



Roll Number: 47

Seat Number: \_\_\_\_\_

Vivekanand Education Society's Institute of Technology

Hashu Advani memorial Complex

Collector's Colony, R C Marg, Chembur Mumbai 400074, Phone Number 022-61532532

[www.vesit.edu](http://www.vesit.edu)  
SINCE 1962

## CERTIFICATE

Certified that Mr./Miss. Yash Sarang

Of D1AD AI-DS FE semester I has successfully completed necessary experiments in **Engineering Chemistry-I** course under my supervision in VES Institute of Technology during academic Year **2020-2021**.

Mr. Vivek Umrikar  
[ HOD]

Dr. J.M. Nair.  
[PRINCIPAL]

Dr. Sunanda M.  
[Lab In Charge]

Subject Teacher

# **Vivekanand Education Society's Institute of Technology**

## **Index Page**

### **Engineering Chemistry I [Lab 503]**

#### **Sem I [Odd Sem]**

**2020 - 2021**

#### **Course outcomes:**

Learners will be able to...

1. Determine Chloride content and hardness of water sample
2. Determine free acid pH of different solutions
3. Determine metal ion concentration
4. Synthesize polymers, biodegradable plastics.

<b>Sr. No.</b>	<b>Experiment Name</b>	<b>Date</b>	<b>Grade</b>	<b>Page No.</b>	<b>CO Mapping</b>	<b>Sign</b>
1	Hardness Of Water By EDTA Method	10/04/2021		3	1	
2	Determination Of pH	10/04/2021		8	2	
3	Chloride Content Of Water	10/04/2021		12	1	
4	Estimation Of Copper By Colorimetric Method	10/04/2021		17	3	
5	To Prepare Phenol Formaldehyde (P-F) Resin	10/04/2021		22	4	
6	To Prepare Urea Formaldehyde (U-F) Resin	10/04/2021		25	4	

## 1. HARDNESS OF WATER BY EDTA

AIM:

To determine the hardness of water sample by EDTA method.

APPARATUS:

Burette, pipette, conical flask, etc., and 1M NaOH.

REAGENTS REQUIRED:

EDTA solution, buffer solution of pH=10, std.  $\text{CaCl}_2$  solution and solution of Eriochrome black T.

THEORY:

This is a very accurate method based on the fact that when a blue colored Eriochrome black T is added to hard water in alkaline medium, it gives a wine red unstable complex with  $\text{Ca}^{2+}$  and  $\text{Mg}^{2+}$  ions. Now if EDTA is added then  $\text{Ca}^{2+}$  and  $\text{Mg}^{2+}$  ions from an unstable complex are attracted by EDTA to form a stable complex and Eriochrome black T is given back.

PROCEDURE:

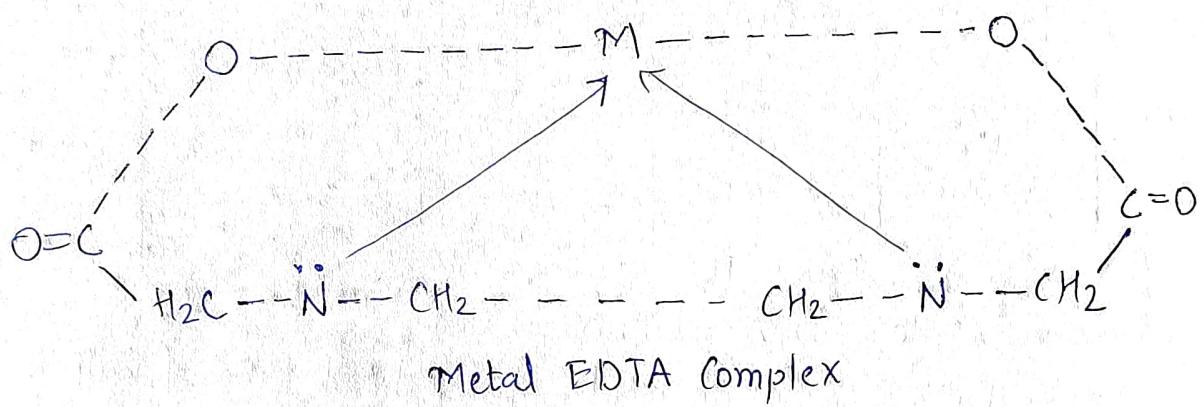
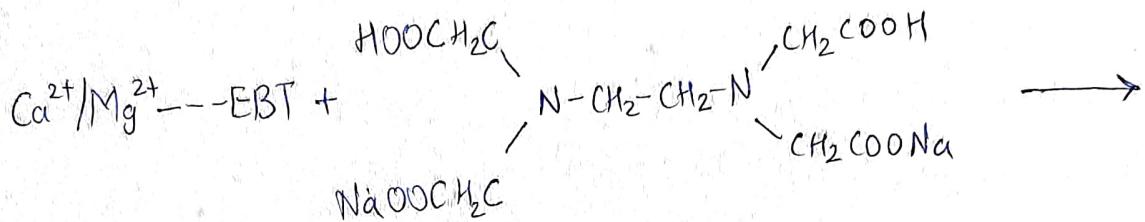
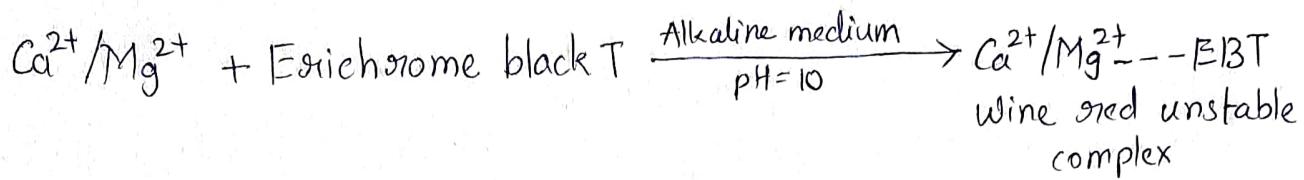
(a) Preparation of Standard Hard Water

Weigh accurately 1.1 gm of  $\text{CaCl}_2$ . Transfer the contents to 100ml beaker. Add water to dissolve  $\text{CaCl}_2$ . Transfer the content to 1000ml volumetric flask and dilute up the mark.

(b) Standardization of EDTA solution

Rinse and fill burette with EDTA solution. Pipette out 25 ml of standard  $\text{CaCl}_2$  solution in a conical flask. Add 1 test tube of buffer solution. Add 5-6 drops of Eriochrome black

## REACTIONS:



+ Eriochrome black T  
(blue)

Till wine red colour is obtained. Then add EDTA solution from the burette till colour changes from wine red to blue.

(c) Titration of unknown hard water sample.

Take 25 ml of hard water sample in a conical flask and add 1 test tube of buffer solution and 5-6 drops of indicator (EBT). Titrate the mixture against EDTA solution till blue colour is obtained.

RESULT:

Hardness of given water sample is 400 ppm.

## OBSERVATION:

### PART I

Solution in burette: EDTA solution

Solution in conical flask : 25 ml of  $\text{CaCl}_2$  solution + 1 test tube buffer solution + 5-6 drops indicator.

Indicator: Eriochrome black T

End point: Wine red to blue

Pilot reading: 24 ml to 25 ml

Readings	I	II	III	CONSTANT $V_2 \text{ (ml)}$
Initial (ml)	0.0 ml	0.0 ml	0.0 ml	
Final (ml)	25 ml	25 ml	25 ml	25 ml
Difference	25 ml	25 ml	25 ml	

### PART II

Solution in burette: EDTA solution

Solution in conical flask: 25 ml of hard water + 1 test tube of buffer solution

Indicator: Eriochrome black T

End point: wine red to blue

Pilot reading: 9 ml to 10 ml

Readings	I	II	III	CONSTANT $V_2 \text{ (ml)}$
Initial (ml)	0.0 ml	0.0 ml	0.0 ml	
Final (ml)	10 ml	10 ml	10 ml	10 ml
Difference	10 ml	10 ml	10 ml	

## CALCULATIONS:

1ml of standard  $\text{CaCl}_2$  solution = 1mg  $\text{CaCO}_3$

25ml of standard  $\text{CaCl}_2$  solution = 25 ml EDTA

i.e. 25ml EDTA = 25 mg  $\text{CaCO}_3$  equivalent

Hence, 1ml EDTA =  $25/25$  mg  $\text{CaCO}_3$  equivalent

25ml of unknown hard water = 10ml EDTA

=  $10 * 25/25$  mg  $\text{CaCO}_3$  equivalent

Hence, 1000ml of unknown hard water =  $(25/25) * 10 * (1000/25)$  mg  
of  $\text{CaCO}_3$  equivalent

= 400 mg  $\text{CaCO}_3$  equivalent

Hence, hardness of water = 400 ppm

## 2. CHLORIDE CONTENT OF WATER

### AIM:

To determine the chloride content of water.

### APPARATUS:

Burette, conical flask, measurement cylinder, etc.

### REAGENTS REQUIRED:

Silver nitrate solution and potassium chromate.

### THEORY:

When silver nitrate is titrated against chlorides present in water using ~~Pot~~ Potassium chromate as indicator, silver chloride is formed. When all the chlorides in water are consumed, the slight excess of silver nitrate imparts Brick red colour due to the formation of silver nitrate to silver chromate.

### PROCEDURE:

#### (a) Preparation of 0.01 N KCl

Weigh accurately 0.0745 gm of KCl. Transfer the contents to 100ml beaker. Add water to dissolve KCl. Transfer the contents to 1000ml volumetric flask, and dilute up to the mark.

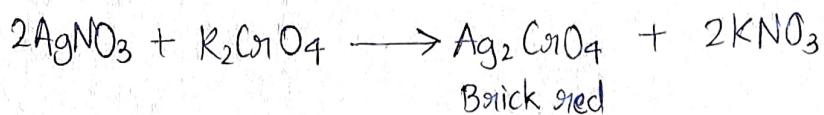
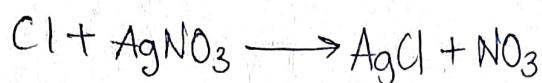
#### (b) Standardization of $\text{AgNO}_3$

Fill the burette with approx 0.01 N  $\text{AgNO}_3$ . Pipette out 10ml 0.01 N KCl solution in conical flask. Add 3/4 drops of 5%  $\text{K}_2\text{CrO}_4$  indicator. Titrate the yellow solution with  $\text{AgNO}_3$  adding drop wise with stirring. When solution shows brick red ting stop titration and record the burette reading.

#### (c) Estimation of Chloride in water sample

Pipette out 10ml of sample water in a conical flask and

## REACTIONS:



## OBSERVATION:

- Standardization of  $AgNO_3$

Solution in burette : 0.01N (approx.) of  $AgNO_3$

Solution in conical flask : 10ml of 0.01N  $KCl$

Indicator : Potassium chromate solution

End point : yellow to reddish orange

Pilot Reading : 10 to 11 ml

Readings	I	II	III	Constant
Initial (ml)	0.0ml	0.0ml	0.0ml	
Final (ml)	6.4ml	6.3ml	6.4ml	6.4ml
Difference	6.4ml	6.3ml	6.4ml	

- Estimation of Chloride in water sample

Solution burette : 0.01N of  $AgNO_3$

Solution in conical flask : 10ml of sample water

Indicator : Potassium chromate solution

Endpoint : yellow to reddish orange

Pilot readings : 6ml to 7ml

Readings	I	II	III	Constant
Initial (ml)	0.0ml	0.0ml	0.0ml	
Final (ml)	6.4ml	6.3ml	6.4ml	6.4ml
Difference	6.4ml	6.3ml	6.4ml	

add a 3/4 drop (1ml) of Potassium chromate to it.

Titrate the contents of conical flask against approx  
0.01N  $\text{AgNO}_3$  solution from burette till brick red colouration  
appears.

### RESULT:

The chloride content of water is 228.4 ppm.

## CALCULATION:

- Standardisation of  $\text{AgNO}_3$

$$\begin{array}{ll} \text{KCl} & \text{AgNO}_3 \\ N_1 V_1 & N_2 V_2 \\ 0.01 \times 10 & = N_2 \times [10.4] \end{array}$$

$$\frac{0.01 \times 10}{10.4} = 9.6153 \times 10^{-3} N$$

$$\therefore \text{Normality of } \text{AgNO}_3 = 9.6153 \times 10^{-3} N$$

- Estimation of Chloride in water sample

$$1000 \text{ ml of } 1N \text{ AgNO}_3 = 35.5 \text{ g of Chlorine}$$

$$\text{Hence, } [6.4] \text{ ml of } 9.6153 \times 10^{-3} N \text{ AgNO}_3 = \frac{35.5 \times 9.6153 \times 10^{-3} \times 1000 \times [6.4]}{1000} \\ = 2.184 \text{ mg of Cl}$$

$\therefore$  10 ml of sample water contains of 2.184 mg of Cl

$$\text{Hence, } 1000 \text{ ml of sample water contains} = \frac{[2.184] \times 1000 \text{ mg of Cl}}{10} \\ = 228.4 \text{ mg}$$

Hence, chloride content of Water = 228.4 ppm.

### 3. DETERMINATION OF pH

#### AIM:

To determine the pH of the given concentrations of Hydrochloric acid solution.

#### INTRODUCTION:

The term pH refers to the measure of hydrogen ion concentration in a solution and defined as the negative log of  $H^+$  ions concentration in water and waste water. The values of pH 0 to a little <sup>less</sup> than 7 are termed as acidic and the value of pH little above 7 to 14 are termed as basic. When the concentration of  $H^+$  and  $OH^-$  ions are equal then it is termed as neutral pH.

#### PRINCIPLE:

The pH electrode used in the pH measurement is a combined glass electrode system. The sensing half cell is a thin pH sensitive semi permeable membrane separating two solutions, viz., the outer solution, the sample to be analyzed and the internal solution, enclosed inside the glass membrane and has a known pH value. An electrical potential is developed inside and another electrical potential is developed outside, the difference in this potential is measured and is given as the pH of the sample.

#### APPARATUS REQUIRED:

pH meter, Standard flasks, funnel, Beaker, Wash Bottle, Tissue paper, Forceps.

#### CHEMICALS REQUIRED:

Buffer solutions of pH 4.01, 7.0 and 9.2, Potassium chloride, distilled water, HCl solution of different concentrations.

## OBSERVATION TABLE:

Ser. No.	ml of Initial Concentration of HCl acid	Dilution to -- ml	pH	Final concentration of HCl acid solution.
1	50ml of 1M solution	500ml	2.2	$6.3 \times 10^{-3}$
2	50ml of $10^{-1}$ M solution	500ml	3.2	$6.3 \times 10^{-4}$
3	50ml of $10^2$ M solution	500ml	5.25	$5.62 \times 10^{-6}$
4	50 ml of $10^{-3}$ M solution	500ml	7.6	$2.51 \times 10^{-8}$

## CALCULATIONS:

Solution 1:  $\text{pH} = 2.2$

$$= \frac{1}{\text{Antilog}[2.2]}$$

$$= 6.3 \times 10^{-3} \text{M}$$

Solution 2:  $\text{pH} = 3.2$

$$= \frac{1}{\text{Antilog}[3.2]}$$

$$= 6.3 \times 10^{-4} \text{M}$$

And so on.

## PROCEDURE:

Three major steps are involved in the experiment. They are...

- (a) Preparation of Reagents
- (b) Calibrating the Instrument
- (c) Testing of Sample

### (a) Preparation of Reagents

#### (i) Buffer solution of pH 4.0

Take 100ml standard measuring flask and place a funnel over it. Using the forceps carefully transfer one buffer tablet tablet and dissolved it. Make up the volume to 100ml using distilled water.

#### (ii) Buffer solution of pH 7.0

Take 100ml standard measuring flask and place a funnel over it. Using the forceps carefully transfer one buffer tablet of pH 7.0 to the funnel. Add little amount of distilled water, crush the tablet and dissolved it. Make up the volume to 100ml using distilled water.

#### (iii) Buffer solution of pH 9.2

Take 100ml standard measuring flask and place a funnel over it. Using the forceps carefully transfer one buffer tablet of pH 9.2 to the funnel. Add little amount of distilled water, crush the tablet and dissolved it. Make up the volume to 100ml using distilled water.

### (b) Calibrating the instrument

Using the buffer solutions calibrate the instrument.

#### (i) Step I:

In a 100ml beaker take pH 9.2 buffer solution and place it in a magnetic stirrer insert the teflon coated stirring bar and stir well. Now place the

electrode in the beaker containing the stirred buffer and check for the reading in the pH meter. If the instrument is not showing pH value of 9.2, using calibration knob adjust the reading to 9.2. Take the electrode from the buffer wash it with distilled water and then wipe gently with soft tissue.

(ii) Step II:

In a 100ml beaker take pH 7.0 buffer solution and place it in a magnetic stirrer, insert the teflon coated stirring bar and stir well. Now place the electrode in the beaker containing the stirred buffer and check for reading in the pH meter. If the instrument is not showing pH value of 7.0 using the calibration knob adjust the reading to 7.0. Take the electrode from the buffer, wash it with distilled water and then wipe gently with soft tissue.

(iii) Step III:

In a 100ml beaker take pH 4.0 buffer solution and place it in a magnetic stirrer, insert the teflon coated stirring bar and stir well. Now place the electrode in the beaker containing the stirred buffer and check for the reading in the pH meter. If the instrument is not showing pH value of 4.0 using the calibration knob adjust the reading to 4.0. Take the electrode from the buffer wash it with distilled water and then wipe gently with soft tissue.

(c) Testing of Sample

In a clean dry 100ml beaker take the oxalic acid solution sample and place it in a magnetic stirrer, insert the teflon coated stirring bar and stir well.

Now place the electrode in the beaker take the oxalic acid solution sample and place it in a magnetic stirrer, insert the teflon coated stirring bar and stir well. Now place the electrode in beaker containing the water sample and check for the reading in the pH meter. Wait until you get you get a stable reading.

The pH of given sample is

Take the electrode from the water sample, wash off salts and hit ~~wet~~ with distilled water and then wipe gently with a soft tissue.

**RESULT:** As we know the formula for pH

It is confirmed that pH of the solution increases as the hydrogen ion concentration (Molarity) decreases.

## 4. ESTIMATION OF COPPER BY COLORIMETRIC METHOD

AIM:

Estimation of Copper by Colorimetry.

APPARATUS:

Colorimeter, Test tubes, Burette.

PRINCIPLE:

Colorimeter measures the optical density of an absorbing substance where optical density (O.D) is defined as

$$O.D = \log \frac{I_0}{I}$$

Where,  $I_0$  = Intensity of incident light,

$I$  = Intensity of transmitted light.

As per beers law, optical density of an absorbing substance is related to the concentration by the equation

$$O.D = ECl$$

$$O.D = (E.l)C \rightarrow 2$$

where 'C' is the concentration of the substance,  $l$  is the path length, which represents the width of the cell used and is constant for a given cell used,  $E$  is the molar adsorption coefficient and is a constant for a given cell used, written as  $O.D \propto C$   $\rightarrow 3$

Equation 3 represents the quantitative form of Beer's law. If the optical density of a substance is determined at varying concentration. A plot of O.D. vs C gives a straight line.

PROCEDURE:

Take the sample solution of  $CuSO_4$  and prepare the following 10 sample solutions in test tubes as 1 to 10.

(a) 1ml 1M  $CuSO_4$  + 9ml Distilled water.

(b) 2ml 1M  $CuSO_4$  + 8ml Distilled water.

## OBSERVATION:

Table -1

Filter No.	Range (nm)	Optical Density (OD)
1	400	0.19
2	450	0.12
3	490	0.04
4	520	0.04
5	540	0.13
6	570	0.30
7	620	0.46
8	680	0.74

Table -2

Selected Filter: 680nm

SINo.	Volume of CuSO <sub>4</sub> (ml)	Volume of H <sub>2</sub> O(ml)	Concentration of CuSO <sub>4</sub>	Optical Density
1	1	9	0.01	0.18
2	2	8	0.02	0.32
3	3	7	0.03	0.48
4	4	6	0.04	0.61
5	5	5	0.05	0.73
6	6	4	0.06	0.84
7				0.84

- (c) 3ml 1m  $\text{CuSO}_4$  + 7ml Distilled water  
 (d) 4ml 1m  $\text{CuSO}_4$  + 6ml Distilled water  
 (e) 5ml 1m  $\text{CuSO}_4$  + 5ml Distilled water  
 (f) 6ml 1m  $\text{CuSO}_4$  + 4ml Distilled water  
 (g) 7ml 1m  $\text{CuSO}_4$  + 3ml distilled water  
 (h) 8ml 1m  $\text{CuSO}_4$  + 2ml Distilled water  
 (i) 9ml 1m  $\text{CuSO}_4$  + 1ml Distilled water  
 (j) 10ml 1m  $\text{CuSO}_4$  + 0ml Distilled water

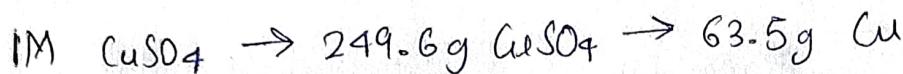
The ten sample solutions prepared above have a varying concern from 0.1m to 1m, choose the filter in the colorimeter with maximum absorbance. Tabulate the result of filter and O.D with a given  $\text{CuSO}_4$  sample solutions.

After selecting filter, determine the O.D. of the above mentioned ten sample solutions and tabulate the results.

#### RESULT:

Amount of copper present in given  $\text{CuSO}_4$  solution is 2.2225g

## CALCULATIONS:



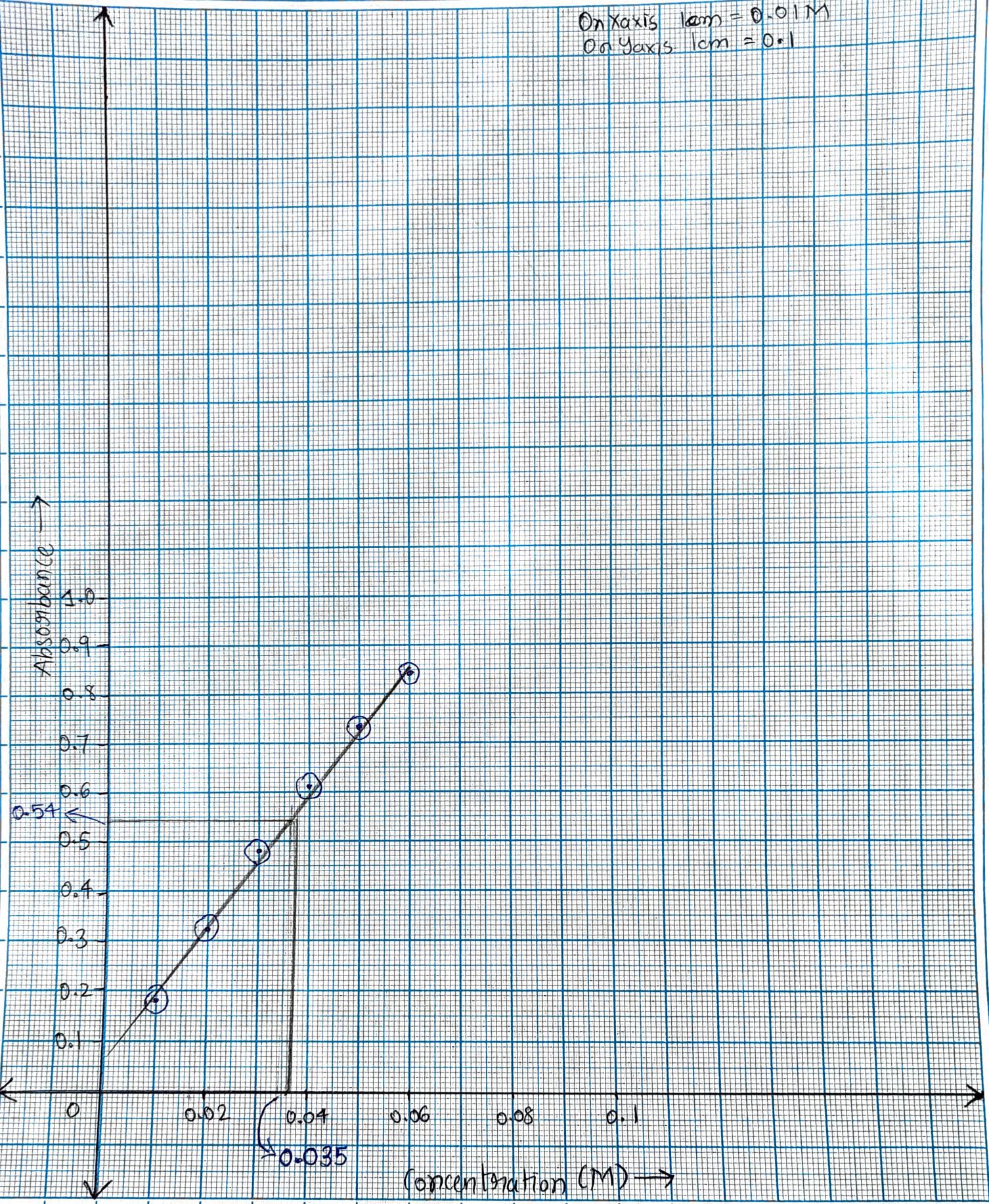
249.6 g of CuSO<sub>4</sub> in 1L = 1M solution



249.6 g of CuSO<sub>4</sub> → 0.035 g of Cu

$$\therefore 0.035 \times 249.6 \text{ g of CuSO}_4 \rightarrow 0.035 \times 63.5 \text{ g of Cu} \\ = 2.225 \text{ g of Cu}$$

On Xaxis  $1\text{cm} = 0.01\text{M}$   
On Yaxis  $1\text{cm} = 0.1$



## 5. PREPARATION OF (P-F) resin

### AIM:

To prepare Phenol (2g), 40% aq formaldehyde solution or formalin (2.5 mL), glacial acetic acid (5mL) and conc. HCl (8mL).

### THEORY:

Phenol formaldehyde resin or P-F resin or phenolic resins (also called phenoplasts) are important class of polymers which are formed by condensation polymerization of phenol and formaldehyde in acidic or alkaline medium. Following steps are involved.

- Step I: Formation of methylol phenol derivative

Initially the monomers combine to form methylol phenol derivative depending upon phenol to formaldehyde ratio.

- Step II: The phenol formaldehyde derivatives react among themselves or with phenol to give a linear polymer or a higher cross linked polymer.

### PROCEDURE:

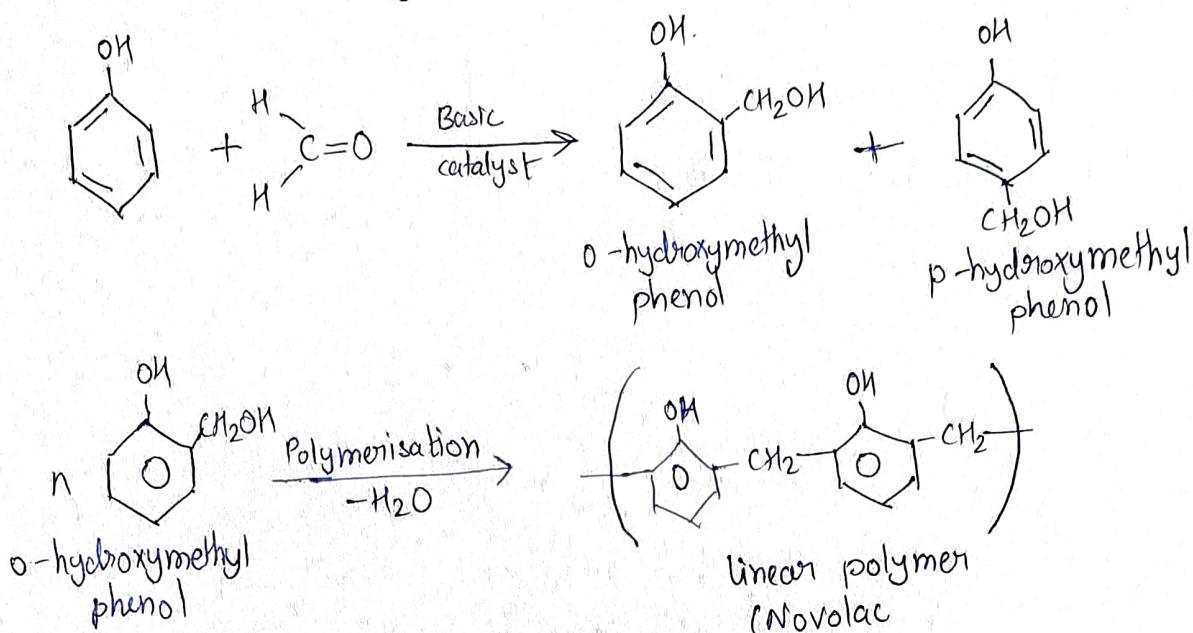
- Place 5mL of glacial acetic acid and 2.5 mL of 40% aq formaldehyde solution in a 100mL beaker. Add 2g phenol safely.
- Wrap the beaker with a wet cloth or place it in a 250mL beaker having small amount of water in it.
- Add conc. HCl drop wise with vigorous stirring by a glass rod till a pink coloured gummy mass appears.
- Wash the pink residue several times with water to make it free from acid.
- Filter the product and weight it after drying in folds of a filter or in an oven. Report the yield of polymer formed.

### RESULT:

Weight of phenol formaldehyde resin = 2.6g

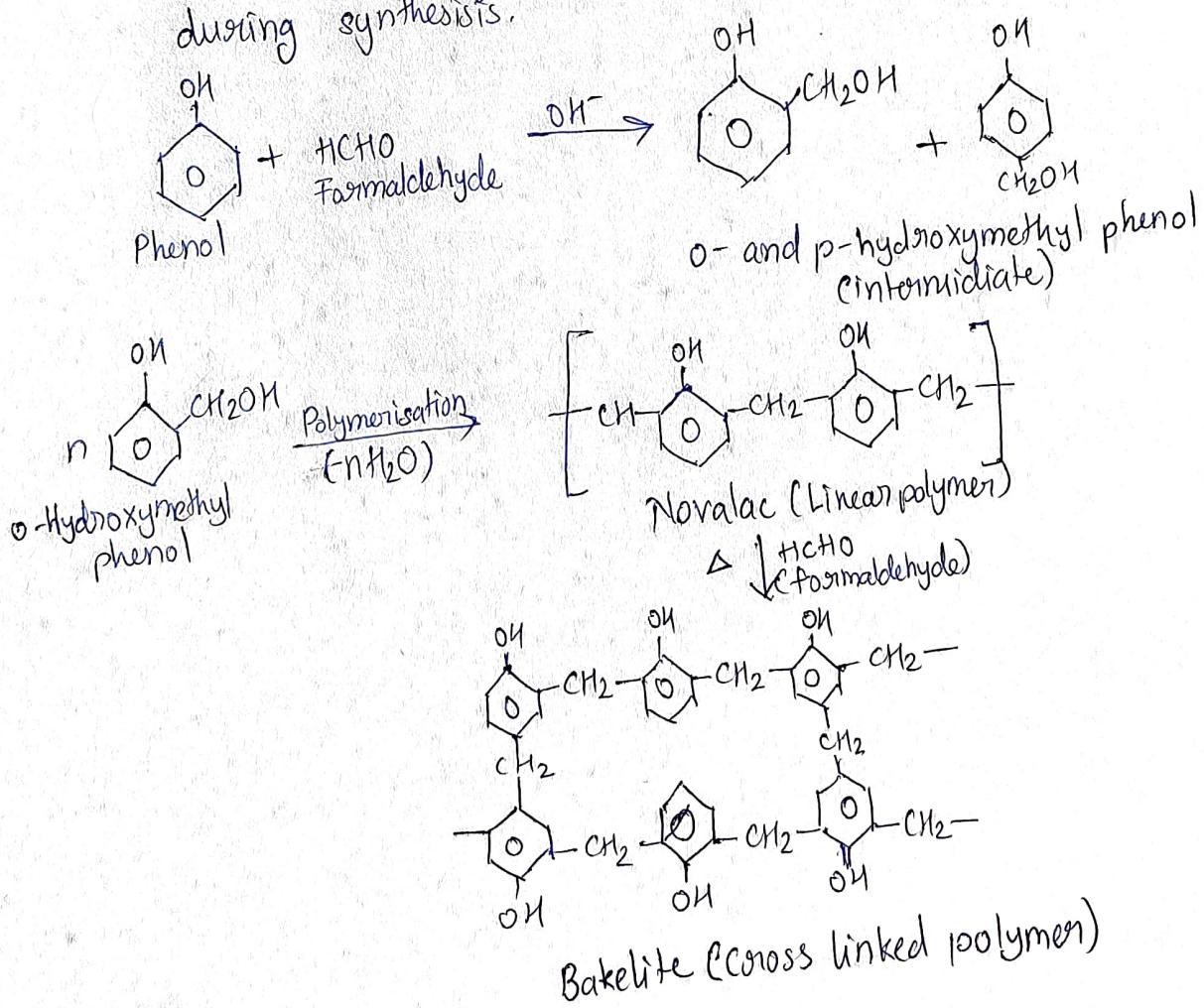
Step 2:

(a) Linear polymer (Novolac)



(b) Cross linked polymer (Bakelite)

A highly cross linked thermosetting polymer called Bakelite may be formed by further condensation of novolac or methylol derivative. It was first prepared by Backeland. It is easily formed if curing agent hexamethylenetetramine is added during synthesis.



## OBSERVATION:

Weight of empty watch glass = 68.55g

Weight of watch + polymer formed = 71.15g

Weight of polymer formed =  $(W_2 - W_1)$  g = 2.6g

## 6. PREPARATION OF (U-F) resin

AIM:

To prepare Urea formaldehyde (U-F) resin.

THEORY:

Urea formaldehyde resins are formed by condensation of urea and formaldehyde in acidic medium in following steps:

- Step I: Formation of methylol urea derivative

Initially urea and formaldehyde react to form methylol urea derivatives depending upon formaldehyde (U/F) ratio

- Step II: Polymerization of methylol urea

Several molecules of methylol urea derivatives condense with loss of water molecules to form a highly cross linked urea formaldehyde resin.

PROCEDURE:

Take a 5ml of 40% aqueous formaldehyde solution in a 100ml beaker. To this add 2g urea powder. Stir with a glass rod to make a saturated solution. Add a few drops of conc.  $H_2SO_4$  and stir vigorously till a white solid mass is formed. Filter the residue and wash it several times with ~~weigh~~ distilled water to remove any acid. Dry the residue in folds of filter paper or in an oven and weigh. Report the yield of urea formaldehyde polymer formed.

RESULT:

Weight of urea formaldehyde resin = 8.21g

## OBSERVATION :

Weight of empty watch glass = 72.99g

Weight of watch glass + polymer formed = 81.2g

Weight of polymer formed =  $(w_2 - w_1)$ g = 8.21g