

SBG STUDY

17/08/17

Chapter

Redox Reaction

* Oxidation :-

Increase in oxidation state called oxidation.

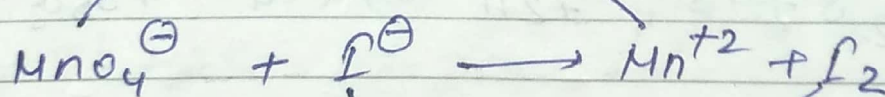
Substance which oxidised during the rxn called oxidising agent

* Reduction :-

Decrease in oxidation state called Reduction.

Substance that reduce called oxidising agent
Reduction (oxidising agent)

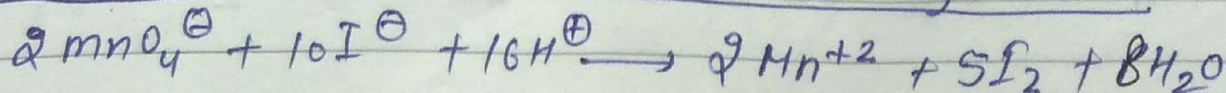
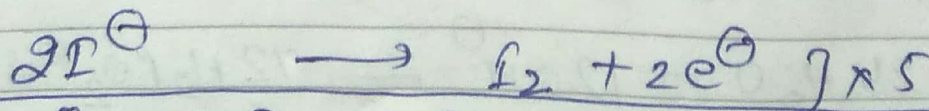
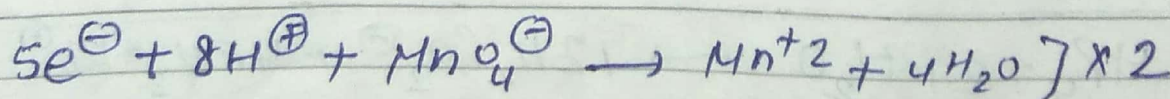
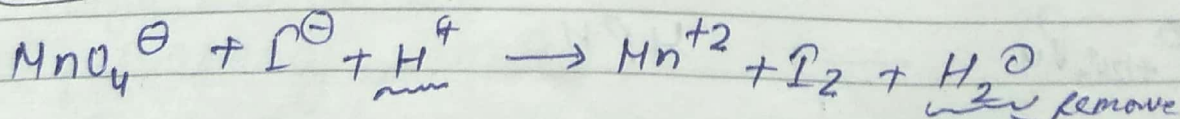
for ex:

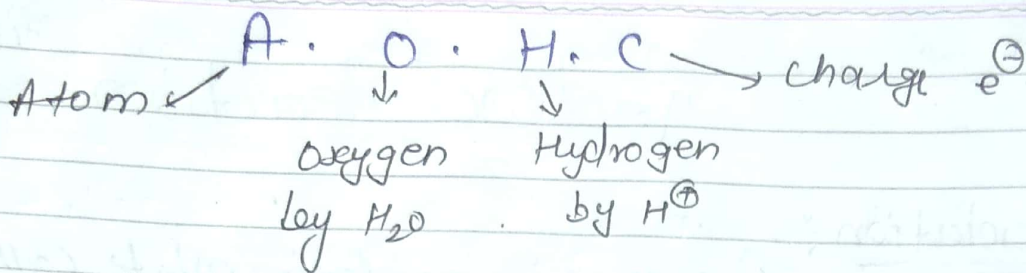


Oxidation (Reducing agent)

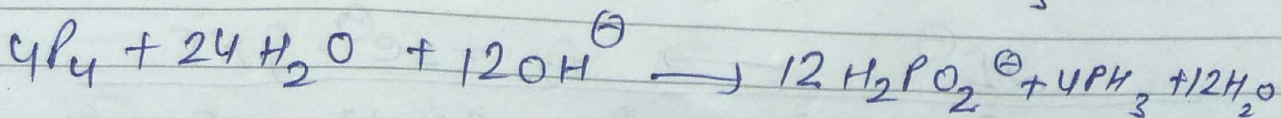
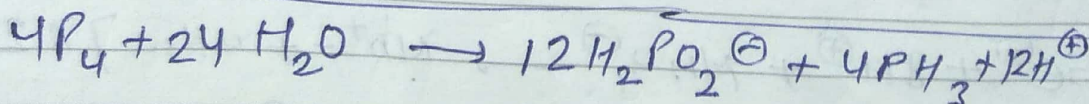
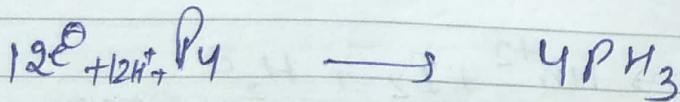
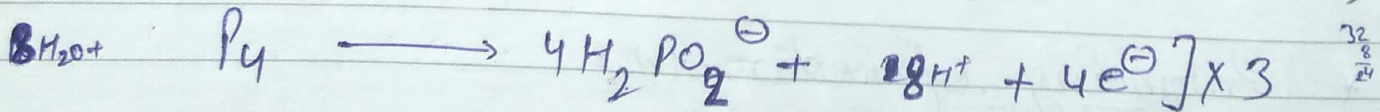
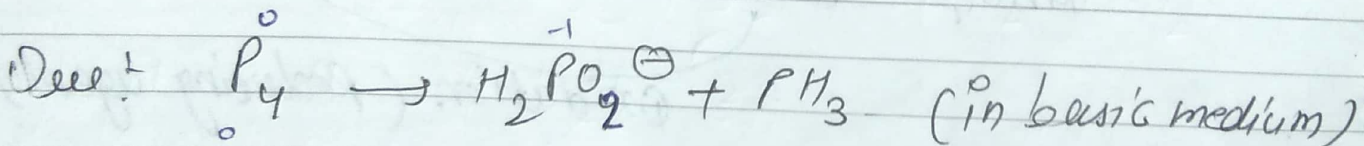
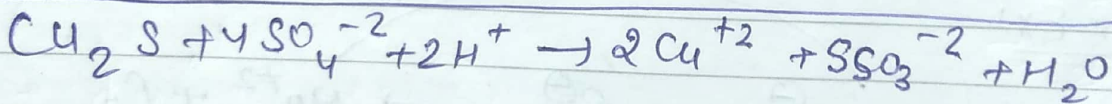
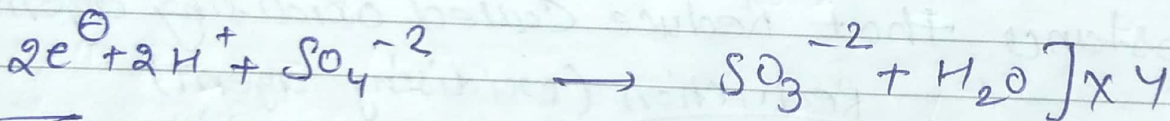
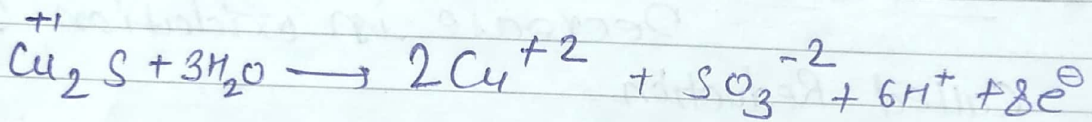
* Balancing of Redox Rxn

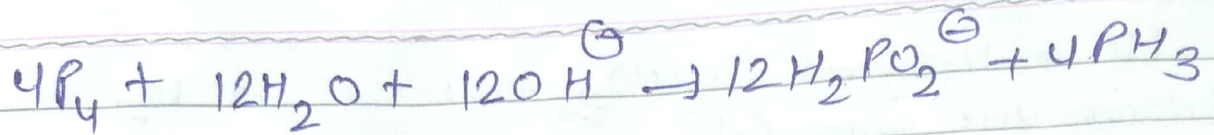
(i) Ion electron Method





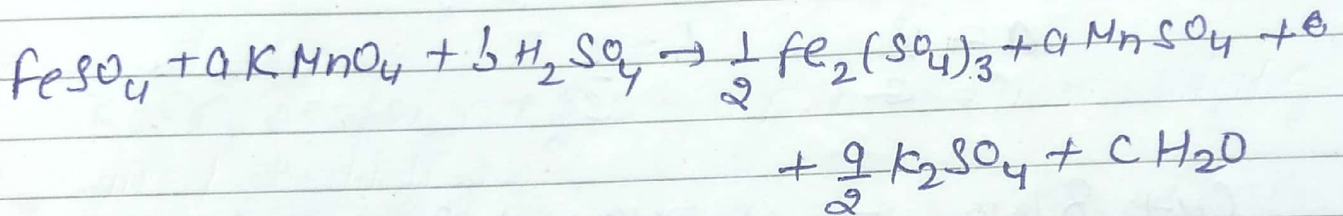
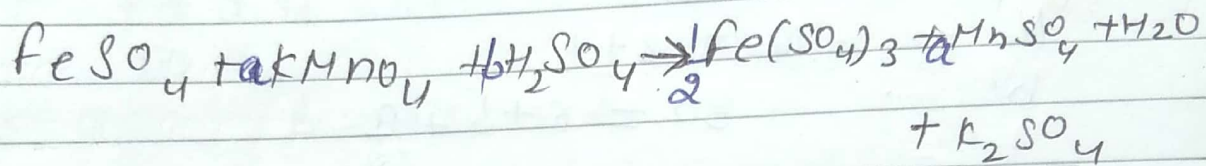
Ques: Balance the Redox Rxn?





* Second Method $\frac{0}{0}$

for ex:



$$S' = 1 + b = \frac{3}{2} + a + \frac{g}{2} \Rightarrow \frac{b - \frac{3g}{2}}{2} = 1$$

$$O' = 4 + 4a + 4b = 6 + 4a + 2a + c \Rightarrow 4a + 4b - 4a - 2a = -4 + 6 + c$$

$$= 4b - 2a = +2 + c$$

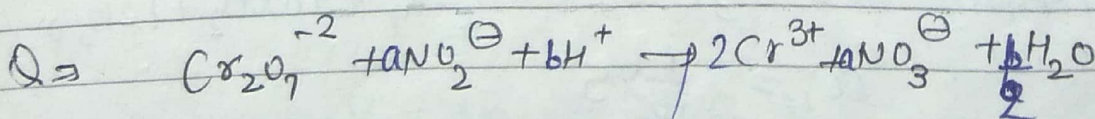
$$H' = 2b + 2c$$

$$a = \frac{1}{5}, b = \frac{12}{15}$$

Step:

Value of unknown coefficient will be calculated by

- (i) Atom balancing
- (ii) Charge balancing
- (iii) Equivalency balancing

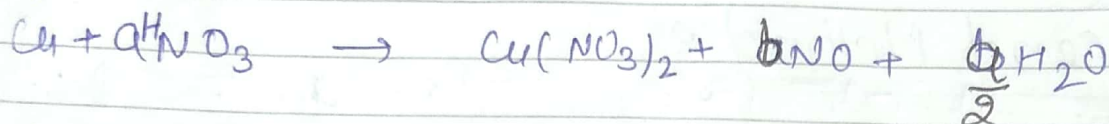


Charge balancing $\Rightarrow -2 - a + b = 6 - a$

$$O' = 7 + 2a = 3a + \frac{b}{2}$$

$$b = 8, a = 3$$

Q.iii: $\text{Cu} + \text{HNO}_3 \rightarrow \text{Cu}(\text{NO}_3)_2 + \text{NO} + \text{H}_2\text{O}$
 Balance the given rxn.

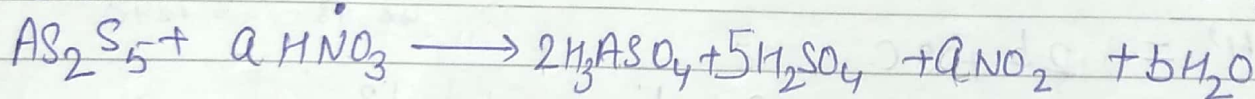
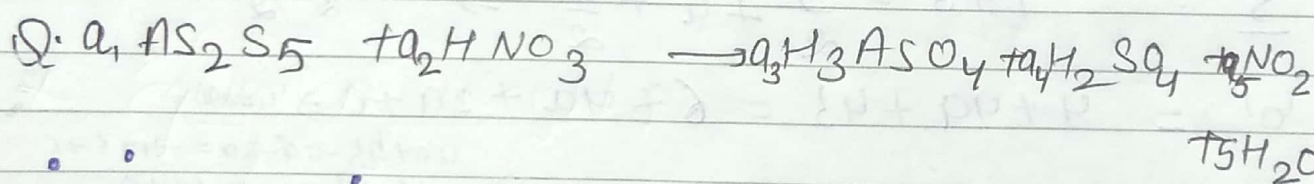
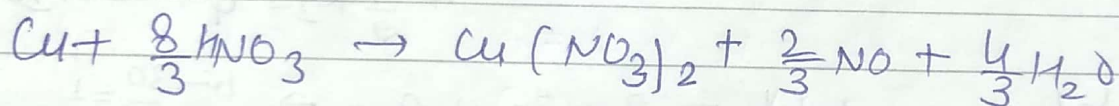


$$'O' = 3a = 6 + b + \frac{c}{2}$$

$$'N' = a = 2 + b$$

$$'H' = 3a = 6 + b + \frac{c}{2}$$

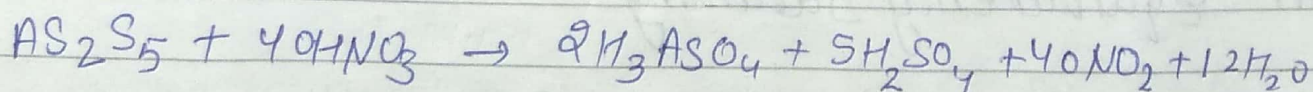
$$a = \frac{8}{3}, \quad b = \frac{2}{3}$$



$$'H' = a = 6 + 10 + 2b$$

$$'O' = 3a = 8 + 20 + 2a + b$$

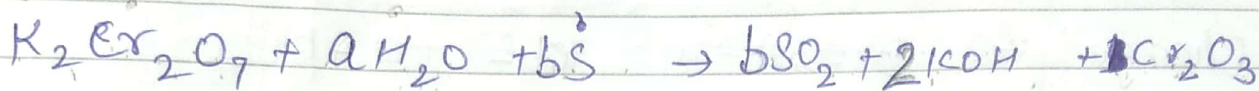
$$a = 40 \quad b = 12$$



$$a_1 = \frac{1 \times 5}{12}$$

$$a_2 = \frac{40}{12} \times 5$$

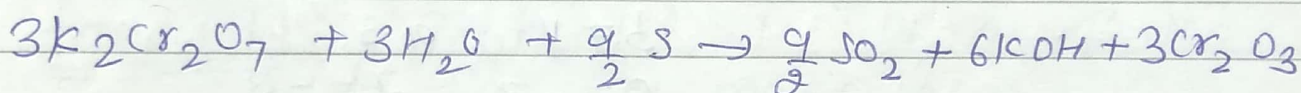
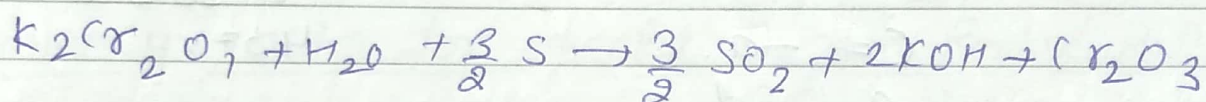
Ques 200



$$'O' = 7 + a = 2b + 3$$

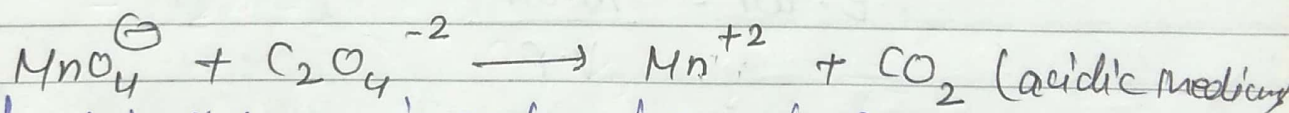
$$'H' = 2a = 2$$

$$a = 1, b = \frac{3}{2}$$

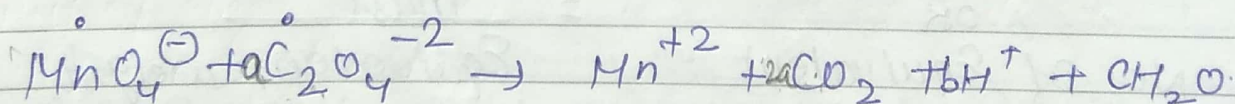


$$a_1 = 3 \quad a_2 = 3$$

Q. Balance in Acidic medium



if H^+ & H_2O is not given in Ques.
then



Charge balancing \Rightarrow

$$-1 - 2a = +2 + b$$

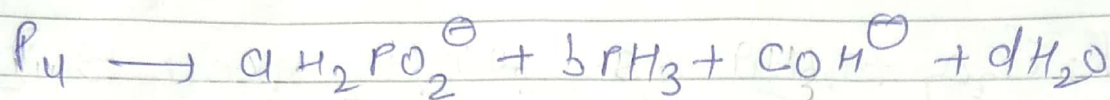
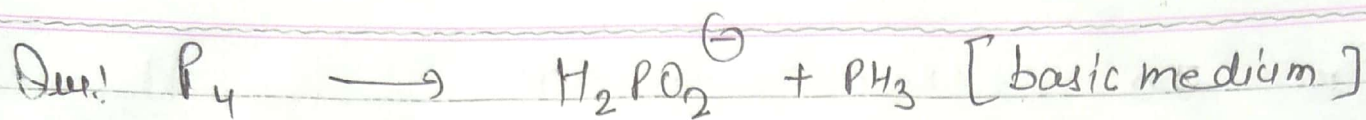
$$'O' \Rightarrow 4 + 4a = 4 + b + c$$

$$c = 4$$

$$'H' \Rightarrow 0 = b + 2c$$

$$b = -8$$

$$a = \frac{5}{2}$$



'Charge' = $0 = -a - c$

'P' = $4 = a + b$

'O' = $0 = 2a + c + d$

'H' = $0 = 2a + 3b + c + 2d$

$$a = -c$$

$$4b = 4$$

$$c = -a$$

$$a = -d$$

$$b = 1 \quad a = 3$$

$$c = -3 \quad d = -3$$

* Equivalent weight :

$$E. wt = \frac{M. wt}{V. f}$$

* Gram equivalent =

$$\text{No. of Equivalent} = \frac{\text{mass}}{\text{Equivalent weight}}$$

$$= \frac{\text{mass}}{M. wt} \times V. f$$

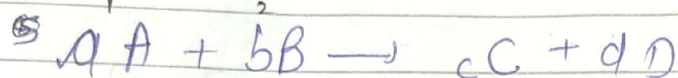
$$\text{No. of Equivalent} = \text{mol} \times V. f$$

(Eq).

$$= MV \times V. f$$

$$= N \times [N = M \times V. f]$$

* Law of gram equivalence:



$$\boxed{Eq(A) = Eq(B) = Eq(C) = Eq(D)}$$

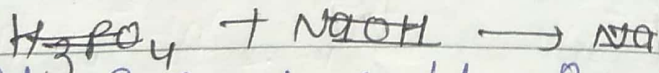
$$5 \times 1 = n \times 2$$

$$n = \frac{5}{2}$$

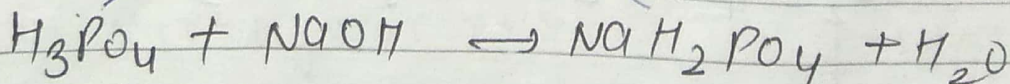
* Valency factor for species in non Redox Rxn:

(i) for acid: Replacable H^+ or acceptable OH^- ion per molecules

Acid	v. f
H_3PO_4	3
H_3PO_3	2
H_3PO_2	1
CH_3COOH	1
H_3BO_3	1



1] If Rxn of acid given in the Question then Valency factor of Acid will be calculated acc. to this Rxn.



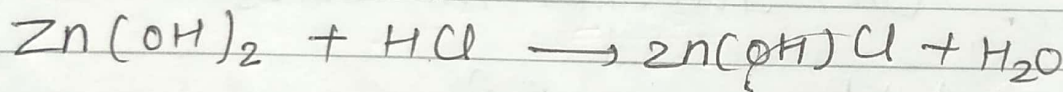
$$v. f = 1$$



* V.f for Base \div Replaceable OH^- ion or acceptable H^+ ion by per molecules of Base.

Base	V.f
$\text{Zn}(\text{OH})_2$	2
NaOH	1
NH_3 or NH_4OH	1

Imp. point: If R^{n+} of Base is provided the V.f of a calculated acc. to R^{n+} .



V.f = 1

* V.f for salt \div

In one molecules either total charge on cation or total charge on anion

Salt	V.f
$\text{Al}_2(\text{SO}_4)_3$	6
$\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$	2
KNaSO_4	2
$\text{K}_2\text{SO}_4 \cdot \text{Al}_2(\text{SO}_4)_3 \cdot 24\text{H}_2\text{O}$	= 8.

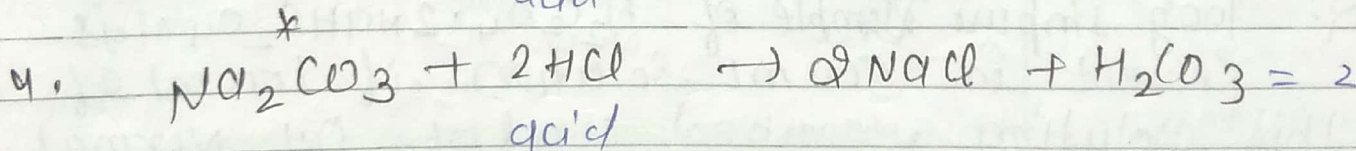
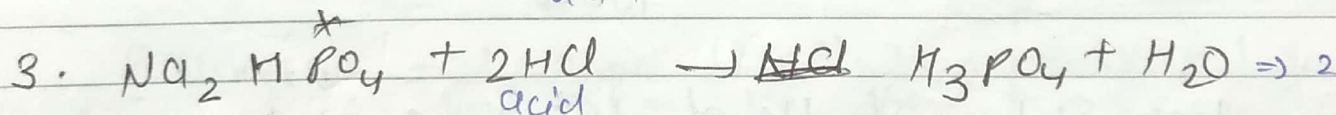
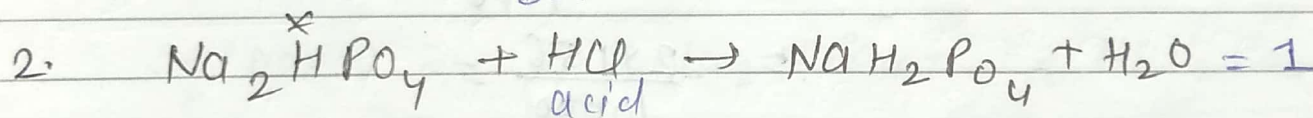
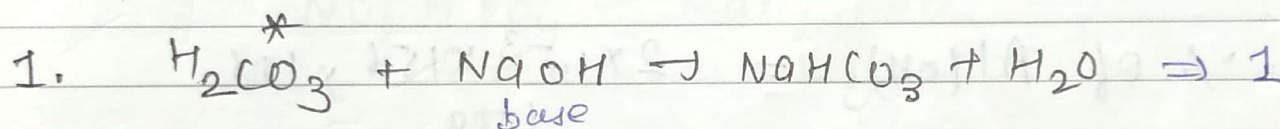
mole \times v.f

$$M V \times v.f = N V \quad v.f.$$

* v.f for ion: Total charge on one ion will be its v.f

Ion	v.f
Cl^-	1
PO_4^{3-}	3
NH_4^+	1

Q. In given rxn calculate v.f of marked species



Ques! 0.1 molar 50ml HNO₃ solution is neutralised by 0.05 molar Barium Hydroxide solution then calculate volume in Barium Hydroxide used in its neutralisation

$$eq(HNO_3) = eq.(Ba(OH)_2)$$

$$0.1 \times 50 \times 1 = 0.05 \times V \times 2$$

$$V = 50 \text{ ml}$$

$$\begin{aligned} 0.1 \times 50 &= 0.05 \times V \\ \frac{50}{10} &= \frac{5V}{100} \\ 500 &= 5V \\ V &= \end{aligned}$$

Q. 1 g impure sample of $\text{Al}(\text{OH})_3$ Alims Al req.
 3 mm millimole of H_2SO_4 then calculate % purity of initial sample.

Ans

$$E_1 \text{Al}(\text{OH})_3 = E_2(\text{H}_2\text{SO}_4)$$

M. mass = 156

$$n \times 3 = 3 \times 2$$

$$n = \frac{6}{3} = 2$$

$$n = 2 \times 10^{-3} \text{ mol.}$$

$$\text{mass of } \text{Al}(\text{OH})_3 = 2 \times 10^{-3} \times 156$$

$$\% \text{ of } \text{Al}(\text{OH})_3 = \frac{2 \times 10^{-3} \times 156 \times 100}{1000}$$

$$= \frac{2 \times 156}{10000} =$$

Q. 100g impure sample of $\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{NaHC}_2\text{O}_4$ is present in 500 ml solution if 100 ml of this solution required 10 ml of 0.1 Normal $\text{Ba}(\text{OH})_2$ solution then calculate initial mole of $\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{NaHC}_2\text{O}_4$ in initial sample

v.f = 4

v.f = 4

$$E_1(\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{NaHC}_2\text{O}_4) = E_2(\text{Ba}(\text{OH})_2)$$

$$n \times 4 \times 100$$

$$= 10 \text{ ml} \times 0.1 \times 2$$

$$= n \times 4$$

$$n \times 4 = 0.1 \times 10$$

$$n = \frac{1}{4}$$

$$n \times 400 = 2$$

$$n = \frac{2}{400} = \frac{1}{200}$$

This amount will present in 100 ml

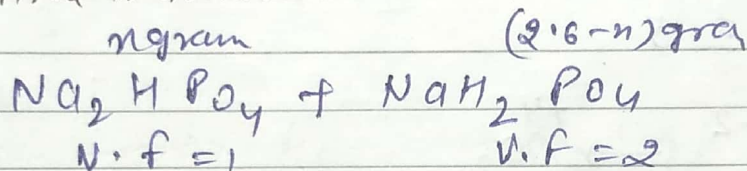
R react e

$n = \frac{m}{\text{mwt}}$

So amount is 500 ml is

$\frac{1}{4} \times 5 = \frac{5}{4}$

Que: 2.6g mixture of Na_2HPO_4 (Mwt = 150) and NaH_2PO_4 (Mwt = 120) is present in a 100 ml solution. 1 ml of this solution required 10 ml of 0.3 molar NaOH solution for complete neutralisation then calculate % composition by mass of initial mixture



$\text{Eq}(\text{NaOH}) = \text{Eq. of } \text{Na}_2\text{HPO}_4 + \text{Eq } \text{NaH}_2\text{PO}_4$

for mm → m.

$$\frac{3 \times 10}{1000} \times 1 = \frac{1}{100} \left(\frac{n}{150} \right) \times 1 + \frac{(2.6-n)}{120} \times \frac{1}{100} \times 2$$

$$0.3 \times 10 \times 1 = n \times 1 \times 100 + (2.6-n) \times 2 \times 100$$

$$3 = 100n + 200(2.6-n)$$

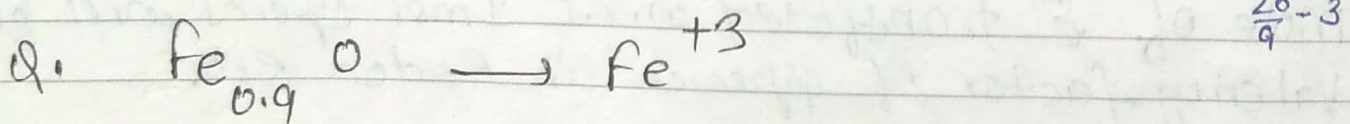
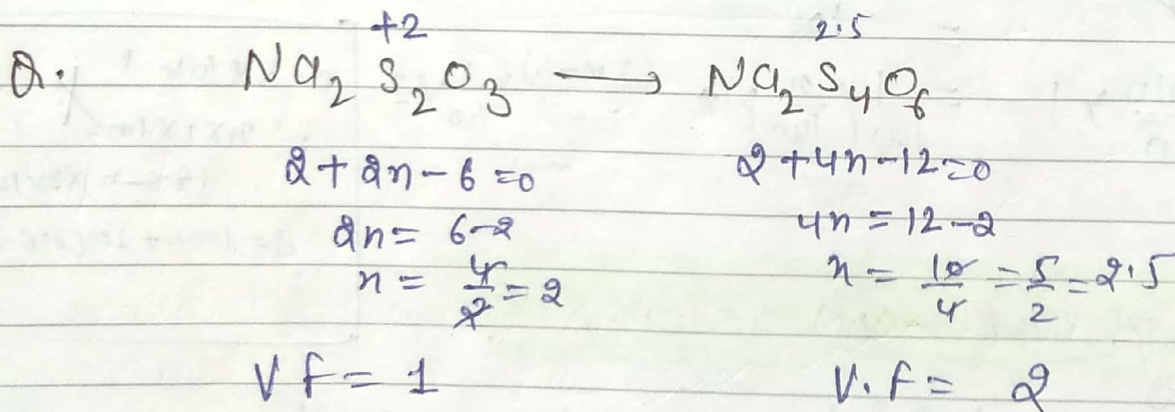
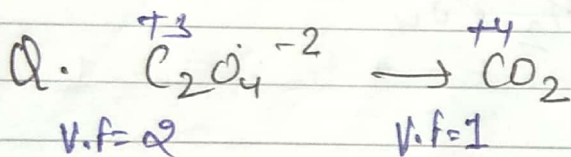
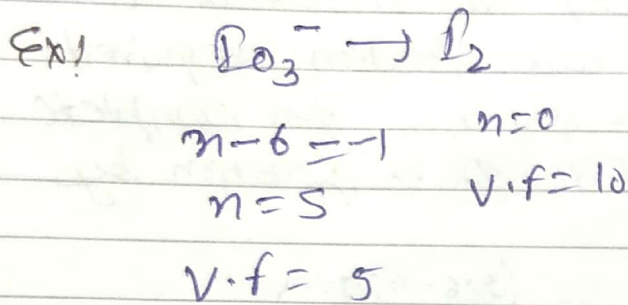
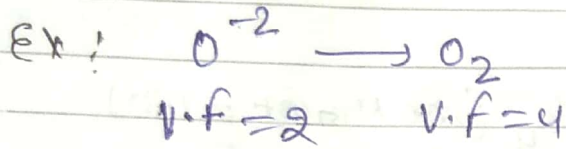
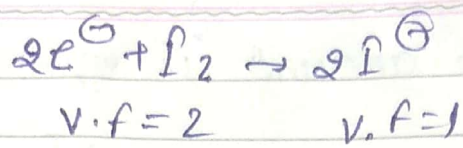
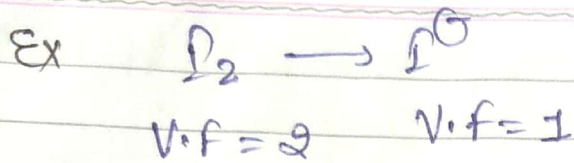
* Valency factor in Redox Rxn

mole of e transferred w.r.t 1 mol species will be valency factor of species in Redox Rxn.

Case - I : if only one type of atom either oxidising or Reducing in Redox Rxn

Imp:

$$\text{Number of atom in molecule} \times \left| \text{Change in o.s of atom} \right|$$



~~0.9n~~ $n = +3$
 $0.9n - 2$
 $0.9n = 2$
 $n = \frac{20}{9}$

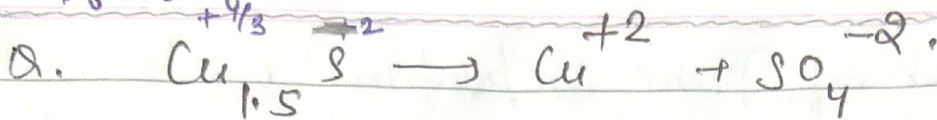
$v.f = 1 \times (3 - \frac{20}{9})$

$v.f = 0.9 (3 - \frac{20}{9}) = \frac{7}{9}$

$= 0.7$

Case : 2

If ~~one~~ more than one type of atom transfer of atom.



$$1.5x - 2 = 0$$

1

$$x - 8 = -2$$

$$x = \frac{2}{1.5}$$

$$x = -2 + 8$$

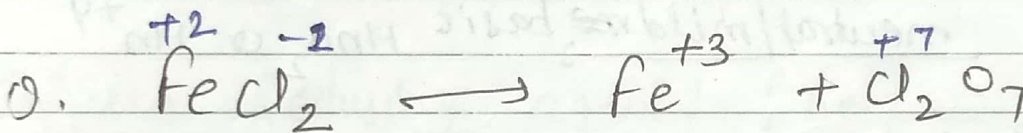
$$x = 6.$$

$$= \frac{4}{3}$$

$$O.S(S) = -2$$

$$O.S(Cu) = \frac{4}{3}$$

$$v.f \Rightarrow \left[1.5 \left(2 - \frac{4}{3} \right) + 1 \times (6 - (-2)) \right]$$



$$x - 2 = 0$$

$$x = 3$$

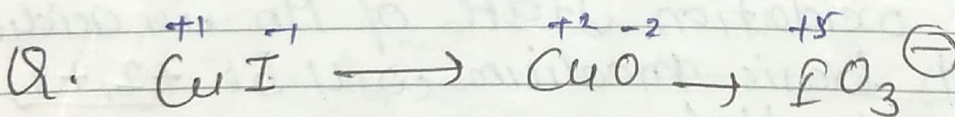
$$2x - 14 = 0$$

$$x = \frac{14}{2} = 7$$

$$x = 2$$

$$1 + 16$$

$$v.f = 17$$



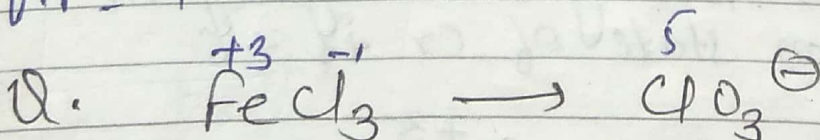
$$x - 6 = -1$$

$$x = -1 + 6$$

$$x = 5$$

$$1 + 6$$

$$v.f = 7$$



$$x - 6 = -1$$

$$x = -1 + 6$$

$$x = 5$$

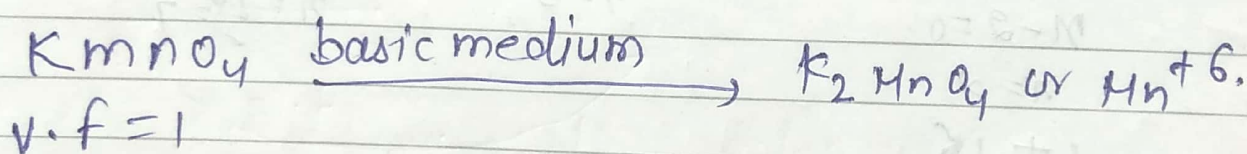
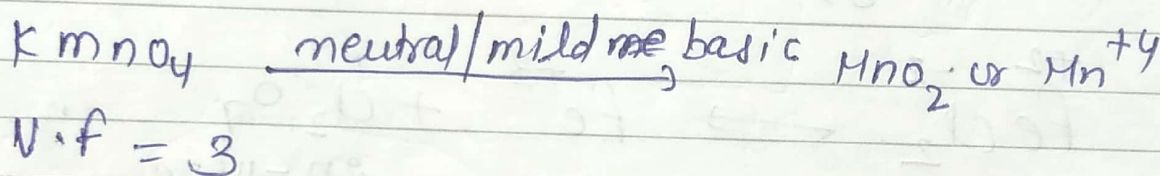
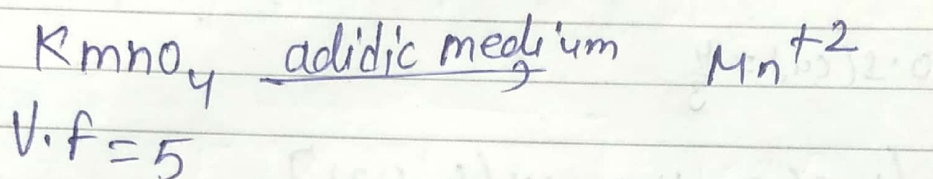
$$6 \times 3$$

$$v.f = 18$$

* Valency factor of Some Important Oxidising and Reducing agent:

* KMnO_4 is a strong oxidising agent

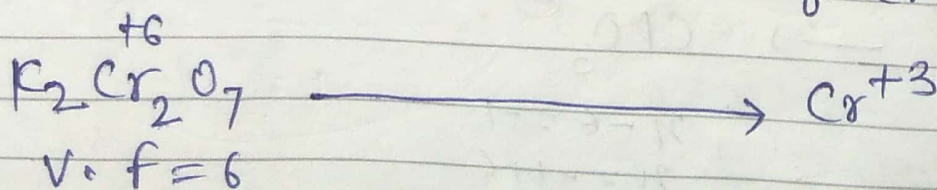
Mn will be its highest oxidation state +7.

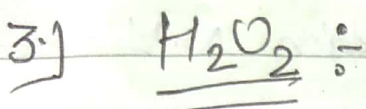


Imp. point

Stable oxidation state of Mn in acidic, neutral and basic medium will be +2, +4, and +6 respectively.

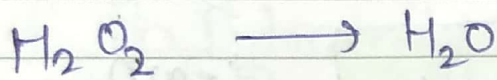
* $\text{K}_2\text{Cr}_2\text{O}_7$ is a strong oxidising agent in which oxidation state of Cr is +6





$H_2O_2 \rightarrow$ in this oxidation state of oxygen is -1 i.e. a intermediate o.s of oxygen so H_2O_2 can behave here both oxidising and Reducing Agent.

* As oxidising agent (self Reduction)

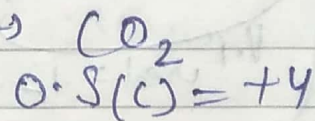
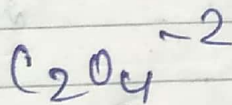
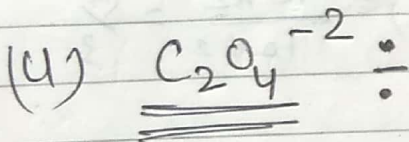


$$V.f = 2$$

* As Reducing agent (self oxidation)



$$V.f = 2$$

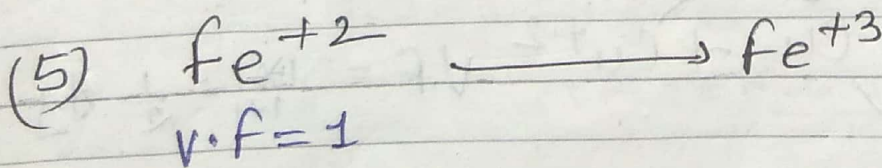


$$O.S(C) = +4$$

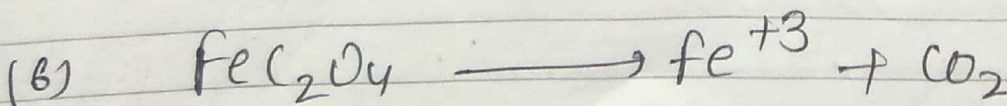
$$O.S(C) = +3$$

$$V.f = 2$$

$$V.f = 1$$



$$V.f = 1$$



$$1 + 2 + 3$$

Imp case - 1 and C-3

Important.

Imp!

Cases Valency factor of In disproportionation Rx^n !

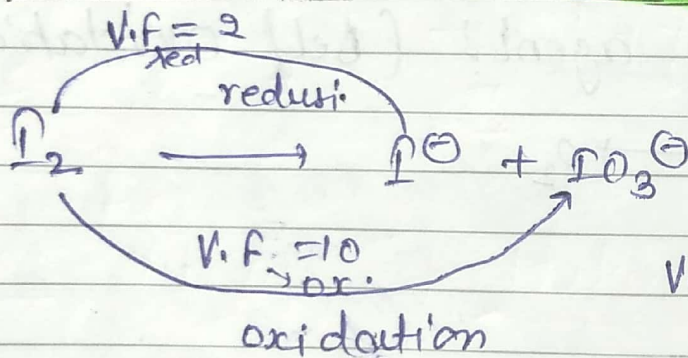
When same type of atom oxidised and reduced in species then such types of Rx^n s called disproportionation Rx^n .

Valency factor of this type of species can be calculated as

$$V.f = \frac{V.f_{ox} \times V.f_{red.}}{V.f_{ox} + V.f_{red}}$$

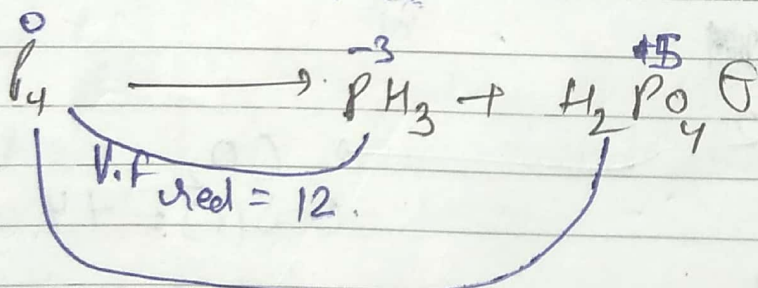
Learn Imp.

Ex:



$$V.f_{(P_2)} = \frac{10 \times 2}{10 + 2} = \frac{20}{12} = \frac{5}{3}$$

Q.



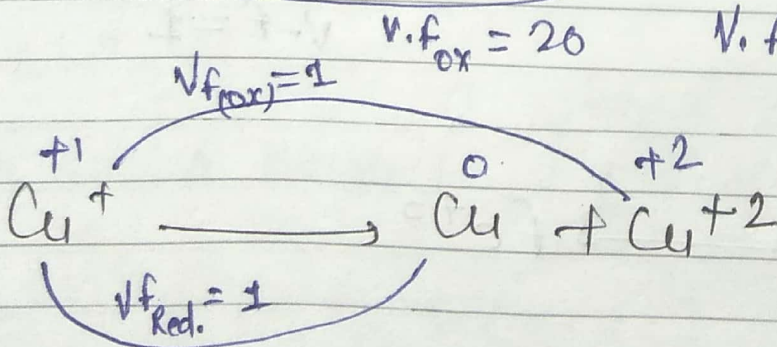
$$2 + n - 8 = 1$$

$$n = 1 + 8 - 2$$

$$n = 5$$

$$V.f_{(P_4)} = \frac{12 \times 20}{12 + 20} = 7.5$$

Q.



$$V.f = \frac{1 \times 1}{1 + 1} = \frac{1}{2} \text{ Ans}$$

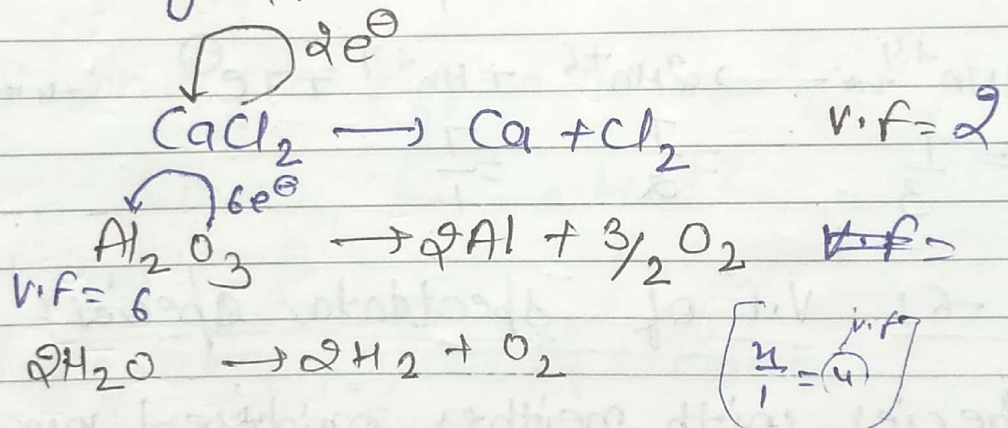
Not Imp!

Total change in oxidation or cation

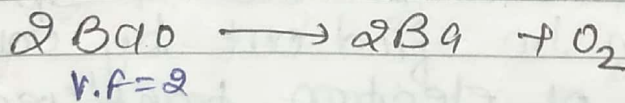
Case 4 Valency factor in Intramolecular Redox Rxn!

If within one molecule one type of atom oxidised and another type of atom reduce then this type of Redox Rxn called Intramolecular Redox Rxn

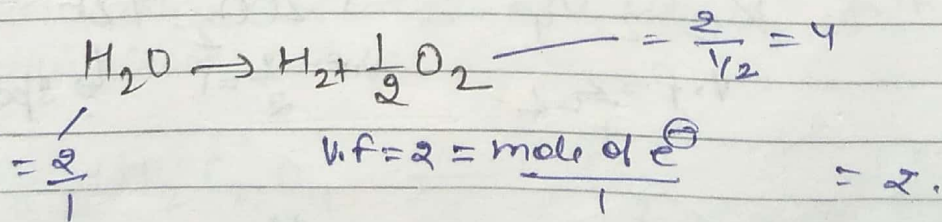
V.f in Intramolecular Redox Rxn will be in no. of e^- transferred from Reducing species to oxidising species within one molecule



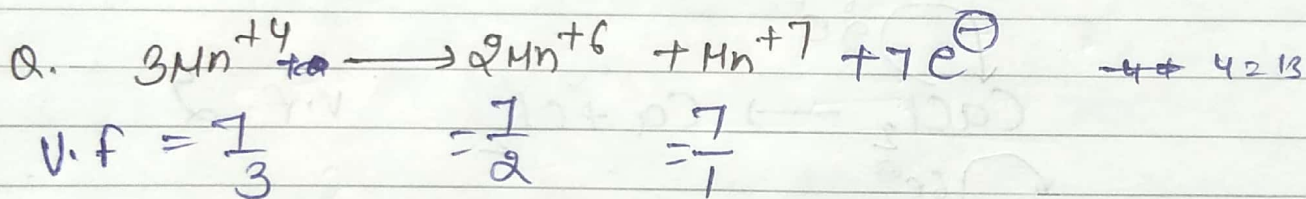
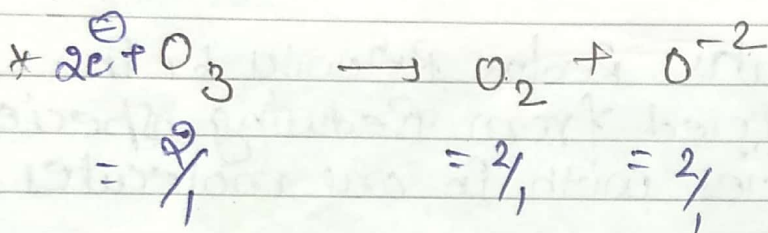
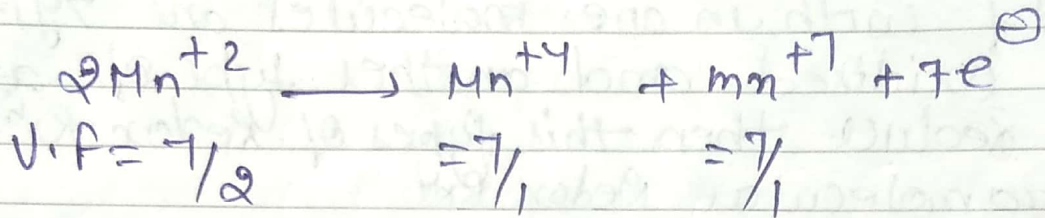
v.f = 2



Q. Calculate mole of e^- that are transferred in given Rxn.

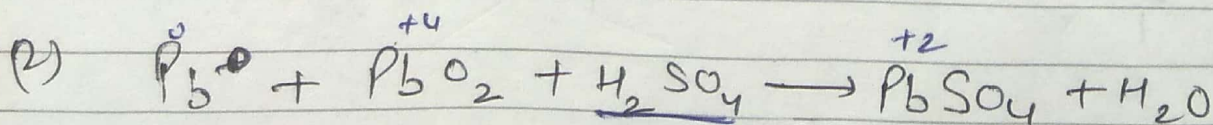
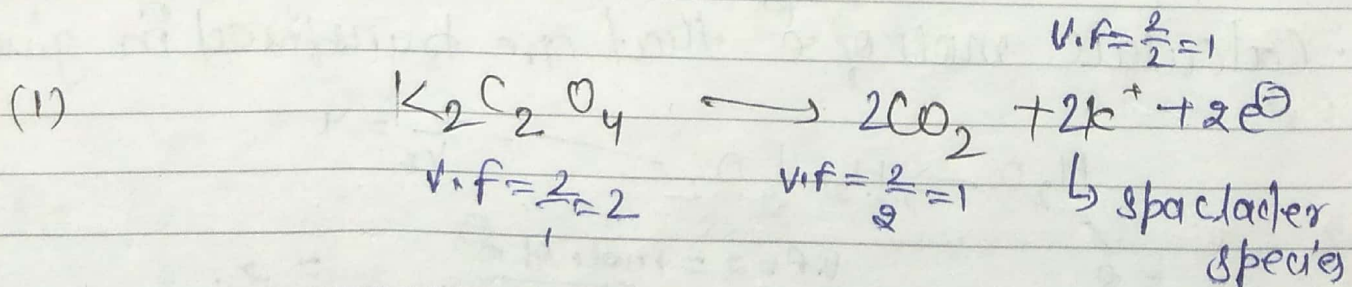


* Case-5: If one type of atom oxidising or Reducing in more than one type of oxidation state.



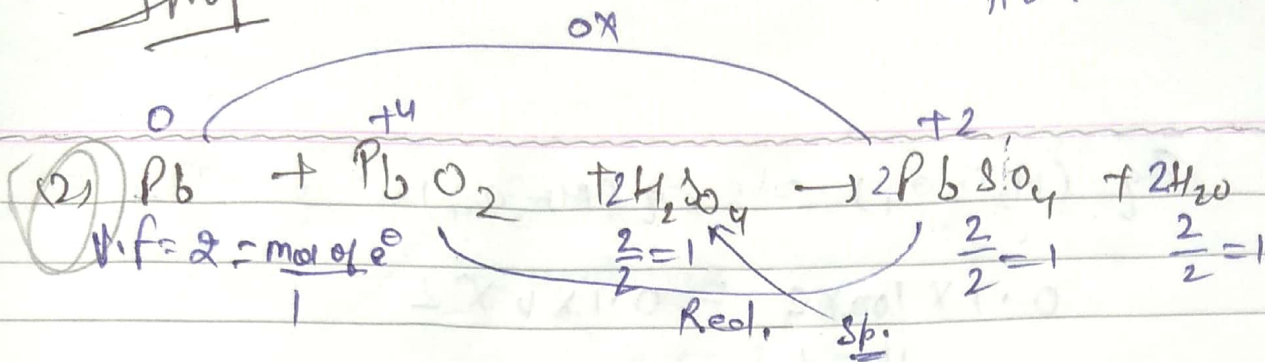
* Case-6: V.F of spectator species!

Species with neither oxidised nor Reduce during a Redox Rxn called Spectator species
 Its V.F can be find out by calculating total mole of electron transferred in the redox Rxn.

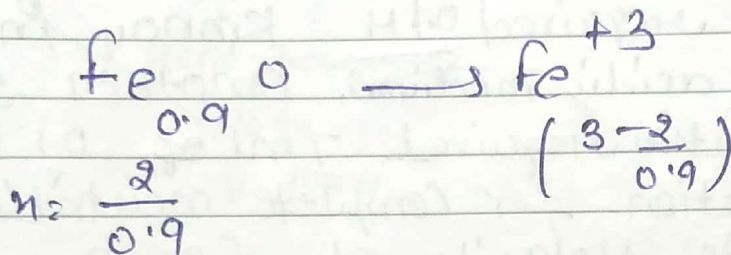


Imp.

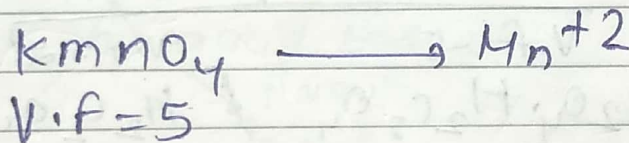
H.W: J. Advanced.



* Calculate mole of $\text{Fe}_{0.9}\text{O}$ i.e. required for oxidation by one mol KMnO_4 in acidic medium.

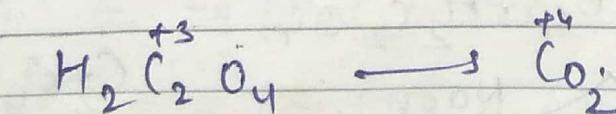


$$\text{V.F} = 0.9 \left(3 - \frac{2}{0.9}\right) = 0.7$$



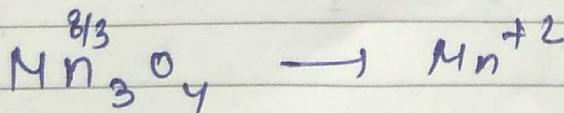
$$\begin{array}{l}
 \text{Eq. } \text{Fe}_{0.9}\text{O} = \text{Eq. } \text{KMnO}_4 \\
 n \times 0.7 = 1 \times 5 \\
 n = \frac{5}{0.7} = \frac{50}{7}
 \end{array}$$

Ques: 0.1 Molar, 100 ml $\text{H}_2\text{C}_2\text{O}_4$ solution is titrated by 0.1 M Mn_3O_4 solution in acidic medium. Then calculate vol. of Mn_3O_4 solⁿ required till equivalence point.



$$\begin{array}{l}
 2 + 2n - 8 = 2 \\
 2n = 8 - 2 \\
 n = \frac{6}{2} = 3
 \end{array}$$

$$\text{V.F} = 2.$$



$$\begin{array}{l}
 3n = 8 \\
 n = \frac{8}{3}
 \end{array}$$

$$3\left(\frac{8}{3} - 2\right) = 2$$

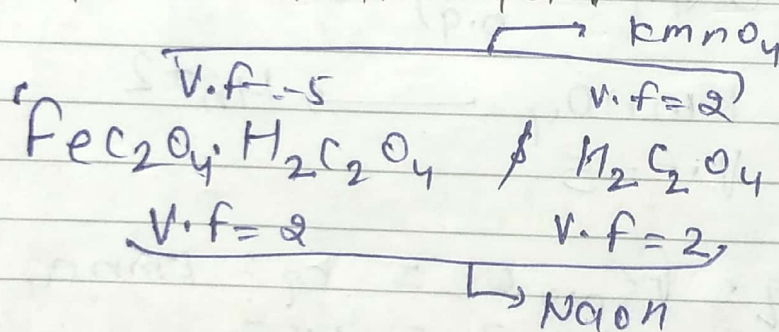
$$\text{Eq} (\text{H}_2\text{C}_2\text{O}_4) = \text{Eq} (\text{Mn}_3\text{O}_4)$$

$$0.1 \times 100 \times 2 = 0.1 \times V \times 2$$

$$V = 100 \text{ ml}$$

$$\text{Vol. } \text{KMnO}_4 = 10 \text{ ml}$$

Ques! In a 50 ml solution $\text{FeC}_2\text{O}_4 \cdot \text{H}_2\text{C}_2\text{O}_4$ & $\text{H}_2\text{C}_2\text{O}_4$ is present 10 ml of this solution required 0.1M KMnO_4 in presence H_2SO_4 (acidic medium). Another 30 ml of initial solution required 7 ml of 0.1 Molar NaOH solution for complete neutralisation then calculate molarity of $\text{FeC}_2\text{O}_4 \cdot \text{H}_2\text{C}_2\text{O}_4$ and $\text{H}_2\text{C}_2\text{O}_4$ in initial soln.



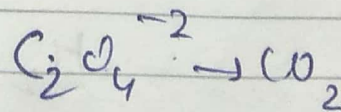
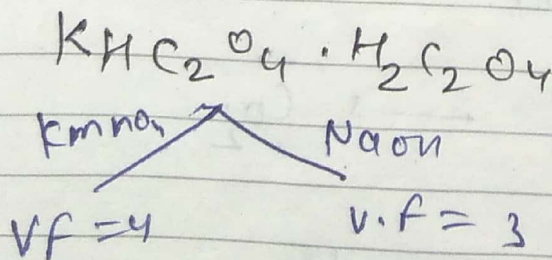
$$\text{Eq.} (\text{KMnO}_4) = \text{Eq} \text{FeC}_2\text{O}_4 \cdot \text{H}_2\text{C}_2\text{O}_4 + \text{Eq} \cdot \text{H}_2\text{C}_2\text{O}_4$$

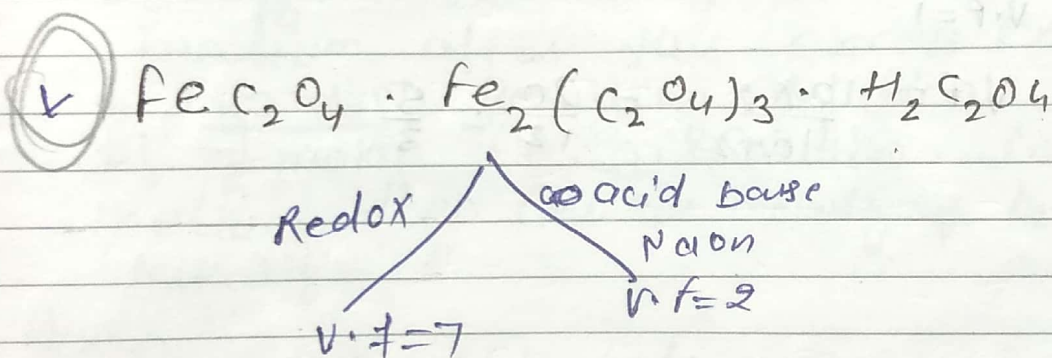
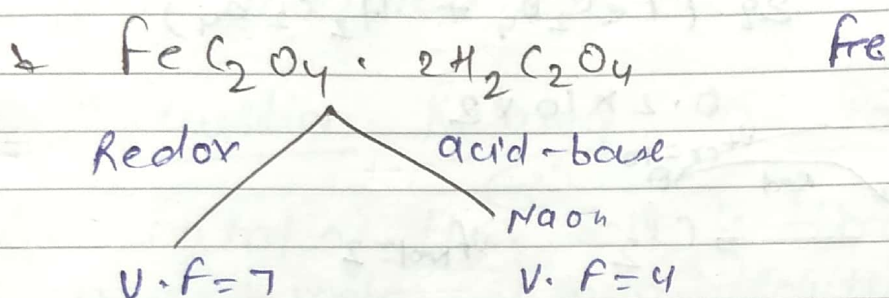
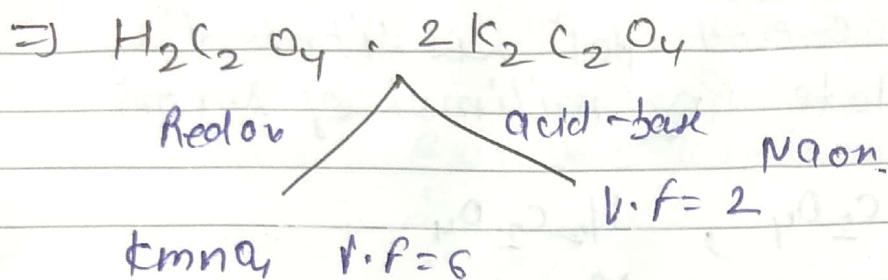
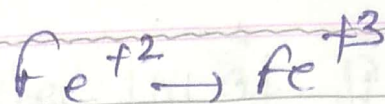
$$0.1 \times 10 \times 5 = M_1 \times 10 \times 5 + M_2 \times 10 \times 2$$

$$\text{Eq} (\text{NaOH}) = \text{Eq} \text{FeC}_2\text{O}_4 \cdot \text{H}_2\text{C}_2\text{O}_4 + \text{Eq} \text{H}_2\text{C}_2\text{O}_4$$

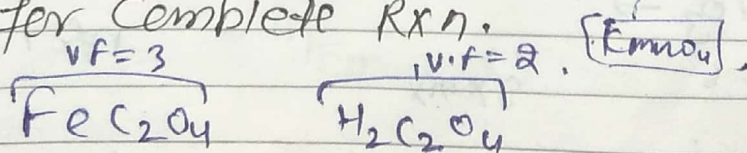
$$0.1 \times 7 \times 1 = M_1 \times 30 \times 2 + M_2 \times 30 \times 2$$

Method:





Q. In a 500 ml sol concⁿ. of FeC_2O_4 & $H_2C_2O_4$ are 0.1 M and 0.2 M respectively if 10 ml of this solution is titrated by $KMnO_4$ in presence of H_2SO_4 then calculate millimol of $KMnO_4$ required for complete rxn.



$= 500 \cdot 0.1 \times 3 + 0.2 \times$

$Eq(KMnO_4) = Eq(FeC_2O_4) + Eq \cdot H_2C_2O_4$

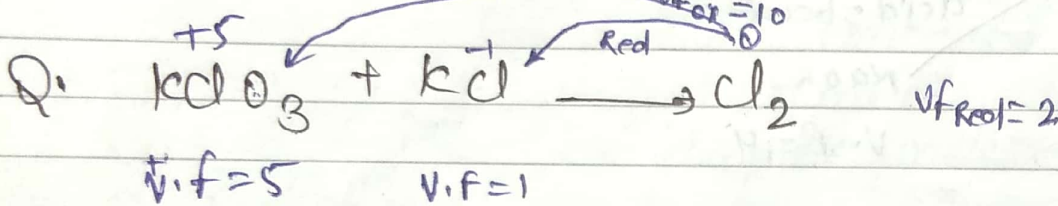
$n \times 5 = 0.1 \times 10 \times 3 + 0.2 \times 10 \times 2$

(ii) If 10 ml of ^{above} $0.1M$ is titrated by $NaOH$ then calculate Req. millimol of NaOH.



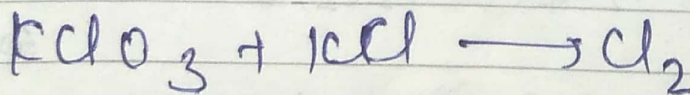
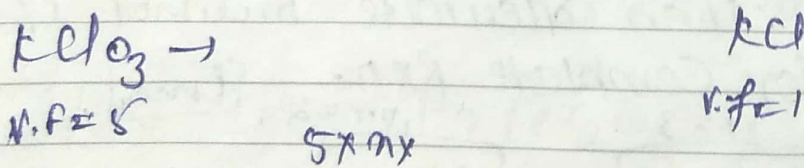
$$Eq\ NaOH = Eq\ (FeC_2O_4 + H_2C_2O_4)$$

$$n \times V = 0.2 \times 10 \times 2$$



$$v.f = \frac{10 \times 2}{10 + 2} = \frac{20}{12} = \frac{5}{3}$$

Q. In a 100 $0.1M$ of solⁿ of $KClO_3$ 600 ml. of $0.1M$ KCl solⁿ is mixed then calculate unreacted millimole of excess reagent KCl . and also calculate produced ~~to~~ millimole of Cl_2 .



$$Eq\ KClO_3 = Eq\ KCl = Eq\ Cl_2$$

$$0.1 \times 100 \times 5 \times 100 = n_{KCl} \times 1 = n_{Cl_2} \times 5/3$$

$n_{\text{fcl}} = 50 \text{ millimol} \rightarrow \text{reacted}$

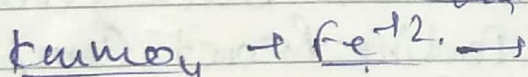
$n_{\text{Cl}_2} = \frac{3}{5} \times 50 = 30 \text{ millimol} \rightarrow \text{Produced}$
millimol of Cl_2 .

Total millimole = 10 mmol

Question Related to Back titration.

Q. 200 ml of H_2O_2 solⁿ is titrated by 200 ml of $\frac{1}{10}$ molar KMnO_4 solution in acidic medium after this excess KMnO_4 present in 40 ml of resulting solution. require 5 ml of $\frac{1}{5}$ molar Fe^{+2} solution in acidic medium then calculate molarity of H_2O_2 solution taken initially

Ans. for calculation of remaining millimole of



$$E_{\text{Fe}^{+2}} = E_{\text{KMnO}_4}$$

$$\frac{1}{5} \times 5 \times 1 = n_{\text{KMnO}_4} \times 5$$

$$n_{\text{KMnO}_4} = \frac{1}{5} \text{ millimol}$$

Remaining amount of KMnO_4 in 40 ml of resultant solⁿ =

Overall remaining KMnO_4 in resulting solution of 40 ml = $\frac{1}{5} \times 10 = 2 \text{ millimol}$

used KMnO_4 in 1st Rx^n / with H_2O_2

$$= 20 - 2 = 18 \text{ ml.}$$

$$\text{Eq. of } \text{KMnO}_4 = \text{Eq. } \text{H}_2\text{O}_2$$

$$18 \times 5 = M \times 20 \times 2$$

$$M = \frac{9}{40}$$

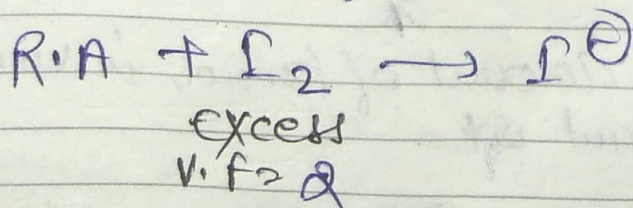
* It is better to find out minimal of excess reagent in back titration.

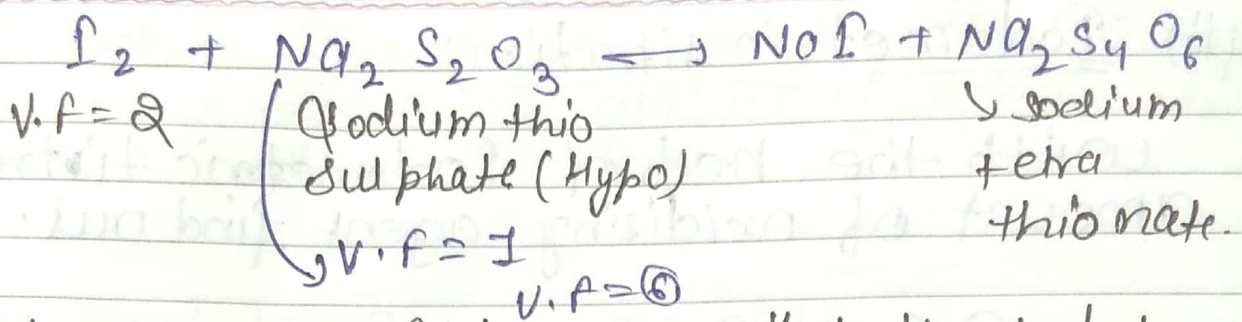
Titration Related with Iodine! Important

In Iodine ^{involving} titration starch is used as indicator. Starch by combining with I_2 form a complex compound that represent dark blue or dark black colour of solution. But as Iodine react completely from solution blue colour of solⁿ disappear. This titration can be of two type.

(i) Iodimetric titration!

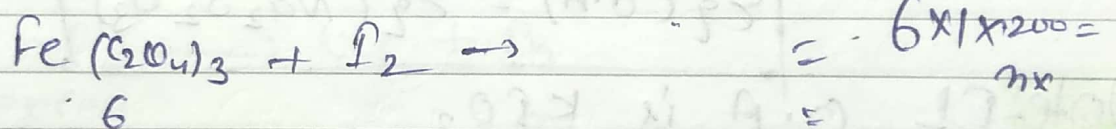
Used for finding amount of reducing Agent.





Que! A 200 ml $Fe_2(C_2O_4)_3$ solⁿ is titrated by 200 ml of 1 molar I_2 solution in presence of starch excess I_2 present in 40 ml of resulting solⁿ. Required 100 ml of 0.1 molar Hypo solⁿ to disappear the blue colour completely then calculate molarity of $Fe_2(C_2O_4)_3$ taken initially.

Ans!



$$Eq. Fe_2(C_2O_4)_3 = Eq. I_2$$

Remaining millimole of I_2 after 1st Rxn.

$$Eq. I_2 = Eq. Na_2S_2O_3$$

$$n \times 2 = 0.1 \times 100 \times 1$$

$$n = 5 \text{ millimol.} \rightarrow \text{Rem In } 40 \text{ ml.}$$

Overall Remaining millimol. of I_2 after first Rxn = 50 millimol

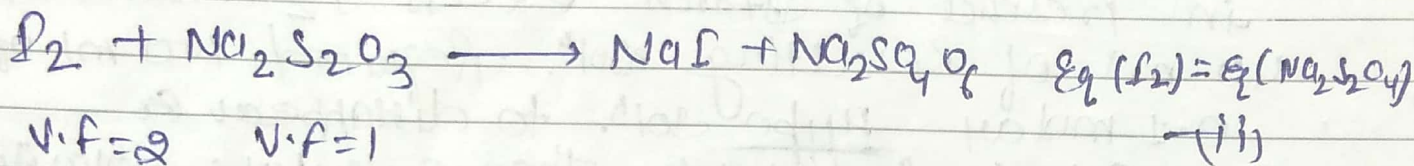
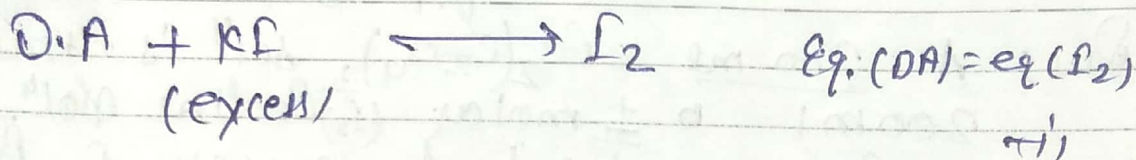
used millimol of I_2 with $Fe_2(C_2O_4)_3 = 200 - 50 = 150 \text{ mm}$

$$Eq. I_2 = Eq. Fe_2(C_2O_4)_3$$

$$150 \times 2 = M \times 200 \times 6.$$

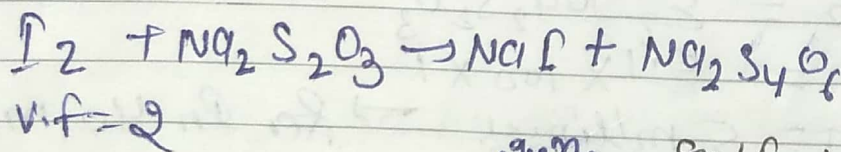
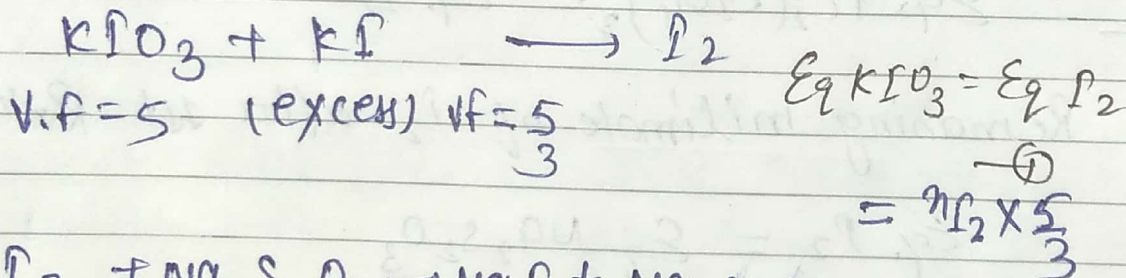
(ii) Iodometric titration:

With the help of Iodometric titration amount of oxidising agent find out.



$$\boxed{\text{Eq. (O.A)} = \text{Eq. (Na}_2S_2O_3)}$$

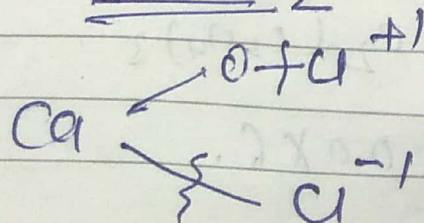
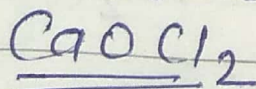
Note: If O.A is KIO_3



$$2 \times n_{I_2} = \text{Eq. (I}_2) = \text{Eq. Na}_2S_2O_3 \quad \text{--- (ii)}$$

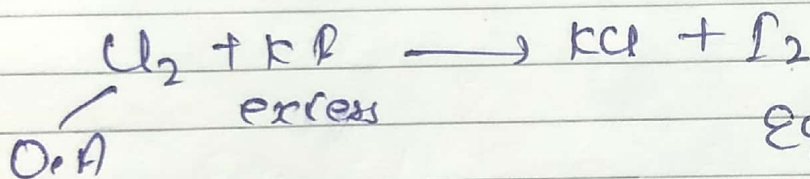
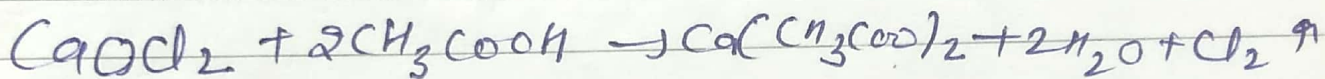
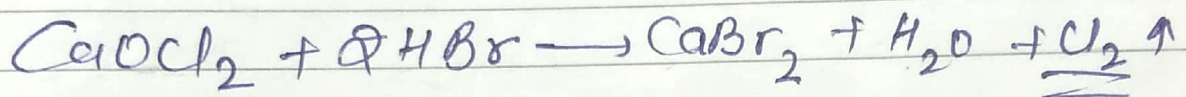
$$\text{Eq. } KIO_3 \times \text{Eq. Na}_2S_2O_3$$

* Iodometric titration can be used to find out % available Cl in Bleaching powder

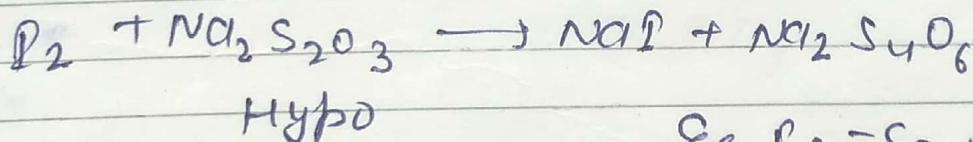


If Bleaching Powder is treated with H_2O and Acid it release Cl_2 amount of release Cl_2 called % Available Chlorine.

$$\% \text{ available } Cl_2 = \frac{\text{mass } Cl_2}{\text{mass of } CaOCl_2} \times 100$$



$$Eq. Cl_2 = Eq. I_2$$



$$Eq. I_2 = Eq. Na_2S_2O_3$$

$$Eq. Cl_2 = Eq. Na_2S_2O_3$$

Q. 5g of Bleaching Powder is mixed in 500 ml of H_2O in 25 ml of this solⁿ put in excess amount of HBr and KI Released Iodine from 25 ml. Solution Required 0.1 Normal Hypo Solution of Vol^{um} of Hypo Solution i.e used is 25 ml then calculate % available Cl_2 in Bleaching Powder taken initially.