Republic of Iraq
Ministry of Higher Education & Scientific research
Al-Mustaqbal University
Science College
Medical physics Department

Analytical Chemistry

For

First Year Student

Lecture 3

By

Dr. Karrar M. Obaid

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The relationship between molarity, normality and part per million

1- ppm= M×M.wt×1000

2- ppm= N×M.wt×1000

Example :(a) Calculate the molar conc. of 1.0 ppm solutions each of Li^{+} and Pb^{+2}.(b) What weight of $Pb(NO_3)_2$ will have to be dissolved in 1 liter of water to prepare a 100 ppm Pb^{+2}

solution:

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

$$MLi+= \frac{1.0}{6.94 \times 1000} = 1.44 \times 10-4\ mole/L$$

$$Mpb = \frac{1.0}{207 \times 1000} = 4.83 \times 10-6\ mole/L$$

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

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

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

Wt= 0.137g $pb(NO_3)_2$

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

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

a) AgNO3 b) $Al_2(SO_4)_3$ c) CO_2 d) $HClO_4$

Q2: Calculate the ppm conc. Of 2.5×10^{-4} M solutions of each of the following ?
a) Ca^{+2} b) $CaCl_2$ c) HNO_3 d) KCN

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

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

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^3) or ($gm.cm^{-3}$) in 20C (is the ratio of the mass in (gm) and volume (mL).

Example :Calculate the molarity of 28.0% NH3, specific gravity 0.898.

Solution:

M.wt NH_3=14+(3×1)=17 $M = \frac{\% \times \mathbf{density} \times \mathbf{1000}}{\boldsymbol{M.wt}}$

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

M= 16.470mmol mL =16.470 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.

$$\mathbf{Mstock \times Vstock = Mdiluted \times Vdiluted}$$

Example: What is the molarity and normality of a 13.0% solution of H_2SO_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.

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

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

M=1.45 M

$\mathbf{M_1 \times V_1 = M_2 \times}$

$\mathbf{2.90 \times 100 = 1.50 \times V_2}$

$\mathbf{V_2 = 193\ mL}$

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,

$$\mathbf{pX = -\log [X]}$$

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 X 10^{-3} NaCl and 5.4 X 10^{-4} M in HCl.

Solution:

$NaCl \longrightarrow Na^{+} + Cl^{-}$, $HCl \longrightarrow H^{+} + Cl^{-}$

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

pNa = -log (2.00 × 10-3) = -log 2.00 × 10^{-3} = 2.699

[Cl-] = 2.00 × 10^{-3} M + 5.4 × 10^{-4} M

=2.00 × 10^{-3} M + 0.54 × 10^{-3} M = 2.54 × 10^{-3} M

pCl = -log 2.54 × 10^{-3} M = 2.595

Example : Calculate the molar concentration of Ag+ in a solution that has a pAg of 6.372.

solution:

pAg = -log [Ag+] = 6.372, log [Ag+] = - 6.372

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