

Analytical Chemistry

1<sup>st</sup> Class

**IV. Molality (m):** It is number of moles of solute in kilogram of solvent.  
Or no. of millimoles of solute in (g) of solvent.

$$m = \frac{W \times 1000}{M.wt. \times W \text{ solvent kg}}$$

In dilute aqueous solution:

$$M = m$$

Weight of solution = Weight of solvent = Volume of solution

**Molar Fraction (X):**

It's the ratio between numbers of solute moles to number of moles of all solution contains.

$$\text{Mole of Fraction of Solute}(X) = \frac{\text{no. moles of (solute)}}{\text{no. moles of (solution)}}$$

*no. of moles of solution = no. of solute moles + no. of solvent moles*

$$\text{Mole of Fraction of solvent}(X) = \frac{\text{no.moles of (solvent)}}{\text{no.moles of (solution)}}$$

$$X_{\text{solute}} + X_{\text{solvent}} = 1$$

**Ex.:** Calculate the mole fraction of 5.8g acetone solution



$$\text{Mole of Fraction of Solute}_{\text{Acetone}}(X) = \frac{\text{no.moles of (solute)}}{\text{no.moles of (solution)}}$$

$$\begin{aligned} \text{Moles (solute)} &= \frac{\text{Wt.}}{\text{M.wt.}} \\ &= \frac{5.8 \text{ g}}{(3 \times 12) + (1 \times 16) + (6 \times 1) = 58 \text{ g/mol}} \end{aligned}$$

$$\text{Mole}_{(\text{solute})} = 0.1 \text{ mole}$$

$$\text{Mole}_{(\text{solvent})} = \frac{90}{18} = 5 \text{ mole}$$

$$\text{no.of solution moles} = 5.0 + 0.1 = 5.1 \text{ mole}$$

$$\text{Mole Fraction of Solute} = \frac{\text{no.moles of (solute)}}{\text{no.moles of (solution)}}$$

$$X_{\text{solute}} = \frac{0.1}{5.1}$$

$$X = 0.0196$$

$$\text{Mole Fraction of Solvent} = \frac{5.0}{5.1}$$

$$X = 0.9804$$

$$\begin{aligned}\text{Total Mole Fraction} &= 0.9804 + 0.0196 \\ &= 1.0\end{aligned}$$

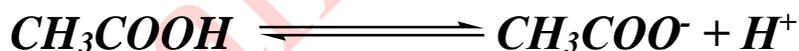
## ***Aqueous Solution and Chemical Equilibria***

***Electrolysis:*** are solutes which are ionized in solution to produce an electrically conducting medium. There are two types of electrolytes.

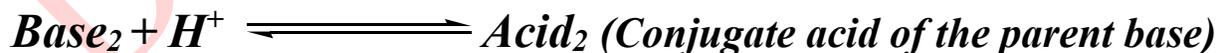
***Strong electrolytes:*** the compounds which are completely ionized or dissociate in solution.



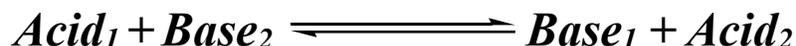
***Weak electrolytes:*** the compounds which are partially dissociate in Solution.



## ***Conjugate Acids and Bases***



The result in an acid /base or neutralization reaction :

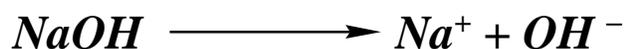


A conjugate acid: is formed when a base accepts a proton.

A conjugate base: is formed when an acid loses a proton.

e.g. acetate ion is conjugate base of acetic acid.

### ***Neutralization Reaction:***



$NH_3$ ,  $NH_4^+$  are conjugate pair.

### ***Chemical Equilibrium***

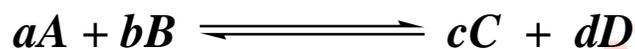
Many reaction used in analytical Chemistry never result in complete conversion of reactants to products.

Instead, they proceed to a state of chemical equilibrium that describe the concentrations of reactants existing among reactants product is constant.

Equilibrium constant expressions are algebraic equation that describe the concentration relationships existing among reactants and products at equilibrium.

## ***Equilibrium- Constant Expressions:***

A generalized equation for a chemical equilibrium is:



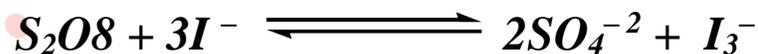
where the capital letters represent the formulas of participating chemical species and the lower case are the small whole numbers required to balance the equation.

A,b,c,d = mole of A,B,C,D.

The equilibrium –constant expression of the above reaction is :

$$K_{eq.} = \frac{[C]^c [D]^d}{[A]^a [B]^b}$$

***Ex. 1. :***



***H.W***

***Ex.2***

Calculate the concentration of each of A,B of equilibrium state of 0.1 M AB solution (AB: weak electrolyte).  $K_{eq} = 3 \times 10^{-6}$ .

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