



Ministry of Higher Education
and Scientific Research
Alrasheed college university
Pharmacy department

Lecture (1)

- Definition of the analytical chemistry
- Methods for expressing the concentration of solutions
- Density and the specific gravity

Analytical chemistry:-

Analytical chemistry is often described as the area of chemistry responsible for characterizing the composition of matter, both qualitatively (what is present) and quantitatively (how much is present).

Analytical chemistry involves separating, identifying and determining the relative amounts of the components in a sample of matter. Chemical analysis is divided into two types:

- ✓ **Qualitative analysis** reveals the identity of the elements and compounds in a sample.
- ✓ **Quantitative analysis** indicates the amounts of each substance in a sample.



Quantitative methods are classified according to the nature of final measurements to:

1. **Gravimetric methods** determine the mass of the analyte.
2. **Volumetric methods** determine the volume of solution containing sufficient reagent to react completely with the analyte is measured.
3. **Electroanalytical methods** involve the measurements of such electrical properties as voltage, current, resistance and quantity of electrical charge.
4. **Spectroscopic methods** are based on measurement of the interaction between electromagnetic radiation and analyte atoms or molecules or on the production of such radiation by analyte.

Notes

n_{mol} = number of moles , V =volume (L) , $M.\text{mass}$ =molar mass (g mol^{-1}),
 $\text{mol}=10^3 \text{ mmol}$, Liter (L) = 10^3 milliliter (mL).

Base quantity	Base unit	name
mass	g	gram
volume	L	liter
Amount of substance	mol	mole
density	Kgm^{-3}	Kilograms per cubic meter
concentration	Mol.L^{-1}	Mole per liter
Molecular weight	g mol^{-1}	Gram per mol

- **mole (mol):** is Avogadro's number (6.02×10^{23}) of particles (atoms, molecules, ions)

$$\text{number of mole} = \frac{\text{mass}}{\text{molar mass}}$$

- **Molecular mass (M.mass)** is the sum of the atomic mass of all the atoms in the molecular formula of the compound.

$$\text{M.wt}_{xy} = (n_x \times \text{A.mass}_x) + (n_y \times \text{A.mass}_y)$$

A.mass =Atomic mass, n= number of atoms.

Methods for expressing the concentration of solutions

The concentration of solutes in solution is expressed in several ways. The most important ways are:

1. **Molarity and Molar solution:** Symbol (**M**)

Molarity (M) is the number of moles of solute per liter of solution. Molarity has the dimensions of mol L^{-1} .

$$M = \frac{n \text{ mol}}{\text{Vol (L)}}$$

$$n \text{ mol} = \frac{\text{mass}}{M \text{ mass}}$$

$$M = \frac{\text{mass}}{M \text{ mass}} \times \frac{1000}{\text{Vol (L)}} \iff \text{mass} = \frac{M \times M \text{ mass} \times \text{Vol (L)}}{1000}$$



Example 1:-

Describe the preparation of 500 mL of 0.1M NaOH solution. (A.mass of Na=23, H=1, O=16)

Solution:

$$M.\text{mass}_{\text{NaOH}} = (n_{\text{Na}} \times A.\text{mass}_{\text{Na}}) + (n_{\text{H}} \times A.\text{mass}_{\text{H}}) + (n_{\text{O}} \times A.\text{mass}_{\text{O}})$$

$$M.\text{mass}_{\text{NaOH}} = (1 \times 23) + (1 \times 1) + (1 \times 16) = 23 + 1 + 16 = 40 \text{ g mol}^{-1}$$

$$\text{mass} = \frac{M \times M.\text{mass} \times V(\text{mL})}{1000} \longrightarrow \text{mass} = \frac{0.1 \times 40 \times 500}{1000} \longrightarrow \text{mass} = 2 \text{ g}$$

Dissolve 2 g of NaOH in water and dilute to 500 mL.



Example 2:-

Calculate the number of moles and molarity of methanol in an aqueous solution that contains 2.4 g of CH_3OH in 2 L of solution. (A.mass of C=12, H=1, O=16).

Solution:

$$\text{M.mass}_{\text{CH}_3\text{OH}} = (n_{\text{C}} \times \text{A.mass}_{\text{C}}) + (n_{\text{H}} \times \text{A.mass}_{\text{H}}) + (n_{\text{O}} \times \text{A.mass}_{\text{O}})$$

$$\text{M.mass}_{\text{CH}_3\text{OH}} = (1 \times 12) + (4 \times 1) + (1 \times 16) = 32 \text{ g mol}^{-1}$$

$$n_{\text{mol}} = \frac{\text{mass}}{\text{M.mass}} = \frac{2.4 \text{ g}}{32 \text{ g mol}^{-1}} = 0.075 \text{ mol CH}_3\text{OH}$$

$$M = \frac{n_{\text{mol}}}{V(\text{L})} = \frac{0.075 \text{ mol}}{2 \text{ L}} = 0.0375 \text{ mol L}^{-1}$$



Example 3:-

Exactly 4.57 g of $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$ (244 g mol^{-1}) are dissolved in sufficient water to give 250 mL of solution. Calculate the molar concentration of $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$

Solution:

$$M = \frac{\text{mass}}{\text{M.mass}} \times \frac{1000}{V(\text{mL})}$$

$$M = \frac{4.57 \text{ g}}{244 \text{ g mol}^{-1}} \times \frac{1000 \text{ ml L}^{-1}}{250 \text{ ml}} = 0.0749 \text{ mol L}^{-1} \text{ BaCl}_2 \cdot 2\text{H}_2\text{O}$$



Thank you