**Practical work N°2.** Preparation of aqueous 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.

| | |
|---|---|
| Molarity | $C_M = \frac{n_{solute}}{V_{solution}} \ (\frac{mol}{L})$ |
| Mass concentration | $T = \frac{m_{solute}}{V_{solution}} \ (\frac{g}{L})$ |
| Normality | $C_N = \frac{n_{eq.g}}{V_{solution}} \ (\frac{eq.g}{L})$ |
| 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. Both 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. (HCI : Z = 1) - ($H_2SO_4$: Z = 2).
- **For base :** Z is the number of hydroxides – $OH^-$ that the base can lose (NaOH : Z=1 ; $BaOH_2$ : Z=2)
- **For oxidation and reduction:** Z is the number of transferred electrons.
  $[MnO_4^- + 5e^- + 8OH^- \; Mn^{2+} + 4H_2O]$: Z = 5
- **For salts:** Z is the number of metal atoms in its valence.
  $[Al_2(SO_4)_3 \; 2Al_3^+ + 3SO_4^{2-}]$ : Z = 2 × (+3) = 6

**Objective of the experiment**

1. To identify and use the equipment and tools required for preparing solutions.
2. To prepare a sodium hydroxide (NaOH) solution by dissolution.
3. To dilute a hydrochloric acid (HCl) solution.

**Materials and Chemicals**

| **Materials** | **Chemicals** |
|---|---|
| • Graduated pipette or graduated cylinder<br>• Volumetric flask<br>• Spatula - Watch Glass - Funnel<br>• Analytical balance | • Distilled water<br>• Hydrochloric acid (HCI)<br>• Sodium hydroxide (NaOH) |

**Procedure**

1. **Preparation of solution from a solid:**

This section describes how to prepare a chemical solution using a solid dissolved in a liquid. We need to calculate the mass of the solid required using the equation: $\mathbf{m = C_M . M . V}$

**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.

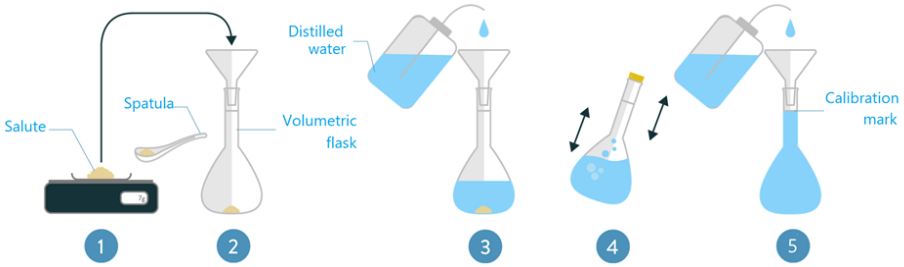
$$C_M = \frac{n}{V} = \frac{m}{M.V} \rightarrow m = C_M . M . V$$

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

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

- 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 a liquid:**

This section explains how to prepare 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.

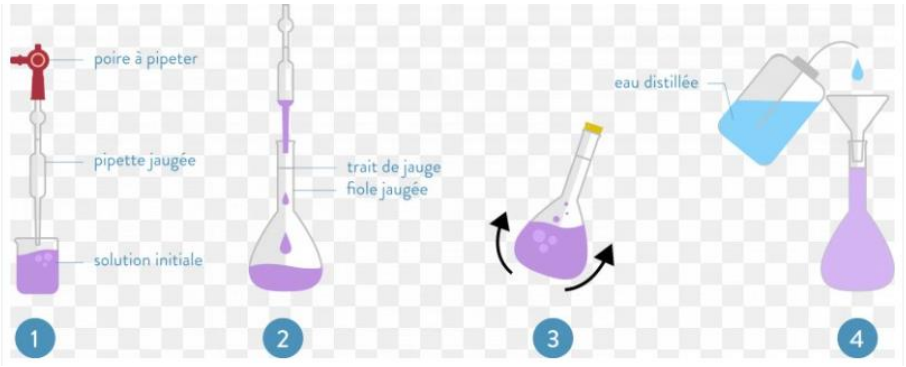
$$C_{HCl} = \frac{n_{HCl}}{V} = \frac{m_{HCl}}{M_{HCl}.V} = \frac{436.6}{36.6 \times 1} = 11.96\ (\frac{\text{mol}}{\text{L}})$$

- 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

**Given**

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

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

$CH_3COOH$: (M = 60 g/mol - d = 1.05)