



**Republic of Iraq  
Ministry of Higher Education & Scientific research  
Al-Mustaql University  
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**Analytical Chemistry**

**For  
First Year Student  
Lecture 3**

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## The relationship between molarity, normality and part per million

$$1- \text{ppm} = M \times M.wt \times 1000$$

$$2- \text{ppm} = N \times M.wt \times 1000$$

**Example :** (a) Calculate the molar conc. of 1.0 ppm solutions each of  $\text{Li}^+$  and  $\text{Pb}^{+2}$ . (b) What weight of  $\text{Pb}(\text{NO}_3)_2$  will have to be dissolved in 1 liter of water to prepare a 100 ppm  $\text{Pb}^{+2}$

solution:

$$M = \frac{\text{ppm}}{m.wt \times 1000}$$

$$M_{\text{Li}^+} = \frac{1.0}{6.94 \times 1000} = 1.44 \times 10^{-4} \text{ mole/L}$$

$$M_{\text{Pb}^{+2}} = \frac{1.0}{207 \times 1000} = 4.83 \times 10^{-6} \text{ mole/L}$$

$$M = \frac{100}{207 \times 1000} = 4.83 \times 10^{-4} \text{ mole/L}$$

$$M = \frac{wt}{m.wt} \times \frac{1000}{V \text{ mL}}$$

$$4.83 \times 10^{-4} = \frac{wt}{283.2} \times \frac{1000}{1000}$$

$$\text{Wt} = 0.137 \text{ g pb}(\text{NO}_3)_2$$

**Example:** The concentration of Zinc ion ( $\text{Zn}^{+2}$ ) in blood serum is about (1 ppm). Express this as meq/L.

Q1:- Calculate the molar concentration of 1 ppm solutions of each of the following?

a) AgNO<sub>3</sub> b) Al<sub>2</sub>(SO<sub>4</sub>)<sub>3</sub> c) CO<sub>2</sub> d) HClO<sub>4</sub>

Q2: Calculate the ppm conc. Of  $2.5 \times 10^{-4}$  M solutions of each of the following ?

a) Ca<sup>+</sup><sub>2</sub> b) CaCl<sub>2</sub> c) HNO<sub>3</sub> d) KCN

**Molarity concentration for solution prepared from dissolved liquid solute in liquid solvent.**

$$M = \frac{\% \times \text{density} \times 1000}{M.wt} = \frac{\% \times \text{sp.gr} \times 1000}{M.wt}$$

Notice -The Specific gravity (sp. gr.) its without unit.

**Density:** is the weight per unit volume at the specified temperature, usually (gm/mL) or (gm/cm<sup>3</sup>) or (gm.cm<sup>-3</sup>) in 20C (is the ratio of the mass in (gm) and volume (mL)).

Example :Calculate the molarity of 28.0% NH<sub>3</sub>, specific gravity 0.898.

Solution:

$$\text{M.wt NH}_3 = 14 + (3 \times 1) = 17 \quad M = \frac{\% \times \text{density} \times 1000}{M.wt}$$

$$M = \frac{\frac{28}{100} \times 0.898 \times 1000}{17}$$

$$M = 16.470 \text{ mmol mL}^{-1} = 16.470 \text{ M}$$

**Diluting Solutions:** We often must prepare dilute solutions from more concentrated stock solutions. For example ,we may prepare a dilute HCl solution from concentrated HCl to be used for titration .Or ,we may have a stock standard solution from which we wish to prepare a series of more dilute standards. The

millimoles of stock solution taken for dilution will be identical to the millimoles in the final diluted solution.

$$M_{\text{stock}} \times V_{\text{stock}} = M_{\text{diluted}} \times V_{\text{diluted}}$$

**Example:** What is the molarity and normality of a 13.0% solution of  $\text{H}_2\text{SO}_4$ ? To what volume should 100 ml of acid be diluted in order to prepare a 1.50 N solution?

Solution: From specific gravity table in the appendix, the specific gravity of the acid is 1.090.

$$M = \frac{\% \times \text{sp. gr} \times 1000}{M. \text{wt}}$$

$$\frac{0.13 \times 1.09 \times 1000}{98}$$

$$M = 1.45 \text{ M}$$

$$M_1 \times V_1 = M_2 \times$$

$$2.90 \times 100 = 1.50 \times V_2$$

$$V_2 = 193 \text{ mL}$$

## p- Functions

Scientists frequently express the concentration of a species in terms of its p-function, or p-value. The p-value is the negative logarithm (to the base 10) of the molar concentration of that species. Thus, for the species X,

$$pX = -\log [X]$$

As shown by the following examples, p-values offer the advantage of allowing concentrations that vary over ten or more orders of magnitude to be expressed in terms of small positive numbers

**Example :** Calculate the p-value for each ion in a solution that is  $2.00 \times 10^{-3}$  M NaCl and  $5.4 \times 10^{-4}$  M in HCl.

Solution:



$$\text{pH} = -\log [\text{H}^+] = -\log (5.4 \times 10^{-4}) = 3.27$$

$$\text{pNa} = -\log (2.00 \times 10^{-3}) = -\log 2.00 \times 10^{-3} = 2.699$$

$$\begin{aligned} [\text{Cl}^-] &= 2.00 \times 10^{-3} \text{ M} + 5.4 \times 10^{-4} \text{ M} \\ &= 2.00 \times 10^{-3} \text{ M} + 0.54 \times 10^{-3} \text{ M} = 2.54 \times 10^{-3} \text{ M} \\ \text{pCl} &= -\log 2.54 \times 10^{-3} \text{ M} = 2.595 \end{aligned}$$

**Example :** Calculate the molar concentration of Ag<sup>+</sup> in a solution that has a pAg of 6.372.

solution:

$$\text{pAg} = -\log [\text{Ag}^+] = 6.372, \log [\text{Ag}^+] = -6.372$$

$$[\text{Ag}^+] = \frac{-6.372}{\log} = \text{Log}^{-1} (-6.372) = 4.246 \times 10^{-7} = 4.25 \times 10^{-7} \text{ M}$$