ALMUSTAQBAL UNIVERSITY

College of Health and Medical Techniques

Medical Laboratories Techniques Department

Stage : First year students

Subject : Lecture 5A

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<u>Molality(m):</u> The number of moles of solute per kilogram of **solvent**.

انتبه هنا استخدم وزن المذيب وليس المحلول

(المولاليه =عدد مولات المذاب في الكيلوغرام من المذيب)

Solute = والمذاب   solution = المحلول و   solvent = المذيب

Example

Determine the molality of a solution prepared by dissolving 75 g of solid KNO_3 (101 g/mol) into 374 gm of water at 25°C.

<u>Solution:</u>

Molality(m) $= \frac{number\ of\ moles(solute) x\ 1000}{mass\ of\ solvent(gm)}$

No of moles(solute) $= \frac{wt}{M.wt} = \frac{75\ gm}{101\ g/mol}$ **= 0.743 moles**

Molality(m) $= \frac{number\ of\ moles(solute) x\ 1000}{mass\ of\ solvent(gm)} = \frac{0.743\ mol\ x\ 1000}{374\ gm}$

Molality(m) = 1.987

<u>Mole fraction:</u>

The number of moles of one component relative to the total number of moles of all components in the solution.

Mole fraction of component 1(x_1)= $\frac{\textbf{moles of component 1}(n_1)}{\textbf{moles of component 1 }(n_1)+\textbf{moles of component 2 }(n_2)}$

Mole fraction of component 2(x_2)= $\frac{\textbf{moles of component 1}(n_2)}{\textbf{moles of component 1 }(n_1)+\textbf{moles of component 2 }(n_2)}$

$X_1 + X_2 = 1$	$X_1 = 1 - X_2$	$X_2 = 1 - X_1$

$X1 = \frac{n1}{n1 + n2}$	$X2 = \frac{n2}{n1 + n2}$

Example:

Calculate the mole fraction for each of solute and solvent in a solution if the solute is (2 mole) and the solvent in (3 mole) .

Solution:

$$X_1 = \frac{n_1}{n_1+n_2} = \frac{2}{2+3} = \frac{2}{5} = 0.4$$

$$X_2 = \frac{n_2}{n_1+n_2} = \frac{3}{2+3} = \frac{3}{5} = 0.6$$

$X_1 + X_2 = 0.4 + 0.6 = 1$

For 3 components mixture we have X_1 , X_2 , and X_3 Then:

$$X_1 = \frac{n1}{n1+n2+n3}$$

$$X_2 = \frac{n2}{n1+n2+n3}$$

$$X_3 = \frac{n3}{n1+n2+n3}$$

<u>Example:</u> Calculate the mole fraction for each component in a mixture that contains 1mole of A , 2 moles of B and 3 moles of C .

Total No of moles n_T = moles of A (n_A) + moles of B (n_B) + moles of C (n_C)

$$n_T = n_A + n_B + n_C$$

$$n_T = 1 + 2 + 3 = 6 \text{ moles}$$

$$X_A = \frac{n_A}{n_T} = \frac{1}{6} = 0.17$$

$$X_B = \frac{n_B}{n_T} = \frac{2}{6} = 0.33$$

$$X_C = \frac{n_C}{n_T} = \frac{3}{6} = 0.5$$

$$X_T = \sum X_i = 1$$

$$X_T = X_A + X_B + X_C$$

$$X_T = 0.17 + 0.33 + 0.5 = 1$$

Exercise:

The mass of an aqueous solution that contains 7.45 g of KCl (74.5 g/mol) is 151.45 g . Calculate :

1. The molality of the solution.

2. The mole fraction of each of the solute(KCl) and solvent (H_2O)(18 g/mol).

P- fuctions:

$pX = -\log[X]$

Examples:

$pH = -\log[H_3O^+]$

$[H_3O^+] = 10^{-pH}$

$pOH = -\log[OH^-]$

$[OH^-] = 10^{-pOH}$

$pNa = -\log[Na^+]$

$pCl = -\log[Cl^-]$

Example:

Calculate the P-value of each ion in 1.76×10^{-3} M aqueous solution of Na_3PO_4 .

Solution:

$$Na_3PO_4 \longrightarrow 3Na^+ + PO_4^{3-}$$

1 mole	**3 mole**	**1 mole**
1.76×10^{-3}	**$3(1.76 \times 10^{-3})$**	**1.76×10^{-3}**

$[Na^+] = 3 \times 1.76 \times 10^{-3} = 5.28 \times 10^{-3}$ M

pNa^+ $= -\log[5.28 \times 10^{-3}] = 2.277$

$p(PO_4^{3-})$ $= -\log[1.76 \times 10^{-3}] = 2.754$

Note :

in case of $Na_2CO_3 \rightarrow 2Na^+ + CO_3^{2-}$ or $K_2CO_3 \rightarrow 2K^+ + CO_3^{2-}$

$NaCl \rightarrow Na^+ + Cl^-$ or $KCl \rightarrow K^+ + Cl^-$

Example:

Calculate the P-value of each ion in 1740 ppm aqueous solution of K_2SO_4 (174 g / mol).

Solution:

$$Molarity(M) = \frac{PPm}{Mwt\, x1000}$$

$$Molarity(M) of\ K2SO4\ solution = \frac{1740}{174\, x1000} = 0.01\ M$$

K_2SO_4	$\rightarrow$	$2K^+$	$+$	SO_4^{2-}
1 mole		2 mole		1 mole
0.01		2(0.01)		0.01

$[K^+] = 0.02$ M

$pK^+ = -\log(0.02) = 1.69$

$[SO_4^{2-}] = 0.01$ M

$pSO_4^{2-} = -\log(0.01) = 2$