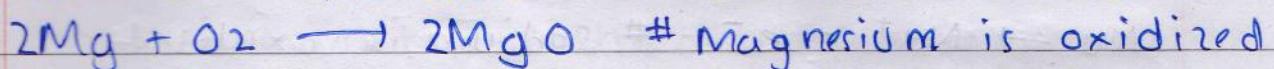


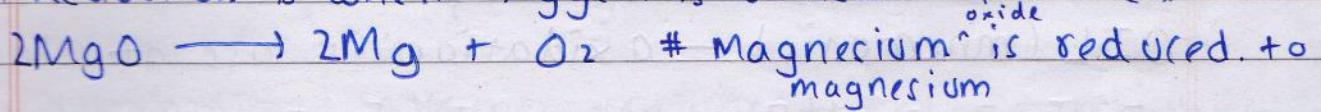
REDOX

→ Oxidation and Reduction

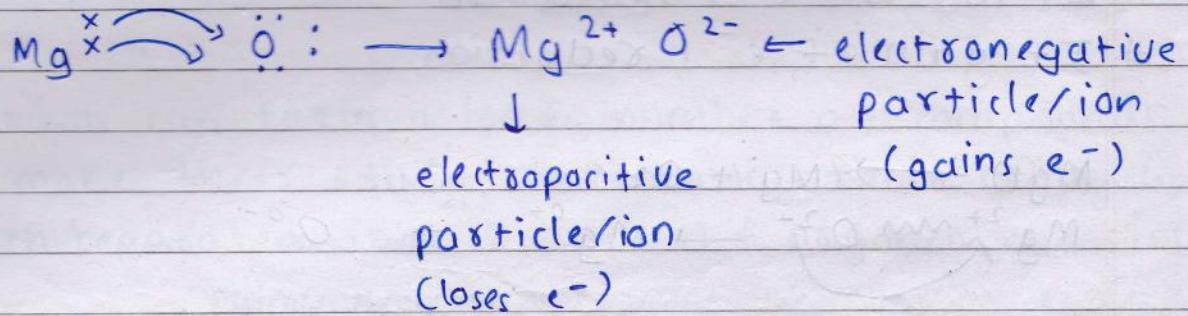
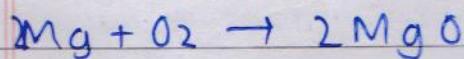
→ Oxidation is burning process of elements. It is the reaction of elements with O₂.



→ Reduction is when oxygen is removed from elements.



→ Redox reaction Oxidation and Reduction reaction are jointly called Redox reaction.



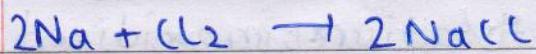
Sodium is oxidized^{to Na⁺} because it has combined with electro negative particle, chlorine

Chlorine is reduced^{to Cl⁻} because it has combined with electropositive particle, sodium.

So, redox reaction is not only limited to Oxygen reactions.

When electropositive radical is added to electronegative radical, the electronegative radical is said to be reduc-

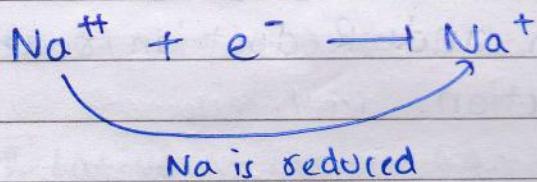
The modern concept deals with redox as combination of electro+ve particle with electro-ve rather than the combination of electro+ve particle with O₂.



Na → Na⁺ + e⁻ # sodium is oxidized.

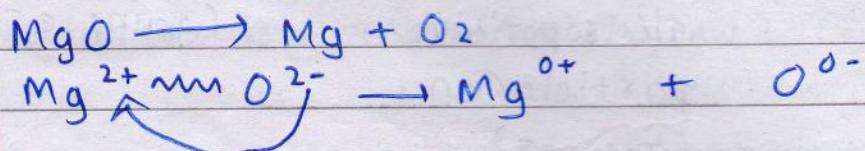


OIL (mnemonic) → oxidation is loss of electrons



If loss of e⁻, oxidation

If gain of e⁻, reduction.

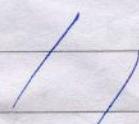


Valency is the no of electrons lost, gained or shared during a chemical reaction.

The classical concept said that valency was combining power.

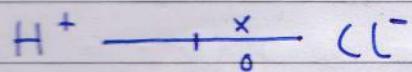
→ Valency of sodium is +1

→ Valency of chlorine is -1



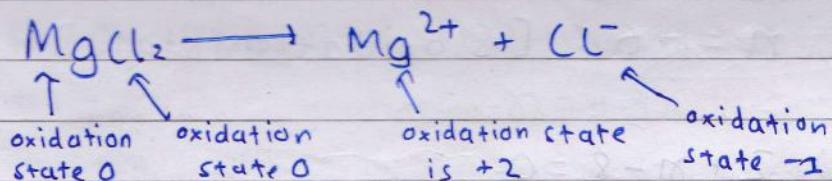
REDOX...

Oxidation state can also be said as the charged state of atoms.



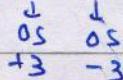
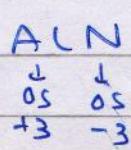
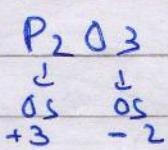
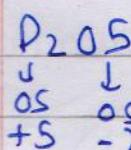
Since, the electron does not go to the chlorine entirely but due to the strong nuclear force of chlorine the electrons move towards chlorine slightly. But since Hydrogen also has very strong nuclear force of attraction, it doesn't allow the electron to reach chlorine completely. So, this is a covalent bond, not an ionic bond.

In homonuclear molecules, ($\text{H}-\text{H}$, $\text{Cl}-\text{Cl}$), the atoms don't have charge due to equal nuclear force of attraction, but in heteronuclear (polar) molecules there is a charge.

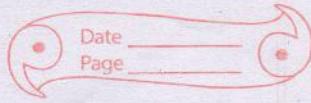


For first 20 elements, their oxidation state is their valency.

↑ Oxidation state of sodium (atom) is 0 (neutral) but that of Sodium ion is +1.



(N⁻²)



H₂SO₄ Sulfur can have variable oxidation state
+2, +4, +6

$$\begin{array}{c} \text{H}_2 \text{S} \text{O}_4 \\ \text{(+1) } \text{x} \text{ (-2)} \end{array} \Rightarrow 2(+1) + x + 4(-2) = 0 \quad [\text{Neutral molecule}]$$
$$\text{or, } 2 + x - 8 = 0$$
$$\text{or, } -6 + x = 0$$
$$\therefore x = +6$$

∴ Sulfur's oxidation state is +6

$$\begin{array}{c} \text{Na}_2\text{S}_2\text{O}_3 \\ \text{(+1) } \text{x} \text{ (-2)} \end{array} \Rightarrow 2(+1) + 2x + 3(-2) = 0$$
$$\text{or, } 2 + 2x - 6 = 0$$
$$\text{or, } 2x = 4$$
$$\therefore x = +2$$

$$\begin{array}{c} \text{HNO}_3 \\ \text{(+1) } \text{x} \text{ (-2)} \end{array} \Rightarrow +1 + x + 3(-2) = 0$$
$$\text{or, } x = +5$$

$$\begin{array}{c} \text{S}_2\text{O}_7^{2-} \\ \text{x } (-2) \end{array} \Rightarrow 2x + 7(-2) = -2 \quad [\text{This is formed when K}_2\text{ is removed from K}_2\text{S}_2\text{O}_7]$$
$$\text{or, } 2x = 12$$
$$\therefore x = +6$$

$$\begin{array}{c} \text{K}_2\text{MnO}_4 \\ \text{(+1) } \text{x} \text{ (-2)} \end{array} \Rightarrow 2 + x - 8 = 0$$
$$\therefore x = +6$$

$$\begin{array}{c} \text{NO}_3^- \\ \text{x } (-2) \end{array} \Rightarrow x - 6 = -2$$
$$\therefore x = -5$$

$$\begin{array}{c} \text{NH}_4^+ \\ \text{x } (+1) \end{array} \Rightarrow x - 8 = 1 \quad x + 4 = 1$$
$$\therefore x = +9 \quad x = -3$$

$$\text{te} \quad (\text{FeO}_4)^{2-} \Rightarrow 2\alpha_1 - 2\cdot 4 = -2 \\ \therefore \alpha_1 = +6 \text{ II.}$$

$$\text{[e]} \quad \# \text{K}_3[\text{ClO}_3] \Rightarrow 1 + \alpha_1 - 6 = 0 \\ \therefore \alpha_1 = +5 \text{ II.}$$

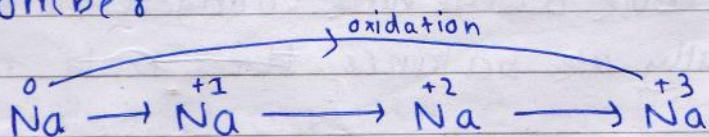
$$\# \text{K}_4[\text{Fe}(\text{CN})_6] \Rightarrow 4(+1) + \alpha_1 + 6(-1) = 0 \\ \text{or, } 4 + \alpha_1 - 6 = 0 \\ \text{or, } -2 + \alpha_1 = 0 \\ \therefore \alpha_1 = +2 \text{ II.}$$

$$\# \text{K}_3[\text{Fe}(\text{CN})_6] \Rightarrow 3(+1) + \alpha_1 + 6(-1) = 0 \\ \text{or, } 3 + \alpha_1 - 6 = 0 \\ \text{or, } -3 + \alpha_1 = 0 \\ \therefore \alpha_1 = +3 \text{ II.}$$

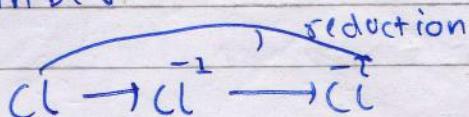
$$\# \text{Fe}_3[\text{O}_4]^{2-} \Rightarrow 3\alpha_1 - 8 = 0 \\ \text{or, } 3\alpha_1 = 8 \\ \therefore \alpha_1 = \pm \frac{8}{3}$$

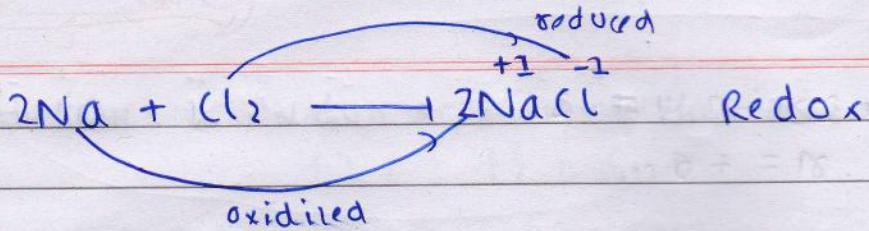
$$\# \text{H}_2[\text{O}_4]^{2-} \Rightarrow 2 + 2\alpha_1 - 8 = 0 \\ \therefore \alpha_1 = +3 \text{ II.}$$

- Oxidation numbers can be fractional as well
- Oxidation can also be said as increase in oxidation number



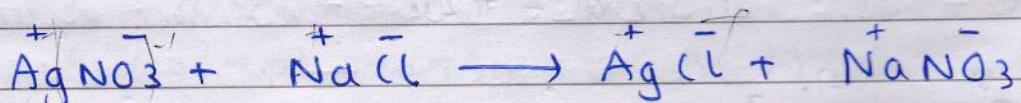
- Reduction can also be said as decrease in oxidation number.



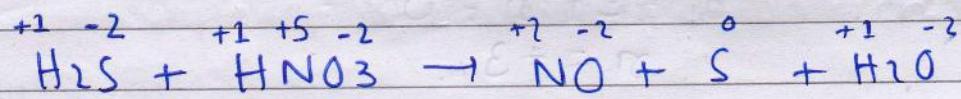


Here chlorine undergoes reduction to bring oxidized Sodium. So it is the oxidation agent oxidizing agent and Na has brought the reduction of Cl so it is called reducing agent.

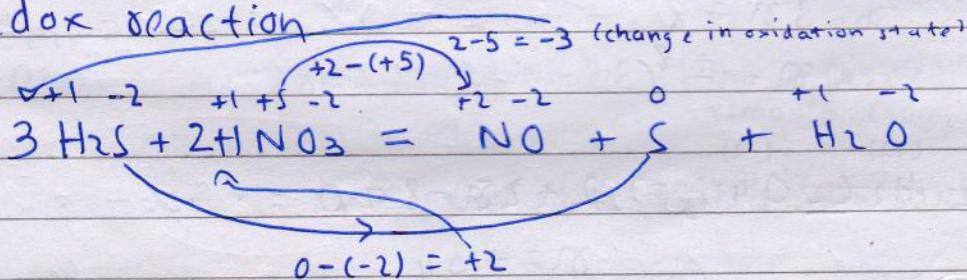
Balancing Redox equations



This is not redox reaction. because there is no change in oxidation state

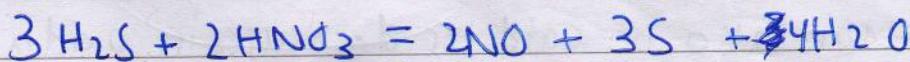


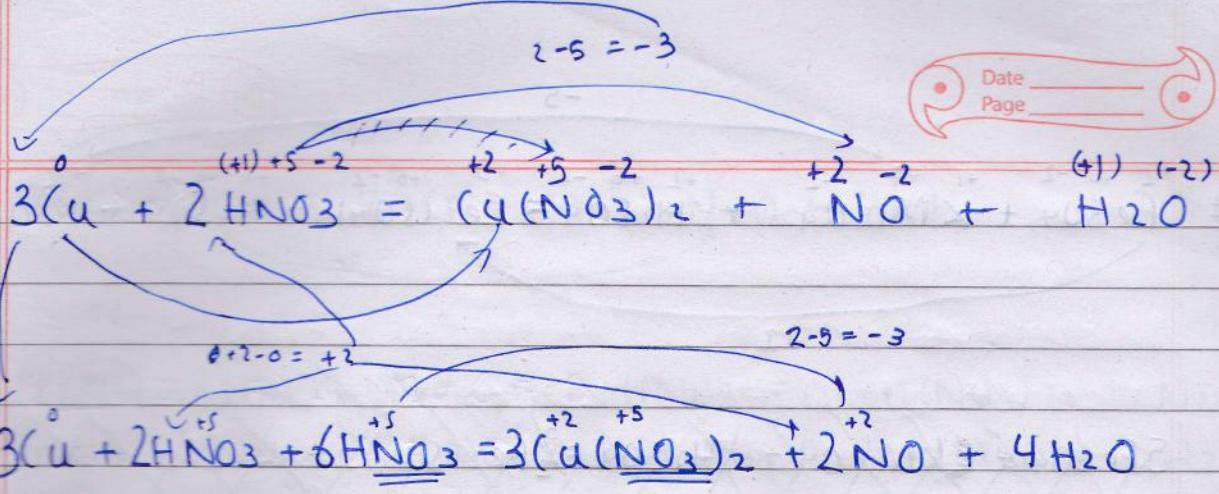
Here the oxidation state of Sulfur¹ and Nitrogen is changed so it is redox reaction



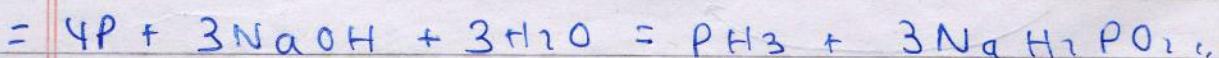
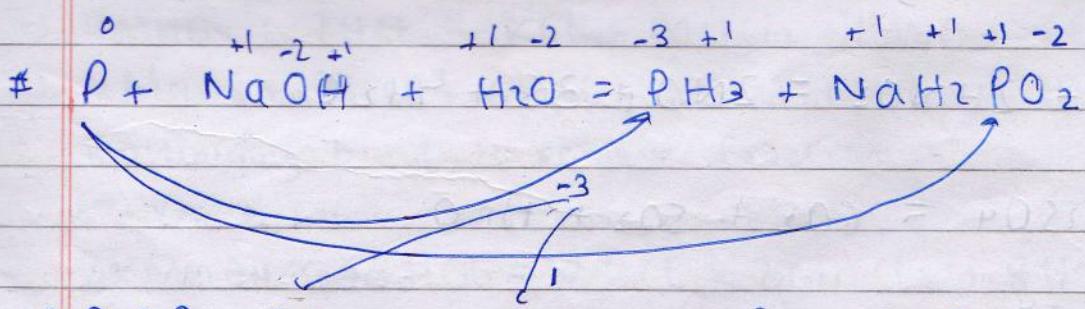
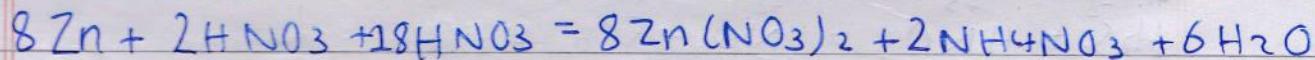
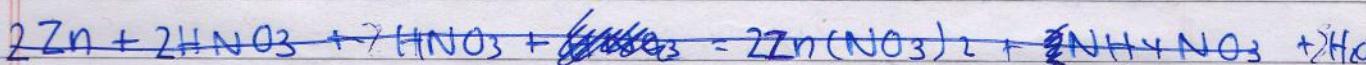
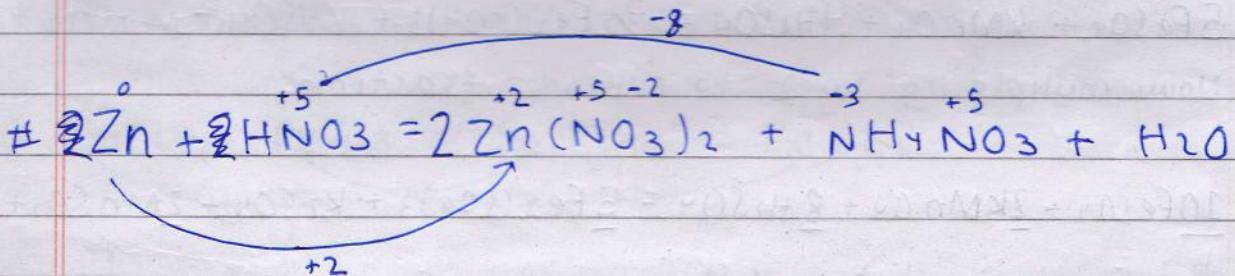
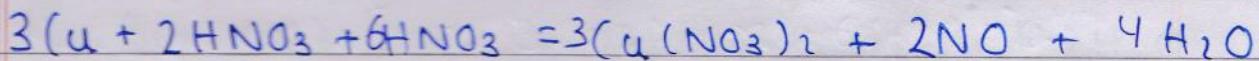
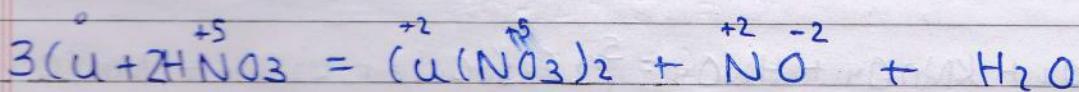
They should be crossed oxidation to reduction & vice versa

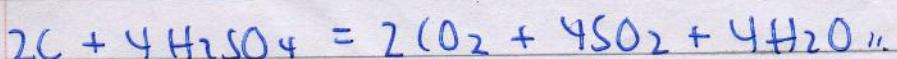
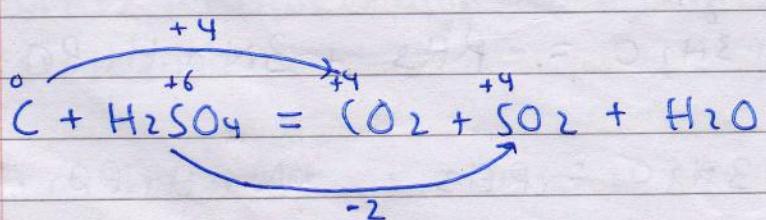
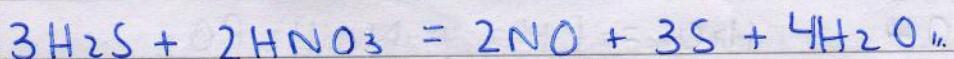
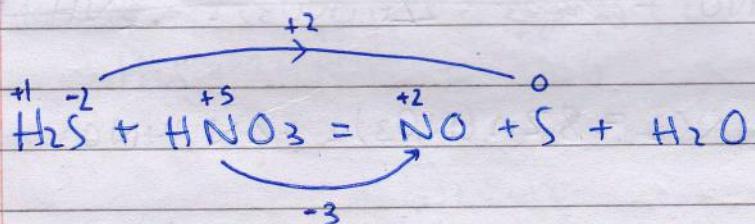
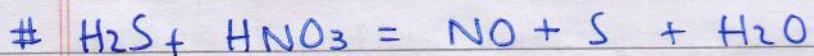
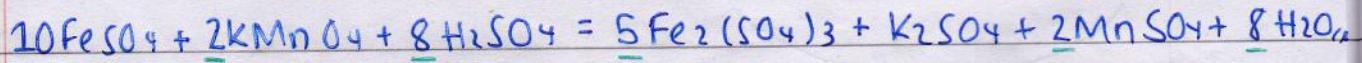
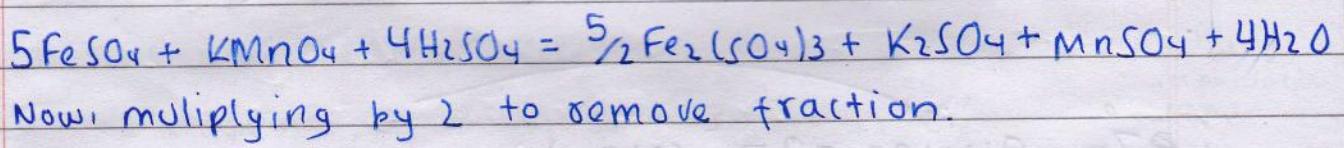
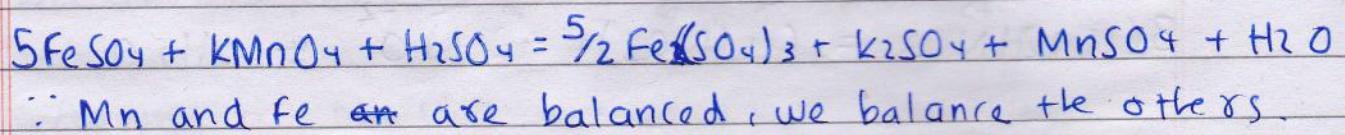
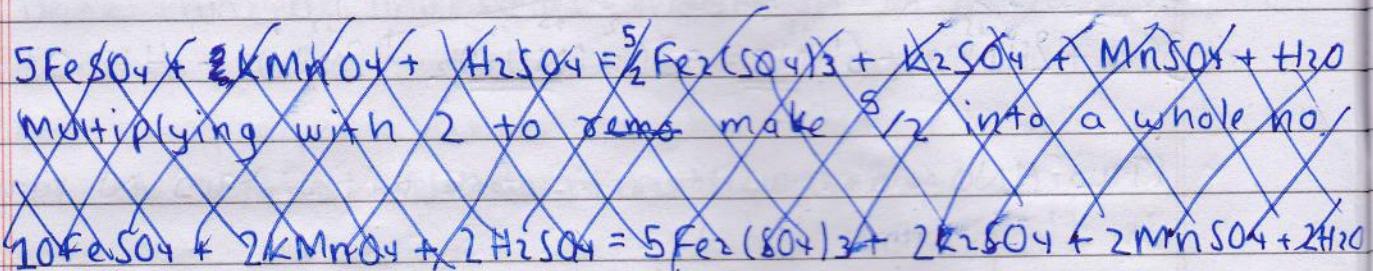
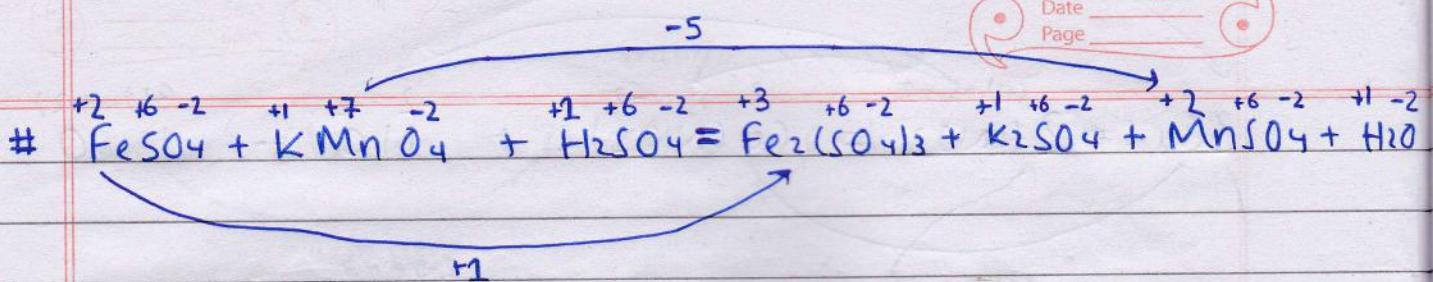
Now we balance those which have changed their oxidation state, then finally we balance ~~H or O~~ the other elements.

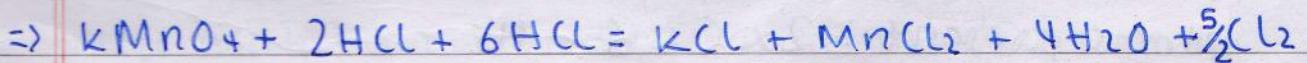
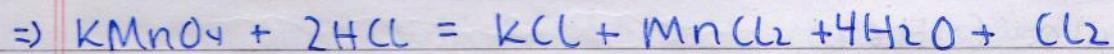
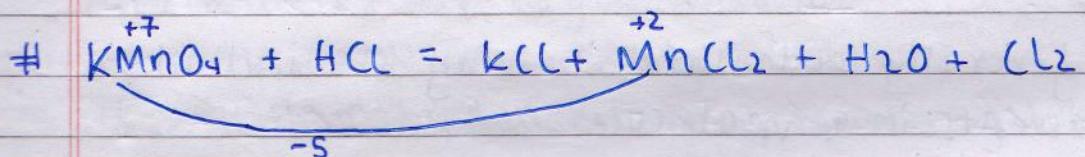
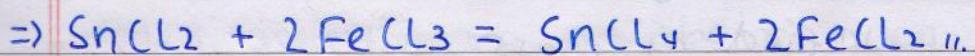
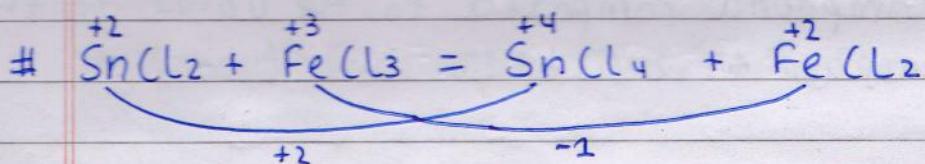
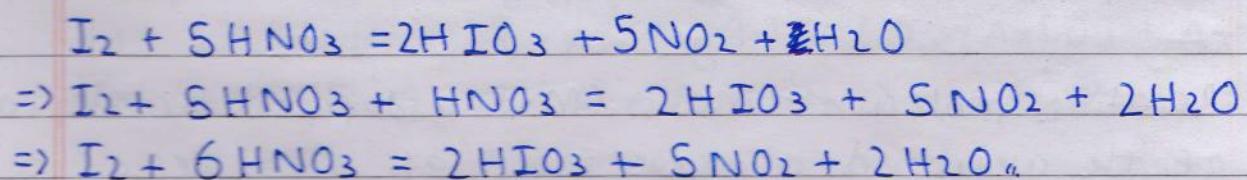
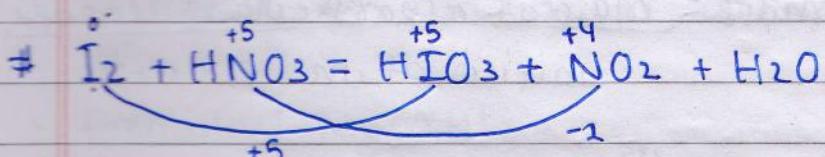
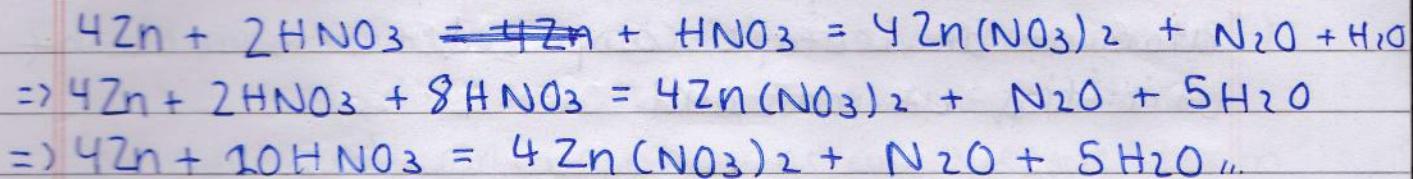
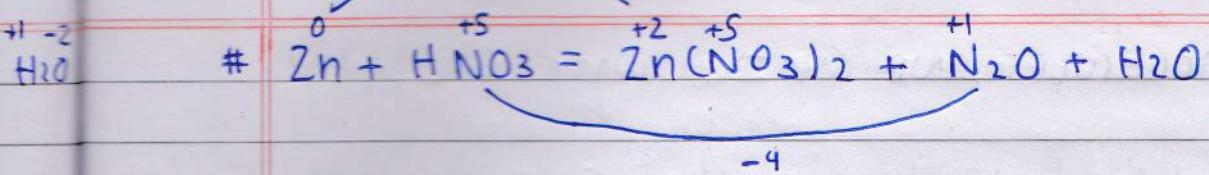




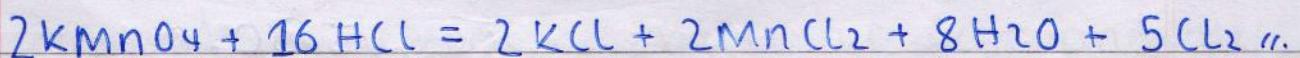
(Two HNO_3 are written to work with two N compounds in the product side)





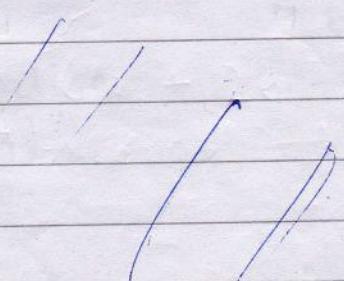
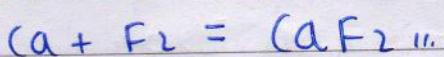
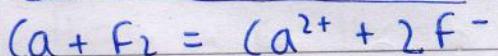
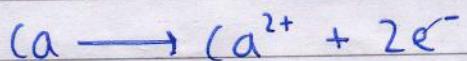
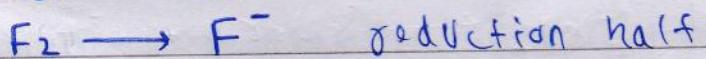
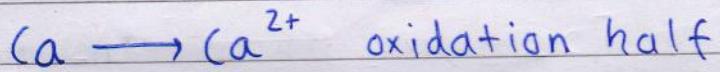
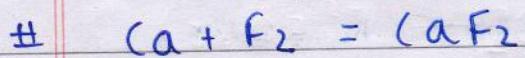
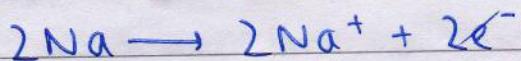
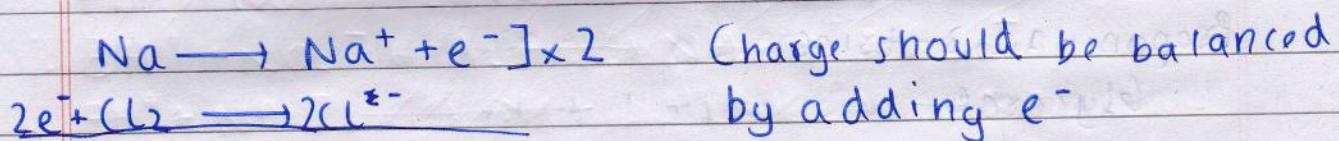
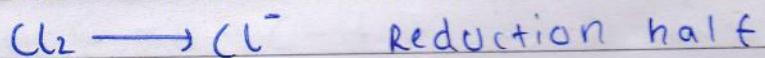
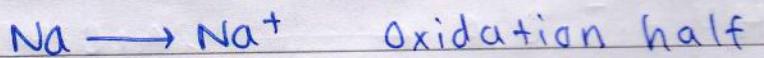


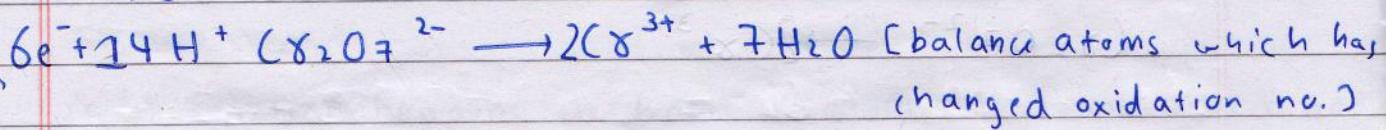
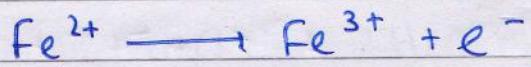
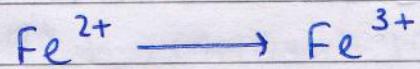
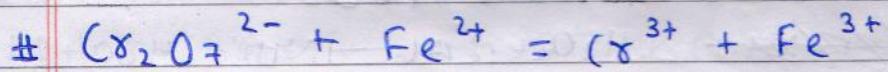
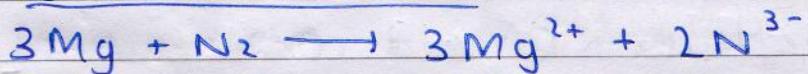
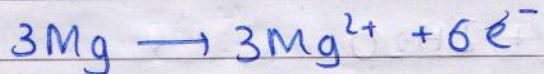
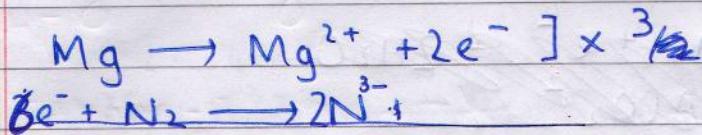
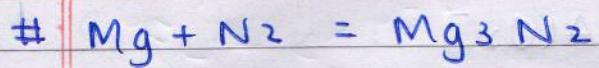
Multiplying by 2 to remove fraction.



REDOX...

Ion electron method



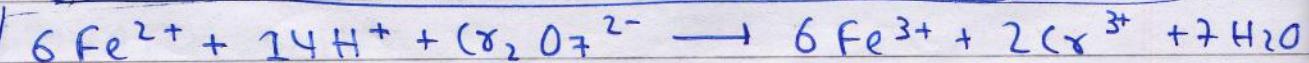
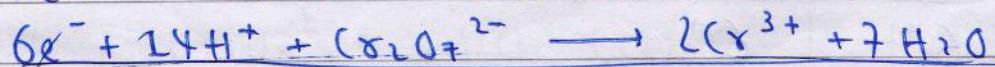
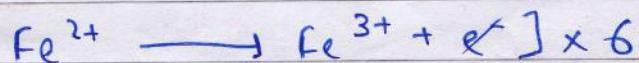


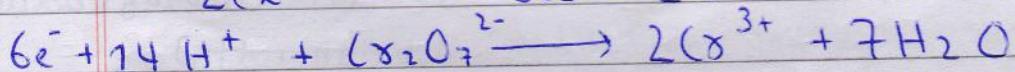
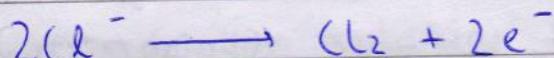
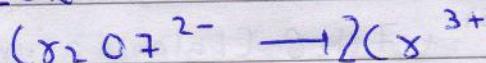
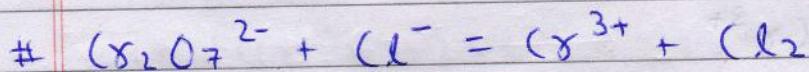
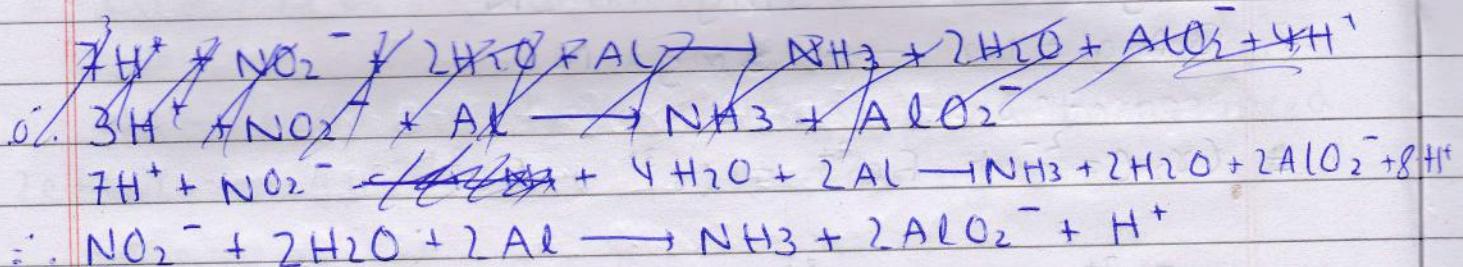
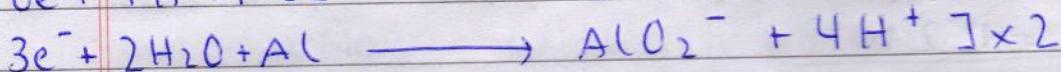
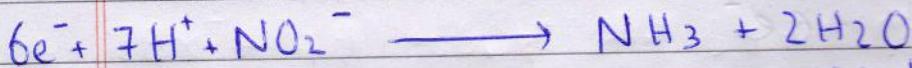
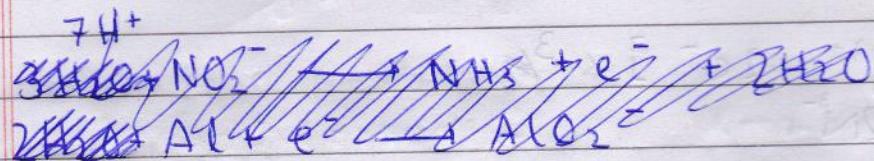
LHS	RHS
$N^{+}, 2^-$	6^+
12^+	6^+
Add $6e^-$	
6^+	6^+

[balance O_2] by adding H_2O

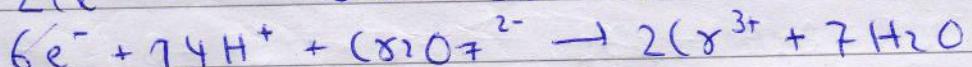
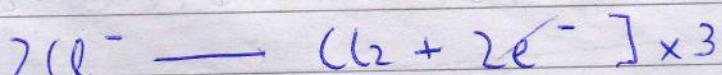
[balance H_2]

[balance charge]

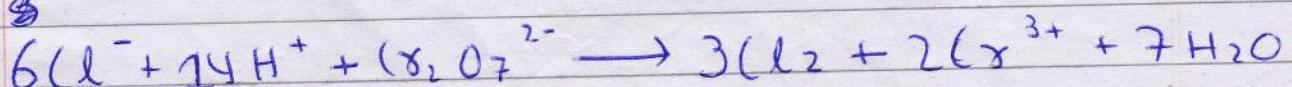


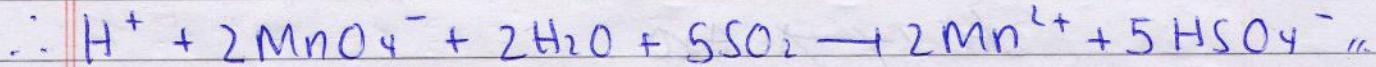
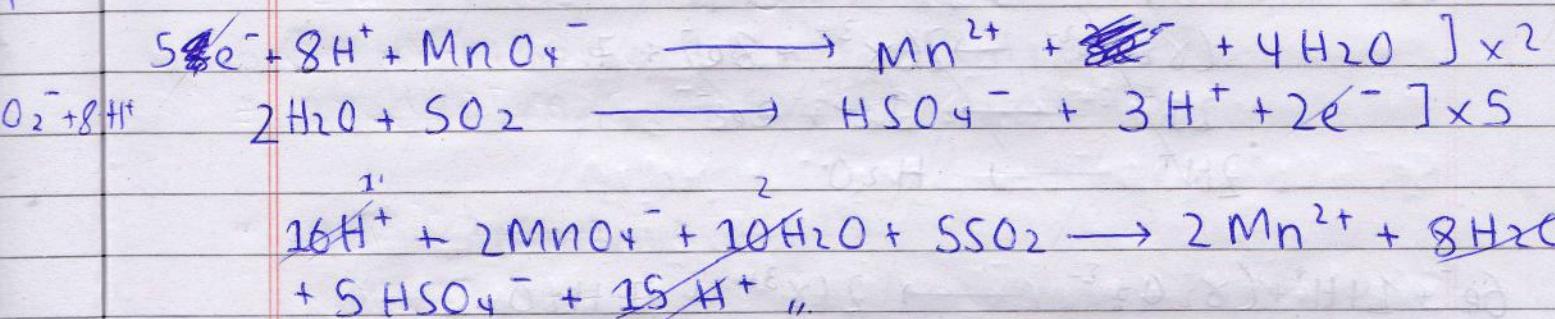
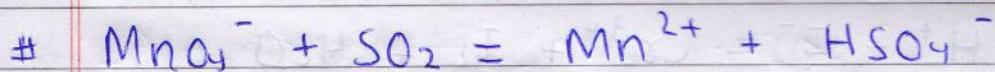
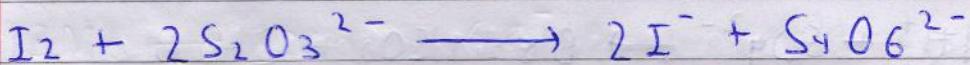
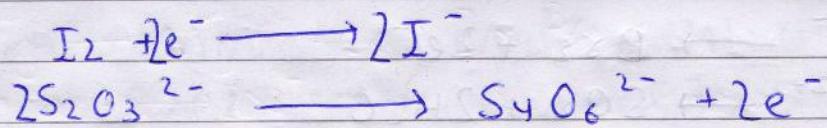
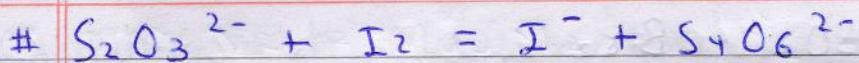


LHS	RHS
$14^+, 2^-$	6^+
22^+	6^+
$+ 6e^-$	
6^+	6^+

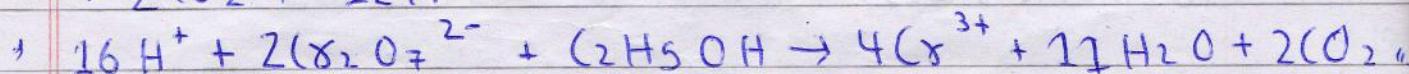
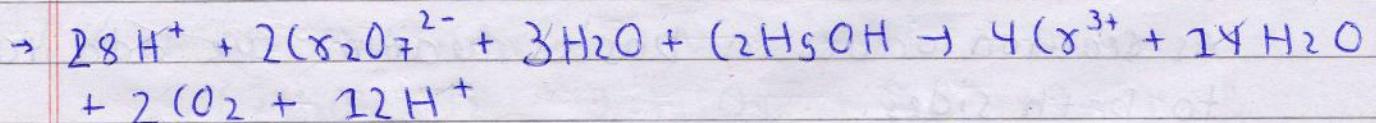
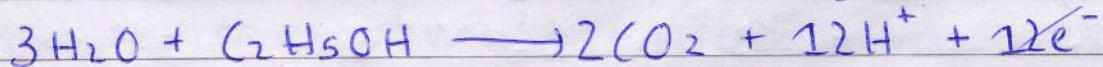
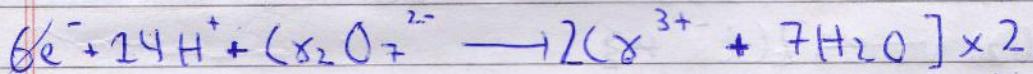
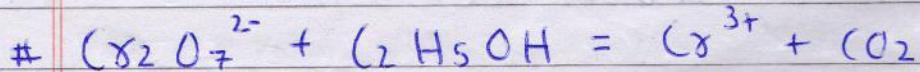


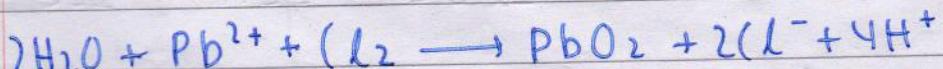
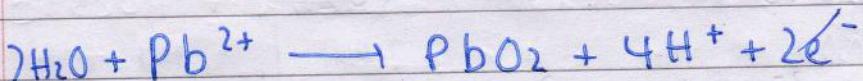
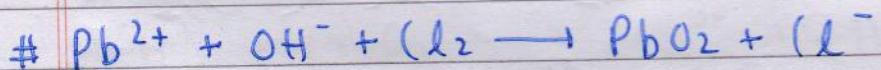
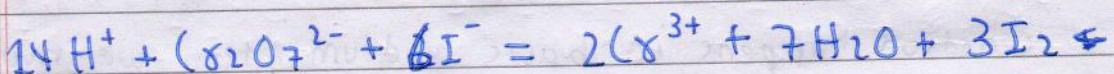
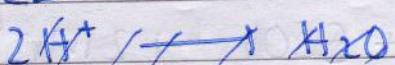
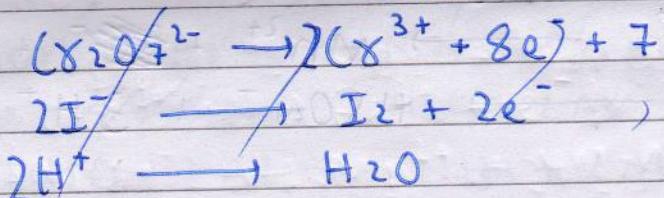
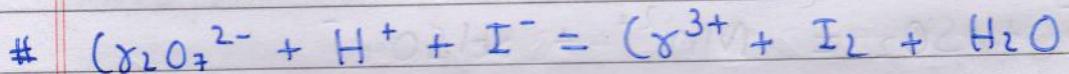
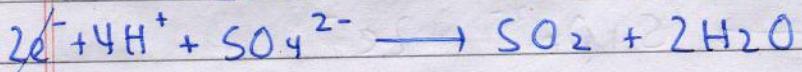
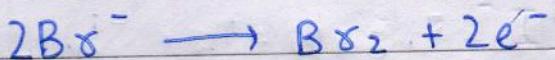
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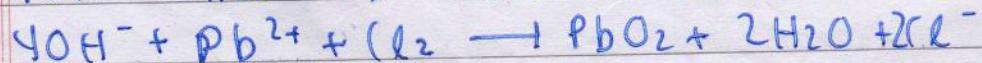
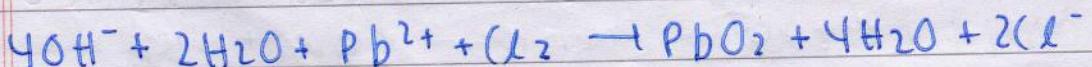


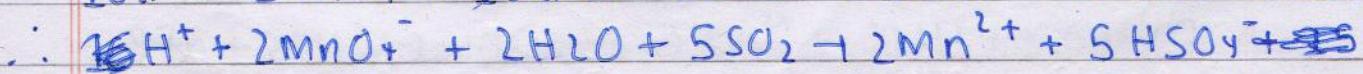
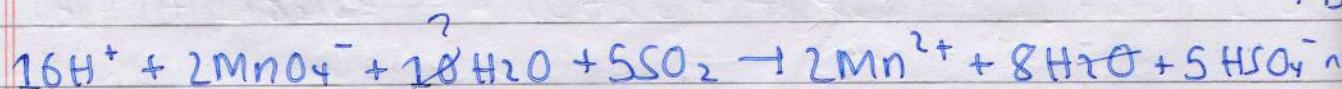
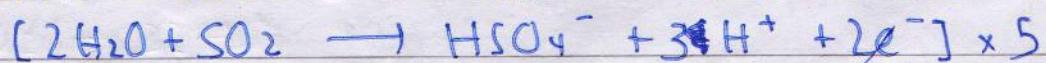
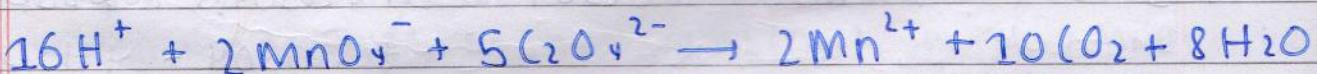
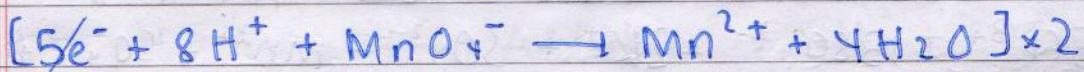
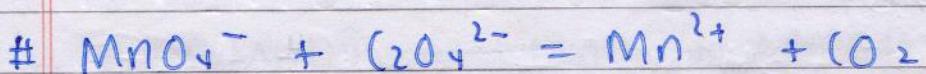
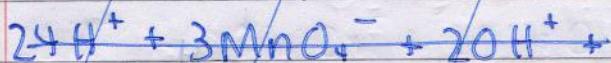
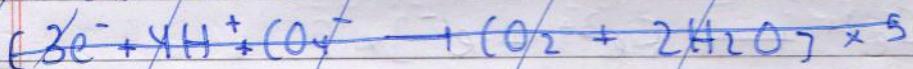
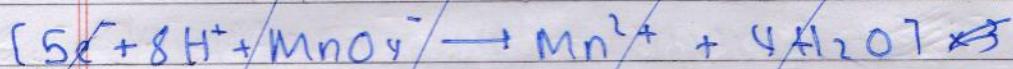
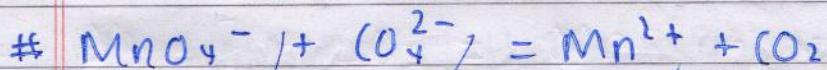
If the reaction happens in basic medium, then we must add OH^- to both sides.

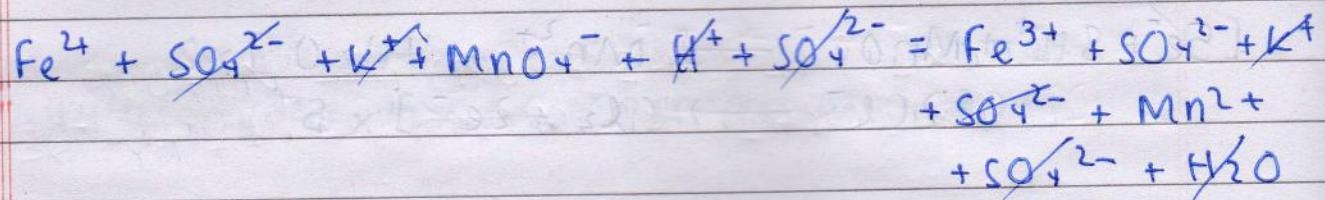
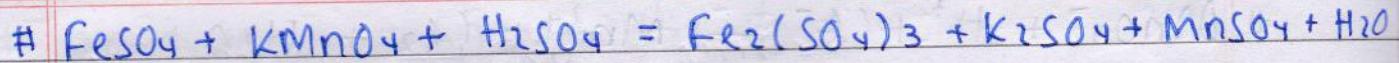




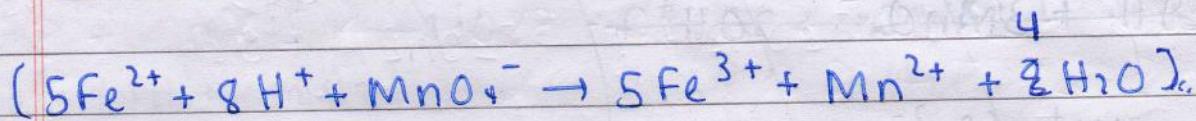
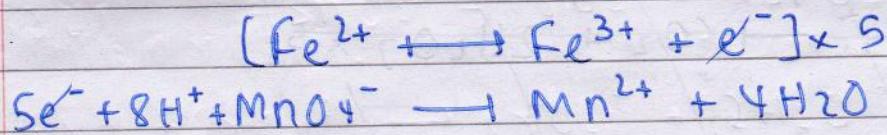
As reaction occurs in basic medium we add 4OH^- to both sides.



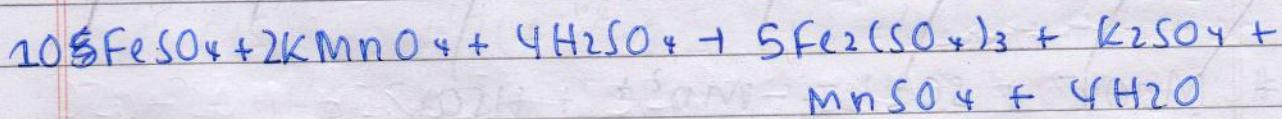
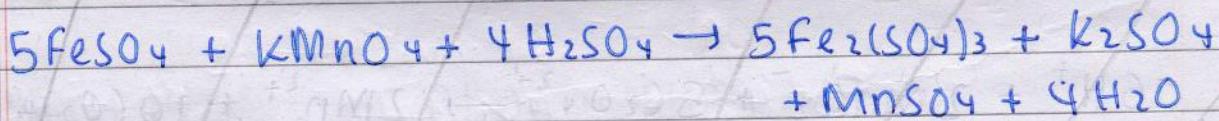
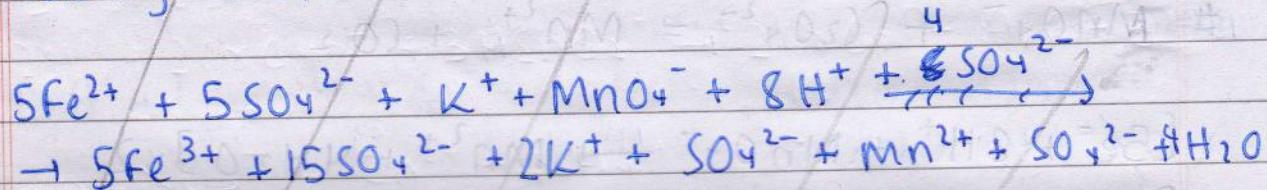


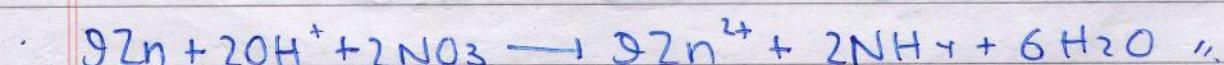
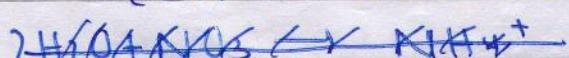
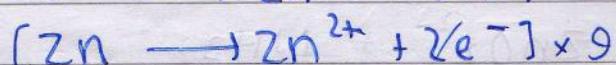
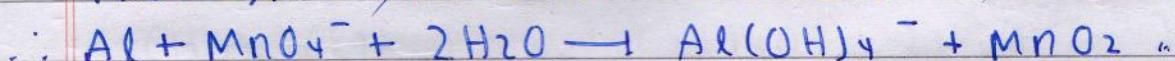
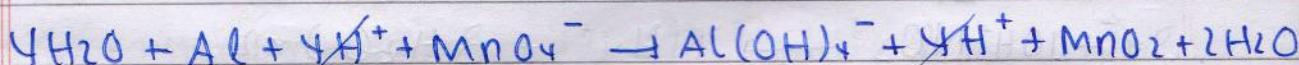
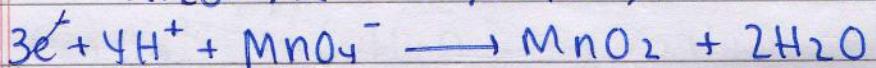
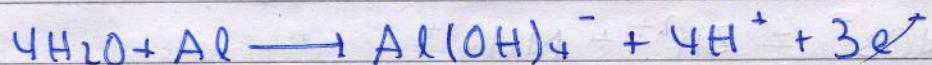
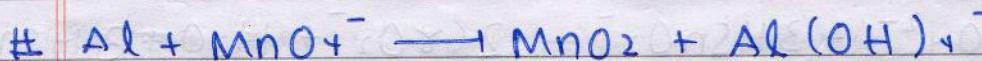
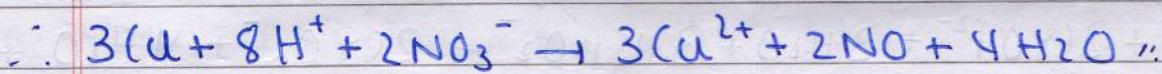
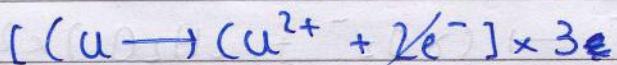
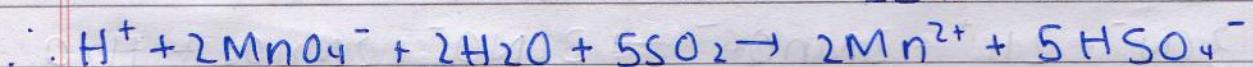
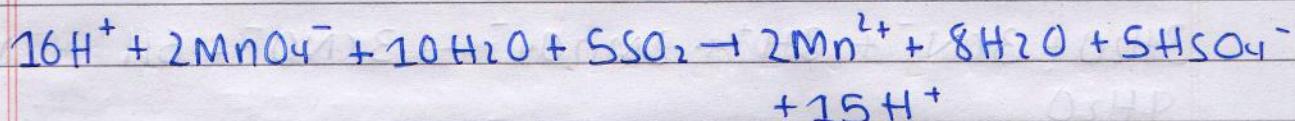
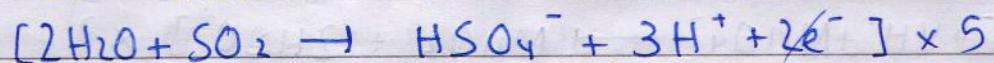
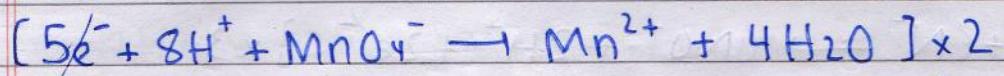


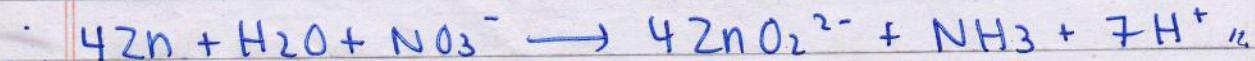
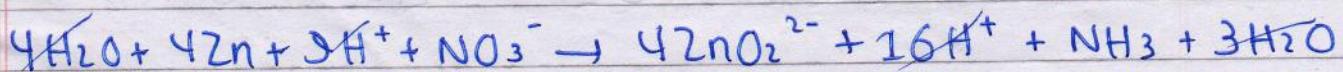
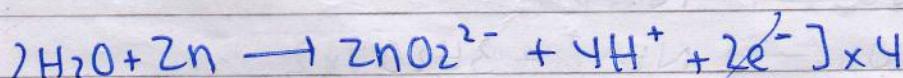
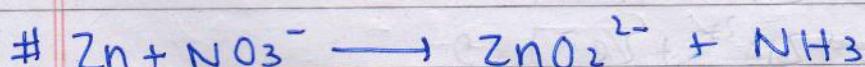
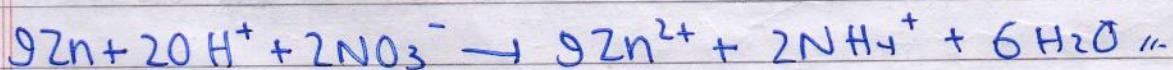
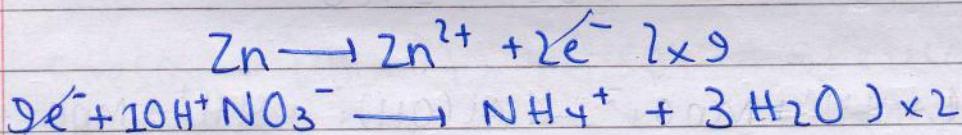
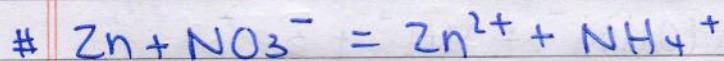
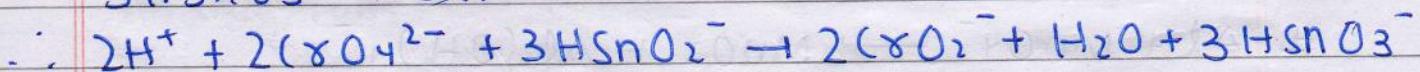
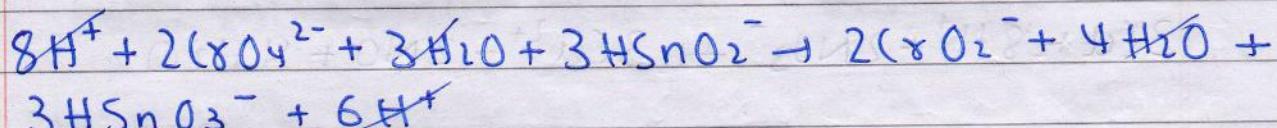
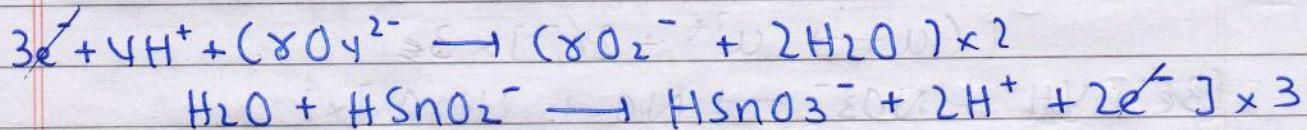
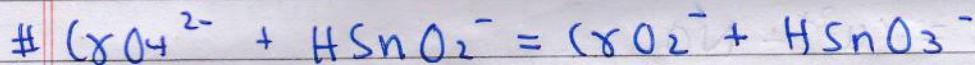
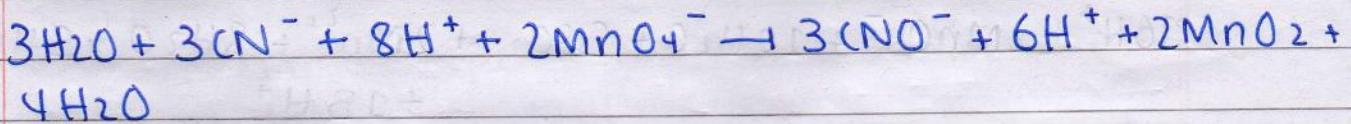
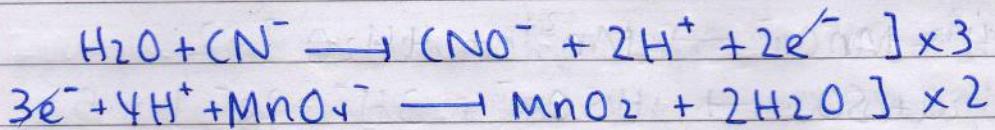
Now we remove spectator ions (which don't change their oxidation states)

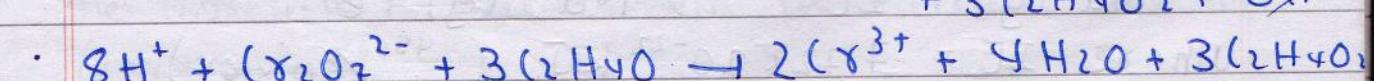
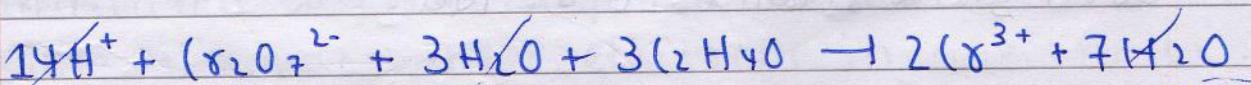
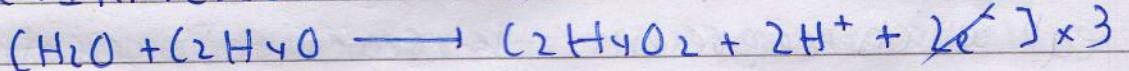
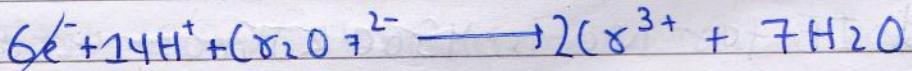
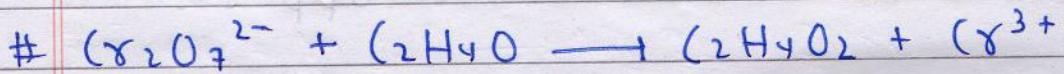
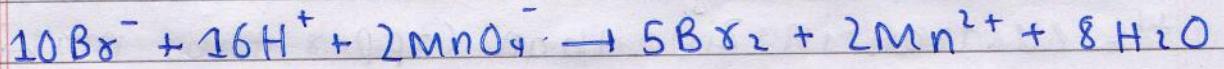
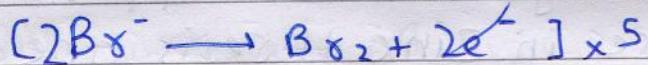
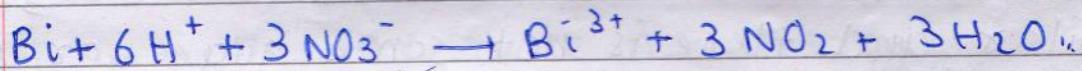
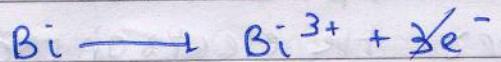
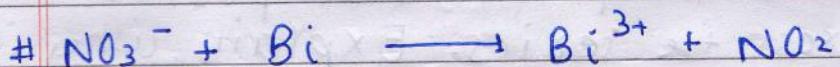
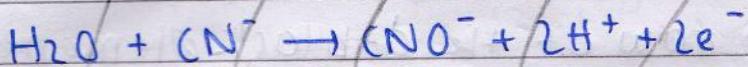
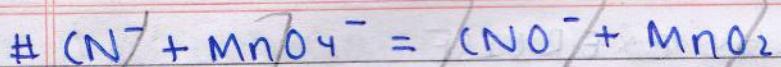


Adding ions,









Naming of compounds

Cu_2O - Cuprous oxide (Copper (I) oxide)

CuO - Cupric oxide (Copper (II) oxide)

Cr_2O_3 - Chromium (III) oxide

V_2O_5 - Vanadium (V) oxide

$\text{Fe}_2(\text{SO}_4)_3$ - Iron (III) sulphate

Mn_2O_7 - Manganese (VII) oxide

$\text{K}_2\text{Cr}_2\text{O}_7$ - Potassium dichromate (VI)

$\text{Na}_2\text{Cr}_2\text{O}_4$ - Sodium chromate (VI)

AuCl_3 - Gold (III) chloride

NaClO_3 - Sodium chlorate (V)