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 milliter 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 .

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

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

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

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

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

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

الجواب : نكتب الاشتقاق (الخطوات الاربعه اعلاه)

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

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

N = $\frac{\boldsymbol{wt\ x\ 1000}}{\frac{\boldsymbol{Mwt\ xV(mL)}}{\boldsymbol{\eta}}}$

N = $(\frac{\boldsymbol{wt\ x1000}}{\boldsymbol{Mwt\ x\ V(mL)}})\ \boldsymbol{\eta}$

N= η M , or M = N / η

e.g: Normality(N) of 1M KCl = 1x1 = 1 N KCl ,

Normality(N) of 1M HCl = 1x1 = 1N HCl,

Normality(N) of 1 M H_2SO_4 = 2x1= 2 N H_2SO_4 ,

Normality(N) of 1 M Na_2CO_3 = 2x1 = 2N Na_2CO_3

I. <u>Equivalent mass in neutralization reaction:</u>

A) Equivalent mass of acids (Eq):-

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

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

1. Mono protic acid e.g: (HCl , HNO_3 , CH_3COOH) η=1

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

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

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

2. Diprotic acid e.g: (H_2SO_4, H_2S, H_2SO_3) η= 2

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

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

Eq = $\frac{82}{2} =$ 41 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 = $\frac{Mwt}{number\ of\ OH}$

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 :

$2KMnO_4 + 10FeSO_4 + 8H_2SO_4 \rightarrow 5Fe_2(SO_4)_3 + 2MnSO_4 + K_2SO_4 + 8H_2O$

$Mn^{7+}O_4^- + 10Fe^{2+} + 8H^+ \rightleftharpoons 10Fe^{3+} + Mn^{2+}SO_4$ (acidic medium)

$Mn^{7+} \rightarrow Mn^{2+}$ (5 e gain – reduction)

$Fe^{2+} \rightarrow Fe^{3+}$ (1 e loss – oxidation)

Eq. of $KMnO_4 = \frac{Mwt}{5} = \frac{157.9}{5} = 31.6$

III. Equivalent mass for salts:

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

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

e.g: **$BaSO_4$ ($Ba^{2+} + SO_4^{2-} \leftrightarrow BaSO_4$)**

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

Mwt for $BaSO_4$ = 233 g/mol

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

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 Na^+ =1 , Then(η) = 2 x 1 = 2

Eq. of Na_2CO_3 = $\frac{Mwt}{2} = \frac{106}{2}$ =**53.0 gm**

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

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

e.g: $KAl(SO_4)_2$ (258 g/mol)

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

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

η= K^+ (1) x (1+) **+** Al^{3+}(1) x (3+)= 4

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

e.g: $AgNO_3$ (η = Ag^+ (1) x 1= 1)

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

e.g: Na_2CO_3 (η= Na^+ (2) x 1= 2)

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

e.g: $La(IO_3)_3$ (η = La^{3+} (1) x 3 = 3)

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

<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 = المذاب و solution = المحلول و solvent = المذيب

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

Example

Determine the molality of a solution prepared by dissolving 75.0 gm of solid $Ba(NO_3)_2$ (261.32 g/mol) into 374.00 gm of water.

<u>Solution:</u>

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

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

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

Molality(m) = 0.769

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

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

$X_1 + X_2 = 1$ Then $X_1 = 1 - X_2$ and $X_2 = 1 - X_1$

<u>Example:</u> 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:

$$X1 = \frac{n1}{n1+n2+n3} \qquad X2 = \frac{n2}{n1+n2+n3} \qquad X3 = \frac{n3}{n1+n2+n3}$$

<u>Example:</u> Calculate the mole fraction for each component in amixture 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)

$n_T = n_A + n_B + n_C$

$n_T = 1 + 2 + 3 = 6$ moles

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

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

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

$X_T = X_A + X_B + X_C$

$X_T = 0.17 + 0.33 + 0.5 = 1$