

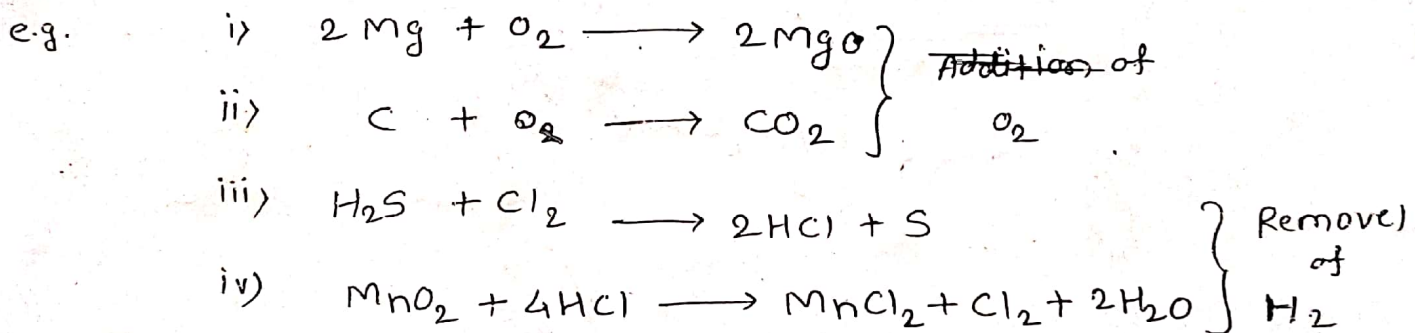
oxidation & Reduction.Introduction:-

The concept of oxidation & reduction is very important in our day to day life.

- e.g.
- 1) Rusting of iron
 - 2) Generation of electricity
 - 3) Extraction & purification of metal
 - 4) Digestion of food in our body.

* Classical concept :-

oxidⁿ :- According classical (earlier) concept oxidation is defined as the addition of oxygen ~~or~~ (electronegative elements) or removal of hydrogen.

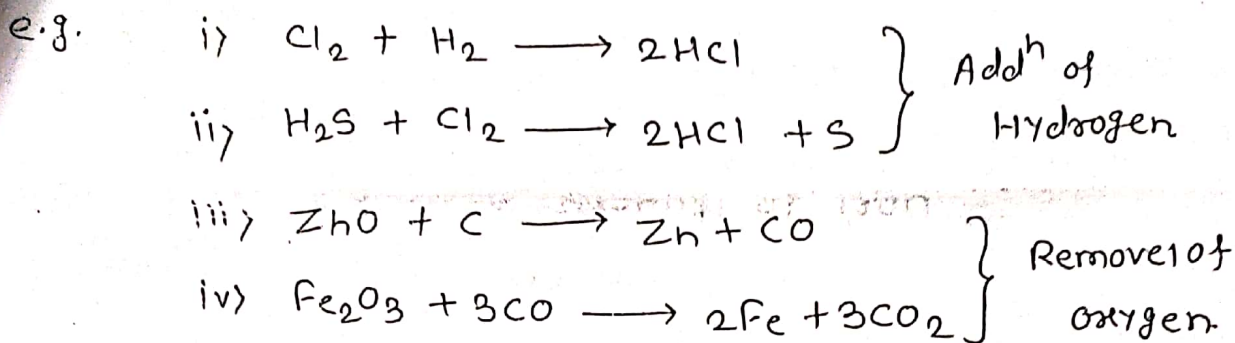


oxidising agent :- A substance which can bring about the oxidation called oxidising agent or oxidant.

- e.g. In above example 1 & 2 O_2 is an oxidising agent
 1) Cl_2 & MnO_2 act as oxidising agent in reacⁿ
 ③ & ④ respectively because they remove hydrogen &
 bring about oxidation.

Reduction :-

According to classical concept, reduction is defined as the addition of hydrogen or removal of oxygen.



Reducing agent :-

A substance which provides hydrogen or removes oxygen is called as reducing agent.

or
The substance which can bring about reduction called reducing agent or reductant.

eg. In above ex. H_2 , H_2S , C & CO are reducing agent because they bring about reduction reaction.

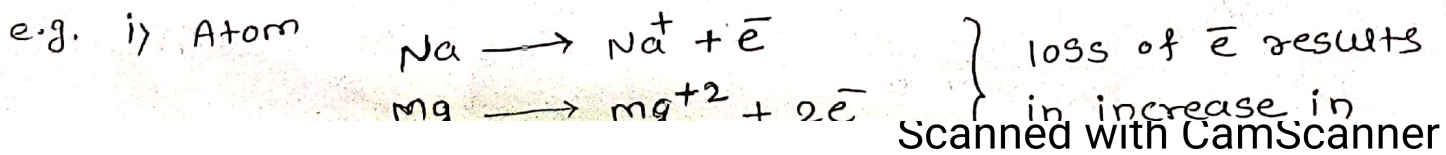
* Electronic concept :-

oxidation & reduction reaction are defined in terms of electron transfer betⁿ the reactants, known as electronic concept of oxidation & reduction.

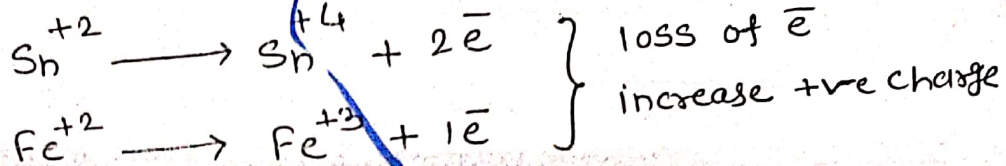
1) oxidation :- (de-electronation)

According to electronic concept, oxidation is a process which involves loss of electrons by an atom or group of atoms.

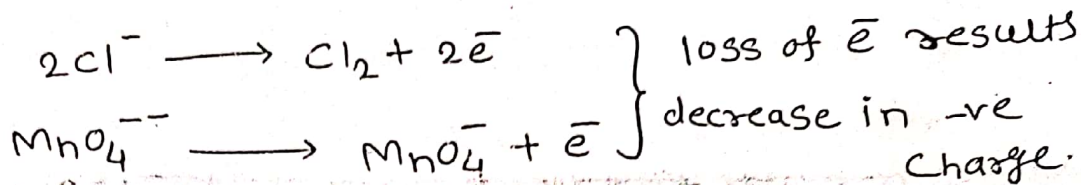
As a result of loss of \bar{e} s, there is increase in the positive charge or decrease in negative charge of the atom or ion undergoing oxidation.



ii) cation



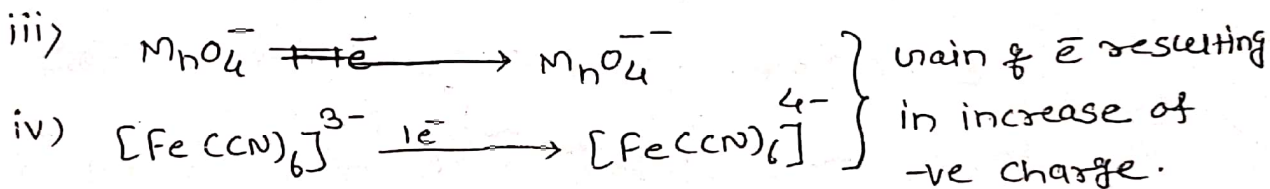
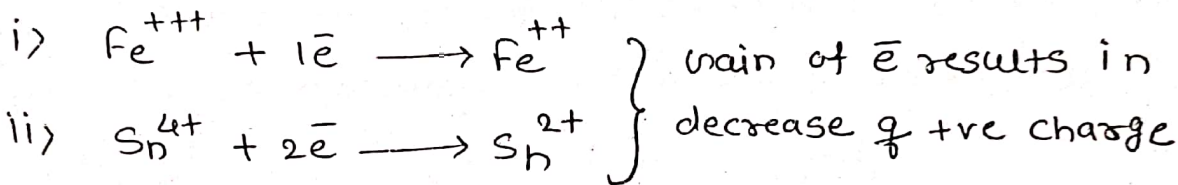
iii) Anion



2) Reduction :- (Electronation)

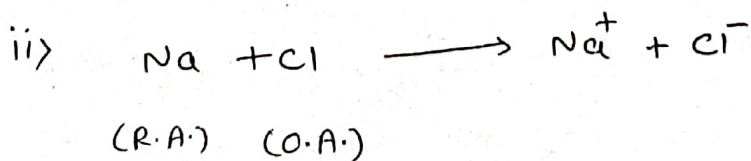
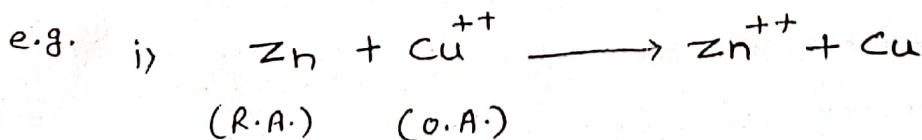
According to electronic concept, reduction is a process which involves gain of \bar{e} by an atom or group of atoms. Due to gain of \bar{e} there is increase of negative charge of an atom or ion undergoing reduction.

e.g.



oxidising agent / Reducing agent :-

According to electronic concept, the substance which accept \bar{e} known as oxidising agent. & which gives \bar{e} s are known as reducing agent.



Oxidation state or oxidation number :-

oxidation number is defined as the charge which an atom appears to have when all other atoms are removed from it as ions.

The sign of charge or numerical value on the element known as oxidatⁿ state or oxidⁿ number.

Rules to assign the oxidation number :-

1) The oxidation number of an element in the free or elementary state is always zero.

e.g. He, H₂, O₂, Fe, Br₂, P₄, Cl₂, S₈ etc have zero oxidⁿ state

2) The oxidation number of an element in a single (mono-atomic) ion is the same as the charge on the ion.

e.g. $K^{+1} = +1$; $Al^{+3} = +3$; $SO_4^{2-} = -2$
 $\underline{Ca^{+2}} = +2$; $Cl^{-} = -1$; $PO_4^{3-} = -3$

3) In binary compounds of metals & non-metals the oxidation number of metal is always +ve, while that of the non-metal is -ve.

e.g. NaCl \Rightarrow Na = +1, Cl = -1.

4) In compounds formed by the combination of non-metallic atoms, the atom with higher electronegativity is given negative oxidation number.

e.g. HCl \Rightarrow Cl = -1, H = +1

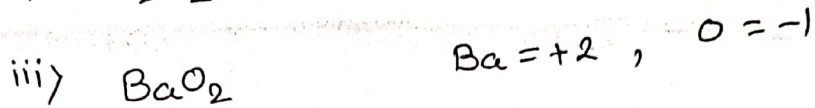
NaF \Rightarrow Na = +1, F = -1

5) The oxidation number of hydrogen is +1, except in hydrides of active metal

e.g. LiH, NaH, KH, MgH₂, CaH₂ where hydrogen has

(4)

The oxidation number of oxygen is -2 except in Peroxides in which it is -1. & in the compound OF_2 is +2.



7) For neutral molecule the sum of the oxidation numbers of all the atoms is equal to zero.

e.g. In NH_3 the sum of oxidⁿ numbers of nitrogen & hydrogen atom is equal to zero.

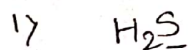
8) For a complex ion, the sum of the oxidation numbers of all the atoms is equal to charge on the ion.



$$S - 8 = -2$$

$$\therefore \underline{S = +6}$$

Q. Calculate the oxidⁿ number of an underline element

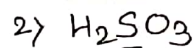


$$\Rightarrow +1 \times 2 + x = 0$$

$$+2 + x = 0$$

$$\therefore \underline{x = -2}$$

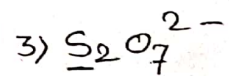
O.N. of S in H_2S is -2.



$$\Rightarrow +1 \times 2 + x + (-2 \times 3) = 0$$

$$+2 + x - 6 = 0$$

$$\underline{x = +4}$$

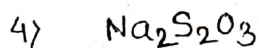


$$\Rightarrow 2x + (-2 \times 7) = -2$$

$$2x - 14 = -2$$

$$2x = +12$$

$$\therefore \underline{x = +6}$$



$$\Rightarrow +1 \times 2 + 2x - 6 = 0$$

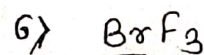
$$2x - 4 = 0$$

$$\therefore x = +2$$



$$x - 6 = -1$$

$$\underline{x = +5}$$



$$x + (-1 \times 3) = 0$$

$$\underline{x = +3}$$

(F)

$$\begin{aligned} &\underline{\text{C}}\text{H}_4 \\ &x + 4 = 0 \\ &\underline{x = -4} \end{aligned}$$

$$\begin{aligned} 8) &\underline{\text{C}}_6\text{H}_{12}\text{O}_6 \\ &6x + 12 - 12 = 0 \\ &\underline{x = 0} \end{aligned}$$

$$\begin{aligned} 9) &\text{Na}_2\underline{\text{B}}_4\text{O}_7 \\ &+ 2 + 4x - 14 = 0 \\ &4x = 12 \\ &\underline{x = +3} \end{aligned}$$

$$\begin{aligned} 10) &\underline{\text{C}}\text{O}_2 \\ &x - 4 = 0 \\ &\underline{x = +4} \end{aligned}$$

$$\begin{aligned} 11) &\underline{\text{Si}}\text{O}_2 \\ &x - 4 = 0 \\ &\underline{x = +4} \end{aligned}$$

$$\begin{aligned} 12) &\underline{\text{Pb}}\text{SO}_4 \\ &x - 2 = 0 \\ &\underline{x = +2} \end{aligned}$$

$$\begin{aligned} 13) &\underline{\text{Cl}}\text{O}_4^- \\ &x - 8 = -1 \\ &\underline{x = +7} \end{aligned}$$

$$\begin{aligned} 14) &\underline{\text{P}}\text{O}_4^{3-} \\ &x - 8 = -3 \\ &\underline{x = +5} \end{aligned}$$

$$\begin{aligned} 15) &\underline{\text{C}}\text{Cl}_4 \\ &x - 4 = 0 \\ &x = +4 \end{aligned}$$

$$\begin{aligned} 16) &\text{H}\underline{\text{N}}\text{O}_3 \\ &+ 1 + x - 6 = 0 \\ &\underline{x = +5} \end{aligned}$$

$$\begin{aligned} 17) &\text{H}\underline{\text{N}}\text{O}_2 \\ &+ 1 + x - 4 = 0 \\ &\underline{x = +3} \end{aligned}$$

$$18) \underline{\text{N}}\text{O} = +2$$

$$19) \underline{\text{N}}_2\text{O} = +1$$

$$20) \underline{\text{N}}_2 = 0$$

$$\begin{aligned} 21) &\text{K}_2\underline{\text{Cr}}_2\text{O}_7 \\ &+ 2 + 2x - 14 = 0 \\ &2x = +12 \\ &\underline{x = +6} \end{aligned}$$

$$\begin{aligned} 22) &\text{H}_3\underline{\text{P}}\text{O}_4 \\ &+ 3 + x - 8 = 0 \\ &\underline{x = +5} \end{aligned}$$

$$\begin{aligned} 23) &\text{K}_2\underline{\text{S}}_2\text{O}_8 \\ &+ 2 + 2x - 16 = 0 \\ &2x = +14 \\ &\underline{x = +7} \end{aligned}$$

$$\begin{aligned} 24) &\underline{\text{Si}}\text{O}_4^- \\ &x - 8 = -1 \\ &\underline{x = +7} \end{aligned}$$

$$\begin{aligned} 25) &\text{Na}_2\underline{\text{S}}_4\text{O}_6 \\ &+ 2 + 4x - 12 = 0 \\ &4x = 10 \\ &x = +2.5 \end{aligned}$$

$$\begin{aligned} 26) &\underline{\text{Fe}}_3\text{O}_4 \\ &3x - 8 = 0 \\ &x = +8/3 \end{aligned}$$

$$27) \underline{\text{C}}_2\text{O}_4^{2-} = +3$$

$$29) \underline{\text{N}}_3\text{H} = -1/3$$

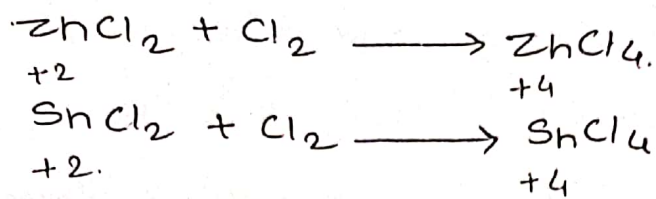
$$28) \underline{\text{N}}\text{H}_4^+ = -3$$

$$30) \underline{\text{S}}_2\text{Cl}_2 = +1$$

Oxidation:-

According to oxidⁿ number concept, to increase the o.n. of an element is known as oxidation.

e.g.



2) Reduction:-

According to oxidation number concept, to decrease the oxidation number of an element is known as reduction.

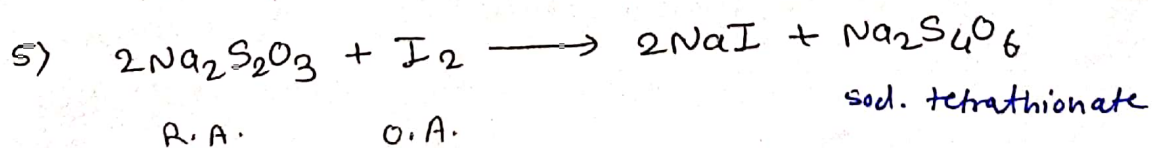
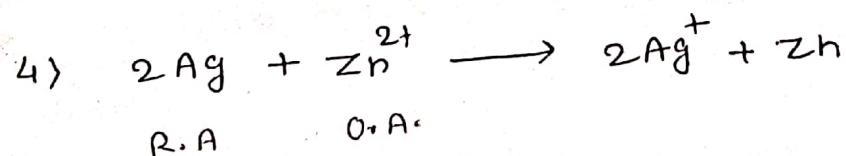
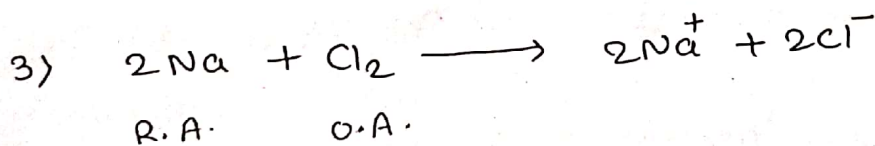
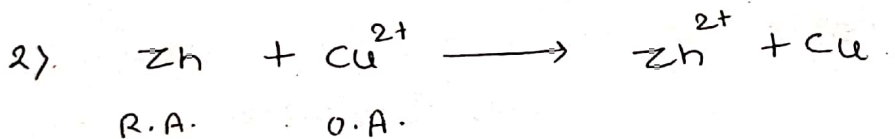
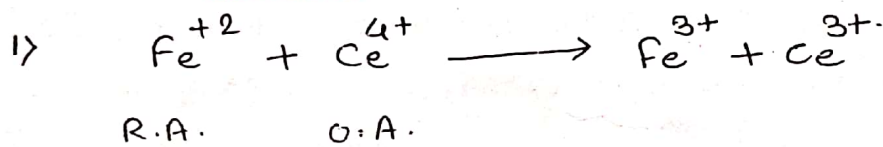
e.g.



oxidising agent (oxidant) / Reducing agent (Reductant)

According to oxidⁿ number concept, oxidising agent is a substance, whose o.n. decreases & Reducing agent is a substance whose o.n. increases.

e.g.



Balancing of Oxidation-Reduction Reaction :-

There are two important methods for the balancing redox reaction

- 1) Oxidation number method
- 2) Ion electron method.

1) Oxidation number method :-

This method was developed by Janson in 1880 for balancing the redox reaction. This method is based on the fact that the increasing & decreasing the o.n. of one or more elements.

In this method increased o.n. should be balanced by decreased o.n. There are several rules to balance the redox reaction by o.n. method & these are as follows

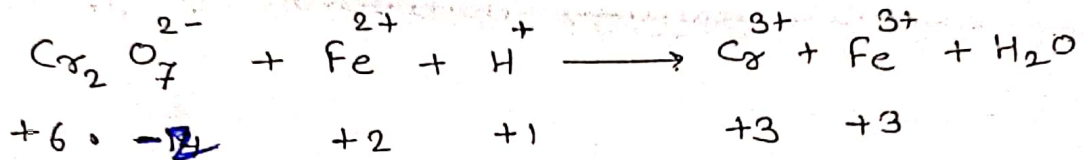
- 1) Write complete redox reaction.
- 2) Write o.n. of each element in compound.
- 3) Find out the element whose o.n. is change, in which one element show increase in o.n. & other element show decrease in o.n.
- 4) Balance both these elements separately by adding e^- to the deficient side.
- 5) Multiply both eqⁿ by a suitable number for balancing equation
- 6) Add both these eqⁿ & cancel the common term from both side.
- 7) Balance the remaining atom by adding oxygen and hydrogen atom.

consider the following reactⁿ in acidic solⁿ as

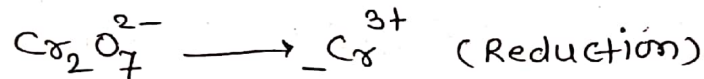
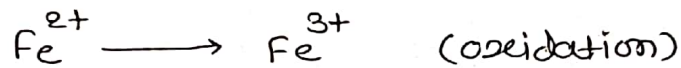


Solⁿ →

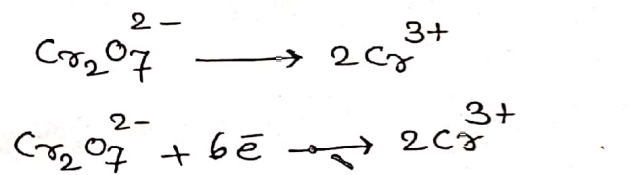
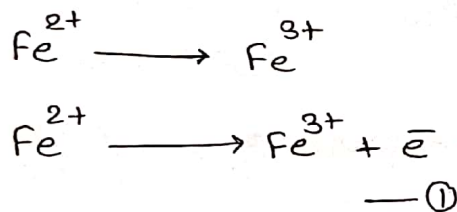
Step-I Write down the oxidⁿ number of various atom.



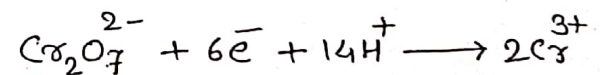
Step-II Write separate eqⁿ for oxidⁿ & redⁿ



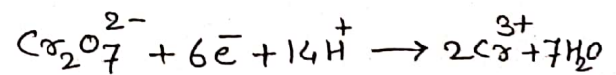
Step-III Balance each half reactⁿ separately.



∵ reactⁿ is in acidic medium
add 14H⁺ on the left side

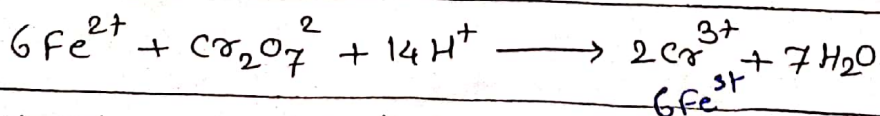
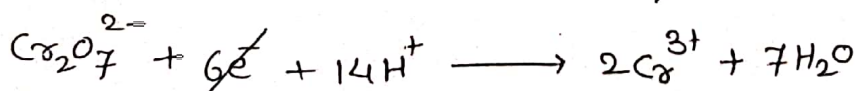
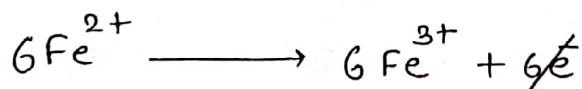


Balance H-atom, add H₂O

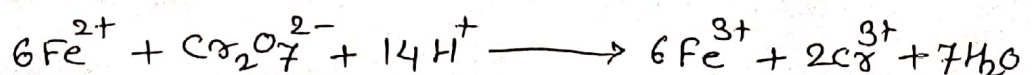


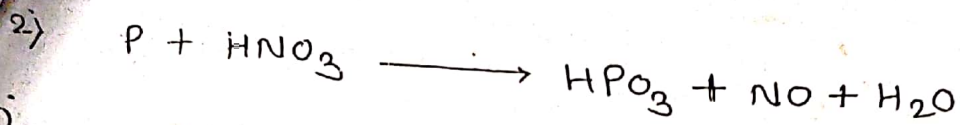
--- ②

Now, multiply eqⁿ ① by 6 so that
e⁻ are balanced

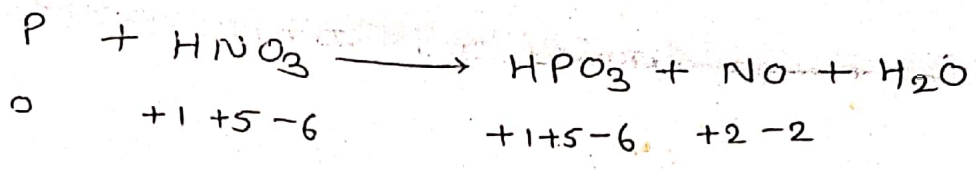


∴ The balanced eqⁿ is

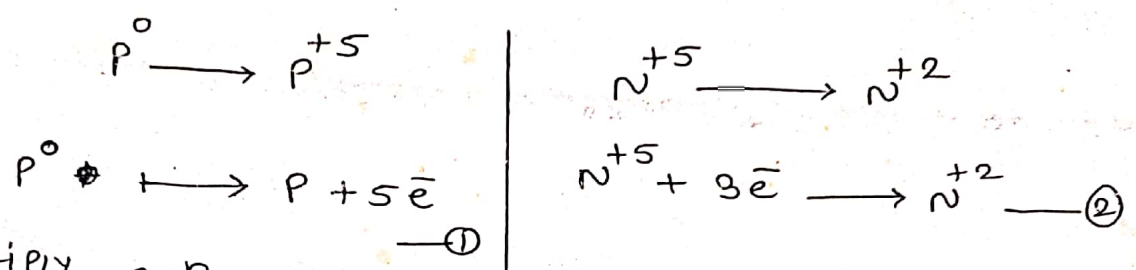




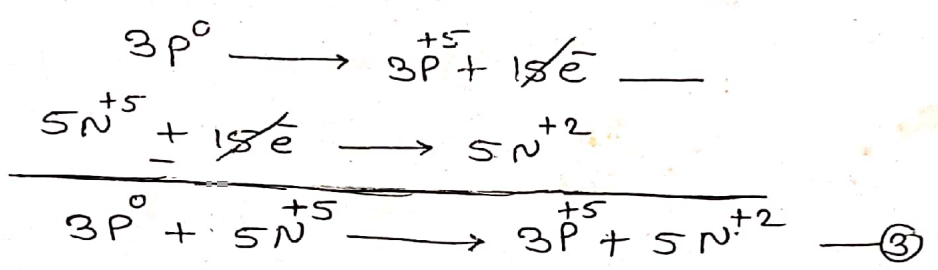
Soln



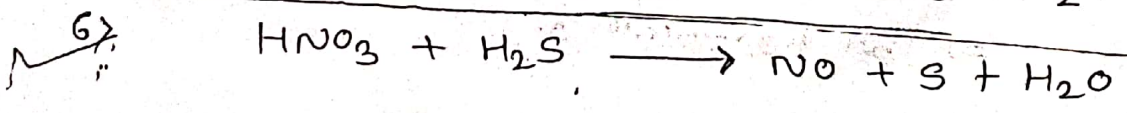
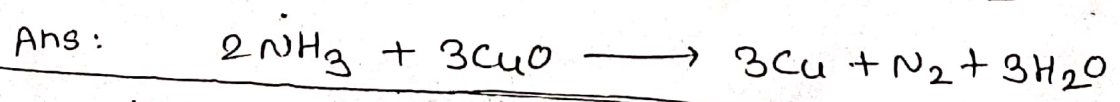
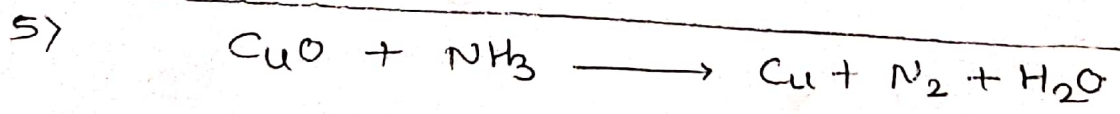
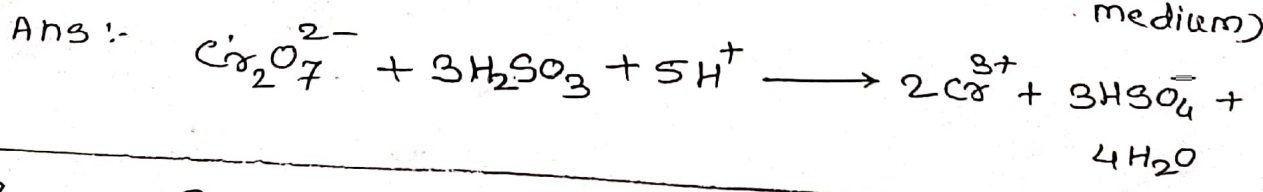
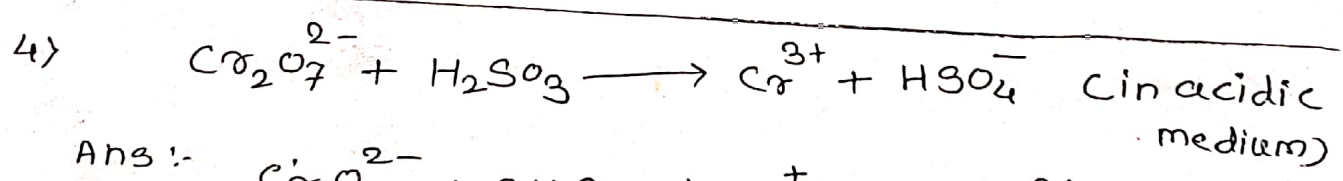
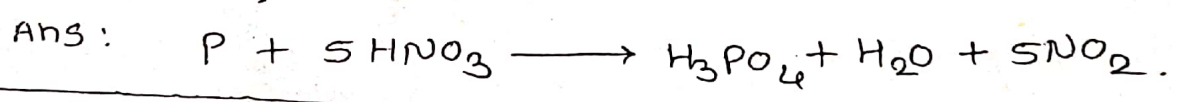
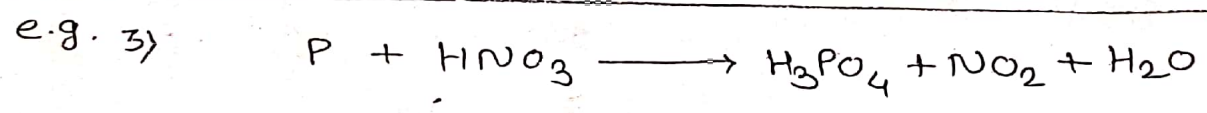
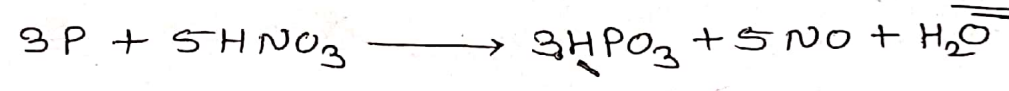
STEP-II



multiply eqn ① by 3 & eqn ② by 5 & add



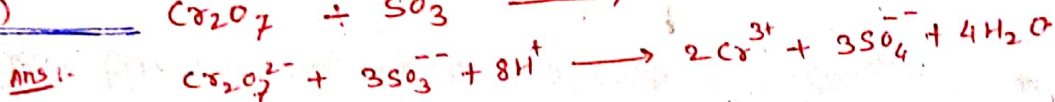
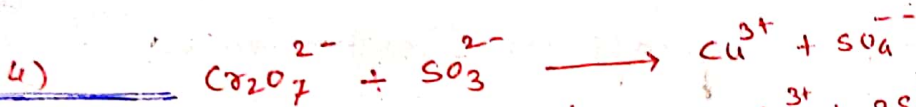
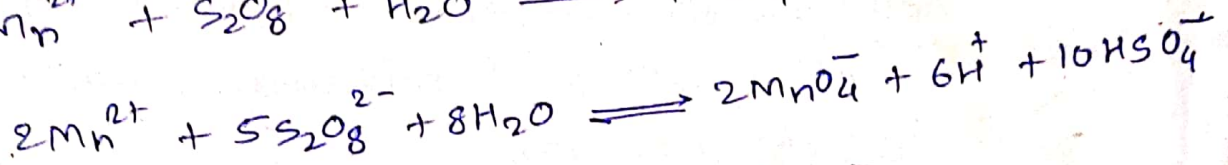
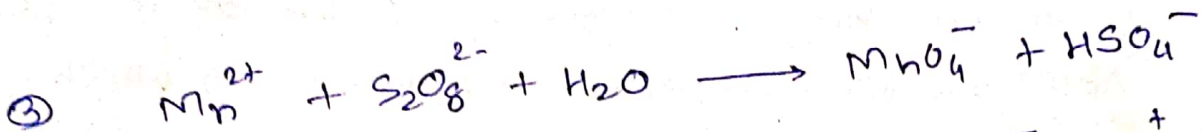
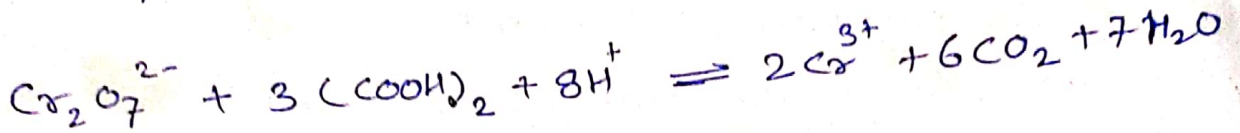
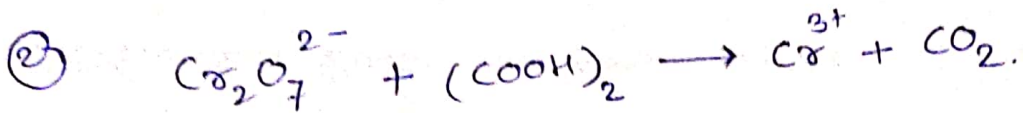
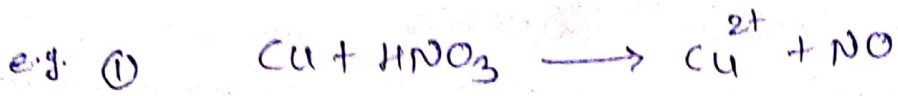
Substitute the coefficient from # 3 in the skeleton eqn



• Ion - Electron method : (Half reacⁿ method)

This method was developed by Jette & LaMer in 1927 for balancing the redox reaction. The rules are as follows

- 1) Write complete reaction using ionic form of reactant & product.
- 2) Split the complete reaction into two half reacⁿ on the basis of pairing of ion or molecule appears in reactant or product. In which one half reacⁿ is of oxidation & another half reacⁿ is of reduction.
- 3) Balance each half reacⁿ separately.
- 4) Balance the oxygen atom by adding water molecule to deficient side.
- 5) Balance the hydrogen atom by adding H^+ to the deficient side.
- 6) Balance the charges by adding e^- s to the deficient side.
- 7) multiply both these reacⁿ by suitable number to balance the reacⁿ.
- 8) Add both these reacⁿ & cancel the common term from both side.



O by H_2O

H by H^+

Charge by e^-

Add & cancel e^-

change $H^+ \rightarrow H_2O$

by adding OH^-

to both side

