The express of the concentration for a solutions

The concentration of a solution can be expressed by the following ways.

1. Mass (weight) Percent (w/w %)

Is the mass of the solute in grams per grams of the solution.

Weight percent = (grams solute / grams solution) x **100%**

Ex: What is the weight percent of hydrogen in water?

Solution:

Hydrogen mass = 1grams per mole
oxygen mass = 16 grams per mole

Here the calculation correctly is to note there are 2 atoms of hydrogen in each water molecule. So, in 1 mole of water there are 2 x 1 grams of hydrogen. The total mass of the compound is the sum of the mass of the two hydrogen atoms and one oxygen atom.

Weight percent = (grams solute / grams solution) x 100
weight percent hydrogen = [(2 x 1) / (2 x 1+ 16.00)] x 100
weight percent hydrogen = (2/18) x 100
weight percentage hydrogen = 11.11%

H.W: Find the masses of sodium chloride and water required to obtain 175 g of a 15% solution.

-Answer = 26.25g , 148.75 g

2. Volume percent (v/v %)

Is the number of units of volume of the solute per the volume of solution.

Volume percent = (volume of solute / volume of solution) x 100%

Ex: Calculate the volume/volume percent solution formed by combining 25 milliliters of ethanol with enough water to make 200 milliliters of solution.

Solution:

Volume of solute = 25 mL
Volume of solution = 200 mL
Volume percent = (volume of solute / volume of solution) x 100%
Volume percent = 25mL / 200mL ×100%
Volume percent = 12.5%

H.W: If 6.3mL of acetone are dissolved in a water solution such that the total volume of solution is 500.0mL, what is the concentration of the acetone expressed as a volume percent?

-Answer = 1.26%

3. Weight / Volume percent (w/v %)

Is the mass of the solute in grams per the volume of solution.

Weight / Volume percent = (weight of solute / volume of solution) x **100%**

Ex: What is the concentration in percent weight/volume of 150 mL of solution containing 30 g of solute?

Solution

Weight of solute = 30 g

Volume of solution = 150 mL

Weight / Volume percent = (weight of solute / volume of solution) x 100%

Weight / Volume percent = 30 g / 150 mL ×100%

Weight / Volume percent = 20%

H.W: What volume of a 40 % W/v solution contains 70 g of solute?

-Answer = 175 mL

4. Molarity(M)

Is defined as the number of moles of solute dissolved per liter (dm3) of the solution. It is denoted by the symbol **M** . Measurements in Molarity can change with the change in temperature.

Molarity = number of mole (mol) of solute / volume (L) of solution.

Number of mole (mol) = weight (g) / molecular weight ($g.mol^{-1}$).

Ex: What is the molarity of 245 g of H_2SO_4 dissolved in two liter of solution?

Solution

Number of mole = weight / molecular weight

molecular weight (M.wt) H_2SO_4= 2(1) + 1(32) + 4(16)

= 2 + 32 + 64 = 98 $g.mol^{-1}$

Number of mole = 245 g / 98 $g.mol^{-1}$, Number of mole = 2.5 mol
Molarity = number of mole (mol) of solute / volume (L) of solution
= 2.5 mol / 2 L , Molarity= 1.25 $mol . L^{-1}$

5. Normality (N)

Is defined as the number of mole equivalents per liter of solution. It is denoted by the symbol **N** .

Normality = number of mole equivalents(Eq.Wt) / volume(L) of solution

Number of mole equivalents (Eq.Wt) = molecular weight ($g.mol^{-1}$)/ the mole equivalents (n)

The mole equivalents (n= mole equivalents) calculated by determining the number of

- **A.** For acid-base reactions, 1 equivalent = 1 mole of hydrogen ions or 1 mole of hydroxide ion donated.
- **B.** For oxidation-reduction reactions, 1 equivalent = 1 mole of electrons .(number of Gained electron in the reduction or lose electron in the oxidation)
- **C.** For salts, 1 equivalent = 1 mole of charge. (number of metal per the equivalence number

Example for The mole equivalents (n)

1- $H_3PO4 + 2NaOH \longrightarrow Na_2HPO4 + 2H_2O$ n=2

2- $MnO_4^- + 8H^+ + 5e \longrightarrow Mn^{2+} + 4H_2O$ n=5

3- AgCl n=1 , Ag_2CrO_4 n=2 , $Al_2(CO_4)_3$ n=6

Relation between Normality (N) and Molarity(M)

Normality(N) = Molarity(M) x number of equivalents (n)

E x: What is the normality of 1 M H_2SO_4 in the following reaction?

$$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$$

Solution

In this reaction, 2 moles of H^+ ions (2 equivalents) from sulfuric acid (H_2SO_4) react with NaOH to form sodium sulfate and water.

Normality (N) = Molarity(M) x number of equivalents (n)

N= 1 x 2 , N = 2

H.W: What is the Normality of 2 M H_3PO_4 in the following reaction?

$$H_3PO_4 + 2NaOH \rightarrow Na_2HPO_4 + 2H_2O$$

-Answer = 4 N

H.W: What is the Normality of Aluminium sulfate ($Al_2(SO4)^3$) dissolved in 1.5 liter of solution? M.Wt of ($Al_2(SO4)^3$) =342.15 g/mol

-Answer = 38 N