

3- Normality :- is the number of equivalents (Eq. wt.) per unit volume, the units 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.

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

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

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

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

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

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

n is H^+ for acid } Neutralization reactions
n is OH^- for base }

n is electrons number for oxidation-reduction reactions

n is ion charge \times its atoms for precipitation reactions

n is number of pair electron need to form

Complex

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.



Solution:

number of reacting (n) = 2 eq/mol

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

$$\text{Normality} = \frac{n \text{ eq}}{V (\text{L})} = \frac{\frac{0.53 \text{ g}}{53 \text{ g/eq}}}{0.1 \text{ L}} = 0.1 \frac{\text{eq}}{\text{L}}$$

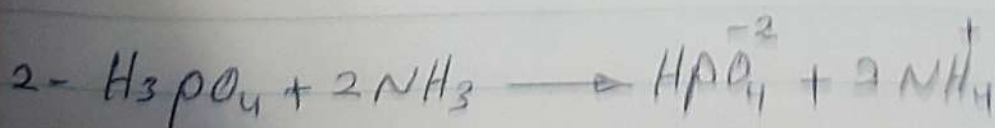
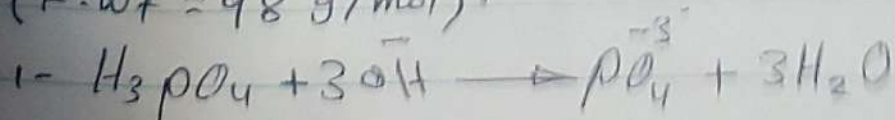
$$\text{Normality} \left(\frac{\text{eq}}{\text{L}} \right) = \frac{m (\text{g})}{\text{Eq wt} (\text{g/eq})} * \frac{1000}{V (\text{ml})}$$

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

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

Question (2)

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



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

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

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

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

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

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

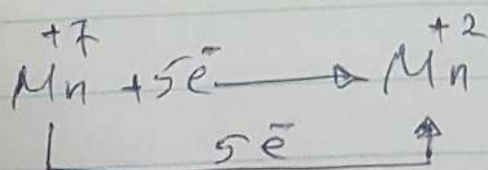
$$N = n \times M \rightarrow N = 1 \left(\frac{eq}{mol} \right) * 6 \left(\frac{mol}{L} \right) = 6 \frac{eq}{L}$$

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}



Solution:-



$$n = 5 eq/mol$$

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

An easy short-cut

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

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

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 $Na_2CO_3 = 2 \text{ eq/mole}$.

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

$$N = \frac{m(g)}{EW} \times \frac{1000}{V(L)} = \frac{0.53}{53} \times \frac{1000}{100} = 0.1 N$$

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

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

The molarity can be calculated first, then Normality as

$$\text{Shown } M = \frac{m(g)}{F.wt} \times \frac{1000}{V(L)} = \frac{0.53}{106} \times \frac{1000}{100} = 0.05 \text{ mole/L}$$

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