

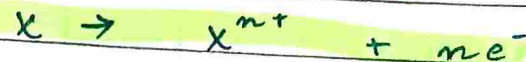
REDOX Rxⁿ

REDOX

Nothing is impossible!

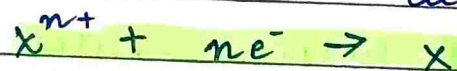
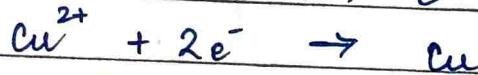
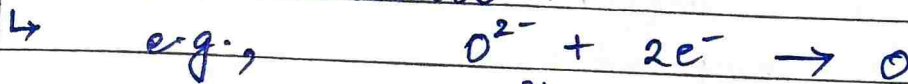
Oxidation :-

- ↳ De-electronation.
- ↳ The process in which one or more e⁻ are lost by an atom, ion or molecule.



Reduction :-

- ↳ Electronation.
- ↳ The process in which one or more e⁻ are gained by an atom, ion or molecule.

# Redox Reaction (Oxidation-Reduction Rxⁿ) :-

- ↳ Rxⁿ involving transfer of e⁻ from one chemical substance to another.
- ↳ Rxⁿ involving oxidation and reduction both simultaneously.
- ↳ Rxⁿ in which increase as well as decrease in oxidation numbers of same or different atoms occurs.

Oxidation state :- of an atom

↳ O.S. in a molecule or ion is the hypothetical or real charge present on an atom due to electronegativity charge

↳ O.S. of an element in a compound represents the number of electron ^{are lost or} gained during its change from free elemental state into that compound.

↳ can be +ve or -ve.

↳ can be zero, fractional value or whole number.

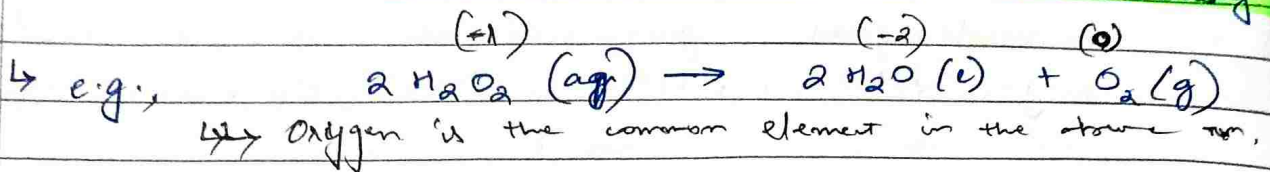
↳ can be different in same or different compound.

↳ Some helping rules for calculating oxidation numbers :-

- 1) The O.S. of an element in its free (elemental) state is zero. (e.g., Na, Zn, O₂, etc. are 0)
- 2) The O.S. of an element in its allotropic form (e.g., C_{diamond}, C_{graphite}, S_{monoclinic}, S_{rhombic}) is 0.
- 3) The O.S. of all the components of an alloy are zero.

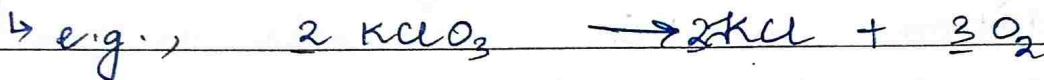
2) Disproportionation Redox Rxⁿ :-

↳ A redox rxⁿ in which redox same element in a particular compound in a definite oxidation state is oxidized as well as reduced simultaneously.



3) Intra molecular Redox Rxⁿ :-

↳ Both elements undergoing oxidation & reduction belongs to the same compound



↳ KClO₃ plays the roles of both oxidant & reductant.

4) comproportionation Redox Rxⁿ :-



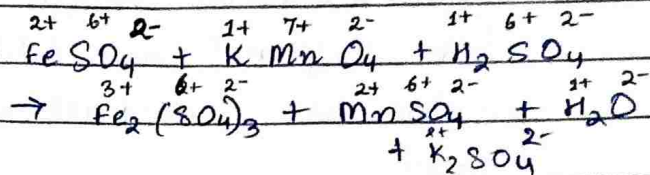
↳ Here, nitrogen in this compound has +3 and -3 oxidation numbers, which is not a definite value.

↳ A redox rxⁿ in which an element from two different oxidation state converted into a single oxidation state.

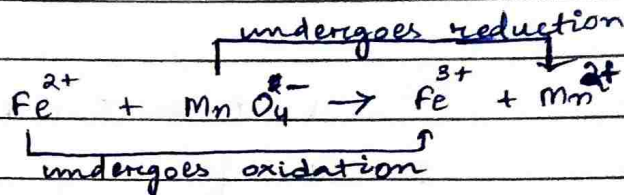
Balancing a Redox Rxⁿ :-

1/ Ion - Electron Method :-

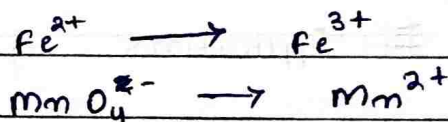
① Assign the oxidation numbers to each element present in the rxⁿ.



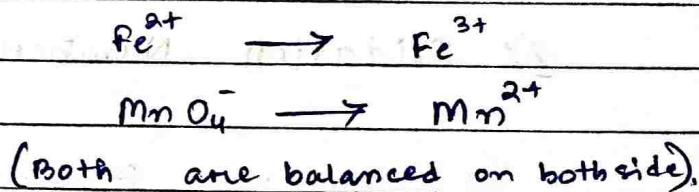
② Convert the eqⁿ in ionic form, by eliminating the species, which are not undergoing either oxidation and reduction.



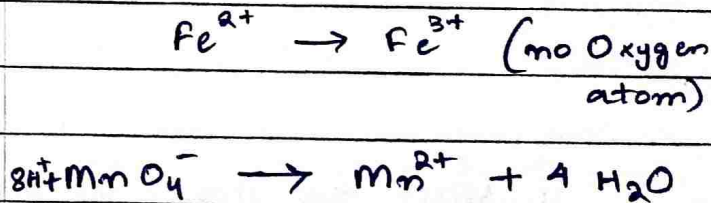
③ Split the Ionic Rxⁿ in two half rxⁿ, (one for oxidation and other for reduction)



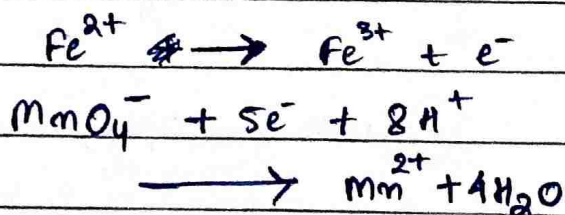
④ Balance the atom other than O & H₂ atom in both half rxⁿs.



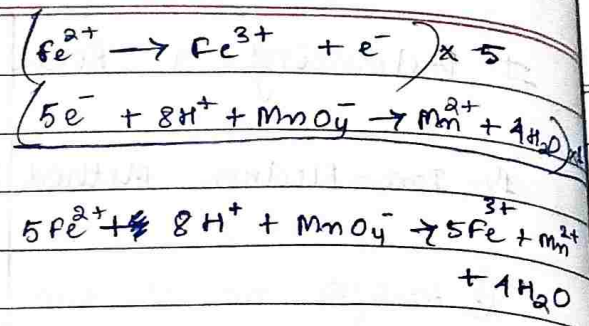
⑤ Balance O and H atom by H₂O & H⁺ respectively by the following way :- For one excess oxygen atom, add one H₂O on the other side and two H⁺ on the same side.



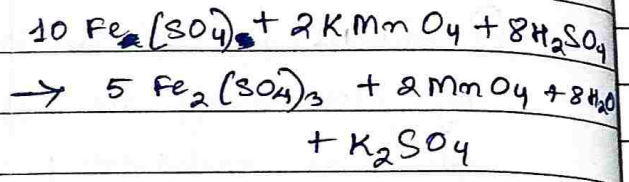
⑥ Balance the eqⁿs charges by adding e⁻ to the electrically positive side.



⑦ The no. of e^- gained & lost in each half-rxn are equalised by multiplying both the half rxn with a suitable factor & finally the half rxn are added to give the overall balanced rxn.



⑧ Convert the Ionic Rxn into molecular form by adding the elements or species, which are removed in step (2).

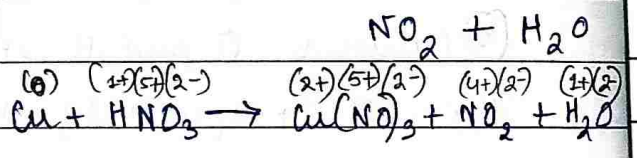
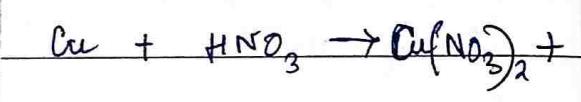


Applications of Oxidation Number :-

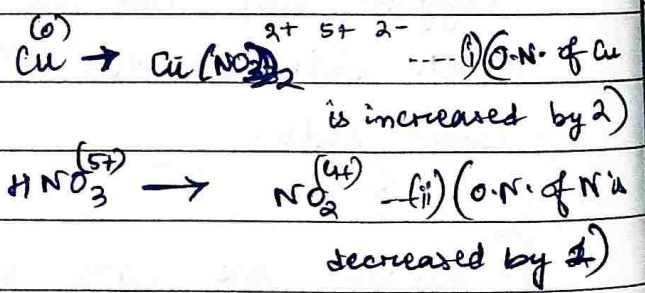
~~1)~~

2) Oxidation Number Method :-

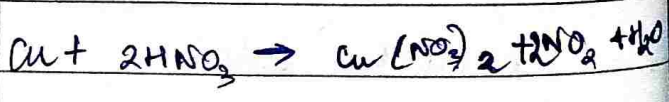
(a) Write the oxidation number of all the atoms.



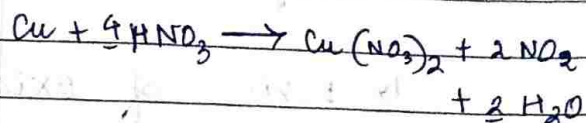
(b) select the atom in oxidant/reductant whose O.N. decrease/increases and indicate the number of gain of e^- / loss of e^- per molecule.



(c) Cross multiply, i.e., multiplying oxidant by no. of lossed e^- & reductant by no. of gained e^- .



(d) Balance the no. of atom on both sides whose O.N. change in the rxn.



(e) Balance O_2 atoms by adding required no. of H_2O molecules to the side of deficient of oxygen. Balance the required no. of H atoms by adding H^+ ions to the side deficient of Hydrogen.

Application of Oxidation Number :-

- 1) To compare the strength of oxyacid.
- 2) To determine the oxidising and reducing nature of the substances.

↳ If **effective element** in a compound is **present in maximum O.S.** then the compound acts as **oxidant**.

Effective Element \rightarrow maximum O.S. presence \rightarrow Oxidant.

↳ If **effective element** in a compound is **present in minimum O.S.** then the compound acts as **Reductant**.

Effective Element \rightarrow minimum O.S. presence \rightarrow Reductant.

↳ If **Effective element** in a compound is **present in intermediate O.S.** then the compound can act as **oxidant** as well as **Reductant**.

Effective Element \rightarrow intermediate O.S. presence \rightarrow Both Oxidant & Reductant.

*** **EQUIVALENT WEIGHT** :- of an oxidising agent or reducing agent is what weight which accept 1 mole electrons or loses 1 mole electrons in a chemical rxn.

3) To calculate the equivalent weight of ~~the~~ compounds.

$$\rightarrow \text{E.W. of oxidant} = \frac{\text{Molecular Weight}}{\text{No. of } e^- \text{ gained by 1 molecule}} = M / \text{Net change in O.N. per molecule}$$

$$\rightarrow \text{E.W. of Reductant} = \frac{\text{Molecular Weight}}{\text{No. of } e^- \text{ lost by 1 molecule}} = \frac{M}{\text{Net change in O.N. per molecule}}$$

4) ~~The~~ Different equivalent wt. of a compound is different in different condition.

4) To determine the possible molecular formula of compound.

Key Note

- * Max. O.S. = No. of valence e^- } (for an element)
- * Min. O.S. = $8 - (\text{max. O.S.})$

Concept of n-factor / Valency Factor

1. $n_f = \text{No. of } e^- \text{ exchanged per molecule}$
 $= \text{Net change in O.N. per molecule.}$

2. $E = \frac{M}{n_f}$ (E = eq. wt., M = molecular wt.)

3. Number of eqv. = No. of moles $\times n_f$

e.g., Suppose there are 3 atoms A, B and C and their eq oxidation numbers are 12, -2 and -4 respectively. Then the molecular formula will be -

Ans: Net charge on a free compound is zero.

$$\therefore +12 = (-2)(x) + (-4)(y)$$

$$\Rightarrow +12 = (-2)(2) + (-4)(2)$$

$$\Rightarrow +12 = -4 - 8 = -12$$

$$\text{or, } +12 = (-2)(4) + (-4)(1)$$

$$\Rightarrow +12 = -8 - 4 = -12.$$

So, the molecular formula is AB_2C_2 or

Law of Equivalence :-

↳ one equivalent of an element combine with one equivalent of the other, and in a chemical rxn same no. of equivalent (or mill equivalent) of reactants reacts to give mill equivalent of products separately.



$$m.\text{eq. } A = m.\text{eq. } B = m.\text{eq. } C = m.\text{eq. } D \quad \left[\begin{array}{l} \text{In} \\ \text{General} \\ \text{Rxn} \end{array} \right]$$

↳ In a compound M_xN_y

$$m.\text{eq. of } M_xN_y = m.\text{eq. } M = m.\text{eq. of } N.$$

Key Note :-

$$N_1 V_1 = N_2 V_2 \text{ (always true)}$$

$$M_1 V_1 = M_2 V_2 \text{ (may or may not be true)}$$

$$\neq M_1 \times n_1 \times V_1 = M_2 \times n_2 \times V_2 \text{ (always true)}$$

- where 'n' terms represents 'n' factor.

Redox Titration :-

↳ Titrations based on Redox Processes.

↳ Titrate / Titrants are oxidising / reducing agents.

↳ Titrate + Titrants → Products.

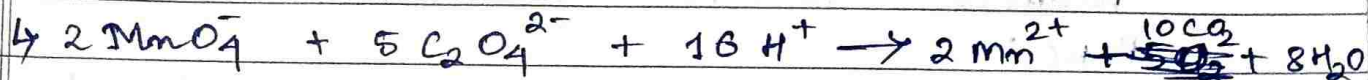
$$M \cdot \text{eq. of Titrate} = M \cdot \text{eq. of Titrants} \text{ (at equivalent point)}$$

→ Titration using acidified KMnO₄ :-

↳ In Redox Rxn, Use of KMnO₄ as oxidising agent was 1st made for Fe²⁺ ions.

→ # Imp. titrations using KMnO_4 :-

1) KMnO_4 vs Oxalic Acid :-



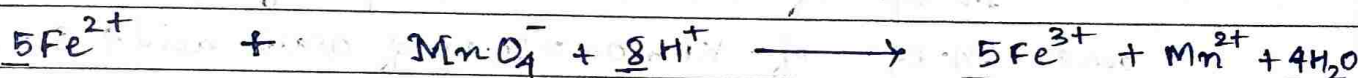
end point :- light pink color of MnO_4^- solⁿ, KMnO_4 acts as self indicator.

↳ Mill equivalent of KMnO_4 = Mill equivalent of Oxalic Acid

$$\Rightarrow N_{\text{KMnO}_4} \times V_{\text{KMnO}_4} = N_{\text{Oxalic acid}} \times V_{\text{Oxalic acid}}$$

2) KMnO_4 vs Fe^{2+} ions :-

↳ Fe^{2+} gets readily oxidised by MnO_4^- to Fe^{3+} .



End Point :- MnO_4^- acts as self indicator and light pink color of solⁿ indicates end point.

↳ At equivalent point :-

1 mol MnO_4^- reacts with 5 mol Fe^{2+}

\Rightarrow M. eq. of MnO_4^- = M. eq. of Fe^{2+}

$$\Rightarrow N_{\text{KMnO}_4} \times V_{\text{KMnO}_4} = N_{\text{Fe}^{2+}} \times V_{\text{Fe}^{2+}}$$

$$\Rightarrow 5 \times M_{\text{KMnO}_4} \times V_{\text{KMnO}_4} = 1 \times M_{\text{KMnO}_4} \times V_{\text{KMnO}_4}$$

3) Estimation of Fe^{2+} and Fe^{3+} ions in a solution :-

↳ In this estimation, the solution is titrated twice. First without reduction with

in which only Fe^{2+} and Fe^{3+} ~~ion~~ ^{reacts} remain unreacted. In 2nd step same volume of solution is taken, Fe^{3+} ions are reduced to Fe^{2+} and then titrated.

Here :-

i) In step I :- $M \cdot eq. \text{ of } KMnO_4 \text{ (let } x) = M \cdot eq. \text{ of } Fe^{2+}$

ii) In step-II :- $M \cdot eq. \text{ of } KMnO_4 \text{ (let } y) = M \cdot eq. \text{ of } Fe^{2+} + M \cdot eq. \text{ of } Fe^{3+}$

4) Analysis of sample containing oxalic acid and sodium oxalate :-

same volume of solution are titrated separately with NaOH and $KMnO_4$ solⁿ.

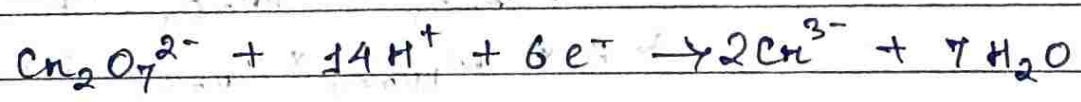
$M \cdot eq. \text{ of } NaOH = M \cdot eq. \text{ of } \text{Oxalic Acid}$

and $M \cdot eq. \text{ of } KMnO_4 = M \cdot eq. \text{ of oxalic acid} + M \cdot eq. \text{ of Sodium oxalate}$

→ Titration using acidified $K_2Cr_2O_7$:-

In volumetric analysis,

~~$Cr_2O_7^{2-}$~~ $Cr_2O_7^{2-}$ is also used as oxidant. (weaker than MnO_4^-)



$$E_{Cr_2O_7^{2-}} = \frac{M_{Cr_2O_7^{2-}}}{6} = \frac{296}{6} = 49.$$

These titrations are made in 1-2 N acid solⁿ. In neutral or alkaline medium,

it is not used. In alkaline medium orange $Cr_2O_7^{2-}$ changes to yellow CrO_4^{2-}

Iodometric and Iodimetric Titration :-

↳ Iodine acts as mild oxidising agent.

↳ These titrations fall into 2 categories :-

(a) Iodimetry :- standard I_2 soln is used to titrate easily oxidisable substances.

(b) Iodometry :- In iodometric titrations, an oxidant is allowed to react with excess KI (or I^-) soln.

The I_2 liberated is titrated with hypo soln.

I_2 (insoluble in water) remains in the soln containing KI as KI_3 .

Miscellaneous :-

1. n_f for species undergoes disproportionation
= $\frac{n_R \times n_O}{n_R \times n_O}$ (where n_R and n_O are n_f for Reduction & Oxidation Process)

2. Oxidation species :-

