Preparing Solutions

Preparing a solution of known concentration is perhaps the most common activity in any analytical lab. Two methods for preparing solutions are described in this section. A ***stock solution*** is prepared by weighing out an appropriate portion of a pure solid or by measuring out an appropriate volume of a pure liquid and diluting to a known volume.

Preparing Solutions by Dilution

Solutions with small concentrations are often prepared by diluting a more concentrated stock solution. A known volume of the stock solution is transferred to a new container and brought to a new volume.

Methods for the expression of concentration

1-Mole: Symbol (mol)

Is defined as the quantity of given substance that contains as many molecules for formula units as the number of atoms in exactly

Number of moles for compounds = $\frac{\text{weight}}{\text{Molecular weight}}$

Note: Molecular weight of compounds is the sum of the atomic weight of all the atoms in the molecular formula of the compounds

For example: number of moles of $(NH_2)_2CO$ = $\frac{\text{weight}}{(14+(2x1))x2+12+16}$

Number of moles of ion = $\frac{\text{wt}}{\text{Ionic weight}}$, for SO4 = $\frac{\text{weight}}{32+(4x16)}$

Number of moles of element = $\frac{\text{wt}}{\text{Atomic weight}}$, Ag = $\frac{\text{wt}}{108}$

2-Molarity: symbol (M)

When we dissolve a substance in a liquid, we call the substance (solute) and the liquid (solvent), so the molarity of solution defines the number of gram-molecular weight (or) moles of solute dissolved in 1 liter of solution, or the number of millimolecular weight in 1 millimeter of solution

$$M = \frac{number\ of\ moles\ of\ solute}{volumeof\ solution\ in\ liter}$$

$$Number\ of\ moles = \frac{wt}{M.wt}$$

For solid sustances

Thus : $M = \frac{wt}{Mwt} x \frac{1000}{Vol\ ml}$

Notes: (wt) means weight in gram unit (gm)

(vol) means volume of solution in milliter unit (ml)

For liquid substances

Also $M = \frac{Density\ or\ specific\ gravity\ x\ percentage\ x1000}{M.wt}$

Example: 1

What is the molarity of a solution containing (16 gm) CH3OH in 200 ml of solution? M.wt =32.

Sol.

M=$\frac{wt}{M\ wt}$ x $\frac{1000}{Vol}$

=$\frac{16}{32}$x $\frac{1000}{200}$

=2.5 mol/L

Example:2

Calculate the molarity of H2SO4 solution of specific gravity 1.198 , containing 27 % H2SO4 by by weight ?

At.wt. of H=1 , S=32 , O=16 .

Sol.

M.wt of H2So4 = (2x1)+32 +(4x16)=98 gm/mol

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

$$=\frac{1.198 \times 0.27 \times 1000}{98}$$

=3.3 mol/L

3- Normality: symbol (N)

The normality of a solution expresses the number of milliequivalents of solute contained in 1 ml of the solution, or the number of gram equivalents contained in 1 liter.

$$N=\frac{number\ of\ gram-equivalent\ weight\ of\ solute}{Volume\ of\ solution\ in\ liters}$$

Number of gram-equivalent weight = $\frac{wt}{eq.wt}$

Note: (eq.wt) means equivalent weight. (Its unit is $\frac{gm}{gm.m.eq}$)

So, for solid substances

$$N=\frac{wt.(gm)}{eq.wt} \text{ x } \frac{1000}{vol.(ml)}$$

And, for liquid substances

$$N=\frac{specific\ gravity\ or\ density \times \% \times 1000}{eq.wt.}$$

Example :1

How many gram-equivalent of solute are contained in 0.5L of 0.2 N solution?

Sol.

$$N= \frac{number\ of\ gram-equivalent\ weight\ of\ solute}{Volume\ of\ solution\ in\ liters}$$

$0.2= \frac{x}{0.5}$ = 0.1 gm. Equivalent of solute

Example: 2

How many grams of solute are required to prepare 1 liter of 1N solution of NaCl , M.wt = 58.45 ?

Sol.

$$N=\frac{wt.(gm)}{eq.wt} \times \frac{1000}{vol.(ml)}$$

=58.45 gm.

Note: $N=n \times M$

Which, N=Normality

n= Valence number or equivalence number *

M=Molarity

*Valence number of an element is the number of atoms of hydrogen (or its equivalent) which one atom of the element combines with or displaces. So, in NaCl: M.wt =eq.wt

But in H2SO4: eq.wt= M.wt/2 because there are 2 hydrogens (protons) which displaces

Example3

What will be the normality of 3 molar solution of calcium hydroxide $Ca(OH)_2$?

Solution: $M=\frac{N}{n} = \frac{3}{2}$ = 1.5 N

Calculation of n:

HCl=1 , H_2SO4=2 , H_3PO4=3, NaOH =1, $Ca(OH)_2$=2 , $Al(OH)_3$ =3, $CaCl_2$=2, Na_2SO4=2 , Na_2CO3=2, CaSO4=2

4-Percentage concentration:

The percentage composition of a solution can be expressed in several ways. Three of the common methods are defined as follows:

Weight percent $=\frac{weight\ of\ solute}{weight\ of\ solution}$ x100

Volume percent = $\frac{volume\ of\ solute}{volume\ of\ solution}$ x100

5-parts per million concentration :

For much diluted solution, the concentration is more conveniently expressed is part per million (ppm). This term is defined by equation:

ppm = $\frac{weight\ of\ solute\ (g)}{total\ weight\ of\ solution\ (g)}$ x 10^6 or mg/L

ppm = $\frac{volume\ of\ solute\ (ml)}{total\ volumeof\ solution\ (ml)}$ x 10^6

Thus, an aqueous solution containing 0.0003 % nickel by weight contains 3ppm of nickel by weight. How?

0.0003% means 0.0003 gm solute in 100gm solution.

So, ppm = $\frac{weight\ of\ solute}{weight\ of\ solution}$ x 10^6

= $\frac{0.0003}{100}$ x 10^6

=3 ppm

The relation between (ppm) and (molarity) is

ppm= molarity x molecular weight x 1000

The relation between (ppm) and (normality) is:

ppm = normality x equivalent weight x 1000