KARPAGAM ACADEMY OF HIGHER EDUCATION DEPARTMENT OF CHEMISTRY

17CHU111 ATOMIC STRUCTURE AND CHEMICAL BONDING PRACTICAL

2H 1C

Instruction Hours/week:L: 0 T:0 P:2 Marks: Internal: 40 External: 60 Total:100

Scope

The course presents the practical knowledge in the in-organic chemistry, about the basics of atomic structure and chemical bonding. This involves quantitative techniques like volumetric analysis.

Programme outcome

- 1. To understand the principles of volumetric analysis.
- 2. To provide a versatile knowledge of preparations of solutions with appropriate concentrations, titrations and to handle the respective apparatus while doing a titration.
- 3. To provide a knowledge about the calculations involved in the estimation of compounds using volumetric analysis,

Programme learning outcome

The student understood about the principles of volumetric analysis and also able to handle the apparatus and to prepare solutions individually

Methodology

Titrations, Volumetric analysis.

Inorganic Chemistry - Volumetric Analysis

1. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.

- 2. Estimation of oxalic acid by titrating it with KMnO₄.
- 3. Estimation of water of crystallization in Mohr's salt by titrating with KMnO₄.
- 4. Estimation of Fe (II) ions by titrating it with K₂Cr₂O₇ using internal indicator.
- 5. Estimation of Cu (II) ions iodometrically using Na₂S₂O₃.

Suggested Readings:

Text Book:

1. Svehla, G. (2012). *Vogel's Qualitative Inorganic Analysis*. Pearson Education. **Reference Book:**

1. Mendham, J. (2009) Vogel's Quantitative Chemical Analysis, Pearson.

1. Estimation of Sodium carbonate and Sodium hydrogen carbonate present in a mixture

AIM:

To determine the amount of sodium carbonate and sodium hydroxide in a mixture

PRINCIPLE:

Carbonate ion reacts with hydrogen ions

$$\begin{array}{c} 2^{-} \\ CO_{3}^{2} + H^{+} \longrightarrow HCO_{3}^{-} \\ HCO_{3}^{-} + H^{+} \longrightarrow H_{2}CO_{3} \longrightarrow H_{2}O + CO_{2} \end{array}$$

The pKa1 and pKa2 values of H_2CO_3 are quite distinct and so when a carbonate solution is titrated against hydrochloric acid, there occur two distinct regions of sharp pH change. The first corresponding to the formation of HCO (pH 8 to 10) and the second due to complete neutralization at pH 4-6.

The first is roughly in the pH range in which colour of phenolphthalein changes from red to colourless and the second is that at which methyl orange changes from yellow to orange red. This end point, however, is not very sharp in the titration of the strong base NaOH.

The sharp change of pH occurs over a range of pH that includes the regions of colour change of both the indicators, so both of them give the end point correctly. When we have both sodium carbonate and sodium hydroxide present together in a solution, a titration using phenolphthalein gives the titre (volume at the equivalence point) corresponding to sodium hydroxide plus half the carbonate and the titre obtained with methyl orange corresponds to the total alkali. The individual sodium carbonate and hydroxide concentrations may be calculated from the data.

The HCl solution used may be standardized by titration with a standard solution of sodium tetraborate decahydrate (borax) or anhydrous sodium carbonate. The reaction involved in the case of borax.

Borax is preferable as a primary standard because of its higher equivalent weight.

Procedure :

Prepare 100 mL of a standard solution of $Na_2B_4O_7$.10H₂O (approximately N/20) by weighing accurately about one gram of borax, dissolving it in distilled water and making up to 100 mL. Titrate 10 mL portion of this solution against the supplied hydrochloric acid till concordant titres are obtained, using 2 drops of methyl orange as indicator. Calculate the strength of the HCl solution.

Pipette out 10 mL solution of a mixture of sodium carbonate and sodium hydroxide into a conical flask, add two drops of methyl orange indicator and titrate against HCl, till the colour changes from pale yellow to orange. Note the titre value (V1). Titrate 10 mL portions of the solution using phenolphthalein as indicator (1-2 drops). The color changes here at the end point is from red to colourless and is quite sharp. Let the titre be V2 of HCl. Therefore, 2(V1 - V2) corresponds to carbonate, and V1 - 2(V1 - V2) = 2V2 - V1 corresponds to sodium hydroxide. Calculate the amount of NaOH and Na₂CO₃ present in a litre of the given solution in g/L.

Tabulation - I

INDICATOR: methyl orange

SL.NO	Volume of sodium carbonate	BURE READI	TTE INGS	VOLUME OF	CONCORDANT VALUE
		INITIAL	FINAL	HCL	
	ml	ml	ml	ml	ml
1					
2					

CALCULATION:

Volume of $Na_2CO_3 (V_1) = 20 \text{ ml}$

Normality of $Na_2CO_3(N_1) = 0.1N$

Volume of HCl $(V_2) = ml$

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Normality of HCl $(N_2) = N$

 $\mathbf{V}_1\mathbf{N}_1 = \mathbf{V}_2\mathbf{N}_2$

 $N_2 = V_1 N_1 / V_2$

Normality of HCl $(N_2) =$ _____N

Tabulation - II

INDICATOR: methyl orange

SL.NO	Volume of Na ₂ CO ₃	BURETTE READINGS		VOLUME OF	CONCORDANT
		INITIAL	FINAL	HCl	VALUE
	ml	ml	ml	ml	ml
1					
2					

CALCULATION:

Volume of HCl $(V_1) = ml$

Normality of HCl $(N_1) = 0.1N$

Volume of $Na_2CO_3 (V_2) = 20 \text{ ml}$

Normality of $Na_2CO_3(N_2) = ?$

 $V_1N_1 = V_2N_2$

 $N_2 = V_1 N_{1/V_2}$

Normality of Na_2CO_3 (N_2) = _____ N

Amount of Na_2CO_3 present in 1 litre =Normality X Equivalent mass X 100 / 1000

Result:

The amount of sodium carbonate present in the given solution is

2. ESTIMATION OF OXALIC ACID BY TITRATING IT WITH STANDARD KMnO4

Aim:

To estimate the amount of oxalic acid is present in 500 ml of the given solution using standard FAS and $KMnO_4$ as a link solution.

APPARATUS REQUIRED:

Burette, pipette, conical flask and bottles containing oxalic acid, STD FAS and KMnO₄ solution.

PRINCIPLE:

Equal volumes of equiv-normal solutions interact with each other.

 $V_1N_1 = V_2N_2$

FAS known

KMnO₄

(Unknown solution) oxalic acid unknown

PROCEDURE:

TITRATION- I Standardization of KMnO₄ solution:

The burette is washed with water and rinsed with KMnO₄ solution. It is then filled with the same solution up to zero mark without any air bubbles. The initial burette reading is noted.

The pipette is washed with water and rinsed with standard FAS solution. 20 ml of the same solution is pipette out into a clean conical flask. 20ml of 2 N H_2SO_4 is added to this solution and titrated against the burette solution. Appearance of the pale permanent pink colour is the end point. The titration is repeated for the concordant value. From this titre value, the normality of KMnO₄ solution is calculated.

TITRATION-II Standardization of oxalic acid solution:

The burette is washed with water and it is rinsed with KMnO₄ solution. It is then filled with the same solution up to zero mark without any air bubbles. The initial burette reading is noted.

The pipette is washed with water and rinsed with given oxalic acid solution.20ml of this solution is pipette out into a clean conical flask. 20 ml of 2N H₂SO₄ is added to the conical flask and the

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solution is heated to be arable warmth $(70^{\circ} c)$

and titrated against the burette solution. Appearance of the pale permanent pink colour is the end point. The titration is repeated for the concordant value. From this titre value, the normality and the weight of oxalic acid are calculated.

SL.NO	CONTENT	TITRATION – I	TITRATION – II
1	Burette solution	KMnO ₄	KMnO ₄
2	Pipette solution	20 ml of FAS solution	20 ml of Oxalic acid solution
3	Acid to be added	20 ml 2N H ₂ SO ₄	20 ml 2N H ₂ SO ₄
4	Temperature	Lab Temperature	$60 - 70^{0}$ C
5	Indicator	Self Indicator (KMnO ₄)	Self Indicator (KMnO ₄)
6	End Point	Appearance of pale permanent pink colour	Appearance of pale permanent pink colour

SHORT PROCEDURE:

Equivalent mass of Oxalic acid = 63

Normality of FAS solution = 0.1N

TITRATION-I

STANDARDISATION OF KMnO₄ (KMnO₄ VS FAS)

INDICATOR: KMnO₄ (SELF-INDICATOR)

SL.NO	Volume of FAS	BURETTE READINGS		VOLUME OF	CONCORDANT
		INITIAL	FINAL	KMnO ₄	VALUE
	ml	Ml	ml	ml	ml
1					
2					

CALCULATION:

Volume of FAS $(V_1) = 20$ ml

Normality of FAS $(N_1) = 0.1N$

Volume of $KMnO_4(V_2) = ml$

Normality of $KMnO_4(N_2) = N$

 $\mathbf{V}_1 \mathbf{N}_1 = \mathbf{V}_2 \mathbf{N}_2$

 $N_2 = V_1 N_1 / V_2$

Normality of $KMnO_4(N_2) =$ _____N

TITRATION-II

STANDARDISATION OF OXALIC ACID (KMnO4 VS OXALIC ACID)

INDICATOR: KMnO4 (SELF-INDICATOR)

SL.NO	Volume of OXALIC ACID	BURETTE READINGS		VOLUME OF	CONCORDANT
		INITIAL	FINAL	KMnO ₄	VALUE
	ml	Ml	ml	ml	ml
1					
2					

CALCULATION:

Volume of $KMnO_4(V_1) = ml$

Normality of $KMnO_4(N_1) = N$

Volume of Oxalic acid $(V_2) = 20$ ml

Normality of Oxalic acid $(N_2) = N$

 $V_1N_1 = V_2N_2$

 $N_2 = V1N1/V2$

Normality of Oxalic acid $(N_2) =$ _____N

The amount of Oxalic acid in 500 ml of given sol =

Nor. of Oxalic acid X Eq. mass of Oxalic acid X500

1000

The amount of Oxalic acid present in 500 ml of given solution = _____ g

Result

- Normality of KMnO₄ (N₂) = _____ N
 Normality of Oxalic acid (N₂) = _____ N
- 3. The amount of Oxalic acid present in 500 ml of given solution = _____ g

3. Estimation of water of crystallisation in Mohr's salt by titrating with KMnO4

Aim:

To determine the strength of KMnO₄ solution by titrating it against a standard solution of; Ferrous ammonium sulphate (Mohr's salt)

Principle:

Theory Hydrated sodium carbonate has the formula Na2CO3 .xH2O, where x is the number of molecules of water of crystallisation present. In this experiment, x is determined by titration of a solution made using hydrated sodium carbonate with a standard solution of hydrochloric acid. The equation for the reaction is Na2CO3 + 2HCl 2NaCl + H2O + CO2 Methyl orange indicator solution is used. At the end-point the indicator changes colour from yellow to peach/pink.

Titration of KMnO4 against Oxalic acid

Preparation of standard solution of Oxalic acid [250 ml M/10 (0.1 M) solution]

The molecular mass of crystalline oxalic acid is, $H_2C_2O_4.2H_2O = 126$

Weight of oxalic acid crystals required to prepare 1000 ml of 1 M solution = 126 g

Therefore, weight of oxalic acid required to prepare 250 ml 0.1 M solution =

$$\frac{126}{1000} \cdot 250 \cdot 0.1 = 3.15 \text{ g}$$

Determination of strength of KMnO4 using standard solution of oxalic acid

In this titration KMnO₄ is the titrant and oxalic acid is the analyte. Here, potassium permanganate is the oxidizing agent and oxalic acid is the reducing agent. The reaction between potassium permanganate and oxalic acid is carried out in an acidic medium because permanganate ion in the acidic medium is a very strong oxidizing agent. Acidity is introduced by adding dil. H_2SO_4 .

$$MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^2 + + 4H_2O$$

No other indicators are used to determine the endpoint, because $KMnO_4$ acts as the indicator. Permanganate (MnO_4^-) ion has a dark purple colour. In an acidic medium, MnO_4^- is reduced to colourless manganous (Mn^{2+}) ions. On reaching the end point, the addition of the last single drop of permanganate imparts a light pink colour to the solution. The chemical reaction that takes place during titration can be represented by the chemical equation.

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LF-INDICATOR)

SL.NO	Volume of FeSO ₄	BURETTE READINGS		VOLUME OF	CONCORDANT
		INITIAL	FINAL	KMnO ₄	VALUE
	Ml	ml	ml	ml	Ml
1					
2					

CALCULATION:

Volume of FeSO₄ (V_1) = 20 ml

Normality of FeSO₄ $(N_1) = 0.1N$

Volume of $KMnO_4(V_2) = ml$

Normality of $KMnO_4(N_2) = N$

 $\mathbf{V}_1\mathbf{N}_1 = \mathbf{V}_2\mathbf{N}_2$

 $N_2 = V_1 N_1 / V_2$

Normality of $KMnO_4(N_2) =$ _____N

Titration of Potassium permanganate (KMnO4) against Ferrous Ammonium Sulphate Mohr's salt solution

Preparation of standard solution of Mohr's salt[250 ml M/20 (0.05 M) solution]

The molecular mass of Mohr's salt is, FeSO₄.(NH₄)₂SO₄.6H₂O= 392

Weight of Mohr's salt required to prepare 1000 ml of 1 M solution = 392 g

Therefore, weight of Mohr's salt required to prepare 250 ml 0.05 M Mohr's salt solution =

$$\frac{392}{1000} \cdot 250 \cdot 0.05 = 409 \text{ g}$$

Determination of strength of KMnO4 using standard solution of Mohr's salt

In this titration, potassium permanganate is the oxidizing agent and Mohr's salt is the reducing agent. Mohr's salt is a double salt of ferrous sulphate and ammonium sulphate and its

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composition is $FeSO_4.(NH_4)_2SO_4.6H_2O$. It is a primary standard. Therefore, its standard solution can be prepared directly. Ferrous ions of Mohr's salt undergo hydrolysis in aqueous solution. To prevent the hydrolysis, Conc. H_2SO_4 needs to be added to the Mohr's salt crystals during the preparation of its standard solution.

In this titration, the MnO_{4}^{-} ion is reduced to Mn^{2+} in the presence of acid and Fe^{2+} ions of Mohr's salt is oxidized to Fe^{3+}

SL.NO	Volume of Mohr's salt	BURETTE READINGS		VOLUME OF	CONCORDANT
		INITIAL	FINAL	KMnO ₄	VALUE
	ml	ml	ml	ml	ml
1					
2					

INDICATOR: KMnO4 (SELF-INDICATOR)

CALCULATION:

Volume of $KMnO_4 (V_2) = 20 ml$

Normality of $KMnO_4 (N_2) = 0.1 N$

Volume of Mohr's salt $(V_1) = ml$

Normality of Mohr's salt $(N_1) = N$

 $\mathbf{V}_1\mathbf{N}_1 = \mathbf{V}_2\mathbf{N}_2$

 $N_2 = V_1 N_1 / V_2$

Normality of Mohr's salt $(N_2) =$ _____N

Amount of Mohr's salt present in 1 litre =Normality X Equivalent mass X 100 / 1000

Result :

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

4. Estimation of Fe (II) ions by titrating it with K₂Cr₂O₇ using external indicator

Aim:

To estimate the amount of iron present in the whole of the given solution of ferrous sulphate using potassium dichromate solution.

Principle:

As an oxidant, dichromate has some advantages over permanganate, but, as it is less powerful, its use is much more limited. It is obtainable in a state of high purity and can be used as a primary standard. Solutions of dichromate in water are stable indefinitely. The half reaction for the dichromate system is:

 $Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O \quad E^\circ = 1.33 V$

The most important application of dichromate is in its reaction with iron(II) in which it is often preferred to permanganate.

The relevant half reaction is :

 $Fe^{2+} \rightarrow Fe^{3+} + e^{-}$ $E^{\circ} = -0.77 V$

and the total reaction is:

 $Cr_2O_7^{2-} + 6 Fe^{2+} + 14H^+ \rightarrow 2Cr^{3+} + 6 Fe^{3+} + 7H_2O$ $E^{\circ} = 0.56 V$

Unlike permanganate, dichromate titrations require an indicator. There are three indicators that may be used for the titration of Fe²⁺ with K₂Cr₂O₇. These are diphenylamine, diphenylbenzidine and diphenylamine sulfonate. The colour change for all three indicators is green to violet and the standard electrode potentials are all ca 0.78 V. According to Kolthoff and Sandell, this should lie between the electrode potentials of the two reduction reactions. This not being the case, phosphoric acid is added to reduce the electrode potential for the Fe³⁺ \rightarrow Fe²⁺ reaction by stabilising the ferric ion.

Procedure

Titration – I

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Standardization of Potassium dichromate solution

20 ml of std. FAS solution is pipetted out in a clean conical flask . Then 20 ml of dilute $2N H_2SO_4$ is added and followed by 2 drops of indicator (diphenyl amine). The solution is titrated against Potassium dichromate solution which is taken in burette until colour changes to violet red. The titration is repeated for the concordant value.

Titration I

INDICATOR: DIPHENYL AMINE

SL.NO	Volume of FAS	BURETTE READINGS		VOLUME OF	CONCORDANT
		INITIAL	FINAL	K ₂ CrO ₇	VALUE
	Ml	ml	ml	Ml	Ml
1					
2					

CALCULATION:

Volume of FAS $(V_1) = 20 \text{ ml}$

Normality of FAS $(N_1) = 0.1N$

Volume of $K_2CrO_7 (V_2) = ml$

Normality of $K_2CrO_7(N_2) = N$

 $\mathbf{V}_1 \mathbf{N}_1 = \mathbf{V}_2 \mathbf{N}_2$

 $N_2 = V_1 N_1 / V_2$

Normality of $K_2CrO_7(N_2) =$ _____N

Titration II

Estimation of Ferrous Ion

The given ferrous salt is transferred into 100 ml standard flask and make upto the mark. 20 ml of the made up solution is pipetted out into a clean conical flask . Then 20 ml of dilute 2N H₂SO₄ is added and followed by 2 drops of indicator (diphenyl amine). The solution is titrated

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against Potassium dichromate solution which is taken in burette until colour changes to violet red. The titration is repeated for the concordant value.

Titration II

INDICATOR: DIPHENYL AMINE

SL.NO	Volume of Ferrous ion	BURETTE READINGS		VOLUME OF	CONCORDANT
		INITIAL	FINAL	K_2CrO_7	VALUE
	Ml	ml	ml	Ml	Ml
1					
2					

CALCULATION:

Volume of $K_2CrO_7 (V_2) = 20 \text{ ml}$

Normality of $K_2CrO_7 (N_2) = 0.1 N$

Volume of Ferrous ion $(V_1) = ml$

Normality of Ferrous ion $(N_1) = N$

 $\mathbf{V}_1 \mathbf{N}_1 = \mathbf{V}_2 \mathbf{N}_2$

 $N_2 = V_1 N_1 / V_2$

Normality of Ferrous ion $(N_2) =$ _____N

Amount of Ferrous ion present in 1 litre =Normality X Equivalent mass X 100 / 1000

Result:

Amount of Ferrous ion present in the whole of the given solution is

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5. Estimation of Cu (II) ions Iiodometrically using Na₂S₂O₃

Aim:

To estimate the amount of Copper Present in a given solution of Copper sulphate using $K_2Cr_2O_7$ and $Na_2\,S_2O_3$

Principle:

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 Cu2+ in neutral or slightly acidic medium, quantitative liberation of iodine takes place.

2CuSO4.5H2O + 4KI 2CuI2 + 2K2SO4 + 5H2O 2CuI2 Cu2I2 + I2 This liberated iodine is then titrated against standard Na2S2O3 solution using starch solution as indicator near the end point.

2Na2S2O3 + I2 Na2S4O6 + 2NaI Ionic equation will be: 2Cu2+ + 2I - Cu2 2+ + I2 + 2e I2 + 2S2O3 2- + 2e S4O6 2- + 2I -

From the above equation it is evident that $2Cu2+ \equiv I2 \equiv 2S2O3 \ 2- \equiv 2e$ The equivalent weight of Cu2+ will be one half of twice the molecular weight since the reaction involves two electrons per two moles of Cu2+.

Eq. wt. of Cu2+ = $(2 \times 63.5) / 2 = 63.5$

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 dropwise addition of NH4OH until a slight blue precipitate just appears. H + OH - H2O 2NH4OH + Cu2 + 2NH4 + Cu(OH)2 blue precipitate The precipitate can be removed by addition of CH3COOH in the solution. Cu(OH)2 + 2CH3COOH Cu2+ + 2CH3COO- + 2H2O Moreover, the precipitate of Cu2I2 absorbs I2 from the solution and releases it slowly making the detection of sharp end point difficult. So, a small amount of NH4SCN is added near the end point to displace the absorbed iodine from Cu2I2 precipitate.

Apparatus:

Burette, pipette, beakers, conical flask, burette stand and clamp. Chemicals: K2Cr2O7, Na2S2O3.5H2O, CuSO4.5H2O, NaHCO3, KI, NH4OH, CH3COOH, starch, NH4SCN, HCl.

Procedure:

1. Standard K2Cr2O7 solution (0.1 N) is provided. 2. Sodium thiosulphate and copper sulphate solution of unknown strength were supplied. 3. Standardization of sodium thiosulphate

(Na2S2O3) solution with standard K2Cr2O7 solution – Take 40 mL of water in a 250 mL conical flask. To that add 20 mL of potassium iodide (KI) solution (10%) and 1 g of sodium bicarbonate (NaHCO3). Add 6 mL of concentrated hydrochloric acid (HCl) to the above solution and finally add 20 mL of standard K2Cr2O7 solution using a pipette. Shake the flask and keep it covered with watch glass in dark for 3–5 minutes. Titrate the liberated iodine with Na2S2O3 solution taken in burette. When the colour of the solution fades to straw yellow, add few drops of starch solution and continue the titration till the colour of the solution changes from deep blue to bluish green. Repeat the titration three times.

4. Estimation of copper – Pipette out 20 mL of solution in a 250 mL conical flask and neutralized the solution by dropwise addition of ammonium hydroxide (NH4OH) solution (1:1) until a blue precipitate appears. Dissolve the precipitate in acetic acid (CH3COOH) adding about 0.5 mL in excess. Dilute the solution to about 80 mL and add 20 mL of potassium iodide solution (10%). Keep the flask covered with watch glass in a dark and cool place for about 3–5 minutes and titrate the liberated iodine with standard sodium thiosulphate solution form burette. When the colour of the solution fades to a light yellow, add few drops of starch followed by 20 mL of ammonium thiocyanate (NH4SCN) solution (10%). Titrate the solution till the blue colour discharges and a white or flesh white residue is left in the flask. Repeat the titration three times

Titration I

SL.NO	Volume of K ₂ Cr ₂ O ₇	BURETTE READINGS		VOLUME OF	CONCORDANT
		INITIAL	FINAL	$Na_2 S_2 O_3$	VALUE
	Ml	Ml	ml	Ml	Ml
1					
2					

INDICATOR: STARCH

CALCULATION:

Volume of K₂CrO₇ (V₁) = 20 ml Normality of K₂CrO₇ (N₁) = 0.1N Volume of Na₂ S₂O₃ (V₂) = ml Normality of Na₂ S₂O₃ (N₂) = N V₁N₁ = V₂N₂ N₂ = V₁N₁/V₂

Normality of $Na_2 S_2O_3$ (N₂) = _____ N

Titration II

Estimation of Copper using std. Na₂S₂O₃

INDICATOR: STARCH

SL.NO	Volume of CuSO4	BURETTE READINGS		VOLUME OF	CONCORDANT
		INITIAL	FINAL	$Na_2 S_2O_3$	VALUE
	Ml	ml	Ml	Ml	Ml
1					
2					

CALCULATION:

Volume of Na₂ S_2O_3 (V₁) = 20 ml

Normality of $Na_2 S_2 O_3 (N_1) = 0.1 N$

Volume of $CuSO_4(V_2) = ml$

Normality of $CuSO_4(N_2) = N$

 $\mathbf{V}_1\mathbf{N}_1 = \mathbf{V}_2\mathbf{N}_2$

 $N_2 = V_1 N_1 / V_2$

Normality of $CuSO_4(N_2) =$ _____N

Amount of Copper present in 1 litre of $CuSO_4$ solution = Normality X Eq. mass X 100 / 1000

Result:

Amount of Copper present in 1 litre of CuSO₄ solution is