المحاضرة رقم 2

The normality   or the equivalent concentration

$$Molarity\ (mole/L) = \frac{Number\ of\ mole\ of\ solute}{Volume\ of\ solution\ (L)} \rightarrow M\left(\frac{mole}{L}\right) = \frac{no.mole\ (mole)}{v(L)}$$

$$Normality\ \left(\frac{eq}{L}\right) = \frac{Number\ of\ equivalent\ of\ solute}{Volume\ of\ solution\ (L)} \rightarrow N\left(\frac{eq}{L}\right) = \frac{no.eq\ (eq)}{v(L)}$$

$$no.\ eq(eq) = \frac{mass\ (g)}{Equivalenta\ weight\ (\frac{g}{eq})} \rightarrow no.\ eq(eq) = \frac{m(g)}{EW(\frac{g}{eq})}$$

$$no.\ mole(mole) = \frac{mass\ (g)}{Formule\ weight\ (\frac{g}{mole})} \rightarrow no.\ mole(mole) = \frac{mass\ (g)}{F.wt\ (\frac{g}{mole})}$$

What's an equivalent ?

An equivalent of a substance is the mass (grams) of that substance that will combine with one mole of another reactant.

$$EW\ (g/eq) = \frac{f.wt\ (g/mol)}{n\ (eq/mol)}$$

$$EW\left(\frac{g}{eq}\right) = \frac{Formule\ weight\ (\frac{g}{mol})}{number\ of\ reacting\ units\ (\frac{eq}{mol})}$$

- **The normality of a solution is the gram equivalent weight of a solute per liter of solution.**
- It may also be called the **equivalent concentration**.
- It is indicated using the symbol **N**, **eq/L**, or **meq/L** .

→ no. eq = N(eq/L) · V(L)

Number of equivalents (eq) = $\frac{m\ (g)}{eq.wt\ (\frac{g}{eq})}$ = normality (eq/L) × volume (L)

Number of milliequivalents (meq) = $\frac{m\ (mg)}{eq.wt\ (\frac{mg}{meq})}$ = normality (meq/L) × volume (L)

Reaction Type	Reacting Unit
Acid , base	H^+ , OH^-
Oxidation—reduction	electron

Number of reactant

- Neutralization reactions
- Precipitation reactions
- Oxidation-Reduction reactions
- Complexation reactions

- **Neutralization reactions**

$$HCl + NaOH \longrightarrow NaCl + H_2O$$

+1 -1 → no. of oxidant → Eq NaCl = f.wt (g/mol) / (1) → n

Therefore, 1 mol of NaOH = 1 equivalent of NaOH.

Therefore, 1 mol of HCl = 1 equivalent of HCl

What is the n of:

A.	1 M HCl =	n= 1 H+
B.	1 M CH_3COOH =	n= 1 H+
C.	0.3M H_3PO_4 =	n= 3 H +
D.	1 M NaOH =	n= 1 OH-

- **Precipitation reactions**

$$AgNO_3 + NaCl \longrightarrow AgCl + NaNO3$$

$$Na_2SO_4 + BaCl_2 \longrightarrow BaSO_4 + 2\,NaCl$$

+1 -1
AgCl ⇒ EW = f.wt (g/mol) / n(e) ⇒ EW = f.wt / (1) ⇒ n

n = +1, -1

+2 -2
BaSO4 ⇒ n = 2 ⇒ EW = f.wt / 2

- **Oxidation-Reduction reactions**

$$\overset{+1\ \ x\ \ -2}{[K_2Cr_2O_7]^0} \longrightarrow 2\,Cr^{3+}$$

$(+1*2)+(2*x)+(-2*7)=0$

$2+2x-14=0$

$2x-12=0 \Rightarrow x=6$

$n=6$

$Cr^{+6} \longrightarrow 2\,Cr^{3+}$ (3e) $\Rightarrow 2*3$

$n=6$

$$\overset{+1\ \ x\ \ -2}{[KMnO_4]^0} \rightleftharpoons \overset{x\ \ -2}{[MnO_2]^{2-}}$$

$\frac{+1*1}{K}+\frac{x*1}{Mn}+\frac{-2*4}{O}=0$

$1+x-8=0$

$x=+7 \Rightarrow Mn$

$\frac{x*1}{Mn}+\frac{-2*2}{O}=-2$

$x-4=-2$

$x=2 \Rightarrow Mn$

$Mn^{+7} \longrightarrow Mn^{+2}$ (5e)

$n=5$

- **Complexation reactions**

$$Zn^{2+} + 4\,CN^{1-} \rightleftharpoons Zn(CN)_4^{2-}$$

$4 \Rightarrow :CN \Rightarrow$ n = number of pair electron need to form complexe

$n=4$

$$Ag^{+} + 2NH_3 \rightleftharpoons [Ag(NH_3)_2]^{+}$$

$n=2 \Rightarrow 2 \Rightarrow :NH_3 \Rightarrow EW_{[Ag(NH_3)_2]^+} = \frac{F.wt}{2}$ → n

$$Al^{3+} + 6F^{-} \rightleftharpoons [AlF_6]^{3-}$$

$n=6 \Rightarrow 6 = :F^- \Rightarrow EW_{(AlF_6)^{-3}} = \frac{F.wt}{6}$ → n

Calculate the Normality of 2.35 g/250 ml solution of $KMnO_4$ (F.wt=158.04 g/mol) if Mn^{7+} is reduced to Mn^{2+}?

Solution:

$$Ew\left(\frac{eq}{g}\right) = \frac{F.wt\ (\frac{g}{mol})}{n\ (\frac{eq}{mol})}$$

$$Ew\left(\frac{eq}{g}\right) = \frac{158\ (\frac{g}{mol})}{5\ (\frac{eq}{mol})} \longrightarrow E.W = 31.6(\frac{g}{eq})$$

$$N\left(\frac{eq}{L}\right) = \frac{m(g)}{eq.wt(\frac{g}{eq})} \times \frac{1000\ ml/L}{v\ (ml)}$$

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

$$N\left(\frac{eq}{L}\right) = 0.2974\ (\frac{eq}{L})$$

$KMnO_4 \rightleftharpoons Mn^{2+}$

$Mn^{7+} \rightleftharpoons Mn^{2+}$

e = +5

reduced

n = 5 → number of reactant (charge)

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

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

Solution:

$$Ew\left(\frac{eq}{g}\right) = \frac{F.wt\ (\frac{g}{mol})}{n\ (\frac{eq}{mol})}$$

$$Ew\left(\frac{eq}{g}\right) = \frac{106\ (\frac{g}{mol})}{2\ (\frac{eq}{mol})} \longrightarrow E.W = 53\ (\frac{g}{eq})$$

$$N\left(\frac{eq}{L}\right) = \frac{no.eq\ (eq)}{v(L)}$$

$$N\left(\frac{eq}{L}\right) = \frac{\frac{m(g)}{eq.wt\ (\frac{g}{eq})}}{v(L)}$$

$$N\left(\frac{eq}{L}\right) = \frac{m(g)}{eq.wt(\frac{g}{eq})} \times \frac{1000\ ml/L}{v\ (ml)}$$

$$N\left(\frac{eq}{L}\right) = \frac{0.53(g)}{53(\frac{g}{eq})} \times \frac{1000\ ml/L}{100\ (ml)}$$

$$N\left(\frac{eq}{L}\right) = 0.1\ (\frac{eq}{L})$$

What is normality of 2 M of H_3PO_4?

$$H_3PO_4 \rightleftharpoons 3H^+$$

Solution:

$$Ew\left(\frac{eq}{g}\right) = \frac{F.wt\ (\frac{g}{mol})}{n\ (\frac{eq}{mol})} \longrightarrow n = 3\ (H+)$$

$$N = n \times M$$

$$N = 3\ \left(\frac{eq}{mol}\right) \times 2\ (\frac{mol}{L})$$

$$N = 6\ \left(\frac{eq}{L}\right)$$