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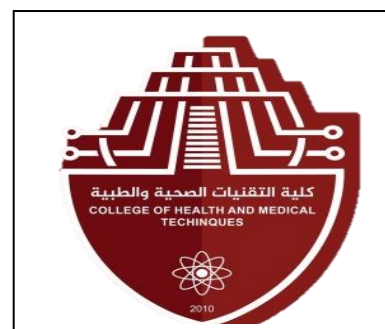
College of Health and Medical Techniques

Medical Laboratories Techniques Department

Stage : First year students

Subject : Lecture 5A

Lecturer: Assistant professor Dr. SADIQ . J. BAQIR



Molality(m): The number of moles of solute per **kilogram of solvent**.

انتبه هنا استخدم وزن المذيب وليس المحلول

(المولالية = عدد مولات المذاب في الكيلوغرام من المذيب)

Solute = والمذاب solution = والمحلول 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.

Solution:

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

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

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

$$\text{Molality(m)} = 1.987$$

Mole fraction:

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

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

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

$$X_1 + X_2 = 1$$

$$X_1 = 1 - X_2$$

$$X_2 = 1 - X_1$$

$X_1 = \frac{n_1}{n_1 + n_2}$	$X_2 = \frac{n_2}{n_1 + n_2}$
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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:

$$X_1 = \frac{n_1}{n_1 + n_2 + n_3}$$

$$X_2 = \frac{n_2}{n_1 + n_2 + n_3}$$

$$X_3 = \frac{n_3}{n_1 + n_2 + n_3}$$

Example: 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 (H₂O)(18 g/mol).

P- fuctions:

$$\text{pX} = -\log [\text{X}]$$

Examples:

$$\text{pH} = -\log[\text{H}_3\text{O}^+]$$

$$[\text{H}_3\text{O}^+] = 10^{-\text{pH}}$$

$$\text{pOH} = -\log[\text{OH}^-]$$

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

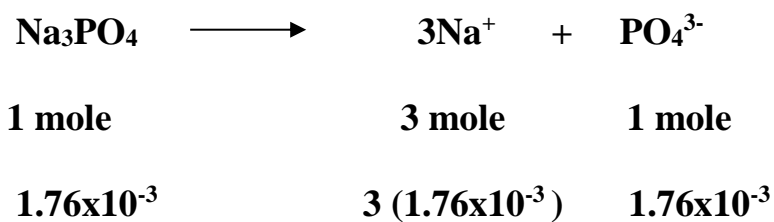
$$\text{pNa} = -\log[\text{Na}^+]$$

$$\text{pCl} = -\log [\text{Cl}^-]$$

Example:

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

Solution:



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

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

$$\text{p}(\text{PO}_4^{3-}) = -\log [1.76 \times 10^{-3}] = 2.754$$

Note :

in case of $\text{Na}_2\text{CO}_3 \rightarrow 2\text{Na}^+ + \text{CO}_3^{2-}$ or $\text{K}_2\text{CO}_3 \rightarrow 2\text{K}^+ + \text{CO}_3^{2-}$

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

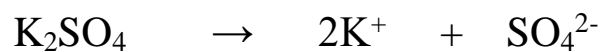
Example:

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

Solution:

$$\text{Molarity}(M) = \frac{PPm}{Mwt \times 1000}$$

$$\text{Molarity}(M) \text{ of } \text{K}_2\text{SO}_4 \text{ solution} = \frac{1740}{174 \times 1000} = 0.01 \text{ M}$$



1 mole 2 mole 1 mole

0.01 2(0.01) 0.01

$$[\text{K}^+] = 0.02 \text{ M}$$

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

$$[\text{SO}_4^{2-}] = 0.01 \text{ M}$$

$$\text{pSO}_4^{2-} = -\log(0.01) = 2$$