Experiment-2: **Preparation of Solutions in Chemistry**

Introduction

Solution : A solution is a homogeneous mixture of two or more pure substances that do not interact with each other. A solution is formed when a substance, called a solute, is dissolved in another substance, called the solvent.

Solute : Substance which dissolves in a solution.

Solvent : Substance which dissolves another to form a solution (water).

Solution = Solute + Solvent

Ways of expressing concentration

There are numerous ways to describe the concentration of a solution, and they are a useful ways to describe solutions concentrations in chemistry reactions.

1. Mass concentration : $t = \frac{m_{solute}}{V_{solution}}$ $(\frac{g}{L})$
2. Molarity : $C_M = \frac{n_{solute}}{V_{solution}}$ $(\frac{mol}{L})$
3. Normality : $C_N = \frac{n_{eq.g}}{V_{solution}}$ $(\frac{eq.g}{L})$
4. Molality : $C_m = \frac{n_{solute}}{m_{solvent}}$ $(\frac{mol}{Kg})$

Relation between Normality and Molarity

Normality and Molarity are two important and commonly used expressions in chemistry. They are used to indicate the quantitative measurement of a substance. But what relation does Molarity have with Normality ?

$$C_N = \mathbf{Z}\ C_M$$

Where Z is a constant with a number of states

- **For acid :** Z is the number of H^+ protons that the acid can lose.

Examples : HCl ($HCl \rightarrow H^+ + Cl^-$) ; Z= 1

- **For base :** Z is the number of hydroxides – OH^- that the base can lose

Examples : NaOH ($NaOH \rightarrow Na^+ + OH^-$) ; Z= 1

- **For oxidation and reduction :** Z is the number of transferred electrons.

Examples : MnO_4^- ($MnO_4^- + 5e^- + 8H^+ \rightarrow Mn^{2+} + 4H_2O$) ; Z = 5

Objective of the experiment

1. Recognising and using the equipment and tools for preparing solutions.
2. How to prepare a solution from sodium hydroxide (NaOH) by dissolving.
3. How to dilute Hydrochloric acid (HCI) solution.

Materials

- Graduated pipette or graduated cylinder
- Volumetric flask

- Spatula - Watch Glass – Funnel
- Analytical balance

Chemicals

- Hydrochloric acid (HCI)
- Sodium hydroxide (NaOH)
- Distilled water

Procedure

1. Preparation of solution from solid : This is how to make a chemical solution using a solid dissolved in a liquid. We need to calculate the mass of the solid required using with the equation : $\mathbf{m} = \mathbf{C_M}.\boldsymbol{M}.\boldsymbol{V}$

Question : Calculate and describe how to prepare 100 ml of sodium hydroxide (NaOH) solution with a molar concentration of 0.1 mol/L (M_{NaOH} =40 g/mol) ?

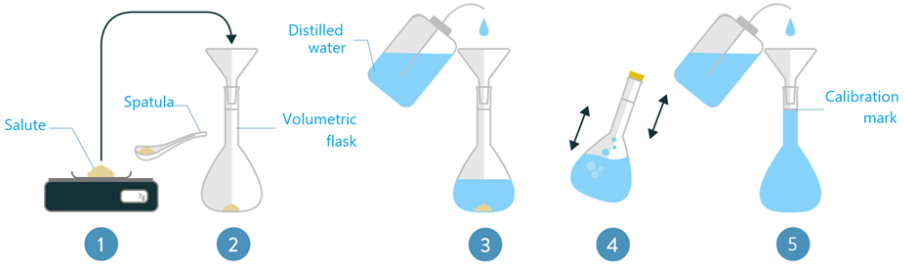
- Calculate the mass of sodium hydroxide (NaOH) needed to prepare 100 ml of 0.1 mol/L NaOH solution.

$$C_M = \frac{n}{V} = \frac{m}{M.V} \rightarrow m = C_M.M.V$$

$$m_{NaOH}(g) = C_{\text{المحلول}}\left(\frac{mol}{L}\right).M_{NaOH}\left(\frac{g}{mol}\right).V_{\text{المحلول}}\,(L)$$

$$m_{NaOH}(g) = 0{,}1 \times 40 \times 0.1 = 0.4\ g$$

- Weight the mass of 0.4 g of NaOH.
- Fill a clean 100 mL volumetric flask at third of it with water.
- Add 0.4g of NaOH to this volumetric flask using a funnel.
- Stir the mixture until the NaOH is completely dissolved.
- Completely fill the volumetric flask with distilled water to the measuring line.
- Close the volumetric flask, then mix to obtain homogeneous solution of NaOH.



Scheme 1. How to prepare solutions from solid

2. Preparation of solution from liquid : This is how to make a chemical solution through dilution method. We need to calculate the volume of the starting solution required using with the equation :

$$C_i \,.\, V_i = C_f \,.\, V_f \rightarrow V_i = \frac{C_f \,.\, V_f}{C_i}$$

Question : Calculate and describe how to prepare 100 ml of 0.1 mol/L hydrochloric acid HCI from concentarted HCl solution ?

- Read the information on the concentrated HCl(commercial); the density is 1.18, the purity rate is 37%, and the molar mass is 36.5 g/mol.
- Calculate the mass of the concentrated HCl.

We have d= 1.18 so ρ=1.18 Kg/L **i.e.** one L of HCI weighs 1180 g.

- Determine the amount of pure concentrated HCl in grammes.

$$m_{HCl}(\text{Concentrated}) = \frac{1180 \times 37}{100} = 436.6\ (\text{g})$$

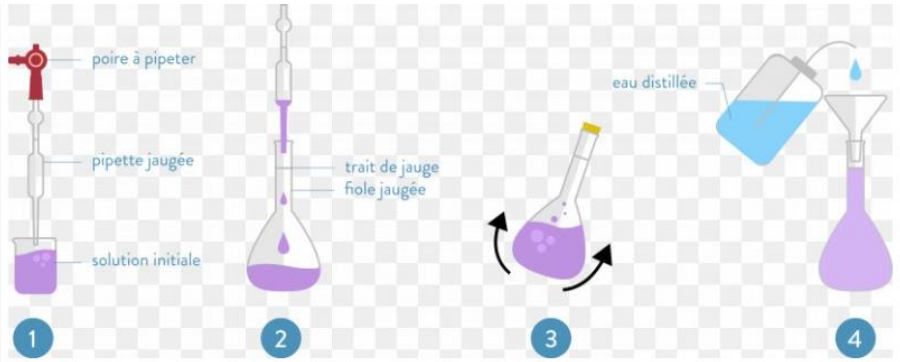
- Determining the concentration of concentrated HCl.

$$C_{HCl} = \frac{n_{HCl}}{V} = \frac{m_{HCl}}{M_{HCl}.V} = \frac{436.6}{36.6 \times 1} = 11.96\ (\frac{\text{mol}}{\text{L}})$$

- Calculating the volume required of concentrated HCl to prepre the needed solution

$$V_{HCl} = \frac{C_f \,.\, V_f}{C_{HCl}} = \frac{0.1 \times 100}{11.96} = 0.83\ (\text{ml})$$

- Fill a clean 100 mL volumetric flask at third of it with water.
- Take out 0.83 mL of concentrated HCl using the graduated pipette.
- Transfer it to the volumetric flask.
- Completely fill the volumetric flask with distilled water to the measuring line.
- Close the volumetric flask, then mix to obtain homogeneous solution of HCl.



Scheme 2. How to prepare solutions through dilution

<u>We give</u>

KOH: (%=85 - M=56.11g/mol)

H_2SO_4 : (M = 98 g/mol – d = 1,18 - % = 96)

CH_3COOH: (M = 60 g/mol – d = 1.05 - % = 99)