3- Normality:- is the number of equivalents (Eq.) per unit volume, the unite of Normality are N, eq/L, meq/ml.

Equivalent weight:- is defined as the ratio of a chemical species' formula weight (F.wt) to the number of its equivalents.

$$\text{Normality} = \frac{\text{number of Eq of solute}}{\text{liter of solution}}$$

$$\text{Equivalent weight (EM)} = \frac{\text{Formula weigh (g/mol)}}{n\ (\text{eq/mol})}$$

$$\text{Formula weigh (F.wt)} = \Sigma(\text{no. of atom} \times \text{Atomic weigh})$$

Consequently, the following simple relationship exists between Normality and Molarity.

$$\text{Normality} = n \times \text{Molarity}$$

where (n) is number of reacting units ($\frac{eq}{mol}$).

n is H^+ for acid }
n is OH^- for base } Neutralization reactions
n is electrons number for oxidation-reduction reactions
n is ion change × its atoms for precipitation reactions
n is number of pair electron need to form Complexe

Question (1)

Calculate the Normality of 0.53 g in 100 ml Solution of Na_2CO_3 (F.wt = 106 g/mol) as the following reaction.

$$Na_2CO_3 + 2H^+ \rightarrow H_2CO_3 + 2Na^+$$

Solution:

number of reacting (n) = 2 eq/mol

$$EW\left(\frac{g}{eq}\right) = \frac{F.wt\,(g/mol)}{n\,(eq/mol)} = \frac{106\ g/mol}{2\ eq/mol} = 53\ \frac{g}{eq}$$

$$Normality = \frac{no\ eq}{V\,(L)} = \frac{\frac{0.53\ g}{53\ g/eq}}{0.1\ L} = 0.1\ \frac{eq}{L}\quad or$$

$$Normality\left(\frac{eq}{L}\right) = \frac{m\,(g)}{EW\,(g/eq)} * \frac{1000}{V\,(ml)} \rightarrow$$

$$Normality = \frac{0.53\ g}{53\ g/eq} * \frac{1000\ ml/L}{100\ ml} \rightarrow$$

$$Normality = 0.01\ eq * 10\ L = 0.1\ \frac{eq}{L}$$

Question (2)

Calculate the equivalent weight and normality for a solution of 6.0M H_3PO_4 given the following reactions (F.wt = 98 g/mol).

1- $H_3PO_4 + 3OH^- \rightarrow PO_4^{-3} + 3H_2O$

2- $H_3PO_4 + 2NH_3 \rightarrow HPO_4^{-2} + 2NH_4^+$

3- $H_3PO_4 + F^- \rightarrow H_2PO_4^- + HF$

For phosphoric acid, the number of equivalents is the number of H^+ ion donated to the base. For the reactions in (1), (2), and (3) the number of equivalents are 3, 2, and 1, respectively. Thus, the calculated equivalent weights and normality are

1- $EW = \frac{F.wt\ (g/mol)}{n\ (eq/mol)} = \frac{98\ g/mol}{3\ eq/mol} = 32.6\ \frac{g}{eq}$

$N = n \times M \rightarrow N = 3\left(\frac{eq}{mol}\right) * 6\left(\frac{mol}{L}\right) = 18\ \frac{eq}{L}$

2- $EW = \frac{F.wt\ (g/mol)}{n\ (eq/mol)} = \frac{98\ g/mol}{2\ eq/mol} = 49\ \frac{g}{eq}$

$N = n \times M \rightarrow N = 2\left(\frac{eq}{mol}\right) * 6\left(\frac{mol}{L}\right) = 12\ \frac{eq}{L}$

3- $EW = \frac{F.wt\ (g/mol)}{n\ (eq/mol)} = \frac{98\ g/mol}{1\ eq/mol} = 98\ \frac{g}{eq}$

$N = n \times M \rightarrow N = 1\left(\frac{eq}{mol}\right) * 6\left(\frac{mol}{L}\right) = 6\ \frac{eq}{L}$

Question (3)

Calculate the normality of 2.35 g in 250 ml solution of $KMnO_4$ (F.wt = 158 g/mol) if Mn^{+7} is reduced to Mn^{+2}

$KMnO_4 \rightleftharpoons MnO$

Solution:-

$\overset{+7}{Mn} + 5\bar{e} \longrightarrow \overset{+2}{Mn}$

$5\bar{e}$

$n = 5\ eq/mol$

$$EW = \frac{F.wt}{n} = \frac{158\ \frac{g}{mol}}{5\ \frac{eq}{mol}} = 31.6\ g/eq$$

An Easy short_Cut

$$N\left(\frac{eq}{L}\right) = \frac{m(g)}{EW} \times \frac{1000}{V\,ml} \rightarrow N = \frac{2.35\,g}{31.6\ g/eq} \times \frac{1000}{250\,ml}$$

$$N = 0.297\ \frac{eq}{L}$$

Question (4)
Calculate the normality and molarity of 0.53 g in 100 ml Solution of Na_2CO_3. F.wt = 106 g/mole.

Number of reacting units of Na_2CO_3 = 2 eq/mole.

$$EW \text{ of } Na_2CO_3 = \frac{F.wt \text{ of } Na_2CO_3}{n \text{ of } Na_2CO_3} = \frac{106\ \frac{g}{mol}}{2\ eq/mol} = 53\ \frac{g}{eq}$$

$$N = \frac{\frac{m(g)}{EW}}{V(L)} = \frac{\frac{0.53}{53}}{0.1} = 0.1\,N$$

$$N = nM \rightarrow 0.1\ eq/L = 2\ eq/mole \times M \rightarrow$$

$$M = \frac{0.1\ \frac{eq}{L}}{2\ \frac{eq}{mole}} = 0.05\ mole/L$$

The molarity Can be Calculated first, then Normality as shown

$$M = \frac{\frac{m(g)}{F.wt}}{V(L)} = \frac{\frac{0.53}{106}}{0.1} = 0.05\ mole/L$$

$$N = nM \rightarrow N = 2 * 0.05 = 0.1\ eq/L$$