

ALMUSTAQBAL UNIVERSITY COLLEGE

Medical Labs Techniques Department

Stage : First year students

Subject :General chemistry 1 - Lecture 3

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Normality (N)

represents the number of milli equivalents of solute contained in one milliliter of solution or number of equivalents contained in one liter.

e.g: 0.2 N HCl contains 0.2 milli equivalent (meq) of HCl in each mL of solution or (0.2) equivalents (eq) in liter solution .

$$N = \frac{\text{number of equivalents(solute)}}{VL(\text{solution})}$$

$$\text{Number of equivalents(eq)} = \frac{wt (gm)}{eq.wt(gm)}$$

$$N = \frac{\frac{wt}{eq.wt}}{V(\text{liter})}$$

$$N = \frac{\frac{wt}{eq.wt}}{\frac{V(mL)}{1000}}$$

$$N = \frac{wt \times 1000}{eq.wt \times V(mL)}$$

Exercise: proof that $N = \frac{wt \times 1000}{eq.wt \times V(mL)}$

الجواب : نكتب الاشتقاق (الخطوات الاربعه اعلاه)

$$\text{Eq. wt} = \frac{Mwt}{\eta}$$

$$N = \frac{wt \times 1000}{\frac{Mwt}{\eta} \times V(mL)}$$

$$N = \frac{wt \times 1000}{Mwt \times V(mL) \times \eta}$$

$$N = \left(\frac{wt \times 1000}{Mwt \times V(mL)} \right) \eta$$

$N = \eta M , \text{ or } M = N / \eta$

e.g: Normality(N) of 1M KCl = $1 \times 1 = 1 \text{ N KCl}$,

Normality(N) of 1M HCl = $1 \times 1 = 1 \text{ N HCl}$,

Normality(N) of 1 M H₂SO₄ = $2 \times 1 = 2 \text{ N H}_2\text{SO}_4$,

Normality(N) of 1 M Na₂CO₃ = $2 \times 1 = 2 \text{ N Na}_2\text{CO}_3$

I. Equivalent mass in neutralization reaction:

A) Equivalent mass of acids (Eq):-

Is the mass that either contribute or reacts with one mole of hydrogen ion in the reaction.

$$\text{Eq} = \frac{Mwt}{\text{number of H}}$$

1. Mono protic acid e.g: (HCl , HNO₃ , CH₃COOH) $\eta=1$

$$\text{Eq} = \frac{Mwt}{1}$$

$$Eq = \frac{36.5}{1} = 36.5 \text{ for } HCl,$$

$$Eq = \frac{63}{1} = 63 \text{ for } HNO_3$$

2. Diprotic acid e.g: (H₂SO₄, H₂S, H₂SO₃) η= 2

$$Eq = \frac{Mwt}{2} = \frac{98}{2} = 49 \quad \text{for } H_2SO_4$$

$$Eq = \frac{34}{2} = 17 \text{ for } H_2S$$

$$Eq = \frac{82}{2} = 41 \text{ for } H_2SO_3$$

B) Equivalent mass of Bases:

Is the mass that either contribute or reacts with one mole of OH in the reaction.

$$Eq = \frac{Mwt}{\text{number of } OH}$$

1. Mono hydroxy base e.g: (η=1)

e.g: NaOH

for KOH

$$Eq. = \frac{Mwt}{1} = \frac{40}{1} = 40$$

$$Eq. = \frac{Mwt}{1} = \frac{56}{1} = 56$$

2. Di hydroxy base (η=2)

e.g: Ca(OH)₂

Zn(OH)₂

Ba(OH)₂

$$Eq. = \frac{Mwt}{2} = \frac{74}{2} = 37$$

$$Eq. = \frac{Mwt}{2} = \frac{99.4}{2} = 49.7$$

$$Eq. = \frac{Mwt}{2} = \frac{171.35}{2} = 85.67$$

II. Equivalent mass in (oxidation – reduction) reaction (Redox):

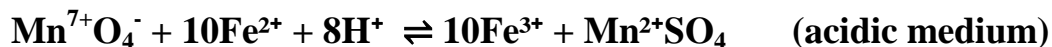
The equivalent mass of a participant in an (oxidation–reduction) reaction is that mass which directly produce or consume one mole of electron.

$$Eq = \frac{Mwt}{\eta}$$

η= change in oxidation state number

η = numbers of electrons participate in oxidation - reduction processes (Redox)

Example :

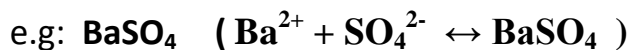


$$\text{Eq. of KMnO}_4 = \frac{Mwt}{5} = \frac{157.9}{5} = 31.6$$

III. Equivalent mass for salts:

$$\text{Eq} = \frac{Mwt}{\eta}$$

$$(\eta) = \Sigma [\text{no. of cations} \times \text{its valency}(\text{cation charge})]$$



$$\eta = \text{Ba}^{2+} (1) \times (2+) = 2$$

$$\text{Mwt for BaSO}_4 = 233 \text{ g/mol}$$

$$\text{Eq.} = \frac{Mwt}{2} = \frac{233}{2} = 116.5$$

Example

Find the Normality of the solution containing 5.300 g/L of Na_2CO_3 (106 g/mol).

Solution:

To find η for Na_2CO_3 (η) = Σ [no. of cations x its valency(cation charge)]

No. of cations = 2Na^+ while the cation charge for $\text{Na}^+ = 1$,

$$\text{Then}(\eta) = 2 \times 1 = 2$$

$$\text{Eq. of Na}_2\text{CO}_3 = \frac{Mwt}{2} = \frac{106}{2} = 53.0 \text{ gm}$$

$$\text{Normality (N)} = \frac{wt}{\text{Eq.} \times VL}$$

$$\text{Normality} = \frac{5.3 \text{ gm}}{53.0 \times 1L} = 0.1$$

e.g: $\text{KAl(SO}_4)_2$ (258 g/mol)

$$(\eta) = \sum [\text{no. of cations} \times \text{its valency(cation charge)}]$$

$$\text{no. of cations} = 1 \text{ K}^+ + 1 \text{ Al}^{3+}$$

$$\eta = \text{K}^+ (1) \times (1+) + \text{Al}^{3+}(1) \times (3+) = 4$$

$$\text{Eq.} = \frac{M.wt}{4} = \frac{258}{4} = 64.5$$

e.g: AgNO_3 ($\eta = \text{Ag}^+ (1) \times 1 = 1$)

$$\text{Eq.} = \frac{Mwt}{1} = \frac{170}{1} = 170$$

e.g: $\text{La(IO}_3)_3$ ($\eta = \text{La}^{3+} (1) \times 3 = 3$)

$$\text{Eq.} = \frac{Mwt}{3} = \frac{663.6}{3} = 221.1$$

e.g: Na_2CO_3 ($\eta = \text{Na}^+ (2) \times 1 = 2$)

$$\text{Eq.} = \frac{Mwt}{2} = \frac{106}{2} = 53$$

Molality(m): 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)

المذيب = solvent و المحلول = solution والمذاب = Solute

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

Example

Determine the molality of a solution prepared by dissolving 75.0 gm of solid $\text{Ba}(\text{NO}_3)_2$ (261.32 g/mol) into 374.00 gm of water.

Solution:

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

$$\text{No of moles}(\text{solute}) = \frac{\text{wt}}{\text{M.wt}} = \frac{75.0 \text{ gm}}{261.32 \text{ gm/mol}} = 0.287 \text{ moles}$$

$$\text{Molality}(m) = \frac{\text{number of moles}(\text{solute}) \times 1000}{\text{mass of solvent}(\text{gm})} = \frac{0.287 \text{ mol} \times 1000}{374 \text{ gm}}$$

$$\text{Molality}(m) = 0.769$$

Mole fraction:

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

$$\text{Mole fraction of solute}(x_1) = \frac{\text{no. of moles of solute } (n_1)}{\text{mole of solute } (n_1) + \text{moles of solvent } (n_2)}$$

$$\text{Mole fraction of solvent}(x_2) = \frac{\text{moles of solvent } (n_2)}{\text{moles of solute } (n_1) + \text{moles of solvent } (n_2)}$$

1 = مجموع الكسور المولية في المحلول

$$\boxed{X_1 + X_2 = 1} \quad \text{Then} \quad \boxed{X_1 = 1 - X_2} \quad \text{and} \quad \boxed{X_2 = 1 - X_1}$$

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:

$$X_1 = \frac{n_1}{n_1+n_2+n_3} \quad X_2 = \frac{n_2}{n_1+n_2+n_3} \quad X_3 = \frac{n_3}{n_1+n_2+n_3}$$

Example: Calculate the mole fraction for each component in a mixture 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)

$$n_T = n_A + n_B + n_C$$

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

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

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

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

$$X_T = X_A + X_B + X_C$$

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