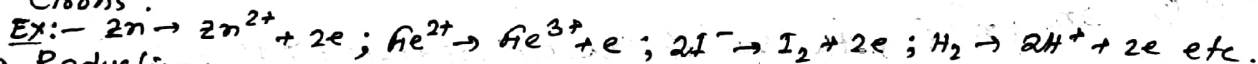


Oxidation & Reduction (Redox Chemistry Section III)

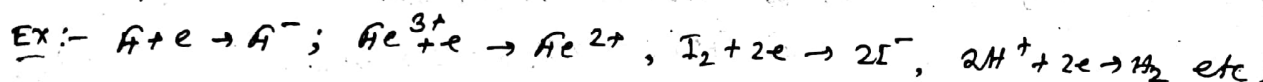
⊗ Oxidation:-

According to the electronic concept, oxidation is a process in which an atom, an ion or a molecule loses one or more electrons.



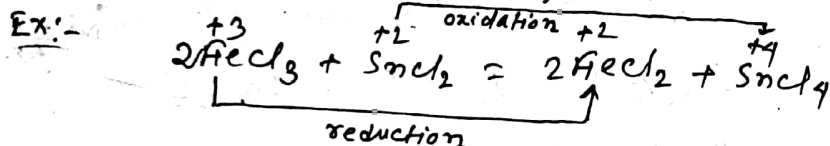
⊗ Reduction:-

According to the electronic concept, reduction is a process in which an atom, an ion or a molecule gains one or more electrons.



⊗ Redox-oxn:-

Redox rxn is a process in which oxidation and reduction takes place simultaneously.

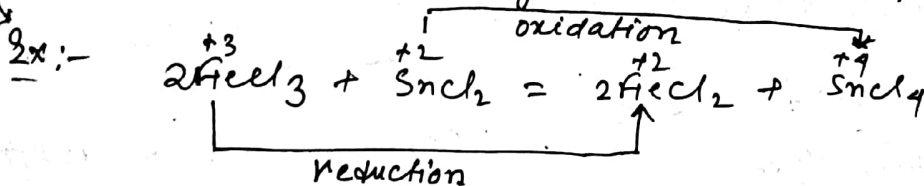


⊗ Oxidising agent:-

An oxidising agent is one that gains electrons and is reduced to a lower oxidation state.

⊗ Reducing agent:-

A reducing agent is one that loses electrons and is oxidised to a higher oxidation state.



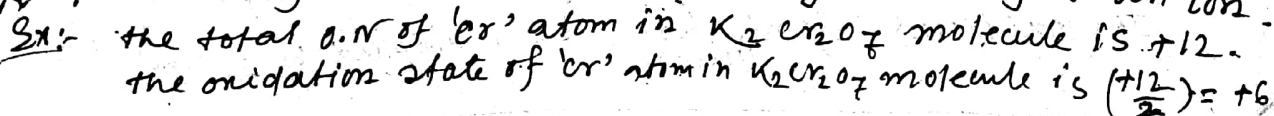
In this rxn $FeCl_3$ acts as an oxidising agent and $SnCl_2$ acts as a reducing agent.

⊗ Oxidation number (O.N):-

The oxidation number of an element in a particular comp. is a number which denotes the extent of oxidation or reduction required for conversion from free state into its particular state in the compound.

⊗ Oxidation state:-

Oxidation state of an atom is the oxidation number (O.N) per atom of that element in a given compound or ion.

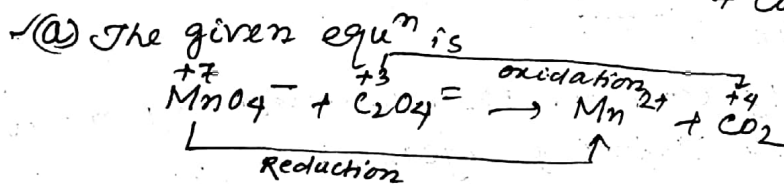
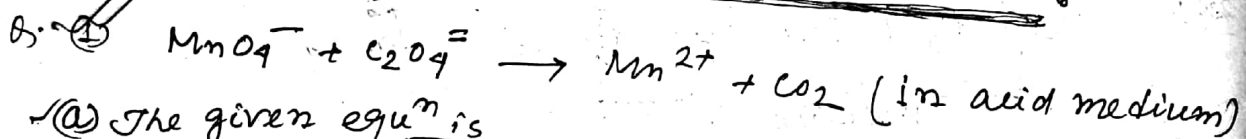


Electrode	Reduction Rxn	Standard redox potential
(6)		
(5) Mg^{2+}/Mg	(5) $Mg^{2+} + 2e \rightarrow Mg$	(5) -2.36
(4) Mn^{2+}/Mn	(4) $Mn^{2+} + 2e \rightarrow Mn$	(4) -1.18
(3) Zn^{2+}/Zn	(3) $Zn^{2+} + 2e \rightarrow Zn$	(3) -0.76
(2) Fe^{2+}/Fe	(2) $Fe^{2+} + 2e \rightarrow Fe$	(2) -0.44
(1) $2H^+/H_2$	(1) $2H^+ + 2e \rightarrow H_2$	(1) 0.00
(2) Cu^{2+}/Cu	(2) $Cu^{2+} + 2e \rightarrow Cu$	(2) $+0.34$
(3) Cu^{2+}/Cu^+	(3) $Cu^{2+} + e \rightarrow Cu^+$	(3) $+0.15$
(4) Cu^+/Cu	(4) $Cu^+ + e \rightarrow Cu$	(4) $+0.52$
(5) Fe^{3+}/Fe^{2+}	(5) $Fe^{3+} + e \rightarrow Fe^{2+}$	(5) $+0.77$
(6) I_2/I^-	(6) $I_2 + 2e \rightarrow 2I^-$	(6) $+0.54$
(7) Ag^+/Ag	(7) $Ag^+ + e \rightarrow Ag$	(7) $+0.80$
(8) Ag^{2+}/Ag	(8) $Ag^{2+} + 2e \rightarrow Ag$	(8) $+1.98$
(9) $[Fe(CN)_6]^{3-}/[Fe(CN)_6]^{4-}$	(9) $[Fe(CN)_6]^{3-} + e \rightarrow [Fe(CN)_6]^{4-}$	(9) $+0.36$ v
(10) AsO_4^{3-}/AsO_3^{3-}	(10) $AsO_4^{3-} + 2e \rightarrow AsO_3^{3-}$	(10) $+0.56$ v
(11) MnO_4^-/Mn^{2+}	(11) $MnO_4^- + 5e \rightarrow Mn^{2+}$	(11) $+1.51$ v
(12) NO_2^-/NO^-	(12) $NO_2^- + 2e \rightarrow NO^-$	(12) $+1.07$ v
(13) Cl_2/Cl^-	(13) $Cl_2 + 2e \rightarrow 2Cl^-$	(13) $+1.36$ v
(14) $Cr_2O_7^{2-}/Cr^{3+}$	(14) $Cr_2O_7^{2-} + 6e \rightarrow 2Cr^{3+}$	(14) $+1.33$ v

⊗ General rules for calculating the oxidation state (O.N/atom of elements):

- (1) $\overset{0}{\text{Cl}}_2, \overset{0}{\text{Ar}}_2$
- (2) In Na_2SO_4 , the sum of the O.N's = $2 \times (+1) + 1 \times (+6) + 4 \times (-2) = 0$
- (3) In $\text{Cr}_2\text{O}_7^{2-}$, the sum of the O.N's = $2 \times (+6) + 7 \times (-2) = -2$
- (4) In Ca_3N_2 and NH_3 , the O.N of 'N' is (-3).
- (5) O.N of 'H' atom is
 - (a) zero (0) in H_2 molecule.
 - (b) (+1) in $\text{NH}_3, \text{PH}_3, \text{H}_2\text{O}_2$
 - (c) (-1) in metallic hydrides - $\text{NaH}, \text{LiAlH}_4, \text{CaH}_2$
- (6) O.N of 'O' atom is
 - (a) (-2) in $\text{H}_2\text{O}, \text{SO}_2, \text{Cl}_2\text{O}$ etc.
 - (b) (-1) in peroxide ($\text{H}_2\text{O}_2, \text{BaO}_2, \text{Na}_2\text{O}_2$)
 - (c) $(-1/2)$ in KO_2 (super oxide)
 - (d) (+1) in O_2F_2
 - (e) (+2) in OF_2
 - (f) zero (0) in O_2 molecule.
- (7) O.N of 'F' atom in all the compounds is (-1)
- (8) O.N of all the halogen is (-1)

Balance the redox-oxn by O.N method :-



MnO_4^- acts as an oxidising agent and $\text{C}_2\text{O}_4^{2-}$ acts as a reducing agent.

(b) Increase of O.N in one 'C' atom = $(+4) - (+3) = +1$.

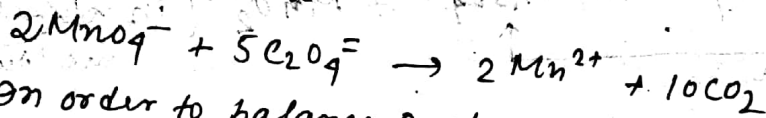
Increase of O.N in two 'C' atoms = $2 \times (+1) = +2$.

Decrease of O.N in one Mn atom = $(+7) - (+2) = +5$.

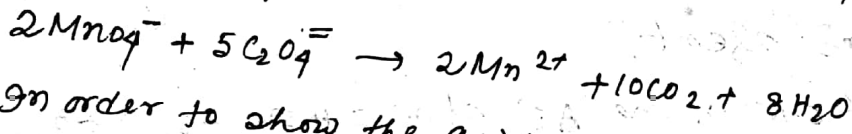
In order to make the total increase in O.N equal to the total decrease in O.N.

The oxidising agent should be multiplied by 2 and

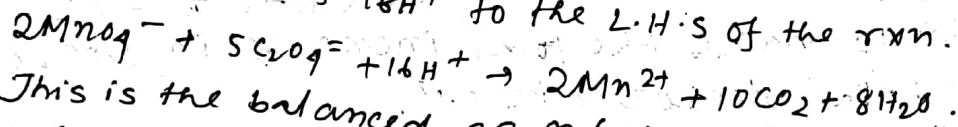
reducing agent should be multiplied by 5. Thus the given eqn should be written as



(c) In order to balance O atom, $8\text{H}_2\text{O}$ is added to the R.H.S of the above rxn

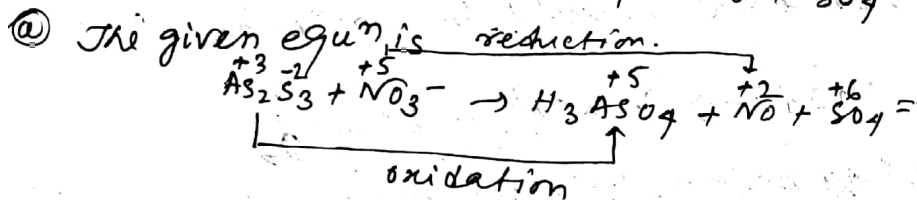


(d) In order to show the acidic medium and to balance H atoms adding 16H^+ to the L.H.S of the rxn.



This is the balanced eqn (since electrical charges on both sides are equal).

5(2) $\text{As}_2\text{S}_3 + \text{NO}_3^- \rightarrow \text{H}_3\text{AsO}_4 + \text{NO} + \text{SO}_4^{2-}$ (in acid medium)



NO_3^- acts as a oxidising agent and As_2S_3 acts as a reducing agent.

(b) Increase in o.n. in one 'As' atom = $(+5) - (+3) = +2$

Increase in o.n. in two 'As' atoms = $2 \times (+2) = +4$

Increase in o.n. in three 'S' atoms = $3 \times [(+6) - (-2)] = 3 \times (+8) = +24$

(Decrease in o.n. in one N atom = $(+5) - (+2) = +3$)

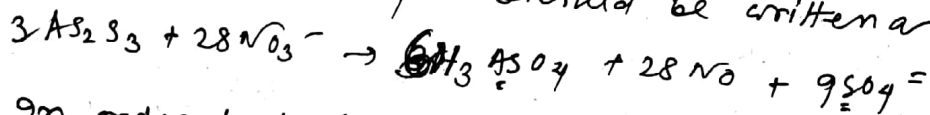
total increase in o.n. in two As atoms and three S atoms = $(+4) + (+24) = +28$

In order to make the total increase in o.n. equal to the total decrease in o.n.

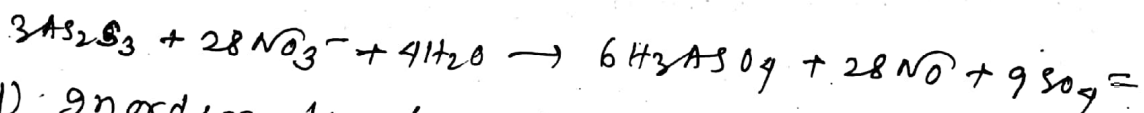
The oxidising agent (NO_3^-) should be multiplied by 28

and the reducing agent (As_2S_3) should be multiplied by 3

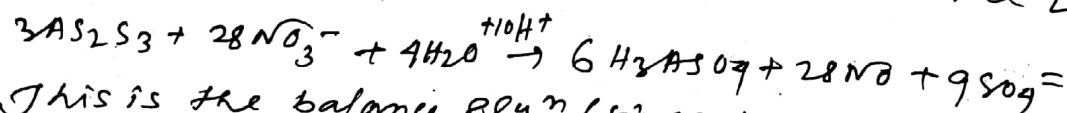
Thus the given eqn should be written as



(c) In order to balance 'O' atom, $4\text{H}_2\text{O}$ is added to the R.H.S of the above rxn.



(d) In order to show the acidic medium of the rxn and to balance H atom, added 10H^+ to the L.H.S of the rxn.



This is the balanced eqn (since the electrical charges on both sides are equal).