Experiment 3

Preparation of liquid-liquid solution & solid liquid solution (Molar calculations)

Solubility of a substance is its maximum amount that can be dissolved in a specified amount of solvent at a specified temperature. It depends upon the nature of solute and solvent as well as temperature and pressure.

A solution is a homogeneous mixture of two or more substances on molecular level. The constituent of the mixture present in a smaller amount is called the Solute and the one present in a larger amount is called the Solvent. For example, when a smaller amount of sugar (solute) is mixed with water (solvent), a homogeneous solution in water is obtained.

Sampling and sample preparation of liquids and solids often present significant challenges for real-world quantitative analyses using spectrometric techniques (e.g., UV–vis and infrared absorption, luminescence and Raman spectroscopies). Very often, the native form of a sample is unsuitable for analysis. This could be due to

1. the complex nature of the object, which could provide false measurements due to interferences or masking agents.
2. the size of the object being too large to analyze in its entirety (e.g., laboratory sample of contaminated soil).
3. the awkward shape of the object, preventing it from fitting within the instrument in which the measurement is to be made.

To overcome these problems, some sort of sample preparation must be performed. In many cases, sample preparation is required before any quantitative analysis, and both can have dramatic impacts on the measured results and their accuracy.

Measurement Process

Samples collected for spectral analysis can generally be classified into three categories based on their state:

1- solids.
2- liquids.
3- gases.

Standard Solution

That is a solution that has a known weight of the solute in the solution of unknown size.

Equivalent weight (Eq.Wt.) (also known as gram equivalent) is the mass of one equivalent, that is the mass of a given substance which will combine with or displace a fixed quantity of another substance.

Normality (N)

Normality is a measure of concentration that is equal to the gram equivalent weight of solute per litre of solution. Gram equivalent weight is a measure of the reactive capacity of a molecule*. Unit of normality is Eq/L. "N" is the symbol used to denote normality.

For example, 1M of hydrogen chloride gives 1M of hydrogen ions and 1M of chloride ions into the solution. 1M of hydrogen ions is equal to one equivalent of hydrogen ions. Therefore, 1M HCl is the same as 1N HCl, but when we take sulphuric acid, 1M of sulphuric acids gives 2M of hydrogen ions into the solution. Therefore, normality of hydrogen ions will be 2N for a sulphuric acid solution.

Molarity (M)

Molarity (M) - the number of moles of solute per liter of solution (moles/Liter) to measure the concentration of a solution.

Molar concentration (also called molarity) is a measure of the concentration of a chemical species, in particular of a solute in a solution. The most commonly used unit for molarity is the number of moles per liter, having the unit symbol mol/L or $mol{\cdot}dm^{-3}$ in the SI unit.

To calculate the molarity of a solution, the number of moles of solute must be divided by the total liters of the solution produced. If the amount of solute is given in grams, we must first calculate the number of moles of solute using the solute's molar mass, then calculate the molarity using the number of moles and total volume.

Converting from Molarity to Normality

You can convert from molarity (M) to normality (N) using the following equation:

M=M.Wt

N = M*n

where n is the number of equivalents

To illustrate further, molarity and normality of some acids and bases are given below

The Molar Mass (MM), Equivalent Mass (Equ M), Molarity (M) and Normality (N) for some acids and bases

Acid/base	MM	Equ M	M vs N
HCl	36.5	36.5	1M=1N
H_2SO_4	98	98/2=49	1M=2N
NaOH	40	40	1M=1N
$Ca(OH)_2$	74	74/2=37	1M=2N

*Gram equivalent weight is determined by the amount of an ion that reacts, which could change depending on the reaction. Normality is not so straightforward as it will have different meanings depending on what you are dealing with:

In acid-base chemistry, normality is used to express the concentration of protons (H^+) or hydroxide ions (OH^-) in a solution.

In redox reactions, the equivalence factor describes the number of electrons that an oxidizing/reducing agent can accept/donate.

In precipitation reactions, the equivalence factor measures the number of ions which will precipitate in a given reaction.

What is a Normal Solution?

Normality (N) is another way to quantify solution concentration. It is similar to molarity but uses the gram-equivalent weight of a solute in its expression of solute amount in a liter (L) of solution, rather than the gram molecular weight (GMW) expressed in molarity. A 1N solution contains 1 gram-equivalent weight of solute per liter of solution.

Expressing gram-equivalent weight includes the consideration of the solute's valence. The valence is a reflection of the combining power of an element often as measured by the number of hydrogen atoms it can displace or combine with. A 1.0 gram-equivalent weight is the amount of a substance that will combine with or displace 1 atom of hydrogen.

To determine gram-equivalent weight of a substance:

Divide the GMW (formula weight) of a solute by the valence (number of hydrogen ions that can be displaced).

Example:

The normality of a 1.0 liter NaCl solution that contains 1.0 gram-equivalent weight will be the GMW of NaCl divided by the valence of NaCl:

(atomic weight of Na = 22.99; atomic weight of Cl = 35.45)

GMW of NaCl = 22.99 + 35.45 = 58.44 g

N = GMW/valence (the valence for NaCl is 1.0)

58.44 g/1.0 = 58.44 g = 1.0 gram-equivalent weight of NaCl = 1N solution of NaCl

In this situation, because NaCl has a valence of one, the molarity and normality of the solution are the same.

Some compounds, however, will not have the same normality as molarity, as in the case of H2SO4:

Example:

The normality of a 1.0-liter solution of H_2SO_4 containing 1.0 gram-equivalent weight will be the molecular weight of H_2SO_4 divided by the valence of H_2SO_4:

(atomic weight of H = 1; atomic weight of S = 32.06; atomic weight of O = 16)

GMW of H_2SO_4 = 1(2) + 32.06 + 16(4) = 98 g

N = GMW/valence (the valence for H_2SO_4 is 2.0, as there are 2.0 H ions that could be displaced)

98 g /2 = 49 g = 1.0 gram-equivalent weight of H_2SO_4 = 1N solution of H_2SO_4

The molarity of this 1N solution of H_2SO_4 would be 0.5 (M = g /GMW per liter or 49g/98g = 0.5)

To simply calculate the amount or weight of a substance needed for a desired normal solution, the following formula may be used:

Weight in grams = desired normality x volume needed in liters x GMW/valence

(W = N x V x GMW/valence)

Example:

500 mL of a 0.1N solution of NaOH is needed for a procedure. Calculate the amount of solute (NaOH) needed to prepare the solution. (atomic weights: Na = 22.99; O = 16; H = 1) Valence = 1

X g= 0.1N x 500 mL (0.5 L) x GMW 39.99 / 1.0

X = 0.1 x 0.5 x 39.99/1.0

X = 1.99

1.99 g of NaOH must be diluted to 500 mL to prepare a 0.1N solution.

Some important directories

Directory	Over the acidic function pH	Directory color in base	Directory color in acid
instance of Orange (MO)	**4.5 _ 3**	Yellow	Red and pink
instance of Red (MR)	**6.4 _ 4.2**	Yellow	Red
Phenol Naphthalene **(Ph.Ph)**	**10 _ 8.3**	Red and pink	Colorless

Preparation The Concentration of Acid (HCl) and Concentration of the Base (NaOH)

The purpose of this experiment to determine the concentration of sodium hydroxide solution and then and calibrated with a standard reagent of known chlorine acid solution 0.1). It reacts with the acid sodium hydroxide N) chlorine concentration according to the following equation:

$$NaOH + HCl \rightarrow NaCl + H_2O$$

And when the end point is the center neutral and using phenolphthalein guide the color at this point changes from red pink in the center basement to colorless.

A- **Preparation hydrochloric solution (0.1M)** is done by taking a given volume of hydrochloric acid center by graduated cylinder (Graduated cylinder) and empties the bottle volumetric capacity (500 ML) and wash cylinder with distilled water and empties water washing in the bottle volumetric so as to make sure that all the acid has been the center transfer to the bottle and then completes the volumetric size with distilled water to the mark in the volumetric bottle. To calculate the titer hydrochloric acid status by the following equation

$$M1 = \frac{SP. * Wt.\% * 1000}{M.wt} \quad ------------- \ (1)$$

Where :-

M1 = hydrochloric acid calibration Centre

Sp. = Specific weight of acid (acid density)

Wt. % = The percentage of the weight of hydrochloric acid Center

Making a Dilute Solution

Use the general a dilute solution law

$$M_1V_1 = M_2\, V_2 \ldots\ldots\ldots\ldots (2)$$

$$N_1V_1 = N_2\, V_2 \ldots\ldots\ldots\ldots (3)$$

Note/ If use

Molarity (M) = M.wt

Normality (N) = M/n or M.Wt/n

B- Preparation of sodium hydroxide solution (0.1)

It is not possible to prepare a standard solution of sodium hydroxide dissolving exact weights of sodium hydroxide and mitigated to the desired size because of the being a non-standard an initial material to dilute and to contain some of the sodium carbonate. Some solutions minute require that sodium hydroxide solution free of Alcarbonat In such a situation requires adding a sufficient amount of barium chloride deposition Alcarbonat then filtered solution**.**

As the solubility of sodium carbonate are very few in concentrated solutions of sodium hydroxide melted If a sufficient amount of NaOH containing Alcarbonat in the water, the Alcarbonat will settle to the bottom of the pot and then can nominate a solution to get free of Alcarbonat NaOH solution.

In the preliminary calculations, the method of preparation of sodium hydroxide solution are as follows

Weighed amount of sodium hydroxide (can be calculated) and placed in a bowl, then add to it a little distilled water until it melts and then move it to the vial volumetric container and wash with distilled water and add to the solution and then complete the volume to the mark in the volumetric bottle.

To calculate the weight of sodium hydroxide to prepare the solution (0.1) of the following relationship:

$$M_1 \quad \frac{Wt}{M.Wt} * \frac{1000}{V_1}$$

$$Wt. = \frac{M_1 * V_1 * M.Wt}{1000}$$

Where:

Wt = weight of sodium hydroxide

M1 = up standard solution of sodium hydroxide

V1 = the volume of sodium hydroxide preparation (Balumblyltr)

M.wt = weight equivalent of sodium hydroxide

Ex:- Calculate the volume of concentrated sulfuric acid (H_2SO_4) for the preparation 250 ml of sulfuric acid the concentration 0.3N.
knowing that (Sp=1.84, W%=98%)

Ex:- prepare 2N solution in 250 ml volumetric flask from 5N of HCl stock solution.

Ex:- / prepare 500 ml, 5M H_2SO_4 (Sulfuric acid) solution from original concentrated solution.

Sp. = Specific weight of acid (acid density) = 1.835

Wt. % = The percentage of the weight of hydrochloric acid Center = 96%

H = 1 , S = 16 , O = 8

Ex:- Preparation of 0.1M potassium permanganate ($KMnO_4$).

Ex:- Preparation of 0.1N sodium oxalate ($Na_2C_2O_4$).

Dilution

Problem: What volume of stock (11.6 M) hydrochloric acid is needed to prepare 250. mL of 3.0 M HCl solution?

moles solute before dilution = moles solute after dilution

$M_1V_1 = M_2V_2$

$M_{stock}V_{stock} = M_{dilute}V_{dilute}$

$(11.6\ M)(V_{Liters}) = (3.0\ M)(0.250_{Liters})$

$X_{Liters} = (3.0\ M)(0.250_{Liters}) / 11.6\ M$

$= 0.065\ L$