Concept of oxidation: Real or imagnery charge present on an atom.

$\overset{+1}{H}\!-\!\overset{-1}{Cl}$, $\overset{+1}{H}\!-\!\overset{-1}{O}\!-\!\overset{+1}{H}$

Rules:- ① O.N of H is +1 but in Metal hydrides it is -1

② O.N of 'O' is usually -2 but

- -1 in peroxides O_2^{-2} $O^{-1}-O^{-1}$
- $-\frac{1}{2}$ in superoxides O_2^{-1} $O^{-1/2}-O^{-1/2}$
- $-\frac{1}{3}$ in ozonide eg. KO_3 $1+3x=0 \Rightarrow x=-1/3$
- $+1$ in O_2F_2
- $+2$ in OF_2
- $+\frac{1}{2}$ in $O_2^{+}[AsF_6]^{-}$

③ O.N of Halogens (except f) is usususally -1 to $+7$

f → -1 in all compounds

④ O.N of Alkali Metal → +1 always
(Li, Na, K, Rb, Cs, Fr)

⑤ O.N of Alkaline earth metals → +2 always
(Be, Mg, Ca, Sr, Ba, Ra)

⑥ O.N of N is usually -3 to $+5$

⑦ O.N of elements in elemental state is always ZERO
eg O_2, P_4, S_8, N_2, X_2 etc

⑧ The sum of O.N of all the elements in a compound is always zero.

⑨ The sum of O.N of all the elements in an ION is always equal to charge on that ion.

⑩ O.N in Covalent Bond

$\mathring{A}-\mathring{A}$ E.N: A < B

$A-B$ (+1, −1) $A=B$ (+2, −2) $A\equiv B$ (+3, −3)

⑪ O.N in Co-ordinate Bond

$A \leftarrow B$ EN: A < B

eg $H-N\rightarrow C$ or $H-\overset{+}{N}\equiv\overset{-}{C}$

$H-N\rightarrow C$: +1, −1-2, +2 → +1, −3, +2

$H-\overset{+}{N}\equiv\overset{-}{C}$: +1, −1-3, +3 → +1, −3, +2

① $KClO_3$

$+1 + x + 3x - 2 = 0$

$x = +5$

② $Fe_{0.94}O$

$0.94x - 2 = 0$

$x = \frac{2}{0.94} = \frac{200}{94}$

③ SO_6^{-2}

$4x + 6x - 2 = -2$

$4x - 12 = -2$

$x = 2.5$

④ $Na_2S_2O_3$

$2 + 2x - 6 = 0$

$x = 2$

⑤ H_5IO_6

$5 + x - 12 = 0$

$x = 7$

⑥ HN_3

$1 + 3x = 0$

$x = -1/3$

⑦ $[Ni(CO)_4]$

$x + 4 \times 0 = 0$

$x = 0$

⑧ $[Co(NH_3)_4(H_2O)Cl]SO_4$

$x + 4 \times 0 + 0 - 1 = 2$

$x = +3$

⑨ $Y\ Ba_2Cu_3O_7$

$\rightarrow 3 + 4 + 3x + 14 = 0$

$x = 7/3$

⑩ $(N_2H_5)_2SO_4$

$\rightarrow H_2^{+}\ SO_4^{--}$

$2 + x - 8 = 0$

$x = +6$

⑪ $NH_4^{+}\ NO_3^{-}$

$x + 4 = 1 \qquad x - 6 = -1$

$x = -3 \qquad x = +5$

⑫ $[Fe(CN)_6]^{4-}$

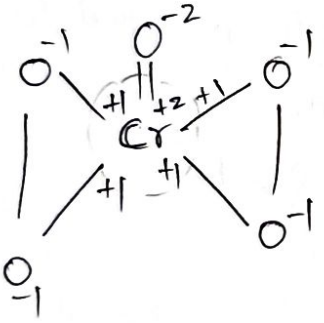
$\rightarrow x + 6x - 1 = -4$

$x = -4 + 6$

$x = +2$

Calculation of Individual O.N

① CrO_5



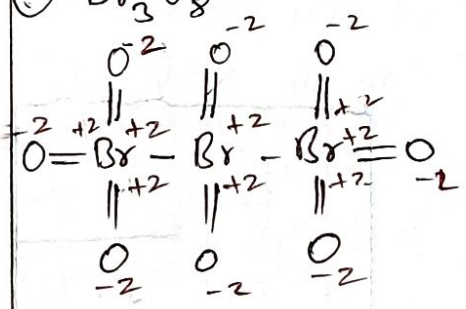
O.N of Cr = +6

O.N of O = −1

peroxy Bond = 2 $[^{-1}O - O^{-1}]$

Avg of O = $-\frac{6}{5}$

② Br_3O_8



O.N of Br = +4 & +6

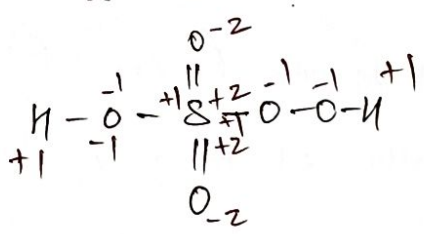
" " O = −2

Peroxy Bond = 0

Avg. o.N of Br = $\frac{16}{3}$

③ Caro's Acid

H_2SO_5



O.N of S = +6

O.N of O = −1 & −2

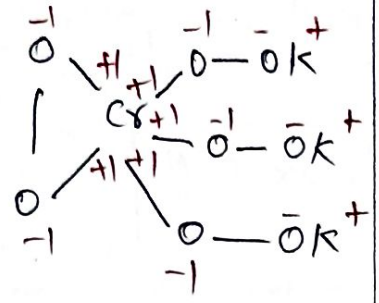
P. Linkage = 1

A.V O.N of 'O' = $-\frac{4}{3}$

$^{-2}O\ \ ^{-1}O\ \ ^{-1}O$

Avg oxidⁿ No. of Y = $\frac{\text{Total charge of atom Y}}{\text{No. of atom Y}}$

④ K_3CrO_8



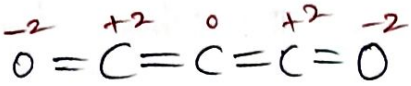
O.N of Cr = +5

O.N of 'O' = −1

Peroxy Bond = 4

O.N of K = +1

⑤ C_3O_2

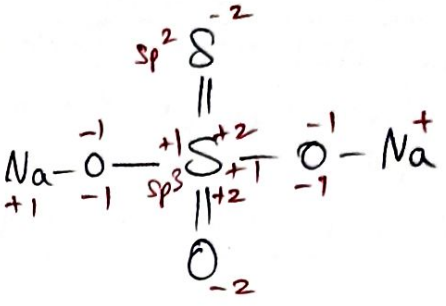


O.N of 'C' = 0 & +2

O.N of O = −2

P.L = 1

⑥ $Na_2S_2O_3$ ~~*~~ ~~*~~ EN : $sp^2 > sp^3$



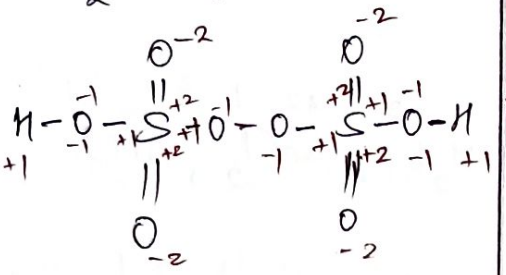
O.N of 'S' = −2 & +6

O.N of 'O' = −2

" " Na = +1

Peroxy linkage = 0

⑦ $H_2S_2O_8$



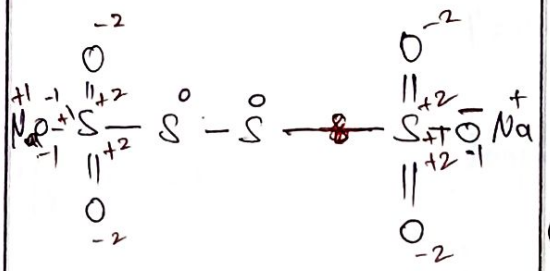
O.N of S = +6

O.N of O = −1 & −2

O.N of H = +1

Peroxy linkage = 1

⑧ $Na_2S_4O_6$



O.N of S = +5 & 0

O.N of O = −2

O.N of Na = +1

P.L = 0

① Fe_3O_4 → Avg O.N = 8/3

exist as

$FeO.Fe_2O_3$

② Pb_3O_4 → Avg = 8/3

exist as $2PbO.PbO_2$

How to find P.L without structure.

→ Peroxy linkage is present when

Avg O.N > Max O.N

Max O.N for s & d Block → group No.

for p Block → group. No − 10

eg. CrO_5

$x - 10 = 0$

$x = +10 > +6$

Yes, P.L is present

eg. H_2SO_5

$2 + x - 10 = 0$

$x = +8 > +6$

Yes, P.L is present

How to find no. of P.L without struct in us.

Case I: when only one central atom is present

$$P.L = \frac{\text{Avg O.N} - \text{max O.N}}{2}$$

Eg $Cr O_5$

$$P.L = \frac{10-6}{2} = \frac{4}{2} = 2$$

Eg $K_3 Cr O_8$: $3 + x - 16 = 0$

$x = +13 > +6$

$$P.L = \frac{13-6}{2} = \frac{7}{2} \approx 3.5 \approx 4$$

Case II: when two C.A are present

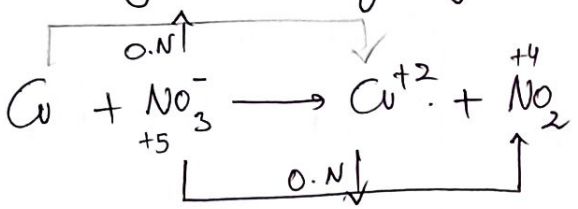
$$P.L = \text{Avg O.N} - \text{max O.N}$$

Eg $H_2 S_2 O_8$ $\quad 2 + 2x - 16 = 0$

$x = +7 > +6$

$P.L = 7 - 6 = 1$

Oxidising & Reducing agent



O.N↑, oxidises itself, Reducing agent

O.N↓, Reduces itself, ~~Reducing~~ Oxidizing agent.

Case I: If C.A is in its max. O.N

Reduces itself, oxidizing agent

Eg $K\overset{+7}{M}nO_4$, $K_2\overset{+6}{C}r_2O_7$, $H\overset{+3}{N}O_3$, etc

Case 2: If C-A is in its min O.N

oxidises itself, Reducing Agent

~~Case~~ 3: Eg. $H_2\overset{-2}{S}$, $Sn\overset{+2}{Cl}_2$, $H\overset{-1}{Cl}$

Case 3: If C.A is in its intermediate O.N

oxidises, Reduces itself,

oxidizing & Reducing agent Both

Eg $H\overset{+8}{N}O_2$, $H\overset{+5}{I}O_3$ etc.

Normality (N)

$$N = \frac{\text{No. of gm equivalent}}{\text{Volume (in L)}}$$

$$\text{No. of gm equi} = \frac{\text{Weight}}{\text{Equivalent Weight}}$$

$$\text{Equivalent weight} = \frac{\text{Atomic or Molecular weight}}{\text{n-factor}}$$

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

n-factor

① Case I: for acids

nf = no. of H^+ ions furnish in the solution

eg. $H_2SO_4 \longrightarrow H^+ + HSO_4^-$

nf = 1

$H_2SO_4 \longrightarrow 2H^+ + SO_4^{2-}$

nf = 2

H_3PO_4, nf = 1, 2, 3

H_3PO_3, nf = 1, 2

H_3PO_2, nf = 1

H_3BO_3, nf = 1

Case 2: for Bases

nf = no. of OH^- ions furnish in the solution

$MOH \rightarrow nf = 1$

$M(OH)_2 \rightarrow nf = 1, 2$

$M(OH)_3 \rightarrow nf = 1, 2, 3$

Case 3: for salts

nf = Total +ve charge or Total -ve charge

eg $NaCl \rightarrow nf = 1$

$CaCl_2 \rightarrow nf = 2$

$Ca_3(PO_4)_2 \rightarrow nf = 6$

$AlPO_4 \rightarrow nf = 3$

Case 4: Redox Rxn

I: When only one atom can undergo either oxidation or reduction

eg. $K\overset{+7}{M}nO_4 \longrightarrow Mn^{2+}$ → Acidic media

$nf = (7-2) \times 1 = 5 \times 1 = 5$

$K\overset{+7}{M}nO_4 \longrightarrow K_2\overset{+6}{M}nO_4$ → Basic mediom

$nf = (7-6) \times 1 = 1$

$K\overset{+7}{M}nO_4 \longrightarrow \overset{+4}{M}nO_2$ → Alkaline or Neutral

$nf = (7-4) \times 1 = 3$

$K_2\overset{+6}{C}r_2O_7 \longrightarrow Cr^{+3}$ $nf = (6-3) \times 2 = 6$

② when two or more atoms can undergo either oxidation or reduction

eg. $\overset{+2}{Fe}\overset{-1}{S_2} \longrightarrow Fe^{+3} + \overset{+4}{SO_4}$

$nf_1 = (-1-4)\times 2 = 10$

$nf_2 = (3-2)\times 1 = 1$

$nf = 10 + 1 = 11$

eg. $\overset{+2\ +3}{Fe}\overset{2-}{C_2O_4} \longrightarrow Fe^{3+} + \overset{+4}{CO_2}$

$nf_1 = (3-2)\times 1 = 1$

$nf_2 = (4-3)\times 2 = 2$

$nf = 2+1 = 3$

③ Disproportionation Rxn

$$nf = \frac{n_1 n_2}{n_1 + n_2}$$

eg. $P_4 \longrightarrow PH_3 + \overset{+1}{H_2PO_2^{\ominus}}$

$nf_1 = 2\times 4 = 12$

$nf_2 = 1\times 4 = 4$

$nf = \frac{n_1 n_2}{n_1+n_2} = \frac{12\times 4}{12+4} = \frac{\overset{3}{\cancel{12}}\times 4}{\cancel{16}_1} = 3$

eg $X_2 \longrightarrow X^{\ominus} + \overset{+5}{XO_3^{\ominus}}$

$nf_1 = 1\times 2 = 2$

$nf_2 = 5\times 2 = 10$

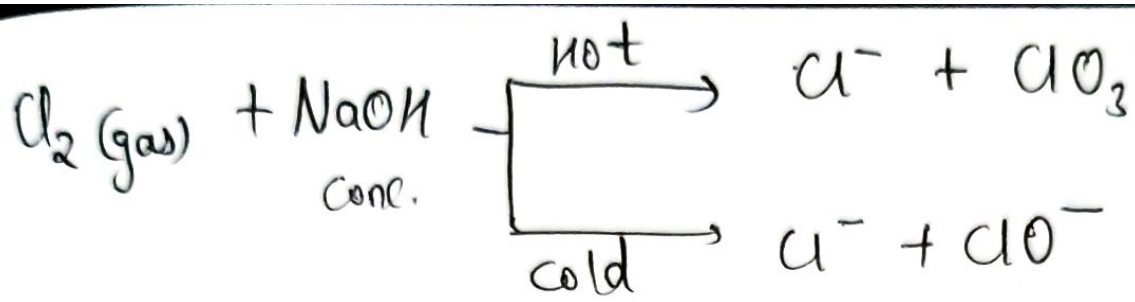
$nf = \frac{2\times 10}{2+10} = \frac{20}{12} = \frac{5}{3}$

eg. $S_8 \longrightarrow \overset{-2}{S^{2-}} + \overset{+2}{S_2O_3^{2-}}$

$nf_1 = 2\times 8 = 16$

$nf_2 = 2\times 8 = 16$

$nf = \frac{16\times 16}{16+16} = \frac{\overset{8}{\cancel{16}}\times 16}{\underset{1}{\cancel{2}}\times 16} = 8$


Cl_2 (gas) + NaOH
Conc.
hot
$Cl^- + ClO_3^-$
cold
$Cl^- + ClO^-$