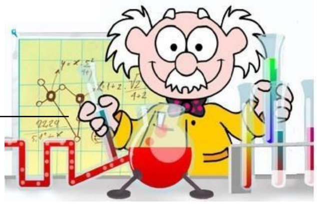


Practical Work N°3

Preparation of aqueous solutions from solid and liquid matter

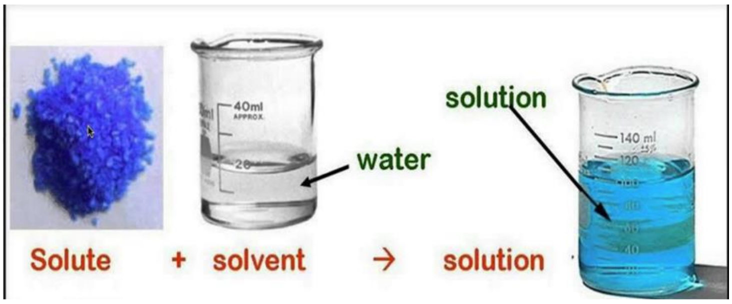
I. Introduction

Making solutions is a very common activity for lab workers in a chemistry lab. Proper solution making requires basic math skills, accurate measurement, and the ability to follow instructions.

A **solution** is a homogeneous mixture of two or more substances. In a solution, the **solute** is the substance that is dissolved in the **solvent**. Most of the time, the solvent will be H_2O, so if it is not otherwise specified, assume that you should dissolve the necessary amount of solute calculated in H_2O.

For example, when a smaller amount of sugar (solute) is mixed with water (solvent), a homogeneous solution in water is obtained.

Solution = Solute + Solvent



A **dilute solution** is one in which there is a relatively small amount of solute dissolved in the solution.

A **concentrated solution** contains a relatively large amount of solute.

A **standard solution** is a solution that has a known weight of the solute in the solution of unknown size.

An **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.

II. Ways of Expressing Concentration

We always discuss a solution being diluted or concentrated; this is a qualitative way of expressing the concentration of the solution.

There are several different ways to quantitatively describe the concentration of various solutions around us, we commonly express levels in the following way:

1. *Concentration*

It is the amount of solute present in one liter of solution. It is denoted by C.

$$C= \frac{\textit{Weight of solute in grams}}{\textit{Volume in liters}}$$

1) Mass Percentage (w/w):

When the concentration is expressed as the percent of one component in the solution by mass it is called mass percentage (w/w).

Suppose we have a solution containing component A as the solute and B as the solvent, then its mass percentage is expressed as:

$$\textbf{Mass \% of A} = \frac{\textit{Mass of component A in the solution}}{\textit{Total mass of the solution}} \times 100$$

2) Volume Percentage (V/V):

Sometimes we express the concentration as a percent of one component in the solution by volume, it is then called as volume percentage and is given as:

$$\textbf{volume \% of A} = \frac{\textit{Volume of component A in the solution}}{\textit{Total volume of the solution}} \times 100$$

For example, if a solution of NaCl in water is said to be 10 % by volume that means a 100 ml solution will contain 10 ml NaCl.

3) Mass by Volume Percentage (w/V):

This unit is majorly used in the pharmaceutical industry. It is defined as the mass of a solute dissolved per 100mL of the solution.

$$\% \text{ w/V} = \frac{\textit{Mass of component A in the solution}}{\textit{Total volume of the solution}} \times 100$$

4) Molarity (M):

One of the most commonly used methods for expressing the concentrations is molarity. It is the number of moles of solute dissolved in one liter of a solution. Suppose a solution of ethanol is marked 0.25 M, this means that in one liter of the given solution 0.25 moles of ethanol is dissolved.

$$M = \frac{\textit{Moles of solute}}{\textit{Volume of the solution in liters}}$$

5) Molality ($\mathcal{M}$):

Molality represents the concentration regarding moles of solute and the mass of solvent. It is given by moles of solute dissolved per kg of the solvent. The molality formula is as given-

$$\mathcal{M} = \frac{\textit{Moles of solute}}{\textit{Mass of solvent in Kg}}$$

6) Normality

It is the number of gram equivalents of solute present in one litre of the solution and it is denoted by N.

$$N = \frac{\textit{Weight of solute in grams}}{\textit{Equivalent mass X volume in liters}}$$

The relation between normality and molarity.

- N x Eq.Wt = Molarity x Molar mass
- N = Molarity x Valency

- N = Molarity x Number of H^+ or OH^- ion, e^-…

7) Mole Fraction:

If the solution has a solvent and the solute, a mole fraction gives a concentration as the ratio of moles of one component to the total moles present in the solution. It is denoted by x. Suppose we have a solution containing A as a solute and B as the solvent. Let nA and nB be the number of moles of A and B present in the solution respectively. So, mole fractions of A and B are given as:

$$x_A = \frac{nA}{n1+nB} \text{ and } x_B = \frac{nB}{n1+nB}$$

III. Aims

- Preparation of solution from a solid solute.
- Preparation of solution by dilution of a concentrated stock solution.

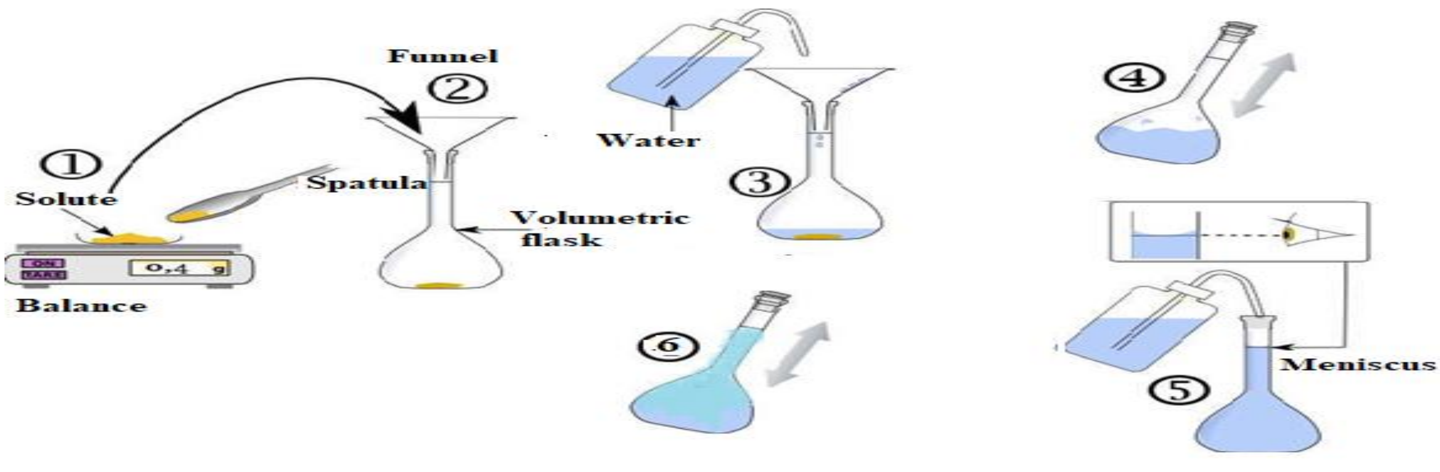
IV. Materials Required:

Balance, watch glass, spatula, funnel, wash bottle, volumetric flask, Rubber bulbs, pipette, beaker. Caustic soda NaOH. Making Solutions of Differing Mass/Volume Concentrations

a) Preparing a standard solution from a solid

Procedure: The teacher instructed four groups of student ‘A’, ‘B’, ‘C’ and ‘D’ respectively to prepare 50 mL, 100mL of (0,001 M, 0,002 M, 0,003 M, 0,004 M) sodium hydroxide solution NaOH (M=40g/mol).

1. Calculate grams of solute “m” of NaOH needed to prepare the solution. m=C.M. V=[X].M.V
2. Weigh solute with scale out in a watch glass and then transferred directly to a volumetric flask calibrated to prepare desired volume. A funnel might be helpful when transferring the solid into the slim neck of the volumetric flask.
3. A small quantity of water is then added to the volumetric flask and the contents are swirled gently until the substance is completely dissolved.
4. More water is added until the meniscus of the liquid reaches the calibration mark on the neck of the volumetric flask (a process called “diluting to volume”).
5. The volumetric flask is then capped and inverted several times until the contents are mixed and completely dissolved.



b) Diluting a Solution of Known Concentration

Dilution is the addition of more solvent to produce a solution of reduced concentration. Most often a diluted solution is created from a small volume of a more concentrated stock solution.

Procedure: We need to prepare V1=100 mL (Or V1=50 mL) of **C1=**0,**001** M sodium hydroxide solution from C_0 = 0,005 M solution.

To make such a solution,

1. Calculate volume of stock solution needed using Dilution Equation: $\mathbf{C_0V_0=C_1V_1}$
2. A volumetric pipet is used to deliver an exact amount of the stock solution into a clean volumetric flask to prepare desired volume. **(**To prevent extra dilution or contamination, prerinse the vol pipet with the stock solution to remove any water droplets or impurities**)**.
3. Adds enough water until the meniscus of the liquid reaches the calibration mark on the neck of the volumetric flask