution becomes brown due to liberated iodine.
6. Now titrate the liberated iodine with hypo solution added from burette. The brown color of iodine becomes fainter as the addition of hypo solution proceeds and when only a faint yellow colour remains add 2ml of starch solution and 1g of NH_4SCN . This immediately forms a deep blue iodo - starch complex.
7. Now add hypo solution further, drop by drop, till only milky



white color remains.

• Result

The strength of copper present in copper sulphate solution is 6.985 g/L

• Precautions

1. The solution of $\text{Na}_2\text{S}_2\text{O}_3$ is always taken in the burette in iodometric titrations.
2. Sufficient amount of KI solution is to be added for the reason explained earlier.
3. The indicator should be added just before the end point.

— X —



AIM

Determine the strength of chloride ion in given water sample using $\text{AgNO}_3 \text{ N}_{\frac{1}{100}}$ solution by Mohr's Method.

APPARATUS

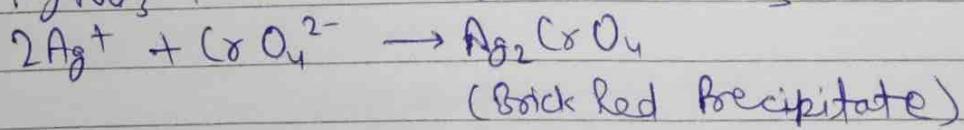
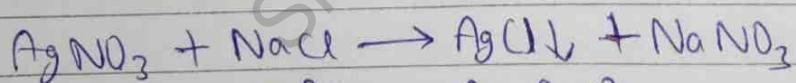
Burette, pipette, beakers, titration flask, stand.

Theory

When silver nitrate solution is added to a solution of sodium chloride containing a few drops of potassium chromate, white silver chloride is precipitated initially. As soon as all the chloride ions have been precipitated out, even a drop of silver nitrate added in excess gives a red precipitate of silver chromate. This indicates the end point.

The solubility product of silver chloride is lower than that of silver chromate. Hence as long as the chloride ions are available the less soluble silver chloride is precipitated.

As soon as the chloride ions have been precipitated out, even a slight excess of Ag^+ produces insoluble silver chromate which is red in color.



OBSERVATIONS

S. No.	Volume of the soln taken in the titra- tion flask (mL)	Burette Reading		volume of AgNO_3 used (Initial-Final Reading) (mL)
		Initial Reading (cmL)	Final Reading (mL)	
1.	10	0	4.9	4.9
2.	10	4.9	9.4	4.5
3.	10	9.4	13.9	4.5

$$V_1 = \underline{4.5 \text{ mL}}$$

CALCULATIONS

$$\begin{aligned} \text{AgNO}_3 & \quad \text{NaCl} \\ N_1 V_1 &= N_2 V_2 \\ N_2 &= \frac{N_1 V_1}{V_2} = \frac{0.0045 \times 4.5}{10} = 0.0045 \text{ N} \end{aligned}$$

Strength of Chloride ion in water sample = $N_2 \times 35.5$

$$\begin{aligned} &\Rightarrow 0.0045 \times 35.5 \\ &\Rightarrow 0.15975 \text{ g/L} \end{aligned}$$



• Procedure

1. Rinse & fill burette with given AgNO_3 solution.
2. Pipette out 10ml of NaCl solution in titration flask.
3. Add 0.5 mL of $\text{K}_2\text{Cr}_2\text{O}_4$ indicator.
4. Add AgNO_3 from burette, shake the flask constantly. A white precipitate of AgCl is obtained. After adding of few ml of AgNO_3 a red color appears in flask but disappears quickly upon shaking.
5. Continue the addition drop by drop till a permanent reddish brown is obtained. Take three concordant reading.

• Result

The strength of given Chloride ion in water sample is
0.15975 - g/L

• Precautions

1. Store AgNO_3 in a colored bottle.
2. The whole apparatus must be washed with distilled water.
3. Same amount of indicator must be added each time.
4. The reaction mixture should be briskly shaken during titration.



AIM: To standardize EDTA solution and to determine total hardness (temporary + permanent) of the given water sample by complexometric titration.

APPARATUS:

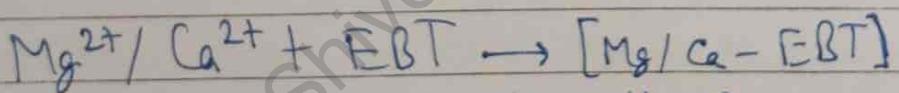
Burette, pipette, beakers, titration flask, stand.

THEORY:

The hardness of water can be determined by complexometric titration. EDTA (Ethylene Diamine Tetraacetic Acid) is used as a complexing agent. In form of its disodium salt it is used to estimate Ca^{2+} and Mg^{2+} ions, using Eriochrome black-T as an indicator.

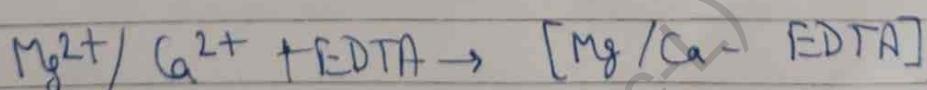
Estimation of Ca^{2+} & Mg^{2+} by EDTA method is based on following principal:

- First, the indicator Eriochrome Black T, which is blue colored dye, forms an unstable complex with Ca^{2+} or Mg^{2+} ions of hard water at a pH of 9 to 10. The complex is wine red in colour.



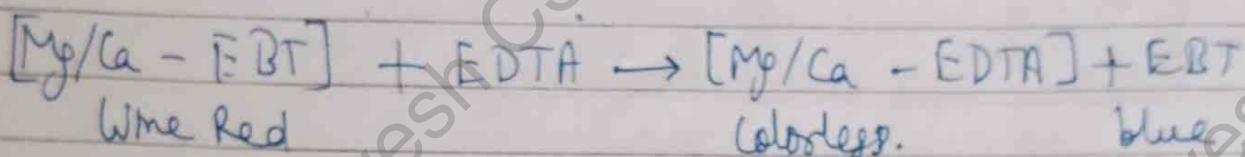
(Unstable Complex (Wine Red))

- As this solution is titrated against EDTA, free Ca^{2+} or Mg^{2+} ions in water form stable metal - ion EDTA complex.



Stable Complex (Colorless)

- Once the free metal ions are complexed, the EDTA replaces Ca or Mg ions from unstable red indicator and the indicator is set free. Once the indicator is blue at above pH, the end point is appearance of blue color.



Thus ; the amount of EDTA used corresponds to the hardness of water.

The temporary hardness is removed by boiling and after removal of precipitate by filtration, the permanent hardness of ~~the~~ filtrate is determined by titration with EDTA as above. The temporary hardness will be given by difference of total hardness & permanent hardness.

① Titration of EDTA with given water sample

For determination of total hardness of water sample

• Procedure

1. Rinse & fill burette with EDTA solution.
 2. Pipette out 10ml of given hard water sample in a conical flask.
 3. Add 2 ml of ammonia buffer solution and 2-3 drops of EBT indicator.
 4. Titrate solution till wine red color changes to deep blue.

• Observation Table

S. No.	Volume of soln taken in titration flask (mL)	Burette Readings (mL)		Volume of titrant used (Final - Initial Reading) (mL)
		Initial Reading	Final Reading	
1.	10	5.5	8.9	3.4
2.	10	9.0	12.7	3.7
3.	10	12.7	16.4	3.7

$$V_B = 3.7 \text{ mL}$$

(EDTA) (Water)

$$M_B V_B = M_T V_T$$

$$\frac{1}{100} \times 3.7 = M_T \times 10$$

$$M_T = \frac{3.7}{1000} = 0.0037 \text{ M}$$



5. Repeat titration to get 3 concordant readings.

• CALCULATIONS

Concordant volume of EDTA consumed = V_B mL

For 10 mL of given hard water V_B mL of EDTA is used.
(Total hardness)

$$M_T = 0.0037 \text{ M}$$

Total Hardness = $M_T \times \text{Molecular mass of CaCO}_3 \times 1000$

$$\Rightarrow 0.0037 \times 100 \times 1000 = 370 \text{ ppm}$$

II) Titration of EDTA with boiled water sample.

• Procedure

1. Take 200 mL of given hard water sample in beaker.
2. Boil sample for about two hours.
3. Cool the sample and filter it.
4. From the filtrate pipette out 10 mL of water sample & titrate with EDTA as per previous procedure.

• CALCULATIONS

$$\frac{(EDTA)}{M_B V_B} = \frac{(Water)}{M_P V_P}$$

Observation Table

S. No.	Volume of solution taken in titration flask (mL)	Burette Reading (mL)		Volume of titrant used (Final - Initial Reading) (mL)
		Initial	Final	
1.	10	0.0	3.0	3.0
2.	10	3.0	5.6	2.6
3.	10	5.6	8.2	2.6

$$V_B = 2.6 \text{ mL}$$



$$\frac{1}{100} \times 2.6 = M_p \times 10 \Rightarrow M_p = \frac{2.6}{1000} \rightarrow 0.0026 M$$

(Permanent Hardness) $M_p = 0.0026 M$

Permanent Hardness = $M_p \times \text{Mol. mass of } CaCO_3 \times 1000$

$$\Rightarrow 0.0026 \times 100 \times 1000$$

$$\Rightarrow 260 \text{ ppm}$$

$$\Rightarrow \text{Now; Temporary Hardness} = \text{Total hardness} - \text{Permanent Hardness}$$
$$\Rightarrow 370 - 260 \Rightarrow 110 \text{ ppm}$$

• RESULT

1. Total Hardness of given water sample = 370 ppm
2. Permanent Hardness = 260 - ppm.
3. Temporary Hardness = 110 - ppm

• PRECAUTIONS

1. The burette should be rinsed with EDTA solution.
2. Conical flask should be rinsed with distilled water.
3. Re-distilled water should be employed for preparing EDTA solution.
4. The colour change near end point is very slow & thus should be observed carefully.

— X —

- AIM

Determination of coefficient of viscosity of given liquid by Ostwald's viscometer method.

Apparatus: Ostwald viscometer, stopwatch, specific gravity bottle, 10mL pipette, distilled water.

- Theory

The Ostwald's viscometer method is based on Poiseuille's equation. This relates the rate of flow of liquid through a capillary tube with the coefficient of viscosity and is expressed by the equation,

$$\eta = (\pi r^4 t p) / 8 V L \quad \dots \dots \dots (1)$$

where V = Volume of liquid of viscosity η flowing in time t , through a capillary tube of radius r and length L .

P = Hydrostatic pressure of liquid.

This determination of absolute viscosity by means by Poiseuille's expression involves the determination of V, r, t, L and p .

The method is however tedious and laborious one. Hence, a simple method is used where in we compare the viscosities of two liquids. If the coefficient of viscosity of one liquid is known, then that of the other can be calculated.

If t_1 & t_2 are the flow time required to flow for equal volumes of two liquids through the same length of a capillary tube then from equation (1) we have

$$\eta_1 = (\pi r^4 t_1) / 8 V L$$

$$\eta_2 = (\pi r^4 t_2) / 8 V L$$

$$\eta_1 / \eta_2 = \frac{r_1^4 t_1}{r_2^4 t_2} \quad \dots \dots \dots (2)$$

$$p = h \rho g \quad \dots \dots \dots (3)$$

Diagram

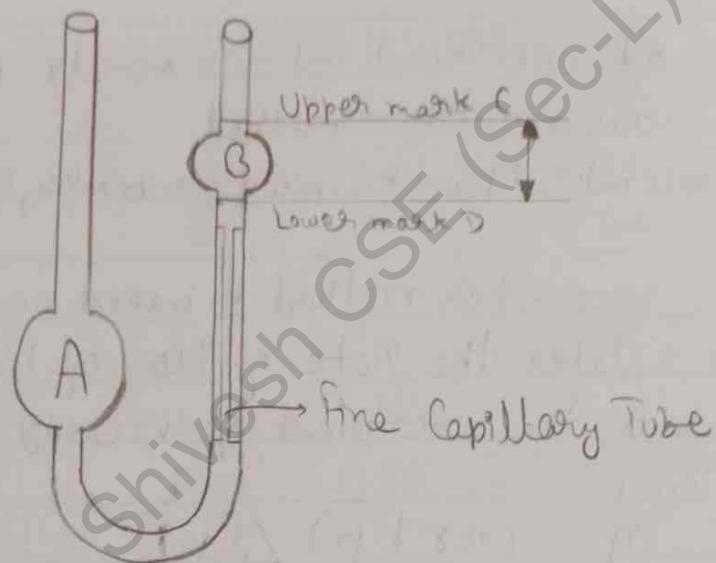


Fig. Viscometer

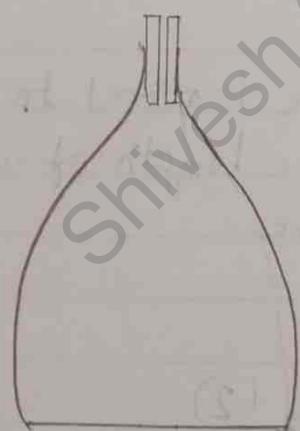


Fig. Density bottle



where h is height of liquid column (it is constant for all the liquid if taken for identical points and liquids are taken in equal volume for a particular set of observations.)

g = acceleration due to gravity

d = density of liquid

Since in this case for two liquids h & g are same hence,

$$\eta_1/\eta_2 = \frac{d_1 t_2}{d_2 t_1}$$

This will give us the relative viscosity of given liquid. Relative viscosity has no units. The absolute viscosity $\eta_1 = (d_1/d_2) \cdot (t_1/t_2) \cdot \eta_2$

• Description

- 1) Ostwald's Viscometer: It consists of a capillary tube connected at its upper end with a bulb A and its lower end with a U-tube provided with bulb B. Bulb B is of larger size than A. Marks X & Y are etched on the capillary tube above & below the bulb A. The bulbs are necessary to maintain the hydrostatic pressure during flow of liquid. Through capillary, the liquid flows with a measurable speed.
- 2) Relative viscosity is conveniently measured by means of a relative density bottle or specific gravity bottle.
- 3). Density bottle.



• Procedure

- ① Clean viscometer with chromic acid & then wash it several times with distilled water. It is finally washed with alcohol and ether & then dried.
- ② Attach a piece of clean rubber to the end of arm 2 and clamp with viscometer vertically in air.
- ③ Now introduce a sufficient volume of given liquid with the help of a pipette in bulb A so that the bend portion of the U-tube & more than half of the bulb A are filled up.
- ④ Through the rubber tube, suck up the liquid until it rises above the mark C. Make sure that there is no air bubble inside the liquid.
- ⑤ Now, allow the liquid to fall freely through the capillary up to the mark C. Start the stopwatch and note the time t_1 for the flow of liquid from mark C to mark D.
- ⑥ Repeat the experiment thrice. The values should be concordant.
- ⑦ Remove the liquid and clean up & dry viscometer again.
- ⑧ Repeat experiment by taking the same volume of distilled water & note the time taken t_2 for the flow of water from mark C to D. Repeat thrice.

Observations

Room Temperature = 25 °C

Observation Table

S. No.	Given Liquid A		Given Liquid B		Water
	Time of flow (s)	Mean (s)	Time of flow (s)	Mean (s)	Time of mean flows (s)
1.	165		182		163
2.	161	163	169	179	165
3.	163		173		164



- ⑨ Weigh the relative density bottle and note down its weight.
⑩ Fill it with given liquid and weigh it again.
⑪ Remove the liquid. Wash it with chromic acid & then distilled water. Dry it in the oven. Now fill it with distilled water and weigh it.

CALCULATIONS

Density of water, $d_w = 1 \text{ gm/cc}$

η_w , viscosity of water = 10 milipoise

(d_L), density of sample A = 1.2 gm/cc

(d_L'), density of sample B = 1.39 gm/cc

$\eta_{L_1} = \text{viscosity of sample } 'A'$

$$\Rightarrow \frac{\eta_{L_1}}{\eta_w} = \frac{d_{L_1} \times t_{L_1}}{d_w \times t_w}$$

$$\Rightarrow \frac{10 \times 1.2 \times 174}{1 \times 164}$$

$\eta_{L_1} = \text{viscosity of sample } 'A'$

$\Rightarrow 13.79 \text{ milipoise}$

$$\Rightarrow \frac{\eta_{L_1}}{\eta_w} = \frac{d_{L_1} \times t_{L_1}}{d_w \times t_w} = \frac{10 \times 1.2 \times 163}{1 \times 164}$$

$\Rightarrow 11.92 \text{ milipoise}$

Result

The relative viscosity of given solution is _____ at _____ °C

The absolute viscosity of given solution is _____ Pa-s at _____ °C.

The relative viscosity of given liquids

(A) 11.92 milipoise

(B) 13.79 milipoise

} Both at room temperature 25 °C

Implications

1. It is used in factories to check viscosity of fluids such as ketchup / honey.



- ② Used to measure the viscosity of fluid to be filled in water cooled PCs.
- ③ By the viscosity formula, we can develop a software which can determine the viscosity.