Stoichiometry

→ Concentration terms

→ M (molarity) $= \text{no. of moles } (n) \times \dfrac{1000}{V\,(\text{in ml})} = \dfrac{(\%w/w) \times d \times 10}{\text{G.M.W of solute}}$ d = density

$M \propto \dfrac{1}{\text{temp}}$

→ m (molality) $= \dfrac{\text{no. of moles of solute}}{\text{mass of solvent (in kg)}}$

$m = \dfrac{1000 \times M}{1000 \times d - MM'}$ M' = mol. wt of solute

$M_{H_2O_2} = \dfrac{V.S \text{ of } H_2O_2}{11.2}$

→ N (Normality) $= \dfrac{\text{no. of equivalents of solute}}{\text{Volume (in L)}}$ Eq wt $= \dfrac{GMW}{n\text{-factor}}$

% purity $= \dfrac{\text{actual yield}}{\text{theoritical yield}} \times 100\%$

$C_xH_y + (x + y/4)\,O_2 \longrightarrow x\,CO_2 + y/2\;H_2O$

$n = \dfrac{wt}{GMW} = \dfrac{wt}{GAW}$ $N_A = 6.023 \times 10^{23}$ $n = \dfrac{\text{vol of substance (at STP)}}{22.4\text{ L (at STP)}}$

⟶ no. of molecules = no. of moles × N_A

⟶ no. of atoms = no. of moles × atomicity × N_A

$\%C = \dfrac{12}{44} \times \dfrac{\text{wt of } CO_2}{\text{wt of organic compound}} \times 100$

→ Eq. wt of organic compound ⇒ $\dfrac{W_{comp}}{E_{comp}} = \dfrac{W_a}{8}$

→ strength (g/L) = $M \times$ mol. wt of compound.

→ $M = 0.1$ deci molar

Ex: Eq. of $CaCl_2$ is

$Ca^{2+}\,Cl^- = \dfrac{M}{2 \times 1}$

$Al_2(SO_4)_3 = \dfrac{M}{3 \times 2}$

Volumetric analysis:

→ $n = \dfrac{W}{GMW} = M \times V(\text{lt}) = \dfrac{M \times V(\text{mL})}{1000}$

$n_{eq} = \dfrac{W}{Eq.W} = N \times V(\text{lt}) = Z \times M \times V(\text{lt}) = Z \times n$

→ $N_1V_1 + N_2V_2 + N_3V_3 + \cdots = N \times V$ (resulting)

→ $n_{eq}(A) = n_{eq}(A) - n_{eq}(B)$ $\boxed{\text{acid}(A) > \text{base}(B)}$

$n_{eq}(B) = n_{eq}(B) - n_{eq}(A)$ $\boxed{\text{base}(B) > \text{acid}(A)}$

Milliequivalent law

$N_1V_1 = N_2V_2$ for any titration.

$M_1V_1 = M_2V_2$

→ **Titrations** – procedure of determining the conc. of soln. by carefully measured volume to read with known amount of substance & known amount of conc.

Titrant: Reagent which is added from a buret to read.

Non redox reaction: Equivalent law – $\boxed{n_{eq_1} = n_{eq_2}}$

→ Acid-base titrations: milli eq. of acid = milli eq. of base.

→ double indicator acid-base titration:

$$Na_2CO_3 + HCl \longrightarrow NaHCO_3 + NaCl$$

$$NaHCO_3 + HCl \longrightarrow H_2CO_3 + NaCl$$

To know end point we use indicators

	pH range
phenolphthalein	8.3 – 10
methyl orange	3.1 – 4.4

→ Precipitation titration: meq. of NaCl = meq of $AgNO_3$ = meq of $AgCl$

Redox reactions:

meq of oxidizing agent used = meq of reducing agent reacted

Ex: FAS (Mohr's salt) $FeSO_4 . \underbrace{(NH_4)_2SO_4 . 6H_2O}_{\text{non reactive}}$

$Fe^{2+} \longrightarrow Fe^{3+} + e^-$ n-factor = 1

MnO_4^- (acidic) $Mn^{7+} + e^- \longrightarrow Mn^{2+}$ n-f = 5

neutral(or)(basic) $Mn^{7+} + e^- \longrightarrow Mn^{4+}$ nf = 3

$Cr_2O_7^{2-}$ ⇒ $Cr_2O_7^{2-} + 14H^+ + 6e^- \longrightarrow 2Cr^{3+} + 7H_2O$ n-f = 6

$CaOCl_2$ ⇒ $CaOCl_2 + H_2O + KI \rightarrow Ca(OH)_2 + I_2 + 2KCl$ nf = 2

H_2O_2 (disprop) ⇒ $H_2O_2 \rightarrow H_2O + \frac{1}{2}O_2$ nf = 1

$Na_2S_2O_3$ (hypo) ⇒ $2Na_2S_2O_3 + I_2 \longrightarrow Na_2S_4O_6 + 2NaI$ nf = 1

⇒ **Volume strength of H_2O_2**

i) 10 Vol.st of H_2O_2 = 0.893 M of H_2O_2 = 1.786 N of H_2O_2 = 3.036% (w/v) st of H_2O_2 = 30.36 (g/L) st. of H_2O_2 per 1 lt ⇒ 10 lt of O_2 gas at STP

ii) V_{O_2} (mL) = Vol st. × Volume of H_2O_2 soln (mL)

iii) V.S = 5.6 × N = 11.2 × M

% strength of H_2O_2 = $\frac{17}{56}$ × Volume strength

iv) 30% of (w/v) of H_2O_2 is called perhydrol.

v) V.S of perhydrol = 100 ml

V.S	%(w/v)	M	N
5.6	1.7	0.5	1
11.2	3.4	1	2
22.4	6.8	2	4
10	3	0.893	1.786

vi) 11.2 vol of H_2O_2 = 1M = 2N
= 3.4%(w/v)

vii) Eq wt of H_2O_2 = 17

→ Degree of hardness ⇒ $\frac{\text{wt of } CaCO_3(g)}{\text{wt of } H_2O(g)} \times 10^6$ ppm

$= \frac{\text{wt of salt}}{\text{mol wt of salt}} \times \frac{10^8}{\text{wt of } H_2O}$ ppm

162(g) of $Ca(HCO_3)_2$
146(g) of $Mg(HCO_3)_2$
111(g) of $CaCl_2$
95(g) of $MgCl_2$
136(g) of $CaSO_4$
120(g) of $MgSO_4$
} = 100 g of $CaCO_3$

Types Titrations

→ If $KMnO_4$ is used in titration → permanganometry
→ If $K_2Cr_2O_7$ is used → dichromometry
→ If I_2 is involved → iodometry

a) Calculation O.no. of $Fe_{0.94}O$

$(x \times 0.94) + (-2\times1) = 0 \Rightarrow x = \frac{2}{0.94} = \frac{200}{94}$, If $Fe_{0.94}O \xrightarrow{\Delta} Fe_2O_3$

then n-factor $= \left(3 - \frac{200}{94}\right) \times 0.94$

$nf = 0.76$

$ppm = \frac{\text{mass of solute} \times 10^6}{\text{mass of soln.}}$

$ppb = \frac{\text{mass of solute} \times 10^{12}}{\text{mass of soln}}$

→ %(w/w) ⇒ 10% of glucose soln ⇒ 10 g of glucose in 100 g of soln.
%(w/v) ⇒ 25% of glucose soln ⇒ 25 g of glucose in 100 ml of soln.
%(v/v) ⇒ 20% of ethanol soln. ⇒ 20 ml of ethanol in 100 ml of soln.

→ Eq.wt of As_2S_3

$\overset{+3}{As_2}\overset{-2}{S_3} \longrightarrow \overset{+5}{As_2O_4^{3-}} + \overset{+6}{SO_4^{2-}}$

$5-3=2$

$6-(-2)=8$

n-factor
of As = 2×2 = 4
of S = 8×3 = 24
of As_2S_3 = 24+4 = 28

Eq. Mol.wt = M/28