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.

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. 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. (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. 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 and Chemicals

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

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.

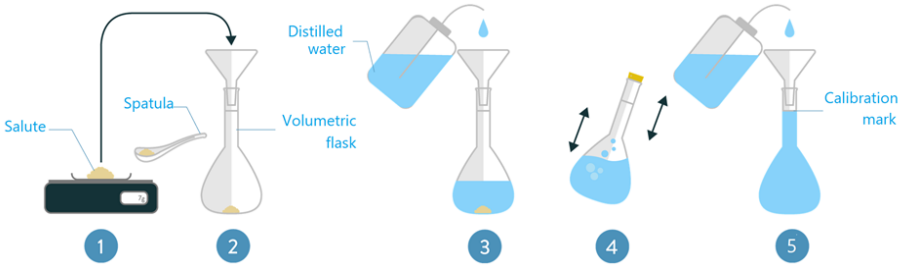
$$C_M = \frac{n}{V} = \frac{m}{M.V} \rightarrow m = C_M.M.V$$

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

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

- 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 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.

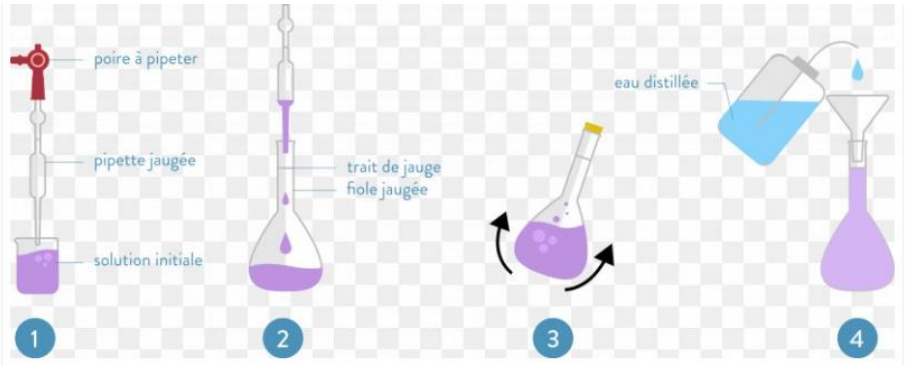
$$C_{HCl} = \frac{n_{HCl}}{V} = \frac{m_{HCl}}{M_{HCl}.V} = \frac{436.6}{36.6 \times 1} = 11.96\ \left(\frac{\text{mol}}{\text{L}}\right)$$

- 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

Answer the questions

Calculate and describe how to prepare the following solutions :

1. 100 mL of 0.1 M KOH using solid KOH.
2. 200 ml of 0.25N (eq.g/L) H_2SO_4 using concentrated H_2SO_4
3. 250 ml of a 0.3 M CH_3COOH from 0.5 M CH_3COOH.

We give

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 - % = 99)