

## Some Basic Concepts of Chemistry

### Q 1.

What weight of AgCl will be precipitated when a solution containing 4.77 g of NaCl is added to a solution of 5.77 g of AgNO<sub>3</sub>? (IIT JEE – 1978 – 3 Marks)

### Q 2.

One gram of an alloy of aluminium and magnesium when treated with excess of dil. HCl forms magnesium chloride, aluminium chloride and hydrogen. The evolved hydrogen, collected over mercury at 0°C has a volume of 1.20 litres at 0.92 atm. Pressure. Calculate the composition of the alloy

[H = 1, Mg = 24, Al = 27]

(IIT JEE 1978 – 5 Marks)

### Q 3.

Igniting MnO<sub>2</sub> converts it quantitatively to Mn<sub>3</sub>O<sub>4</sub>. A sample of pyrolusite is of the following composition: MnO<sub>2</sub> 80%, SiO<sub>2</sub> and other inert constituents 15%, rest being water. The sample is ignited in air to constant weight. What is the percentage of Mn in the ignited sample?

[O = 16, Mn = 54.9]

(IIT JEE 1978 – 6 Marks)

### Q 4.

4.215 g of a metallic carbonate was heated in a hard glass tube and the CO<sub>2</sub> evolved was found to measure 1336 ml at 27°C and 700 mm pressure. What is the equivalent weight of the metal?

(IIT JEE 1979 - 5 Marks)

### Q 5.

(a) 5.5 g of a mixture of FeSO<sub>4</sub>, 7H<sub>2</sub>O and Fe<sub>2</sub>(SO<sub>4</sub>)<sub>3</sub>·9H<sub>2</sub>O requires 5.4 ml of 0.1 N KMnO<sub>4</sub> solution for complete oxidation. Calculate the number of gram mole of hydrated ferric sulphate in the mixture.

(b) The vapour density (hydrogen = 1) of a mixture consisting of NO<sub>2</sub> and N<sub>2</sub>O<sub>4</sub> is 38.3 at 26.7°C. Calculate the number of moles of NO<sub>2</sub> in 1000 g of the mixture. (IIT JEE 1979 – 4 Marks)

### Q 6.

5 ml of a gas containing only carbon and hydrogen were mixed with an excess of oxygen (30 ml) and the mixture exploded by means of an electric spark. After the explosion, the volume of the mixed gases remaining was 25 ml. on adding a concentrated solution of potassium hydroxide, the volume further diminished to 15 ml of the residual gas being pure oxygen. All volumes have been reduced to N.T.P. Calculate the molecular formula of the hydrocarbon gas.

(IIT JEE 1979 – 4 Marks)

### Q 7.

In the analysis of 0.500 g sample of feldspar, a mixture of chlorides of sodium and potassium is obtained which weighs 0.1180g. Subsequent treatment of mixed chlorides, with silver nitrate

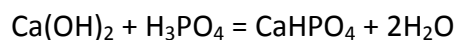
gives 0.2451 g of silver chloride. What is the percentage of sodium oxide and potassium oxide in feldspar. **(IIT JEE 1979 – 5 Marks)**

**Q 8.**

A compound contains 28 percent of nitrogen and 72 percent of metal by weight. 3 atoms of metal combine with 2 atoms of nitrogen. Find the atomic weight of metal. **(IIT JEE 1980 – 2 Marks)**

**Q 9.**

Find the equivalent weight of  $\text{H}_3\text{PO}_4$  in the reaction:



**(IIT JEE 1980 – 2 Marks)**

**Q 10.** (i) A sample of  $\text{MnSO}_4 \cdot 4\text{H}_2\text{O}$  is strongly heated in air. The residue is  $\text{Mn}_3\text{O}_4$ .

(ii) The residue is dissolved in 100 ml of 0.1 N  $\text{FeSO}_4$  containing dilute  $\text{H}_2\text{SO}_4$

(iii) The solution reacts completely with 50 ml of  $\text{KMnO}_4$  solution.

(iv) 25 ml of  $\text{KMnO}_4$  solution used in step (iii) requires 30 ml of 0.1 N  $\text{FeSO}_4$  solution for complete reaction.

Find the amount of  $\text{MnSO}_4 \cdot 4\text{H}_2\text{O}$  present in the sample.

**(IIT JEE 1980 - 4 Marks)**

**Q 11.**

(a) One litre of a sample of hard water contains 1 mg of  $\text{CaCl}_2$  and 1 mg of  $\text{MgCl}_2$ . Find the total hardness in terms of parts of  $\text{CaCO}_3$  per  $10^6$  parts of water by weight.

(b) A sample of hard water contains 20 mg of  $\text{Ca}^{++}$  ions per litre. How many milli-equivalents of  $\text{Na}_2\text{CO}_3$  would be required to soften 1 litre of the sample?

(c) 1 gm of Mg is burnt in a closed vessel which contains 0.5 gm of  $\text{O}_2$ .

(i) Which reactant is left in excess?

(ii) Find the weight of the excess reactants.

(iii) How many milliliters of 0.5 N  $\text{H}_2\text{SO}_4$  will dissolve the residue in the vessel.

**(IIT JEE 1980)**

**Q 12.**

A hydrocarbon contains 10.5g of carbon per gram of hydrogen. 1 litre of the vapour of the hydrocarbon at  $127^\circ\text{C}$  and 1 atmosphere pressure weighs 2.8g. Find the molecular formula.

**(IIT JEE 1980 – 3 Marks)**

**Q 13.**

Find

(i) The total number of neutrons and

(ii) The total mass of neutrons in 7 mg of  $^{14}\text{C}$ .

(Assume that mass of neutron = mass of hydrogen atom)

**(IIT JEE 1980 – 3 Marks)**

**Q 14.**

A mixture contains  $\text{NaCl}$  and unknown chloride  $\text{MCl}$ .

(i) 1 g of this is dissolved in water. Excess of acidified  $\text{AgNO}_3$  solution is added to it. 2.567 g of white ppt. is formed.

(ii) 12 g of original mixture is heated to 300°C. Some vapour come out which are absorbed in acidified AgNO<sub>3</sub> solution, 1.341 g of white precipitate was obtained. Find the molecular weight of unknown chloride. **(IIT JEE 1980)**

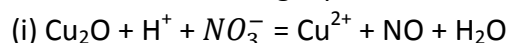
**Q 15.**

A 1.00 gm sample of H<sub>2</sub>O<sub>2</sub> solution containing X per cent H<sub>2</sub>O<sub>2</sub> by weight requires X ml of a KMnO<sub>4</sub> solution for complete oxidation under acidic conditions. Calculate the normality of the KMnO<sub>4</sub> solution.

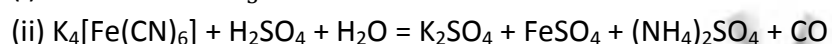
**(IIT JEE 1981 – 3 Marks)**

**Q 16.**

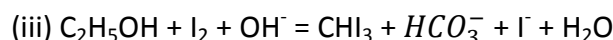
Balance the following equations.



**(IIT JEE 1981 – 3 MARKS)**



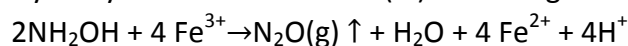
**(IIT JEE 1981 – 3 MARKS)**



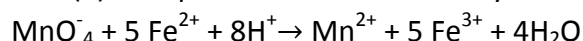
**(IIT JEE 1981 – 3 MARKS)**

**Q 17.**

Hydroxylamine reduces iron (III) according to the equation:



Iron (II) thus produced is estimated by titration with standard permanganate solution. The is :



A 10 ml. sample of hydroxylamine solution was dilute to 1 litre. 50 ml. of this diluted solution was boiled with an excess of iron (III) solution. The resulting solution required 12 ml. of 0.02 M KMnO<sub>4</sub> solution for complete oxidation of iron (II). Calculate the weight of hydroxylamine in one litre of the original solution. (H = 1, N = 14, O = 16, K = 39, Mn = 55, Fe = 56)

**(IIT JEE 1982 – 4 MARKS)**

**Q 18.**

The density of a 3 M sodium thiosulphate solution (Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub>) is 1.25 g per ml. Calculated (i) the percentage by weight of sodium thiosulphate, (ii) the mole fraction of sodium thiosulphate and (iii) the molalities of Na<sup>+</sup> and S<sub>2</sub>O<sub>3</sub><sup>2-</sup> ions.

**(IIT JEE 1983 – 5 MARKS)**

**Q 19.**

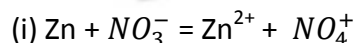
4.08 g of a mixture of BaO and an unknown carbonate MCO<sub>3</sub> was heated strongly. The residue weighed 3.64 g. This was dissolved in 100 ml of 1 N HCl. The excess acid required 16 ml of 2.5 N NaOH solution for complete neutralization. Identify the metal M.

**(IIT JEE 1983 – 4 MARKS)**

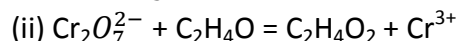
(At. wt. H = 1, C = 12, O = 16, Cl = 35.5, Ba = 138)

**Q 20.**

Complete and balance the following reaction :



**(IIT JEE 1983 – 1 Marks)**



**(IIT JEE 1983 – 1 Marks)**

(ii)  $\text{HNO}_3 + \text{HCl} = \text{NO} + \text{Cl}_2$  (IIT JEE 1983 – 1 Marks)

(iv)  $\text{Ce}^{3+} + \text{S}_2\text{O}_8^{2-} = \text{SO}_4^{2-} + \text{Ce}^{4+}$  (IIT JEE 1983 – 1 Marks)

(v)  $\text{Cl}_2 + \text{OH}^- = \text{Cl}^- + \text{ClO}^-$  (IIT JEE 1983 – 1 Marks)

(vi)  $\text{Mn}^{2+} + \text{PbO}_2 \rightarrow \text{MnO}_4^- + \text{H}_2\text{O}$  (IIT JEE 1986 – 1 Marks)

(vii)  $\text{S} + \text{OH}^- \rightarrow \text{S}^{2-} + \text{S}_2\text{O}_3^{2-}$  (IIT JEE 1986 – 1 Marks)

(ix)  $\text{Ag}^+ + \text{AsH}_3 \rightarrow \text{H}_3\text{AsO}_3 + \text{H}^+$  (IIT JEE 1986 – 1 Marks)

**Q 21.**

2.68 \* 10<sup>-3</sup> moles of a solution containing an ion A<sup>n+</sup> require 1.61 \* 10<sup>-3</sup> moles of MnO<sub>4</sub><sup>-</sup> for the oxidation of A<sup>n+</sup> to AO<sub>3</sub><sup>-</sup> in acid medium. What is the value of n?

(IIT JEE 1984 – 2 Marks)

**Q 22.**

Five ml of 8N nitric acid, 4.8 ml of 5N hydrochloric acid and a certain volume of 17M sulphuric acid are mixed together and made upto 2litre. Thirty ml. of this acid mixture exactly neutralize 42.9 ml of sodium carbonate solution containing one gram of Na<sub>2</sub>CO<sub>3</sub>. 10H<sub>2</sub>O in 100 ml. of water. Calculate the amount in gram of the sulphate ions in solution.

(IIT JEE 1985 – 4 Marks)

**Q 23.**

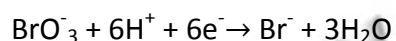
Arrange the following in increasing oxidation number of iodine.

I<sub>2</sub>, HI, HIO<sub>4</sub>, ICl

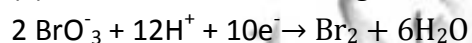
(IIT JEE 1986 – 1 Marks)

**Q 24.**

(i) What is the weight of sodium bromate and molarity of solution necessary to prepare 85.5 ml of 0.672 N solution when the half-cell reaction is



(ii) What would be the weight as well as molarity if the half-cell reaction is :



(IIT JEE 1987 – 5 Marks)

**Q 25.**

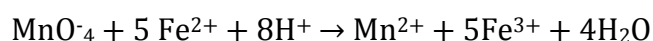
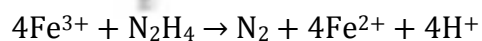
A sugar of weight 214.2 g contains 34.2 g of sugar (C<sub>12</sub>H<sub>22</sub>O<sub>11</sub>). Calculate : (i) molal concentration and (ii) mole fraction of sugar in the syrup.

(IIT JEE 1988 – 2 Marks)

**Q 26.**

A sample of hydrazine sulphate (N<sub>2</sub>H<sub>6</sub>SO<sub>4</sub>) was dissolved in 100 ml. of water, 10 ml of this solution was reacted with excess of ferric chloride solution and warmed to complete the reaction. Ferrous ion formed was estimated and it required 20 ml. of M/50 potassium permanganate solution. Estimate the amount of hydrazine sulphate in one litre of the solution.

Reaction :



(IIT JEE 1988 – 3 Marks)

**Q 27.**

An equal volume of a reducing agent is titrated separately with 1M  $\text{KMnO}_4$  in acid neutral and alkaline media. The volumes of  $\text{KMnO}_4$  required are 20 ml. in acid, 33.4 ml. neutral and 100 ml. in alkaline media. Find out the oxidation state of manganese in each reduction product. Give the balanced equations for all the three half reactions. Find out the volume of 1M  $\text{K}_2\text{Cr}_2\text{O}_7$  consumed; if the same volume of the reducing agent is titrated in acid medium.

(IIT JEE 1989 – 5 Marks)

**Q 28.**

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 solution made upto one liter. Ten milliliters 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. Require 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.

(IIT JEE 1990 – 5 Marks)

**Q 29.**

A solid mixture (5.0 g) consisting of lead nitrate and sodium nitrate was heated below  $600^\circ\text{C}$  until the weight of the residue was constant. If the loss in weight is 28.0 per cent, find the amount of lead nitrate and sodium nitrate in the mixture.

(IIT JEE 1990 – 4 Marks)

**Q 30.**

Calculate the molarity of 1 litre solution of 93%  $\text{H}_2\text{SO}_4$  (weight/volume). The density of the solution is 1.84 g/ml.

(IIT JEE 1990 – 1 Marks)

**Q 31.**

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  $\text{Na}_2\text{CO}_3$ , acidified with dil. 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 molar 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 titration.

(IIT JEE 1991 – 5 Marks)

**Q 32.**

A 1.0 g sample of  $\text{Fe}_2\text{O}_3$  solid of 55.2% purity is dissolved in acid and reduced by heating the solution with zinc dust. The resultant solution is cooled and made upto 100.0 ml. An aliquot of 25.0 ml of this solution requires 17.0 ml of 0.0167 M solution of an oxidant for titration. Calculate the number of electrons taken up by the oxidant in the reaction of the above titration.

(IIT JEE 1991 – 4 Marks)

**Q 33.**

A 2.0 g sample of a mixture containing sodium carbonate, sodium bicarbonate and sodium sulphate is gently heated till the evolution of  $\text{CO}_2$  ceases. The volume of  $\text{CO}_2$  at 750 mm Hg

pressure and at 298 K is measured to be 123.9 ml. A 1.5g of the same sample requires 150 ml. of (M/10) HCl for complete neutralization. Calculate the % composition of the components of the mixture.

(IIT JEE 1992 – 5 Marks)

**Q 34.**

One gram of commercial  $\text{AgNO}_3$  is dissolved in 50 ml. of water. It is treated with 50 ml. of a KI solution. The silver iodide thus precipitated is filtered off. Excess of KI in the filtrate is titrated with (M/10)  $\text{KIO}_3$  solution in presence of 6M HCl till all  $\text{I}^-$  ions are 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 the percentage of  $\text{AgNO}_3$  in the sample.

(Reaction :  $\text{KIO}_3 + 2\text{KI} + 6\text{HCl} \rightarrow 3\text{ICl} + 3\text{KCl} + 3\text{H}_2\text{O}$ )

(IIT JEE 1992 – 4 Marks)

**Q 35.**

Upon mixing 45.0 ml. of 0.25 M lead nitrate solution with 25.0 ml of 0.10 M chromic sulphate solution, precipitation of lead sulphate takes place. How many moles of lead sulphate are formed? Also, calculate the molar concentrations of the species left behind in the final solution. Assume that lead sulphate is completely insoluble.

(IIT JEE 1993 – 3 Marks)

**Q 36.**

The composition of a sample of wustite is  $\text{Fe}_{0.93}\text{O}_{1.00}$ . What percentage of the iron is present in the form of Fe (III)?

(IIT JEE 1994 – 2 Marks)

**Q 37.**

$8.0575 \times 10^{-2}$  kg of Glauber's salt is dissolved in water to obtain  $1 \text{ dm}^3$  of a solution of density  $1077.2 \text{ kg m}^{-3}$ . Calculate the molarity, molality and mole fraction of  $\text{Na}_2\text{SO}_4$  in the solution.

(IIT JEE 1994 – 3 Marks)

**Q 38.**

A 3.00 g sample containing  $\text{Fe}_3\text{O}_4$ ,  $\text{Fe}_2\text{O}_3$  and an inert impure substance, is treated with excess of KI solution in presence of dilute  $\text{H}_2\text{SO}_4$ . The entire iron is converted into  $\text{Fe}^{2+}$  along with the liberation of iodine. The resulting solution is diluted to 100 ml. A 20 ml of the diluted solution requires 11.0 ml of 0.5 M  $\text{Na}_2\text{S}_2\text{O}_3$  solution to reduce the iodine present. A 50 ml of the diluted solution, after complete extraction of the iodine requires 12.80 ml of 0.25 M  $\text{KMnO}_4$  solution in dilute  $\text{H}_2\text{SO}_4$  medium-for the oxidation of  $\text{Fe}^{2+}$ . Calculate the percentages of  $\text{Fe}_2\text{O}_3$  and  $\text{Fe}_3\text{O}_4$  in the original sample.

(IIT JEE 1996 – 5 Marks)

**Q 39.**

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 45.0 mL of thiosulphate solution to decolourise the blue starch-iodine complex. Calculate the molarity of the sodium thiosulphate solution.

(IIT JEE 1998 – 5 Marks)

**Q 40.**

How many millilitres of 0.5 M  $\text{H}_2\text{SO}_4$  are needed to dissolve 0.5 g copper (II) carbonate?  
(IIT JEE 1999 – 3 Marks)

**Q 41.**

A plant virus is found to consist of uniform cylindrical particles of 150 Å in diameter and 5000 Å long. The specific volume of the virus is  $0.75 \text{ cm}^3/\text{g}$ . If the virus is considered to be a single particle, find its molar mass.  
(IIT JEE 1999 – 3 Marks)

**Q 42.**

Hydrogen peroxide solution (20 ml) reacts quantitatively with a solution of  $\text{KMnO}_4$  (20 ml) acidified with dilute  $\text{H}_2\text{SO}_4$ . The same volume of the  $\text{KMnO}_4$  solution is just decolourised by 10 ml of  $\text{MnSO}_4$  in neutral medium simultaneously forming a dark brown precipitate is dissolved in 10, l of 0.2 M sodium oxalate under boiling condition in the presence of dilute  $\text{H}_2\text{SO}_4$ . Write the balanced equations involved in the reactions and calculate the molarity of  $\text{H}_2\text{O}_2$ /  
(IIT JEE 2001 – 5 Marks)

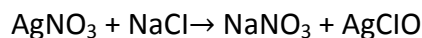
**Q 43.**

Calculate the molarity of water if its density is  $1000 \text{ kg}/\text{m}^3$   
(IIT JEE 2003 – 2 Marks)

## Some Basic Concepts of Chemistry

### Sol 1.

Write the balance chemical equation and use mole concept for limiting reagent.



$$170 \text{ g} \quad 58.5 \text{ g} \quad 143.5 \text{ g}$$

From the given data, we find  $\text{AgNO}_3$  is limiting reagent as  $\text{NaCl}$  is in excess.

$$\therefore 170.0 \text{ g of } \text{AgNO}_3 \text{ precipitates } \text{AgCl} = 143.5 \text{ g}$$

$$\therefore 5.77 \text{ g of } \text{AgNO}_3 \text{ precipitates } \text{AgCl}$$

$$= 143.5/170 * 5.77 = 4.87 \text{ g}$$

### Sol 2.

(i) Find volume of  $\text{H}_2$  at N.T.P.

(ii) Total amount of  $\text{H}_2$  liberated =  $\text{H}_2$  liberated by  $\text{Mg}$  &  $\text{HCl}$  +  $\text{H}_2$  liberated by  $\text{Al}$  &  $\text{HCl}$ .

Conversion of volume of  $\text{H}_2$  to N.T.P

Given condition                      N.T.P condition

$$P_1 = 0.92 \text{ atm.} \quad P_2 = 1 \text{ atm.}$$

$$V_1 = 1.20 \text{ litres} \quad V_2 = ?$$

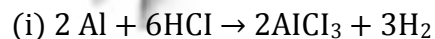
$$T_1 = 0 + 273 = 273 \text{ K} \quad T_2 = 273 \text{ K}$$

Applying ideal gas equation,  $P_1V_1/T_1 = P_2V_2/T_2$

$$0.92 * 1.20/273 = 1 * V_2/273, V_2 = 0.92 * 1.20 * 273/273 * 1 \text{ litres} = 1.104$$

$$\text{Litres} = 1104 \text{ ml}$$

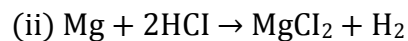
The relevant chemical equation are



$$2 * 27 \quad 3 * 22400$$



= 54 g = 67200 ml at NTP



24 g    22400 ml at NTP

Wt. of alloy = 1g

Let the wt. of aluminium in alloy = x g

∴ Wt. of magnesium in alloy = (1 - x) g

According to equation (i)

54 g Al = 67200 ml of  $\text{H}_2$  at N.T.P

∴ x g of Al =  $67200/54 * x = 1244.4 x$  ml of  $\text{H}_2$  at N.T.P

Similarly, from equation (ii)

24 g of Mg = 22400 ml of  $\text{H}_2$  at N.T.P

(1 - x) g of Mg =  $22400/24 * (1 - x) = 933.3 (1 - x)$  ml of  $\text{H}_2$

Hence total vol. of  $\text{H}_2$  collected at N.T.P

=  $12244.4 x + 933.3 (1 - x)$  ml

But total vol. of  $\text{H}_2$  as calculated above = 1104 ml

∴  $1244.4 x + 933.3 (1 - x) = 1104$  ml

$1244.4 x - 933.3 x = 1104 - 933.3$

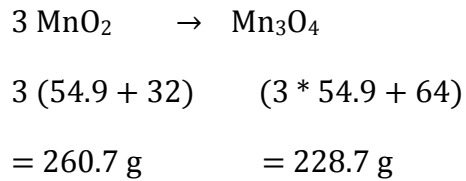
$311.1 x = 170.7, x = 0.5487$

Hence 1 g of alloy contains Al = 0.5487 g

∴ percentage of Al in alloy =  $0.5487 * 100/1 = 54.87\%$

% of Mg in alloy =  $100 - 54.87 = 45.13\%$

**Sol 3.**



Let the amount of pyrolusite ignited = 100.00 g

∴ Wt. of MnO<sub>2</sub> = 80 g (80% of 100 g = 80 g)

Wt. of SiO<sub>2</sub> and other inert substances = 15 g

Wt. of water 100 - (80 + 15) = 5 g

According to equation,

260.7 g of MnO<sub>2</sub> gives = 228.7 g of Mn<sub>3</sub>O<sub>4</sub>

∴ 80 g of MnO<sub>2</sub> gives = 228.7/260.7 \* 80 = 70.2 g of Mn<sub>3</sub>O<sub>4</sub>

**NOTE :**

During ignition, H<sub>2</sub>O present in pyrolusite is removed while silica and other inert substances remain as such.

∴ Total wt. of the residue = 70.2 + 15 = 85.2 g

Calculation of % of Mn in ignited Mn<sub>3</sub>O<sub>4</sub>



Since, 228.7 g of Mn<sub>3</sub>O<sub>4</sub> contains 164.7 g of Mn

70.2 g of Mn<sub>3</sub>O<sub>4</sub> contains = 164.7/228.7 \* 70.2 = 50.55 g of Mn

Weight of residue = 85.2 g

Hence, percentage of Mn in the ignited sample

= 50.55/85.2 \* 100 = 59.33%

#### **Sol 4.**

##### **TIPS/Formulae:**

- (i) Find the volume of CO<sub>2</sub> at NTP
- (ii) Find molecular wt. of metal carbonate
- (iii) Find the wt. of metal
- (iv) Calculate equivalent weight of metal

Given  $P_1 = 700$  mm,  $P_2 = 760$  mm,  $V_1 = 1336$  ml,  $V_2 = ?$   $T_1 = 300$  K,  $T_2 = 273$  K

$$P_1V_1/T_1 = P_2V_2/T_2, \text{ or } V_2 = P_1V_1T_2/P_2T_1 = 700 * 1336 * 273/760 * 300$$

$$= 1119.378 \text{ ml} = 1.12 \text{ L at NTP}$$

$$\therefore 1.12 \text{ L of CO}_2 \text{ is given by carbonate} = 4.215 \text{ g}$$

$$\text{Molecular weight of metal carbonate} = 4.215/1.12 * 22.4 = 84.3$$

$$\text{Metal carbonate is } MCO_3 = M + 12 + 48 = M + 60$$

$$\text{Atomic weight of } M = 84.3 - 60 = 24.3$$

$$\text{Eq. wt. of metal} = 1/2 * M. \text{ wt.} = 1/2 * 24.3 = 12.15$$

#### **Sol 5.**

(a) Equivalents of KMnO<sub>4</sub> = Equivalents of FeSO<sub>4</sub> 7H<sub>2</sub>O

$$5.4 \text{ ml } 0.1 \text{ N KMnO}_4 = 5.4 * 0.1/1000 = 5.4 * 10^{-4} \text{ equivalents}$$

$$\text{Amount of FeSO}_4 = 5.4 * 10^{-4} * \text{Mol. wt. of FeSO}_4 \cdot 7\text{H}_2\text{O} = 5.4 * 10^{-4} * 278 = 0.150 \text{ g}$$

$$\text{Total weight of mixture} = 5.5 \text{ g}$$

$$\text{Amount of ferric sulphate} = 5.5 - 0.150 \text{ g} = 5.35 \text{ g}$$

$$\text{Hence Moles of ferric sulphate} = \text{Mass}/\text{M. wt.} = 5.35/562 = 9.5 * 10^{-3} \text{ gram-mole}$$

(b) Using the relation, Mol. wt. = 2 \* vapour density, we get

$$\text{Mol. wt.} = 2 * 38.3 = 76.6$$

$$\text{No. of moles} = \text{Mass}/\text{Mol. wt.} = 100/76.6 = 1.30 \text{ .....(i)}$$

Let weight of  $\text{NO}_2$  in mixture =  $x$  g

Then weight of  $\text{N}_2\text{O}_4$  in mixture =  $100 - x$

No. of moles of  $\text{NO}_2$  = Mass/Mol. wt. =  $x/46$  .....(i)

No. of moles of  $\text{N}_2\text{O}_4$  = Mass/Mol. wt. =  $100 - x/92$  ....(ii)

According to problem

$$1.30 = x/46 + 100 - x/92$$

On solving the equation we find,  $x = 20.1$

$\therefore$  weight of  $\text{NO}_2 = 20.1$  g

Moles of  $\text{NO}_2 = \text{Mass/M. wt.} = 20.1/46 = 0.437$  moles.

### **Sol 6.**

Volume of oxygen taken = 30 ml

Volume of unused oxygen = 15 ml

Volume of  $\text{O}_2$  used = Volume of  $\text{O}_2$  added – Volume of  $\text{O}_2$  left

$$= 30 - 15 = 15 \text{ ml}$$

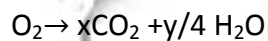
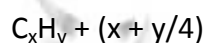
Volume of  $\text{CO}_2$  produced

= Volume of gaseous mixture after explosion – Volume of unused oxygen

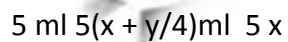
Or Volume of  $\text{CO}_2$  produced =  $25 - 15 = 10$  ml

Volume of hydrocarbon = 5 ml;

General equation for combustion of a hydrocarbon is as follows –



(Hydrocarbon)



$\therefore$  Volume of  $\text{CO}_2$  produced =  $5x$ , Since Volume of  $\text{CO}_2 = 10$  ml

$$\therefore 5x = \Rightarrow x = 2, \text{ Volume of } O_2 \text{ used} = \text{ml}$$

$$\therefore 5(x + y/4) = 15 \Rightarrow x + y/4 = 3$$

$$\Rightarrow 2 + y/4 = 3 \quad (\because x = 2)$$

$$\Rightarrow 8 + y = 12 \therefore y = 4$$

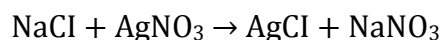
### **Sol 7.**

(i) Equate given mass of AgCl against mass obtained from NaCl and KCl

(ii)  $2\text{NaCl} \equiv \text{Na}_2\text{O}$  &  $2\text{KCl} \equiv \text{K}_2\text{O}$

Let amount of NaCl in mixture = x gm

$\therefore$  amount of KCl in mixture =  $(0.118 - x)$  gm

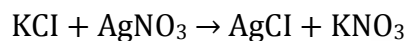


58.5 g 143.5 g

$\therefore$  58.5 g NaCl gives AgCl = 143.5 g

$\therefore$  x g NaCl gives AgCl =  $143.5/58.5 * x$  g

Again



74.5 g 143.5 g

$\therefore$  74.5 g KCl gives AgCl = 143.5 g

$\therefore$   $(0.118 - x)$  g KCl gives AgCl =  $(143.5/74.5 * 0.118 - x)$ g

Total weight of AgCl = 0.2451g

$\therefore (143.5/58.5 * x) + [143.5/74.5 * (0.118 - x)] = 0.2451$

$\therefore x = 0.0338\text{g}$

$\therefore$  Amount of NaCl in mixture = 0.0338g

$\therefore$  Amount of KCl in mixture =  $0.118 - 0.0338 = 0.0842\text{g}$

Since  $2\text{NaCl} \equiv \text{Na}_2\text{O}$

$2 * 58.5 \quad \quad \quad 62$

$$= 117.0$$

$\therefore$  117g NaCl is equivalent = 62.0g Na<sub>2</sub>O

$\therefore$  0.033g NaCl is equivalent to =  $62.0/117 * 0.0338$  g Na<sub>2</sub>O

$$= 0.0179\text{g}$$

% of Na<sub>2</sub>O in 0.5g of feldspar =  $0.0179/0.500 * 100 = 3.58\%$



$$2 * 774.5 = 149 \quad 94$$

$\therefore$  149g of KCl is equivalent to = 94g K<sub>2</sub>O

$\therefore$  0.0842g of KCl is equivalent to  $94/149 * 0.0842$

$$= 0.0531 \text{ g K}_2\text{O}$$

$\therefore$  % of K<sub>2</sub>O in 0.5 of feldspar =  $0.0531/0.5 * 10.62\%$

% of Na<sub>2</sub>O in feldspar = 3.58%

% of K<sub>2</sub>O in feldspar = 10.62%

### **Sol 8.**

According to problem, three atoms of M combine with 2 atoms of N

Equivalent wt of N =  $14/3$  ( $\therefore$  valency of N in compound is 3)

$\therefore$  288 g n combines with = 72g metal

$\therefore$   $14/3$  N combines with =  $72/28 * 14/3 = 12$

$\therefore$  Eq. wt. of metal = 12

At wt of metal = Eq. wt \* valency =  $12 * 2 = 24$  [Valency]

### **Sol 9.**

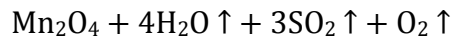
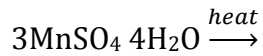
In the given reaction two hydrogen atoms of H<sub>3</sub>PO<sub>4</sub> are replaced so the basicity of H<sub>2</sub>PO<sub>4</sub> is 2.

Using the relation, eq. wt. of acid = Mol. wt. of acid/Basicity

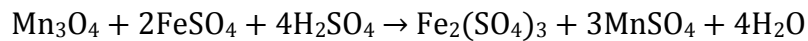
We get, eq. wt. of H<sub>3</sub>PO<sub>4</sub> = Molwt/2 =  $(1 * 3) + 31 + (4 * 16)/2 = 98/2 = 49$  g

### **Sol 10.**

Following reaction take place-



(residue)



Milliequivalents of  $\text{FeSO}_4$  in 30 ml of 0.1N  $\text{FeSO}_4 = 30 * 0.1 = 3 \text{ m.eq.}$

According to problem step (iv)

25 ml of  $\text{KMnO}_4$  reacts with = 3 m eq of  $\text{FeSO}_4$

Thus in step (iii) of the problems,

50 ml of  $\text{KMnO}_4$  reacts with =  $3/25 * 50 \text{ m. eq. of FeSO}_4 = 6 \text{ meq of FeSO}_4$

Milli eq. of 100 ml of 0.1N  $\text{FeSO}_4 = 100 * 0.1 = 10 \text{ meq.}$

$\text{FeSO}_4$  which reacted with  $\text{Mn}_3\text{O}_4 = (10-6) = 4 \text{ m eq.}$

Milli eq of  $\text{FeSO}_4 = \text{Millie q. of Mn}_3\text{O}_4$

(∵ Millie q of oxidizing agent and reducing agent are equal)

∵  $\text{Mn}_3\text{O}_4 \equiv 3\text{MnSO}_4 \cdot 4\text{H}_2\text{O}$

∴ 1 Meq of  $\text{Mn}_3\text{O}_4 = 3 \text{ Meq of MnSO}_4 \cdot 4\text{H}_2\text{O}$

∴ 4 Meq of  $\text{Mn}_3\text{O}_4 = 12 \text{ Meq of MnSO}_4 \cdot 4\text{H}_2\text{O}$

Eq. wt of  $\text{MnSO}_4 \cdot 4\text{H}_2\text{O} = \text{Mol wt.}/2 = 223/2 = 111.5$

Wt. of  $\text{MnSO}_4 \cdot 4\text{H}_2\text{O}$  in sample =  $12 * 111.5 = 1338 \text{ mg} = 1.338 \text{g.}$

### **Sol 11.**

(a)  $\text{CaCl}_2 \equiv \text{CaCO}_3 \equiv \text{MgCl}_2$

M. wt. 111                      100                      95

From this it is evident, the

111 mg  $\text{CaCl}_2$  will give  $\text{CaCO}_3 = 100\text{mg}$

$\therefore 1 \text{ mg } \text{CaCl}_2$  will give  $\text{CaCO}_3 = 100/111 \text{ mg} = 0.90 \text{ mg}$

95 mg  $\text{MgCl}_2$  gives  $\text{CaCO}_3 = 100\text{mg}$

$\therefore 1 \text{ mg } \text{MgCl}_2$  gives  $\text{CaCO}_3 = 100/95 \text{ mg} = 1.05 \text{ mg}$

$\therefore$  Total  $\text{CaCO}_3$  formed by 1 mg  $\text{CaCl}_2$  and 1 mg  $\text{MgCl}_2 = 0.90 + 1.05 = 1.95 \text{ mg}$

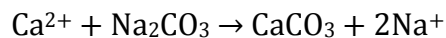
$\therefore$  Amount of  $\text{CaCO}_3$  present per litre of water = 1.95mg

$\therefore$  wt of 1 ml of water = 1g =  $10^3 \text{ mg}$

$\therefore$  wt of 100 ml of water =  $10^3 * 10^3 = 10^6\text{mg}$

$\therefore$  Total hardness of water in terms of parts of  $\text{CaCO}_3$  per  $10^6$  parts of water by weight = 1.95 parts.

(b) Eqwt of  $\text{Ca}^{++} = \text{Mol.wt}/\text{Charge} = 40/2 = 20$



1 milliequivalent of  $\text{Ca}^{2+} = 20 \text{ mg}$

1 milliequivalent of  $\text{Na}_2\text{CO}_3$  is required to soften 1 litre of hard water.



$$2 * 24 = 48\text{g} \quad 32\text{g} \quad 2(24 + 16) = 80\text{g}$$

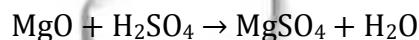
$\therefore 32\text{g}$  of  $\text{O}_2$  reacts with = 48g Mg

$\therefore 0.5\text{g}$  of  $\text{O}_2$  reacts with =  $48/32 * 0.5 = 0.75\text{g}$

Weight of unreacted Mg =  $1.00 - 0.75 = 0.25\text{g}$

Thus Mg is left in excess.

Weight of MgO formed =  $80/48 * 0.75 = 1.25\text{g}$



(40g)

According to reaction

$\therefore 40\text{g}$  MgO is dissolved it gives 1000 ml of 1 N.  $\text{H}_2\text{SO}_4$



∴ 40 g MgO is dissolved it gives 2000 ml 0.5 N H<sub>2</sub>SO<sub>4</sub>

∴ 1.25 MgO is dissolved it gives

= 2000 \* 1.25 / 40 ml of 0.5 N H<sub>2</sub>SO<sub>4</sub>

= 62.5 ml of 0.5N H<sub>2</sub>SO<sub>4</sub>

### **Sol 12.**

Given  $P = 1 \text{ atm}$ ,  $V = 1 \text{ L}$ ,  $T = 127^\circ\text{C} = 127 + 273 = 400 \text{ K}$

$PV = nRT$  (Ideal gas equation)

Or  $n = PV/RT = 1 * 1 / 0.082 * 400 = 0.0304$

Mol. wt Mass/Moles =  $2.8 / 0.0304 = 92.10$

Element	Wt. of element	Relation no. of atom	Ratio of of atoms	Whole no. of atoms
C	10.5	$10.5/12 = 0.875$	$0.875/0.875 = 1$	$1 * 7 = 7$
H	1.0	$1.0/1 = 1$	$1/0.875 = 1.14$	$1.14 * 7 = 8$

∴ Empirical formula = C<sub>7</sub>H<sub>8</sub>

Empirical formula, wt =  $12 * 7 + 1 * 8 = 92$

$n = \text{Molecular wt} / \text{Empirical formula wt} = 92.10 / 92 = 1$

molecular formula =  $n * \text{empirical formula}$

=  $1 (C_7H_8) = C_7H_8$

### **Sol 13.**

(i) No. of C atom in 14g of <sup>14</sup>C =  $6.02 * 10^{23}$

∴ No. of C atom in 7 mg (7/1000g) of <sup>14</sup>C

=  $6.02 * 10^{23} * 7 / 14 * 1000 = 3.01 * 10^{20}$

No. of neutrons in 1 carbon atom = 7

∴ Total no. of neutrons in 7 mg of <sup>14</sup>C =  $3.01 * 10^{20} * 7$

=  $21.07 * 10^{20}$

Wt of neutron = wt of 1 hydrogen atom

$$= 1/6.02 * 10^{23} \text{ g}$$

∴ Wt of  $3.01 * 10^{20} * 7$  neutrons

$$= 3.0 * 10^{20} * 7 / 6.02 * 10^{23} = 3.5 * 10^{-3} \text{ g}$$

#### **Sol 14.**

Weight of AgCl formed = 2.567 g

Amount of AgCl formed due to MCl = 1.341 g

(∵ NaCl does not decompose on heating to 300°C)

∴ Weight of AgCl formed due to NaCl

$$= 2.567 - 1.341 = 1.226 \text{ g}$$

NaCl ≡ AgCl ≡ MCl

58.5    143.5

{NaCl + AgNO<sub>3</sub> → AgCl + NaNO<sub>3</sub>    MCl + AgNO<sub>3</sub> → AgCl + MNO<sub>3</sub>}

∴ 143.5g of AgCl is obtained from NaCl = 58.5g

∴ 1.226 g of AgCl is obtained from NaCl

$$= 58/143.5 * 1.226 = 0.4997 \text{ g}$$

∴ Wt of MCl 1 g of mixture = 1.000 - 0.4997 = 0.5003g

∴ 1.341 g of AgCl is obtained from MCl = 0.5003g

∴ 143.5g of AgCl is obtained from MCl

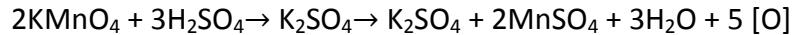
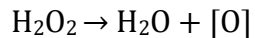
$$= 0.5003/1.341 * 143.5 * 53.53 \text{ g}$$

∴ Molecular weight of MCl = 53.53

#### **Sol 15.**

(i) Find equivalent wt. of H<sub>2</sub>O<sub>2</sub> and KMnO<sub>4</sub>.

(ii) X mol of N.KMnO<sub>4</sub> = X ml of N.H<sub>2</sub>O<sub>2</sub>



$$\therefore \text{Equivalent wt. of H}_2\text{O}_2 = \text{Mol. wt.}/2 = 34/2 = 17$$

$$\text{Equivalent wt. of KMnO}_4 = \text{Mol. wt.}/5 = 158/5 = 31.6$$

Let normality of  $\text{KMnO}_4$  solution =  $N$ , then

$$X \text{ ml. of } N \cdot \text{KMnO}_4 = X \text{ ml. of } N \cdot \text{H}_2\text{O}_2$$

$$w = X * N * 17 / 1000 \text{ g of H}_2\text{O}_2$$

According to problem  $X * 17 * N / 1000$  g of  $\text{H}_2\text{O}_2$  is present in

1 g of solution, Also given .....(1)

100 g of  $\text{H}_2\text{O}_2$  contain  $X$  g of  $\text{H}_2\text{O}_2$

1 g of  $\text{H}_2\text{O}_2$  contain =  $X/100 * 1$  g of  $\text{H}_2\text{O}_2$  .....(2)

Comparing the two relation (1) and (2)

$$17 * N * X / 1000 = X / 100$$

$$\text{Or } N = X / 100 * 1000 / 17 \quad X = 1000 / 100 * 17 = 10 / 17$$

Hence, normality of  $\text{KMnO}_4$  solution is  $10/17$  *N* or  $0.588$  *N*

### ALTERNATIVE SOLUTION:

The complete oxidation under acidic conditions can be represented as follows:



Since 34 g of  $\text{H}_2\text{O}_2 = 2000$  ml of 1 *N* .  $\text{H}_2\text{O}_2$

( $\therefore$  Eq. wt or  $\text{H}_2\text{O}_2 = 34/2$ )

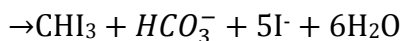
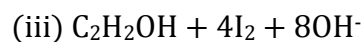
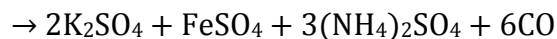
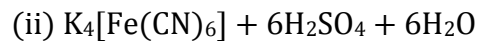
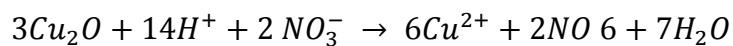
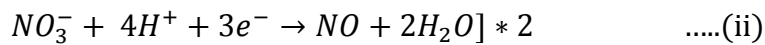
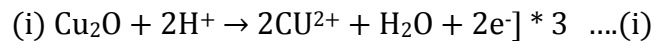
$\therefore$  34 g of  $\text{H}_2\text{O}_2 = 2000$  ml of 1 *N*  $\text{KMnO}_4$  [ $\therefore N_1 V_1 = N_2 V_2$ ]

Or  $X/100$  g of  $\text{H}_2\text{O}_2 = 2000 * X/100 * 34$  ml of 1 *N*  $\text{KMnO}_4$

Therefore the unknown normality =  $2000 * X/34 * 100 * X = 10/17$  or  $0.588$  *N*

**Sol 16.**

Balance the reactions by ion electron method.

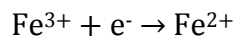
**Sol 17.**

**TIPS/Formulae:**

(i) Write balanced reaction for changes.

$$(ii) \text{M. eq. of Fe}^{2+} \text{ formed} = \text{M. eq. KMnO}_4 \text{ used} \\ = V \text{ in ml} * \text{molarity} * x$$

The given redox changes are



[In  $\text{NH}_2\text{OH}$ , O.S. of N = - 1 and in  $\text{N}_2\text{O}$ , O.S. of N = + 1. For two molecules of  $\text{NH}_2\text{OH}$ , electron involved = 4]



$$= \text{Meq. Of KMnO}_4 \text{ used} = \text{Vol. in ml} * \text{Molarity} * x$$

$$= 12 * 0.02 * 5 = 12 \quad [50/10 = 5]$$

$\therefore$  Meq. of  $\text{Fe}^{2+}$  formed by  $\text{NHH}_2\text{OH}$  in 1000 ml of dil. Solution

$$= 1.2 * 1000/50 = 24$$

Meq. of original solution

= Meq. of  $\text{NH}_2\text{OH}$  in 1000 ml. of dilute solution

$$W_{\text{NH base } 2\text{OH}}/33/2 * 1000 = 24 \text{ [Eq. wt} = 33/2\text{]}$$

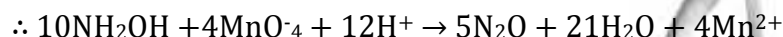
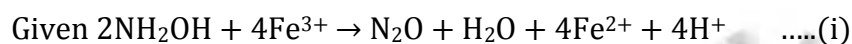
$$W_{\text{NH base } 2\text{OH}} = 24 * 16.5/1000 = 0.396 \text{ g}$$

$\therefore$  Wt. of  $\text{NH}_2\text{OH}$  in 10 ml. of original solution = 0.396 g

$\therefore$  Wt. of  $\text{NH}_2\text{OH}$  in 1 litre of original solution

$$= 0.396 * 100 = 39.6 \text{ g l}^{-1}$$

#### ALTERNATIVE SOLUTION:



[On multiplying (i) by 5 and (ii) by 4 and then adding the resulting equations]

Molecular weight of  $\text{NH}_2\text{OH} = 33$

Thus 400 ml of 1M  $\text{MnO}_4^-$  would react with  $\text{NH}_2\text{OH} = 330\text{g}$

$\therefore$  12 ml of 0.02 M  $\text{KMnO}_4$  would react with  $\text{NH}_2\text{OH} = 330 * 12 * 0.02/400 \text{ g}$

$\therefore$  Amount of  $\text{NH}_2\text{OH}$  present in 1000 ml of dilute solution  $330 * 12 * 0.02 * 1000/400 * 50 \text{ g}$

Since 10 ml of sample of hydroxylamine is dilute to one litre

$\therefore$  A amount of hydroxyl amine in one litre of original solution  $= 330 * 0.02 * 12 * 1000/4000 * 50 * 1000/10 \text{ g} = 39.6 \text{ g}$

#### **Sol 18.**

##### TIPS/Formulae:

(i) Mole fraction = Moles of substance/Total moles

(ii) 1 mole of  $\text{Na}_2\text{S}_2\text{O}_3$  gives 2 moles of  $\text{Na}^+$  and 1 mole  $\text{S}_2\text{O}_3^{2-}$

Molecular wt. of sodium thiosulphate solution ( $\text{Na}_2\text{S}_2\text{O}_3$ )  $= 23 * 2 + 32 * 2 + 16 * 3 = 158$

(i) The percentage by weight of  $\text{Na}_2\text{S}_2\text{O}_3$

$$= \text{wt of } \text{Na}_2\text{S}_2\text{O}_3/\text{wt of solution} * 100 = 3 * 158 * 100/100 * 1.25 = 37.92$$

[wt. of  $\text{Na}_2\text{S}_2\text{O}_3 = \text{Molarity} * \text{Molwt}$ ]

(ii) Mass of 1 litre solution =  $1.25 * 1000 \text{ g} = 1250 \text{ g}$

[ $\because$  density =  $1.25\text{g/l}$ ]

Mole fraction of  $\text{Na}_2\text{S}_2\text{O}_3$

= Number of moles of  $\text{Na}_2\text{S}_2\text{O}_3$  / Total number of moles

Moles of water =  $1250 - 158 * 3/18 = 43.1$

Mole fraction of  $\text{Na}_2\text{S}_2\text{O}_3 = 3/3 + 43.1 = 0.065$

(iii) 1 mole of sodium thiosulphate ( $\text{Na}_2\text{S}_2\text{O}_3$ ) yields 2 moles of  $\text{Na}^+$  and 1 mole of  $\text{S}_2\text{O}_3^{2-}$

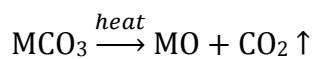
Molality of  $\text{Na}_2\text{S}_2\text{O}_3 = 3 * 1000/776 = 3.87$

Molality of  $\text{Na}^+ = 3.87 * 2 = 7.74\text{m}$

Molality of  $\text{S}_2\text{O}_3^{2-} = 3.87\text{m}$

### **Sol 19.**

One mole of metal carbonate, on heating, decomposes to form 1 mole of oxide with the evolution of 1 mole of  $\text{CO}_2$  gas.



1 mole    1 mole    1 mole

Thus on heating, metal carbonate will lose weight corresponding to the weight of carbon dioxide.

From the given data, loss in wt. =  $4.08 - 3.64 \text{ g} = 0.44 \text{ g}$

Conversion of  $0.44 \text{ g}$  of  $\text{CO}_2$  into mole of  $\text{CO}_2$

$44 \text{ g of } \text{CO}_2 = 1 \text{ mole of } \text{CO}_2$

$\therefore 0.44 \text{ g of } \text{CO}_2 = 0.44/44 = 0.01 \text{ mole}$

From the equation, it is also obvious that

$1 \text{ mole of } \text{CO}_2 \equiv 1 \text{ mole of } \text{MCO}_3$

$\therefore 0.01$  mole of  $\text{CO}_2 \equiv 0.01$  mole of  $\text{MCO}_3$

Thus the given mixture has 0.01 mole of  $\text{MCO}_3$  which will yield 0.01 mole of  $\text{MO}$ .

From the problem, we also know that

16 ml of 2.5 N  $\text{NaOH} \equiv 16$  ml of 2.5 n  $\text{HCl}$  [ $N_1V_1 = N_2V_2$ ]

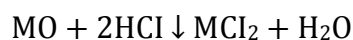
$= 16 * 2.5$  ml of N  $\text{HCl} = 40$  ml of N  $\text{HCl}$

$\therefore$  volume of N  $\text{HCl}$  remain unused = 40 ml

Total volume of N  $\text{HCl}$  added = 100 ml

$\therefore$  Volume of N  $\text{HCl}$  used = 100 - 40 = 60 ml

Hence 60 ml of N  $\text{HCl}$  is used in neutralizing  $\text{BaO}$  and  $\text{MO}$  according to the following reaction.



Thus 0.01 mole of  $\text{MO} \equiv 0.02$  mole of  $\text{HCl}$

$= 0.02 * 1000$  ml of N  $\text{HCl}$

$= 20$  ml of N  $\text{HCl}$

$\therefore$  Vol. of N  $\text{HCl}$  used = 60 - 20 = 40 ml

Eq. wt. of  $\text{BaO} = 138 + 16/2 = 77$

40 ml of N  $\text{HCl} = 40$  ml of N  $\text{BaO} = 40 * 77/1000 = 3.08$  g of  $\text{BaO}$

Total wt. of the oxides = 3.64 g

$\therefore$  Wt. of  $\text{MO}$  in the mixture = 3.64 - 3.08 = 0.56 g

But we know that 0.01 mole of  $\text{MO}$  is present in the residue it means

0.01 mole of  $\text{MO} = 0.56$  g of  $\text{MO}$

1 mole of  $\text{MO} = 56$  g of  $\text{MO}$

Suppose the atomic weight of  $\text{M} = a$

Then the mol. wt. of  $\text{MO} = a + 16$

We also know that 1 mole of  $\text{MO}$  (i.e. Mol. wt. of  $\text{MO}$ ) = 56

$$\therefore a + 16 = 56 \text{ or } a = 56 - 16 = 40$$

$\therefore$  The atomic weight of metal M = 40

Hence, the metal M must be calcium

#### ALTERNATIVE SOLUTION:

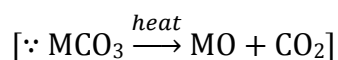
Weight of  $\text{MCO}_3$  and  $\text{BaO} = 4.08 \text{ g}$  (given)

Weight of residue = 3.64 g (given)

$\therefore$  Weight of  $\text{CO}_2$  evolved on heating =  $(4.08 - 3.64) \text{ g} = 0.44 \text{ g}$

$$= 0.44/44 = 0.01 \text{ mole}$$

Number of moles of  $\text{MCO}_3 \equiv 0.01 \text{ mole}$

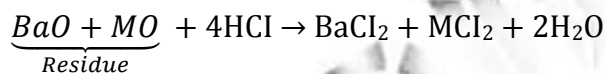


Volume of 1N HCl in which residue is dissolved = 100 ml

Volume of 1N HCl used for dissolution =  $(100 - 2.5 * 16) \text{ ml} = 60 \text{ ml}$

$$= 60/1000 = 0.06 \text{ equivalents}$$

The chemical equation for dissolution can be written as



[Number of moles of  $\text{BaO}$  and  $\text{MO} = 1 + 1 = 2$ ]

Number of moles of  $\text{BaO}$  + Number of moles of  $\text{MO} = 0.06/2 = 0.03$

Number of moles of  $\text{BaO} = (0.03 - 0.01)$

$$= 0.02 \text{ moles}$$

Molecular weight of  $\text{BaO} = 138 + 16 = 154$

$\therefore$  Weight of  $\text{BaO} = (0.02 * 154) \text{ g}$

$$= 3.08 \text{ g}$$

Weight of  $\text{MCO}_3 = (4.08 - 3.08) = 1.0 \text{ g}$

Since weight of 0.01 mole of  $\text{MCO}_3 = 1.0 \text{ g}$



$$\therefore \text{Mol. wt. of } \text{MCO}_3 = 1/0.01 = 100$$

$$\text{Hence atomic weight of unknown M} = (100 - 60) = 40$$

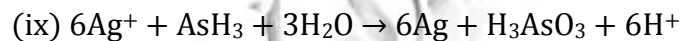
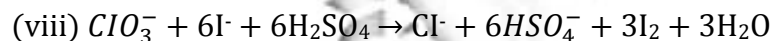
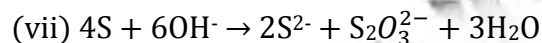
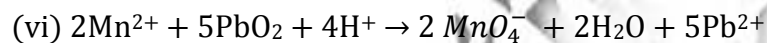
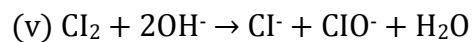
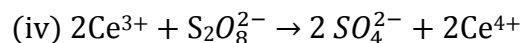
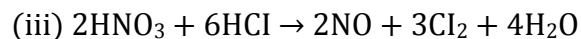
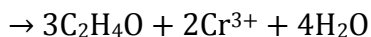
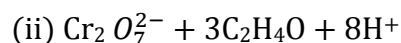
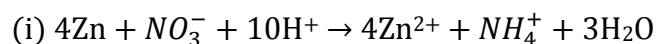
The atomic weight of metal is 40 so the metal M is Ca

### **Sol 20.**

#### **TIPS/Formulae:**

Balanced the atoms as well as charges by ion electron/ oxidation number method.

While balancing the equations, both the charges and atoms must balance.



### **Sol 21.**

#### **TIPS/Formulae:**

Equivalents of A oxidized = Equivalents of A reduced. Since in acidic medium,  $\text{A}^{n+}$  is oxidized to  $\text{AO}_3^-$ , the change in oxidation state from

$$(+5) \text{ to } (+n) = 5 - n \quad [\because \text{O.S. of A in } \text{AO}_3^- = +5]$$

$\therefore$  Total number of electrons that have been given out during oxidation of  $2.68 \times 10^{-3}$  moles of  $\text{A}^{n+}$

$$= 2.68 \times 10^{-3} \times (5 - n)$$

Thus the number of electrons added to reduce  $1.61 \times 10^{-3}$

Moles of  $Mn^{+4}$  to  $Mn^{2+}$ , i.e.

$$(+7) \text{ to } (+2) = 1.61 \times 10^{-3} \times 5$$

$$[\text{Number of electrons involved} = +7 - (+2) = 5]$$

$$\therefore 1.61 \times 10^{-3} \times 5 = 2.68 \times 10^{-3} \times (5 - n)$$

$$5 - n = 1.61 \times 5 / 2.68 \text{ or } n = 5 - 8.05 / 2.68 = 2$$

### Sol 22.

#### TIPS/Formulae:

(i) Find normality of acid mixture and  $Na_2CO_3 \cdot 10H_2O$ . Equate them to find volume of  $H_2SO_4$ .

(ii) Meq. Of  $H_2SO_4 = V \times N = V \times N / 1000$  eq.

(iii) Equivalent of  $SO_4^{2-} = \text{Equivalents of } H_2SO_4 \times \text{Eq. wt. of } SO_4^{2-}$

$$N \times V(\text{ml.}) = \text{meq}$$

Acid mixture contains 5 ml of 8N,  $HNO_3$ , 4.8 ml of 5N, HCl

and say, 'V' ml of 17 M  $\equiv$  34 N,  $H_2SO_4$ .

$$[1MH_2SO_4 = 2N.H_2SO_4]$$

N of the acid mixture = meq. (total) of acid/mls. Of solution

$$= 5 \times 8 + 4.8 \times 5 + V \times 34 / 2000 \text{ [Total volume} = 2 \text{ L} = 2000 \text{ ml]}$$

$$\text{or, } N_{\text{mixture}} = 64 + 34V / 2000$$

$\therefore$  Eq. of wt. of  $Na_2CO_3 \cdot 10H_2O = \text{Mol. wt.} / 2$

$$= 106 + 180 / 2 = 143$$

N of  $Na_2CO_3 = \text{Meq. Of } Na_2CO_3 / \text{Volume of solution (ml)}$

$$= 1 / 143 / 100 / 1000 = 1 / 143 \times 1000 / 100 = 0.069N$$

$$N_1V_1 = N_2V_2$$

$$\text{Or } 30 \times N_{\text{mixture}} = 42.9 \times 0.069$$

(acid) (sod. carbonate)

$$\therefore N_{\text{mixture}} = 42.9 * 0.069 / 30 = 0.0986 \text{ N}$$

$$\text{Hence } 64 + 34V / 2000 = 0.0986$$

$$64 + 34 V = 0.0986 * 2000, 64 + 34 V = 197.2$$

$$34 V = 197.2 - 64.0 = 133.2 \quad \therefore \text{ or } V = 133.2 / 34 = 3.9 \text{ ml.}$$

$$\text{Hence meq. Of } H_2SO_4 = V * N \text{ of } H_2SO_4$$

$$= 3.9 * 34 = 132 \text{ meq.}$$

$$= 0.1326 \text{ eq. of } H_2SO_4$$

$$= 0.1326 \text{ eq. of } SO_4^{2-}$$

$$= 0.1326 * 48 \text{ g of } SO_4^{2-}$$

$$(\because \text{ Eq. wt. of } SO_4^{2-} = 32 + 64 / 2 = 48)$$

$$= 6.3648 \text{ g of } SO_4^{2-} \text{ are in 3.9 ml of 17M } H_2SO_4$$

### **Sol 23.**

HI < I<sub>2</sub> < ICl < HIO<sub>4</sub>; O.N. of I in I<sub>2</sub> = 0, HI = - 1, ICl = + 1, HIO<sub>4</sub> = + 7.

### **Sol 24.**

(i) From the given half-cell reaction,

$$\text{Here Eq. wt. of } NaBrO_3 = \text{Mol. wt.} / 6 = 151 / 6 = 25.17$$

[ $\because$  number of electron involved = 6]

Now we know that

$$\text{Meq.} = \text{Normally} * \text{Vol. in ml.} = 85.5 * 0.672 = 57.456$$

$$\text{Aslo Meq.} = W_{NaBrO_3} / \text{Eq. wt.}_{NaBrO_3} * 1000$$

$$= W_{NaBrO_3} / 25.17 * 1000$$

$$W_{NaBrO_3} / 25.17 * 1000 = 57.456 \text{ g}$$

$$\therefore W_{\text{NaBrO}_3} = 1.446 \text{ g}$$

Molarity of  $\text{NaBrO}_3 = \text{Normality/Valence factor}$

$$= 0.672/6 = 0.112 \text{ M}$$

(ii) From the given-cell reaction,

$$\text{Eq. wt. of } \text{NaBrO}_3 = \text{Mol. wt.}/5 = 151/5 = 30.2$$

[Number of electron involved per  $\text{BrO}_3^- = 10/2 = 5$ ]

Thus, the amount of  $\text{NaBrO}_3$  required for preparing 1000 ml. of 1 N  $\text{NaBrO}_3 = 30.2 \text{ g}$

$\therefore$  The amount of  $\text{NaBrO}_3$  required for preparing 85.5 ml of 0.672 N  $\text{NaBrO}_3$ .

$$= 30.2 * 0.672 * 85.5/1000 = 1.7532 \text{ g}$$

Hence, Molality =  $0.672/5 = 0.1344 \text{ M}$

### **Sol 25.**

(i) Molal concentration = Molality

$$= \text{Moles of solute/Mass of solvent in Kg}$$

(ii) Mole fraction of sugar

$$= \text{Moles of sugar/Total moles in solution}$$

(i) Weight of sugar syrup = 214.2 g

Weight of sugar in the syrup = 34.2 g

$$\therefore \text{Weight of water in the syrup} = 214.2 - 34.2 = 180.0 \text{ g}$$

Mol. wt. of sugar,  $\text{C}_{12}\text{H}_{22}\text{O}_{11} = 342$

$$\therefore \text{Molal concentration} = 34.2 * 1000 / 342 * 180 = 0.56$$

(ii) Mol. wt. water,  $\text{H}_2\text{O} = 18$

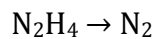
$$\therefore \text{Mole fraction of sugar} = 34.2/342 / 180/18 + 34.2/342$$

$$= 0.1/10 + 0.1 = 0.1/10.1 = 0.0099$$

**Sol 26.**

No. of equivalent of  $\text{KMnO}_4$

= No. of equivalents of hydrazine sulphate.



Change in oxidation state for each  $\text{N}_2\text{H}_4 = 2 * 2 = 4$

Equivalent weight of  $\text{N}_2\text{H}_6\text{SO}_4 = 130/4 = 32.5$

Normality of  $\text{KMnO}_4 = 5 * 450$  ( $\because$  valence factor = 5)

Number of equivalents of  $\text{KMnO}_4 = 20 * 5/50 * 1000 = 1/500$  and if weight of hydrazine sulphate be  $x$  gm then equivalents of hydrazine sulphate =  $x/32.5$

$$\therefore 1/500 = x/32.5 \text{ or } x = 32.5/500 = 0.065 \text{ g}$$

Hence wt. of  $\text{N}_2\text{H}_6\text{SO}_4$  in 10 ml solution = 0.065 g

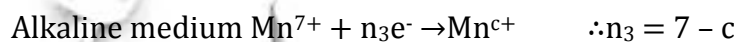
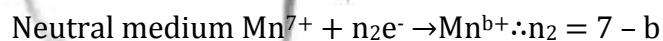
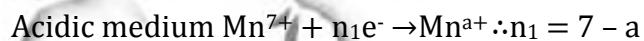
$\therefore$  Wt. of  $\text{N}_2\text{H}_6\text{SO}_4$  in 1000 ml solution = 6.5 g

**Sol 27.****TIPS/Formulae:**

No. of equivalents of  $\text{KMnO}_4$  in neutral medium

= No. of equivalents of reducing agent.

Assuming that  $\text{KMnO}_4$  shows the following changes during its oxidising nature.



Let  $V$  ml. of reducing agent be used for  $\text{KMnO}_4$  in different medium.

$\therefore$  Meq. of reducing agent

= Meq. of  $\text{KMnO}_4$  in acid medium

Meq. of  $\text{KMnO}_4$  in neutral medium

= Meq. of  $\text{KMnO}_4$  in alkaline medium

$$= 1 * n_1 * 20 = 1 * n_2 * 33.4 = 1 * n_3 * 100$$

$$= n_1 = 1.667 n_2 = 5 n_3$$

Since  $n_1$ ,  $n_2$  and  $n_3$  are integers and  $n_1$  is not greater than 7

$$\therefore n_3 = 1$$

Hence  $n_1 = 5$  and  $n_2 = 3$

$\therefore$  Different oxidation states of Mn in

Acidic medium  $\text{Mn}^{7+} + 5e^- \rightarrow \text{Mn}^{a+}$  or  $a = + 2$

Neutral medium  $\text{Mn}^{7+} + 3e^- \rightarrow \text{Mn}^{b+}$  or  $b = + 4$

Alkaline medium  $\text{Mn}^{7+} + 1e^- \rightarrow \text{Mn}^{c+}$  or  $c = + 6$

Further, same volume of reducing agent is treated with  $\text{K}_2\text{Cr}_2\text{O}_7$ , and therefore

Meq. of reducing agent = Meq. of  $\text{K}_2\text{Cr}_2\text{O}_7$

$$1 * 5 * 20 = 1 * 6 * V [\because \text{Cr}^{+6} + 6e^- \rightarrow 2\text{Cr}^{3+}]$$

$$V = 16.66 \text{ mL} \therefore 1\text{M} = 6 * 1\text{N}$$

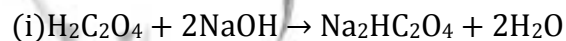
### **Sol 28.**

**TIPS/Formulae:**

No. of equivalent of  $\text{KMnO}_4$

= No. of equivalent of reducing agents.

Case I. Reaction of  $\text{NaOH}$  with  $\text{H}_2\text{C}_2\text{O}_4$  and  $\text{NaHC}_2\text{O}_4$ .



Number of milliequivalents of  $\text{NaOH} = N * V = 3.0 * 0.1 = 0.3$

$\therefore$  Combined normality of the mixture titrated with  $\text{NaOH}$

$$= 0.3/10 = 0.03$$

Case II. Reaction of  $\text{C}_2\text{O}_4^-$  ion and  $\text{KMnO}_4$

(iii)  $5\text{C}_2\text{O}_4^- + \text{MnO}_4^- + 16\text{H}^+ \rightarrow 2\text{Mn}^{2+} + 10\text{CO}_2 + 8\text{H}_2\text{O}$   $\text{KMnO}_4$  will react in same manner with both  $\text{NaHC}_2\text{O}_4$  and  $\text{H}_2\text{C}_2\text{O}_4$  as it can be seen from the above reaction.

Number of milliequivalents of  $\text{KMnO}_4 = 4.0 * 0.1 = 0.4$

$\therefore$  Combined normality of the mixture titrated with  $\text{KMnO}_4$

$= 0.4/10 = 0.04$

The difference ( $0.04\text{N} - 0.03\text{N} = 0.01\text{N}$ ) is due to  $\text{NaHC}_2\text{O}_4$

The total normality of  $\text{NaHC}_2\text{O}_4$  will be  $= 0.01 + 0.01 = 0.02\text{N}$

From equation (ii) in case I.

Eq. wt. of  $\text{NaHC}_2\text{O}_4 = 112$

Amount of  $\text{NaHC}_2\text{O}_4$  in one litre of solution formed

$= 0.01 * 112 = 1.12\text{ g}$  and amount of  $\text{H}_2\text{C}_2\text{O}_4$

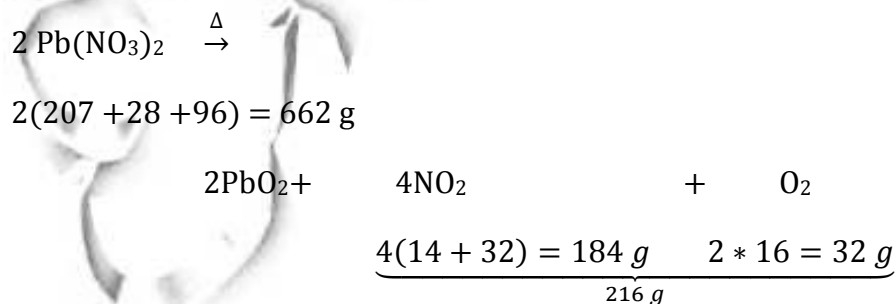
$= 2.02 - \text{Wt. of NaHC}_2\text{O}_4 = 2.02 - 1.12 = 0.90\text{ g}$

### **Sol 29.**

Let the amount of  $\text{NaNO}_3$  in the mixture  $= x\text{ g}$

$\therefore$  The amount of  $\text{Pb}(\text{NO}_3)_2$  in the mixture  $= (5 - x)\text{ g}$

Heating effect of sodium nitrate and lead nitrate



Now since,  $170\text{ g}$  of  $\text{NaNO}_3$  gives  $= 32\text{ g}$  of  $\text{O}_2$

$\therefore x\text{ g}$  of  $\text{NaNO}_3$  gives  $= 32/170 * x\text{ g}$  of  $\text{O}_2$

Similarly, 662 g of  $\text{Pb}(\text{NO}_3)_2$  gives = 216 g of gases

(5 - x) g of  $\text{Pb}(\text{NO}_3)_2$  gives =  $216/662 * (5 - x)$  g of gases

( $\text{NO}_2 + \text{O}_2$ )

Actual loss, on heating, is 28% of 5 g of mixture

$$= 5 * 28/100 = 1.4 \text{ g}$$

$$\therefore 32x/170 + 216/662 * (5 - x) = 1.4$$

$$32x * 662 + 216(5 - x) * 170 = 1.4 * 170 * 662$$

$$21184x + 183600 - 36720x = 157556$$

$$-15536x = -26044$$

$$X = 1.676 \text{ g}$$

$$\text{Wt. of } \text{NaNO}_3 = 1.676 \text{ g}$$

$$\text{And Wt. of } \text{Pb}(\text{NO}_3)_2 = 5 - 1.676 \text{ g} = 3.324 \text{ g}$$

### **Sol 30.**

Molality = Mass of solute/M. wt. of solute/Mass of solvent in kg

Mass of  $\text{H}_2\text{SO}_4$  in 100 ml of 93%  $\text{H}_2\text{SO}_4$  solution = 93 g

$\therefore$  Mass of  $\text{H}_2\text{SO}_4$  in 1000 ml of the  $\text{H}_2\text{SO}_4$  solution = 930 g

Mass of 1000 ml  $\text{H}_2\text{SO}_4$  solution =  $1000 * 1.84 = 1840 \text{ g}$

Mass of water in 1000 ml of solution =  $1840 - 930 \text{ g}$

$$= 910 \text{ g} = 0.910 \text{ kg}$$

Moles of  $\text{H}_2\text{SO}_4 = \text{Wt. of } \text{H}_2\text{SO}_4 / \text{Mol. wt. of } \text{H}_2\text{SO}_4 = 930/98$

$\therefore$  Moles of  $\text{H}_2\text{SO}_4$  in 1 kg of water

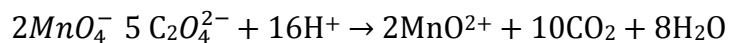
$$= 930/98 * 1/0.910 = 10.43 \text{ mol}$$

$\therefore$  Molality of solution = 10.43m

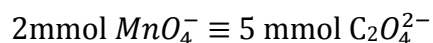


### **Sol 31.**

In the given problem, a solution containing  $\text{Cu}^{2+}$  and  $\text{C}_2\text{O}_4^{2-}$  is titrated first with  $\text{KMnO}_4$  and then with  $\text{Na}_2\text{S}_2\text{O}_3$  in presence of  $\text{KI}$ . In titration with  $\text{KMnO}_4$ , it is the  $\text{C}_2\text{O}_4^{2-}$  ions that react with the  $\text{C}_2\text{MnO}_4^-$  ions. The concerned balanced below may be written as given below.



Thus according to the above reaction



However,

No. of mmol of  $\text{MnO}_4^-$  used in titration = Vol. in ml \* M

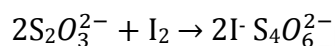
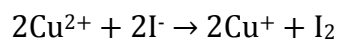
$$= 22.6 * 0.02 = 0.452\text{ mmol MnO}_4^-$$

since  $2\text{ mmol MnO}_4^- \equiv \text{mmol C}_2\text{O}_4^{2-}$

$$0.452\text{ mmol MnO}_4^- \equiv 5/2 * 0.452 = 1.130\text{ mmol C}_2\text{O}_4^{2-}$$

*Titration with  $\text{Na}_2\text{S}_2\text{O}_3$  in the presence of  $\text{KI}$ .*

Here  $\text{Cu}^{2+}$  react and the reactions involved during titration are



Thus  $2\text{Cu}^{2+} \equiv \text{I}_2 \equiv 2\text{S}_2\text{O}_3^{2-}$

No. of m mol of  $\text{S}_2\text{O}_3^{2-}$  used in titration

$$= 0.05 * 11.3 = 0.565\text{ mmol S}_2\text{O}_3^{2-}$$

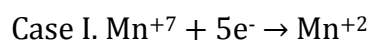
Now since  $2\text{ mmol S}_2\text{O}_3^{2-} \equiv 2\text{ mmol Cu}^{2+}$  [From above equation]

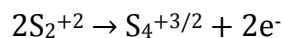
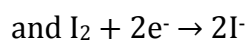
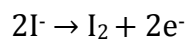
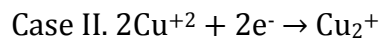
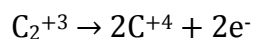
$$0.565\text{ mmol S}_2\text{O}_3^{2-} = 2/2 * 0.565\text{ mmol Cu}^{2+}$$

$$= 0.565\text{ mmol Cu}^{2+}$$

$\therefore$  Molar ratio of  $\text{Cu}^{2+}$  to  $\text{C}_2\text{O}_4^{2-} = 0.565\text{ mmol}/1.130\text{ mmol} = 1 : 2$

Balanced equations in two cases





### **Sol 32.**

Mass of  $Fe_2O_3$  in the sample =  $55.2/100 * 1 = 0.552 \text{ g}$

Number of moles of  $Fe_2O_3 = 0.552/159.8 = 3.454 * 10^{-3}$

Number of moles of  $Fe^{3+}$  ions =  $2 * 3.454 * 10^{-3}$   
 $= 6.9 * 10^{-3} \text{ mol} = 6.90 \text{ mmol}$

Since its only 1 electron is exchanged in the conversion of  $Fe^{3+}$  to  $Fe^{2+}$ , the molecular mass is the same as equivalent mass.

$\therefore$  Amount of  $Fe^{2+}$  ion in 100 ml. of sol. = 6.90 meq

Volume of oxidant used for 100 ml of  $Fe^{2+}$  sol

=  $17 * 4 = 68 \text{ ml.}$

Amount of oxidation used =  $68 * 0.0167 \text{ mmol}$

= 1.1356 mmol

Let the number of electrons taken by the oxidant =  $n$

$\therefore$  No. of meq. of oxidant used =  $1.1356 * n$

Thus  $1.1356 * n = 6.90$

$n = 6.90/1.1356 = 6$

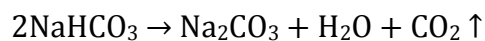
### **Sol 33.**

1.5 g of sample require = 150 ml. of M/10 HCl

$\therefore$  2 g of sample require =  $150/1.5 \text{ ml of M/10 HCl}$

= 200 ml. of M/10 HCl

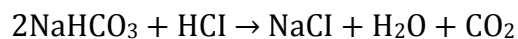
On heating, the sample, only  $\text{NaHCO}_3$  undergoes decomposition as given below.



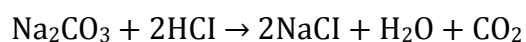
2 moles          1 mole          1 mole

2 eq

Neutralization of the sample with HCl takes place as given below.



1 eq                  1 eq



1 mole      1 mole

2 eq          2 eq

Hence, 2 g sample  $\equiv$  200 ml. of M/10 HCl

$=$  200 ml. of N/10 HCl  $=$  20 meq  $=$  0.020 eq

Number of moles of  $\text{CO}_2$  formed, i.e.

$$N = PV/RT = 750/760 * 123.9/0.082 = 0.005$$

Moles of  $\text{NaHCO}_3$  in the sample (2 g)  $= 2 * 0.005 = 0.01$

Equivalent of  $\text{NaHCO}_3 = 0.01$

Wt. of  $\text{NaHCO}_3 = 0.01 * 84 = 0.84$  g

% of  $\text{NaHCO}_3 = 0.84 * 100/2 = 42\%$

Equivalent of  $\text{Na}_2\text{CO}_3 = 0.02 - 0.01 = 0.01$

Wt. of  $\text{Na}_2\text{CO}_3 = 0.01 * 53 = 0.53$  g

$\therefore$  % of  $\text{Na}_2\text{CO}_3 = 0.53 * 100/2 = 26.5\%$

$\therefore$  % of  $\text{Na}_2\text{SO}_3$  in the mixture  $= 100 - (42 + 26.5) = 31.5\%$

### **Sol 34.**

Reaction involved titration is



1 mole          2 mole

20 ml. of stock KI solution  $\equiv$  30 ml. of M/10  $KIO_3$  solution

Molarity of KI solution =  $30 * 1 * 2 / 20 * 10 = 3/10$

Millimoles in 50 ml. of KI solution =  $50 * 3/10 = 15$

Millimoles of KI left unreacted with  $AgNO_3$  solution  
 $= 2 * 50 * 1/10 = 10$

$\therefore$  millimoles of KI reacted with  $AgNO_3 = 15 - 10 = 5$

Millimoles of  $AgNO_3$  present in  $AgNO_3$  solution = 5

$\therefore$  Wt. of  $AgNO_3$  in the solution =  $5 * 10^{-3} * 170 = 0.850$  g

%  $AgNO_3$  in the sample =  $0.850/1 * 100 = 85\%$

### **Sol 35.**

Calculation of number of moles in 45 ml. of 0.025 M  $Pb(NO_3)_2$

Moles of  $Pb(NO_3)_2 = 0.025 * 45/1000 = 0.01125$

$\therefore$  Initial moles of  $Pb^{2+} = 0.01125$

Moles of  $NO_3^- = 0.01125 * 2 = 0.02250$  [1 mole  $Pb(NO_3)_2 \equiv 2$  moles of  $NO_3^-$ ]

Calculation of number of moles in 25 ml. of 0.1 M chromic sulphate

Moles of chromic sulphate ( $Cr_2(SO_4)_3 = 0.1 * 25/1000 = 0.0025$  moles.

Moles of  $SO_4^{2-} = 0.0025 * 3 = 0.0075$  [1 Mole of chromic sulphate  $\equiv 3$  moles of  $SO_4^{2-}$ ]

Moles of  $PbSO_4$  formed = 0.0075 [ $SO_4^{2-}$  is totally consumed]

Moles of  $Pb^{2+}$  left =  $0.01125 - 0.0075 = 0.00375$

Moles of  $NO_3^-$  left = 0.02250 [ $NO_3^-$  remain untreated]

Moles of chromium ions =  $0.0025 * 2 = 0.005$

Total volume of the solution =  $45 + 25 = 70$  ml.

$\therefore$  Molar concentration of the species left

(i)  $Pb^{2+} = 0.00375/70 * 1000 = 0.05357$  M

$$(ii) NO_3^- = 0.0225/70 * 1000 = 0.3214 \text{ M}$$

$$(iii) Cr^{3+} = 0.005/70 * 1000 = 0.0714 \text{ M}$$

### **Sol 36.**

In pure iron oxide (FeO), iron and oxygen are present in the ratio 1 : 1.

However, here number of  $Fe^{2+}$  present = 0.93

Or No. of  $Fe^{2+}$  ions missing = 0.07

Since each  $Fe^{2+}$  ion has 2 positive charge, the total number of charge due to missing (0.07)  $Fe^{2+}$  ions =  $0.07 * 2 = 0.14$

To maintain electrical neutrality, 0.14 positive charge is compensated by the presence of  $Fe^{3+}$  ions. Now since, replacement of one  $Fe^{2+}$  ion by one  $Fe^{3+}$  ion increases one positive charge, 0.14 positive charge must be compensated by the presence of 0.14  $Fe^{3+}$  ions.

In short, 0.93  $Fe^{2+}$  ions have 0.14  $Fe^{3+}$  ions

$$100 \text{ } Fe^{2+} \text{ ions have} = 0.14/0.93 * 100 = 15.05\%$$

### **Sol 37.**

(i) Density = Mass/Volume

(ii) Molarity = Moles of solute/Volume of solution in L

(iii) Molality = Moles of solute/Mass of solvent in kg

(iv) Mole fraction of solute = Moles of solute/Total moles

The formula of Glauber's salt is  $Na_2SO_4 \cdot 10H_2O$

Molecular mass of  $Na_2SO_4 \cdot 10H_2O$

$$= [2 * 23 + 32.1 + 4 * 16] + 10 (1.01 * 2 + 16) = 322.3 \text{ g mol}^{-1}$$

Weight of the Glauber's salt taken = 80.575 gm

Out of 80.575 g of salt, weight of anhydrous  $Na_2SO_4$

$$= 142.1/322.3 * 80.575 = 35.525 \text{ g}$$

Number of moles of  $Na_2SO_4$  per  $dm^3$  of the solution

$$= 35.525/142.1 = 0.25$$

Molarity of the solution = 0.25 M

Density of solution = 1077.2 kgm<sup>-3</sup>

$$= 1077.2 \cdot 10^3 / 10^6 \text{ gm cm}^{-3} = 1.0772 \text{ g cm}^{-3}$$

Total weight of sol =  $V \cdot d = 1 \text{ dm}^3 \cdot d$

$$= 1000 \text{ cm}^3 \cdot 1.0772 \text{ gcm}^{-3} = 1077.2 \text{ g}$$

Weight of water = 1077.2 - 35.252 = 1041.67 g

Molality of sol.  $0.25 / 1041.67 \text{ g} \cdot 1000 \text{ g} = 0.2399 = 0.24 \text{ m}$

Number of moles of water in the solution =  $1041.67 / 18 = 57.87$

Mole fraction of Na<sub>2</sub>SO<sub>4</sub>

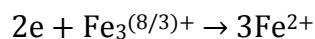
$$= \text{No. of moles of Na}_2\text{SO}_4 / \text{Total number of moles} = 0.25 / 0.25 + 57.87$$

$$= 0.0043 = 4.3 \cdot 10^{-3}$$

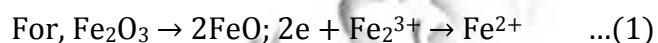
### **Sol 38.**

Find the milliequivalents and equate them as per data given in question.

For Fe<sub>3</sub>O<sub>4</sub> → 3FeO



Thus, valence factor for Fe<sub>3</sub>O<sub>4</sub> is 2 and for FeO is 2/3



Thus valence factor for Fe<sub>3</sub>O<sub>3</sub> is 2 and for FeO is 1.

Let Meq. of Fe<sub>3</sub>O<sub>4</sub> and Fe<sub>3</sub>O<sub>3</sub> be *a* and *b* respectively.

∴ Meq. of Fe<sub>3</sub>O<sub>4</sub> + Meq. Fe<sub>3</sub>O<sub>3</sub> = Meq. of I<sub>2</sub> liberated

= Meq. of hypo used

$$A + b = 11 \cdot 0.5 \cdot 100 / 20 = 27.5$$

Now, the Fe<sup>2+</sup> ions are again oxidized to Fe<sup>3+</sup> by KMnO<sub>4</sub>.

Note that in the change



Thus,

Meq. of  $\text{Fe}^{2+}$  (from  $\text{Fe}_3\text{O}_4$ ) + Meq. of  $\text{Fe}^{2+}$  (from  $\text{Fe}_3\text{O}_3$ )

= Meq. of  $\text{KMnO}_4$  used .....(2)

If valence factor for  $\text{Fe}^{2+}$  is  $2/3$  from Eq. (1),

Then Meq. of  $\text{Fe}^{2+}$  (from  $\text{Fe}_3\text{O}_4$ ) =  $a$

If valence factor for  $\text{Fe}^{2+}$  is 1

Then Meq. of  $\text{Fe}^{2+}$  (from  $\text{Fe}_3\text{O}_4$ ) =  $3a/2$  .....(3)

Similarly, from Eq. (2), Meq. of  $\text{Fe}^{2+}$  from ( $\text{Fe}_3\text{O}_3$ ) =  $b$ .

$\therefore 3a/2 + b = 0.25 * 5 * 12.8 * 100/50 = 32$

or  $3a + 2b = 64$

from Eqs (3) and (4)

Meq. of  $\text{Fe}_3\text{O}_4 = a = 9$  & Meq. of  $\text{Fe}_3\text{O}_3 = b = 18.5$

$\therefore W_{\text{Fe base 30 base 3}} = 9 * 232/2 * 1000 = 1.044 \text{ g}$

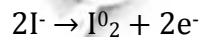
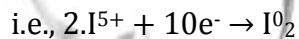
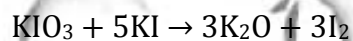
And  $W_{\text{Fe base 30 base 3}} = 18.5 * 160/2 * 1000 = 1.48 \text{ g}$

$\therefore \% \text{ of } \text{Fe}_3\text{O}_4 = 1.044 * 100/3 = 34.8$

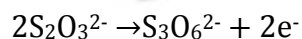
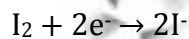
and  $\% \text{ of } \text{Fe}_3\text{O}_3 = 1.48 * 100/3 = 49.33$

### **Sol 39.**

Write the reactions taking place, balance them and equate moles of  $\text{I}_2$  and  $\text{Na}_2\text{S}_2\text{O}_3$ .



Now liberated  $\text{I}_2$  reacts with  $\text{Na}_2\text{S}_2\text{O}_3$



$\therefore$  millimole ratio of  $\text{I}_2 : \text{S}_2\text{O}_3 = 1 : 2$

Thus,  $m$  mole of  $I_2$  liberated

$$= m \text{ mole of } Na_2S_4O_6 \text{ used} * 1/2 = 45 * M * 1/2$$

[ $M$  is molarity of thiosulphate]

$$\text{Also } m \text{ mole of } KIO_3 = 0.1/214 * 1000$$

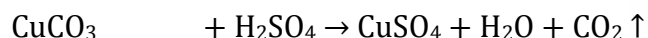
Now  $m$  mole ratio of  $KIO_3 : I_2 = 1 : 3$

$$\text{Thus, } (0.1/214) * 1000 / (45 M / 2) = 1/3$$

$$\therefore M = 0.1 * 100 * 3 * 2 / 214 * 45 = 0.062$$

#### **Sol 40.**

Use molarity equation to find volume of  $H_2SO_4$  solution.



$$63.5 + 12 + 48.98 \quad 98g$$

$$= 123.5 g$$

$\therefore$  For 123.5 gms of Cu(II) carbonate 98 g of  $H_2SO_4$  are required

For 0.5 gms of Cu(II) carbonate weight of  $H_2SO_4$  reqd.

$$= 98 * 0.5 / 123.5 g = 0.39676 g H_2SO_4$$

$$\text{Weight of required } H_2SO_4 = 0.39676 g$$

Weight of solute in grams

$$= \text{Mol. wt.} * \text{Molarity} * \text{Volume in mL} / 1000$$

$$0.39676 = 98 * 0.5 * V / 1000$$

$$\text{or } V = 0.39676 * 1000 / 98 * 0.5 \text{ ml}$$

$$\text{volume of } H_2SO_4 \text{ solution} = 8.097 \text{ ml}$$

#### **Sol 41.**

(i) Volume of virus =  $\pi r^2 \ell$  (Volume of cylinder)

(ii) Mass of single virus = Volume / Sp. Volume



(iii) Molecular mass of virus

$$= \text{Mass of single virus} * 6.02 * 10^{23}$$

$$\text{Volume of virus} = \pi r^2 h$$

$$= \frac{22}{7} * \frac{150}{2} * \frac{150}{2} * 10^{-16} * 500 * 10^{-8}$$

$$= 0.884 * 10^{-16} \text{ cm}^3$$

$$\text{Weight of one virus} = \frac{0.884 * 10^{-16}}{0.75} \text{ g}$$

$$= 1.178 * 10^{-19} \text{ g}$$

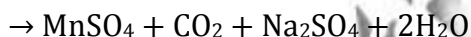
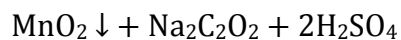
$$\therefore \text{Mol. wt. of virus} = 1.178 * 10^{-19} * 6.02 * 10^{23}$$

$$= 7.09 * 10^7$$

### **Sol 42.**

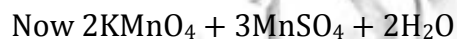
Write the balanced chemical reaction for change and apply mole concept.

The given reactions are :



$$\therefore \text{Meq. of MnO}_2 \equiv \text{Meq of C}_2\text{O}_4 = 10 * 0.2 * 2 = 4$$

$$\therefore \text{mM of MnO}_2 = \frac{4}{2} = 2 \quad [\text{Mn}^{4+} + 2e \rightarrow \text{Mn}^{2+} \therefore \text{Valance factor of MnO}_2 = 2]$$



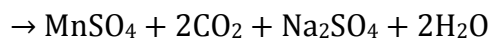
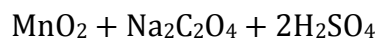
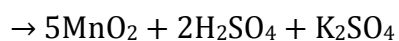
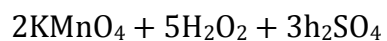
Since eq. wt. of MnO<sub>2</sub> is derived from KMnO<sub>4</sub> and MnSO<sub>4</sub> both, thus it is better to proceed by mole concept

$$\text{mM of KMnO}_4 \equiv \text{mM of MnI}_2 * \left(\frac{2}{5}\right) = \frac{4}{5}$$



$$\therefore \text{mM of H}_2\text{O}_2 = \text{mM of KMnO}_4 = \text{mm OF KMnO}_4 * \frac{5}{2} = \frac{4}{5} * \frac{5}{2} = 2$$

$$\therefore M_{\text{H}_2\text{O}_2} * 20 = 2 \text{ or } M_{\text{H}_2\text{O}_2} = 0.1$$



**Sol 43.**

1 litre water = 1 kg i.e. 1000 g water ( $\because d = 1000 \text{ kg/m}^3$ )

$\equiv 1000/18 = 55.55$  moles of water

So, molarity of water = 55.55M