Science College/New&Renewable Energy Dep.

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Analytical Chemistry

1st 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.

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

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.

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

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

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

$$\textbf{\textit{X solute + X solvent = 1}}$$

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

$$CH_3-\overset{\overset{\large O}{\|}}{C}-CH_3$$

with 90g water? A.wt.: C = 12, O = 16, H = 1

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

Moles (solute) = $\frac{Wt.}{M.wt.}$

$$= \frac{5.8\ g}{(3\times12)+(1\times16)+(6\times1)=58g/mol}$$

$Mole_{(solute)}$ = 0.1 mole

$Mole_{(solvent)}$ = $\frac{90}{18}$ = 5 mole

no.of solution moles = 5.0 +0.1 = 5.1 mole

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

X solute = $\frac{0.1}{5.1}$

X = 0.0196

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

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$X = 0.9804$

Total Mole Fraction = 0.9804 + 0.0196

= 1.0

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.

$$HCl \rightarrow H^{+} + Cl^{-}$$

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

$$CH_3COOH \rightleftharpoons CH_3COO^{-} + H^{+}$$

Conjugate Acids and Bases

$$Acid_1 \rightleftharpoons Base_1 + H^{+} \quad \text{(Conjugate base of the parent acid)}$$

$$Base_2 + H^{+} \rightleftharpoons Acid_2 \quad \text{(Conjugate acid of the parent base)}$$

The result in an acid /base or neutralization reaction :

$$Acid_1 + Base_2 \rightleftharpoons Base_1 + Acid_2$$

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

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

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

Neutralization Reaction:

$$HCL + NaOH \longrightarrow NaCl + H_2O$$

$$HCl \longrightarrow H^+ + Cl^-$$

$$NaOH \longrightarrow Na^+ + OH^-$$

$$NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$$

Conjugated of NH_3 Conjugated base of H_2O

NH_3 , NH_4^+ are conjugate pain.

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.

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Equilibrium- Constant Expressions:

A generalized equation for a chemical equilibrium is:

$$aA + bB \rightleftharpoons cC + dD$$

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 :

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

Ex. 1. :

$$S_2O8 + 3I^- \rightleftharpoons 2SO_4^{-2} + I_3^-$$

H.W

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Ex.2

Calculate the concentration of each of A,B of equilibrium state of 0.1 M AB solution (AB: weak electrolyte). $K_{eq} = 3\times10^{-6}$.

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