

BP 118
Physical Pharmacy-I Lab

Prepared by
Dr. Mst. Hajera Khatun

What are 3 ways to measure the concentration of a solution?

1. Normality:

Normality (N) is defined as the number of gm equivalents per liter of solution

normality = number of gm equivalents/1 L of solution.

A 1 N solution is said to be "one normal."

For calculation of weight to prepare normal solution

$$\text{Weight} = \text{SMV}/1000$$

Here S=Strength

$$M = \text{Gram equivalent weight}$$

$$V = \text{Volume}$$

Example; How can you prepare 0.1 N 250 ml NaOH solution?

Answer: Here S=0.1 N

$$M = 40 \text{ gm}$$

$$V = 250 \text{ ml}$$

$$\text{Weight} = \text{SMV}/1000$$

$$= 0.1 \times 40 \times 250/1000$$

$$= 1 \text{ gm}$$

So to prepare 0.1 N 250 ml NaOH solution, firstly weigh 1 gm of NaOH and take into 250 ml volumetric flask and dissolve it in 200 ml distilled water. Finally make the volume upto 250 ml with distilled water.

2. Molarity:

Molarity is defined as the moles of a solute per liters of a solution. Molarity is also known as the molar concentration of a solution.

Molarity formula and units

The units of molarity are M or mol/L. A 1 M solution is said to be "one molar."

Molarity equation

$$M = \text{moles solute} / \text{liters solution}$$

For calculation of weight to prepare molar solution

$$\text{Weight} = \text{SMV}/1000$$

Here S=Strength

$$M = \text{Molecular weight in gram}$$

$$V = \text{Volume}$$

Example; How can you prepare 0.1 M 500 ml NaOH solution?

Answer: Here S=0.1 M

$$M = 40 \text{ gm}$$

$$V = 500 \text{ ml}$$

$$\text{Weight} = \text{SMV}/1000$$

$$= 0.1 \times 40 \times 500/1000$$

$$= 2 \text{ gm}$$

So to prepare 0.1 M 500 ml NaOH solution, firstly weigh 2 gm of NaOH and take into 500 ml volumetric flask and dissolve it in 300 ml of distilled water. Finally make the volume upto 500 ml with distilled water.

3. Molality:

Molality (m), or molal concentration, is the amount of a substance dissolved in a certain mass of solvent. It is defined as the moles of a solute per kilograms of a solvent.

Molality formula and units

The units of molality are m or mol/kg.

Molality equation

$$m = \text{moles solute} / \text{kilograms solvent}$$

Difference between Molality and Molarity

	Molarity (M)	Molality (m)
Measure of	Concentration	Concentration
Definition	The moles of a solute per liters of a solution	The moles of a solute per kilograms of a solvent
Units	M	m
Equation	$M = \text{moles solute} / \text{liters solution}$	$m = \text{moles solute} / \text{kg solvent}$
Ratio of moles to:	Volume (in liters)	Mass (in kilograms)

Titration:

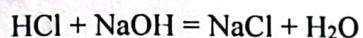
Titration refers to a process where the use of a solution of known concentration takes place for the determination of the concentration of an unknown solution.

Titrant: The known solution whose concentration is known, is added from a burette to a known quantity of the analyte.

Analyte: The unknown solution whose concentration is to be determined.

An acid-base titration is an experimental procedure used to determine the unknown concentration of an acid or base by precisely neutralizing it with an acid or base of known concentration.

Neutralizing reaction:



End point: The point during a titration when an indicator shows that the amount of reactant necessary for a complete reaction has been added to a solution.

Indicator: A substance that changes color in response to a chemical change. An acid-base indicator (e.g., phenolphthalein) changes color depending on the pH. ... A drop of indicator solution is added to the titration at the beginning; the endpoint has been reached when the color changes.

Examples of indicator

Indicator	Acidic	Alkaline
Methyl orange	Red	Yellow
Phenolphthalein	Colourless	Pink
Methyl red	Red	Yellow
Bromothymol blue	Yellow	Blue

	H ₂ SO ₄	NaOH	Na ₂ CO ₃
M.W	98	40	106
E.W	49	40	53

1 N NaOH solution

=40 gm NaOH dissolved in 1 l (1000 ml) dH₂O

0.1 N Na₂CO₃ 500 ml solution

1 M NaOH solution

=40 gm NaOH dissolved in 1 l (1000 ml) dH₂O

1 N Na₂CO₃ solution

=53 gm Na₂CO₃ dissolved in 1 l (1000 ml) dH₂O

1 M Na₂CO₃ solution

=106 gm Na₂CO₃ dissolved in 1 l (1000 ml) dH₂O

0.1 M Na₂CO₃ 500 ml solution

Semester: Spring 2024

Name of the Teacher	:	
Designation	:	
Department	:	
Mobile No.	:	
Course Title (Code)	:	Chemistry Lab (CHE 1262)
Semester & Section	:	2 nd semester
Total No. of Lectures	:	14 (Duration 2 hours)
Total Credit Hours	:	28
Total No. of Topics	:	7

Lecture No.	Topics	Date & Day	Time	Room No.
1	Preparation of standard solution (0.1N NaOH, 0.1N HCl, 0.1N H ₂ SO ₄ , 0.1 N Na ₂ CO ₃ , 0.1 N oxalic acid)			
2	Preparation of standard solution (0.1N NaOH, 0.1N HCl, 0.1N H ₂ SO ₄ , 0.1 N Na ₂ CO ₃ , 0.1 N oxalic acid)			
3	Determination of P ^H of different solutions (0.1N NaOH, 0.1N HCl, 0.1N H ₂ SO ₄ , 0.1 N Na ₂ CO ₃ , 0.1 N oxalic acid)			
4	Determination of P ^H of different solutions (0.1N NaOH, 0.1N HCl, 0.1N H ₂ SO ₄ , 0.1 N Na ₂ CO ₃)			
5	Determination of strength of strong acid (HCl) and weak acid (oxalic acid) by standard Na ₂ CO ₃ solution.			
6	Determination of strength of strong acid (HCl) and weak acid (oxalic acid) by standard Na ₂ CO ₃ solution.			
7	Determination of strength of base (Na ₂ CO ₃) with primary standard acid (oxalic acid).			
8	Determination of strength of base (Na ₂ CO ₃) with primary standard acid (oxalic acid).			
9	Standardization of strong acid (HCl) with strong base (NaOH).			
10	Standardization of strong acid with strong base (NaOH).			
11	Determination of integral heat of solution of NH ₄ Cl and NaCl			

12	Determination of integral heat of solution of NH ₄ Cl and NaCl.			
13	Preparatory class of Examination			
14	Examination			

Chemistry Lab

(CHE 1262)

INDEX

Serial No.	Date	Name of the experiment	Page No.
1		Preparation of primary and secondary standard solutions.	
2		Determination of strength of strong acid and weak acid by standard Na_2CO_3 solution.	
3		Determination of strength of base with primary standard acid.	
4		Standardization of strong acid with strong base.	
5		Determination of integral heat of solution of KCl, NH_4Cl and NaCl.	

Experiment No.01	Date:
Name of The experiment: <ul style="list-style-type: none"> Preparation of primary standard solution of Sodium thiosulfate (Na_2SO_3), Oxalic acid $\{(\text{COOH})_2 \cdot 2\text{H}_2\text{O}\}$, Potassium dichromate ($\text{K}_2\text{Cr}_2\text{O}_7$). Preparation of secondary standard solution of sulfuric acid (H_2SO_4), Hydrochloric acid (HCl) and Acetic acid (CH_3COOH). 	

PRINCIPLE:

Standard solution: In the case of volumetric analysis, the solution whose strength is known is called standard solution. Standard solution can be prepared directly from primary standard substance by taking exact weight and then dissolving in distilled water.

- Primary Standard substance:** Primary Standard substances are substances from which standard solution can be prepared directly by taking weight at an electrical balance and then dissolving that substance in distilled water or any other suitable solvent. Examples are:



- Criteria of Primary Standard substance:**

- They are chemically pure substance.
- The molecular weight of the substance corresponds to the chemical formula.
- The substances are stable both in solid or liquid state.
- The gram equivalent weight is large.

- Secondary Standard Substance:** Secondary standard substances are the substances from which standard solution cannot be prepared by directly weighting and then dissolving in suitable solvent. Examples are: NaOH , KOH , H_2SO_4 , HCl , CH_3COOH , KMnO_4 etc.

In this case, the appropriate weight of the substance under test is taken and then dissolved in distilled water and dilute solution is prepared. This solution is then standardized with primary standard solution and then its strength is determined by using the following equation:

$$V_1 S_1 = V_2 S_2$$

Where,
 V_1 = Volume of primary standard solution
 S_1 = Strength of primary standard solution
 V_2 = Volume of secondary standard solution
 S_2 = Strength of secondary standard solution

Concentration term: Normal solution.

Reagent:

Primary standard substance:

- Sodium carbonate (Na_2CO_3)
- Oxalic acid (HOOC-COOH)
- Sodium oxalate (NaOOC-COONa)
- Potassium dichromate ($\text{K}_2\text{Cr}_2\text{O}_7$)

Secondary standard substance:

- Sulfuric acid (H_2SO_4)
- Hydrochloric acid (HCl)
- Nitric acid (HNO_3)
- Acetic acid (CH_3COOH)
- Sodium hydroxide (NaOH)
- Distilled water (H_2O)

Apparatus:

- Balance
- Measuring cylinder
- Funnel
- Volumetric flask

Procedure:

- **Primary Standard Substance:**

- **Preparation of standard 0.1 (N) Na_2CO_3 solution:** The gram equivalent weight of Na_2CO_3 is $53.50 \cdot 53 \div 100 = 0.53$ gram of Na_2CO_3 is needed to prepare 0.1 (N) 100ml solution of Na_2CO_3

Now 0.53gm of Na_2CO_3 was weighed in the electrical balance and dissolved it in 50ml of distilled water in 100ml volumetric flask and shake gently. Then make the volume up to the mark with distilled water.

- ii **Preparation of standard 0.1 (N) Oxalic acid solution:** The gram equivalent weight of oxalic acid is $126 \div 2 = 63$. So, to prepare 100ml of 0.1(N) solution of oxalic acid, we need $(63 \div 100) = 0.63$ gm of oxalic acid.

Now weight out 0.63gm of oxalic acid in the electrical balance and dissolved it in 50ml of distilled water in 100ml volumetric flask and shake gently. Then make the volume up to the mark with distilled water.

- iii **Preparation of standard 0.1 (N) Sodium oxalate solution:** The gram equivalent weight of this substance is $170 \div 2 = 85$. So, to prepare 100ml of 0.1(N) solution of sodium oxalate, we need $(85 \div 100) = 0.85$ gm of sodium oxalate.

Now weigh 0.85gm of sodium oxalate in the electrical balance and dissolved it in 50ml of distilled water in 100ml volumetric flask and shake gently. Then make the volume up to the mark with distilled water.

- iv. **Preparation of standard 0.1(N) Potassium dichromate ($\text{K}_2\text{Cr}_2\text{O}_7$) solution:** The gram equivalent weight of potassium dichromate is $149 \div 6 = 49$, So, to prepare 100ml of 0.1 (N) potassium dichromate solution we need $(49 \div 100) = 0.49$ gm $\text{K}_2\text{Cr}_2\text{O}_7$ in the electrical balance and dissolved it in 50ml of distilled water in 100ml volumetric flask and shake gently. Then make the volume up to the mark with distilled water.

- v. **Preparation of standard 0.1 (N) Sodium thiosulfate solutions:** The gram equivalent weight of this substance is 158. So, to prepare 100ml of 0.1(N) solution of $\text{Na}_2\text{S}_2\text{O}_3$, we need $(158 \div 100) = 1.58$ gm of $\text{Na}_2\text{S}_2\text{O}_3$.

Now weigh 1.58gm of $\text{Na}_2\text{S}_2\text{O}_3$ in the electrical balance and dissolve it in 50ml of distilled water in 100ml volumetric flask and shake gently. Then make the volume up to the mark with distilled water.

b) Secondary standard substance

i. **Preparation of standard 0.1(N) Sulfuric acid solution:** The gram equivalent weight of H_2SO_4 is $(98 \div 2) = 49$. So to prepare 100ml of 0.1(N) H_2SO_4 solution $(49 \div 100) = 0.49\text{gm}$ of 100% H_2SO_4 acid is needed. Since H_2SO_4 is not 100% pure, it is 98% pure. So to prepare 100ml of 0.1(N) H_2SO_4 Solution $\{(100 \times 0.49) \div 98\} = 0.5\text{gm}$ H_2SO_4 is needed. But H_2SO_4 is needed. But H_2SO_4 is liquid and secondary standard substance. So its volumetric measurement is needed which may be obtained by the following equation.

$$\text{Mass} = \text{volume} \times \text{density}$$

Thus density of H_2SO_4 is 1.89. So, to prepare 100ml 0.1(N) H_2SO_4 the needed volume of 98% H_2SO_4 is $0.5 \div 1.89 = 0.2645\text{ml}$

Now take 100ml volumetric flask, which contains 50ml of distilled water and 0.2645 ml of H_2SO_4 is added slowly. Then make the volume up to the mark with distilled water.

- **Preparation of standard 0.1(N) HCl solution:** The gram equivalent weight of HCl is 36.5. So, to prepare 100ml of 0.1(N) HCl solution $(36.5 \div 100) = .365\text{ gm}$ of 100% HCl acid is needed. Since HCl is not 100% pure, it is 32% pure. So, to prepare 100ml of 0.1(N) HCl solution $\{(100 \times 0.365) \div 32 = 1.14\text{gm}$ HCl is needed}. But HCl is liquid and secondary standard substance. So, its volumetric measurement is needed which may be obtained by the following equation :

$$\text{Mass} = \text{volume} \times \text{density}$$

Thus density of HCl is 1.18. So, to prepare 100ml 0.1(N) solution of HCl the needed volume of 32% HCl is $(1.14 \div 1.18) = 0.96\text{ml}$ 1ml.

Now take 100ml volumetric flask, which contains 50ml of distilled water and 1ml of HCl is added slowly. Then make the volume up to the mark with distilled water.

iii) **Preparation of standard 0.1 (N) Acetic acid (CH_3COOH) solution:** The gram equivalent weight of CH_3COOH is 60. So to prepare 100ml of 0.1(N) acetic acid solution $(60 \div 100) = 0.6\text{gm}$ of 100% CH_3COOH is needed. But CH_3COOH is liquid and secondary standard substance. So its volumetric measurement is needed which may be obtained by the following equation:

Mass = volume x density

Thus density of HCl is 1.055. So, to prepare 100ml 0.1(N) solution of CH₃COOH the needed volume of CH₃COOH is $(0.6 \div 1.055) = 0.56\text{ml}$.

Now take 100ml volumetric flask, which contains 50ml of distilled water and 0.6ml of CH₃COOH, is added slowly. Then make the volume up to the mark with distilled water.

iv) **Preparation of standard 0.1 (N) NaOH solution:** The gram equivalent weight of NaOH is 40. So, to prepare 100ml of 0.1(N) NaOH solution, we need $(40 \div 100) = 0.4\text{gm}$ of NaOH.

Now take 100ml volumetric flask, which contains 50ml of distilled water and 0.4gm of NaOH is added slowly and shake gently until the NaOH granules dissolved completely. Then make the volume up to the mark with distilled water.

ii) **Preparation of standard 0.1 (N) KOH solution:** The gram equivalent weight of KOH is 56. So, to prepare 100ml of 0.1(N) KOH solution, we need $(56 \div 100) = 0.56\text{gm}$ of KOH.

Now take 50ml of distilled water in a conical flask and shake gently until the KOH granules dissolved completely. Then pour this solution to 100ml volumetric flask and rinse the conical flask into the volumetric flask and make the volume up to the mark with distilled water.

Precaution:

- Acid should be poured very slowly to the water .If acid is poured to water very rapidly then the flask will be heated and may burst.
- Concentrated acid should be measured with measuring cylinder pipette as accurately as possible.
- The surface of the funnel should be washed into flask with distilled water so that no acid loss occurs.

Experiment No. 02

Date:

Name of The experiment:

Determination of strength of 0.1(N) H₂SO₄, 0.1 (N) HCl solution by standard 0.1(N) sodium carbonate (Na₂CO₃) solution.

Principle:

This can be considered as the neutralization reaction between a strong base {e.g. 0.1(N) Na₂CO₃} and strong acid {e.g. 0.1(N) HCl, 0.1(N) H₂SO₄ etc.}. The following reactions take place between them.



To determine the strength of the acid the following equation is used

$$V_1S_1 = V_2S_2$$

Where,

V₂ = Volume of primary standard solution

S₂ = Strength of primary standard solution

V₁ = Volume of secondary standard solution

S₁ = Strength of secondary standard solution

Chemicals:

- 0.1 (N) H₂SO₄ (secondary standard solution)
- 0.1 (N) HCl (secondary standard solution))
- 0.1 (N) Na₂CO₃ (Primary standard solution)
- Indicator – methyl orange

Apparatus:

- | | | |
|-----------------|----|--------------------|
| • Conical flask | e) | Volumetric flask |
| • Pipette | f) | Beaker |
| • Burette | g) | Measuring cylinder |
| • Funnel | | |

Procedure

- **Filling the burette:** A clear and dried burette is filled with 0.1(N) Na₂CO₃ solution and mark is adjusted with respect to zero.
- **Placement of 0.1(N) acid solution in conical flask by pipette:** A clear and dried conical flask is used to take 0.1(N) acid solution from the volumetric flask to the conical flask. Take 10 ml of 0.1(N) acid solution in a conical flask, add 10 ml of distilled water and 2-3 drops of methyl orange. The color becomes orange. Wipe out the bottom of the conical

flask and place a piece of white paper below it. Take initial burette reading. Now add drops of base solution from the burette to the conical flask along with gentle shaking. A drop of basic solution will make it yellow colour but this colour will fade away rapidly. When the end point reaches, then the colour become yellow. Taken the final burette reading and fill the table for each acid.

Table for 0.1(N) H₂SO₄

Solution no.	Volume of acid in ml	Initial burette reading	Final burette reading	Difference	Mean (Volume of base) in ml
1	10				
1	10				
1	10				

Where, V_1 = Volume of acid = ml

S_1 = Strength of acid = (N)

V_2 = Volume of base = ml

S_2 = Strength of base = (N)

We Know, $V_1 S_1 = V_2 S_2$

Or, $S_1 = V_2 S_2 / V_1$

Thus, strength of acid (H₂SO₄) =

Table for 0.1 (N) HCl

Solution No.	Volume of acid in ml	Initial burette reading	Final burette reading	Difference	Mean (Volume of base) in ml
2	10				
2					
2					

Where, V_1 = Volume of acid = ml
 S_1 = Strength of acid = (N)
 V_2 = Volume of base = ml
 S_2 = Strength of base = (N)

We Know, $V_1 S_1 = V_2 S_2$

$$\text{Or, } S_1 = V_2 S_2 / V_1$$

Thus, strength of acid (HCl) =

Result:

- Strength of H_2SO_4 {0.1(N)} =
- Strength of HCl {0.1(N)} =

Precaution:

- Taken necessary step to prevent from the stop cork of burette.
- Acid solution from burette should be added slowly.
- Not more than 3-4 drops of methyl orange should be used.
- Difference of acid solution between two titrations should not vary more than 0.2ml. If it is high, repeat the titration.

Experiment No. 03

Date:

Name of The experiment:

Determination of strength of 0.1(N) Potassium hydroxide (KOH), 0.1(N) Sodium hydroxide (NaOH) by standard oxalic acid.

Principle:

Standardization of strong base by oxalic acid can be considered as neutralization reaction between strong base and weak acid. Phenolphthalein should be used as indicator. The following reaction takes place.



The calculation is performed by using the following equation:

$$V_1 S_1 = V_2 S_2$$

Where, V_1 = Volume of base solution

S_1 = Strength of base solution

V_2 = Volume of acid solution

S_2 = Strength of acid solution

Chemicals:

- 0.1 (N) KOH (secondary standard solution)
- 0.1 (N) NaOH (secondary standard solution))
- 0.1 (N) oxalic acid (Primary standard solution)
- Indicator – Phenolphthalein

Apparatus:

- | | | |
|-----------------|----|--------------------|
| • Conical flask | e) | Volumetric flask |
| • Pipette | f) | Stand clamp |
| • Burette | g) | Measuring cylinder |
| • Funnel | | |

procedure

- **Filling the burette:** A clear and dried burette is filled with 0.1(N) standard oxalic acid solution and lower meniscus of the solution is adjusted to zero.
- **Placement of 0.1(N) basic solution in conical flask by pipette:** A clear and dried conical flask is used to take 0.1(N) 10 ml basic solution from the volumetric flask. Add 10ml distilled water and 3-4 drops phenolphthalein solution to it. The solution becomes pink color.
- **Titration:**
 - The bottom of the conical flask is wiped and a piece of white paper is placed below it.
 - Take initial burette reading.
 - Add drop by drop oxalic acid solution from the burette to the conical flask along with gentle shaking. Each drop produces colourless which disappears rapidly.
 - At the end point the solution becomes colorless which remains for long time.
 - Take the final burette reading and fill the table, from which we can calculate the strength of solution

Table for 0.1(N) KOH

Solution no.	Volume of base in ml	Initial burette reading	Final burette reading	Difference	Mean (Volume of acid) in ml
1	10				
1	10				
1	10				

Where, V_1 = Volume of base = ml

S_1 = Strength of base = (N)

V_2 = Volume of acid = ml

S_2 = Strength of acid = (N)

We Know, $V_1 S_1 = V_2 S_2$

$$\text{Or, } S_1 = V_2 S_2 / V_1$$

Thus, strength of base (KOH) =

Table for 0.1 (N) NaOH

Solution No.	Volume of base in ml	Initial burette reading	Final burette reading	Difference	Mean (Volume of acid) in ml
2	10				
2	10				
2	10				

Where, V_1 = Volume of base = ml

S_1 = Strength of base = (N)

V_2 = Volume of acid = ml

S_2 = Strength of acid = (N)

We Know, $V_1 S_1 = V_2 S_2$

$$\text{Or, } S_1 = V_2 S_2 / V_1$$

Thus, strength of base (NaOH) =

Result:

- Strength of KOH {0.1(N)} =
- Strength of NaOH {0.1(N)} =
- Strength of NH₄OH {0.1(N)} =

Precaution:

- The necessary step should be taken to prevent the breaking of stop cork of burette.
- Acid solution from burette should be added slowly.
- Not more than 3-4 drops of phenolphthalein should be used.

- Difference of acid solution between two titrations should not vary more than 0.2ml. If it is high, repeat the titration.

Experiment No.04	Date:
Name of The experiment: The standardization of strong acid {secondary standard solution 0.1(N) HCl} with strong base {secondary standard solution 0.1(N) NaOH}	

Principle:

During the standardization of a strong base with a strong acid neutralization reaction takes place by this way:

$$\text{H}^+ + \text{OH}^- \rightarrow \text{H}_2\text{O}$$

As both acid and alkali are secondary standard substance, so anyone of them must be standardized by primary standard solution.

Calculation is done by the following equation:

$$VS = V_1S_1$$

Where, S = Strength of base S_1 = Strength of acid
 V = Volume of base V_1 = Volume of acid

Chemicals:

- 0.1 (N) Potassium hydroxide (NaOH)
- 0.1 (N) Hydrochloride acid (HCl)
- 0.1 (N) Oxalic acid solution
- Indicator – methyl orange and phenolphthalein

Apparatus :

- | | |
|-----------------|-----------------------|
| • Conical flask | e) Volumetric flask |
| • Pipette | f) Stand clamp |
| • Burette | g) Measuring cylinder |
| • Funnel | h) Beaker |

Procedure:

- Determination of standard 0.1 (N) oxalic acid solution.
- Determination of strength of 0.1 (N) NaOH solution by oxalic acid solution.
- Calculation of strength of 0.1 (N) NaOH by titration.

Standardization of 0.1 (N) HCl with standardized NaOH solution.

- Calculation of strength of 0.1 (N) HCl by titration.

Table for 0.1 (N) NaOH

Solution No.	Volume of base in ml	Initial burette reading	Final burette reading	Difference	Mean (Volume of acid) in ml
1	10				
1	10				
1	10				

Where, V_1 = Volume of acid = ml

S_1 = Strength of acid = (N)

V_2 = Volume of base = ml

S_2 = Strength of base = (N)

We Know, $V_2S_2 = V_1 S_1$

Or, $S_2 = V_1 S_1 / V_2$

Thus, strength of base (NaOH) = (N)

Table for 0.1 (N) HCl

Solution No.	Volume of acid in ml	Initial burette reading	Final burette reading	Difference	Mean (Volume of base) in ml
3	10				
3	10				

Where, V_1 = Volume of acid = ml

S_1 = Strength of acid = (N)

V_2 = Volume of base = ml

S_2 = Strength of base = (N)

We Know, $V_1 S_1 = V_2 S_2$

Or, $S_1 = V_2 S_2 / V_1$

Thus, strength of acid (HCl) = (N)

Result :

Precaution:

- Take necessary step to prevent the breaking the stop cork of burette.
- Acid solution from the burette should be added slowly.
- Not more than 3-4 drops of phenolphthalein should be used.
- Difference of acid solution between two titrations should not vary more than 0.2ml. If it is high, repeat the titration.

Experiment No. 05

Date:

Name of The experiment:

Determination of integral heat of solution of Potassium chloride (KCl), Ammonium chloride (NH_4Cl) and Sodium chloride (NaCl)

Principle:

When solids are dissolved into H_2O or any other solvent heat is either absorbed or evolved. Heat of the solution is the heat content change of the solvent when one mole of a solute is dissolved in it. It depends on the concentration of the resulting solution. The integral heat of a solution is the total heat content change for dissolving one mole completely that is when the solution is complete.

Theory:

Since the heat which is evolved or absorbed on dissolving a substance depends on amount of water or other solvent employed, the statement of the heat of solution has a definite meaning. Only when the concentration of the solution formed is given. If the dilution is so great that further dilution is unaccompanied by any heat effect, then the heat measured per mole of solute is known as the heat of solution at infinite dilution, usually, however, it will not be possible to determine this heat of solution directly and one therefore must state the number of moles of water in which one mole of solute is dissolved. Further a clear definition must be made between the quantity known as the integral heat of solution (which is the heat obtained when 1 mole is dissolved in X moles of solvent) and the different heat of solution. The latter is the heat change per mole of the solute when an infinitesimal amount of solute is dissolved in a large amount of solution of stated concentration.

The dissolution of most of the solid salt (MA) in water is an endothermic process. This means that a definite amount of heat energy is necessary for the decomposition of MA into M^+ and A^- ions and hence to go into solution. The heat absorbed in the reaction must be equal to the heat loss due to the decrease of temperature of the solution in the calorimeter and other glass and with the calorimeter through $(T_2 - T_1)^0\text{C}$. This is exactly equal to the sum of the masses of the parts multiplied by their specification.

$$\text{Total heat absorbed} = (M_1 S_1 - M_2 S_2) (T_2 - T_1) \text{ cal} = Q \text{ cal} \text{ (say)}$$

Where, M_1 = mass of the solution

M_2 = mass of the Calorimeter + stirrer + Thermometer

S_1 = Specific heat of solution

S_2 = Specific heat of glass

T_1 = Initial temperature

T_2 = Final temperature

Now let the amount of solid MH taken for the experiment in n gm of molecular weight M.

Numbers of moles =

For the dissolution of moles of the salt MA, the amount of heat absorbed Q cal (say).

For one mole of MA, the heat absorbed H = Q x

$$H = \{ (M_1 S_1 + M_2 S_2)(T_2 - T_1) \} \text{ Kcal}$$

Apparatus:

- | | |
|------------------|--------------------|
| • Calorimeter | iv) Rough balance |
| ii) Stirrer | v) Measuring flask |
| iii) Thermometer | vi) Stop watch |

Chemicals:

- | | |
|--------------------------|-------------------------------|
| • Solid KCl | iii. Solid NH ₄ Cl |
| • Solid KNO ₃ | iv. Solid NaCl |

Procedure:

- 200ml of distilled water is taken into a pre-weighed calorimeter with stirrer and thermometer.
- The temperature of the contents of the calorimeter was noted and recorded.
- 10gm of supplied solid sample was weight using a rough balance.
- Supplied sample added quickly to the calorimeter.
- The temperature recorded after 30 second interval at the time the solution was stirred quickly. The temperature time recording contained for 15 minutes.
- The final weight of calorimeter with its whole content was taken. The differences between the weight of calorimeter and final weight give the weight of the solution.
- The temperature time curve was drawn and corrected final temperature was taken from the graph in case of each supplied sample.

Calculation:

For KCl

Mass of Kill (W) = gm

Molecular weight of Kill (M) =

Mass of Calorimeter + Stirrer + Thermometer (M₂) = gm

Mass of solution + Calorimeter + Stirrer + Thermometer (M₃) = gm

Mass of solution (M₁) = gm

Specific heat of solution (S₁) = 1

Specific heat of glass (S₂) = 0.16

Initial temperature (T₁) =

Final temperature (T₂) =

Time (min)	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7	7.5
Temp (°C)															

Time (min)	8	8.5	9	9.5	10	10.5	11	11.5	12	12.5	13	13.5	14	14.5	15
Temp (°C)															

The total heat absorbed :

$$H = \{(M_1 S_1 + M_2 S_2)(T_2 - T_1)\} \text{ Kcal}$$

For NH₄Cl

Mass of NH₄Cl (W) =

Molecular weight of NH₄Cl (M) =

Mass Calorimeter + Stirrer + Thermometer (M₂) =

Mass of solution + Calorimeter + Stirrer + Thermometer (M₃) =

Mass of solution (M₁) =

Specific heat of solution (S₁) = 1

Specific heat of glass (S₂) = 0.16

Initial temperature (T₁) =

Final temperature (T₂) =

Time (min)	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7	7.5
Temp (°C)															

Time (min)	8	8.5	9	9.5	10	10.5	11	11.5	12	12.5	13	13.5	14	14.5	15
Temp (°C)															

The total heat absorbed :

$$H = \{ (M_1 S_1 + M_2 S_2)(T_2 - T_1) \} \text{ Kcal}$$

For NaCl

Mass of NaCl (W) =

Molecular weight of NaCl (M) =

Mass Calorimeter + Stirrer + Thermometer (M_2) =

Mass of solution + Calorimeter + Stirrer + Thermometer (M_3) =

Mass of solution (M_1) =

Specific heat of solution (S_1) = 1

Specific heat of glass (S_2) = 0.16

Initial temperature (T_1) =

Final temperature (T_2) =

Time (min)	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7	7.5
Temp (°C)															

Time (min)	8	8.5	9	9.5	10	10.5	11	11.5	12	12.5	13	13.5	14	14.5	15
Temp (°C)															

The total heat absorbed :

$$H = \{(M_1 S_1 + M_2 S_2)(T_2 - T_1)\} \text{ Kcal}$$

Result:

Heat of KCl solution absorbed per mole = Kcal

Heat of NH₄Cl solution absorbed per mole = Kcal

Heat of NaCl solution absorbed per mole = Kcal