

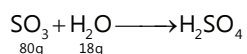
# Stoichiometry and Redox Reactions

## Solved Examples

### JEE Main/Boards

**Example 1:** Calculate the composition of 109% oleum.

**Sol:** Let the mass of  $\text{SO}_3$  in the sample be 'w' g, then the mass of  $\text{H}_2\text{SO}_4$  would be  $(100 - w)$ g. On dilution,



Moles of  $\text{SO}_3$  in oleum =  $\frac{w}{80}$  = Moles of  $\text{H}_2\text{SO}_4$  formed after dilution.

$$\therefore \text{Mass of } \text{H}_2\text{SO}_4 \text{ formed on dilution} = \frac{98w}{80}$$

$$\begin{aligned} \text{Total mass of } \text{H}_2\text{SO}_4 \text{ present in oleum after dilution} \\ = \frac{98w}{80} + (100 - w) = 109; \quad w = 40 \end{aligned}$$

Thus oleum sample contains 40%  $\text{SO}_3$  and 60%  $\text{H}_2\text{SO}_4$ .

**Example 2:** 20g of a sample of  $\text{Ba}(\text{OH})_2$  is dissolved in 10 mL of 0.5 N HCl sol. The excess of HCl was titrated with 0.2 N NaOH. The volume of NaOH used was 10 cc. Calculate the percentage of  $\text{Ba}(\text{OH})_2$  in the sample.

**Sol:** The titration principle is applied wherein milli-equivalents of the neutralization reactions is calculated.

Solving further, one gets the mass and % of the base.

$$\text{Milli eq. of HCl initially} = 10 \times 0.5 = 5$$

$$\text{Milli eq. of NaOH consumed}$$

$$= \text{Milli eq. of HCl in excess} = 10 \times 0.2 = 2$$

$$\therefore \text{Milli eq. of HCl consumed}$$

$$= \text{Milli eq. of } \text{Ba}(\text{OH})_2 = 5 - 2 = 3$$

$$\therefore \text{Eq. of } \text{Ba}(\text{OH})_2 = \frac{3}{1000} = 3 \times 10^{-3}$$

$$\text{Mass of } \text{Ba}(\text{OH})_2 = 3 \times 10^{-3} (171/2) = 0.2565 \text{ g}$$

$$\% \text{Ba}(\text{OH})_2 = (0.2565/20) \times 100 = 1.28\%$$

**Example 3:** One litre of mixture of CO and  $\text{CO}_2$  is passed through red hot charcoal in tube. The new volume becomes 1.4 litre. Find out % composition of original mixture by volume. All measurements are made at same P and T.

**Sol:** Assuming the mixture contents as a and b, the reaction is framed and values are laid down.

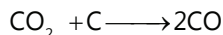
Let the mixture contains

$$\text{CO} = a \text{ litre}; \quad \text{CO}_2 = b \text{ litre}$$

$$\therefore a + b = 1$$

...(i)

On passing the mixture over charcoal only  $\text{CO}_2$  reacts as:



Vol. before reaction	b	0
Vol. after reaction	0	2b

$$\therefore a + 2b = 1.4$$

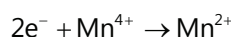
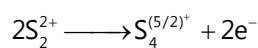
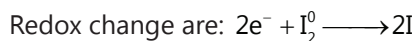
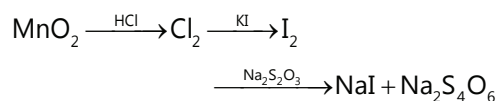
By Eqs. (i) and (ii)

$$a = 0.6 \text{ litre} \quad \text{or} \quad a = 60\%$$

$$b = 0.4 \text{ litre} \quad \text{or} \quad b = 40\%$$

**Example 4:** 0.5 g sample containing is treated with HCl liberating  $\text{Cl}_2$ . The is passed into a Sol. of KI and  $30.0 \text{ cm}^3$  of 0.1 M are required to titrate the liberated iodine. Calculate the percentage of in sample. (At. wt. of Mn = 55).

**Sol:** Principle of titration is involved in which equating the neutralization reactions is done and milliequivalents of each species is calculated. Thus, weight is calculated and the purity is found.



The reactions suggest that,

$$\text{Meq. of MnO}_2 = \text{Meq. of Cl}_2 \text{ formed}$$

$$= \text{Meq. of I}_2 \text{ liberated} = \text{Meq. of Na}_2\text{S}_2\text{O}_3 \text{ used}$$

$$\therefore \frac{w}{M/2} \times 1000 = 0.1 \times 1 \times 30$$

[ $\because N_{\text{Na}_2\text{S}_2\text{O}_3} = M_{\text{Na}_2\text{S}_2\text{O}_3}$  since valency factor = 1, see redox changes for  $\text{Na}_2\text{S}_2\text{O}_3$ ]

$$\text{Or } w_{\text{MnO}_2} = \frac{0.1 \times 1 \times 30 \times M}{2000} = \frac{0.1 \times 1 \times 30 \times 87}{2000}$$

$$(\because M_{\text{MnO}_2} = 87); w_{\text{MnO}_2} = 0.1305$$

$$\therefore \text{Purity of MnO}_2 = \frac{0.1305}{0.5} \times 100 = 26.1\%$$

**Example 5:** 10 mL mixture of  $\text{CH}_4$ ,  $\text{C}_2\text{H}_4$  and  $\text{C}_3\text{H}_8$  in the ratio 1: 1.5: 2.5 respectively is burnt in excess of air. Calculate the volume of air used and volume of  $\text{CO}_2$  formed after combustion. All measurements are made at same P and T.

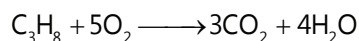
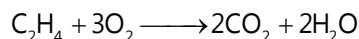
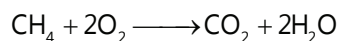
**Sol:** Using the given ratios, find the volumes of the hydrocarbons and frame the balanced combustion reactions.

The calculated  $\text{O}_2$  level is 1/5th of the air. Hence volume of  $\text{CO}_2$  is found.

$$\text{Volume of CH}_4 = \frac{1 \times 10}{5} = 2 \text{ mL}$$

$$\text{Volume of C}_2\text{H}_4 = \frac{1.5 \times 10}{5} = 3 \text{ mL}$$

$$\text{Volume of C}_3\text{H}_8 = \frac{2.5 \times 10}{5} = 5 \text{ mL}$$



$\therefore$  Volume of  $\text{O}_2$  needed

$$= 2 \times 2 + 2 \times 3 + 3 \times 5 = 38 \text{ mL}$$

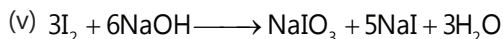
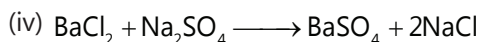
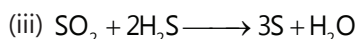
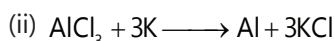
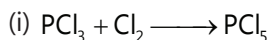
Since,  $\text{O}_2$  is 1/5th part of air

$$\therefore V_{\text{air}} = \frac{25 \times 100}{20} = 125 \text{ mL}$$

Volume of  $\text{CO}_2$  formed

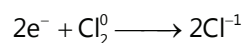
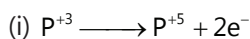
$$= 2 \times 1 + 2 \times 3 + 3 \times 5 = 23 \text{ mL}$$

**Example 6:** Select the species acting as reductant and oxidant in the reaction given below:



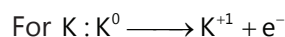
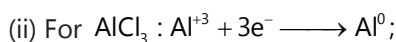
**Sol:** Calculate the oxidation numbers, find the loss/gain of electrons and thus identify the respective oxidants and reductants.

In a conjugate pair oxidant has higher oxidation number.

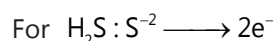
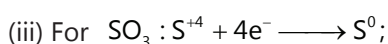


$\therefore$   $\text{PCl}_3$  is reductant and  $\text{Cl}_2$  is oxidant.

$\therefore$  In a conjugate pair of redox, the one having higher ox. no. is oxidant.



Oxidant is  $\text{AlCl}_3$  and reductant is  $\text{K}$ .



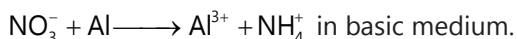
$\therefore$   $\text{SO}_2$  is oxidant and  $\text{H}_2\text{S}$  is reductant.

(iv) No change in ox. no. of either of the conjugate pair.

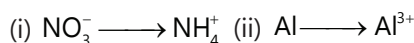
$\therefore$  None is oxidant or reductant.

(v) For  $\text{I}_2 : \text{I}_2^0 \longrightarrow 2\text{I}^{+3}$  and  $\text{I}_2^0 + 2\text{e}^- \longrightarrow 2\text{I}^{-1}$   $\text{I}_2$  acts as oxidant and reductant both.

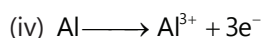
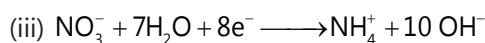
**Example 7:** Balance the following reaction



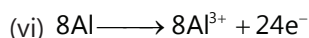
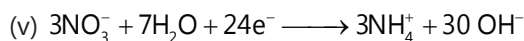
**Sol:** Here  $\text{NO}_3^-$  is undergoing reduction and Al is undergoing oxidation.



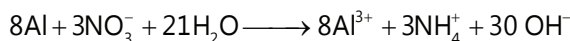
by balancing each half reaction, we get



by multiplying equation (iii) by 3 and equation (iv) by 8, we get



by combining these equations, we get



**Example 8:** The composition of a sample of wurtzite is  $\text{Fe}_{0.93}\text{O}_{1.00}$ . What percentage of iron is present in the form of Fe III?

**Sol:** Oxidation no. of Fe in wurtzite is  $\frac{200}{93} = 2.15$

It is an intermediate value between two oxidation state of Fe as, Fe (II) and (III).

Let percentage of Fe (III) be a, then

$$2 \times (100 - a) + 3 \times a = 2.15 \times 100 \quad \text{Or } a = 15$$

$$\therefore \text{Percentage of Fe(III)} = 15\%$$

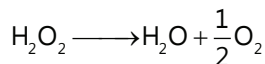
**Example 9:** A 5.0 cm<sup>3</sup> solution of  $\text{H}_2\text{O}_2$  liberates 0.508g of iodine from an acidified KI solution. Calculate the strength of  $\text{H}_2\text{O}_2$  solution in term of volume strength at STP.

**Sol:** Volume strength is the volume of oxygen released from 1 mL of hydrogen peroxide solution.

$$\text{Meq. of } \text{H}_2\text{O}_2 = \text{Meq. of } \text{I}_2$$

$$\frac{w}{17} \times 1000 = \left[ \frac{0.508}{\frac{254}{2}} \right] \times 1000$$

$$\therefore w = 0.068 \text{ g}$$



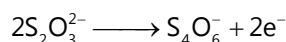
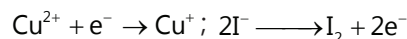
$\therefore$  34 g  $\text{H}_2\text{O}_2$  gives 11.2 litre  $\text{O}_2$ ,

$$\therefore 0.068 \text{ g gives } \frac{11.2 \times 0.068}{34} = 0.0224 \text{ litre} = 22.4 \text{ ml } \text{O}_2$$

$$\therefore \text{Volume strength of } \text{H}_2\text{O}_2 = \frac{22.4}{5} = 4.48\%$$

**Example 10:** A 1.100 g sample of copper ore is dissolved and the  $\text{Cu}^{2+}$  is treated with excess KI. The liberated  $\text{I}_2$  requires 12.12 mL of 0.10 M  $\text{Na}_2\text{S}_2\text{O}_3$  solution for titration. What is % copper by mass in the ore?

**Sol:** The titration reaction is framed to identify the loss/gain of electrons. The milliequivalents of the respective ions are equated and the amount is calculated. % can be found by dividing the whole weight.



$$\text{Meq. of } \text{Cu}^{2+} = \text{Meq. of liberated } \text{I}_2 = \text{Meq. of } \text{Na}_2\text{S}_2\text{O}_3 \\ = 12.12 \times 0.1 \times 1 = 1.212$$

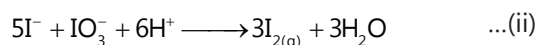
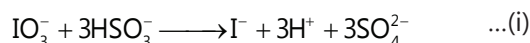
$$\therefore \frac{w_{\text{Cu}^{2+}}}{63.6/1} \times 1000 = 1.212$$

$$\therefore w_{\text{Cu}^{2+}} = 0.077 \text{ g} = w_{\text{Cu}} \quad (\text{Cu} \xrightarrow{\text{H}_2\text{SO}_4} \text{CuSO}_4)$$

$$\therefore \% \text{ Cu} = \frac{0.077}{1.10} \times 100 = 7\%$$

## JEE Advanced/Boards

**Example 1:** Chile salt petre, a source of  $\text{NaNO}_3$  also contains  $\text{NaIO}_3$ . The  $\text{NaIO}_3$  can be used as source of iodine, produced in the following reactions.



One litre of chile salt petre solution containing 5.80g  $\text{NaIO}_3$  is treated with stoichiometric quantity of  $\text{NaHSO}_3$ . Now an additional amount of same solution is added to reaction mixture to bring about the second reaction.

How many grams of  $\text{NaHSO}_3$  are required in step I and what additional volume of chile salt petre must be added in step II to bring in complete conversion of  $\text{I}^-$  to  $\text{I}_2$ ?

**Sol:** The titration reaction is used to identify the loss/gain of electrons. The milliequivalents of the respective species are equated and the amount is calculated. Stepwise calculation gives the volume of  $\text{NaIO}_3$ .

Meq. of  $\text{NaHSO}_3$  = Meq. of  $\text{NaIO}_3$

$$= N \times V = \frac{5.8}{198/6} \times 1000$$

[Et. wt. of  $\text{NaI}$  =  $M/6$  because  $\text{I}^{3+} + 6e \longrightarrow \text{I}^-$ ]

Meq. of  $\text{NaHSO}_3$  = 175.76

$$\therefore W_{\text{NaHSO}_3} = \frac{175.76 \times 104}{2000} = 9.14 \text{ g}$$

Also Meq. of  $\text{I}_2$  formed in I step using valence factor 6 = 175.76

In II step valence factor of  $\text{IO}_3^-$  is 1 and valence factor of  $\text{I}_2$  is 5.

Thus, Meq. of  $\text{I}_2$  formed using valence factor 1 =  $\frac{175.76}{6}$

Also Meq. of  $\text{NaIO}_3$  used in step II =  $\frac{175.76}{6}$

$$\therefore N \times V = \frac{175.76}{6}; \Rightarrow \frac{5.8}{198/5} \times V = \frac{175.76}{6}$$

$$\therefore V_{\text{NaIO}_3} = 200 \text{ mL}$$

**Example 2:** What amount of substance containing 60%  $\text{NaCl}$ , 37%  $\text{KCl}$  should be weighed out for analysis so that after the action of 25 mL of 0.1 N  $\text{AgNO}_3$  solution, excess of  $\text{Ag}^+$  is back titrated with 5 mL of  $\text{NH}_4\text{SCN}$ . Given that 1 mL of  $\text{NH}_4\text{SCN}$  = 1.1 mL of  $\text{AgNO}_3$ .

**Sol:** Let a g of the given sample be weighed out for the purpose. The reaction of the chlorides with  $\text{AgNO}_3$  will give  $\text{AgCl}$ . The unreacted  $\text{Ag}^+$  ions will get consumed by  $\text{NH}_4\text{SCN}$  to give  $\text{AgSCN}$ . Proceeding accordingly, equate the milliequivalents and calculate a.

$$\therefore \text{Wt. of NaCl} = \frac{60}{100} \times a = 0.6 \text{ a g}$$

$$\therefore \text{Wt. of KCl} = \frac{37}{100} \times a = 0.37 \text{ a g}$$

Now this mixture reacts with  $\text{AgNO}_3$ , the excess of  $\text{AgNO}_3$  is back titrated with  $\text{NH}_4\text{SCN}$ . Meq. of  $\text{AgNO}_3$  added to mixture

$$= 25 \times 0.1 = 2.5$$

Normality of  $\text{NH}_4\text{SCN}$  can be derived as

Meq. of  $\text{NH}_4\text{SCN}$  = Meq. of  $\text{AgNO}_3$

$$N \times 1 = 0.1 \times 1.1$$

$$N = 0.11$$

Meq. of  $\text{AgNO}_3$  left = Meq. of  $\text{NH}_4\text{SCN}$

$$= 5 \times N$$

$$\therefore \text{Meq. of AgNO}_3 \text{ left} = 5 \times 0.11 = 0.55$$

$$\therefore \text{Meq. of AgNO}_3 \text{ used for mixture} = 2.5 - 0.55 = 1.95$$

Meq. of  $\text{KCl}$  + Meq. of  $\text{NaCl}$  is mixture

$$= 1.95; \frac{0.73a}{74.5} \times 1000 + \frac{0.6a}{58.5} \times 1000 = 1.95$$

$$\therefore a = 0.128 \text{ g}$$

**Example 3:**  $\text{NaOH}$  and  $\text{Na}_2\text{CO}_3$  are dissolved in 200 mL aqueous solution. In the presence of phenolphthalein indicator, 17.5 mL of 0.1 N  $\text{HCl}$  are used to titrate this solution. Now methyl orange is added in the same sol. titrated and it requires 2.5 mL of the same  $\text{HCl}$ . Calculate the normality of  $\text{NaOH}$  and  $\text{Na}_2\text{CO}_3$  and their mass present in the solution.

**Sol:** The titration of a simple acid and a base using an indicator is seen over here. The milliequivalents of the acid is calculated and equated with that of the base. The volume and the mass is thus calculated.

Milli equivalent (a) of  $\text{HCl}$  used in the presence of phenolphthalein indicator.

$$= N \times V \text{ (mL)} = 0.1 \times 17.5 = 1.75$$

$$1.75 \text{ (a)} = \text{milli. eq. of NaOH} + \frac{1}{2} \text{ milli eq. of Na}_2\text{CO}_3 \quad \dots \text{ (i)}$$

Milli eq. (b) of  $\text{HCl}$  used in the presence of methyl orange indicator

$$= N \times V \text{ (mL)} = 0.1 \times 2.5 = 0.25$$

$$0.25 \text{ (b)} = \frac{1}{2} \text{ milli eq. of Na}_2\text{CO}_3 \quad \dots \text{ (ii)}$$

For  $\text{Na}_2\text{CO}_3$  solution; from equation (ii)

$$\text{Milli eq. of acid used by Na}_2\text{CO}_3 = 2b = 2 \times 0.25 = 0.5$$

Volume of  $\text{Na}_2\text{CO}_3$  solution = 200 mL

Suppose, Normality of  $\text{Na}_2\text{CO}_3$  = N

$$\text{Milli equivalents of } = N \times V \text{ (mL)} = 200 N$$

$$\text{Putting equivalents of acid and Na}_2\text{CO}_3 \text{ equal } 200 N = 0.5$$

$$\text{Or (Normality of Na}_2\text{CO}_3 \text{ solution) } N = \frac{1}{400}$$

$$\text{Mass of Na}_2\text{CO}_3 = N \times E \times V \text{ (litre)}$$

$$\text{(E for Na}_2\text{CO}_3 = 53) = \frac{1}{400} \times 53 \times 0.2 = 0.0265 \text{ gram}$$

For  $\text{NaOH}$  Sol.; from equation (i) and (ii)

Milli eq. acid used by NaOH =  $a - b = 1.75 - 0.25 = 1.50$

Volume of NaOH solution = 200 mL

Suppose, Normality of NaOH solution = N

Milli eq. of NaOH =  $N \times V$  (mL) = 200 N

Putting the milli eq. of NaOH and acid used equal 200  
 $N = 1.5$

(Normality of NaOH Sol.)  $N = \frac{1.5}{200}$

Mass of NaOH =  $N \times E \times (V \text{ litres})$

$= \frac{1.5}{200} \times 40 \times 0.2$  (E for NaOH = 40) = 0.06 g

**Example 4:** The molarity and molality of a solution are M and m respectively. If the molecular weight of the solute is M'. Calculate the density of the solution in terms of M, m and M'.

**Sol:** Let weight of solute be w g and weight of solvent be W g, volume of solution be V mL and density be D. Substitute as follows.

$$\therefore M = \frac{w \times 1000}{M' \times V} \quad \dots(i)$$

$$m = \frac{w \times 1000}{M' \times W} \quad \dots(ii)$$

$$D = \frac{w + W}{V} \quad \dots(iii)$$

By Eq. (i)  $w = \frac{MM'V}{1000} \quad \dots(iv)$

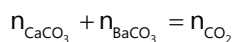
By Eq. (ii)  $W = \frac{w \times 1000}{M' \times m}$

By Eq. (iv)  $W = \frac{MM'V \times 1000}{1000 \times M' \times m} = \frac{MV}{m} \quad \dots(v)$

$$\therefore \text{By Eq. (iii)} D = \frac{\frac{MM'V}{1000} + \frac{MV}{m}}{V}; D - M \left[ \frac{1}{m} + \frac{M'}{1000} \right]$$

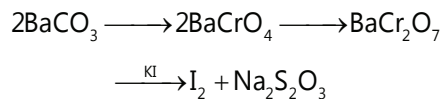
**Example 5:** 1.249 g of a sample of pure  $\text{BaCO}_3$  and impure  $\text{CaCO}_3$  containing some CaO was treated with dil. HCl and it evolved 168 mL of  $\text{CO}_2$  at NTP. From this solution  $\text{BaCrO}_3$  was precipitated, filtered and washed. The precipitate was dissolved in dilute sulphuric acid and diluted to 100 mL. 10 mL of this solution when treated with KI solution, liberated iodine which required exactly 20 mL of 0.05 N  $\text{Na}_2\text{S}_2\text{O}_3$ . Calculate the percentage of CaO in the sample.

**Sol:** An acid-base titration accompanied with iodine titration gives the following equation.



Calculating the equivalents of the involved species gives their amount and the %.

$$= \frac{168}{22400} = 7.5 \times 10^{-3} \quad \dots(i)$$



Eq. of  $\text{Na}_2\text{S}_2\text{O}_3$  = Eq. of  $\text{I}_2$  = Eq. of  $\text{BaCr}_2\text{O}_7$

$$= \frac{20 \times 10^{-3} \times 0.05 \times 100}{10} = 1 \times 10^{-2}$$

$$\text{Moles of BaCr}_2\text{O}_7 = \frac{1}{6} \times 10^{-2},$$

$$\text{Moles of BaCrO}_4 = \frac{2}{6} (1 \times 10^{-2})$$

$$\text{Moles of BaCO}_3 = \frac{1}{3} \times 10^{-2} = 3.33 \times 10^{-3} \quad \dots(ii)$$

Weight of  $\text{BaCO}_3$  = 0.650 gm

From equation (i) and (ii) we get  $\Rightarrow n_{\text{CaCO}_3} = 4.17 \times 10^{-3}$

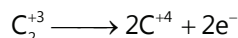
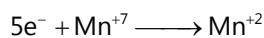
Weight of  $\text{CaCO}_3$  =  $100 \times 4.17 \times 10^{-3} = 0.417$  g

Weight of CaO =  $1.249 - 0.656 - 0.417 = 0.176$

$$\% \text{ of CaO} = \frac{0.176}{1.249} \times 100 = 14.09 \%$$

**Example 6:** Find out the percentage of oxalate ion in a given sample of oxalate salt of which 0.3 g dissolved in 100 mL of water required 90 mL of N/20  $\text{KMnO}_4$  for complete oxidation.

**Sol:** Redox changes are



$\therefore$  Meq. of oxalate ion = Meq. of  $\text{KMnO}_4$

$$\frac{w}{E} \times 1000 = 90 \times \frac{1}{20}; E_{\text{C}_2\text{O}_4^{2-}} = \frac{\text{Ionic wt.}}{2} \quad \frac{w}{88} \times 1000 = \frac{9}{2}$$

$$\therefore w_{\text{C}_2\text{O}_4^{2-}} = 0.198 \text{ g}$$

$\therefore$  0.3 g  $\text{C}_2\text{O}_4^{2-}$  sample has oxalate ion = 0.198 g

$$\therefore \text{Percentage of C}_2\text{O}_4^{2-} \text{ in sample} = \frac{0.198 \times 100}{0.3} = 66\%$$

**Example 7:** Balance the following redox equation,  $\text{AsO}_3^{-3} + \text{MnO}_4^- \longrightarrow \text{AsO}_4^{-3} + \text{MnO}_2$  using ion-electron method (alkaline medium)

**Sol:** (i) Identify the oxidation and reduction halves.

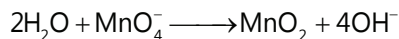
Reduction half reaction:  $\text{MnO}_4^- \longrightarrow \text{MnO}_2$

Oxidation half reaction:  $\text{AsO}_3^{3-} \longrightarrow \text{AsO}_4^{3-}$

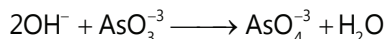
(ii) Atoms of the element undergoing oxidation and reduction are already balanced.

(iii) Balancing O atoms,

Reduction half reactions:



Oxidation half reactions:



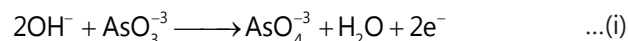
(iv) Balancing H atoms, H atoms are already balanced in both the half reactions.

(v) Balancing charge,

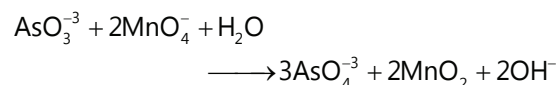
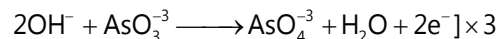
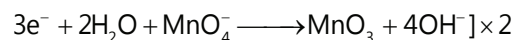
Reduction half reaction:



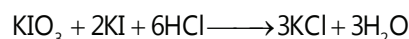
Oxidation half reaction:



(vi) Multiply equation (i) by 3 and equation (ii) by 2 and then add (i) and (ii).



**Example 8:** 1 g sample of  $\text{AgNO}_3$  is dissolved in 50 mL of water. It is titrated with 50 mL of KI solution. The  $\text{AgI}$  precipitated is filtered off. Excess of KI in filtrate is titrated with  $M/10$   $\text{KIO}_3$  in presence of  $6M$   $\text{HCl}$  till all  $\text{I}^-$  converted into  $\text{ICl}$ . It requires 50 mL of  $M/10$   $\text{KIO}_3$  solution. 20 mL of the same stock solution of KI requires 30 mL of  $M/10$   $\text{KIO}_3$  under similar conditions. Calculate % of  $\text{AgNO}_3$  in sample. The reaction is:

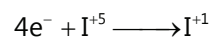


**Sol:** Follow the reaction  $\text{AgNO}_3 + \text{KI} \longrightarrow \text{AgI} + \text{KNO}_3$

1. Ag present in  $\text{AgNO}_3$  is removed as  $\text{AgI}$  by adding 50 mL KI of which 20 mL requires 30 mL of  $M/10$   $\text{KIO}_3$ .

2. The solution contains KI unused. The unused KI is converted into  $\text{ICl}$  by  $\text{KIO}_3$ .

$\therefore$  Meq. of KI in 20 mL = Meq. of  $\text{KIO}_3$



$\therefore$  Meq. of KI in 50 mL added to  $\text{AgNO}_3$

$$\therefore \text{Eq. wt. of KI} = \frac{M}{2} = \frac{30 \times 4 \times 50}{10 \times 20} = 30$$

Now, Meq. of KI left unused by  $\text{AgNO}_3 = 30 - 20$

$\therefore$  Mole ratio of  $\text{AgNO}_3$  and KI

$\therefore$  Meq. of  $\text{AgNO}_3 = 10$

Reaction is 1: 1 and thus if Eq.

$$\therefore \frac{w}{170/2} \times 1000 = 10 \quad \left| \quad \text{Wt. of KI is } M/2, \right.$$

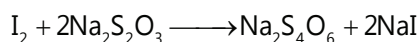
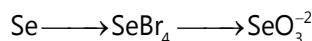
$w = 0.85$  g then Eq. wt. of  $\text{AgNO}_3 = M/2$

$\therefore$  Percentage of purity of  $\text{AgNO}_3$  in sample

$$= \frac{0.85 \times 100}{1} = 85\%$$

**Example 9:** Selenium in a 10.0 gm soil sample is distilled as the tetrabromide, which is collected in an aqueous solution, where it is hydrolysed to  $\text{SeO}_3^{2-}$ . The  $\text{SeO}_3^{2-}$  is estimated iodometrically, requiring 4.5 mL of standard  $\text{Na}_2\text{S}_2\text{O}_3$  solution for the titration. If 1 mL of  $\text{Na}_2\text{S}_2\text{O}_3 = 0.049$  mg of  $\text{K}_2\text{Cr}_2\text{O}_7$ , what is the concentration of Se in the soil in ppm?

**Sol:** Follow the reaction



$$1\text{mL } \text{Na}_2\text{S}_2\text{O}_3 \equiv \frac{0.049 \times 10^{-3} \times 6}{294} \text{ eq. of } \text{K}_2\text{Cr}_2\text{O}_7$$

$$\equiv \frac{0.049 \times 10^{-3} \times 6 \times 10^3}{294} \text{ Meq. of } \text{K}_2\text{Cr}_2\text{O}_7$$

$\therefore$  4.5 mL  $\text{Na}_2\text{S}_2\text{O}_3$

$$= \frac{0.049 \times 10^{-3} \times 6 \times 10^3 \times 4.5}{294} \text{ Meq. of } \text{K}_2\text{Cr}_2\text{O}_7 = 4.5 \times 10^{-3}$$

Meq. of  $\text{K}_2\text{Cr}_2\text{O}_7$  or Meq. of  $\text{Na}_2\text{S}_2\text{O}_3$

Meq. of Se = Meq. of  $\text{SeO}_3^{2-}$  = Meq. of KI = Meq. of  $\text{I}_2$  = Meq. of  $\text{Na}_2\text{S}_2\text{O}_3$

$$\frac{w_{\text{Se}}}{79} \times 1000 \times 4 = 4.5 \times 10^{-3}$$

$$\therefore w_{\text{Se}} = 8.8875 \times 10^{-5} \text{ g}$$

$$\therefore \text{ppm} = \frac{8.8875 \times 10^{-5} \times 10^6}{10} = 8.8875$$

## JEE Main/Boards

### Exercise 1

#### Mole Concept

**Q.1** Express the following in S.I. units:

(i) 125 pounds, the average weight of an Indian boy  
(1 lb = 545 g)

(ii) 14 lb/m<sup>2</sup> (atmospheric pressure)

(iii) 5'8", the average height of ramp models.

**Q.2** The isotropic distribution of potassium is 93.2% <sup>39</sup>K and 6.8% <sup>41</sup>K. How many <sup>41</sup>K atoms are there in 2g-atoms?

**Q.3** How many oxygen atoms are present in 6.025 g of Barium phosphate (at. mass of Ba=137.5, P= 31, O = 16 amu)

**Q.4** The vapour density of a mixture containing NO<sub>2</sub> and N<sub>2</sub>O<sub>4</sub> is 3.83 at 27°C. Calculate the moles of NO<sub>2</sub> in 100 g mixture.

**Q.5** Assume that the nucleus of the F atom is a sphere of radius 5 × 10<sup>-3</sup> cm. Calculate the density of matter in F nucleus. (At. mass F = 19)

**Q.6** 20.0 mL of dil. HNO<sub>3</sub> is neutralised completely with 25 mL of 0.08 M NaOH. What is molarity of HNO<sub>3</sub>?

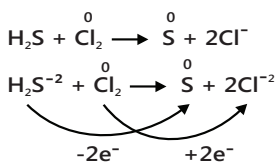
**Q.7** Gastric juice containing 3.0 g of HCl per litre. If a person produces about 2.5 litres of gastric juice a per day, how many antacid tablets each containing 400 mg of Al(OH)<sub>3</sub> are needed to neutralise all the HCl produced in one day.

**Q.8** 10 mL of HCl solution produced 0.1435 g of AgCl when treated with excess of Silver nitrate solution. What is the Molarity of acid solution [At. mass Ag = 100].

**Q.9** A certain compound containing only carbon and oxygen. Analysis show it has 36% carbon and 64% oxygen. If its molecular mass is 400 then what is the molecular formula of the compound.

**Q.10** 0.44 g of a hydrocarbon on complete combustion with oxygen gave 1.8 g water and 0.88 g carbon dioxide. Show that these results are in accordance with the law of conservation of mass.

**Q.11** A chloride of phosphate contains 22.57% P. Phosphine contains 8.82% hydrogen and hydrogen chloride gas contain 97.26% chlorine. Show that the data illustrate law of reciprocal proportions.



**Q.12** 1.375 g of cupric oxide was reduced by heating in a current of hydrogen and the mass of copper that remained was 1.098 g. In another experiment, 1.179 g of copper was dissolved in the nitric acid and the resulting copper nitrate converted into cupric oxide by ignition. The mass of cupric oxide formed was 1.476 g. Show that these results illustrate the law of constant composition.

**Q.13** 1.020 g of metallic oxide contains 0.540 g of the metal. Calculate the equivalent mass of the metal and hence its atomic mass with the help of Dulong and Petit's law. Taking the symbol for the metal as M, find the molecular formula of the oxide. The specific heat of the metal is 0.216 cal deg<sup>-1</sup> g<sup>-1</sup>.

**Q.14** Potassium permanganate is a dark green crystalline substance whose composition is 39.7% K, 29.9% Mn and rest O. Find the empirical formula?

**Q.15** Calculate the molarity of pure water at 4°C.

**Q.16** (i) What is the mass in grams of one molecule of caffeine (C<sub>8</sub>H<sub>20</sub>N<sub>4</sub>O<sub>2</sub>)?

(ii) Determine the total number of electrons in 0.142 g Cl<sub>2</sub>.

**Q.17** Calculate the molarity of distilled water if its density is 10<sup>3</sup> kg/m<sup>3</sup>.

**Q.18** A plant virus if found to consist of uniform cylindrical particles of 150 Å in diameter and 5000 Å long. The specific volume of virus is 0.75 cm<sup>3</sup>/g. If the virus is considered to be a simple particle, find the its molecular weight.

**Q.19** Calculate the mass of two litre sample of water containing 25% heavy water D<sub>2</sub>O in it by volume. Density of H<sub>2</sub>O is 1.0 g cm<sup>-3</sup> whereas that of D<sub>2</sub>O is 1.06 g cm<sup>-3</sup>.

**Q.20** 2.5 moles of sulphuryl chloride were dissolved in water to produce sulphuric acid and hydrochloric acid. How many moles of KOH will be required to completely neutralise the solution?

**Q.21** 100 g of a sample of common salt containing contamination of  $\text{NH}_4\text{Cl}$  and  $\text{MgCl}_2$  to the extent of 2% each by mass is dissolved in water. How much volume of 5% by mass of  $\text{AgNO}_3$  solution ( $d = 1.04 \text{ g cm}^{-3}$ ) is required to precipitate all chloride ions?

**Q.22** A mixture of formic acid and oxalic acid is heated with concentrated  $\text{H}_2\text{SO}_4$ . The gases produced are collected and on treatment with KOH solution, the volume of the gases decreased by 1.6th. Calculate the molar ratio of the two acids in the original mixture.

**Q.23** The mean molecular mass of a mixture of methane ( $\text{CH}_4$ ) and ethene ( $\text{C}_2\text{H}_4$ ) in the molar ratio of x: y is found to be 20. What will be the mean molecular mass if the molar ratio of the gases is reversed?

**Q.24** 1 g sample of  $\text{KClO}_3$  was heated under such conditions that a part of it decomposes as  $2\text{KClO}_3 \longrightarrow 2\text{KCl} + 3\text{O}_2$  while the remaining part decomposes as  $4\text{KClO}_3 \longrightarrow 3\text{KClO}_4 + \text{KCl}$ .

If net oxygen obtained is 146.8 mL at STP.

Calculate the mass of  $\text{KClO}_4$  in the residue.

**Q.25** A mixture of  $\text{FeO}$  and  $\text{Fe}_3\text{O}_4$  was heated in air to constant mass and it was found to gain 5% in its mass. Find the composition of the initial mixture.

**Q.26** Equal masses of zinc (at. mass 65) and iodine (at. mass 127) were allowed to react till completion of reaction to form  $\text{ZnI}_2$ . Which substance is left unreacted and to what fraction of its original mass?

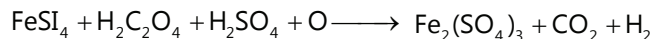
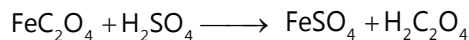
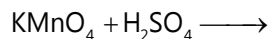
**Q.27** Two gram each of  $\text{P}_4$  and  $\text{O}_2$  are allowed to react till none of the reactant is left. If the products are  $\text{P}_4\text{O}_6$  and  $\text{P}_4\text{O}_{10}$ . Calculate the mass of each of the product.

**Q.28** A piece of aluminium weighing 2.7 g was heated with 100 mL of  $\text{H}_2\text{SO}_4$  (25% by mass,  $d = 1.18 \text{ g cm}^{-3}$ ). After complete dissolution of metal, the solution is diluted by adding water to 500 mL.

What is the molarity of free  $\text{H}_2\text{SO}_4$  in resulting solution?

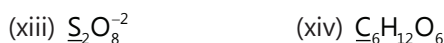
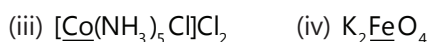
**Q.29** Chemical reaction between ferrous oxalate and  $\text{KMnO}_4$  has been given in the form of three partial equations. Write the complete balanced equation and thus find out the volume of 0.5 M  $\text{KMnO}_4$  required to

completely react with 1.5 mol of  $\text{FeC}_2\text{O}_4$ .

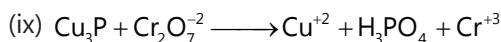
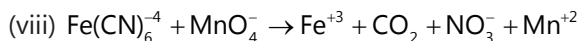
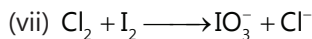
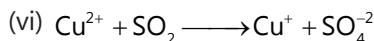
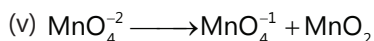
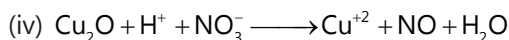
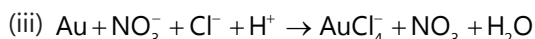
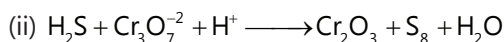
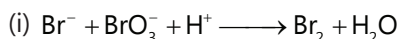


## Redox Reactions

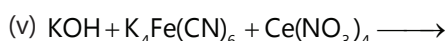
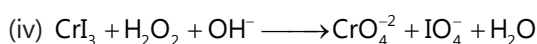
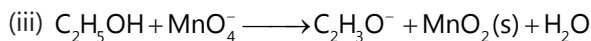
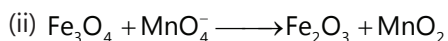
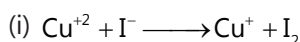
**Q.1** Indicate the oxidation number of underlined in each case:



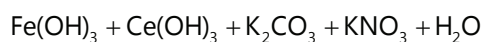
**Q.2** Write complete balanced equation for the following in acidic medium by ion-electron method:



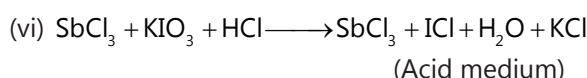
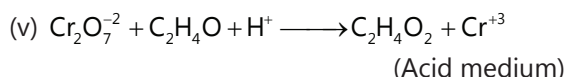
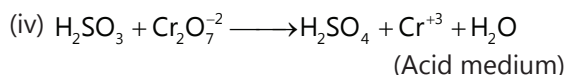
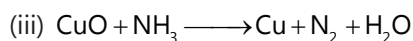
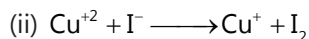
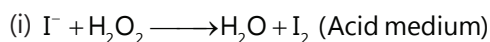
**Q.3** Write complete balanced equation for the following in basic medium by ion-electron method:







**Q.4** Balance the following equations by oxidation method:



**Q.5** Define disproportionation? Give one example.

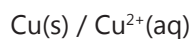
**Q.6** Define difference between ion electron method and oxidation method?

**Q.7** What is the most essential conditions that must be satisfied in a redox reaction?

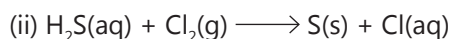
**Q.8** Does the oxidation number of an element in any molecule or any poly atomic ion represents the actual charge on it?

**Q.9** What is redox couple?

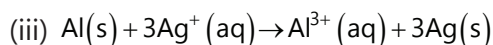
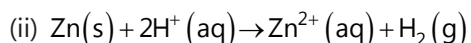
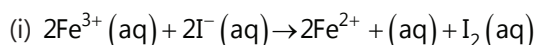
**Q.10** Calculate the standard e.m.f. of the cells formed by different combinations of the following half cells.



**Q.11** Balance the following equations in acidic medium by both oxidation number and ion electron methods & identify the oxidants and the reductants.



**Q.12** Write the half reactions for the following redox reactions:



**Q.13** Define oxidation & reduction in term of oxidation number.

**Q.14** Discuss the following redox reactions?

- (i) Combination reactions
- (ii) Decomposition reactions
- (iii) Displacement reactions
- (iv) Disproportionation reaction

**Q.15** What is the difference between valence and oxidation number?

**Q.16**  $\text{H}_2\text{S}$  acts only as reducing agent while  $\text{SO}_2$  can act both as a reducing agent and oxidising agent. Explain.

**Q.17** What are half reactions? Explain with examples?

**Q.18** Explain the term:

- (i) Oxidation
- (ii) Reduction
- (iii) Oxidizing agent
- (iv) Reducing agent

## Exercise 2

### Mole Concept

#### Single Correct Choice Type

**Q.1** If 'x' gms of an element A reacts with 16 gms of oxygen then the equivalent weight of element A is

- (A)  $\frac{x}{4}$       (B)  $\frac{x}{2}$       (C) x      (D) 2x

**Q.2** The mass of CO containing the same amount of oxygen as in 88 gms of  $\text{CO}_2$  is

- (A) 56 gms      (B) 28 gms      (C) 112 gms      (D) 14 gms

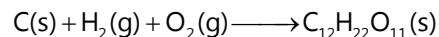
**Q.3** When 8 gms of oxygen reacts with magnesium then the amount of MgO formed is

- (A) 18 gm      (B) 20 gm      (C) 24 gm      (D) 32 gm

**Q.4** One gram of the silver salt of an organic dibasic acid yields, on strong heating 0.5934 g of silver. If the weight percentage of carbon in it 8 times the weight percentage of hydrogen and one half the weight percentage of oxygen, determine the molecular formula of the acid. [Atomic weight of Ag = 108]

- (A)  $\text{C}_4\text{H}_6\text{O}_4$       (B)  $\text{C}_4\text{H}_6\text{O}_6$       (C)  $\text{C}_2\text{H}_6\text{O}_2$       (D)  $\text{C}_5\text{H}_{10}\text{O}_5$

**Q.5** Mass of sucrose  $C_{12}H_{22}O_{11}$  produced by mixing 84 gm of carbon, 12 gm of hydrogen and 56 liter  $O_2$  at 1 atm and 273 K according to given reaction, is



- (A) 138.5      (B) 155.5      (C) 172.5      (D) 199.5

**Q.6** 40 gm of carbonate of an alkali metal or alkaline earth metal containing some inert impurities was made to react with excess HCl solution. The liberated  $CO_2$  occupied 12.315 lit. at 1 atm and 300 K. The correct option is

- (A) Mass of impurity is 1 gm and metal is Be  
 (B) Mass of impurity is 3 gm and metal is Li  
 (C) Mass of impurity is 5 gm and metal is Be  
 (D) Mass of impurity is 2 gm and metal is Mg

**Q.7** An hydride of nitrogen decomposes to give nitrogen and hydrogen. It was formed that one volume of the hydride gave one volume of  $N_2$  and 2 volume of  $H_2$  at STP. The hydride of nitrogen is

- (A)  $NH_3$       (B)  $N_2H_6$       (C)  $NH_2$       (D)  $N_2H_4$

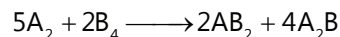
**Q.8** 5 volumes of a hydrocarbon on complete consumed 10 volumes of oxygen giving 5 volumes of  $CO_2$  at STP. The hydrocarbon is

- (A)  $C_2H_6$       (B)  $C_2H_4$       (C)  $CH_4$       (D)  $C_2H_4$

**Q.9** The percentage by mole of  $NO_2$  in a mixture of  $NO_2(g)$  and  $NO(g)$  having average molecular mass 34 is

- (A) 25%      (B) 20%      (C) 40%      (D) 75%

**Q.10** The minimum mass of mixture of  $A_2$  and  $B_4$  required to produce at least 1 kg of each product is (Given At. mass of 'A' = 10; At. mass of 'B' = 120)



- (A) 2120 gm    (B) 1060 gm    (C) 560 gm    (D) 1660 gm

**Q.11** 74 gm of a sample on complete combustion given 132 gm  $CO_2$  and 54 gm of  $H_2O$ . The molecular formula of the compound may be

- (A)  $C_5H_{12}$       (B)  $C_4H_{10}O$       (C)  $C_3H_{10}O_2$       (D)  $C_3H_7O_2$

**Q.12** The volume of oxygen used when x gms of Zn is converted to ZnO is

- (A)  $\frac{2x}{65} \times 5.6$  litres      (B)  $\frac{x}{65} \times 5.6$  litres  
 (C)  $\frac{4x}{65} \times 5.6$  litres      (D) None of these

**Q.13** A sample of clay was partially dried and then contained 50% silica and 7% water. The original clay contained 12% water. The silica in original sample is

- (A) 51.69      (B) 47.31  
 (C) 63.31      (D) None of these

**Q.14** The mass of  $CO_2$  produced from 620 mixture of  $C_2H_4O_2$  and  $O_2$ , prepared produce maximum energy is (combustion reaction is exothermic)

- (A) 413.33 gm      (B) 593.04 gm  
 (C) 440 gm      (D) 320 gm

**Q.15** In the quantitative determination of nitrogen,  $N_2$  gas liberated from 0.42 gm of a sample of organic compound was collected over water. If the volume of  $N_2$  gas collected was 100/11 mL at total pressure 860 mm Hg at 250 K, % by mass of nitrogen in the organic compound is

[Aq. tension at 250 K is 24 mm Hg and  $R = 0.08 \text{ L atm mol}^{-1} \text{ K}^{-1}$ ]

- (A)  $\frac{10}{3}\%$       (B)  $\frac{5}{3}\%$       (C)  $\frac{20}{3}\%$       (D)  $\frac{100}{3}\%$

**Q.16** 300 mL of 0.1 M HCl and 200 mL of 0.3 M  $H_2SO_4$  are mixed. The normality of the resulting mixture is

- (A) 0.4 N      (B) 0.1 N      (C) 0.3 N      (D) 0.2 N

**Q.17** The volume of water which should be added to 300 mL of 0.5 M NaOH solution so as to get a solution of 0.2 M is

- (A) 550 mL      (B) 350 mL      (C) 750 mL      (D) 450 mL

**Q.18** The mole fraction of a solution containing 3.0 gms of urea per 250 gms of water would be

- (A) 0.00357      (B) 0.99643  
 (C) 0.00643      (D) None of these

**Q.19** The mass of  $P_4O_{10}$  produced if 440 gm of  $P_4S_3$  is mixed with 384 gm of  $O_2$  is  $P_4S_3 + O_2 \longrightarrow P_4O_{10} + SO_2$

- (A) 568 gm      (B) 426 gm  
 (C) 284 gm      (D) 396 gm

**Q.20** Calculate percentage change in  $M_{avg}$  of the mixture, if  $PCl_5$  undergo 50% decomposition.  $PCl_5 \longrightarrow PCl_3 + Cl_2$

- (A) 50%      (B) 66.66%  
 (C) 33.33%      (D) Zero

**Q.21** The mass of  $\text{Mg}_3\text{N}_2$  produced if 48 gm of Mg metal is reacted with 34 gm  $\text{NH}_3$  gas is  $\text{Mg} + \text{NH}_3 \longrightarrow \text{Mg}_3\text{N}_2 + \text{H}_2$

- (A)  $\frac{200}{3}$       (B)  $\frac{100}{3}$       (C)  $\frac{400}{3}$       (D)  $\frac{150}{3}$

**Q.22** The molarity of a solution of conc. HCl containing 36.5% by weight of HCl would be

- (A) 16.75      (B) 17.75      (C) 15.75      (D) 14.75

**Q.23** 0.35 gms of a sample of  $\text{Na}_2\text{CO}_3 \cdot x\text{H}_2\text{O}$  were dissolved in water and the volume was made to 50 mL

of this solution required 9.9 mL of  $\frac{N}{10}$  HCl for complete neutralization. Calculate the value of x.

- (A) 1      (B) 2      (C) 3      (D) None of these

**Q.24** 1.2 gms of a sample of washing soda was dissolved in water and volume was made upto 250 cc. 25 cc of this solution when titrated against N/10 HCl for required 17 mL. The percentage of carbonate is given sample is

- (A) Approximately 70%      (B) Approximately 66%  
(C) Approximately 76%      (D) None of these

**Q.25** The number of carbon atoms present in a signature, if a signature written by carbon pencil weights  $1.2 \times 10^{-3}$  g is

- (A)  $12.40 \times 10^{20}$       (B)  $6.02 \times 10^{19}$   
(C)  $3.01 \times 10^{19}$       (D)  $6.02 \times 10^{20}$

**Q.26** The average atomic mass of a mixture containing 79 mole % of  $^{24}\text{Mg}$  is 24.31. % mole of  $^{26}\text{Mg}$  is

- (A) 5      (B) 20      (C) 10      (D) 15

**Q.27** 25 cc of solution containing NaOH and  $\text{Na}_2\text{CO}_3$  when titrated against N/10 HCl. Using phenolphthalein as indicator required 40 cc. of HCl. The same volume of mixture when titrated against N/10 HCl using methyl orange required 45cc of this HCl. The amount of NaOH and  $\text{Na}_2\text{CO}_3$  in one mixture is

- (A) NaOH = 28 gm/L ;  $\text{Na}_2\text{CO}_3$  = 10.6 gm/L  
(B) NaOH = 10.6 gm/L ;  $\text{Na}_2\text{CO}_3$  = 28 gm/L  
(C) NaOH = 14 gm/L ;  $\text{Na}_2\text{CO}_3$  = 5.3 gm/L  
(D) None of these

**Q.28** 0.5 gms of a mixture of  $\text{K}_2\text{CO}_3$  and  $\text{Li}_2\text{CO}_3$  requires 30 mL of 0.25 NHCl solution for neutralization. The percentage composition of mixture would be

- (A)  $\text{K}_2\text{CO}_3$  = 96%;  $\text{Li}_2\text{CO}_3$  = 4%  
(B)  $\text{K}_2\text{CO}_3$  = 4%;  $\text{Li}_2\text{CO}_3$  = 96%  
(C)  $\text{K}_2\text{CO}_3$  = 50%;  $\text{Li}_2\text{CO}_3$  = 25%  
(D)  $\text{K}_2\text{CO}_3$  = 50%;  $\text{Li}_2\text{CO}_3$  = 74%

**Q.29** How many mL of a 0.05 M  $\text{KMnO}_4$  solution are required to oxidise 2.0 g of  $\text{FeSO}_4$  in a dilute acid solution?

- (A) 5.263      (B) 0.5263  
(C) 52.63      (D) None of these

## Redox Reaction

### Single Correct Choice Type

**Q.1** The equivalent weight of  $\text{FeSO}_4$  when it is oxidised by acidified  $\text{KMnO}_4$  will be equal to

- (A)  $M_0$  of  $\text{FeSO}_4$       (B)  $\frac{M_0 \text{FeSO}_4}{2}$   
(C)  $2M_0 \text{FeSO}_4$       (D)  $\frac{M_0 \text{FeSO}_4}{4}$

**Q.2** The equivalent weight of  $\text{K}_2\text{Cr}_2\text{O}_7$  when it is converted  $\text{Cr}^{3+}$  will be equal to

- (A)  $M_{\text{K}_2\text{Cr}_2\text{O}_7}$       (B)  $\frac{M_{\text{K}_2\text{Cr}_2\text{O}_7}}{3}$   
(C)  $\frac{M_{\text{K}_2\text{Cr}_2\text{O}_7}}{4}$       (D)  $\frac{M_{\text{K}_2\text{Cr}_2\text{O}_7}}{6}$

**Q.3** The amount of  $\text{H}_2\text{S}$  that can be oxidised to sulfur on oxidation using 1.58 gm of  $\text{KMnO}_4$  as oxidising agent in acidic medium will be

- (A) 0.85 gms      (B) 1.7 gms  
(C) 0.425 gms      (D) None of these

**Q.4** The amount of nitric acid required to oxidise 127 gms of  $\text{I}_2$  to  $\text{I}_2\text{O}_5$  will be \_\_\_\_\_. Assume that during the reaction  $\text{HNO}_3$  gets converted to  $\text{NO}_2$ .

- (A) 12.7      (B) 3.15      (C) 315      (D) 31.5

**Q.5** 10 mL of oxalic acid was completely oxidised by 20 mL of 0.02 M  $\text{KMnO}_4$ . The normality of oxalic acid solution is

- (A) 0.05 N      (B) 0.1 N      (C) 0.2 N      (D) 0.025 N

**Q.6** 0.2 g of a sample of  $\text{H}_2\text{O}_2$  required 10 mL of 1N  $\text{KMnO}_4$  in a titration in the presence of  $\text{H}_2\text{SO}_4$ . Purity of  $\text{H}_2\text{O}_2$  is

- (A) 25% (B) 65% (C) 85% (D) None of these

**Q.7** The number of moles of  $\text{KMnO}_4$  that will be needed to react completely with one mole of ferrous oxalate in acidic solution is

- (A)  $\frac{2}{5}$  (B)  $\frac{3}{5}$  (C)  $\frac{4}{5}$  (D) 1

**Q.8** A metal oxide is reduced by heating it in a stream of hydrogen. It is found that after complete reduction, 3.15 g of the oxide has yielded 1.05 g of the metal. We may deduce that

- (A) The atomic weight of the metal is 8  
 (B) The atomic weight of the metal is 4  
 (C) The equivalent weight of the metal is 4  
 (D) The equivalent weight of the metal is 8

**Q.9** Oxidation involves

- (A) Gain of electrons  
 (B) Loss of electrons  
 (C) Increase in the valency of negative part  
 (D) Decrease in the valency of positive part

**Q.10** The oxidation number of Cr in  $\text{K}_2\text{Cr}_2\text{O}_7$

- (A) +2 (B) -2 (C) +6 (D) -6

**Q.11** When  $\text{K}_2\text{Cr}_2\text{O}_7$  is converted into  $\text{K}_2\text{Cr}_2\text{O}_4$  the change in oxidation number of Cr is

- (A) 0 (B) 6 (C) 4 (D) 3

**Q.12** White P reacts with caustic soda. The products are  $\text{PH}_3$  and  $\text{NaH}_2\text{PO}_2$ . This reaction is an example of

- (A) Oxidation (B) Reduction  
 (C) Oxidation and reduction (D) Neutralization

**Q.13** The oxidation number of carbon in  $\text{CH}_2\text{O}$  is

- (A) -2 (B) +2 (C) 0 (D) +4

**Q.14** The oxidation number of C in  $\text{CH}_4$ ,  $\text{CH}_3\text{Cl}$ ,  $\text{CH}_2\text{Cl}_2$ ,  $\text{CHCl}_3$ , and  $\text{CCl}_4$  are respectively

- (A) 0, 2, -2, 4, -4 (B) -4, -2, 0, +2, +4  
 (C) 2, 4, 0, -2, -4 (D) 4, 2, 0, -2, -4

**Q.15** Which of the following reactions is not redox type

- (A)  $2\text{BaO} + \text{O}_2 \longrightarrow 2\text{BaO}_2$   
 (B)  $4\text{KClO}_3 \longrightarrow 2\text{KClO}_4 + \text{KCl}$   
 (C)  $\text{BaO}_2 + \text{H}_2\text{SO}_4 \longrightarrow \text{BaSO}_4 + \text{H}_2\text{O}_2$   
 (D)  $\text{SO}_2 + 2\text{H}_2\text{S} \longrightarrow 2\text{H}_2\text{O} + 3\text{S}$

**Q.16** In which of the following compounds iron has lowest oxidation state

- (A)  $\text{K}_4\text{Fe}(\text{CN})_6$  (B)  $\text{K}_2\text{FeO}_4$   
 (C)  $\text{Fe}_2\text{O}$  (D)  $\text{Fe}(\text{CO})_5$

**Q.17** Select the compound in which chlorine is assigned the oxidation number +5

- (A)  $\text{HClO}$  (B)  $\text{HClO}_2$  (C)  $\text{HClO}_3$  (D)  $\text{HClO}_4$

**Q.18** If three electrons are lost by a metal iron  $\text{M}^{3+}$  its final oxidation number would be

- (A) 0 (B) +2 (C) +5 (D) +6

**Q.19** The oxidation number of Mn in  $\text{MnO}_4^-$  is

- (A) +7 (B) -5 (C) -7 (D) +5

**Q.20** The oxidation number of carbon in  $\text{CHCl}_3$  is

- (A) +2 (B) +4 (C) +4 (D) -3

**Q.21**  $\text{Pb}^{2+}$  loses two electrons in a reaction. What will be the oxidation number of lead after the reaction?

- (A) +2 (B) 0 (C) +4 (D) -2

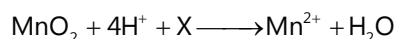
**Q.22** The oxidation number of carbon in  $\text{C}_{12}\text{H}_{22}\text{O}_{11}$  is

- (A) 0 (B) -6 (C) +2 (D) +6

**Q.23** The oxidation state of sulphur in  $\text{SO}_4^{2-}$  is

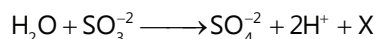
- (A) +2 (B) +4 (C) +5 (D) +6

**Q.24** If the following reaction 'X' is



- (A)  $1\text{e}^-$  (B)  $2\text{e}^-$  (C)  $3\text{e}^-$  (D)  $4\text{e}^-$

**Q.25** In the following reaction the value of 'X' is



- (A)  $4\text{e}^-$  (B)  $3\text{e}^-$  (C)  $2\text{e}^-$  (D)  $1\text{e}^-$

**Q.26** The oxidation state of sulphur is  $S_2O_7^{2-}$  is  
(A) +6 (B) -6 (C) -2 (D) +2

**Q.27** The oxidation number and covalency of sulphur in  $S_8$  are respectively  
(A) 0 & 2 (B) 0 & 8 (C) 6 & 8 (D) 6 & 2

**Q.28** The oxidation state of nitrogen in  $N_3H$  is  
(A) 1/3 (B) +3 (C) -1 (D) -1/3

**Q.29** The oxidation number of iron in potassium ferricyanide is  
(A) +1 (B) +2 (C) +3 (D) +4

**Q.30** Oxidation number of hydrogen in  $MH_2$  is  
(A) +1 (B) -1 (C) +2 (D) -2

**Q.31** The oxidation state of phosphorus varies from  
(A) -1 to +1 (B) -3 to +3 (C) -3 to +5 (D) -5 to +1

**Q.32** Select the compound in which chlorine is assigned the oxidation number +5  
(A)  $HClO_4$  (B)  $HClO_2$  (C)  $HClO_3$  (D)  $HCl$

## Previous Years' Questions

### Mole Concept

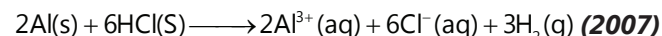
**Q.1** If we consider that 1/6, in place of 1/12, mass of carbon atom is taken to be the relative atomic mass unit, the mass of one mole of a substance will **(2002)**

- (A) Decrease twice  
(B) Increase two fold  
(C) Remain unchanged  
(D) Be a function of the molecular mass of the substance

**Q.2** A molar solution is one that contains one mole of a solute in **(1986)**

- (A) 1000 g of the solvent (B) One litre of the solvent  
(C) One litre of the solution (D) 22.4 litres of the solution

**Q.3** In the reaction,



- (A) 6 l  $HCl(aq)$  is consumed for every 3L  $H_2(g)$  produced

(B) 33.6 l  $H_2(g)$  is produced regardless of temperature and pressure for every mole  $Al$  that reacts

(C) 67.2 l  $H_2(g)$  at STP is produced for every mole  $Al$  that reacts

(D) 11.2  $H_2(g)$  at STP is produced for every mole  $HCl(aq)$  consumed

**Q.4** How many moles of magnesium phosphate,  $Mg_3(PO_4)_2$  will contain 0.25 mole of oxygen atoms **(2006)**

- (A) 0.02 (B)  $3.125 \times 10^{-2}$   
(C)  $1.25 \times 10^{-2}$  (D)  $2.5 \times 10^{-2}$

**Q.5** If  $10^{21}$  molecules are removed from 200 mg of  $CO_2$ , then the number of moles of  $CO_2$  left are **(1983)**

- (A)  $2.85 \times 10^{-3}$  (B)  $28.8 \times 10^{-3}$   
(C)  $0.288 \times 10^{-3}$  (D)  $1.68 \times 10^{-2}$

**Q.6** In standardization of  $Na_2S_2O_3$  using  $K_2Cr_2O_7$  by iodometry, the equivalent weight of  $K_2Cr_2O_7$  is **(2000)**

- (A)  $\frac{MW}{2}$  (B)  $\frac{MW}{3}$  (C)  $\frac{MW}{6}$  (D)  $\frac{MW}{1}$

**Q.7** The molarity of a solution obtained by mixing 750 mL of 0.5(M)  $HCl$  with 250 mL of 2(M)  $HCl$  will be: **(2013)**

- (A) 0.875 M (B) 1.00 M (C) 1.75 M (D) 0.975 M

**Q.8** A gaseous hydrocarbon gives upon combustion 0.72 g of water and 3.08 g of  $CO_2$ . The empirical formula of the hydrocarbon is: **(2013)**

- (A)  $C_2H_4$  (B)  $C_3H_4$  (C)  $C_6H_5$  (D)  $C_7H_8$

**Q.9** Experimentally it was found that a metal oxide has formula  $M_{0.98}O$ . Metal  $M$ , present as  $M^{2+}$  and  $M^{3+}$  in its oxide. Fraction of the metal which exists as  $M^{3+}$  would be: **(2013)**

- (A) 7.01 % (B) 4.08 % (C) 6.05 % (D) 5.08 %

**Q.10** The ratio of masses of oxygen and nitrogen in a particular gaseous mixture is 1 : 4. The ratio of number of their molecule is 3 **(2014)**

- (A) 1 : 4 (B) 7 : 32 (C) 1 : 8 (D) 3 : 16

**Q.11** The molecular formula of a commercial resin used for exchanging ions in water softening is  $C_6H_7SO_3Na$  (Mol. Wt. 206). What would be the maximum uptake of  $Ca^{2+}$  ions by the resin when expressed in mole per gram resin? **(2015)**

- (A)  $\frac{1}{103}$  (B)  $\frac{1}{206}$  (C)  $\frac{2}{309}$  (D)  $\frac{1}{412}$

**Q.12** At 300 K and 1 atm, 15 mL of a gaseous hydrocarbon requires 375 mL air containing 20% O<sub>2</sub> by volume for complete combustion. After combustion the gases occupy 330 mL. Assuming that the water formed is in liquid form and the volumes were measured at the same temperature and pressure, the formula of the hydrocarbon is: **(2016)**

- (A) C<sub>2</sub>H<sub>12</sub>    (B) C<sub>4</sub>H<sub>8</sub>    (C) C<sub>4</sub>H<sub>10</sub>    (D) C<sub>3</sub>H<sub>6</sub>

### Redox Reactions

**Q.13** Several blocks of magnesium are fixed to the bottom of a ship to **(2003)**

- (A) Keep away the sharks  
(B) Make the ship lighter  
(C) Prevent action of water and salt  
(D) Prevent puncturing by under-sea rocks

**Q.14** Which of the following chemical reactions depicts the oxidizing behaviour of H<sub>2</sub>SO<sub>4</sub>? **(2006)**

- (A) 2HI + H<sub>2</sub>SO<sub>4</sub> → I<sub>2</sub> + SO<sub>2</sub> + 2H<sub>2</sub>O  
(B) Ca(OH)<sub>2</sub> + H<sub>2</sub>SO<sub>4</sub> → CaSO<sub>4</sub> + 2H<sub>2</sub>O  
(C) NaCl + H<sub>2</sub>SO<sub>4</sub> → NaHSO<sub>4</sub> + HCl  
(D) 2PCl<sub>5</sub> + H<sub>2</sub>SO<sub>4</sub> → 2POCl<sub>3</sub> + 2HCl + SO<sub>2</sub>Cl<sub>2</sub>

**Q.15** The oxidation number of carbon in CH<sub>2</sub>O is **(1982)**

- (A) -2    (B) +2    (C) 0    (D) 4

**Q.16** The oxidation state of chromium in the final product formed by the reaction between KI and acidified potassium dichromate solution is **(2005)**

- (A) +4    (B) +6    (C) +2    (D) +3

**Q.17** When KMnO<sub>4</sub> acts as an oxidising agent and ultimately forms [MnO<sub>4</sub>]<sup>-2</sup>, MnO<sub>2</sub>, Mn<sub>2</sub>O<sub>3</sub>, Mn<sup>+2</sup> then the number of electrons transferred in each case respectively is **(2002)**

- (A) 4, 3, 1, 5    (B) 1, 5, 3, 7  
(C) 1, 3, 4, 5    (D) 3, 5, 7, 1

**Q.18** Which of the following is a redox reaction **(2002)**

- (A) NaCl + KNO<sub>3</sub> → NaNO<sub>3</sub> + KCl  
(B) CaC<sub>2</sub>O<sub>4</sub> + 2HCl → CaCl<sub>2</sub> + H<sub>2</sub>C<sub>2</sub>O<sub>4</sub>  
(C) Mg(OH)<sub>2</sub> + 2NH<sub>4</sub>Cl → MgCl<sub>2</sub> + 2NH<sub>4</sub>OH  
(D) Zn + 2AgCN → 2Ag + Zn(CN)<sub>2</sub>

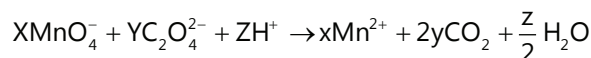
**Q.19** The product of oxidation of I<sup>-</sup> and MnO<sub>4</sub><sup>-</sup> in alkaline medium is **(2004)**

- (A) IO<sub>3</sub><sup>-</sup>    (B) I<sub>2</sub>    (C) IO<sup>-</sup>    (D) IO<sub>4</sub><sup>-</sup>

**Q.20** For H<sub>3</sub>PO<sub>3</sub> and H<sub>3</sub>PO<sub>4</sub> the correct choice is **(2003)**

- (A) H<sub>3</sub>PO<sub>3</sub> is dibasic and reducing  
(B) H<sub>3</sub>PO<sub>3</sub> is dibasic and non-reducing  
(C) H<sub>3</sub>PO<sub>4</sub> is tribasic and reducing  
(D) H<sub>3</sub>PO<sub>3</sub> is tribasic and non-reducing

**Q.21** Consider the following reaction:



The values of X, Y and Z in the reaction are, respectively: **(2013)**

- (A) 5, 2 and 16    (B) 2, 5 and 8  
(C) 2, 5 and 16    (D) 5, 2 and 8

**Q.22** In which of the following reaction H<sub>2</sub>O<sub>2</sub> acts as a reducing agent? **(2014)**

- (A) H<sub>2</sub>O<sub>2</sub> + 2H<sup>+</sup> + 2e<sup>-</sup> → 2H<sub>2</sub>O  
(B) H<sub>2</sub>O<sub>2</sub> - 2e<sup>-</sup> → O<sub>2</sub> + 2H<sup>+</sup>  
(C) H<sub>2</sub>O<sub>2</sub> - 2e<sup>-</sup> → 2OH<sup>-</sup>  
(D) H<sub>2</sub>O<sub>2</sub> + 2OH<sup>-</sup> - 2e<sup>-</sup> → O<sub>2</sub> + 2H<sub>2</sub>O

- (A) (a), (b)    (B) (c), (d)    (C) (a), (c)    (D) (b), (d)

**Q.23** The equation which is balanced and represents the correct product(s) is **(2014)**

- (A) Li<sub>2</sub>O + 2KCl → 2LiCl + K<sub>2</sub>O  
(B) [CoCl(NH<sub>3</sub>)<sub>5</sub>]<sup>+</sup> + 5H<sup>+</sup> → Co<sup>2+</sup> + 5NH<sub>4</sub><sup>+</sup> + Cl<sup>-</sup>  
(C) [Mg(H<sub>2</sub>O)<sub>6</sub>]<sup>2+</sup> (EDTA)<sup>4-</sup>  $\xrightarrow{\text{excess NaOH}}$  [Mg(EDTA)]<sup>2+</sup> + 6H<sub>2</sub>O  
(D) CuSO<sub>4</sub> + 4KCN → K<sub>2</sub>[Cu(CN)<sub>4</sub>] + K<sub>2</sub>SO<sub>4</sub>

**Q.24** From the following statements regarding H<sub>2</sub>O<sub>2</sub>, choose the incorrect statement: **(2015)**

- (A) It can act only as an oxidizing agent  
(B) It decomposed on exposure to light  
(C) It has to be stored in plastic or wax lined glass bottles in dark  
(D) It has to be kept away from dust

## JEE Advanced/Boards

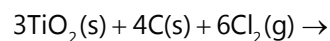
### Exercise 1

#### Mole Concept

**Q.1** How many gm of HCl is needed for complete reaction with 69.6 gm  $\text{MnO}_2$ ?

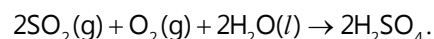


**Q.2** Titanium, which is used to make air plane engines and frames, can be obtained from titanium tetrachloride, which in turn is obtained from titanium oxide by the following process:



A vessel contains 4.32 g  $\text{TiO}_2$ , 5.76 g C and 6.82 g  $\text{Cl}_2$ , suppose the reaction goes to completion as written, how many gram of  $\text{TiCl}_4$  can be produced? (Ti = 48).

**Q.3** Sulphuric acid is produced when sulphur dioxide reacts with oxygen and water in the presence of a catalyst:



If 5.6 mol of  $\text{SO}_2$  reacts with 4.8 mole of  $\text{O}_2$  and a large excess of water, what is the maximum number of moles of  $\text{H}_2\text{SO}_4$  that can be obtained?

**Q.4** What weight of  $\text{Na}_2\text{CO}_3$  of 95% purity would be required to neutralize 45.6 mL of 0.235 N acid?

**Q.5** How much  $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$  and pure water to be mixed to prepare 50g of 12.0% (by wt.)  $\text{BaCl}_2$  solution.

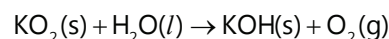
**Q.6** To 50 litre of 0.2 N NaOH, 5 litre of 1N HCl and 15 litre of 0.1 N  $\text{FeCl}_3$  solution are added. What weight of  $\text{Fe}_2\text{O}_3$  can be obtained from the precipitate? Also report the normality of NaOH left in the resultant solution.

**Q.7** 0.5 g fuming  $\text{H}_2\text{SO}_4$  (oleum) is diluted with water. The solution requires 26.7 mL of 0.4 N NaOH for complete neutralization. Find the percentage of free  $\text{SO}_3$  in the sample of oleum.

**Q.8** 200 mL of a solution of mixture of NaOH and  $\text{Na}_2\text{CO}_3$  was first titrated with phenolphthalein and N/10 HCl. 17.5 mL of HCl was required for the end point. After this methyl orange was added and 2.5 mL of same HCl

was again required for next end point. Find out amount of NaOH and  $\text{Na}_2\text{CO}_3$  in mixture.

**Q.9** Potassium superoxide,  $\text{KO}_2$ , is used in rebreathing gas masks to generate oxygen:



If a reaction vessel contains 0.158 mol  $\text{KO}_2$  and 0.10 mol  $\text{H}_2\text{O}$ , how many moles of  $\text{O}_2$  can be produced?

**Q.10** A sample of mixture of  $\text{CaCl}_2$  and NaCl weighing 4.22 gm was treated to precipitate all the Ca as  $\text{CaCO}_3$  which was then heated and quantitatively converted to 0.959 gm of CaO. Calculate the percentage of  $\text{CaCl}_2$  in the mixture.

**Q.11** Cyclohexanol is dehydrated to cyclohexene on heating with conc.  $\text{H}_2\text{SO}_4$ . If the yield of this reaction is 75%, how much cyclohexene will be obtained from 100 g of cyclohexanol?  $\text{C}_6\text{H}_{12}\text{O} \xrightarrow{\text{con. H}_2\text{SO}_4} \text{C}_6\text{H}_{10}$

**Q.12** How many grams of 90% pure  $\text{Na}_2\text{SO}_4$  can be produced from 250 gm of 95% pure NaCl?

**Q.13** A precipitate of AgCl and AgBr weighs 0.4066 g. On heating in a current of chlorine, the AgBr is converted to AgCl and the mixture loses 0.0725 g in weight. Find the percentage of Cl in original mixture.

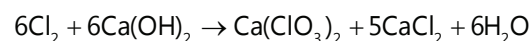
**Q.14** How many milli-litre of 0.5 M  $\text{H}_2\text{SO}_4$  are needed to dissolve 0.5 g of copper II carbonate?

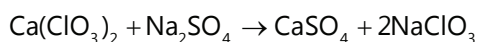
**Q.15** What is the strength in g per litre of a solution of  $\text{H}_2\text{SO}_4$ , 12 mL of which neutralized 15 mL of N/10 NaOH solution.

**Q.16** n-butane is produced by the monobromination of ethane followed by Wurtz reaction. Calculate the volume of ethane at NTP required to produce 55 g n-butane if the bromination takes place with 90% yield and the Wurtz reaction with 85% yield.

**Q.17** 0.50 g of a mixture of  $\text{K}_2\text{CO}_3$  and  $\text{Li}_2\text{CO}_3$  required 30 mL of 0.25 N HCl solution for neutralization. What is percentage composition of mixture?

**Q.18** Sodium chlorate,  $\text{NaClO}_3$ , can be prepared by the following series of reactions:





What mass of  $\text{NaClO}_3$  can be prepared from 100 mL of concentrated  $\text{HCl}$  (density 1.18 gm/mL and 36% by mass)? Assume all other substance are present in excess amounts.

**Q.19** In a determination of P an aqueous solution of  $\text{NaH}_2\text{PO}_4$  is treated with a mixture of ammonium and magnesium ions to precipitate magnesium ammonium phosphate  $\text{Mg}(\text{NH}_4)\text{PO}_4 \cdot 6\text{H}_2\text{O}$ . This is heated and decomposed to magnesium pyrophosphate,  $\text{Mg}_2\text{P}_2\text{O}_7$  which is weighed. A solution of  $\text{NaH}_2\text{PO}_4$  yielded 1.054g of  $\text{Mg}_2\text{P}_2\text{O}_7$ . What weight of  $\text{NaH}_2\text{PO}_4$  was present originally?

**Q.20** 5 mL of 8 N  $\text{HNO}_3$ , 4.8 mL of 5 N  $\text{HCl}$  and a certain volume of 17 M  $\text{H}_2\text{SO}_4$  are mixed together and made upto 2 litre. 30 mL of this acid mixture exactly neutralizes 42.9 mL of  $\text{Na}_2\text{CO}_3$  solution containing 1 g  $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$  in 100 mL of water. Calculate the amount of sulphate ions in g present in solution.

**Q.21** A sample of Mg was burnt in air to give a mixture of  $\text{MgO}$  and  $\text{Mg}_3\text{N}_2$ . The ash was dissolved in 60 Meq of  $\text{HCl}$  and the resulting solution was back titrated with  $\text{NaOH}$ . 12 Meq of  $\text{NaOH}$  were required to reach the end point. As excess of  $\text{NaOH}$  was then added and the solution distilled. The ammonia released was then trapped in 10 Meq of second acid solution. Back titration of this solution required 6 Meq of the base. Calculate the percentage of Mg burnt to the nitride.

**Q.22** A mixture of ethane ( $\text{C}_2\text{H}_6$ ) and ethene occupies 40 litre at 1.00 atm and at 400 K. The mixture reacts completely with 130 g of  $\text{O}_2$  to produce  $\text{CO}_2$  and  $\text{H}_2\text{O}$ . Assuming ideal gas behaviour, calculate the mole fractions of  $\text{C}_2\text{H}_4$  and  $\text{C}_2\text{H}_6$  in the mixture.

**Q.23** A solid mixture 5 g consists of lead nitrate and sodium nitrate was heated below  $600^\circ\text{C}$  until weight of residue was constant. If the loss in weight is 28%, find the amount of lead nitrate and sodium nitrate in mixture.

**Q.24** Upon mixing 45.0 mL of 0.25 M lead nitrate solution with 25 mL of 0.10 M chromic sulphate, precipitation of lead sulphate takes place. How many moles of lead sulphate are formed? Also calculate the molar concentration of the species left behind in final solution. Assume that lead sulphate is completely insoluble.

**Q.25** A 10 g sample of a mixture of calcium chloride and sodium chloride is treated with  $\text{Na}_2\text{CO}_3$  to precipitate calcium as calcium carbonate. This  $\text{CaCO}_3$  is heated to convert all the calcium to  $\text{CaO}$  and the final mass of  $\text{CaO}$  is 1.12 gm. Calculate % by mass of  $\text{NaCl}$  in the original mixture.

**Q.26** A mixture of Ferric oxide ( $\text{Fe}_2\text{O}_3$ ) and Al is used as solid rocket fuel which reacts to give  $\text{Al}_2\text{O}_3$  and Fe. No other reactants and products are involved. On complete reaction of 1 mole of  $\text{Fe}_2\text{O}_3$ , 200 units of energy is released?

(i) Write a balance reaction representing the above change.

(ii) What should be the ratio of masses of  $\text{Fe}_2\text{O}_3$  and Al taken so that maximum energy per unit mass of fuel is released.

(iii) What would be energy released if 16 kg of  $\text{Fe}_2\text{O}_3$  reacts with 2.7 kg of Al.

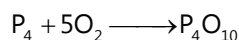
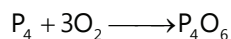
**Q.27** A mixture of nitrogen and hydrogen. In the ratio of one mole of nitrogen to three moles of hydrogen, was partially converted into so that the final product was a mixture of all these three gases. The mixture was to have a density of 0.497 g per litre at  $25^\circ\text{C}$  and 1.00 atm. What would be the mass of gas in 22.4 litres at 1 atm and 273 K? Calculate the % composition of this gaseous mixture by volume.

**Q.28** In one process for waterproofing, a fabric is exposed to  $(\text{CH}_3)_3\text{SiCl}_2$  vapour. The vapour reacts with hydroxyl groups on the surface of the fabric or with traces of water to form the waterproofing film  $[(\text{CH}_3)_2\text{SiO}]_n$  by the reaction

$$n(\text{CH}_3)_2\text{SiCl}_2 + 2n\text{OH}^- \rightarrow 2n\text{Cl}^- + n\text{H}_2\text{O} + [(\text{CH}_3)_2\text{SiO}]_n$$

where n stands for a large integer. The waterproofing film is deposited on the fabric layer upon layer. Each layer is 6.0 Å thick [the thickness of the  $(\text{CH}_3)_2\text{SiO}$  group]. How much  $(\text{CH}_3)_3\text{SiCl}_2$  is needed to waterproof one side of a piece of fabric, 1.00 m by 3.00 m, with a film 300 layers thick? The density of the film is 1.0 g/cm<sup>3</sup>.

**Q.29** Two substance  $\text{P}_4$  and  $\text{O}_2$  are allowed to react completely to form mixture of  $\text{P}_4\text{O}_6$  and  $\text{P}_4\text{O}_{10}$  leaving none of the reactants. Using this information calculate the composition of final mixture when mentioned amount of  $\text{P}_4$  and  $\text{O}_2$  are taken.



(i) If 1 mole  $\text{P}_4$  & 4 mole of  $\text{O}_2$

(ii) If 3 mole  $\text{P}_4$  & 11 mole of  $\text{O}_2$

(iii) If 3 mole  $\text{P}_4$  & 13 mole of  $\text{O}_2$

**Q.30** Chloride samples are prepared for analysis by using  $\text{NaCl}$ ,  $\text{KCl}$  and  $\text{NH}_4\text{Cl}$  separately or as a mixture. What minimum volume of 5% by weight  $\text{AgNO}_3$  solution (sp. gr., 1.04 g mL<sup>-1</sup>) must be added to a sample of 0.3 g in order to ensure complete precipitation of chloride in every possible case?



**Q.31** 124 gm of mixture containing  $\text{NaHCO}_3$ ,  $\text{AlCl}_3$ , and  $\text{KNO}_3$  requires 500 mL, 8% w/w NaOH solution [ $d_{\text{NaOH}} = 1.8 \text{ gm/mL}$ ] for complete neutralisation. On heating same amount of mixture, it known loss in weight of 18.6 gm. Calculate % composition of mixture by moles. Weak base formed doesn't interfere in reaction. Assume  $\text{KNO}_3$  does not decompose under given conditions.

**Q.32** If the yield of chloroform obtainable from acetone and bleaching powder is 75%. What is the weight of acetone required for producing 30 gm of chloroform?

**Q.33** A sample of impure  $\text{Cu}_2\text{O}$  contains 66.67% of Cu. What is the percentage of pure  $\text{Cu}_2\text{O}$  in the sample?

**Q.34** Equal weights of mercury and iodine are allowed to react completely to form a mixture of mercurous and mercuric iodide leaving none of the reactants. Calculate the ratio by weight of  $\text{Hg}_2\text{I}_2$  and  $\text{HgI}_2$  and formed. (Hg = 200, I = 127)

## Redox Reactions

**Q.1** Indicate the oxidation state of underlined in each case:

- (i)  $\text{Na}\underline{\text{N}}\text{O}_2$       (b)  $\underline{\text{H}}$ <sub>2</sub>      (c)  $\underline{\text{Cl}}$ <sub>2</sub> $\text{O}_7$   
 (ii)  $\text{K}\underline{\text{C}}\text{r}\text{O}_3\text{Cl}$       (e)  $\underline{\text{B}}\text{a}\text{Cl}_2$       (f)  $\underline{\text{I}}$  $\text{Cl}_3$   
 (iii)  $\text{K}_2\underline{\text{C}}\text{r}_2\text{O}_7$       (h)  $\underline{\text{C}}$  $\underline{\text{H}}$ <sub>2</sub> $\underline{\text{O}}$       (i)  $\underline{\text{Ni}}$ (CO)<sub>4</sub>  
 (iv)  $\underline{\text{N}}$  $\underline{\text{H}}$ <sub>2</sub> $\underline{\text{O}}$

**Q.2** Indicate the each reaction which of the reactant is oxidized or reduced if any:

- (i)  $\text{CuSO}_4 + 4\text{KI} \longrightarrow 2\text{CuI} + \text{I}_2 + 2\text{K}_2\text{SO}_4$   
 (ii)  $2\text{Na}_2\text{S} + 4\text{HCl} + \text{SO}_2 \longrightarrow 4\text{NaCl} + 3\text{S} + 2\text{H}_2\text{O}$   
 (iii)  $\text{NH}_4\text{NO}_2 \xrightarrow{\Delta} \text{N}_2 + 2\text{H}_2\text{O}$

**Q.3** Calculate the number of electrons lost or gained during the changes:

- (i)  $3\text{Fe} + 4\text{H}_2\text{O} \longrightarrow \text{Fe}_3\text{O}_4 + 4\text{H}_2$   
 (ii)  $\text{AlCl}_3 + 3\text{K} \longrightarrow \text{Al} + 3\text{KCl}$

**Q.4** Explain, why?

- (i)  $\text{H}_2\text{S}$  acts as reductant whereas,  $\text{SO}_2$  acts as reductant and oxidant both.  
 (ii)  $\text{H}_2\text{O}_2$  acts as reductant and oxidant both.

**Q.5**  $\text{MnO}_4^-$  can oxidize  $\text{NO}_2^-$  to  $\text{NO}_3^-$  in basic medium. How many mol of  $\text{NO}_2^-$  are oxidized by 1 mol of  $\text{MnO}_4^-$ ?

**Q.6** Which is stronger base in each pair?

- (i)  $\text{HSO}_4^-$ ;  $\text{HSO}$ ;      (ii)  $\text{NO}_2^-$ ;  $\text{NO}_3^-$ ;  
 (iii)  $\text{Cl}^-$ ;  $\text{ClO}^-$

**Q.7** Fill in the blanks and balance the following equations:

- (i)  $\text{Zn} + \text{HNO}_3 \longrightarrow \dots\dots\dots + \text{N}_2\text{O} + \dots\dots\dots$   
 (ii)  $\text{HI} + \text{HNO}_3 \longrightarrow \dots\dots\dots + \text{NO} + \text{H}_2\text{O} \dots\dots\dots$

**Q.8** What volume of 0.20 M  $\text{H}_2\text{SO}_4$  is required to produce 34.0 g of  $\text{H}_2\text{S}$  by the reaction:



**Q.9** 20 mL of 0.2 M  $\text{MnSO}_4$  are completely oxidized by 16 mL of  $\text{KMnO}_4$  of unknown normality, each forming  $\text{Mn}^{4+}$  oxidation state. Find out the normality and molarity of  $\text{KMnO}_4$  solution.

**Q.10**  $\text{KMnO}_4$  solution is to be standardized by titration against  $\text{As}_2\text{O}_3(\text{s})$ . A 0.1097 g sample of  $\text{As}_2\text{O}_3$  requires 26.10 mL of the  $\text{KMnO}_4$  solution for its titration. What are the molarity and normality of the  $\text{KMnO}_4$  solution?

**Q.11** 0.518 g sample of limestone is dissolved and then Ca is precipitated as  $\text{CaC}_2\text{O}_4$ . After filtering and washing the precipitate, it requires 40 mL of 0.25 N  $\text{KMnO}_4$  solution to equivalence point. What is percentage of CaO in limestone?

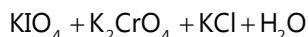
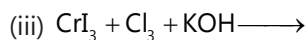
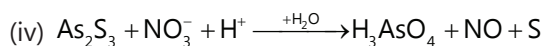
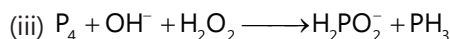
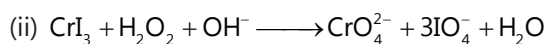
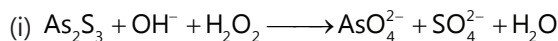
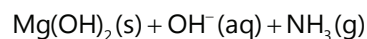
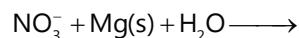
**Q.12** 20 mL of a solution containing 0.2 g of impure sample of  $\text{H}_2\text{O}_2$  reacts with 0.316 g of  $\text{KMnO}_4$  (acidic). Calculate:

- (i) Purity of  $\text{H}_2\text{O}_2$ ,  
 (ii) Volume of dry  $\text{O}_2$  evolved at 27°C and 750 mm P.

**Q.13** 5.7 g of bleaching powder was suspended in 500 mL of water. 25 mL of this suspended on treatment with KI and HCl liberated iodine which reacted with 24.35 mL of N/10  $\text{Na}_2\text{S}_2\text{O}_3$ . Calculate percentage of available  $\text{Cl}_2$  in bleaching powder.

**Q.14** Balance the following equation:

- (i)  $\text{C}_2\text{H}_5\text{OH} + \text{K}_2\text{Cr}_2\text{O}_7 + \text{H}_2\text{SO}_4 \longrightarrow$   
 $\text{C}_2\text{H}_4\text{O}_2 + \text{Cr}_2(\text{SO}_4)_3 + \text{K}_2\text{SO}_4 + \text{H}_2\text{O}$   
 (ii)  $\text{As}_2\text{S}_5 + \text{HNO}_3 \longrightarrow$   
 $\text{NO}_2 + \text{H}_2\text{O} + \text{H}_3\text{AsO}_4 + \text{H}_2\text{SO}_4$

**Q.15** Balance the following equations:**Q.16** Mg can reduce  $\text{NO}_3^-$  to  $\text{NH}_3$  in basic solution:

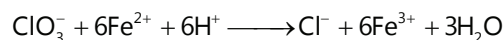
A 25.0 mL sample of  $\text{NO}_3^-$  solution was treated with Mg. The  $\text{NH}_3(\text{g})$  was passed into 50 mL of 0.15 N HCl. The excess HCl required 32.10 mL of 0.10 M NaOH for its neutralization. What was the molarity of  $\text{NO}_3^-$  ions in the original sample?

**Q.17** An acid solution of  $\text{KReO}_4$  sample containing 26.83 mg of combined rhenium was reduced by passage through a column of granulated zinc. The effluent solution including the washing from the column, was then titrated with 0.05 N  $\text{KMnO}_4$ . 11.45 mL of the standard  $\text{KMnO}_4$  was required for the reoxidation of all the rhenium to the perrhenate ion  $\text{ReO}_4^-$ . Assuming that rhenium was the only element reduced, what is the oxidation state to which rhenium was reduced by the zinc column.

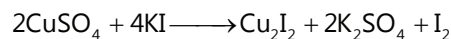
**Q.18** 100 mL solution of  $\text{FeC}_2\text{O}_4$  and  $\text{FeSO}_4$  is completely oxidized by 60 mL of 0.02 M in acid medium. The resulting solution is then reduced by Zn and dil.HCl. The reduced solution is again oxidized completely by 40 mL of 0.02 M  $\text{KMnO}_4$ . Calculate normality of  $\text{FeC}_2\text{O}_4$  and  $\text{FeSO}_4$  in mixture.

**Q.19** 1 g of most sample of KCl and  $\text{KClO}_3$  was dissolved in water to make 250 mL solution, 25 mL of this solution was treated with  $\text{SO}_2$  to reduce chlorate to chloride and excess of  $\text{SO}_2$  was removed by boiling. The total chloride was precipitated as silver chloride. The weight of precipitate was 0.1435 g. In another experiment, 25 mL of original solution was heated with 30 mL of 0.2 N ferrous sulphate solution and unreacted ferrous sulphate required 37.5 mL of 0.08 N solution of an oxidant for complete oxidation. Calculate the molar

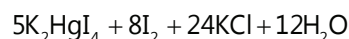
ratio of chlorate to chloride in the given mixture.  $\text{Fe}^{2+}$  reacts with  $\text{ClO}_3^-$  according to equation.



**Q.20** (i)  $\text{CuSO}_4$  reacts with KI in acidic medium to liberate  $\text{I}_2$



(ii) Mercuric per iodate  $\text{Hg}_5(\text{IO}_6)_2$  reacts with a mixture of KI and HCl following the equation:



(iii) The liberated iodine is titrated against  $\text{Na}_2\text{S}_2\text{O}_3$  solution. One mL of which is equivalent to 0.0499 g of  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ . What volume in mL of  $\text{Na}_2\text{S}_2\text{O}_3$  solution will be required to react with  $\text{I}_2$  liberated from 0.7245 g of  $\text{Hg}_5(\text{IO}_6)_2$ ? M. wt. of  $\text{Hg}_5(\text{IO}_6)_2 = 1448.5$  and M. wt. of  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O} = 249.5$ .

**Q.21** 1.249 g of a sample of pure  $\text{BaCO}_3$  and impure  $\text{CaCO}_3$  containing some CaO was treated with dil. HCl and it evolved 168 mL of  $\text{CO}_2$  at NTP. From this solution  $\text{BaCrO}_4$  was precipitated, filtered and washed. The dry precipitate was dissolved in dilute  $\text{H}_2\text{SO}_4$  and dilute to 100 mL. 10 mL of this solution when treated with KI solution liberated iodine which required exactly 20 mL of 0.05 N  $\text{Na}_2\text{S}_2\text{O}_3$ . Calculate percentage of CaO in the sample.

**Q.22** A 10 g mixture of  $\text{Cu}_2\text{S}$  and  $\text{CuS}$  was treated with 200 mL of 0.75 M  $\text{MnO}_4^-$  in acid solution producing  $\text{SO}_2$ ,  $\text{Cu}^{2+}$  and  $\text{Mn}^{2+}$ . The  $\text{SO}_2$  was boiled off and the excess of  $\text{MnO}_4^-$  was treated with 175 mL of 1 M  $\text{Fe}^{2+}$  solution. Calculate percentage of  $\text{CuS}$  in original mixture.

**Q.23** For estimating ozone in the air, a certain volume of air is passed through an acidified or neutral KI solution when oxygen is evolved and iodide is oxidised to give iodine. When such a solution is acidified, free iodine is evolved which can be titrated with standard  $\text{Na}_2\text{S}_2\text{O}_3$  solution. In an experiment 10 litre of air at 1 atm and 27°C were passed through an alkaline KI solution, at the end, the iodine entrapped in a solution on titration as above required 1.5 mL of 0.01 N  $\text{Na}_2\text{S}_2\text{O}_3$  solution. Calculate volume percentage of  $\text{O}_3$  in sample.

**Q.24** 30 mL of an acidified solution of 1.5 N  $\text{MnO}_4^-$  ions, 15 mL of 0.5 N oxalic acid and 15 mL of 0.4 N ferrous salt solution are added together. Find the molarities of  $\text{MnO}_4^-$  and  $\text{Fe}^{3+}$  ions in the final solution?

**Q.25** (i) 25 mL of  $\text{H}_2\text{O}_2$  solution were added to excess of acidified solution of KI. The iodine so liberated required 20 mL of 0.1 N  $\text{Na}_2\text{S}_2\text{O}_3$  for titration. Calculate the strength of  $\text{H}_2\text{O}_2$  in terms of normality, percentage and volume.

(ii) To a 25 mL  $\text{H}_2\text{O}_2$  solution, excess of acidified solution of KI was added. The iodine liberated required 20 mL of 0.3 N sodium thiosulphate solution. Calculate the volume strength of  $\text{H}_2\text{O}_2$  solution.

**Q.26** An aqueous solution containing 0.10 g  $\text{KIO}_3$  (formula weight = 214.0) was treated with an excess of KI solution. The solution was acidified with HCl. The liberated  $\text{I}_2$  consumed 45 mL of thiosulphate solution to decolorise the blue starch-iodine complex. Calculate the molarity of the sodium thiosulphate solution.

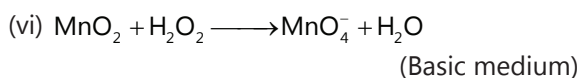
**Q.27** A sample of  $\text{MnSO}_4 \cdot 4\text{H}_2\text{O}$  is strongly heated in air. The residue ( $\text{Mn}_3\text{O}_4$ ) left was dissolved in 100 mL of 0.1 N  $\text{FeSO}_4$  containing dil.  $\text{H}_2\text{SO}_4$ . This solution was completely reacted with 50 mL of  $\text{KMnO}_4$  solution. 25 mL of this  $\text{KMnO}_4$  solution was completely reduced by 30 mL of 0.1 N  $\text{FeSO}_4$  solution. Calculate the amount of  $\text{MnSO}_4 \cdot 4\text{H}_2\text{O}$  in sample.

**Q.28** Write complete balanced equation for the following in acidic medium by ion-electron method:

- $\text{ClO}_3^- + \text{Fe}^{2+} \rightarrow \text{Cl}^- + \text{Fe}^{+3} + \text{H}_2\text{O}$
- $\text{CuS} + \text{NO}_3^- \rightarrow \text{Cu}^{+2} + \text{S}_8 + \text{NO} + \text{H}_2\text{O}$
- $\text{S}_2\text{O}_3^{2-} + \text{Sb}_2\text{O}_3 \rightarrow \text{SbO} + \text{H}_2\text{SO}_3$
- $\text{HCl} + \text{KMnO}_4 \longrightarrow \text{Cl}_2 + \text{KCl} + \text{MnCl}_2 + \text{H}_2\text{O}$
- $\text{KClO}_3 + \text{H}_2\text{SO}_4 \longrightarrow \text{KHSO}_4 + \text{HClO}_4 + \text{ClO}_3 + \text{H}_2\text{O}$
- $\text{HNO}_3 + \text{HBr} \longrightarrow \text{NO} + \text{Br}_2 + \text{H}_2\text{O}$
- $\text{IO}_4^- + \text{I}^- + \text{H}^+ \longrightarrow \text{I}_2 + \text{H}_2\text{O}$

**Q.29** Balance the following equations by oxidation method:

- $\text{Cu} + \text{NO}_3^- + \dots \longrightarrow \text{Cu}^{+2} + \text{NO}_2 + \dots$   
(Acid medium)
- $\text{Cl}_2 + \text{IO}_3^- + \text{OH}^- \longrightarrow \text{IO}_4^- + \dots + \text{H}_2\text{O}$   
(Basic medium)
- $\text{H}_2\text{S} + \text{K}_2\text{CrO}_4 + \text{H}_2\text{SO}_4 \longrightarrow \dots$   
(Acid medium)
- $\text{Fe}^{+2} + \text{MnO}_4^- \longrightarrow \text{Fe}^{+3} + \text{Mn}^{+2} + \dots$   
(Acid medium)
- $\text{KMnO}_4 + \text{H}_2\text{SO}_4 + \text{H}_2\text{O}_2 \longrightarrow$   
 $\text{K}_2\text{SO}_4 + \text{MnSO}_4 + \text{H}_2\text{O} + \dots$   
(Acid medium)



**Q.30** Write complete balance equation for the following in basic medium by ion-electron method:

- $\text{S}_2\text{O}_4^{2-} + \text{Ag}_2\text{O} \rightarrow \text{Ag} + \text{SO}_3^{2-}$
- $\text{Cl}_2 + \text{OH}^- \rightarrow \text{Cl}^- + \text{ClO}^-$
- $\text{H}_2 + \text{ReO}_4^- \rightarrow \text{ClO}_2^- + \text{Sb}(\text{OH})_6^-$
- $\text{I}_2 + \text{OH}^- \rightarrow \text{I}^- + \text{IO}_3^-$
- $\text{MnO}_4^- + \text{Fe}^{+2} \rightarrow \text{Mn}^{+2} + \text{Fe}^{+3}$

## Exercise 2

### Mole Concept

#### Single Correct Choice Type

**Q.1** 'x' gms of an element 'A' on heating in a jar of chlorine give 'y' gms of  $\text{ACl}_2$  the atomic weight of element A is

- (A)  $\left(\frac{x}{y-71}\right) \times \frac{35.5}{2}$       (B)  $\frac{71x}{y-71}$   
(C)  $\frac{35.5x}{y-71}$       (D) None of these

**Q.2** The amount of  $\text{H}_2\text{SO}_4$  present in 1200 mL of 0.2 N solution is

- (A) 10.76 gms      (B) 11.76 gms  
(C) 12.76 gms      (D) 14.76 gms

**Q.3** An iodized salt contains 0.5% of NaI. A person consumes 3 gm of salt everyday. The number of iodide ions going into his body everyday is

- (A)  $10^{-4}$       (B)  $6.02 \times 10^{-4}$   
(C)  $6.02 \times 10^{19}$       (D)  $6.02 \times 10^{23}$

#### Assertion Reasoning Type

- (A) If both statement-I and statement-II are true and statement-II is the correct explanation of statement-I, the mark (A).  
(B) If both statement-I and statement-II are true and statement-II is not the correct explanation of statement -I, the mark (B).  
(C) If statement-I is true but statement-II is false, then mark (C).  
(D) If both statement-I and statement-II are false, then mark (D).

**Q.4 Statement-I:** 0.28 g of  $N_2$  has equal volume as 0.44 g of another gas at same conditions of temperature and pressure.

**Statement-II:** Molecular mass of another gas is  $44 \text{ g mol}^{-1}$ .

**Q.5 Statement-I:** Boron has relative atomic mass 10.81.

**Statement-II:** Borons two isotopes,  $^{10}_5\text{B}$  and  $^{11}_5\text{B}$  and their relative abundance is 19% and 81%.

**Q.6 Statement-I:** The percentage of nitrogen in urea is 46%.

**Statement-II:** Urea is ionic compound.

**Q.7 Statement-I:** The oxidation state of central sulfur of  $\text{Na}_2\text{S}_2\text{O}_3$  is +6.

**Statement-II:** Oxidation state of an element should be determined from structure.

**Q.8 Statement-I:** Molarity of a solution and molality of a solution both change with density.

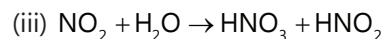
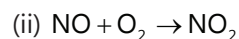
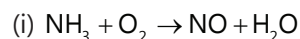
**Statement-II:** Density of the solution changes when percentage by mass of solution changes.

**Q.9 Statement-I:**  $2A + 3B \rightarrow C$ ,  $4/3$  moles of 'C' are always produced when 3 moles of 'A' and 4 moles of 'B' are added.

**Statement-II:** 'B' is the limiting reactant for the given data.

### Multiple Correct Choice Type

**Q.10** Given following series of reactions:



Select the correct option(s):

(A) Moles of  $\text{HNO}_3$  obtained is half of moles of Ammonia used if  $\text{HNO}_2$  is not used to produce  $\text{HNO}_3$  by equation (iv)

(B) 100/6% more  $\text{HNO}_3$  will be produced if  $\text{HNO}_2$  is used to produce  $\text{HNO}_3$  by reaction (iv) than if  $\text{HNO}_2$  is not used to produce  $\text{HNO}_3$  by reaction (iv)

(C) If  $\text{HNO}_2$  is used to produce  $\text{HNO}_3$  then 1/4th of total is produced by reaction (iv)

(D) Moles of NO produced in reaction (iv) is 50% of moles of total  $\text{HNO}_3$  produced.

### Comprehension Type

**Paragraph 1:** Normality is number of gram equivalents dissolved per litre of solution. It changes with change in temperature. In case of monobasic acid, normality and molarity are equal but in case of dibasic acid, normality is twice the molarity. In neutralization and redox reactions, number of mill equivalents of reactants as well as products are always equal.

**Q.11** On heating a litre of a  $\frac{N}{2}$  HCl solution, 2.750 g of HCl is lost and the volume of solution becomes 750 mL. The normality of resulting solution will be

- (A) 0.58      (B) 0.75      (C) 0.057      (D) 5.7

**Q.12** The volume of 0.1 M  $\text{Ca(OH)}$  required to neutralize 10 mL of 0.1 N HCl will be

- (A) 10 mL      (B) 20 mL      (C) 5 mL      (D) 40 mL

**Q.13** Molarity of 0.5 N  $\text{Na}_2\text{CO}_3$  is

- (A) 0.25      (B) 1.0      (C) 0.5      (D) 0.125

**Q.14** 6.90 N KOH solution in water contains 30% by weight of KOH. The density of solution will be

- (A) 1.288      (B) 2.88      (C) 0.1288      (D) 12.88

**Q.15** The amount of ferrous ammonium sulphate required to prepare 250 mL of 0.1 N solution is

- (A) 1.96 g      (B) 1.8 g      (C) 9.8 g      (D) 0.196 g

**Paragraph 2:** A 4.925 g sample of a mixture of  $\text{CuCl}_2$  and  $\text{CuBr}_2$  was dissolved in water and mixed thoroughly with a 5.74 g portion of  $\text{AgCl}$ . After the reaction and solid, a mixture of  $\text{AgCl}$  and  $\text{AgBr}$ , was filtered, washed, and dried. Its mass was found to be 6.63 g.

### Q.16

(1) % By mass of  $\text{CuBr}_2$  in original mixture is

- (A) 2.24      (B) 74.5      (C) 45.3      (D) None

(2) % By mass of Cu in original mixture is

- (A) 38.68      (B) 19.05      (C) 3.86      (D) None

(3) % by mole of  $\text{AgBr}$  in dried precipitate is

- (A) 25      (B) 50      (C) 75      (D) 60

(4) No. of moles of  $\text{Cl}^-$  ion present in the solution after precipitate ion are

- (A) 0.06      (B) 0.02      (C) 0.04      (D) None

**Paragraph 3:** Water is added to 3.52 grams of  $\text{UF}_6$ . The products are 3.08 grams of a solid [containing only U, O and F] and 0.8 gram of a gas only. The gas [containing fluorine and hydrogen only], contains 95% by mass fluorine.

[Assume that the empirical formula is same as molecular formula.]

### Q.17

(1) The empirical formula of the gas is

- (A)  $\text{HF}_2$       (B)  $\text{H}_2\text{F}$       (C)  $\text{HF}$       (D)  $\text{HF}_3$

(2) The empirical formula of the solid product is

- (A)  $\text{UF}_2\text{O}_2$       (B)  $\text{UFO}_2$       (C)  $\text{UF}_2\text{O}$       (D)  $\text{UFO}$

(3) The percentage of fluorine of the original compound which is converted into gaseous compound is

- (A) 66.66%      (B) 33.33%      (C) 50%      (D) 89.9%

### Match the Columns

**Q.18** One type of artificial diamond (commonly called YAG for yttrium aluminium garnet) can be represented by the formula  $\text{Y}_3\text{Al}_5\text{O}_{12}$ . [Y = 89, Al = 27]

Column I	Column II
(A) Y	(p) 22.73%
(B) Al	(q) 32.32%
(C) O	(r) 44.95%

**Q.19** The recommended daily dose is 17.6 milligrams of vitamin C (ascorbic acid) having formula  $\text{C}_6\text{H}_8\text{O}_6$ . Match the following. Given:  $N_A = 6 \times 10^{23}$

Column I	Column II
(A) O-atoms present	(p) $10^{-4}$ mole
(B) Moles of vitamin C in 1 gm of vitamin C	(q) $5.68 \times 10^{-3}$
(C) Moles of vitamin C in 1 gm should be consumed daily	(r) $3.6 \times 10^{20}$

**Q.20** If volume strength of  $\text{H}_2\text{O}_2$  solution is 'X-V' then its

Column I	Column II
(i) Strength in g/L	(p) $\frac{X}{11.2}$
(ii) Volume strength X	(q) $\frac{X}{5.6}$
(iii) Molarity	(r) $\frac{17X}{5.6}$
(iv) Normality	(s) $5.6 \times N$

(A) (i) - r, (ii) - p, (iii) - s, (iv) - q

(B) (i) - s, (ii) - p, (iii) - q, (iv) - p

(C) (i) - r, (ii) - s, (iii) - p, (iv) - q

(D) (i) - r, (ii) - q, (iii) - s, (iv) - p

**Q.21** Match the entries in column I with entries in column II and then pick out correct options:

Column I	Column II
(i) $M_R$ on mixing two acidic solutions	(p) $\frac{x \times d \times 10}{M_{\text{solute}}}$
(ii) $M_R$ on mixing two basic solutions	(q) $n \times M \times V \text{ mL}$
(iii) $M_R$ on mixing two acidic and basic solutions	(r) $\frac{M_1 V_1 - M_2 V_2}{V_1 + V_2}$
(iv) Milliequivalent	(s) $\frac{M_1 V_1}{V_2}$
(v) Molarity	(t) $\frac{M_1 V_1 + M_2 V_2}{V_1 + V_2}$

(A) (i) - p, (ii) - r, (iii) - p, (iv) - q, (v) - s

(B) (i) - t, (ii) - t, (iii) - r, (iv) - q, (v) - p, s

(C) (i) - q, (ii) - p, (iii) - q, (iv) - r, (v) - q

(D) (i) - p, (ii) - q, (iii) - q, (iv) - r, (v) - r

## Redox Reactions

### Single Correct Choice Type

**Q.1** One mole of  $\text{N}_2\text{H}_4$  loses ten moles of electrons to form a new compound Y. Assuming that all the nitrogen appears in the new compound, what is the oxidation state of nitrogen in Y? (There is no change in the oxidation state of hydrogen)

- (A) -1      (B) -3      (C) +3      (D) +5

**Q.2** Which is best reducing agent

- (A)  $\text{F}^-$       (B)  $\text{Cl}^-$       (C)  $\text{Br}^-$       (D)  $\text{I}^-$

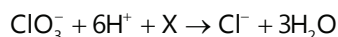
**Q.3** In the aluminothermite process, aluminium acts as

- (A) An oxidizing agent      (B) A flux  
(C) Reducing agent      (D) A solder

**Q.4** Zinc-copper couple that can be used as a reducing agent is obtained by

- (A) Mixing zinc dust and copper gas  
(B) Zinc coated with copper  
(C) Copper coated with zinc  
(D) Zinc and copper wires welded together

**Q.5** In the following equations value of X is



- (A)  $4e^-$       (B)  $5e^-$       (C)  $6e^-$       (D)  $7e^-$

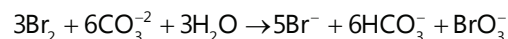
**Q.6** The brown ring complex compound is formulated as  $[\text{Fe}(\text{H}_2\text{O})_5(\text{NO})^+]\text{SO}_4^-$ . The oxidation state of iron is

- (A) 1      (B) 2      (C) 3      (D) 0

**Q.7** Oxidation state of oxygen atom in potassium superoxide is

- (A)  $-1/2$       (B)  $-1$       (C)  $-2$       (D) 0

**Q.8** In the following reaction



- (A) Bromine is both reduced and oxidised  
(B) Bromine is neither reduced nor oxidised  
(C) Bromine is oxidised and carbonate is reduced  
(D) Bromine is reduced and water is oxidised

### Comprehension Type

**Paragraph 1:** The redox titration involve the chemical reaction between the oxidising agent and reducing agent in aqueous solutions under suitable conditions. Titrations involve the direct use of iodine as oxidising agent are known as iodimetric titrations while those titrations involving indirect use of iodine are known as iodometric titrations. These titrations are used for the estimation of oxidising agents like  $\text{KMnO}_4$ ,  $\text{K}_2\text{Cr}_2\text{O}_7$ ,  $\text{CuSO}_4$  etc.

**Q.9** 50 mL of an aqueous solution of  $\text{H}_2\text{O}_2$  was treated with excess of KI solution and the iodine so liberated quantitatively required 20 mL of 0.1 N solution of hypo. This titration is known as:

- (A) Iodometric titration      (B) Iodimetric titration  
(C) Potassium iodide titration      (D) All of these

**Q.10** In the above problem, concentration of  $\text{H}_2\text{O}_2$  in gm/litre is:

- (A) 6.8      (B) 0.68      (C) 0.068      (D) 0.34

**Q.11** 0.5 gm sample of pyrolusite ( $\text{MnO}_2$ ) is treated with HCl, the  $\text{Cl}_2$  gas evolved is treated with KI, the violet vapours evolved are absorbed in 30 mL 0.1 N  $\text{Na}_2\text{S}_2\text{O}_3$  solution percentage purity of pyrolusite sample is

- (A) 30%      (B) 50%      (C) 36%      (D) 26.1%

**Q.12** Arsenite gets converted into arsenate by using iodine, valency factor for Arsenite and Iodine are respectively

- (A) 2 and 2      (B) 2 and 1      (C) 1 and 2      (D) 5 and 2

**Paragraph 2:** Oxidation and reduction process involves the transaction of electrons. Loss of electrons is oxidation and the gain of electrons is reduction. It is thus obvious that in a redox reaction, the oxidant is reduced by accepting the electrons and the reductant is oxidised by losing electrons. The reactions in which a species disproportionate into two oxidation states (lower and higher) are called disproportionation reactions. In electrochemical cells, redox reaction is involved, i.e., oxidation takes place at anode and reduction at cathode.

**Q.13** The reaction:  $\text{Cl}_2 \rightarrow \text{Cl}^- + \text{ClO}_3^-$  is

- (A) Oxidation  
(B) Reduction  
(C) Disproportionation  
(D) Neither oxidation nor reduction

**Q.14** In the reaction:  $\text{I}_2 + 2\text{S}_2\text{O}_3^{2-} \rightarrow 2\text{I}^- + \text{S}_4\text{O}_6^{2-}$

- (A)  $\text{I}_2$  is reducing agent  
(B)  $\text{I}_2$  is oxidising agent  
(C)  $\text{S}_2\text{O}_3^{2-}$  is reducing agent  
(D)  $\text{S}_2\text{O}_3^{2-}$  is oxidising agent

**Q.15** Determine the change in oxidation number of sulphur is  $\text{H}_2\text{S}$  and  $\text{SO}_2$  respectively in the following reaction:  $2\text{H}_2\text{S} + \text{SO}_2 \rightarrow 2\text{H}_2\text{O} + 3\text{S}$

- (A) 0, +2      (B) +2, -4      (C) -2, +2      (D) +4, 0

### Multiple Correct Choice Type

**Q.16** Which of the following reactions is/are correctly indicated?

**Oxidant Reductant**

- (A)  $\text{HNO}_3 + \text{Cu} \longrightarrow \text{Cu}^{2+} + \text{NO}_2$   
(B)  $2\text{Zn} + \text{O}_2 \longrightarrow \text{ZnO}$   
(C)  $\text{Cl}_2 + 2\text{Br}^- \longrightarrow 2\text{Cl}^- + \text{Br}_2$   
(D)  $4\text{Cl}_2 + \text{CH}_4 \longrightarrow \text{CCl}_4 + 4\text{HCl}$

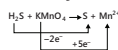
### Assertion and Reasoning Type

Each of the questions given below consist of statement-I and statement-II. Use the following Key to choose the appropriate answer.

- (A) If both statement-I and statement-II are true, and statement-II is the correct explanation of statement-I.  
 (B) If both statement-I and statement-II are true, and statement-II is not the correct explanation of statement-I.  
 (C) If statement-I is true but statement-II is false.  
 (D) If statement-I is false but statement-II is true.

**Q.17 Statement-I:** In  $\text{CrO}_5$  oxidation number of Cr is +6.

**Statement-II:**  $\text{CrO}_5$  has butterfly structure in which



peroxide bonds are present.

**Q.18 Statement-I:** In  $\text{PbO}_4$  all Pb has +8/3 oxidation number.

**Statement-II:**  $\text{PbO}_4$  is mixed oxide of  $\text{PbO}$  and  $\text{PbO}_2$

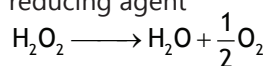
**Q.19 Statement-I:**  $\text{HClO}_4$  is only oxidising agent.

**Statement-II:** Cl is most electro-negative element in H, Cl and O.

**Q.20 Statement-I:** In  $\text{FeS}_2$  oxidation number of iron is +4.

**Statement-II:** In  $\text{FeS}_2$  ( $\text{S}^- - \text{S}^-$ ) linkage is present.

**Q.21 Statement-I:** In given reaction  $\text{H}_2\text{O}_2$  is oxidising & reducing agent



**Statement-II:** In  $\text{H}_2\text{O}_2$  is a bleaching reagent.

**Q.22 Statement-I:** In basic medium colour of  $\text{K}_2\text{Cr}_2\text{O}_7$  is changed from orange to yellow.

**Statement-II:** In basic medium  $\text{K}_2\text{Cr}_2\text{O}_7$  is changed in chromate ion.

**Q.23 Statement-I:**  $\text{I}_2 \longrightarrow \text{IO}_3^- + \text{I}^-$ .

This reaction is disproportionation reaction.

**Statement-II:** Oxidation number of I can vary from -1 to +7.

### Match the Columns

**Q.24** Match the entries in column I with entries in column II and then pick out correct options:

Column I	Column II
(A) Increase in oxidation number	(p) Loss of electrons
(B) Decrease in oxidation number	(q) Redox reaction
(C) Oxidising agent	(r) Fractional oxidation number
(D) Reducing agent	(s) Zero oxidation number
(E) $2\text{Cu}^+ \rightarrow \text{Cu}^{2+} + \text{Cu}$	(t) Simple neutralisation reaction
(F) $\text{MnO}_2 + 4\text{HCl} \rightarrow \text{MnCl}_2$	(u) Gain of electrons + $\text{Cl}_2 + 2\text{H}_2\text{O}$
(G) $\text{Mn}_3\text{O}_4$	(v) Disproportionation
(H) $\text{CH}_2\text{Cl}_2$	(w) Oxidation
(I) $\text{NaOH} + \text{HCl} \rightarrow \text{NaCl} + \text{H}_2\text{O}$	(x) Reduction

**Q.25** Match the reactions in column I with nature of the reactions/type of the products in Column II.

Column I	Column II
(A) $\text{O}_2^- \rightarrow \text{O}_2 + \text{O}_2^{2-}$	(p) Redox reaction
(B) $\text{CrO}_4^{2-} + \text{H}^+ \rightarrow$	(q) One of the products has trigonal planar structure
(C) $\text{MnO}_4^- + \text{NO}_2^- + \text{H}^+ \rightarrow$	(r) Dimeric bridged tetrahedral metal ion
(D) $\text{NO}_3^- + \text{H}_2\text{SO}_4 + \text{Fe}^{2+} \rightarrow$	(s) Disproportionation

## Previous Years' Questions

### Mole Concept

**Q.1** Naturally occurring boron consists of two isotopes whose atomic weights are 10.01 and 11.01. The atomic weight of natural boron is 10.81. Calculate the percentage of each isotope in natural boron. **(1978)**

**Q.2** The vapour density (hydrogen = 1) of a mixture consisting of  $\text{NO}_2$  and  $\text{N}_2\text{O}_4$  is 38.3 at 26.7°C. Calculate the number of moles of  $\text{NO}_2$  in 100 g of the mixture. **(1979)**

**Q.3** A solid mixture (5.0 g) consisting of lead nitrate and sodium nitrate was heated below 600°C until the weight

of the residue was constant. If the loss in weight is 28.0 percent, find the amount of lead nitrate and sodium nitrate in the mixture. **(1990)**

**Q.4** 'A' is a binary compound of a univalent metal. 1.422 g of A reacts completely with 0.321 g of sulphur in an evacuated and sealed tube to give 1.743 g of a white crystalline solid B, that forms a hydrated double salt, C with  $\text{Al}_2(\text{SO}_4)_3$ . Identify A, B and C. **(1994)**

**Q.5** Calculate the molality of 1.0 L solution of 93%  $\text{H}_2\text{SO}_4$ , (weight/volume). The density of the solution is 1.84 g/mL. **(1990)**

**Q.6** 20% surface sites have adsorbed  $\text{N}_2$ . On heating  $\text{N}_2$  gas evolved from sites and were collected at 0.001 atm and 298 K in a container of volume is  $2.46 \text{ cm}^3$ . Density of surface sites is  $6.023 \times 10^{14} / \text{cm}^2$  and surface area is  $1000 \text{ cm}^2$ , find out the number of surface sites occupied per molecule of  $\text{N}_2$ . **(2005)**

**Q.7** If 0.50 mole of  $\text{BaCl}_2$  is mixed with 0.20 mole of  $\text{Na}_3\text{PO}_4$  the maximum number of moles of  $\text{Ba}_3(\text{PO}_4)_2$  that can be formed is **(1981)**

- (A) 0.70      (B) 0.50      (C) 0.20      (D) 0.10

**Q.8** In the standardization of  $\text{Na}_2\text{S}_2\text{O}_3$  using  $\text{K}_2\text{Cr}_2\text{O}_7$  is **(2001)**

(A)  $\left( \frac{\text{Molecular Weight}}{2} \right)$

(B)  $\left( \frac{\text{Molecular Weight}}{6} \right)$

(C)  $\left( \frac{\text{Molecular Weight}}{3} \right)$

(D) Same as molecular weight

**Q.9** The difference in the oxidation numbers of the two types of sulphur atoms in  $\text{Na}_2\text{S}_4\text{O}_6$  is. **(2011)**

Read the following questions and answer as per the direction given below:

(A) Statement-I is true; statement-II is true; statement-II is the correct explanation of statement-I.

(B) Statement-I is true; statement-II is true; statement-II is not the correct explanation of statement-I.

(C) Statement-I is true; statement-II is false.

(D) Statement-I is false; statement-II is true.

**Q.10 Statement-I:** In the titration of  $\text{Na}_2\text{CO}_3$  with HCl using methyl orange indicator, the volume required at the equivalent point is twice that of the acid required using phenolphthalein indicator.

**Statement-II:** Two moles of HCl are required for the complete neutralization of one mole of  $\text{Na}_2\text{CO}_3$ . **(1991)**

**Q.11**  $2.68 \times 10^{-3}$  moles of a solution containing an ion  $\text{A}^{n+}$  require  $1.61 \times 10^{-3}$  moles of  $\text{MnO}_4^-$  for the oxidation of  $\text{A}^{n+}$  to  $\text{AO}_3^-$  in acidic medium. What is the value of n? **(1984)**

**Q.12** A  $5.0 \text{ cm}^3$  solution of  $\text{H}_2\text{O}_2$  liberates 0.508 g of iodine from an acidified KI solution. Calculate the strength of  $\text{H}_2\text{O}_2$  solution in terms of volume strength at STP. **(1995)**

**Q.13** A solution of 0.2 g of a compound containing  $\text{Cu}^{2+}$  and  $\text{C}_2\text{O}_4^{2-}$  ions on titration with 0.02 M  $\text{KMnO}_4$  in presence of  $\text{H}_2\text{SO}_4$  consumes 22.6 mL of the oxidant. The resultant solution is neutralized with  $\text{NaCO}_3$ , acidified with dilute acetic acid and treated with excess KI. The liberated iodine requires 11.3 mL of 0.05 M  $\text{Na}_2\text{S}_2\text{O}_3$  solution for complete reduction. Find out the mole ratio of  $\text{Cu}^{2+}$  to  $\text{C}_2\text{O}_4^{2-}$  in the compound. Write down the balanced redox reactions involved in the above titrations. **(1991)**

**Q.14** A mixture of  $\text{H}_2\text{C}_2\text{O}_4$  (oxalic acid) and  $\text{NaHC}_2\text{O}_4$  weighing 2.02 g was dissolved in water and the solution made up to one litre. Ten millilitres of the solution required 3.0 mL of 0.1 N sodium hydroxide solution for complete neutralization. In another experiment, 10.0 mL of the same solution, in hot dilute sulphuric acid medium, required 4.0 mL of 0.1 N potassium permanganate solution for complete reaction. Calculate the amount of  $\text{H}_2\text{C}_2\text{O}_4$  and  $\text{NaHC}_2\text{O}_4$  in the mixture. **(1990)**

**Q.15** The unbalanced chemical reactions given in list I show missing or condition which are provided in list II. Match list I with list II and select the correct answer using the code given below the lists: **(2013)**

	List I		List II
(i)	$\text{PbO}_2 + \text{H}_2\text{SO}_4 \xrightarrow{?}$ $\text{PbSO}_4 + \text{O}_2 + \text{other product}$	(p)	NO
(ii)	$\text{Na}_2\text{S}_2\text{O}_3 + \text{H}_2\text{O} \xrightarrow{?}$ $\text{NaHSO}_4 + \text{other product}$	(q)	$\text{I}_2$
(iii)	$\text{N}_2\text{H}_4 \xrightarrow{?}$ $\text{N}_4 + \text{other product}$	(r)	Warm
(iv)	$\text{XeF}_2 \xrightarrow{?}$ $\text{Xe} + \text{other product}$	(s)	$\text{Cl}_2$



Codes:

	(i)	(ii)	(iii)	(iv)
(p)	4	2	3	1
(q)	3	2	1	4
(r)	1	4	2	3
(s)	3	4	2	1

**Q.16** For the reaction  $I^- + ClO_3^- + H_2SO_4 \rightarrow Cl^- + HSO_4^- + I_2$

The correct statement(s) in the balanced equation is/are:

**(2014)**

- (A) Stoichiometric coefficient of  $HSO_4^-$  is 6.
- (B) Iodide is oxidized.
- (C) Sulphur is reduced.
- (D)  $H_2O$  is one of the products

**Q.17** Hydrogen peroxide in its reaction with  $KIO_4$  and  $NH_2OH$  respectively, is acting as a **(2014)**

- (A) Reducing agent, oxidising agent
- (B) Reducing agent, reducing agent
- (C) Oxidising agent, oxidising agent
- (D) Oxidising agent, reducing agent

# MasterJEE Essential Questions

## JEE Main/Boards

### Exercise 1

#### Mole Concept

Q.1	Q.3	Q.7
Q.11	Q.13	Q.18
Q.21	Q.29	

#### Redox

Q.3 (C)	Q.4 (F)
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### Exercise 2

#### Mole Concept

Q.1	Q.6	Q.10	Q.15
Q.19	Q.23	Q.29	Q.33

#### Redox

Q.1	Q.8	Q.15
Q.24	Q.25	

### Previous Years' Questions

#### Mole Concept and Redox

Q.1	Q.5	Q.14
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## JEE Advanced/Boards

### Exercise 1

#### Mole Concept

Q.3	Q.7	Q.14
Q.15	Q.22	Q.26
Q.28		

#### Redox

Q.2	Q.5	Q.13
Q.23	Q.17	

### Exercise 2

#### Mole Concept

Q.2	Q.7	Q.13
Q.16		

#### Redox

Q.1	Q.6	Q.9
Q.16	Q.19	Q.21

### Previous Years' Questions

#### Mole Concept and Redox

Q.3	Q.14
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## Answer Key

### JEE Main/Boards

#### Exercise 1

##### Mole Concept

**Q.1** (i) 68.125 Kg (ii) 7.63 Kg/m<sup>2</sup> (iii) 1.72 m

**Q.2**  $7.818 \times 10^{22}$  atoms

**Q.3**  $4.82 \times 10^{22}$  atoms

**Q.4** 0.437

**Q.5**  $6.02 \times 10^{10}$  g / cm<sup>3</sup>

**Q.6** 0.1 M HNO<sub>3</sub>

**Q.7** 14.0 tablets

**Q.8** 0.1 M

**Q.9** (C<sub>3</sub>O<sub>4</sub>) = C<sub>12</sub>O<sub>16</sub>

**Q.10** 0.44 g

**Q.11** 35.5: 1, 35.5: 1, 1: 1

**Q.12** 0.7985, 0.798

**Q.13** M<sub>2</sub>O<sub>3</sub>

**Q.14** K<sub>2</sub>MnO<sub>4</sub>

**Q.15** (i) 55.5 M

**Q.16** (i)  $3.24 \times 10^{-22}$  g/molecule

(ii)  $4.09 \times 10^{22}$

**Q.17** 55.56 moles

**Q.18**  $7.098 \times 10^7$  g mol<sup>-1</sup>

**Q.29** 2.03 kg

**Q.20** 10 mol

**Q.21** 260 mL

**Q.22**  $\frac{x}{y} = 5$

**Q.23** 24

**Q.24** 0.394 g

**Q.25** 79.714 gm

**Q.26** 0.744

**Q.27** 1.125, 1.99, 2.00

**Q.28** 0.302 M

**Q.29** 1800 mL

##### Redox Reaction

<b>Q.1</b> (i) 5/2	(ii) +2	(iii) +3	(iv) +6	(v) +2	(vi) +6
(vii) +2	(viii) -2	(ix) +5/2	(x) +1	(xi) +3	(xii) +8/3
(xiii) +7	(xiv) 0	(xv) +5	(xvi) +5		

**Q.2** (i)  $5\text{Br}^- + \text{BrO}_3^- + 6\text{H}^+ \longrightarrow 3\text{Br}_2 + 3\text{H}_2\text{O}$ ,

(iii)  $\text{Au} + 2\text{NO}_3^- + 4\text{Cl}^- + 4\text{H}^+ \longrightarrow \text{AuCl}_4^- + 2\text{NO}_2 + 2\text{H}_2\text{O}$

(v)  $3\text{MnO}_4^- + 4\text{H}^+ \longrightarrow 2\text{MnO}_4^{1-} + \text{MnO}_2 + 2\text{H}_2\text{O}$

(vii)  $5\text{Cl}_2 + \text{I}_2 + 3\text{H}_2\text{O} \longrightarrow 2\text{IO}_3^- + 10\text{Cl}^- + 6\text{H}^+$

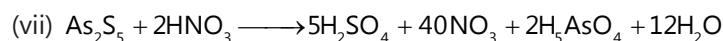
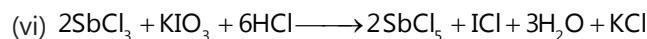
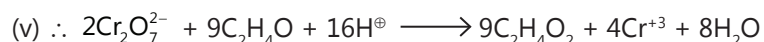
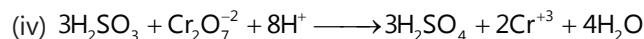
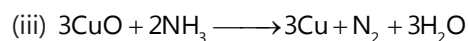
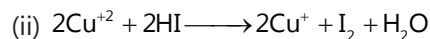
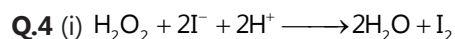
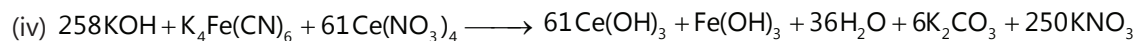
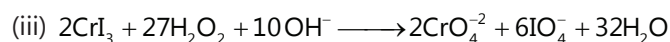
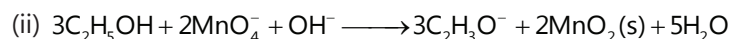
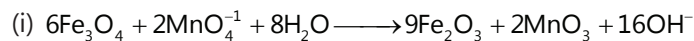
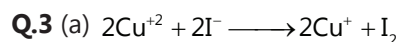
(viii)  $5\text{Fe}(\text{CN})_6^{4-} + 188\text{H}^+ + 61\text{MnO}_4^- \longrightarrow 5\text{Fe}^{3+} + 30\text{CO}_2 + 30\text{NO}_3^- + 61\text{Mn}^{+2} + 94\text{H}_2\text{O}$

(ix)  $6\text{Cu}_3\text{P} + 124\text{H}^+ + 11\text{Cr}_2\text{O}_7^{2-} \longrightarrow 18\text{Cu}^{+2} + 6\text{H}_3\text{PO}_4 + 22\text{Cr}^{+3} + 53\text{H}_2\text{O}$

(ii)  $8\text{Cr}_2\text{O}_7^{2-} + 24\text{H}_2\text{S} + 16\text{H}^+ \longrightarrow 8\text{Cr}_2\text{O}_3 + 3\text{S}_8 + 32\text{H}_2\text{O}$

(iv)  $3\text{Cu}_2\text{O} + 14\text{H}^+ + 2\text{NO}_3^- \longrightarrow 6\text{Cu}^{+2} + 2\text{NO} + 7\text{H}_2\text{O}$

(vi)  $2\text{Cu}^{+2} + \text{SO}_2 + 2\text{H}_2\text{O} \longrightarrow 2\text{Cu}^+ + 4\text{H}^+ + \text{SO}_4^{2-}$



## Exercise 2

### Mole Concept

#### Single Correct Choice Type

<b>Q.1</b> B	<b>Q.2</b> C	<b>Q.3</b> B	<b>Q.4</b> B	<b>Q.5</b> B	<b>Q.6</b> B	<b>Q.7</b> D
<b>Q.8</b> C	<b>Q.9</b> A	<b>Q.10</b> A	<b>Q.11</b> C	<b>Q.12</b> A	<b>Q.13</b> B	<b>Q.14</b> C
<b>Q.15</b> A	<b>Q.16</b> C	<b>Q.17</b> D	<b>Q.18</b> A	<b>Q.19</b> B	<b>Q.20</b> C	<b>Q.21</b> A
<b>Q.22</b> C	<b>Q.23</b> B	<b>Q.24</b> C	<b>Q.25</b> B	<b>Q.26</b> C	<b>Q.27</b> D	<b>Q.28</b> A
<b>Q.29</b> C						

### Redox Reaction

#### Single Correct Choice Type

<b>Q.1</b> A	<b>Q.2</b> D	<b>Q.3</b> A	<b>Q.4</b> C	<b>Q.5</b> C	<b>Q.6</b> C	<b>Q.7</b> B
<b>Q.8</b> C	<b>Q.9</b> B	<b>Q.10</b> C	<b>Q.11</b> D	<b>Q.12</b> C	<b>Q.13</b> C	<b>Q.14</b> B
<b>Q.15</b> C	<b>Q.16</b> D	<b>Q.17</b> C	<b>Q.18</b> D	<b>Q.19</b> A	<b>Q.20</b> A	<b>Q.21</b> C
<b>Q.22</b> A	<b>Q.23</b> D	<b>Q.24</b> B	<b>Q.25</b> C	<b>Q.26</b> A	<b>Q.27</b> A	<b>Q.28</b> D
<b>Q.29</b> C	<b>Q.30</b> D	<b>Q.31</b> C	<b>Q.32</b> C			

### Previous Year's Questions

<b>Q.1</b> A	<b>Q.2</b> C	<b>Q.3</b> D	<b>Q.4</b> B	<b>Q.5</b> A	<b>Q.6</b> C	<b>Q.7</b> A
<b>Q.8</b> D	<b>Q.9</b> B	<b>Q.10</b> B	<b>Q.11</b> D	<b>Q.12</b> A	<b>Q.13</b> C	<b>Q.14</b> A
<b>Q.15</b> C	<b>Q.16</b> D	<b>Q.17</b> C	<b>Q.18</b> D	<b>Q.19</b> A	<b>Q.20</b> A	<b>Q.21</b> C
<b>Q.22</b> D	<b>Q.23</b> B	<b>Q.24</b> A				

## JEE Advanced/Boards

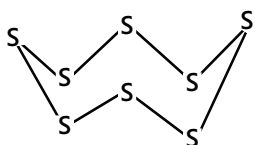
### Exercise 1

#### Mole Concept

- Q.1** 116.8 gm                      **Q.2** 9.12                      **Q.3** 5.6                      **Q.4** 0.597 g  
**Q.5**  $\text{BaCl}_2 \cdot 2\text{H}_2\text{O} = 7.038 \text{ g}$ ,  $\text{H}_2\text{O} = 42.962 \text{ g}$                       **Q.6** 120 g                      **Q.7** 20.78%  
**Q.8**  $\text{NaOH} = 0.06 \text{ g per } 200 \text{ mL}$ ,  $\text{Na}_2\text{CO}_3 = 0.0265 \text{ g per } 200 \text{ mL}$   
**Q.9** 0.1185                      **Q.10** 45%                      **Q.11** 61.5 gm                      **Q.12** 320.3 gm  
**Q.13** 6%                      **Q.14** 8.097 mL                      **Q.15** 6.125 g/litre                      **Q.16** 55.53 litre  
**Q.17**  $\text{K}_2\text{CO}_3 = 96\%$ ,  $\text{Li}_2\text{CO}_3 = 4\%$                       **Q.18** 12.9 gm                      **Q.19** 1.14 gm  
**Q.20**  $\text{SO}_4^{2-}$  ion concentration = 6.528                      **Q.21** 27.27%                      **Q.22**  $\text{C}_2\text{H}_6 = 0.66$ ,  $\text{C}_2\text{H}_4 = 0.34$   
**Q.23**  $\text{Pb}(\text{NO}_3)_2 = 3.32 \text{ g}$ ,  $\text{NaNO}_3 = 1.68 \text{ g}$   
**Q.24** 0.0075,  $[\text{Pb}^{2+}] = 0.0536 \text{ M}$ ,  $[\text{NO}_3^-] = 0.32 \text{ M}$ ,  $[\text{Cr}^{3+}] = 0.0714 \text{ M}$                       **Q.25** %NaCl = 77.8%  
**Q.26** (i)  $\text{Fe}_2\text{O}_3 + 2\text{Al} \longrightarrow \text{Al}_2\text{O}_3 + 2\text{Fe}$ ; (ii) 80: 27; (iii) 10,000 units  
**Q.27** 12.15 gm,  $\text{N}_2 = 14.28\%$ ,  $\text{H}_2 = 42.86\%$ ,  $\text{NH}_3 = 42.86\%$   
**Q.28** 0.9413 gram                      **Q.29** (i) 0.5, 0.5; (ii) 0.66, 0.33; (iii) 1, 2                      **Q.30** 13.4 mL  
**Q.31**  $\text{AlCl}_3 = 33.33\%$ ;  $\text{NaHCO}_3 = 50$ ;  $\text{KNO}_3 = 16.67$   
**Q.32** 9.4 gm                      **Q.33** 75%                      **Q.34** 0.532: 1.00

#### Redox Reaction

- Q.1** (i) +3      (ii) 0      (iii) +7      (iv) +6      (v) +2      (vi) +3      (vii) +6      (viii) 0      (ix) 0      (x) -1  
**Q.2** Oxidized: KI,  $\text{Na}_2\text{S}$ ,  $\text{NH}_4^+$ ; Reduced:  $\text{CuSO}_4$ ,  $\text{SO}_2$ ,  $\text{NO}_2^-$   
**Q.3** (i) 8 electrons, (ii) electrons  
**Q.4** (i) Oxidation number of sulphur in  $\text{H}_2\text{S}$  and  $\text{SO}_2$  are respectively -2 and +4.  
**Q.5**  $\text{NO}_2^-$  is oxidized to  $\text{NO}_3^-$  by  $\text{MnO}_4^-$  (in basic medium) which is reduced to  $\text{MnO}_2$ .

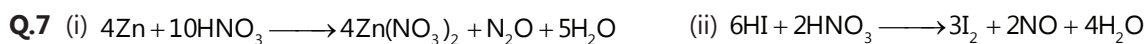


Thus,  $\text{MnO}_4^- \longrightarrow \text{MnO}_2$  oxidation number decreases by 3-units

$\text{NO}_2^- \longrightarrow \text{NO}_3^-$  oxidation number increases by 2 units

Thus,  $2\text{MnO}_4^- \equiv 3\text{NO}_2^-$        $\text{MnO}_4^- \equiv \frac{3}{2}\text{NO}_2^- = 1.5 \text{ mol NO}_2^-$

- Q.6** (i)  $\text{HSO}_3^-$ ; (ii)  $\text{NO}_2^-$ ; (ii)  $\text{Cl}^-$



**Q.8** 25 litre

**Q.9** 0.5 N, 0.167 M

**Q.10** 0.085 M, 0.042 N

**Q.11** 54%

**Q.12** (i) 85%; (ii) 124.79 mL

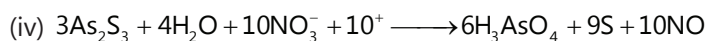
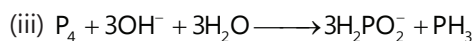
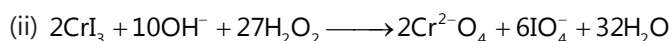
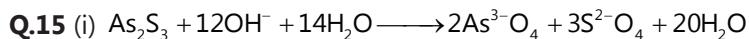
**Q.13** 30.33%

**Q.14** (i) 3      2      8      3      1      2      11

(ii) 1      40      40      12      2      5

(iii) 2      27      64      6      2      54      32

(iv) 3      14      18      14      6      9



**Q.16** 0.1716

**Q.17** +3

**Q.18**  $\text{FeC}_2\text{O}_4 = 0.03 \text{ N}$ ,  $\text{FeSO}_4 = 0.03 \text{ N}$

**Q.19** Molar ratio = 1: 1

**Q.20** 40 mL

**Q.21** 14%

**Q.22** 57.4%

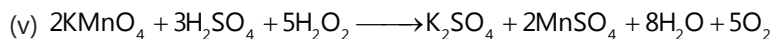
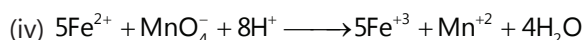
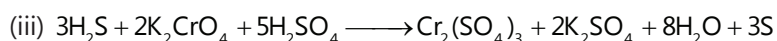
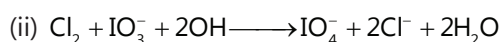
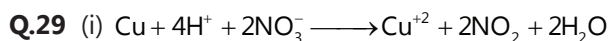
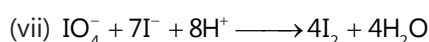
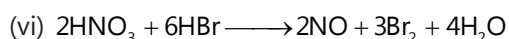
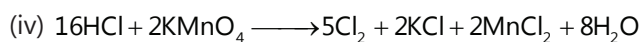
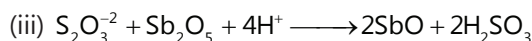
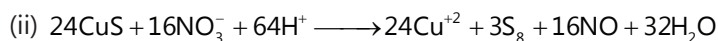
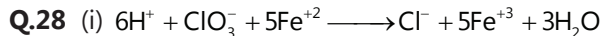
**Q.23**  $1.847 \times 10^{-3}\%$

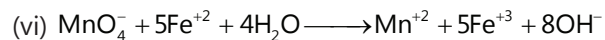
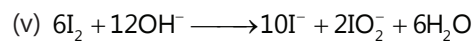
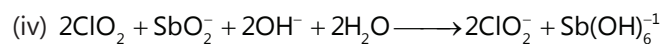
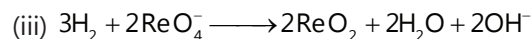
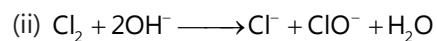
**Q.24**  $[\text{Fe}^{3+}] = 0.1\text{M}$ ,  $[\text{MnO}_4^-] = 0.105\text{M}$

**Q.25** (i) 0.08 N, 0.136%, 0.448 volume; (ii) 1.344

**Q.26** 0.062 M

**Q.27** 1.338 g





## Exercise 2

### Mole Concept

#### Single Correct Choice Type

**Q.1** D

**Q.2** B

**Q.3** C

#### Assertion Reasoning Type

**Q.4** B

**Q.5** A

**Q.6** C

**Q.7** B

**Q.8** A

**Q.9** C

#### Multiple Correct Choice Type

**Q.10** A, C, D

#### Comprehension Type

**Paragraph 1:** **Q.11** A

**Q.12** C

**Q.13** A

**Q.14** A

**Q.15** C

**Paragraph 2:** **Q.16** (1) C; (2) A; (3) B; (4) A

**Paragraph 3:** **Q.17** (1) C; (2) A; (3) A

#### Match the Columns

**Q.18** A → r; B → p; C → q

**Q.19** A → r; B → q; C → p

**Q.20** C

**Q.21** B

### Redox Reaction

#### Single Correct Choice Type

**Q.1** C

**Q.2** D

**Q.3** C

**Q.4** D

**Q.5** C

**Q.6** A

**Q.7** A

**Q.8** B

#### Comprehension Type

**Paragraph 1:** **Q.9** D

**Q.10** D

**Q.11** D

**Q.12** D

**Paragraph 2:** **Q.13** C

**Q.14** B, C

**Q.15** B

**Q.16** A, B, D

**Assertion Reasoning Type**

**Q.17** A      **Q.18** D      **Q.19** C      **Q.20** D      **Q.21** B      **Q.22** A      **Q.23** B

**Match the Columns**

**Q.24** A → w; B → x; C → u; D → p; E → v; F → q; G → r; H → s; I → t

**Q.25** A → p, s; B → r; C → p, q; D → p

**Previous Year's Questions**

**Q.1** 20%      **Q.2** 0.437      **Q.3** 1.7 g      **Q.4** A = KO<sub>2</sub>      **Q.5** 10.43      **Q.6** 2      **Q.7** D  
**Q.8** B      **Q.9** 5      **Q.10** B      **Q.11** 2      **Q.12** 4.48 V  
**Q.13** Moles of Cu<sup>2+</sup>; Moles of C<sub>2</sub>O<sub>4</sub><sup>2-</sup> = 1:2      **Q.14** 0.9 g, 1.12 g      **Q.15** D      **Q.16** A, B, D  
**Q.17** A

**Solutions****JEE Main/Boards****Exercise 1****Mole Concept**

**Sol 1:** (i) 125 pound

1 pound = lb = 545 gm

125 pound = 125 × 545 gm

= 125 × 545 × 10<sup>-3</sup> kg = 68.125 kg

(ii) 14 lb/m<sup>2</sup>

1 lb = 545 gm

In SI units = 14 × 545 × 10<sup>-3</sup> kg/m<sup>2</sup>

= 7.63 kg/m<sup>2</sup>

(iii) 5'8"

(1' = 12")

5'8" = (12" × 5) + 8" = 68"

= 68 × 2.54 cm = 1.72 m

**Sol 2:** M<sub>avg.</sub> = (0.932)39 + (0.068)41 = 39.136

Mass of 2g-atoms = 2 × 39.136 gm

Mass of "41K" in 2g-atoms

= 2 × 39.136 × (0.068)

Number of atoms =  $\frac{2 \times 39.136}{41} \times (0.068) \times 6.023 \times 10^{23}$   
= 7.818 × 10<sup>22</sup>

**Sol 3:** Barium phosphate = Ba<sub>3</sub>(PO<sub>4</sub>)<sub>2</sub>

No. of oxygen atoms =  $\frac{6.025}{602.5} \times 8 \times 6.023 \times 10^{23}$

= 4.82 × 10<sup>22</sup> atoms

**Sol 4:** Molecular weight = Vapour density × 2 = 76.6

Let's suppose x % mole of NO<sub>2</sub> is there

76.6 = x(46) + (1 - x)92

46x = 15.4

x = 0.3347 = 33.47% = mole fraction of NO<sub>2</sub>

Total mole =  $\frac{100}{76.6} = 1.305$  mole

Mole of NO<sub>2</sub> = (0.3347) × (1.305) = 0.437 mole.



**Sol 5: Correction:** radius of fluorine

$$= 5 \times 10^{-3} \text{ \AA}$$

$$\text{Mass of nucleus} = 19 \times 1.67 \times 10^{-27} \text{ kg}$$

Volume of nucleus

$$= \frac{4}{3} \times \pi \times (5 \times 10^{-3})^3 \text{ cm}^3$$

Density

$$= \frac{3 \times 19 \times 1.67 \times 10^{-27} \times 10^3 \text{ gm}}{4 \times \pi \times (5 \times 10^{-3})^3 \times (10^{-10})^3 \text{ cm}^3}$$

$$= \frac{95.19 \times 10^{-27} \times 10^{30}}{1570.79 \times 10^{-9}} \text{ gm/cm}^3$$

$$= 6.02 \times 10^{13} \text{ gm/cm}^3$$

**Sol 6:** mole =  $M_1 V_1$

For neutralisation  $H_{\text{HNO}_3} = H_{\text{NaOH}}$

$$M_1 V_1 = M_2 V_2$$

$$20 \times M_1 = 0.08 \text{ M} \times 25$$

$$M_1 = \frac{0.08 \times 25}{20} = 0.1 \text{ M}$$

**Sol 7:** HCl produced per day

$$= 3.0 \text{ gm} \times 2.5 = 7.5 \text{ gm} = \frac{7.5}{36.5} \text{ mole}$$

Moles of  $\text{Al}(\text{OH})_3$  in an antacid tablet

$$= \frac{400 \times 10^{-3}}{(27 + 51)} = \frac{0.4}{78} \text{ mole}$$

$3 \times$  mole of  $\text{Al}(\text{OH})_3 =$  moles of HCl

$$3 \times n \times \frac{0.4}{78} = \frac{7.5}{36.5}$$

$$n \approx 14$$

**Sol 8:**  $\text{HCl} + \text{AgNO}_3 \rightarrow \text{AgCl} + \text{HNO}_3$

$$M \times 10 \times 10^{-3} = \frac{0.1435}{108 + 35.5}$$

$$M = 0.1 \text{ M.}$$

**Sol 9:** Let it is  $\text{C}_x\text{O}_y$

$$x(12) + y(16) = 400$$

$$\frac{x(12)}{400} = 0.36$$

$$x = 12; y = 16$$

the formula is  $\text{C}_{12}\text{O}_{16} = (\text{C}_3\text{O}_4)_4$

**Sol 10:**  $\text{C}_x\text{H}_y + \text{O}_2 \rightarrow \text{H}_2\text{O} + \text{CO}_2$   
0.1 mole 0.2 mole

$$\text{Mole of H}_2\text{O} = \frac{0.18}{18} = 0.1 \text{ mole}$$

$$\text{Mole of CO}_2 = 0.02 \text{ mole}$$

$$\text{Mole of O}_2 \text{ required} = \frac{1}{2}(0.1) + 0.02 = 0.07 \text{ mole}$$

$$y = \text{Mole of H} = (0.1)2 = 0.2 \text{ mole}$$

$$x = \text{Mole of C} = 0.02 \text{ mole}$$

$$\begin{aligned} \text{Mass of hydro is} &= (0.02)12 + (0.2)1 \\ &= 0.24 + 0.2 = 0.44 \text{ gm.} \end{aligned}$$

**Sol 11:**  $\text{PCl}_3$  and  $\text{PH}_3$

$$2257\% \quad 91.18\%$$

$$\text{Mass of Cl in PCl}_3 = 3 \times 35.5 = 106.5$$

$$\text{Mass of H in PH}_3 = 3 \times 1 = 3$$

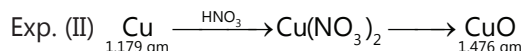
$$\left. \begin{aligned} \text{ratio} &= \frac{106.5}{3} = 35.5 \\ \text{Ratio of Cl : H} &= 35.5 \end{aligned} \right\} \text{equal.}$$

Hence prove.

**Sol 12:** Exp. (I)  $\text{CuO} \rightarrow \text{Cu} + \text{X}$

Ratio of mass of

$$\text{Cu : CuO} = \frac{1.098}{1.375} = 0.7985$$



$$\text{Ratio of mass of Cu : CuO} = \frac{1.179}{1.479} = 0.798$$

both ratio are same. Hence prove.

**Sol 13:**  $\text{M}_x\text{O}_y$

$$x \times \text{atomic mass of M} = 0.540 \quad \dots (i)$$

$$y \times 16 = 1.020 - 0.540$$

$$y = 0.03$$

Dulong-Petit law (atomic mass of M)

$$\times 0.216 = 5.83$$

$$\text{Atomic mass of M} \cong 27 \quad \dots (ii)$$

$$\text{Petit } x \times (27) = 0.540$$

$$x = 0.02$$

Formula of metal oxide =  $\text{M}_2\text{O}_3$ .

**Sol 14:** Let's say substance is 100 gm

$$\text{Moles of K} = \frac{39.7}{39} = 1.017$$

$$\text{Moles of Mn} = \frac{29.9}{55} = 0.5436$$

$$\text{Moles of O} = \frac{100 - 39.7 - 29.9}{16} = 1.9$$

so by seeing on ratio of K : Mn : O

empirical formula is  $\text{K}_2\text{MnO}_4$ .

**Sol 15:** Molarity =  $\frac{\text{no. of moles}}{\text{volume (in litre)}}$

$$\text{No. of moles} = \frac{\text{mass}}{18} = \frac{1000 \times 0.997}{18} \text{ per litre.}$$

$$\text{Molarity} = 55.38 \text{ M}$$

**Sol 16:** (a) Mass =  $(8 \times 12) + (10 \times 1) + (4 \times 14) + (2 \times 16)$   
 $= 96 + 10 + 56 + 32$

$$\text{Mass} = 194 \text{ amu}$$

$$= 194 \times 1.66 \times 10^{-24} \text{ gm/molecule}$$

$$= 3.24 \times 10^{-22} \text{ gm/molecule}$$

(b) Molecular mass of  $\text{Cl}_2 = 71$

Total no. of electrons in one molecule of  $\text{Cl}_2 = 34$

$$\text{So no. of electrons} = \frac{0.142}{71} \times 34 \times 6.023 \times 10^{23}$$

$$= 4.029 \times 10^{22}$$

**Sol 17:** Molarity = moles per litre

$$= \frac{\text{Mass}}{18 \times V} = \frac{\text{Density} \times \text{Volume}}{18 \times \text{Volume}} = \frac{1000}{18} = 55.55 \text{ M}$$

**Sol 18:** Volume of plant virus =  $(\pi r^2 h)$

$$= \pi \times (75 \times 10^{-10})^2 \times (5000 \times 10^{-10})$$

$$= 8.835 \times 10^{-23} \text{ m}^3$$

$$= 8.835 \times 10^{-23} \times (10^{+2})^3 \text{ cm}^3$$

$$= 8.835 \times 10^{-17} \text{ cm}^3$$

$$\text{Mass} = \frac{8.835 \times 10^{-17}}{0.75} \text{ gm}$$

$$= 11.78 \times 10^{-17} \text{ gm}$$

$$= 11.78 \times 6.023 \times 10^{+23} \times 10^{-17}$$

$$= 7.098 \times 10^7 \text{ g mol}^{-1}$$

**Sol 19:** 25% of heavy water = 0.5 litre.

Mass of heavy water

$$= 0.5 \times 10^3 \times 1.06 \text{ gm/cm}^3 = 530 \text{ gm}$$

Mass of normal water

$$= 1.5 \times 10^3 \times 1 \text{ gm/cm}^3 = 1500 \text{ gm}$$

$$\text{Total mass} = 2030 \text{ gm} = 2.030 \text{ kg}$$

**Sol 20**  $\text{SO}_2\text{Cl}_2 + 2\text{H}_2\text{O} \rightarrow \text{H}_2\text{SO}_4 + 2\text{HCl}$

Initially 2.5            0            0

after            0            2.5            5

For 2.5 moles of  $\text{H}_2\text{SO}_4$ ,  $\text{KOH} = 5$  mole

For 5 mole of  $\text{HCl}$ ,  $\text{KOH} = 5$  mole

$$\text{Total KOH} = 5 + 5 = 10 \text{ mole}$$

**Sol 21:**  $\text{NH}_4\text{Cl} + \text{MgCl}_2 + \text{AgNO}_3 \rightarrow$

$\underbrace{\hspace{10em}}_{2\% \text{ by mass}} \quad \underbrace{\hspace{5em}}_{5\% \text{ by mass}}$

$\text{AgCl} + \text{NH}_4\text{NO}_3 + \text{Mg}(\text{NO}_3)_2$

$d = 1040 \text{ gm/lit.}$

Moles of  $\text{Cl}^-$  in

$$\text{NH}_4\text{Cl} = \frac{2}{(14 + 4 + 35.5)} = 0.0373 \text{ mole}$$

Moles of  $\text{Cl}^-$  in

$$\text{MgCl}_2 = 2 \times \frac{2}{(24 + 71)} = 0.0421 \text{ mole}$$

Total mole of  $\text{Cl}^-$

= Total mole of  $\text{AgNO}_3$  required

$$= 0.0421 + 0.0373 = 0.07940 \text{ mole}$$

$$\text{Mass of AgNO}_3 = 0.07940 \times 170 = 13.49 \text{ gm}$$

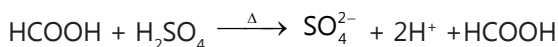
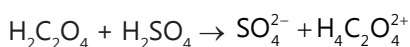
Mass of solution of

$$\text{AgNO}_3 \times 13.49 \times \frac{100}{5} = 269.97 \text{ gm}$$

$$\text{Volume required} = \frac{269.97}{1.04} \text{ cm}^3 = 259.59 \text{ cm}^3$$

**Sol 22:** Oxalic acid =  $\text{H}_2\text{C}_2\text{O}_4$

Formic acid =  $\text{HCOOH}$



**Sol 23:**  $\text{CH}_4 \rightarrow x$  mole  $\rightarrow$  Molecular weight = 16

$(\text{C}_2\text{H}_4) \rightarrow y$  mole  $\rightarrow$  Molecular weight = 28

Mean molecular weight

$$= 20 = \frac{x(16) + y(28)}{x + y}$$

$$20 = 16 + \frac{12y}{x + y}$$

$$0.33 = \frac{y}{x + y}$$

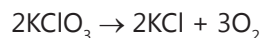
$$\frac{x}{x + y} = 0.66$$

$$x : y = 2 : 1$$

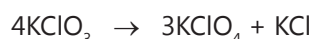
$$\text{If } x : y = 1 : 2$$

$$\text{Then, mean molecular weight} = \frac{1(16) + 2(28)}{3} = 24$$

**Sol 24:**



$$4.369 \times 10^{-3} \quad 6.55 \times 10^{-3}$$



$$3.794 \times 10^{-3} \quad 2.845 \times 10^{-3}$$

Moles of oxygen produced

$$= \frac{146.8 \times 10^{-3}}{22.4} = 6.55 \times 10^{-3} \text{ mole}$$

$$\text{Total mole of } \text{KClO}_3 = \frac{1}{39 + 35.5 + 48}$$

$$= 8.163 \times 10^{-3} \text{ mole}$$

Moles of  $\text{KClO}_3$  in II<sup>nd</sup> reaction =  $3.794 \times 10^{-3}$  moles

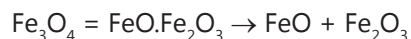
Moles of  $\text{KClO}_4$  produced in II<sup>nd</sup> reaction

$$= 2.8496 \times 10^{-3} \text{ mole}$$

Mass of  $\text{KClO}_4 = 2.8456 \times 10^{-3} \times (39 + 35.5 + 64)$

$$= 0.394 \text{ gm}$$

**Sol 25:** Let's say we have 100 gm mix.

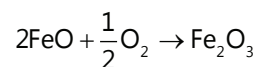


$$x \text{ gram} \quad 0.310 \text{ gram} \quad 0.680x \text{ gram}$$

Initially  $\text{FeO} \rightarrow (100 - x)$  gram

Total ( $\text{FeO}$ )  $\rightarrow (100 - x + 0.310x)$  gm

$$= (100 - 0.690x) \text{ gm}$$



$$(105 - 0.690x) \text{ gm}$$

$$2 \times \left( \frac{100 - 0.690x}{72} \right) = \frac{(105 - 0.690x)}{160}$$

$$(100 \times 0.690x) \times \frac{160}{36} = 105 - 0.690x$$

$$4000 - 27.6x = 945 - 6.21 \times 3055 = 21.39x$$

$$x = \text{oxygen external} = 5 \text{ gm} = \frac{5}{32} \text{ mole}$$

So moles of  $\text{FeO}$  that was present

$$\frac{(100 - 0.690x)}{56 + 16} = \frac{4 \times 5}{32}$$

$$\text{Fe}_3\text{O}_4 + x = 79.71 \text{ gm}$$

$$\text{FeO} = 100 - x = 20.29 \text{ gm}$$

**Sol 26:**  $\text{Zn} + 2\text{I} \rightarrow \text{ZnI}_2$

$$m \quad m$$

2x moles of Zn = moles of I

(to complete reaction)

$$2 \times \frac{m}{65} = 2x \text{ moles of Zn}$$

$$\frac{m}{127} = \text{moles of I}$$

Since moles of I < 2x moles of Zn

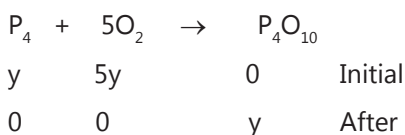
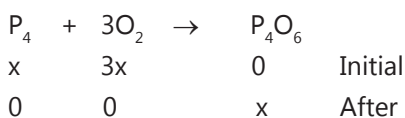
So Zn will be left unreacted

$$\text{Zn unreacted} = \frac{m}{65} - \frac{m}{127 \times 2} \text{ mole}$$

$$\text{Mass Zn unreacted} = m - \frac{65}{254}m = 0.744m$$

**Sol 27:** Mole of  $\text{P}_4 = \frac{2}{4 \times 31} = \frac{1}{62}$  mole

$$\text{Moles of } \text{O}_2 = \frac{2}{2 \times 16} = \frac{1}{16} \text{ mole}$$



$$\left. \begin{aligned} x + y &= \frac{1}{62} = 0.0161 \\ 3x + 5y &= \frac{1}{16} = 0.0625 \end{aligned} \right\} \text{ by solving}$$

$$y = 7.056 \times 10^{-3}$$

$$x = 9.0435 \times 10^{-3}$$

$$\text{Mass of P}_4\text{O}_6 = 9.0435 \times 10^{-3}$$

$$[(4 \times 31) + (6 \times 16)] = 1.9895 \text{ gm}$$

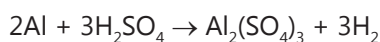
$$\text{Mass of P}_4\text{O}_{10} = 7.056 \times 10^{-3}$$

$$[(4 \times 31) + (10 \times 16)] = 2.003 \text{ gm}$$

**Sol 28:** Moles of aluminium =  $\frac{2.7}{27} = 0.1$  mole

Moles of  $\text{H}_2\text{SO}_4$  in solution

$$= \frac{(1.18 \times 100) \times 0.25}{98} = 0.3010 \text{ mole}$$

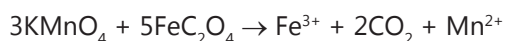
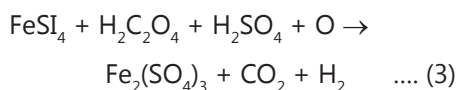
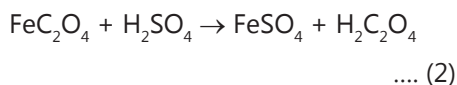
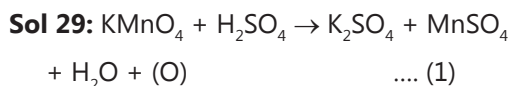


For consumption of Al, required mole of

$$\text{H}_2\text{SO}_4 = (0.10) \times \frac{3}{2} = 0.15 \text{ mole}$$

$$\text{remaining mole of H}_2\text{SO}_4 = 0.3010 - 0.15 = 0.151 \text{ mole}$$

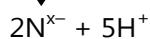
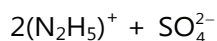
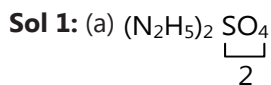
$$\text{Molarity} = \frac{0.151}{500} \times 1000 = 0.302\text{M}$$



$$(0.5)V = \frac{(1.5)}{5} \times 3$$

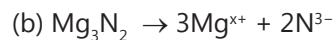
$$V = 1.8 \text{ lit.} = 1800 \text{ mL}$$

### Redox Reactions



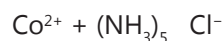
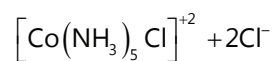
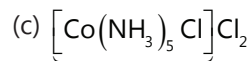
$$\therefore \text{Oxidation number of N} = -\frac{5}{2}$$

$$-2x + 5 = 0; x = \frac{5}{2}$$

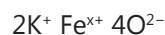


$$3x - 6 = 0$$

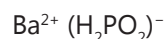
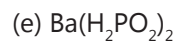
$$x = 2 \quad \text{Mg}^{2+}$$



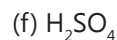
$$\therefore x - 1 = +2 \quad x = +3$$



$$+2 + x - 8 = 0; x = +6$$



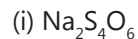
$$2 + x - 4 = 0; x = +2$$



$$+2 + x - 8 = 0; x = +6$$



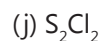
$$-4 + 2x = 0; x = +2$$



$$+2 + 4x - 12 = 0$$



$$x = +\frac{5}{2}$$

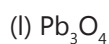


$$+2x - 2 = 0; x = +1$$



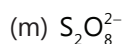


$$+1 + x - 4 = 0; x = 3$$



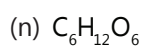
$$+3x - 8 = 0$$

$$x = +\frac{8}{3} \text{ Pb}^{+8/3}$$



$$2x - 16 = -2$$

$$2x = 14; x = +7$$



$$+6x + 12 - 12 = 0; x = 0$$

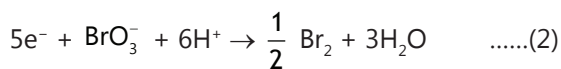
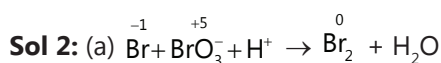


$$+2(2) + 2x - 14 = 0$$

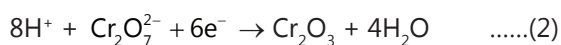
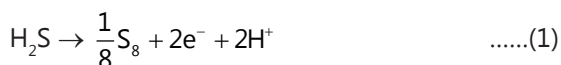
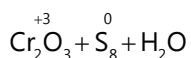
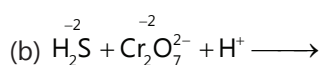
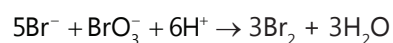
$$x = +5$$



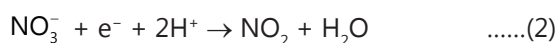
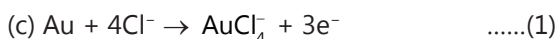
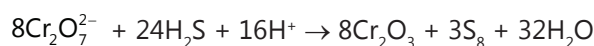
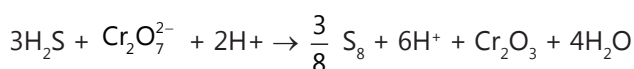
$$+1 + x - 6 = 0; x = +5$$



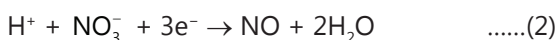
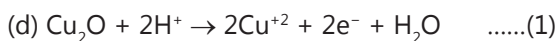
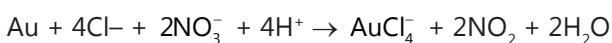
$$((1) \times 5) + (2)$$



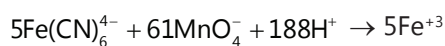
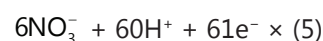
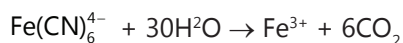
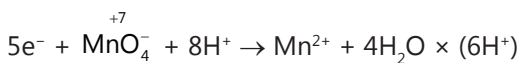
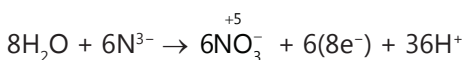
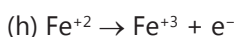
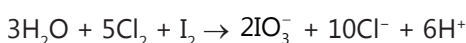
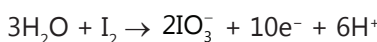
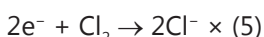
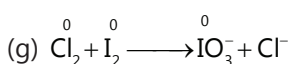
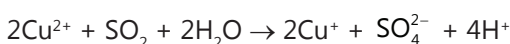
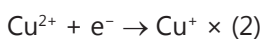
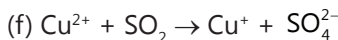
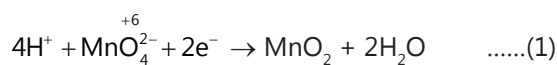
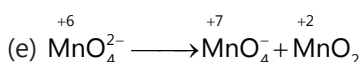
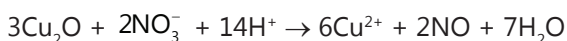
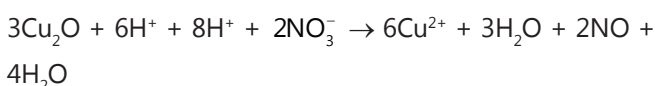
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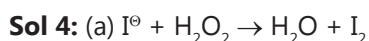
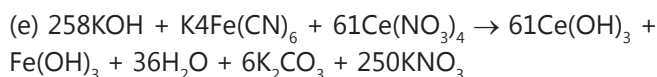
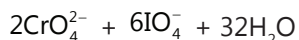
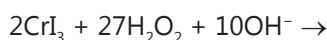
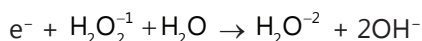
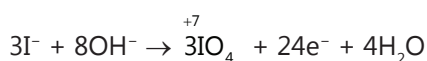
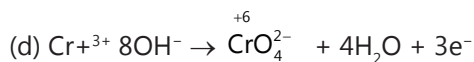
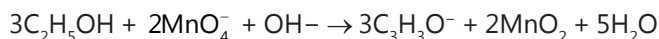
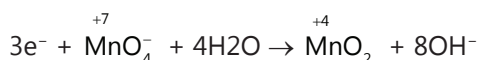
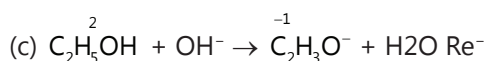
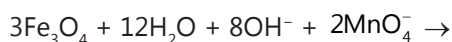
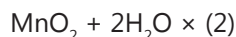
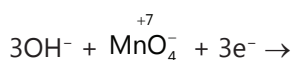
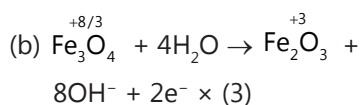
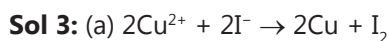
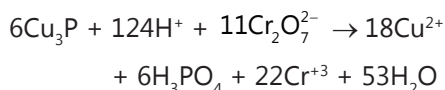
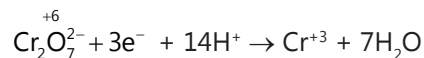
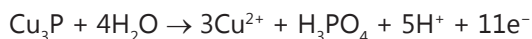
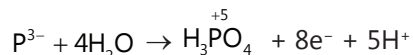
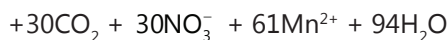


$$(1) + (2 \times (2))$$

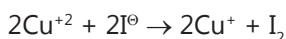
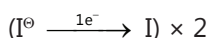
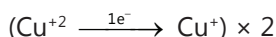
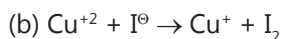
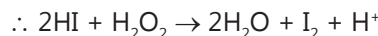
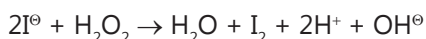
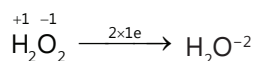
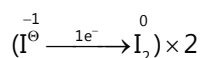


$$(3 \times (1)) + (2 \times (2))$$

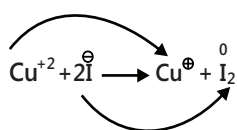




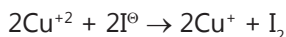
(acidic medium)



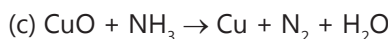
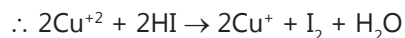
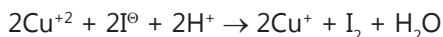
By the oxidation number method,



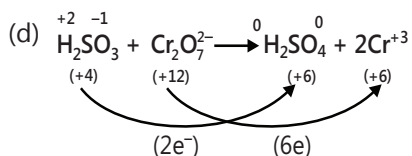
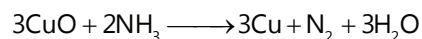
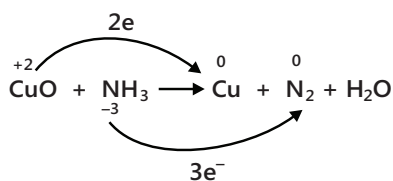
$\therefore$  To balance the electrons transferred,



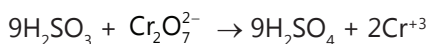
To balance charges on both sides,



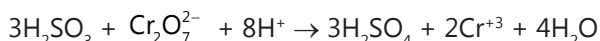
To balance the electrons transferred to balance oxygen



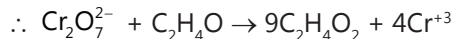
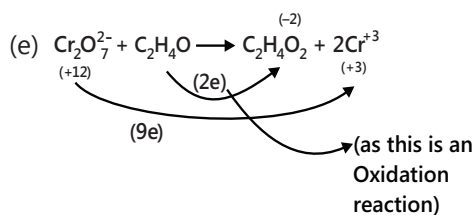
To balance the number of electrons transferred,



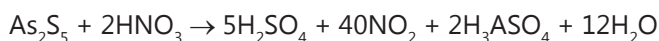
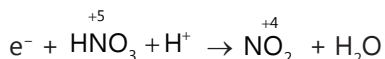
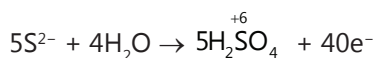
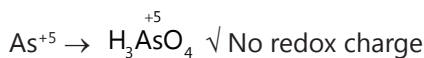
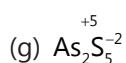
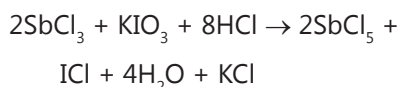
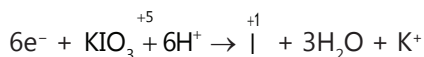
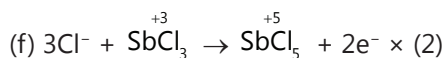
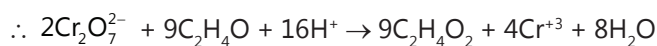
To balance charges on both sides,



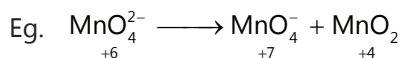
We observe that the number of oxygen atoms are simultaneously balanced



To balance charges on both sides,



**Sol 5:** Disproportionation is a specific type of redox reaction in which a species is simultaneously reduced and oxidized to form two different products.



**Sol 6:** Ion-electron method :-

(I) Divide the complete equations into two half reactions.

(II) Balance the atoms in each half reaction separately according to the following steps :-

(a) Balance all atoms other than O and H.

(b) For O and H.

**1. Acidic Medium:**

(i) Add  $\text{H}_2\text{O}$  to the side which is oxygen deficient.

(ii) Add  $\text{H}^+$  to the side which is hydrogen deficient.

**2. Basic Medium:**

(i) Add  $\text{OH}^-$  to the side which has less -ve charge.

(ii) Add  $\text{H}_2\text{O}$  to the side which is oxygen deficient.

(iii) Add  $\text{H}^+$  to the side which is hydrogen deficient.

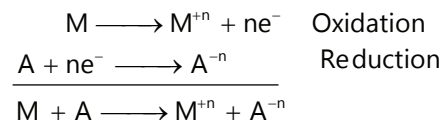
**3. Oxidation State Method:** This method is based on the fact that the number of electrons gained during reduction must be equal to the number of  $e^-$ s lost during oxidation.

**Sol 7: Definition of Redox Reaction:** Reaction which involves change in oxidation state of their atom, generally involve the transfer of electron between species. So, the most essential conditions that must be satisfied is the exchange of electron change in oxidation state.

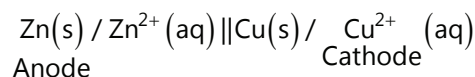
**Sol 8:** No, oxidation state term is just introduced to easily calculate the exchange of electron in redox reaction.

So, oxidation no. of an element in a particular compound represents the no. of  $e^-$ s lost or gained by an element during its change from free state into that compound or it represent the extent of oxidation or reduction of an element during its change from free state into that compound.

**Sol 9: Redox Couple:** Oxidation half reaction and reduction half reaction contributes to redox couple



**Sol 10:** (1) Combination of half cells (a) and (b)

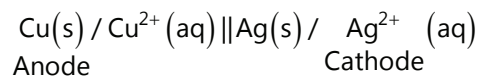


E.M.F. of the cell, E

$$= E_{\text{right}} - E_{\text{left}} = 0.34 - (-0.76)$$

$$= 1.10 \text{ V}$$

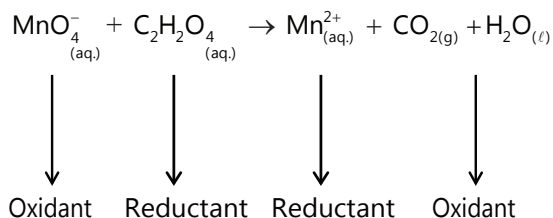
(2) Combination of half cells (b) and (d)



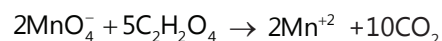
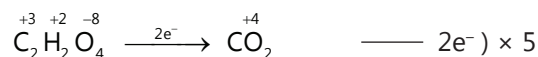
E.M.F. of the cell, E

$$= E_{\text{right}} - E_{\text{left}} = 0.80 - (+0.34)$$

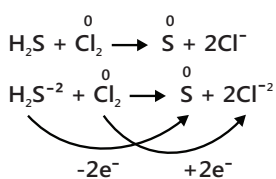
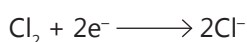
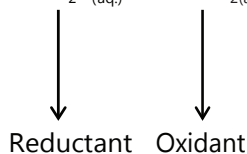
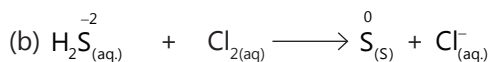
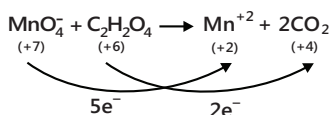
$$= 0.46 \text{ V}$$

**Sol 11:** (a)

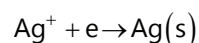
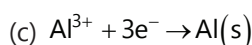
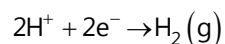
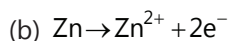
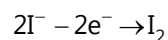
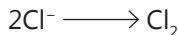
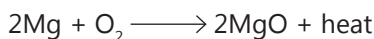
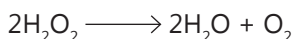
(i) Ion-electron method :-



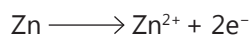
(ii) Oxidation number method :-



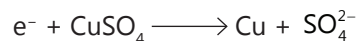
So, no need to multiply this equation with any co-efficients.

**Sol 12** (a)  $\text{Fe}^{3+} + e^- \rightarrow \text{Fe}^{2+}$ **Sol 13: Oxidation:** Increase in oxidation number**Reduction:** Decrease in oxidation number**Sol 14: (a) Combination reaction:** Reaction in which two or more elements or compounds combine together to form a single compound**(b) Decomposition reaction:** Reaction is the separation of a chemical compound into elements or simpler compounds**(c) Displacement reaction:**

Reaction in which one element or ion moves out of one compound and into another

**Sol 15: Oxidation No.:** No. of e<sup>-</sup>s lost or gained by an element during its change from free state into compound or represent the extent of oxidation or reduction of an element during its change from free state into that compound.**Valence:** Number of valence bonds a given atom has formed or can form with one or more than one with other atoms.**Sol 16:** S in  $\text{SO}_2$  has oxidation state +4. It lies between the minimum oxidation state (-2) and maximum oxidation state (+6) of S. Thus, S in  $\text{SO}_2$  can show an increase in its ox. no. (i.e., act as reductant) or can show a decrease in its ox. no. (i.e. acts as oxidant). On the other hand in  $\text{H}_2\text{S}$ , S is in -2 oxidation state and can only increase its oxidation state to act as reductant.**Sol 17: Half Reaction:** This is either the oxidation or reduction reaction component of a redox reaction. This is obtained by considering the change in oxidation states of individual substances involved in the redox reaction

oxidation half reaction



Reduction half reaction.



**Sol 18:** (i) Oxidation-Oxidation is the loss of electrons or an increase in oxidation state by a molecule, atom, or ion.

(ii) Reduction-Reduction is the gain of electrons or a decrease in oxidation state by a molecule, atom, or ion.

(iii) Oxidizing agent an oxidizing agent is a chemical species that removes an electron from another species.

(iv) Reducing agent-Reducing agent is an element or compound that loses an electron to another chemical species in a redox chemical reaction.

## Exercise 2

### Mole Concept

#### Single Correct Choice Type

**Sol 1: (B)**  $A + O_2 \rightarrow$

$$M_1V_1 = N_2V_2$$

Equivalent of A = Equivalent of  $O_2$

$$\frac{x}{\text{Equivalent weight of A}} = \left(\frac{16}{16}\right) \times 2$$

$$\frac{x}{2} = \text{equivalent weight of A}$$

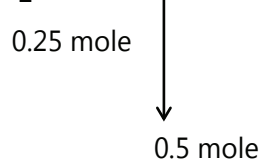
**Sol 2: (C)** Mass  $O_2$  in 88 gm

$$CO_2 = \frac{88 \times 32}{44} = 64 \text{ gm}$$

$$\text{Mole of O} = \frac{64}{16} = 4 \text{ mole}$$

So, mass of CO is =  $4 \times (12 + 16) = 112 \text{ gm}$

**Sol 3: (B)**  $Mg + \frac{1}{2}O_2 \rightarrow MgO$



Mass of MgO =  $0.5 \times (24 + 16) = 20 \text{ gm}$

**Sol 4: (B)** Let's diacidic acid is  $C_xH_yO_z$

$$\text{Weight of C} = \frac{x(12)}{M}$$

$$\text{Weight of H} = \frac{y}{M}$$

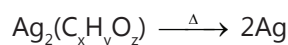
$$\text{Weight of O} = \frac{z(16)}{M}$$

$$x(12) = 8 \times y \Rightarrow 3x = 2y$$

$$x(12) = \frac{1}{2} \times 16(z) \Rightarrow 3x = 2z$$

$$y = z = \frac{3}{2}x$$

$\Rightarrow$  Empirical formula  $C_2H_3O_3$



$$\frac{0.5934}{108}$$

$$\text{Mole of salt} = \frac{0.5934}{2 \times 108} = \frac{1}{[216 + (24 + 3 + 48)x]}$$

$$216 + 75x = 364$$

$$x \sim z$$

So the formula would be =  $C_4H_6O_6$

**Sol 5: (B)**  $12C(s) + 11H_2(g) + \frac{11}{2}O_2(g) \rightarrow C_{12}H_{22}O_{11}(s)$

$$\frac{84}{12} \quad \frac{12}{1} \quad \frac{56}{22.4}$$

$$7 \quad 12 \quad 2.5$$

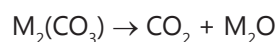
Here  $O_2$  is limiting reagent

$$\text{Moles of } C_{12}H_{22}O_{11} \text{ formed} = \frac{2.5}{11} \times 2 = \frac{5}{11} \text{ mole}$$

$$\text{Mass} = \frac{5}{11} \times [(12 \times 12) + 22 + (11 \times 16)] = 155.45 \text{ gm}$$

**Sol 6: (B)**  $M(CO_3) \rightarrow CO_2 + MO$

or



$$\text{Mass of } CO_3 = 12 + 48 = 60$$

$$\text{Mole of } CO_2 = \frac{12.315}{(PV)}(RT) = \frac{12.315}{1 \times (12.315)} \times 0.0821 \times$$

$$300 = 0.5 \text{ mole}$$

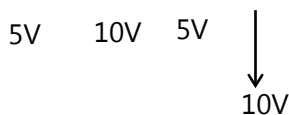
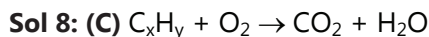
$$\text{Mole of } M(CO_3) \text{ or } M_2CO_3 = 0.5 \text{ mole}$$

$$\text{So, mass of } CO_3 \text{ in carbonate} = 0.5 \times 60 = 30 \text{ gram}$$

Checking all options one by one

(B) is correct.

**Sol 7: (D)** Empirical formula would be  $\text{NH}_2$  because ratio of N and H is given 1 : 2. By stability we see  $\text{N}_2\text{H}_4$  is correct answer.



By oxygen atom balance  $\text{H}_2\text{O} = 10V$

By hydrogen atom balance  $y(5) = 2(10) \therefore y = 4$

By carbon balance  $= x(5) = 5$

the molecule is  $\text{CH}_4$

**Sol 9: (A)** Molecular weight of  $\text{NO}_2 = 32 + 14 = 46$

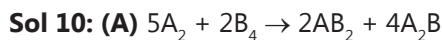
Molecular weight of  $\text{NO} = 16 + 14 = 30$

let's  $x = \text{NO}$   $1 - x = \text{NO}_2$

$$34 = x(30) + (1 - x) 46$$

$$16x = 12$$

$$x = \frac{3}{4} \text{ so } \text{NO}_2 \% = 25\%$$



4 mole

Molecular mass of  $\text{AB}_2 = 250$

Molecular mass of  $\text{A}_2\text{B} = 140$

$$\text{B}_4 = 480$$

$$\text{A}_2 = 20$$

Moles of  $\text{AB}_2$  to be produced  $= \frac{1000}{250} = 4$  mole

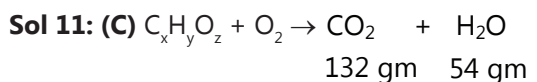
Moles of  $\text{A}_2\text{B}$  to be produced  $= \frac{1000}{140} = 7.14$  mole

So, mass of  $\text{A}_2$ ,  $\text{B}_4$  would to according to  $\text{AB}_2$

So, mass of  $\text{A}_2$  required  $= \frac{5}{2} \times 4 \times 20 = 10 \times 20 = 200$  gm

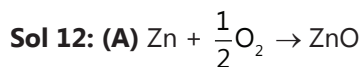
Mass of  $\text{B}_4$  required  $= 4 \times 480 = 2 \times 960$  gm  $= 1920$  gm

Total mass  $= 1920 + 200 = 2120$  gm



$y = 6$  mole

$x = 3$  mole



x gm

$$\frac{1}{2} \times \frac{x}{65} = \frac{v}{22.4}$$

$$v = \frac{x}{65} \times 11.2 = \frac{2x}{65} \times 5.6 \text{ lit.}$$

**Sol 13: (B)** Let's say 100 gm of clay is given initially

12 gm water

x gm silica

y gm other

After that  $(100 - A)$  gm of clay

$(12 - A)$  gm water  $\left(\frac{100 - A}{2}\right)$  silica

$$(12 - A) = \frac{(100 - A) \times 7}{100}$$

$$1200 - 100A = 700 - 7A$$

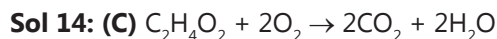
$$93A = 500$$

$$A = \frac{500}{93}$$

By conservation of silica

$$\frac{100 - \frac{500}{93}}{2} = x$$

$$x = 47.31$$



x gm                  620-x gm

11                      11

$\frac{x}{60}$  mole               $\frac{620-x}{32}$

To produce maximum energy  $\text{C}_2\text{H}_4\text{O}_2$  and  $\text{O}_2$  will be fully consumed.

$$x \frac{x}{60} = \frac{620-x}{32} \times \frac{1}{2}$$

$$64x = 37200 - 60x$$

$$x = 300 \text{ gm}$$

$$\text{Weight of } \text{CO}_2 = 2 \times \frac{300 \times 44}{60} = 440 \text{ gm}$$

**Sol 15: (A)** (Organic compound) + H<sub>2</sub>O → N<sub>2</sub>  
0.42 gm

$$\text{Moles of N}_2 = \frac{PV}{RT} = \frac{860}{760} \times \frac{100}{11} \times \frac{10^{-3}}{0.08 \times 250}$$

$$= \frac{86}{167200} = 5.143 \times 10^{-4}$$

$$\text{Mass of N}_2 = 5.143 \times 10^{-4} \times 28 = 0.0144 \text{ gm}$$

$$\text{Fraction} = \frac{0.0144}{0.42} = 0.034 = \frac{10}{3} \%$$

**Sol 16: (C)** Moles of H<sup>+</sup> = (0.1) (0.3) + (0.2) (0.3) × 2  
= 0.15 mole

$$\text{Normality} = \frac{0.15}{500} \times 1000 = 0.3N$$

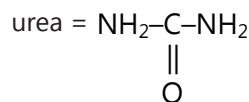
**Sol 17: (D)** Moles of NaOH = (0.300) (0.5) = 0.15 moles

$$\text{For molarity} = 0.2 \text{ M} = \frac{0.15}{V}$$

$$V = 750 \text{ mL}$$

$$\text{Volume to be added} = 750 - 300 = 450 \text{ mL}$$

**Sol 18: (A)** Moles of water =  $\frac{250}{18} = 13.888$  mole



$$\text{Moles urea} = \frac{3}{60} = 0.05 \text{ mole}$$

$$\text{Mole fraction} = 0.0036$$

**Sol 19: (B)** P<sub>4</sub>S<sub>3</sub> + 8O<sub>2</sub> → P<sub>4</sub>O<sub>10</sub> + 3SO<sub>2</sub>

$$\text{Moles of O}_2 = \frac{384}{32} = 12 \text{ mole}$$

$$\text{Moles of P}_4\text{S}_3 = \frac{440}{124 + 96} = 2 \text{ mole}$$

L. R. = O<sub>2</sub>

So mass of P<sub>4</sub>O<sub>10</sub> produced

$$= \frac{12}{8} \times [124 + 160] = 426 \text{ gm}$$

**Sol 20: (C)** PCl<sub>5</sub> → PCl<sub>3</sub> + Cl<sub>2</sub>

Initially 1 mole

$$\text{After } \frac{1}{2} \text{ mole} \quad \frac{1}{2} \text{ mole} \quad \frac{1}{2} \text{ mole}$$

$$\text{Initially } M_{\text{avg.}} = M_{\text{PCl}_5} = 31 + 5(35.5) = 208.5$$

$$\text{After } M_{\text{avg.}} = \frac{M}{3/2} = \frac{208.5}{3} \times 2 = 208.5 \times \frac{2}{3}$$

$$\text{So change in } M_{\text{avg.}} = 33.33\%$$

**Sol 21: (A)** 3Mg + 2NH<sub>3</sub> → Mg<sub>3</sub>N<sub>2</sub> + 3H<sub>2</sub>

2 mole 2 mole

L. R. = Mg

$$\text{Mass of Mg}_3\text{N}_2 \text{ produced} = \frac{2}{3} \times (72 + 28) = \frac{200}{3} \text{ gm}$$

**Sol 22: (C)** Let's say solution is in 100 gm.

HCl mole = 1 mole

$$\text{Molality} = \frac{\text{moles of solute}}{\text{mass of solvent (in kg)}}$$

$$\text{Molality} = \frac{1}{(100 - 36.5)} \times 1000 = 15.75$$

**Sol 23: (B)** Weight of Na<sub>2</sub>CO<sub>3</sub>·xH<sub>2</sub>O in 10 mL solution

$$= \frac{0.025}{5} = 0.07$$

$$2 \times \frac{0.07}{46 + 12 + 48 + x(18)} = \frac{9.9}{10} \times 10^{-3}$$

$$\frac{0.14}{106 + 18x} = 0.99 \times 10^{-3}$$

$$0.07 = [104.94 + 17.82x] \times 10^{-3}$$

$$35.06 = 17.82x$$

$$x \sim 2$$

**Sol 24: (C)** Washing soda (Na<sub>2</sub>CO<sub>3</sub>) in 25 cc = 0.12 gm

$$2 \times \frac{0.12}{106 + 18x} = 1.7 \times 10^{-3}$$

$$240 = 180.2 + 30.6x$$

$$x \sim 2$$

$$\text{Percentage of carbonate} = \frac{106}{106 + 36} \sim 76\%$$

**Sol 25: (B)** No. of carbon atoms

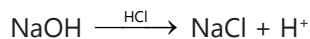
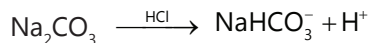
$$= \frac{1.2 \times 10^{-3}}{12} \times 6.023 \times 10^{23} = 6.02 \times 10^{19}$$

**Sol 26: (C)**  $21.31 = (0.79)(24) + (0.21 - x)(25) + (x)(26)$

$$24.31 = 18.96 + 5.25 + x$$

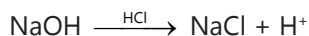
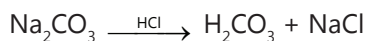
$$x = 0.1 = 10\%$$

**Sol 27: (D)** Using HPh



Using

MeOH



Moles of HCl used in HPh = 4m mole

Moles of HCl used in MeOH = 4.5 m mole

It means that for  $\text{NaHCO}_3 \rightarrow \text{H}_2\text{CO}_3$  required mole of HCl 0.5 m mole

Moles of  $\text{Na}_2\text{CO}_3 = 0.5$  m mole

$$= 0.5 \times 10^{-3} \times 106 \text{ gm}/250 \text{ mL}$$

$$= 5.3 \text{ mg}/25 \text{ mL}$$

$$= 2.12 \text{ g/L}$$

NaOH moles = 3.5 m mole

$$\text{Mass of NaOH} = 40 \times 3.5$$

$$= 140 \text{ mg}/25 \text{ mL}$$

$$= 5.6 \text{ g/L}$$

None of these

**Sol 28: (A)** Moles of HCl =  $0.25 \times 30$  m mole = 7.5 m mole

$$\frac{7.5}{2} = 10^{-3} = \frac{x(0.5)}{138} + \frac{(1-x)0.5}{74}$$

$$7.5 \times 10^{-3}$$

Solving this  $x \sim 96\%$

$$\text{K}_2\text{CO}_3 \sim 96\%$$

$$\text{Li}_2\text{CO}_3 \sim 4\%$$

**Sol 29: (C)**  $\text{KMnO}_4 + 5\text{FeSO}_4 \rightarrow \text{Mn}^{2+} + \text{Fe}^{3+}$

$$\frac{2.0}{152} \text{ moles of KMnO}_4$$

$$= \frac{2.0}{5 \times 152} = 2.631 \times 10^{-3}$$

Volume  $\times$  molarity = moles

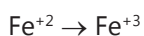
$$\text{Volume} = \frac{2.631 \times 10^{-3}}{0.05} = 52.63 \text{ mL}$$

## Redox Reactions

### Single Correct Choice Type

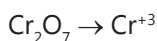
**Sol 1: (A)** Equivalent weight = Molecular weight  $\times n_{\text{factor}}$

$$= (M_0)_{\text{FeSO}_4} \times 1$$

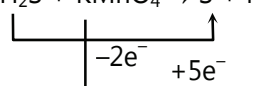


**Sol 2: (D)** Equivalent weight = Molecular weight  $\times n_{\text{factor}}$

$$= (M)_{\text{K}_2\text{Cr}_2\text{O}_7} \times 6$$



**Sol 3: (A)**  $\text{H}_2\text{S} + \text{KMnO}_4 \rightarrow \text{S} + \text{Mn}^{2+}$



$$\frac{m}{34} \times 2 = \frac{1.58}{158} \times 5 = 0.85$$

**Sol 4: (C)**  $\text{HNO}_3 + \text{I}_2 \rightarrow \text{I}_2\text{O}_5 + \text{NO}_2$

$$\frac{m}{63} \times 1 = \frac{127}{127 \times 2} \times 10 = 315$$

**Sol 5: (C)**  $N_1V_1 = N_2V_2$

Oxalic acid  $\text{KMnO}_4$

$$10 \times 10^{-3} \times N = 20 \times 10^{-3} \times 0.02 \times (5)$$

$$n\text{-factor} = 0.2N$$

**Sol 6: (C)**  $\frac{m}{34} \times 2 = 10 \times 10^{-3} \times 1$ ;  $m = 0.17$

$$\therefore \text{Purity} = \frac{0.17}{0.2} \times 100 = 85\%$$

**Sol 7: (B)**  $\text{KMnO}_4 + \text{FeC}_2\text{O}_4 \rightarrow \text{Mn}^{2+} + \text{Fe}^{3+} + \text{CO}_2$

$$n_{\text{KMnO}_4} \times 5 = 1 \times (1 + 2) = \frac{3}{5}$$

**Sol 8: (C)**  $\text{M}_2\text{X}_2 + x\text{H}_2 \rightarrow 2\text{M} + x\text{H}_2\text{O}$

1 mole  $\text{M}_2\text{X}_2$  gives 2 moles M

$$\therefore \frac{3.15 \text{ g}}{(\text{MW})} \rightarrow \frac{1.05}{\text{M}}$$

$$\therefore 6\text{M} = 2\text{M} + x(16)$$

$$\therefore 4\text{M} = x(16)$$

$$\therefore M = 4x$$

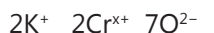
$$\text{Now, } (EW)_M = \frac{(MW)_M}{x} = \frac{M}{x}$$

$$\therefore (EW)_M = \frac{M}{x} = 4.$$

**Sol 9: (B)** Oxidation means increase of oxidation number

$\therefore$  So, there is loss of electrons.

**Sol 10: (C)**  $K_2Cr_2O_7$



$$+ 2 + 2x - 14 = 0$$

$$x = +6$$

**Sol 11: (D)**  $K_2Cr_2O_7 \rightarrow K_2Cr_2O_7$

$$+6 \rightarrow +3$$

$\therefore$  Change in oxidation No. = [3].

**Sol 12: (C)**  $P + NaOH \rightarrow PH_3 + NaH_2PO_2$

P is getting oxidised and also reduced

$\therefore$  It is oxidation and reduction

(D is disproportionation)

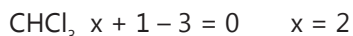
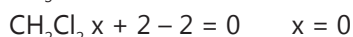
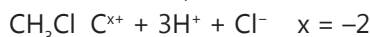
**Sol 13: (C)**  $CH_2O$



$$x + 2 - 2 = 0$$

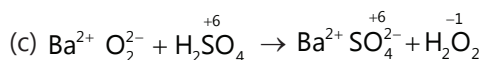
$$x = 0$$

**Sol 14: (B)**  $CH_4 \rightarrow C^{x+} + 4H^+ \quad x = -4$



**Sol 15: (C) Redox:** Exchange of electrons

$\therefore$  Change in oxidation state.



No change in oxidation

**Sol 16: (D)** (a)  $+4 - 6 + x = 0; \quad x = +2$

$$(b) + 2 + x - 8 = 0; \quad x = +6$$

$$(c) +2x - 2 = 0; \quad x = +1$$

$$(d) x + 5(0) = 0; \quad x = 0$$

**Sol 17: (C)** (a)  $HClO^{-2} + 1 + x - 2 = 0; \quad x = +1$

$$(b) HClO_2 + 1 + x - 4 = 0; \quad x = +3$$

$$(c) HClO_3 + 1 + x - 6 = 0; \quad x = 5$$

$$(d) HClO_4 + 1 + x - 8 = 0; \quad x = +7$$

**Sol 18: (D)**  $M^{3+} \rightarrow M^{6+} + 3e^-$

**Sol 19: (A)**  $MnO_4^{+x} + x - 8 = -1; \quad x = +7$

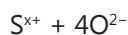
**Sol 20: (A)** The oxidation number of carbon in  $CHCl_3$  is +4

**Sol 21: (C)**  $Pb^{2+} \rightarrow Pb^{4+} + 2e^-$

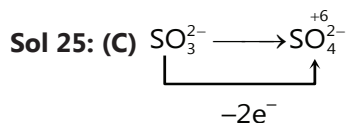
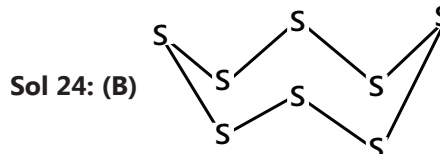
**Sol 22: (A)**  $C_{12}H_{22}O_{11}$

$$12x + 22 + 11(-2) = 0; \quad x = 0$$

**Sol 23: (D)**  $SO_4^{2-}$



$$x - 8 = -2; \quad x = +6$$



**Sol 26: (A)**  $S_2O_7^{2-} + 2x - 14 = -2$

$$2x = +12; \quad x = +6$$

**Sol 27: (A)**

$$MnO_2 + 4H^+ + X \xrightarrow{-2e^-} Mn^{2+} + H_2O$$


$$8x = 0; \quad x = 0$$

$$\text{Covalency} = 2$$

**Sol 28: (D)**  $N_3H$

$$3x + 1 = 0; \quad x = x = -\frac{1}{3}$$

**Sol 29: (C)**  $K_3 [Fe(CN)_6]$ 

$$+3 - (x - 6) = 0; x = +3$$

**Sol 30: (D)**  $MH_2$ 

$$+x + 2 = 0; x = -2$$

**Sol 31: (C)**  $PH_3^{-3}$  to  $H_3PO_4^{+5}$ **Sol 32: (C)** In chlorine atom had +5 oxidation state.

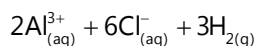
$$HClO_3 + 1 + x - 6 = 0; x = 5$$

## Previous Years' Questions

### Mole Concept

**Sol 1: (A)** If we consider that  $\frac{1}{6}$ , in place of  $\frac{1}{12}$ , mass of carbon atom is taken to be the relative atomic mass unit, the mass of one mole of a substance will decrease twice.

**Sol 2: (C)** According to definition of molar solution is one that contains one mole of a solute in one litre of the solution.

**Sol 3: (D)**  $2Al_{(s)} + 6HCl_{(s)} \longrightarrow$ 

For each mole of HCl reacted, 0.5 mole of is formed at STP.

1 mole of an ideal gas occupies 22.4 lit at STP.

Volume of  $H_2$  gas formed at STP per mole of HCl reacted is  $22.4 \times 0.5$  litre.

**Sol 4: (B)** From molecular formula of magnesium phosphate, it is evident that each mole of  $Mg(PO_4)_2$  contains 8 mole of oxygen atoms.

Therefore, 0.25 mole of oxygen atom will remain present in  $\frac{0.25}{8}$  mole i.e.  $3.125 \times 10^{-2}$  mole of  $Mg(PO_4)_2$ .

**Sol 5: (A)** 200 mg of  $CO_2 = 200 \times 10^{-3} = 0.2$  g

44g of  $CO_2 = 6 \times 10^{23}$  molecules (approx.)

$$0.2g \text{ of } CO_2 = \frac{6 \times 10^{23}}{44} \times 0.2$$

$$= 0.0272 \times 10^{23} = 2.72 \times 10^{21} \text{ molecule}$$

Now,  $10^{21}$  molecule are removed.

$$\text{So remaining molecules} = 2.72 \times 10^{21} - 10^{21}$$

$$= 10^{21}(2.72 - 1) = 1.72 \times 10^{21} \text{ molecule}$$

Now,  $6.023 \times 10^{23}$  molecules = 1 mol

$$1.72 \times 10^{21} \text{ molecules} = \frac{1 \times 1.72 \times 10^{21}}{6.023 \times 10^{23}}$$

$$= 0.285 \times 10^{-2} = 2.85 \times 10^{-3}$$

**Sol 6: (C)**  $K_2Cr_2O_7 + 4H_2SO_4 \rightarrow K_2SO_4 + Cr_2(SO_4)_3$ 

+12/two atom +6/two atom

Change by 6

$$\text{Eq. wt.} = \frac{\text{Mol. wt.}}{6}$$

$$\begin{aligned} \text{Sol 7: (A)} \quad M_f &= \frac{M_1V_1 + M_2V_2}{V_1 + V_2} \\ &= \frac{0.5 \times \frac{3}{4} + 2 \times \frac{1}{4}}{1} = 0.875 \text{ M} \end{aligned}$$

**Sol 8: (D)** 18 g  $H_2O$  contains 2 g H

$\therefore$  0.72 g  $H_2O$  contains 0.08 g H.

44 g  $CO_2$  contains 12 g C

$\therefore$  3.08 g  $CO_2$  contains 0.84 g C

$$\therefore C : H = \frac{0.84}{12} : \frac{0.08}{1} = 0.07 : 0.08 = 7 : 8$$

$\therefore$  Empirical formula =  $C_7H_8$

**Sol 9: (B)**  $M_{0.98}O$ 

Consider one mole of the oxide.

Moles of M = 0.98, Moles of  $O^{2-} = 1$

Let moles of  $M^{3+} = x$

$$\Rightarrow \text{Mole of } M^{2+} = 0.98 - x$$

$\Rightarrow$  Doing charge balance

$$(0.98 - x) \times 2 + 3x - 2 = 0$$

$$\Rightarrow 1.96 - 2x + 3x - 2 = 0$$

$$\Rightarrow x = 0.04$$

$$\Rightarrow \% \text{ of } M^{3+} = \frac{0.04}{0.98} \times 100 = 4.08\%$$

**Sol 10: (B)** Let the mass of  $O_2 = x$

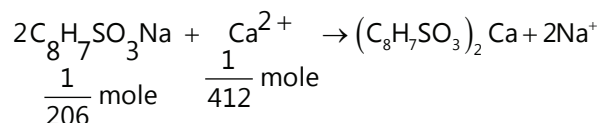
Mass of  $N_2 = 4x$

Number of moles of  $O_2 = \frac{x}{32}$

Number of moles of  $N_2 = \frac{4x}{28} = \frac{x}{7}$

$\therefore$  Ratio =  $\frac{x}{32} : \frac{x}{7} = 7 : 32$

**Sol 11: (D)** 1 g of  $C_8H_7SO_3Na = \frac{1}{206}$  mole



**Sol 12: (A)**  $C_xH_y(g) + \left(x + \frac{y}{4}\right)O_2(g) \rightarrow xCO_2(g) + \frac{y}{2}H_2O(l)$

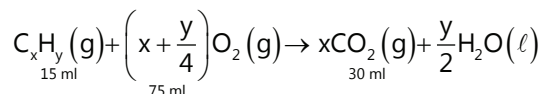
15 mL

Volume of  $O_2$  used =  $\frac{20}{100} \times 375 = 75$  mL

Volume of air remaining = 300 mL

Total volume of gas left after combustion = 330 mL

Volume of  $CO_2$  gases after combustion = 330 - 300 = 30 mL



$$\frac{x}{1} = \frac{30}{15} \Rightarrow x = 2$$

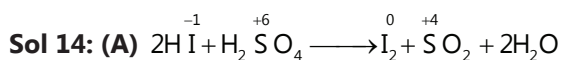
$$\frac{x + \frac{y}{4}}{1} = \frac{75}{15} \Rightarrow x + \frac{y}{4} = 5$$

$$\Rightarrow y = 12$$

$$\Rightarrow C_2H_{12}$$

### Redox Reactions

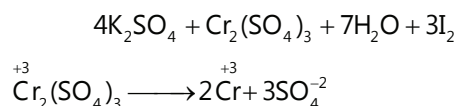
**Sol 13: (C)** Prevent action of water and salt.



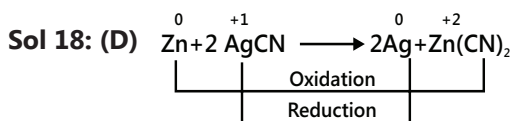
**Sol 15: (C)**  $CH_2O$

$$x + 2 - 2 = 0; x = 0$$

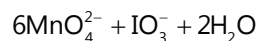
**Sol 16: (D)**  $K_2Cr_2O_7 + 6KI + 7H_2SO_4 \longrightarrow$



**Sol 17: (C)** Number of  $e^-$  transferred in each case is 1, 3, 4, 5.

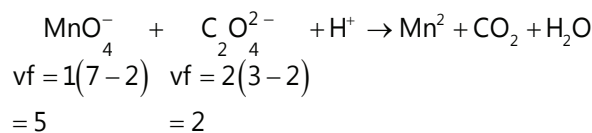


**Sol 19: (A)**  $6MnO_4^- + I^- + 6OH^- \longrightarrow$

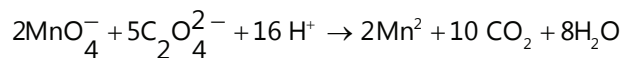


**Sol 20: (A)**  $H-O-\overset{\overset{H}{|}}{\underset{\underset{O}{|}}{P}}-OH$ , hence it is dibasic. It acts as a reducing agent also.

**Sol 21: (C)**

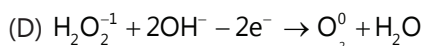
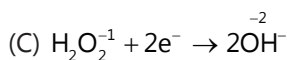
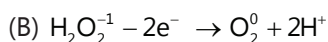
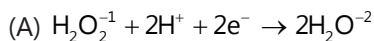


$\therefore$  Balanced Equation:



So,  $x = 2$ ,  $y = 5$  &  $z = 16$ .

**Sol 22: (D)** The reducing agent oxidises itself:

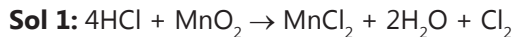


**Note:** Powers of 'O' are oxidation number of 'O' in the compound.

**Sol 23: (B)**

The complex  $[\text{CoCl}(\text{NH}_3)_5]^+$  decomposes under acidic medium, so  $[\text{CoCl}(\text{NH}_3)_5]^+ + 5\text{H}^+ \rightarrow \text{Co}^{2+} + 5\text{NH}_4^+ + \text{Cl}^-$

**Sol 24: (A)**  $\text{H}_2\text{O}_2$  can undergo reduction as well as oxidation because oxidation number of oxygen in  $\text{H}_2\text{O}_2$  is -1. So, it can act both as reducing agent and oxidising agent.

**JEE Advanced/Boards****Exercise 1****Mole Concept**

69.6 gm

$$69.6 \text{ gm of MnO}_2 = \frac{69.6}{87} \text{ mole}$$

$$\text{Mole of HCl} = \frac{69.6}{87} \times 4 \text{ mole}$$

$$\text{Weight of HCl} = \frac{69.6}{87} \times 4 \times 35.5 = 116 \text{ gm}$$



4.32 gm      5.76 gm      6.82 gm

0.054 mole      0.48 mole      0.0960 mole

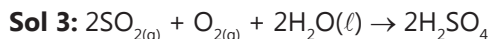


L. R. =  $\text{Cl}_2$

So  $\text{TiCl}_4$  mole produced

$$= \frac{1}{2} \times 0.0960 = 0.048 \text{ mole}$$

$$\text{Weight of TiCl}_4 \text{ produced} = 0.048 \times 190 = 9.12 \text{ gm}$$



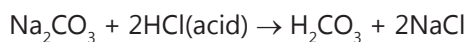
5.6 moles      4.8 moles

L. R. =  $\text{SO}_2$

So  $\text{H}_2\text{SO}_4$  mole obtained in maximum = 5.6 mole



Pure  $\text{Na}_2\text{CO}_3 = (0.95)x \text{ gm}$



$$\text{Mole of acid} = (45.6 \text{ mL}) \times (0.235) = 10.716 \text{ m mole}$$

$$\text{Moles of Na}_2\text{CO}_3 \text{ required} = 5.358 \text{ m mole}$$

$$\text{Weight of Na}_2\text{CO}_3 \text{ required} = (0.95) \times 5.358 (106) \times 10^{-3} \\ x = 0.597 \text{ gm}$$

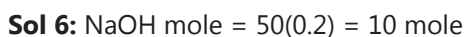


$$\text{Molecular weight of BaCl}_2 \cdot 2\text{H}_2\text{O} = 208 + 36 = 244$$

$$\text{BaCl}_2 = 6 \text{ gm}$$

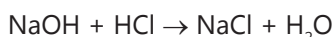
$$\text{BaCl}_2 \cdot 2\text{H}_2\text{O} = 6 \times \frac{244}{208} = 7.038 \text{ gm}$$

$$\text{H}_2\text{O} = 42.962 \text{ gm.}$$

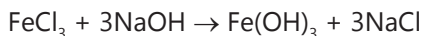


$$\text{HCl mole} = 5 \text{ mole}$$

$$\text{FeCl}_3 \text{ mole} = 1.5 \text{ mole (acidic)}$$



After this reaction  $\text{NaOH}$  left = 5 mole



1.5

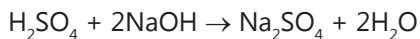
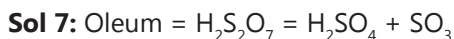
After this reaction  $\text{NaOH}$  left =  $5 - (1.5)3 = 0.5 \text{ mole}$

Volume after reaction =  $15 + 5 + 50 = 70 \text{ litre}$

$$\text{Normality} = \frac{0.5}{70} = 7.142 \times 10^{-3} \text{ N}$$



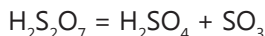
$$\text{Weight of Fe}_2\text{O}_3 = \frac{1.5}{2} \times 160 = 120 \text{ gm}$$



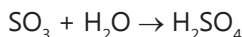
$$\text{Mole of NaOH} = (26.7) \times (0.4) \text{ m mole} = 10.68 \text{ m mole}$$

$$\text{Mole of H}_2\text{SO}_4 = 5.34 \text{ m mole}$$

$$\text{Weight of H}_2\text{SO}_4 = 0.523 \text{ gm}$$



x gram      (0.5 - x) gm



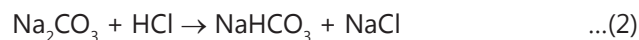
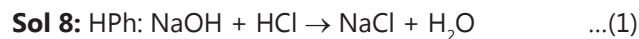
$$= \frac{(0.5 - x)}{80} \times 98 \text{ gm}$$

$$\text{Total H}_2\text{SO}_4 = x + \frac{(0.5 - x)98}{80} \times 0.523$$

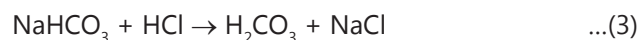
$$x = \frac{0.0895}{0.225} \sim 0.3977 \text{ gm}$$



$$\% \text{SO}_3 = \frac{0.5 - 0.3977}{0.5} \sim 20.4\%$$



**after MeOH:**



Mole of HCl (when HPh) = 1.75 m mole

Mole of HCl (when MeOH) = 0.25 m mole (extra added)

Amount of  $\text{NaHCO}_3$  = 0.25 m mole

Amount of HCl required in (2) and (3)

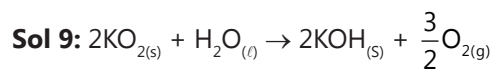
$$= (0.25)_2 = 0.5 \text{ m mole}$$

Amount of  $\text{Na}_2\text{CO}_3$  = 0.25 m mole

Amount of NaOH = 1.75 - (0.25) = 1.5 m mole

NaOH (in gram) =  $1.5 \times 10^{-3} \times 40 = 0.06 \text{ gm per } 200 \text{ mL}$

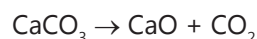
$\text{Na}_2\text{CO}_3$  (in gram) =  $0.25 \times 10^{-3} \times 106$   
= 0.0265 gm/200 mL



0.158 mole                      0.1 mole

L. R =  $\text{KO}_2$

Moles of  $\text{O}_2$  formed =  $\frac{3}{4} \times 0.158 = 0.1185$



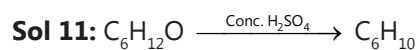
0.959 gm

Moles of CaO = 0.017125 mole

Moles of  $\text{CaCl}_2$  = 0.017125 mole

Mass of  $\text{CaCl}_2$  = (0.017125)  $\times$  111  
= 1.9 gm

$\%$  of  $\text{CaCl}_2$  =  $\frac{1.9}{4.22} = 45\%$



100 gm

Moles of cyclohexanol =  $\frac{100}{100} = 1 \text{ mole}$

Mole of cyclohexene = 0.75 mole

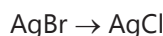
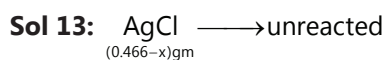
Mass of cyclohexene = (0.75)  $\times$  89 = 66.75 gm



Pure NaCl mole =  $\frac{(0.95)250}{23 + 35.5} = 4.059 \text{ mole}$

Pure  $\text{Na}_2\text{SO}_4$  =  $\frac{4.059}{2} \times (46 + 96) = 288.24 \text{ gm}$

$\text{Na}_2\text{SO}_4$  (90% pure) =  $\frac{288.24 \times 100}{90} = 320.27 \text{ gm}$



x gm

$\text{AgCl}$  formed =  $\frac{x}{188} \times (1435) \text{ gm} = 0.763 x$

Total weight after reaction = 0.4066 - x + 0.763 x

Weight lost = (1 - 0.763)x = 0.0725

$$x = 0.306 \text{ gm} = 30.6\%$$

Weight of Cl in initial mixture

$$= (0.4066 - 0.306) \times \frac{35.5}{143.5} = 0.0248 \text{ gm}$$

$\%$  of Cl =  $\frac{0.0248}{0.4066} = 6.1\%$



0.5 gm

Moles of  $\text{CaCO}_3$  = moles of  $\text{H}_2\text{SO}_4$

required =  $\frac{0.5}{63.5 + 60} = 4.048 \times 10^{-3} \text{ mole}$

m litre of 0.5M  $\text{H}_2\text{SO}_4$  required  $\frac{4.048}{0.5} = \text{mL} = 8.096 \text{ mL}$



Moles of NaOH =  $15 \times \frac{1}{10} = 1.5 \text{ m mole}$

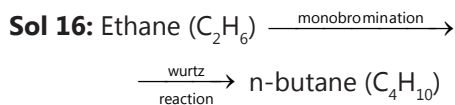
Moles of  $\text{H}_2\text{SO}_4$  required =  $\frac{1.5}{2} = 0.75 \text{ m mole}$

In 12 mL, mole of  $\text{H}_2\text{SO}_4$  = 0.75 m mole

In 1 L, mole of  $\text{H}_2\text{SO}_4$  =  $\frac{0.75}{12} \text{ mole}$

In 1 L, weight of  $\text{H}_2\text{SO}_4$  required

$$= \frac{0.75}{12} \times 98 \text{ gram} = 6.125 \text{ gm/L}$$



XV

Let's say volume of ethane =  $x$  l

$$\text{Weight of } C_4H_{10} = \frac{x}{2 \times 22.4} \times \frac{90}{100} \times \frac{85}{100} \times 58 = 55.53 \text{ l}$$

$$x = 55.53 \text{ l}$$

**Sol 17:** Mole of HCl =  $30 \times 0.25$  m mole = 7.5 m mole

let's say  $x$  fraction is  $K_2CO_3$  so

$$\frac{7.5}{2} \times 10^{-3} = \frac{x(0.5)}{138} + \frac{(1-x)(0.5)}{74}$$

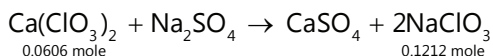
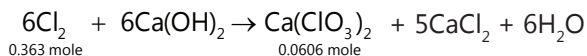
$$x \sim 96\%$$

**Sol 18:** Mass of solution of HCl

$$= 100 \times 1.18 \text{ gm} = 118 \text{ gm}$$

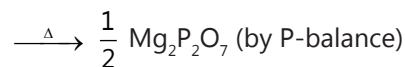
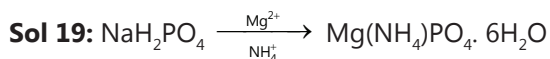
$$\text{Mass of HCl in solution} = (0.36) (118) = 42.48 \text{ gm}$$

$$n_{\text{HCl}} = \text{mole of HCl} = \frac{42.48}{365} = 1.163 \text{ mole}$$



Mass prepared of  $NaClO_3$

$$= 0.1212 \times \text{molecular weight} = 12.911 \text{ gm}$$



$$\text{Mole of } Mg_2P_2O_7 = \frac{1.054}{224} = 4.747 \times 10^{-3}$$

$$\text{Weight of } NaH_2PO_4 = 2 \times 4.747 \times 10^{-3} \times 119.98$$

$$\text{(Molecular weight)} = 1.139 \text{ gm}$$

**Sol 20:** Moles of  $HNO_3$  =  $8 \times 5$  m mole = 40 m mole

$$\text{Mole of HCl} = 4.8 \times 5 \text{ m mole} = 24 \text{ m mole}$$

Let's say volume of  $H_2SO_4$  is  $V$  mL

So mole of  $H_2SO_4$  =  $17V$  m mole

Moles of  $HNO_3$  in 30 mL (picked up from 2 l sol)

$$= \frac{40}{2000} \times 30 = \frac{120}{200} \text{ m mole}$$

Moles of HCl in 30 mL (picked up from 2 l sol)

$$= \frac{24}{2000} \times 30 = \frac{72}{200} \text{ m mole}$$

Moles of  $H_2SO_4$  is 30 mL (picked up from 2 lt. sol)

$$= \frac{17V}{2000} \times 30 = \frac{51V}{200} \text{ m mole}$$

$$\text{Total moles of } H^+ \text{ from 30 mL solution} = \frac{120}{200} + \frac{72}{200} + \frac{102V}{200}$$

$$= \left( \frac{192 + 102V}{200} \right) \text{ m mole}$$

$$\text{Mole } Na_2CO_3 \cdot 10H_2O = \frac{1}{286} \text{ mole}$$

$$\text{Mole of OH} = \frac{2}{286} \text{ mole (in 100 mL)}$$

$$\text{Mole of OH in 42.9 mL} = \frac{2 \times 0.429}{2.86}$$

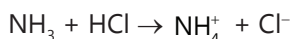
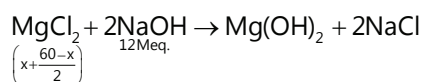
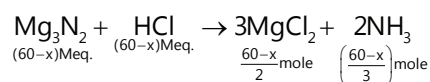
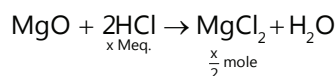
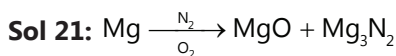
$$= \frac{0.858}{286} = 0.003 \text{ mole}$$

$$10^{-3} \times \left( \frac{192 + 102V}{200} \right) = 0.003 ; V = 4 \text{ mL}$$

$$\text{Amount of sulphate ion in gm} = \frac{51 \times 4}{200} \times (96) \times 10^{-3}$$

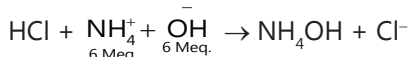
$$= 0.09792 \text{ gm/30 mL}$$

$$= 6.528 \text{ gm/L}$$



initially 10 Meq. x mole

after (10 - x) m mole



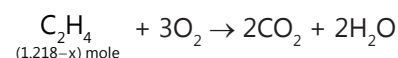
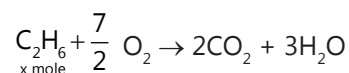
$$\frac{x}{2} + \frac{60-x}{2} = \frac{12}{2}$$

$$x = 27.27\%$$

**Sol 22:**  $PV = n_T RT$

$$(1) (40) = n_T (0.0821) (400)$$

$$n_T = \text{Total mole} = 1.2180$$



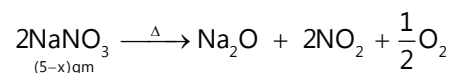
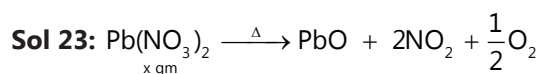
Mole of  $O_2$  required

$$= \frac{7}{2} x + 3(1.218 - x) = \frac{130}{32}$$

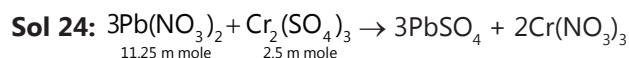
$$x = 0.817 \text{ mole}$$

$$\text{Mole fraction of } C_2H_4 = \frac{1.218 - 0.817}{1.218} = 0.33$$

$$\text{Mole fraction of } C_2H_6 = 0.67$$



$$\left[ \frac{(5-x)}{85} \right] + \frac{1}{4} \left( \frac{5-x}{85} \right) + 2(x)$$



$$L. R. = CrSO_4$$

So moles of  $PbSO_4$  formed

$$= 2.5 \text{ m mole} \times 3$$

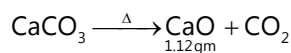
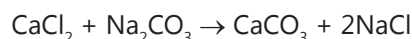
$$= 7.5 \text{ m mole}$$

$$\text{Molar conc. of } [Pb^{2+}] = \frac{11.25 - 7.5}{70} = 0.0536 \text{ M}$$

$$\text{Molar conc. of } [NO_3^-] = \frac{(2 \times 11.25)}{70} = 0.32 \text{ M}$$

$$[Cr^{3+}] = \frac{2 \times 2.5}{70} = 0.0714 \text{ M}$$

**Sol 25:**  $NaCl$



$$\text{Mole of } CaO = \frac{1.12}{56} = 0.02 \text{ mole}$$

$$\text{Moles of } CaCl_2 = 0.02 \text{ mole}$$

$$\text{Weight of } CaCl_2 = 2.22 \text{ gm}$$

$$NaCl = 10 - 2.22 = 7.78 \text{ gm}$$

$$\% NaCl = 77.8\%$$

**Sol 26:** (i)  $Fe_2O_3 + 2Al \rightarrow Al_2O_3 + 2Fe$

(ii) Mole ratio (to complete reaction) = 1 : 2

$$\text{mass ratio} = 1 \times (112 + 48) : (2 \times 27) = 80 : 27$$

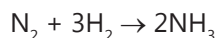
$$(iii) 2.7 \text{ kg of } Al = \frac{2700}{27} \text{ mole} = 100 \text{ mole}$$

$$16 \text{ kg of } Fe_2O_3 = \frac{16000}{160} \text{ mole} = 100 \text{ mole}$$

L. R. = Al

$$\text{So energy released} = 200 \times \frac{100}{2} = 10000 \text{ unit}$$

**Sol 27:**  $N_2 : H_2$  (mole) = 1 : 3



Initially 1      3a

after 1-x    3-3x    2x

P(Molecular weight) = SRT

$$1(M.W.) = (0.497) \times (0.0821) (298)$$

Molecular weight = 12.15 gm

$$\frac{(2x)(17) + (3-3x)2 + (1-x)28}{4-2x} = 12.15$$

$$34x + 6 - 6x + 28 - 28x = 48.63 - 24.31x$$

$$24.31x = 14.63$$

$$x = 0.602$$

% composition by volume

$$N_2 = \frac{1 - 0.602}{4 - 2(0.602)} = \frac{0.398}{2.795} = 14.21\%$$

$$H_2 = 3(N_2\%) = 42.86\%$$

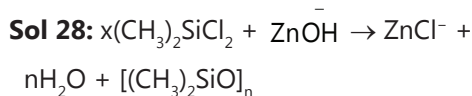
$$NH_3 = \frac{2(0.602)}{2.795} = 42.86\%$$

We know average molecular weight = 12.15

$$\text{So } (1) (12.15)$$

$$= \frac{\text{Mass}}{22.4} \times (0.0821) \times (273)$$

$$\text{Mass} = 12.14 \text{ gm.}$$



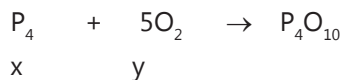
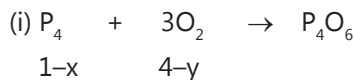
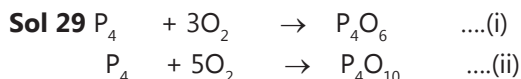
$$\text{Volume of film} = 6 \times 10^{-10} \times 300 \times 1 \times 3 \text{ m}^3$$

$$= 54 \times 10^{-8} \text{ m}^3 = 0.54 \text{ cm}^3$$

$$\text{Mass of the film} = 0.54 \text{ gm}$$

$$\text{Mole of } [(\text{CH}_3)_2\text{SiO}]_n = \frac{0.54}{n[30 + 28 + 16]}$$

$$\text{Mass of } [(\text{CH}_3)_2\text{SiCl}_2] = \frac{0.54}{71} \times (58 + 71) = 0.941 \text{ gm.}$$



$$5x = y$$

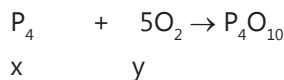
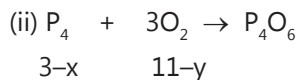
$$3(1-x) = 4-y$$

$$3-3x = 4-5x$$

$$x = \frac{1}{2}$$

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

$$\text{P}_4\text{O}_6 = \text{P}_4\text{O}_{10} = 50\%$$



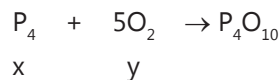
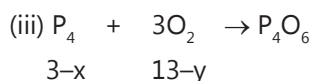
$$5x = y$$

$$3(3-x) = 11-y$$

$$9-3x = 11-5x$$

$$x = 1$$

$$\text{P}_4\text{O}_{10} = \frac{1}{3}; \quad \text{P}_4\text{O}_6 = \frac{2}{3}$$



$$x \quad y$$

$$5x = y$$

$$3(3-x) = 13-y$$

$$9-3x = 13-5x$$

$$x = 2$$

$$\text{P}_4\text{O}_6 = 2$$

$$\text{P}_4\text{O}_{10} = 1$$



Let's say V mL must be added

$$\text{Weight of solution} = (1.04 V) \text{ gm}$$

$$\text{Weight of AgNO}_3 = 0.05 \times (1.04 V) \text{ gm}$$

$$\text{Moles of AgNO}_3 = \frac{(0.05)(1.04V)}{173}$$

Minimum moles of  $\text{Cl}^-$  (it will be case of more molecular weight i. e. KCl)

$$= \frac{0.3}{39 + 35.5} = \frac{0.3}{74.5}$$

$$\frac{(0.05)(1.04V)}{173} = \frac{0.3}{74.5}$$

$$V = 13.4 \text{ mL.}$$

**Sol 31:** In 500 mL of NaOH

$$\text{Weight of solution} = 1.8 \times 500 = 900 \text{ gm}$$

$$\text{So, weight of NaOH} = (0.08) (900) = 72 \text{ gm}$$

$$\text{Mole of NaOH} = \frac{72}{40} = 1.8 \text{ mole}$$

$$\text{Moles of H}^+ = 1.8 \text{ mole}$$



$$\text{On C-balance } n_{\text{CO}_2} = n_{\text{NaHCO}_3}$$

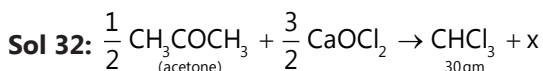
$$\text{Mass of NaHCO}_3 = \frac{18.6}{44} \times (84) = 33.50 \text{ gm}$$

$$\text{H}^+ = 1.8 = \frac{18.6}{44} + 3 \left[ \frac{x}{27 + 3(35.5)} \right] + 0$$

$$1.8 = \frac{x}{44.5} + 0.418 \Rightarrow x = 61.5 \text{ gm} = \text{mass of AlCl}_3$$

$$\text{Mass of KNO}_3 = 124 - 97 = 27 \text{ gm}$$

$$\text{Total mole} = 0.267 + 0.460 + 0.422 = 1.149 \text{ mole}$$



$$\text{Mole of } \text{CHCl}_3 = \frac{30}{119.5}$$

By carbon balance

Mole of acetone (ideally)

$$= \frac{1}{2} \times \frac{30}{119.5}$$

As the yield is 75%

So, weight required

$$= \frac{30}{2 \times 119.5} \times \frac{100}{75} \times (58) = 9.7 \text{ gm}$$

**Sol 33:**  $\text{Cu}_2\text{O} + x$

Let's assume total 100 gm is given

$\text{Cu} = 66.67 \text{ gm}$

$$0 = \frac{66.67}{63.5} \times \frac{1}{2} \times 16$$

Oxygen (O) = 8.4

%  $\text{Cu}_2\text{O} = 66.67 + 8.4 = 75\%$

**Sol 34:**  $\text{Hg} + \text{I}_2 \rightarrow \text{HgI}_2$

$$\left( \frac{M}{200} - x \right) \left( \frac{M}{254} - \frac{x}{2} \right)$$



$$x \text{ mole } \frac{x}{2}$$

Let's say M gm is initially taken

$$\frac{M}{200} - x = \frac{M}{254} - \frac{x}{2}$$

$$M \left( \frac{54}{200} \right) \frac{1}{254} = \frac{x}{2}$$

$$M = \left( \frac{254}{0.54} \right) x$$

$$(\text{gm}) \text{Hg}_2\text{I}_2 = \frac{x}{2} \times (200 + 127) \times 2 = 327x \text{ Hg}_2\text{I}_2(\text{gm})$$

$$= \left( \frac{M}{200} - x \right) = \left[ \frac{254}{(0.54)(200)} - 1 \right]$$

x Molecular weight =  $(1.351 \times 454) \times \text{HgI}_2$

$\text{HgI}_2 : \text{Hg}_2\text{I}_2 = 0.532 : 1$ .

## Redox Reactions

**Sol 1:** (a)  $\text{NaNO}_2$

$$\text{Na}^+ \text{N}^{x+} 2\text{O}_2^- + 1 + x - 4 = 0; x = +3$$

(b)  $\text{H}_2$

$$2x = 0; x = 0$$

(c)  $\text{Cl}_2\text{O}_7$

$$2x - 14 = 0; x = +7$$

(d)  $\text{KCrO}_3\text{Cl}$

$$\text{K}^+ \text{Cr}^{x+} 3\text{O}_2^- \text{Cl}^-; +1 + x - 6 - 1 = 0; x = +6$$

(e)  $\text{BaCl}_2$

$$+x - 2 = 0; x = +2$$

(f)  $\text{ICl}_3$

$$+x - 3 = 0; x = +3$$

(g)  $\text{K}_2\text{Cr}_2\text{O}_7$

$$+2 + 2x - 14 = 0; x = +6$$

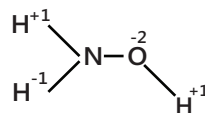
(h)  $\text{CH}_2\text{O}$

$$+x + 2 - 2 = 0; x = 0$$

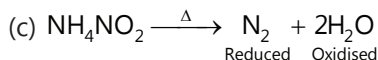
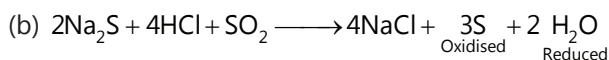
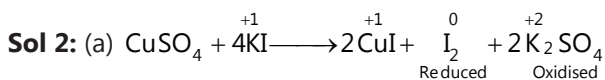
(i)  $\text{Ni}(\text{CO})_4$

$$+x + 0 = 0; x = 0$$

(j)  $\text{NH}_2\text{OH}$



$$+3 + x - 2 = 0; x = -1$$



**Sol 3:** (a)  $3\text{Fe} + 4\text{H}_2\text{O} \longrightarrow \text{Fe}_3\text{O}_4 + 4\text{H}_2 = 8 \text{ electrons}$

(b)  $\text{AlCl}_3 + 3\text{K} \longrightarrow \text{Al} + 3\text{KCl} = 3 \text{ electrons}$

**Sol 4:** (a) Sulphur shows various oxidation states such as  $-2, 0, +2, +4, +6$

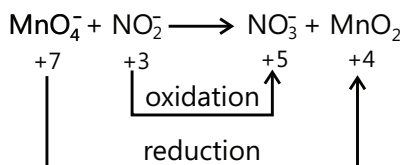
In  $\text{H}_2\text{S}$ , oxidation no. of S is  $-2$ '

So now it can only act as a reducing agent because it can't get more electrons since  $\text{S}^{2-}$  is in its lowest oxidation state.

But in  $\text{SO}_2$ , oxidation state of S is +4 which is an intermediate oxidation state. So, it can gain or lose electrons and can go to -2, 0, +2 or higher +6 oxidation state.

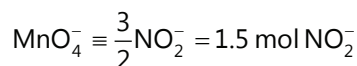
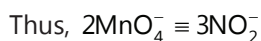
(b) Oxidation state of oxygen in  $\text{H}_2\text{O}_2$  is '-1' so it can get oxidised or reduced because O have multiple oxidation state like -2, -1, 0. By losing electrons it can form  $\text{O}_2$  and act as a reducing agent and by gaining  $e^-$ , it can form  $\text{H}_2\text{O}$  and behave as an oxidising agent.

**Sol 5:**  $\text{NO}_2^-$  is oxidized to  $\text{NO}_3^-$  by  $\text{MnO}_4^-$  (in basic medium) which is reduced to  $\text{MnO}_2$



Thus,  $\text{MnO}_4^- \longrightarrow \text{MnO}_2$  oxidation number decreases by 3-units

$\text{NO}_2^- \longrightarrow \text{NO}_3^-$  oxidation number increases by 2 units



**Sol 6:** (a)  $\text{HSO}_3^-$  (b)  $\text{NO}_2^-$  (c)  $\text{Cl}^-$

**Sol 7:** (a)  $4\text{Zn} + 10\text{HNO}_3 \longrightarrow 4\text{Zn}(\text{NO}_3)_2 + \text{N}_2\text{O} + 5\text{H}_2\text{O}$

(b)  $6\text{HI} + 2\text{HNO}_3 \longrightarrow 3\text{I}_2 + 2\text{NO} + 4\text{H}_2\text{O}$

**Sol 8:** 5 moles of  $\text{H}_2\text{SO}_4$  can produce

1 mole of  $\text{H}_2\text{S}$

$$0.2 \times V \times 10^{-3} = n\text{H}_2\text{SO}_4$$

(equating equivalents)

$\therefore$  Volume = 25 lit.

**Sol 9:**  $\therefore 20 \times 0.2 \times 2 = 0.167 \text{ M}$

$$\text{Normality} = n_f \times M = 0.5 \text{ N}$$

**Sol 10:** mole of  $\text{As}_2\text{O}_3 = 5.54 \times 10^{-4}$

equating equivalents,

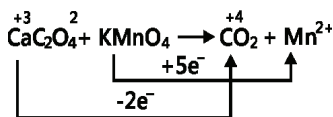
$$(5.54 \times 10^{-4}) \times (2) = (26.1 \times 10^{-3}) \times M \times 5$$

$\therefore$  Molarity =  $8.49 \times 10^{-3}$ ,

Normality = molarity  $\times$  n-factor

$$= (8.49 \times 10^{-3}) \times (5) = 4.24 \times 10^{-2}$$

**Sol 11:**  $\text{CaO} \longrightarrow \text{CaC}_2\text{O}_4$



Equating equivalents

$$(\text{equivalent})_{\text{CaC}_2\text{O}_4} = (\text{equivalent})_{\text{KMnO}_4}$$

$$n_{\text{CaC}_2\text{O}_4} \times 2 = 40 \times 0.25 \times 10^{-3}$$

$$\text{Moles of CaC}_2\text{O}_4 = 5 \times 10^{-3}$$

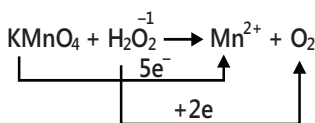
$$\therefore \text{Mole of CaO} = \text{CaC}_2\text{O}_4 = 5 \times 10^{-3}$$

$$\therefore \text{Mass of CaO} = 0.28$$

$\therefore$  % composition

$$= \frac{0.28}{0.518} \times 100 = 54\%$$

**Sol 12:** Reaction



Assume mass of  $\text{H}_2\text{O}_2 = x \text{ gm}$

$\therefore$  Molarity of

$$\text{H}_2\text{O}_2 = \frac{\frac{x}{34} \times 1000}{20} = 147 \times \text{M}$$

$$\text{Moles of KMnO}_4 = \frac{0.316}{158} = 2 \times 10^{-3}$$

Now equating equivalents,

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

$$1.47x \times 20 \times 10^{-3} \times 2 = 2 \times 10^{-3} \times 5$$

$$\therefore x = 0.17 \text{ gm}$$

$$\therefore \text{Purity of H}_2\text{O}_2 = 85\% \quad (\text{i})$$

moles  $\text{O}_2$  evolved = moles of  $\text{H}_2\text{O}_2$  consumed.

$$\therefore \text{Moles of O}_2 = 5 \times 10^{-3}$$

$$\therefore \text{Volume} = \frac{nRT}{P} = 124.8 \text{ ml} \quad (\text{ii})$$

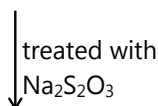
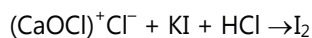
**Sol 13:**  $(\text{CaOCl}) + \text{Cl}^-$  5.7 gm is taken

$\therefore$  Lets take moles of  $\text{CaOCl}_2 = x$

molarity of

$$\text{CaOCl}_2 = \frac{x}{500} \times 1000 = 2x$$

Now on treatment with KI + HCl



$\therefore$  Equivalents of  $\text{I}_2$  = equivalents of  $\text{Na}_2\text{S}_2\text{O}_3$

$$= 24.35 \times \frac{1}{10} \times 10^{-3} = 2.435 \text{ milliequ.}$$

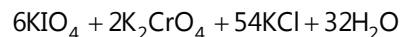
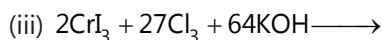
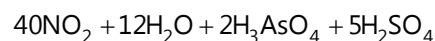
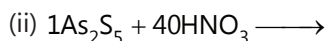
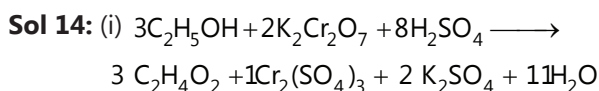
Now, equiv. of  $\text{I}_2$  = equiv. of Bleaching powder

$$2.435 \times 10^{-3} = 2x \times 25 \times 10^{-3}$$

$$\therefore x = 4.87 \times 10^{-2}$$

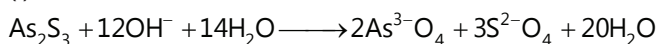
$\therefore$  Mass of bleaching powder = 1.73 gm

$$\therefore \% \text{ availability} = \frac{1.73}{5.7} \times 100 = 30.33\%$$

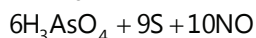
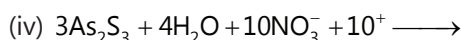
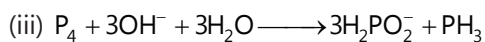
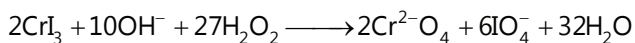


**Sol 15:**

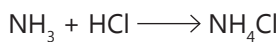
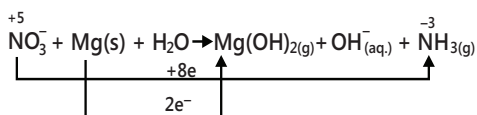
(i)



(ii)



**Sol 16:**



Say molarity of  $\text{NO}_3^-$  ions =  $x$  M

$$\therefore \text{Moles of } \text{NO}_3^- = x \times 25 \times 10^{-3}$$

Equivalents of  $\text{NO}_3^-$

$$= \text{Equivalents of } \text{NH}_3 = 8 \times x + 25 \times 10^{-3} = 0.2x$$

$$\therefore \text{Moles of } \text{NH}_3 = 0.2x$$

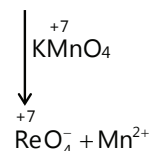
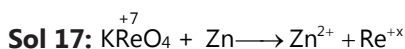
$$\text{Moles of } \text{NaOH} = 32.10 \times 10^{-3} \times 0.1 = 3.21 \times 10^{-3}$$

Now, moles of  $\text{HCl}$  = (moles of  $\text{NH}_3$ ) + (moles of  $\text{NaOH}$ )

$$50 \times 0.15 \times 10^{-3} = 0.2x + 3.21 \times 10^{-3}$$

$$x = 2.145 \times 10^{-2}$$

$$\therefore \text{Molarity} = 8x = 0.1716 \text{ M}$$



$$\therefore \text{Moles of } \text{KReO}_4 = 9.28 \times 10^{-5}$$

$$\therefore \text{Moles of } \text{KMnO}_4 = 0.05 \times 11.45 \times 10^{-3} \times 5$$

Now equating equivalents of

$$\text{Re}^{x+} = \text{KMnO}_4$$

$$(x_{\text{Re}^{x+}})(7-x) = 5.725 \times 10^{-4} \dots\dots (1)$$

Now equating equivalents of

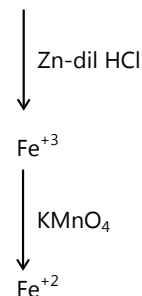
$$\text{KReO}_4 = \text{Re}^{x+}$$

$$9.28 \times 10^{-5} = \text{Re}^{x+} = x_{\text{Re}^{x+}}$$

$$\therefore 7-x = \frac{5.725 \times 10^{-4}}{9.28 \times 10^{-5}}; x = +1$$

**Sol 18:** Let moles of  $\text{FeC}_2\text{O}_4 = x$

$\text{FeSO}_4 = y$



$$\text{Now, } (2x + x + y) 0.1 = 60 \times 0.02 \times 5$$

$$3x + y = 60$$

$$x + y = 40 \times 0.02 \times 5 = 4$$

$$\therefore 4 - x = 6 - 3x$$

$$2x = 2$$

$$x = 1$$

$$y = 3$$

$$\therefore \text{Normality} = 1 \times 3 \times 10^{-2} = 0.03\text{N of FeC}_2\text{O}_4$$

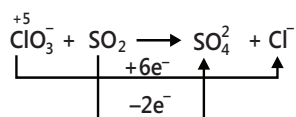
$$= 3 \times 10^{-2} = 0.03 \text{ M of FeSO}_4$$

**Sol 19:** Mass of KCl = x gm

$$\text{H}_2\text{O} = 1 - x - y \text{ gm}$$

$$\text{KClO}_3 = y \text{ gm}$$

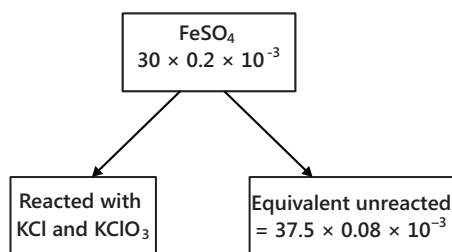
Treating with  $\text{SO}_2$



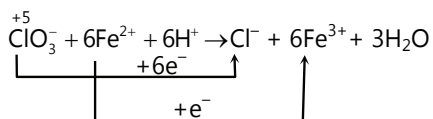
Then silver chloride formed

$$\therefore \text{Total moles of chloride} = 10^{-3} = \frac{x}{74.5} + \frac{y}{122.5}$$

Now for another experiment



$$\therefore \text{Equivalents reacted} = 3 \times 10^{-3}$$



Equivalents of  $\text{Fe}^{2+}$  = Equivalent of  $\text{ClO}_3^-$

$$3 \times 10^{-3}$$

$$= \frac{y}{122.5} \times 10^3 \times 25 \times 10^{-3} \times 6$$

$$y = 0.6125 \text{ gm}$$

$$\text{Moles of ClO}_3^- = 0.005$$

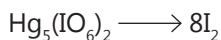
$$\text{Molar ratio} = 1 : 1$$

**Sol 20:** (iii) One mL of  $\text{Na}_2\text{S}_2\text{O}_3$  is equivalent to

$$0.0499 \text{ gm of CuSO}_4$$

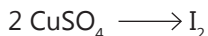
$$0.2 \text{ millimole of CuSO}_4$$

Since reaction is balanced



$$1 \qquad \qquad 8$$

$$5 \times 10^{-4} \qquad 4 \text{ millimole}$$



$$2 \qquad \qquad 1$$

$$0.2 \text{ millimole} \quad 0.1 \text{ millimole}$$

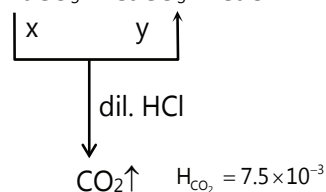
$$\therefore 0.1 \text{ millimole of I}_2 \text{ equivalent to } 0.2 \text{ millimole of CuSO}_4$$

But we have 4 millimole

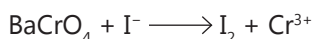
$$\text{So, } 1 \text{ mL} \longrightarrow 0.1 \text{ millimole}$$

$$40 \text{ mL} \longleftarrow 4 \text{ millimole}$$

**Sol 21:**  $\text{BaCO}_3 + \text{CaCO}_3 + \text{CaO}$



$$x + y = 7.5 \times 10^{-3}$$



$$0.1 x$$

Equating equivalents of  $\text{BaCrO}_4 = \text{I}^-$

$$0.1 x - 3 = 20 \times 0.05 \times 10^{-3}$$

$$x = \frac{10^{-2}}{3} = 3.33 \times 10^{-3}$$

$$\therefore y = 4.167 \times 10^{-3}$$

$$\text{Mass of BaCO}_3 = 0.659 \text{ gm}$$

$$\text{CaCO}_3 = 0.4167 \text{ gm}$$

$$\therefore \text{Mass of CaO} = 0.1733$$

$$\% \text{ CaO} = 13.87\%$$

**Sol 22:**  $\text{Cu}_2\text{S} + \text{CuS} + \text{MnO}_4^- \longrightarrow$

$$x \qquad y$$



$$200 \times 0.75 \times 10^{-3} = \frac{175 \times 10^{-3}}{5} + \text{moles of required}$$

$$\therefore \text{Moles required of MnO}_4^- = 0.115$$

$$\text{Let moles of Cu}_2\text{S}^{-2} = x$$

$$\text{CuS} = y$$

$$\therefore 0.115 \times 5 = 8x + 6y$$



Let  $m$  = mass of  $\text{Cu}_2\text{S}$

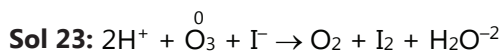
$$8x + 6y = 0.575$$

$$\frac{8m}{159} + \frac{6(10-m)}{95.5} = 0.575$$

$$[(5.03 \times 10^{-2}) - (6.28 \times 10^{-2})] m = -5.327 \times 10^{-2}$$

$$m = 4.26 \text{ gm}$$

$$\% \text{ CuS} = \frac{5.74}{10} \times 100 = 57.4\%$$



$$\begin{array}{l} \text{moles of air} \\ = 0.406 = \frac{PV}{RT} \end{array} \quad \downarrow \text{Na}_2\text{S}_2\text{O}_3$$

$$\text{Equivalents of } \text{I}_2 = 1.5 \times 10^{-3} \times 0.01 = 1.5 \times 10^{-5}$$

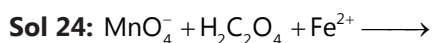
$$\text{Moles of } \text{O}_3 = x$$

$$\therefore x \times 6 = 1.5 \times 10^{-5}$$

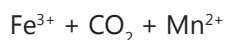
$$x = 2.5 \times 10^{-6}$$

$$\therefore \text{Volume of } \text{O}_3 = 1.847 \times 10^{-4} \text{ lit.}$$

$$\% \text{ O}_3 = 1.847 \times 10^{-3} = \frac{V_{\text{O}_3}}{10} \times 100$$



$$30 \times 1.5 \quad 15 \times 0.5 \quad 15 \times 0.4$$



$$(30 \times 1.5) - (15 \times 0.5 + 15 \times 0.4) = 31.5 \text{ milliequivalents}$$

$$\therefore \text{Final of } \text{MnO}_4^- = \frac{31.5 \times 10^{-3}}{60 \times 10^{-3}} = 0.525 \text{ M}$$

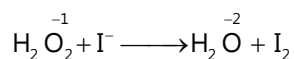
Final molarity of

$$\text{Fe}^{3+} = \frac{15 \times 0.4 \times 10^{-3}}{60 \times 10^{-3}} = 0.1 \text{ M}$$

$$\therefore \text{Final normalities } \text{MnO}_4^- = 0.105 \text{ M}$$

$$\text{Fe}^{3+} = 0.1 \text{ M}$$

**Sol 25:** (i) Equivalents of  $\text{I}^- = 20 \times 0.1 \times 10^{-3}$



$$\therefore \text{Equivalents of } \text{H}_2\text{O}_2 = 2 \times 10^{-3}$$

$$\therefore \text{Moles of } \text{H}_2\text{O}_2 = \frac{2 \times 10^{-3}}{2} = 10^{-3}$$

$$\text{Now, molarity} = \frac{10^{-3}}{25} \times 10^3 = 0.04 \text{ M}$$

$$\therefore \text{Normality} = 0.04 \times 2 = 0.08 \text{ N}$$

$$\text{(ii) } 20 \times 0.3 \times 10^{-3} = \text{equivalent of } \text{I}^-$$

$$\therefore \text{Normality of } \text{H}_2\text{O}_2 = \frac{20 \times 0.3 \times 10^{-3}}{25 \times 10^{-3}} = 0.24$$

$$\therefore \text{Strength} = 1.344$$

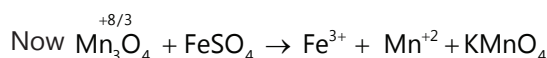
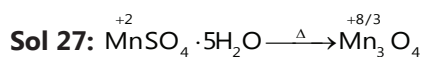
**Sol 26:** Let molarity of  $\text{Na}_2\text{S}_2\text{O}_3$  solution =  $x \text{ M}$

$\therefore$  Equivalent of thiosulphate

$$= \text{Eq. of } \text{I}^- = \text{Eq. of } \text{I}_2 = x \times 45 \times 10^{-3}$$

$$\frac{0.1}{214} \times 5 = x \times 45 \times 10^{-3}$$

$$x = 0.062 \text{ M}$$



Let assume no. of moles of

$$\text{MnSO}_4 \cdot 5\text{H}_2\text{O} = x$$

$$\therefore \text{Moles of } \text{Mn}_3\text{O}_4 = 3x$$

$$3x(6) + 100 \times 0.1 \times 10^{-3} = 0.12 \times 100 \times 10^{-3}$$

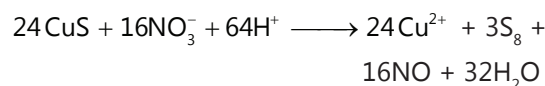
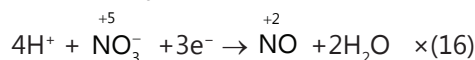
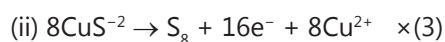
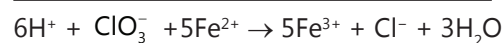
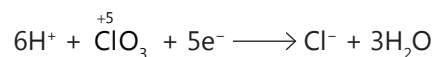
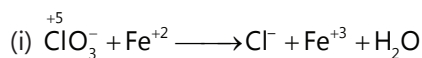
$$25 \times N = 30 \times 0.1$$

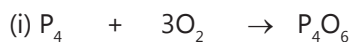
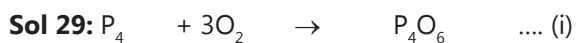
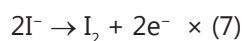
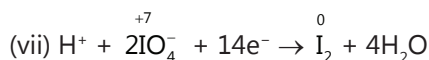
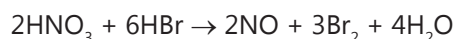
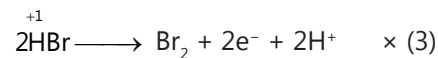
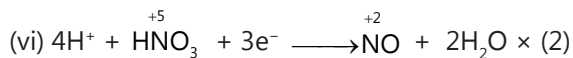
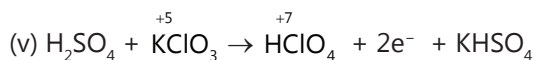
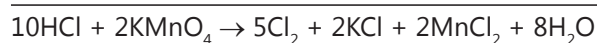
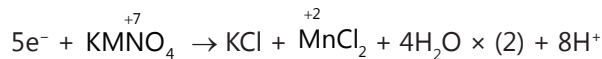
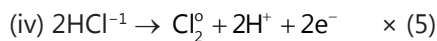
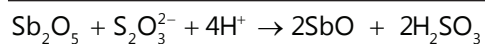
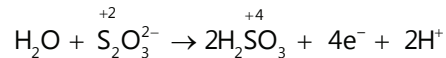
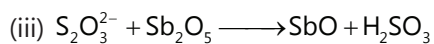
$$N = 0.12$$

$$\therefore x = 1.11 \times 10^{-4}$$

$$\therefore \text{Mass of } \text{MnSO}_4 \cdot 4\text{H}_2\text{O} = 1.338 \text{ gm.}$$

**Sol 28:**





$$5x = y$$

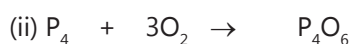
$$3(1-x) = 4-y$$

$$3-3x = 4-5x$$

$$x = \frac{1}{2}$$

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

$$P_4O_6 = P_4O_{10} = 50\%$$



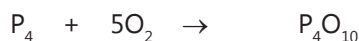
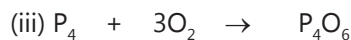
$$5x = y$$

$$3(3-x) = 11-y$$

$$9-3x = 11-5x$$

$$x = 1$$

$$P_4O_{10} = \frac{1}{3}; \quad P_4O_6 = \frac{2}{3}$$



$$5x = y$$

$$3(3-x) = 13-y$$

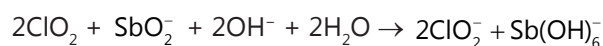
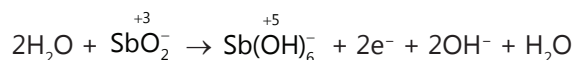
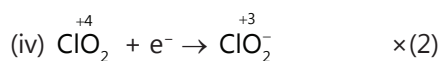
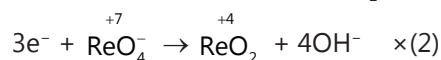
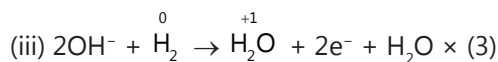
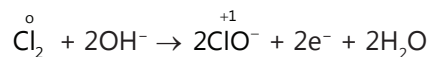
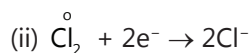
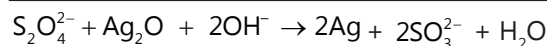
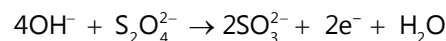
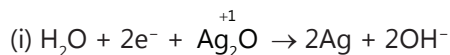
$$9-3x = 13-5x$$

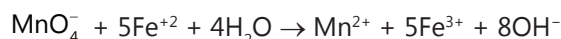
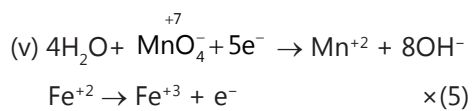
$$x = 2$$

$$P_4O_6 = 2$$

$$P_4O_{10} = 1$$

### Sol 30:

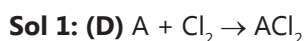




## Exercise 2

### Mole Concept

#### Single Correct Choice Type

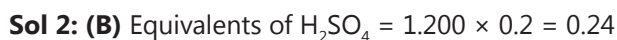


$$\frac{x}{M} = \frac{y}{71+M}$$

$$\frac{x}{M} = \frac{y}{71+M}$$

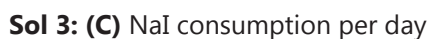
$$71x + Mx = My$$

$$M = \frac{71x}{x-y}$$



$$\text{Moles of } \text{H}_2\text{SO}_4 = 0.12$$

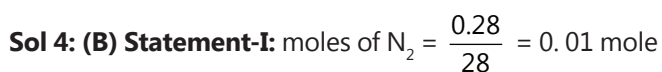
$$\text{Mass of } \text{H}_2\text{SO}_4 = 0.12 \times 98 = 11.76 \text{ gm}$$



$$= \frac{0.5}{100} \times 3 \text{ gm} = 0.015 \text{ gm}$$

$$\text{Number of } \text{I}^- = \frac{0.015}{127+23} \times 6.023 \times 10^{23} = 6.023 \times 10^{19}$$

#### Assertion Reasoning Type



$$PV = nRT$$

At same P and T,  $V \propto n$

If M. W. = 44 gm of gas

$$n = 0.01 \text{ mole}$$

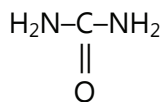
$$V \propto n$$

So, volume will be same as moles are also same.



$$M_{\text{avg.}} = x(M_1) + (1-x)M_2$$

So, statement-II is explaining statement-I and both are correct.



Mass of nitrogen = 28

$$\% = \frac{28}{60} = 46.66$$

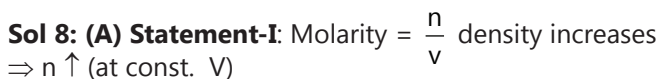
**Statement-II:** Urea not ionic.



$$2x + 3(-2) = -2$$

$$x = +2$$

**Statement:** Yes, Because these may be per-oxide bond.

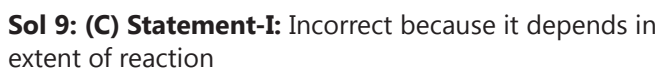


$$= \text{molality} = \frac{\text{moles of solute}}{\text{mass of solvent}}$$

Density increases = moles of solute  $\uparrow$

Molality and molarity both changes.

**Statement-II:** Density results in change in mass thus increases moles.



**Statement-II:** Correct.

#### Multiple Correct Choice Type



by nitrogen balance

$$n_{\text{HNO}_3} = \frac{1}{2} n_{\text{NH}_3}$$



Let's say 1 mole of  $\text{NH}_3$  is initially taken.

It makes  $\frac{1}{2} - \frac{1}{2}$  mole of  $\text{HNO}_2$  and  $\text{HNO}_3$  till

reaction-III  $\frac{1}{2}$  mole  $\text{HNO}_2$  make  $\frac{1}{6}$  mole of  $\text{HNO}_3$  in  
 reaction-IV so  $\text{HNO}_3$  made

$$= \frac{1}{2} + \frac{1}{6} \text{ mole} = \frac{2}{3} \text{ mole}$$

$$\% \text{ increase} = \frac{\frac{1}{6}}{\frac{1}{2}} = \frac{100}{3}\%$$

(C) By above data, it is correct

$$(D) \text{ Mole of NO produced} = \frac{1}{2} \times \frac{2}{3} = 50\% \text{ of } \text{HNO}_3$$

### Comprehension Type

#### Paragraph 1

**Sol 11: (A)** Initially mole of  $\text{HCl} = \frac{1}{2}$  mole

$$= \frac{1}{2} \times 36.5 \text{ gm} = 18.25 \text{ gm}$$

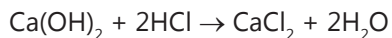
So, after heating mole of  $\text{HCl}$

$$= \frac{18.25 - 2.75}{36.5} = \frac{15.5}{36.5} = 0.424 \text{ mole}$$

$$\text{Normality} = \frac{0.424}{0.750} = 0.5662 \sim 0.58$$

**Sol 12: (C)** Please note that, there is a small typo in questions,

Instead of  $\text{Ca(OH)}$ , it should be  $\text{Ca(OH)}_2$



Moles of  $\text{HCl} = 0.1 \times 10 = 1 \text{m mole}$

Moles of  $\text{Ca(OH)}_2$  required = 0.5 m mole

$$\text{Volume} = \frac{0.5}{0.1} \text{ mL} = 5 \text{ mL}$$

**Sol 13: (A)** We know valency factor for  $\text{Na}_2\text{CO}_3$  is 2

$$\text{So, molarity will be} = \frac{0.5}{2} = 0.25 \text{M}$$

**Sol 14: (A)** 6.90 N means in 1 lit. solution

$\text{KOH} = 6.90 \text{ moles}$

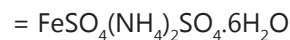
Weight of  $\text{KOH} = 6.90 \times (56) = 386.4 \text{ gm}$

given 30% by weight is  $\text{KOH}$

So, weight of solution = 12.88 gm

$$\text{Density} = \frac{12.88}{1} = 12.88$$

**Sol 15: (C)** Ferrous ammonium sulphate



Molecular weight = 390

$$\text{Moles in 0.1 N, 250 mL} = \frac{(0.1)(0.250)}{\text{Valency factor}}$$

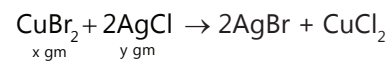
$\text{Fe}^{2+} \rightarrow \text{Fe}^{3+}$  Valency factor = 1

Mass of ferrous ammonium sulphate required

$$= (0.1)(0.250)(390) = 9.8 \text{ gm}$$

#### Paragraph 2

**Sol 16:**  $\text{CuCl}_2 + \text{AgCl} \rightarrow \text{unreacted}$   
(4.925-x)gm (5.74-y)gm



Let's say initially  $\text{CuBr}_2 = x \text{ gm}$

$$\text{CuCl}_2 = 4.925 - x \text{ gm}$$

$\text{AgCl} = y \text{ gram}$  (reacts with reacted)

$\text{AgCl} = 5.74 - y \text{ gram}$  (in reacted)

Finally same  $\text{AgCl} \rightarrow \text{AgBr}$  and  $\text{CuBr}_2$

$\rightarrow \text{CuCl}_2$  (completely)

$$\text{Moles of } \text{AgCl} \text{ in reaction} = \frac{y}{143.5}$$

$$= \text{Mole of } \text{AgBr} \text{ produced}$$

Finally  $\text{AgCl} = (5.74 - y) \text{ gm}$

$$\text{AgBr} = \frac{y}{143.5} \times (80 + 108) = y(1.310)$$

$$\text{AgCl} + \text{AgBr} = 6.63 = 5.74 + y(0.310)$$

$$y = 2.87 \text{ gm}$$

$$\text{So moles of } \text{CuBr}_2 = \frac{2.87}{2 \times 143.5} = \frac{x}{223.5}$$

$$x = 2.235 \text{ gm}$$

$$(1) \text{ (C) } \text{CuBr}_2 \text{ mass \%} = \frac{2.235}{4.925} = 45.38\%$$

(2) **(B)** % mass of  $\text{Cu} =$

$$\left[ \left( \frac{2.235}{223.5} \right) + \left( \frac{4.925 - 2.235}{63.5 + 71} \right) \right] \times \frac{63.5}{4.925}$$

$$= \frac{0.03 \times 63.5}{4.925} = 38.68\%$$

(3) **(B)** Mole % of AgBr =

$$\frac{\left(\frac{2.87}{143.5}\right)}{\left(\frac{2.87}{143.5}\right) + \left(\frac{9.74 - 2.87}{143.5}\right)} = 50\%$$

(4) **(A)** Moles of CuBr<sub>2</sub> = Moles of CuCl<sub>2</sub> produced

= 0.01 mole

Moles of CuCl<sub>2</sub> initially take

$$= \frac{4.925 - 2.235}{134.5} = 0.02 \text{ mole}$$

Mole of Cl<sup>-</sup> in final solution = (0.01 + 0.02) × 2 = 0.06

### Paragraph 3

**Sol 17:** UF<sub>6</sub> + xH<sub>2</sub>O → UO<sub>x</sub>F<sub>y</sub> + gas (F<sub>6-y</sub>, H<sub>2x</sub>)

3.52 gm      3.08 gm      0.8 gm

0.01 mole

Gas contains 95% fluorine by mass

$$= 0.8 \times \frac{95}{100} = (6 - y) \times 19$$

y = 5.96

$$0.8 \times \frac{5}{100} = (2x)$$

x = 0.02

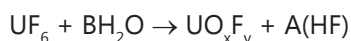
(1) **(C)** So empirical formula F<sub>6-5.96</sub> H<sub>2(0.02)</sub>

$$= F_{0.04} H_{0.04}$$

$$= HF$$

(2) **(A)** Empirical formula of solid = UO<sub>x</sub>F<sub>y</sub>

final reaction



0.01              0.01

A = 2B (H-balance)

6 = Y + A (F - balance)

B = X =  $\frac{A}{2}$  (O - balance)

Y = 6 - A

UO <sub>$\frac{A}{2}$</sub> F<sub>6-A</sub> molecular weight =  $\frac{3.08}{0.01} = 308 \text{ gm}$

$$238 + \frac{A}{2} (16) + (6 - A) \times 19 = 308$$

$$8A + 114 - 19A = 70$$

$$11A = 44$$

$$A = 4$$

So UO<sub>2</sub>F<sub>2</sub>

(3) **(A)** % of F converted =  $\frac{A}{6} = 66.66\%$

### Match the Columns

**Sol 18:** A → r; B → p; C → q

$\frac{1}{3}$  Al<sub>2</sub>O<sub>3</sub> molecular weight = 267 + 135 + 196 = 598

(A) Y =  $\frac{267}{598} = 44.95\%$

(B) Al =  $\frac{135}{598} = 22.57\%$

(C) O =  $\frac{196}{598} = 32.32\%$

**Sol 19:** A → r; B → q; C → p

C<sub>6</sub>H<sub>8</sub>O<sub>6</sub> molecular weight = 72 + 8 + 96 = 176

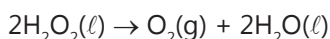
Moles of C<sub>6</sub>H<sub>8</sub>O<sub>6</sub> =  $\frac{17.6 \text{ mg}}{176} = 0.1 \text{ m mole}$

(A) O - atom = 6 × n<sub>C<sub>6</sub>H<sub>8</sub>O<sub>6</sub></sub> × N<sub>A</sub> = 3.6 × 10<sup>20</sup>

(B) Mole =  $\frac{1}{176} = 5.68 \times 10^{-3}$

(C) Moles of C<sub>6</sub>H<sub>8</sub>O<sub>6</sub> = 0.1 m mole

**Sol 20: (C)** Volume strength



1 lt. of H<sub>2</sub>O<sub>2</sub> gives x lt. of O<sub>2</sub> gas then X is said to be volume strength of H<sub>2</sub>O<sub>2</sub>

It X - V is given at S. T. P. then

$$\text{Mole of } O_2 \text{ produced} = \frac{x}{22.4}$$

Mole of H<sub>2</sub>O<sub>2</sub> required =  $\frac{x}{11.2}$  (in litre)

$$\text{Molarity} = \frac{x}{11.2}$$

$$\text{Normality} = \frac{x}{11.2} \times (\text{valency factor}) = \frac{x}{5.6}$$

$$\text{Strength in g/L} = \frac{x}{11.2} \times 34 = \frac{17x}{5.6}$$

Volume strength = Normality × 5.6

**Sol 21: (B)** (A) acid + acid  $\rightarrow$  No reaction

$$M_{\text{avg.}} = \frac{M_1 V_1 - M_2 V_2}{V_1 + V_2} = \frac{\text{Total no. of moles}}{\text{Total volume}}$$

Similarly (B)

(C) acid + basic  $\rightarrow$

$$M_{\text{avg.}} = \frac{M_1 V_1 - M_2 V_2}{V_1 + V_2}$$

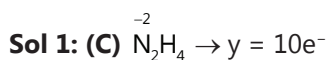
(D) Mili equivalent =  $x \times M \times \text{V mL}$

$$(E) \text{ Molarity} = \frac{\text{moles}}{\text{volume}} = \frac{M_1 V_1}{\text{Volume}} = \frac{M_1 V_1}{V_2}$$

$$\text{or} = \frac{\text{moles}}{\text{volume}} = \frac{\text{mass (gm)}}{M_{\text{solute}} \times \text{Volume (lt.)}}$$

## Redox Reactions

### Single Correct Choice Type

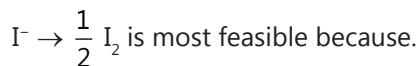


Each nitrogen loses  $5e^-$

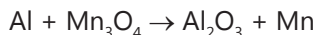
$\therefore$  Oxidation no. of N in

$$y = -2 + 5 = +3$$

**Sol 2: (D)** The ore which gets easily oxidised is best reducing agent



**Sol 3: (C)** Alumino thermite process :-



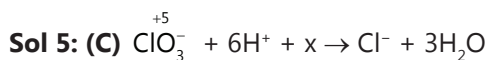
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Reducing agent

**Sol 4: (D)** (a) Oxidation number of S in  $\text{H}_2\text{S} = +2$

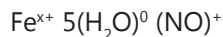
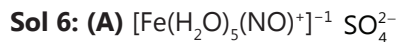
Oxidation number of S in  $\text{SO}_2 = +4$

(b)  $\text{H}_2\text{O}_2$  can undergo reduction as well as oxidation because oxidation number of oxygen in  $\text{H}_2\text{O}_2$  is  $-1$ . So, it can act both as reducing agent and oxidising agent.

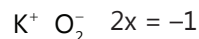
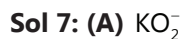


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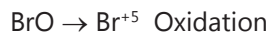
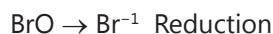
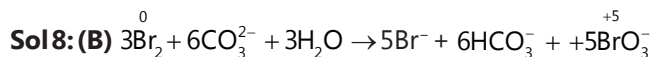
$$6e^- + 5 \rightarrow -1$$



$$x + 1 = +2; x = +1$$

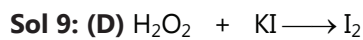


$$\therefore x = -\frac{1}{2}$$



## Comprehension Type

### Paragraph 1



( $\times 5$ )



hypo

**Sol 10: (D)** Eq. of hypo solution eq. of  $\text{I}_2$

$$20 \times 0.1 \times 10^{-3} = 50 \times 10^{-3} \times N_{\text{H}_2\text{O}_2}$$

$$\therefore N_{\text{H}_2\text{O}_2} = 0.04$$

$\therefore$  Concentration of  $\text{H}_2\text{O}_2$

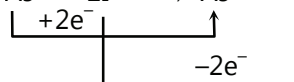
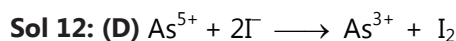
$$\text{in gm/lit.} = \frac{0.04}{4} \times 34 = 0.34$$

**Sol 11: (D)**  $\therefore$  Eq. of  $\text{MnO}_2$  + Eq. of hypo solution

$$\frac{m}{87} \times 2 = 30 \times 0.1 \times 10^{-3}$$

$$m = 0.1305$$

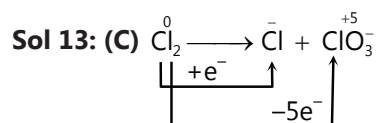
$$\therefore \% = \frac{0.1305}{0.5} \times 100 = 26.1\%$$



$\therefore$  Valence factor = 5 for As

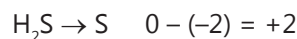
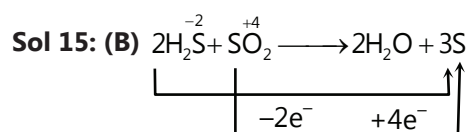
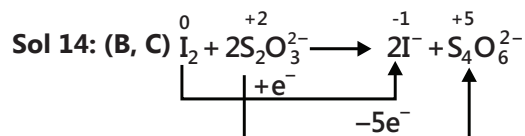
2 for I

## Paragraph 2



Disproportionation

(oxidation as well as reduction)



## Multiple Correct Choice Type

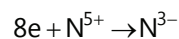
**Sol 16: (A, B, D)** Meq. of  $\text{NH}_3$  formed = Meq. of HCl used for  $\text{NH}_3$

$$= 50 \times 0.15 - 32.10 \times 0.10$$

$$= 4.29$$

These Meq. of  $\text{NH}_3$  are derived using valence factor of  $\text{NH}_3 = 1$  (an acid base reaction)

In redox change valence factor of  $\text{NH}_3$  is 8;



$\therefore$  Meq. of  $\text{NH}_3$  for valence factor

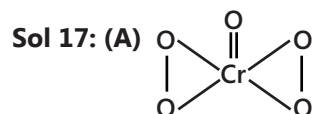
Also, Meq. of  $\text{NO}_3^- = \text{Meq. of } \text{NH}_3$

$$= 8 \times 4.29 = 34.32$$

$$\therefore N_{\text{NO}_3^-} = \frac{34.32}{25} = 1.37$$

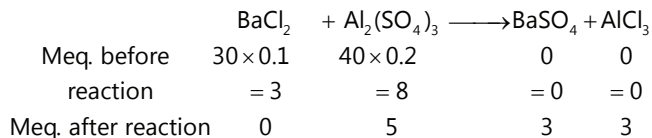
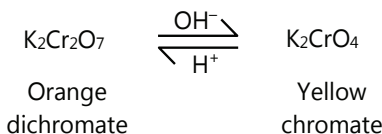
( $N \times V$  in mL = Meq.)

## Assertion Reasoning Type



Valency of Cr is 6 all O have higher electronegativity than Cr

$\therefore$  Cr's oxidation no. = +6



**Sol 18: (D)** Avg. oxidation no. of  $\text{Pb}_3\text{O}_4$  is  $+\frac{8}{3}$ . But in reality,  $\text{Pb}_3\text{O}_4$  is made up of  $\text{PbO} + \text{PbO}_2$ . So, actively, Pb have oxidation state +2, +4.

**Sol 19: (C)** Oxidation no. of Cl = +7 it can not be greater than this

$\therefore$  It can get only reduced

$\therefore$   $\text{HClO}_4$  is an oxidising agent

$\therefore$  In  $\text{HClO}_3$ , oxidation no. of chlorine = +5

E. N. order  $\text{O} > \text{Cl} > \text{H}$

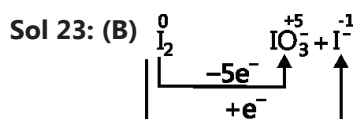
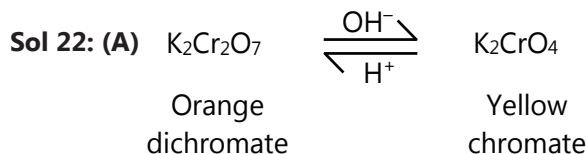
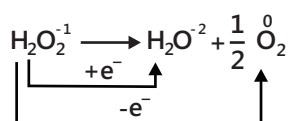
**Sol 20: (D)** Since  $\text{S}_2^{2-}$  has S – S linkage structure

$\therefore \text{FeS}_2^{2-} \rightarrow \text{Fe}^{2+}$  (S – S) oxidation no. = +2

**Sol 21: (B)** Yes, the given reaction is an example of disproportionation

$\therefore \text{H}_2\text{O}_2$  is a reducing as well as an oxidising agent

So it is not only bleaching (oxidising agent)



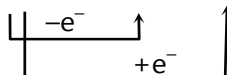
These reactions show  $E^\circ > 0$

∴ It is not feasible because iodine can show multiple oxidation state.

### Match the Columns

**Sol 24:** A → w; B → x; C → u; D → p; E → v; F → q; G → r; H → s; I → t

- (1) Increase in oxidation no:- Loss of electrons (oxidation)
- (2) Decrease in oxidation no:- Gain of only e<sup>-</sup>s (reduction)
- (3) Oxidation agent:- Gain of e<sup>-</sup>s
- (4) Reducing agent:- Loss of e<sup>-</sup>s
- (5)  $2\text{Cu}^+ \longrightarrow \text{Cu}^{2+} + \text{Cu}$



Disproportionation reaction

- (6) Redox reaction
- (7)  $\text{Mn}_3\text{O}_4$  oxidation no:-

$$+\frac{8}{3} \text{ fractional}$$

(8)  $\text{CH}_2\text{Cl}_2$

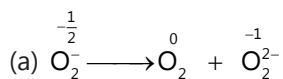
$$x + 2 - 2 = 0 \quad \text{zero oxidation no.}$$

$$x = 0$$

(9)  $\text{NaOH} + \text{HCl} \rightarrow \text{NaCl} + \text{H}_2\text{O}$

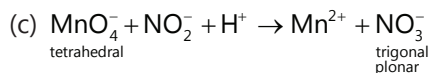
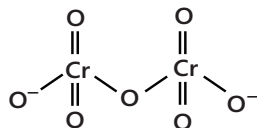
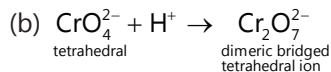
Simple neutralisation reaction

**Sol 25:** A → p, s; B → r; C → p, q; D → p

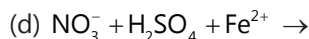
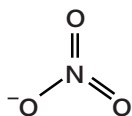


Disproportionation

Redox reaction



Redox Reaction



Redox reaction

## Previous Years' Questions

### Mole Concept

**Sol 1:** Average atomic weight

$$= \frac{\text{Percentage of an isotope} \times \text{atomic weight}}{100}$$

$$\Rightarrow 10.81 = \frac{10.01x + 11.01(100 - x)}{100}$$

$$\Rightarrow x = 20\%$$

Therefore, natural boron contain 20% (10.01) isotope and 80% other isotope.

**Sol 2:** From the vapour density information,

$$\text{Molar mass} = \text{Vapour density} \times 2$$

$$(\because \text{Molar mass of } \text{H}_2 = 2)$$

$$= 38.3 \times 2 = 76.6$$

Now, let us consider 1.0 mole of mixture and it contains x mole of  $\text{N}_2$ .

$$\Rightarrow 46x + 92(1 - x) = 76.6$$

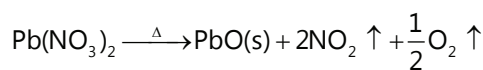
$$\Rightarrow x = 0.3348$$

$$\text{Also, in 100 g mixture, number of moles} = \frac{100}{76.6}$$

$$\Rightarrow \text{Moles of } \text{N}_2 \text{ in mixture}$$

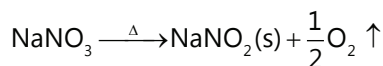
$$= \frac{100}{76.6} \times 0.3348 = 0.437$$

**Sol 3:** Heating below 600°C converts  $\text{Pb}(\text{NO}_3)_2$  into  $\text{PbO}$  but to  $\text{NaNO}_3$  into  $\text{NaNO}_2$  as:



MW. 330

222



MW.85

69

$$\text{Weight loss} = 5 \times \frac{28}{100} = 1.4 \text{ g}$$

$$\Rightarrow \text{Weight of residue left} = 5 - 1.4 = 3.6 \text{ g}$$



Now, let the original mixture contain  $x$  g of  $\text{Pb}(\text{NO}_3)_2$

$\therefore 330$  g gives  $222$  g  $\text{PbO}$

$\therefore x$  g  $\text{Pb}(\text{NO}_3)_2$  will give  $\frac{222x}{330}$  g  $\text{PbO}$

Similarly,  $85$  g  $\text{NaNO}_3$  gives  $69$  g

$\Rightarrow (5-x)$ g will give

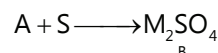
$\frac{69(5-x)}{85}$  g  $\text{NaNO}_2$

$\Rightarrow$  Residue:  $\frac{222x}{330} + \frac{69(5-x)}{85} = 3.6$ g

$x = 3.3$  g  $\text{Pb}(\text{NO}_3)_2$

$\Rightarrow \text{NaNO}_3 = 1.7$  g

**Sol 4:** Compound B forms hydrated crystals with  $\text{Al}_2(\text{SO}_4)_3$ . Also, B is formed with univalent metal on heating with sulphur. Hence, compound B must have the molecular formula  $\text{M}_2\text{SO}_4$  and compound A must be an oxide of M which reacts with sulphur to give metal sulphate as



$\therefore 0.321$  g sulphur gives  $1.743$  g of  $\text{M}_2\text{SO}_4$

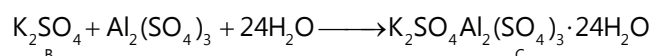
$\therefore 32.1$  g S (one mole) will give  $174.3$  g  $\text{M}_2\text{SO}_4$

Therefore, molar mass of  $\text{M}_2\text{SO}_4 = 174.3$  g

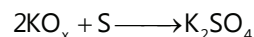
$\Rightarrow 174.3 = 2 \times \text{Atomic weight of M} + 32.1 + 64$

$\Rightarrow$  Atomic weight of M = 39, metal is potassium (K)

$\text{K}_2\text{SO}_4$  on treatment with aqueous  $\text{Al}_2(\text{SO}_4)_3$  gives potash-alum.



If the metal oxide A has molecular formula  $\text{MO}_x$ , two moles of it combine with one mole of sulphur to give one mole of metal sulphate as



$\Rightarrow x = 2$ , i.e., A is  $\text{K}_2\text{O}$ .

**Sol 5:** 93%  $\text{H}_2\text{SO}_4$  solution weight by volume indicates that there is 93 g  $\text{H}_2\text{SO}_4$  in 100 mL of solution.

If we consider 100 mL solution, weight of solution = 184 g

Weight of  $\text{H}_2\text{O}$  in 100 mL solution

=  $184 - 93 = 91$  g

$\Rightarrow$  Molality =  $\frac{\text{Moles of solute}}{\text{Weight of solvent (g)}} \times 1000$

$$= \frac{93}{98} \times \frac{1000}{91} = 10.43$$

**Sol 6:** Partial pressure of  $\text{N}_2 = 0.001$  atm,

$T = 298$  K,  $V = 2.46$  dm<sup>3</sup>.

From Ideal Gas law :  $pV = nRT$

$$n(\text{N}_2) = \frac{pV}{RT} = \frac{0.001 \times 2.46}{0.082 \times 298} = 10^{-7}$$

$\Rightarrow$  No. of molecules of

$$= 6.023 \times 10^{23} \times 10^{-7}$$

$$= 6.023 \times 10^{17}$$

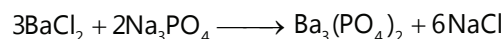
Surface sites used in adsorption

$$= \frac{20}{100} \times 6.023 \times 10^{17} = 2 \times 6.023 \times 10^{16}$$

$\Rightarrow$  Sites occupied per molecules

$$= \frac{\text{Number of sites}}{\text{Number of molecules}} = \frac{2 \times 6.023 \times 10^{16}}{6.023 \times 10^{16}} = 2$$

**Sol 7: (D)** The balanced chemical reaction is



In this reaction, 3 moles of  $\text{BaCl}_2$  combined with 2 moles of  $\text{Na}_3\text{PO}_4$ . Hence, 0.5 mole of  $\text{BaCl}_2$  requires

$$\frac{2}{3} \times 0.5 = 0.33 \text{ mole of } \text{Na}_3\text{PO}_4.$$

Since available  $\text{Na}_3\text{PO}_4$  (0.2 mole) is less than required mole (0.33), it is the limiting reactant and would determine the amount of product  $\text{Ba}_3(\text{PO}_4)_2$ .

$\therefore 2$  moles of  $\text{Na}_3\text{PO}_4$  gives 1 mole  $\text{Ba}_3(\text{PO}_4)_2$

$\therefore 0.2$  mole of  $\text{Na}_3\text{PO}_4$  would give

$$\frac{1}{2} \times 0.2 = 0.1 \text{ mole } \text{Ba}_3(\text{PO}_4)_2$$

**Sol 8: (B)** The following reaction occur between

$\text{S}_2\text{O}_3^{2-}$  and  $\text{Cr}_2\text{O}_7^{2-}$  :

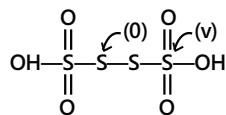


Change in oxidation number of  $\text{Cr}_2\text{O}_7^{2-}$  per formula unit is 6 (it is always fixed for  $\text{Cr}_2\text{O}_7^{2-}$ ).

Hence, equivalent weight of  $\text{K}_2\text{Cr}_2\text{O}_7$

$$= \frac{\text{Molecular weight}}{6}$$

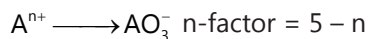
**Sol 9:**  $\text{Na}_2\text{S}_4\text{O}_6$  is a salt of  $\text{H}_2\text{S}_4\text{O}_6$  which has the following structure



$\Rightarrow$  Difference in oxidation number of two types of sulphur = 5.

**Sol 10: (B)** 1. Both assertion and reason are factually true but the reason does not exactly explain the assertion. The correct explanation is, methyl orange and phenolphthalein changes their colours at different pH.

**Sol 11:** For the oxidation of  $\text{A}^{n+}$  as:



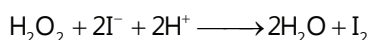
Gram equivalent of  $\text{A}^{n+} = 2.68 \times 10^{-3} (5 - n)$

Now equating the above gram equivalent with gram equivalent of  $\text{KMnO}_4$ :

$$2.68 \times 10^{-3} (5 - n) = 1.61 \times 10^{-3} \times 5$$

$\Rightarrow n = +2$

**Sol 12:** The redox reaction involved is :



If M is molarity of  $\text{H}_2\text{O}_2$  solution, then

$$5M = \frac{0.508 \times 1000}{254}$$

( $\because$  1 mole  $\text{H}_2\text{O}_2 \equiv$  1 mole  $\text{I}_2$ )

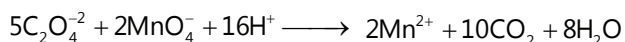
$\Rightarrow M = 0.4$

Also, n-factor of  $\text{H}_2\text{O}_2$  is 2, therefore normality of  $\text{H}_2\text{O}_2$  solution is 0.8 N.

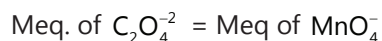
$\Rightarrow$  Volume strength = Normality  $\times$  5.6

$$= 0.8 \times 5.6 = 4.48 \text{ V}$$

**Sol 13:** With  $\text{KMnO}_4$  oxalate ion is oxidized only as:

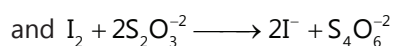
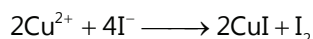


Let, in the given mass of compound, x millimol of  $\text{C}_2\text{O}_4^{2-}$  ion is present, then



$$\Rightarrow 2x = 0.02 \times 5 \times 22.6; \Rightarrow x = 1.13$$

At the later stage, with  $\text{I}^-$ ,  $\text{Cu}^{2+}$  is reduced as :



Let there be x millimole of  $\text{Cu}^{2+}$

$$\Rightarrow \text{Meq of } \text{Cu}^{2+} = \text{Meq of } \text{I}_2 = \text{meq of hypo}$$

$$\Rightarrow x = 11.3 + 0.05 = 0.565$$

$$\Rightarrow \text{Meq of } \text{Cu}^{2+} : \text{Meq of } \text{C}_2\text{O}_4^{2-} = 0.565 : 1.13 = 1 : 2$$

**Sol 14:** Let us consider 10 mL of the stock solution contain x millimol oxalic acid  $\text{H}_2\text{C}_2\text{O}_4$  and y millimol of  $\text{NaHC}_2\text{O}_4$ . When titrated against  $\text{NaOH}$ , basicity of oxalic acid is 2 while that of  $\text{NaHC}_2\text{O}_4$  is 1.

$$\Rightarrow 2x + y = 3 \times 0.1 = 0.3 \quad \dots(i)$$

When titrated against acidic  $\text{KMnO}_4$ , n-factor of both oxalic acid and  $\text{NaHC}_2\text{O}_4$  would be 2.

$$2x + 2y = 4 \times 0.1 = 0.4 \quad \dots(ii)$$

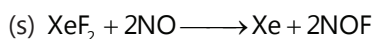
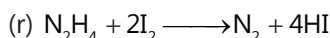
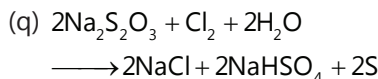
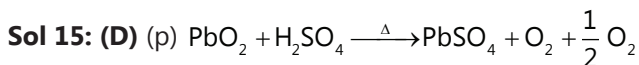
Solving equations (i) and (ii) gives  $y = 0.1$ ,  $x = 0.1$ .

$$\Rightarrow \text{In 1.0 L solution, mole of } = \frac{0.1}{1000} \times 100 = 0.01$$

$$\text{Mole of } \text{NaHC}_2\text{O}_4 = \frac{0.1}{1000} \times 100 = 0.01$$

$$\Rightarrow \text{Mass of } \text{H}_2\text{C}_2\text{O}_4 = 90 \times 0.01 = 0.9 \text{ g}$$

$$\text{Mass of } \text{NaHC}_2\text{O}_4 = 112 \times 0.01 = 1.12 \text{ g}$$



**Sol 16: (A, B, D)** The balanced equation is

