

remove dust from the pans with a soft brush and reset the zero point of the balance

(2) The windows and doors of the balance should be kept shut as far as possible

(3) Before the use of balance, make sure that the pointer moves freely on both the sides of the scale.

(4) Don't place wet or dirty objects on the balance. The substance to be weighed is kept at the left pan and the weights at the right pan of the balance.

(5) Don't move the balance from its place.

(6) Never overload the balance above the permitted load as this causes damage.

(7) Don't weigh hot or very cold objects.

(8) The rider and the weights should be handled only with the forceps provided with the weight box.

(9) After completing the weighing, the weights should be placed at proper places. Put the balance in a static state, close the window and doors of the balance.

Preparation of standard solution : Primary standard solution is prepared directly by weighing the required amount of substance. Standard solution of secondary standard is prepared by standardization of its solution.

Formula used in calculation :

$$a_1 M_1 V_1 = a_2 M_2 V_2$$

Where a_1 = Basicity of acid or acidity of base

M_1 = Molarity of solution having V_1 Volume

M_2 = Molarity of solution having V_2 Volume

a_2 = Basicity or acidity of solution having Volume V_2

Experiment No. # 01

Object : To prepare 0.1M 250 ml standard solution of oxalic acid.

Principle : Crystalline oxalic acid $(\text{COOH})_2 \cdot 2\text{H}_2\text{O}$ is a primary standard. Its molecular mass is 126 gram/mol. Formula to determine amount of the substance to prepare standard solution is as given below :

$$W = \frac{mMV}{1000}$$

Where W = amount of the substance, m = molecular mass of the substance, M = Molarity of solution, V = Volume of solution in ml

$$\therefore W = \frac{126 \times 0.1 \times 250}{1000} = 3.15 \text{ g}$$

Hence on dissolving 3.15 g oxalic acid in 250 ml solution, 250 ml, 0.1 M oxalic acid will be obtained.

Required apparatus : Weighing tube, beaker, washing bottle, 250 ml measuring flask, funnel, chemical balance.

Required material : Distilled water, crystalline oxalic acid.

Method : Exact 3.15 g oxalic acid is weighed in a dry and clean weighing tube. This acid is poured into funnel placed on measuring flask. All crystals of acid are transferred into funnel from weighing tube with the help of washing bottle. After adding some distilled water, funnel is removed. After shaking measuring flask, volume is made upto the mark with distilled water. After stoppering the measuring flask solution is shaken to make it homogeneous.

Observation :

Weight of empty weighing tube = 7.256 g

Weight of weighing tube + oxalic acid = 10.406 g

Weight of oxalic acid = 3.15 g

Result : Solution of oxalic acid prepared is 0.1M.

Precautions : (1) Exact 3.15 g acid must be weighed.

(2) All crystals from weighing tube must be transferred, to measuring flask.

Viva-Voce

Q. 1. What is the formula of oxalic acid ?

Ans. $(\text{COOH})_2 \cdot 2\text{H}_2\text{O}$.

Q. 2. Is oxalic acid primary standard or secondary standard ?

Ans. It is primary standard.

Q. 3. What is the basicity of oxalic acid ?

Ans. Its basicity is two.

Experiment No. # 02

Object : To prepare 250 ml 0.1M standard solution of sodium carbonate.

Principle : Sodium carbonate Na_2CO_3 is a primary standard. Its molecular mass is 106 gram/mol. Formula to determine required weight of substance to prepare standard solution is—

$$W = \frac{mMV}{1000}$$

Where W = weight of the substance, m = molecular mass of substance, M = molarity of solution, V = Volume of solution in ml

$$\therefore W = \frac{106 \times 0.1 \times 250}{1000} = 2.65 \text{ g}$$

Hence on dissolving 2.65 g of sodium carbonate in 250 ml solution, 250 ml 0.1M solution of sodium carbonate will be obtained.

Required apparatus : Weighing tube, beakers, washing bottle, 250 ml measuring flask, funnel, chemical balance.

Material required : Sodium carbonate, distilled water.

Method : Exact 2.65 g Na_2CO_3 is weighed in a dry and clean weighing tube. Na_2CO_3 is transferred into a funnel placed on measuring flask. All crystals are transferred from weighing tube into funnel with the help of washing bottle. After adding some more distilled water to measuring flask funnel is removed and it is shaken well. Volume is made upto the mark with distilled water. After stoppering the measuring flask solution is shaken to make it homogeneous.

Observation :

Weight of empty weighing tube = 8.356 g

Weight of weighing tube + Na_2CO_3 = 11.006 g

Weight of Na_2CO_3 = 2.65 g

Result : Solution of Na_2CO_3 prepared is 0.1M.

Precautions : (1) Exact 2.65 g Na_2CO_3 must be weighed.

(2) All crystals must be transferred from weighing tube to measuring flask.

Viva-Voce

Q. 1. What is the commercial name of sodium carbonate ?

Ans. Soda ash.

Q. 2. What is the formula of washing soda ?

Ans. $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$

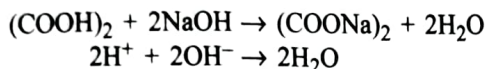
Q. 3. What is the nature of Na_2CO_3 solution ?

Ans. It is alkaline.

Experiment No. # 03

Object : To determine strength in gram/litre of a given solution of NaOH by titrating it against standard 0.1M oxalic acid.

Principle : On adding the solution of sodium hydroxide to oxalic acid solution the following neutralization reaction takes place :



Oxalic acid is a weak acid in above reaction while sodium hydroxide is strong alkali. Hence, phenolphthalein is used as indicator. It's colour becomes pink at the end point.

Molarity of NaOH is determined by the formula

$$a_1 M_1 V_1 = a_2 M_2 V_2$$

Where a_1 = acidity of NaOH, M_1 = molarity of NaOH, V_1 = volume of NaOH used in titration, a_2 = basicity of oxalic acid, M_2 = molarity of oxalic acid, V_2 = volume of oxalic acid.

Concentration of NaOH = $M \times m$ g/L

Where M = molarity of NaOH, m = molecular mass of NaOH.

Required apparatus : Burette, pipette, conical flask, burette stand, funnel, measuring flask, chemical balance.

Required solution : Given NaOH solution, 0.1M oxalic acid solution.

Indicator : Phenolphthalein.

Method : Burette washed with water is rinsed 2-3 times with NaOH solution and filled with NaOH solution to any mark and reading is noted. Pipette washed with water is rinsed with standard oxalic acid solution 2-3 times and 25 ml oxalic acid measured with it is poured in conical flask which was already washed with water. To it two drops of phenolphthalein are added. Now the solution of sodium hydroxide is added drop by drop in flask from burette. The point at which the solution becomes light pink from colourless on adding one drop of NaOH in excess is the end point. Reading of burette is noted. This process is repeated to get two concordant readings.

Observation :

S. No.	Volume (ml) of acid taken by pipette	Reading of burette		Used volume of NaOH (ml)	Corresponding volume of used NaOH
		Initial	Final		
1.	25.0	0.0	25.6	25.6	25.5 ml
2.	25.0	2.0	27.5	25.5	
3.	25.0	4.0	29.5	25.5	

Calculation :

$$\therefore a_1 M_1 V_1 = a_2 M_2 V_2$$
$$a_1 = 1, M_1 = ?, V_1 = 25.5, a_2 = 2, M_2 = 0.1, V_2 = 25$$
$$\therefore 1 \times M_1 \times 25.5 = 2 \times 0.1 \times 25$$

$$\therefore M_1 = \frac{1}{5.1}$$

$$\therefore \text{Concentration of NaOH} = M \times m$$

$$\therefore \text{Concentration of NaOH} = \frac{1}{5.1} \times 40$$

$$= 7.843 \text{ gram/litre.}$$

Result : Concentration of sodium hydroxide solution is 7.843 gram/litre.

Precautions : (1) Burette and pipette must be rinsed with solution which is taken in them.

(2) Air bubbles must be removed from burette before titration.

(3) Funnel must be removed from burette before taking reading.

(4) To note reading eye must be exactly at the level of the meniscus.

(5) During sucking the solution by pipette its lower part must be well below the surface of the solution.

(6) Remaining liquid in narrow end of pipette must not be removed by blowing out.

Viva-Voce

Q. 1. Is oxalic acid weak or strong ?

Ans. It is a weak acid.

Q. 2. Is NaOH weak base or strong base ?

Ans. It is a strong base.

Q. 3. Which indicator will be used for titrating weak acid and strong base ?

Ans. Phenolphthalein indicator is used.

Q. 4. Why are the burette and pipette rinsed with the solution with which these are filled ?

Ans. To remove any water drops sticking to them which can change the concentration of solutions.

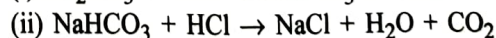
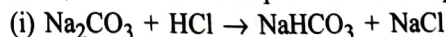
Q. 5. Explain the term end point.

Ans. It is the point at which the reaction occurring in the titration is just complete. At this point indicator shows sharp colour change.

Experiment No. # 04

Object : To determine concentration of given hydrochloric acid by titrating with standard solution of sodium carbonate.

Principle : When strong acid (as HCl) is added to sodium carbonate, the reaction completes in two steps.



In first step carbonate changes to bicarbonate. In second step bicarbonate reacts with acid to give carbon dioxide.

In this titration, methyl orange is used as indicator and acid solution is taken in burette.

Molarity of HCl is determined by the formula

$$a_1 M_1 V_1 = a_2 M_2 V_2$$

Where a_1 = basicity of HCl, M_1 = molarity of HCl, V_1 = volume of HCl used in titration, a_2 = acidity of Na_2CO_3 , M_2 = molarity of Na_2CO_3 , V_2 = volume of Na_2CO_3 .

Concentration of HCl = $M \times m$ g/L

Where M = molarity of HCl

m = molecular mass of HCl

Required apparatus : Burette, pipette, conical flask, burette stand, funnel, measuring flask, chemical balance.

Necessary solution : Standard $\left(\frac{N}{10}\right)$ solution of sodium

carbonate, given hydrochloric acid solution.

Indicator : Methyl orange.

End point : Yellow to red.

Method : (1) Burette is rinsed with hydrochloric acid and is filled with acid solution to any mark and reading is noted.

(2) 25 ml sodium carbonate solution is taken by pipette in a clean conical flask or beaker.

(3) 2-3 drops methyl orange is added to the solution.

(4) Reading of burette is noted and acid solution is added slowly to solution of conical flask from burette. The solution is shaken continuously. As soon as the stable red colour appears the reading of burette is noted.

(5) The titration is repeated to get two concordant readings.

Observation :

S. No.	Volume (ml) of base taken by pipette	Reading of burette		Used volume of acid (ml)	Corresponding volume of used acid
		Initial	Final		
1.	25.0	0.0	25.2	25.2	25.3 ml
2.	25.0	0.0	25.3	25.3	
3.	25.0	0.0	25.3	25.3	

Calculation :

$$a_1 M_1 V_1 = a_2 M_2 V_2$$

$$a_1 = 1, M_1 = ? V_1 = 25.3, a_2 = 2, M_2 = 0.1, V_2 = 25$$

$$\therefore 1 \times M_1 \times 25.3 = 2 \times 0.1 \times 25$$

$$\therefore M_1 = \frac{1}{5.06}$$

$$\therefore \text{Concentration of HCl} = M \times m$$

$$\therefore \text{Concentration of HCl} = \frac{1}{5.06} \times 36.5 = 7.2134 \text{ g/L}$$

Result : Concentration of dil. HCl acid is 7.2134 g/L.

Precautions : (1) Burette and pipette must be rinsed with solution which is taken in them.

(2) Air bubbles must be removed from burette before titration.

(3) Funnel must be removed from burette before taking reading.

(4) To note reading eye must be exactly at the level of the meniscus.

(5) During sucking of the solution by pipette its lower part must be well below the surface of the solution.

(6) Remaining liquid in narrow end of pipette must not be removed by blowing out.

Viva-Voce

Q. 1. What is the colour change at the end point in the titration of sodium carbonate and hydrochloric acid ?

Ans. Red from Yellow.

Q. 2. Can you directly prepare standard solution of HCl, HNO₃ and H₂SO₄ ?

Ans. No, these are not primary standard.

Q. 3. Is Na₂CO₃ base or salt ?

Ans. It is a salt.

Q. 4. Why does its aqueous solution alkaline ?

Ans. Its aqueous solution is alkaline due to hydrolysis.

Q. 5. What type is HCl acid ?

Ans. It is a strong acid.

QUALITATIVE ANALYSIS

Detection of Inorganic Radicals

Finding out the nature of substance and identity of its constituents is known as qualitative analysis. Inorganic salts are prepared by reacting acid and base. Part obtained from acid and base are anion and cation respectively. Hence, inorganic mixture has two types of ion. In qualitative analysis, these ions are called radical. Anion and cation are called acidic and basic radicals, respectively. Some anions (acidic radicals) have characteristic odour e.g. CH₃COO⁻, S²⁻, SO₃²⁻. Some cation (basic radicals) impart colour to salt. e.g., Cu²⁺, Fe²⁺, Ni²⁺, Co²⁺, Mn²⁺.

Some Physical Observations may give Probable Presence of Radicals

S. No.	Property	Probable radical
1.	Water soluble white salt	Cu ²⁺ , Ni ²⁺ , Co ²⁺ , Fe ³⁺ , Mn ²⁺ absent
2.	Water soluble coloured salt	

3.	(i) Blue or green salt; blue solution	Cu ²⁺
	(ii) Green salt; green solution	Ni ²⁺
	(iii) Yellow or brown salt; yellow solution	Fe ³⁺
	(iv) Yellow-pink salt; colourless solution	Mn ²⁺
	(v) Violet-pink salt; pink solution	Co ²⁺
4.	Smell of substance	
	(i) Like ammonia	NH ₄ ⁺
	(ii) Like vinegar	CH ₃ COO ⁻
5.	(iii) Like rotten eggs	S ²⁻
	Density	
	(i) Heavy salt	Pb ²⁺
6.	(ii) Light salt	Al ³⁺ , Zn ²⁺ , Ca ²⁺ , Ba ²⁺ , Sr ²⁺ or Mg ²⁺