Some Basic Concepts of Chemistry
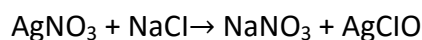
Sol 1.

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

$AgNO_3 + NaCl \rightarrow NaNO_3 + AgClO$

170 g   58.5 g   143.5 g

From the given data, we find $AgNO_3$ is limiting reagent as NaCl is in excess.

$\because$ 170.0 g of $AgNO_3$ precipitates AgCl = 143.5 g

$\therefore$ 5.77 g of $AgNO_3$ precipitates AgCl

= 143.5/170 * 5.77 = 4.87 g

Sol 2.

(i) Find volume of H_2 at N.T.P.

(ii) Total amount of H_2 liberated = H_2 liberated by Mg & HCl + H_2 liberated by Al & HCl.

Conversion of volume of H_2 to N.T.P

Given condition   N.T.P condition

P_1= 0.92 atm. P_2 = 1 atm.

V_1 = 1.20 litres V_2= ?
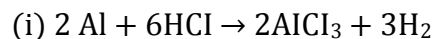
T_1 = 0 + 273 = 273 K T_2 = 273 K

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

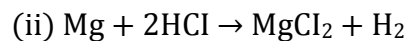$0.92 *1.20/273 = 1 * V_2/273$, V_2 0.92 * 1.20 *273/273 *1 litres = 1.104

Litres = 1104 ml

The relevant chemical equation are

(i) $2 Al + 6HCl \rightarrow 2AlCl_3 + 3H_2$

2 * 27 3 *22400

= 54 g = 67200 ml at NTP

(ii) $Mg + 2HCl \rightarrow MgCl_2 + H_2$

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 H_2 at N.T.P

∴ x g of Al = 67200/54 * x = 1244.4 x ml of H_2 at N.T.P

Similarly, from equation (ii)

24 g of Mg = 222400 ml of H_2 at N.T.P

(1 - x) g of Mg = 222400/24 * (1 - x) = 933.3 (1 - x) ml of H_2

Hence total vol. of H_2 collected at N.T.P

= 12244.4 x + 933.3 (1 - x)ml

But total vol. of H_2 as calculated above = 1104 ml

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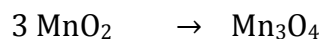
1244.4 x – 933.3 x = 1104 – 933.3

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.

$3 \, MnO_2 \quad \rightarrow \quad Mn_3O_4$

$3 \, (54.9 + 32) \qquad (3 * 54.9 + 64)$

$= 260.7 \, g \qquad \quad = 228.7 \, g$

Let the amount of pyrolusite ignited $= 100.00 \, g$

$\therefore$ Wt. of $MnO_2 = 80 \, g \, (80\%$ of $100 \, g = 80 \, g)$

Wt. of SiO_2 and other inert substances $= 15 \, g$

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

According to equation,

$260.7 \, g$ of MnO_2 gives $= 228.7 \, g$ of Mn_3O_4

$\therefore 80 \, g$ of MnO_2 gives $= 228.7/260.7 * 80 = 70.2 \, g$ of Mn_3O_4

NOTE :

During ignition, H_2O present in pyrolusite is removed while silica and other inert substances remain as such.

$\therefore$ Total wt. of the residue $= 70.2 + 15 = 85.2 \, g$

Calculation of % of Mn in ignited Mn_3O_4

$3 \, Mn \qquad \quad = \qquad \quad Mn_3O_4$
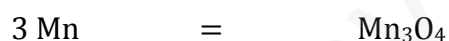
$3 * 54.9 = 164.7 \, g \quad \; 3 * 54.9 + 64 = 228.7g$

Since, $228.7 \, g$ of Mn_3O_4 contains $164.7 \, g$ of Mn

$70.2 \, g$ of Mn_3O_4 contains $= 164.7/228.7 * 70.2 = 50.55 \, g$ of Mn

Weight of resdue $= 85.2 \, g$

Hence, percentage of Mn is the ignited sample

$= 50.55/85.2 * 100 = 59.33\%$

Sol 4.

TIPS/Formulae:

(i) Find the volume of CO_2 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

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

$= 1119.378$ ml $= 1.12$ L at NTP

$\because$ 1.12 L of CO_2 is given by carbonate $= 4.215$ g

Molecular weight of metal corbonate $= 4.215/1.12 * 22.4 = 84.3$

Metal carbonate is $MCO_3 = M + 12 + 48 = M + 60$

Atomic weight of M $= 84.3 - 60 = 24.3$

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

Sol 5.

(a) Equivalents of $KMnO_4$ = Equivalents of $FeSO_4$ $7H_2O$

5.4 ml 0.1 N $KMnO_4 = 5.4 * 0.1/1000 = 5.4 * 10^{-4}$ equivalents

Amount of $FeSO_4 = 5.4 * 10^{-4} *$ Mol. wt. if $FeSO_4.$ $7H_2O = 5.4 * 10^{-4} * 278 = 0.150$ g

Total weight of mixture $= 5.5$ g

Amount of ferric sulphate $= 5.5 - 0.150$ g $= 5.35$ g

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

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

Mol. wt. $= 2 * 38.3 = 76.6$

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

Let weight of NO_2 in mixture $= x$ g

Then weight of N_2O_4 in mixture $= 100 - x$

No. of moles of $NO_2 =$ Mass/Mol. wt. $= x/46$ .....(ii)

No. of moles of $N_2O_4 =$ Mass/Mol. wt. $= 100 - x/92$ ....(ii)

According to problem

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

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

∴ weight of $NO_2 = 20.1$ g

Moles of $NO_2 =$ 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 O_2 used = Volume of O_2 added – Volume of O_2 left
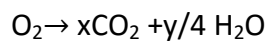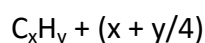
= 30 – 15 = 15 ml

Volume of CO_2 produced

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

Or Volume of CO_2 produced = 25 – 15 = 10 ml

Volume of hydrocarbon = 5 m;

General equation for combustion of a hydrocarbon is as follows –

$C_xH_y + (x + y/4)$

$O_2 \rightarrow xCO_2 + y/4\ H_2O$

(Hydrocarbon)

5 ml 5(x + y/4)ml 5 x

∴ Volume of CO_2 produced = 5x, Since Volume of CO_2 = 10 ml

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

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

$\Rightarrow 2 + y/4 = 3 \qquad (\because x = 2)$
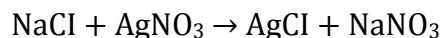
$\Rightarrow 8 + y = 12 \therefore y = 4$

Sol 7.

(i) Equate given mass of AgCI against mass obtained from NaCI and KCI

(ii) $2NaCI \equiv Na_2O$ & $2KCI \equiv K_2O$

Let amount of NaCI in mixture $= x$ gm

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

$NaCI + AgNO_3 \rightarrow AgCI + NaNO_3$

58.5 g 143.5 g

$\because$ 58.5 g NaCI gives AgCI = 143.5 g

$\therefore$ x g NaCI gives AgCI = 143.5/58.5 * x g

Again

$KCI + AgNO_3 \rightarrow AgCI + KNO_3$

74.5 g 143.5 g

$\because$ 74.5 g KCI gives AgCI = 143.5 g
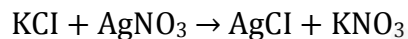
$\therefore$ (0.118 - x) g KCI gives AgCI = (143.5/74.5 * 0.118 – x)g

Total weight of AgCI = 0.2451g

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

$\therefore$ x = 0.0338g

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

$\therefore$ Amount of KCI in mixture = 0.118 – 0.0338 = 0.0842g

Since $\qquad 2NaCI \equiv \qquad Na_2O$

$\qquad\qquad\qquad 2 * 58.5 \qquad\qquad 62$

= 117.0

∵ 117g NaCI is equivalent = 62.0g Na_2O

∴ 0.033g NaCI is equivalent to = 62.0/117 * 0.0338 g Na_2O

= 0.0179g

% of Na_2O in 0.5g of feldspar = 0.0179/0.500 * 100 = 3.58%

2KCI   ≡ K_2O

2 * 774.5 = 149   94

∵ 149g of KCI is equivalent to = 94g K_2O

∴ 0.0842g of KCI is equivalent to 94/149 * 0.0842

= 0.0531 g K_2O

∴ % of K_2O in 0.5 of feldspar = 0.0531/0.5 * 10.62%

% of Na_2O in feldspar = 3.58%

% of K_2O 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 (∵ valency of N in compound is 3)

∵ 288 g n combines with = 72g metal

∴ 14/3 N combines with = 72/28 * 14/3 = 12

∴ Eq. wt. of metal = 12

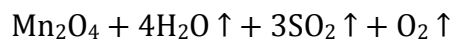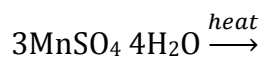At wt of metal = Eq. wt * valency = 12 * 2 = 24 [Valency]

Sol 9.

In the given reaction two hydrogen atoms of H_3PO_4 are replaced so the basicity of H_2PO_4 is 2.
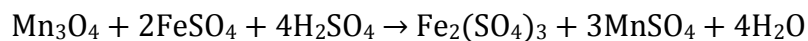
Using the relation, eq. wt. of acid = Mol. wt. of acid/Basicity

We get, eq. wt. of H_3PO_4 = Molwt/2 = (1 *3) +31 +(4 * 16)/2= 98/2 = g

Sol 10.

Following reaction take place-

$$3MnSO_4 \, 4H_2O \xrightarrow{heat}$$

$$Mn_2O_4 + 4H_2O \uparrow + 3SO_2 \uparrow + O_2 \uparrow$$

(residue)

$$Mn_3O_4 + 2FeSO_4 + 4H_2SO_4 \rightarrow Fe_2(SO_4)_3 + 3MnSO_4 + 4H_2O$$

Milliequivalents of $FeSO_4$ in 30 ml of 0.1N $FeSO_4$ = 30 * 0.1 = 3 m.eq.

According to problem step (iv)

25 ml of $KMnO_4$ reacts with = 3 m eq of $FeSO_4$
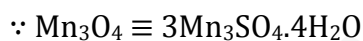
Thus in step (iii) of the problems,

50 ml of $KMnO_4$ reacts with = 3/25 * 50 m. eq. of $FeSO_4$ = 6 meq of $FeSO_4$

Milli eq. of 100 ml of 0.1N $FeSO_4$ = 100 * 0.1 = 10 meq.

$FeSO_4$ wich reacted with Mn_3O_4 = (10-6) = 4m eq.

Milli eq of $FeSO_4$ = Millie q. of Mn_3O_4

($\because$ Millie q of oxidizing agent and reducing agent are equal)

$\because Mn_3O_4 \equiv 3Mn_3SO_4.4H_2O$

$\therefore$ 1 Meq of Mn_3O_4 = 3 Meq of $MnSO_4 \, 4H_2O$

$\therefore$ 4 Meq of Mn_3O_4 = 12 Meq of $MnSO_4 \, 4H_2O$

Eq. wt of $MnSO_4 \, 4H_2O$ = Mol wt./2 = 223/2 = 111.5

Wt. of $MnSO_4 \, 4H_2O$ in sample = 12 * 111.5 = 1338 mg = 1.338g.

Sol 11.

(a) $CaCI_2 \equiv CaCO_3 \equiv MgCI_2$

M. wt. 111   100   95

From this it is evident, the

111 mg $CaCl_2$ will give $CaCO_3 = 100$ mg

$\therefore$ 1 mg $CaCl_2$ will give $CaCO_3 = 100/111$ mg $= 0.90$ mg

95 mg $MgCl_2$ gives $CaCO_3 = 100$ mg

$\therefore$ 1 mg $MgCl_2$ gives $CaCO_3 = 100/95$ mg $= 1.05$ mg

$\therefore$ Total $CaCO_3$ formed by 1 mg $CaCl_2$ and 1 mg $MgCl_2 = 0.90 + 1.05 = 1.95$ mg

$\therefore$ Amount of $CaCO_3$ present per litre of water $= 1.95$ mg

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

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

$\therefore$ Total hardness of water in terms of parts of $CaCO_3$ per 10^6 parts of water by weight $=$ 1.95 parts.

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

$Ca^{2+} + Na_2CO_3 \rightarrow CaCO_3 + 2Na^+$

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

1 milliequivalentof Na_2CO_3 is required to soften 1 litre of hard water.

(c) $2Mg \qquad + \qquad O_2 \qquad \rightarrow 2MgO$

$2 * 24 = 48g \quad 32g \qquad 2(24 + 16) = 80g$

$\because$ 32g of O_2 reacts with $= 448g$ Mg

$\therefore$ 0.5g of O_2 reacts with $= 48/32 * 0.5 = 0.75g$

Weight of unreacted Mg $= 1.00 - 0.75 = 0.25g$

Thus Mg is left in excess.

Weight of MgO formed $= 80/48 * 0.75 = 1.25g$

$MgO + H_2SO_4 \rightarrow MgSO_4 + H_2O$

(40g)

According to reaction

$\because$ 40g MgO is dissolved it gives 1000 ml of 1 N. H_2SO_4

∴ 40 g MgO is dissolved it gives 2000 ml 0.5 N H_2SO_4

∴ 1.25 MgO is dissolved it gives

$= 2000 *1.25/40$ ml of 0.5 N H_2SO_4

$= 62.5$ ml of 0.5N H_2SO_4

Sol 12.

Given $P = 1$ atm $V = 1$L, $T = 127°C = 127 + 273 = 4000$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 1.0/1 = 1	0.875/0.875 = 1 1/0.875 = 1.14	1 * 7 = 7 1.14 *7 = 8
H	1.0			

∴ Emperical formula $= C_7H_8$

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

$n =$ Molecular wt/Emperical formula wt $= 92.10/92 = 1$

molecular formula $= n *$ empirical formula

$= 1 (C_7H_8) = C_7H_8$

Sol 13.

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

∴ No. of C atom in 7 mg (7/1000g) of ^{14}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 $^{14}C = 3.01 * 10^{20} *7$

$$= 21.07 *10^{20}$$

Wt of neutron = wt of 1 hydrogen atom

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

∴ Wt of $3.01 * 10^{20} * 7$ neutrons

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

Sol 14.

Weight of AgCI formed = 2.567 g
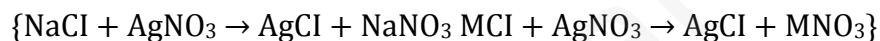
Amount of AgCI formed due to MCI = 1.341 g

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

∴ Weight of AgCI formed due to NaCI

$= 2.567 – 1.341 = 1.226$ g

NaCI ≡ AgCI ≡ MCI

58.5   143.5

{NaCI + AgNO$_3$ → AgCI + NaNO$_3$ MCI + AgNO$_3$ → AgCI + MNO$_3$}

∵ 143.5g of AgCI is obtained from NaCI = 58.5g

∴ 1.226 g of AgCI is obtained form NaCI

$= 58/143.5 * 1.226 = 0.4997$ g

∴Wt of MCI 1 g of mixture $= 1.000 – 0.4997 = 0.5003$ g

∵ 1.341 g of AgCI is obtained from MCI = 0.5003g
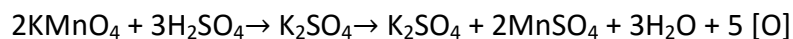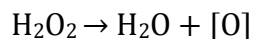
∴ 143.5g of AgCI is obtained from MCI

$= 0.5003/1.341 * 143.5 * 53.53$ g

∴ Molecular weight of MCI = 53.53

Sol 15.

(i) Find equivalent wt. of H_2O_2 and KM_nO_4.

(ii) Xmol of N.KMnO$_4$ = X ml of N.H$_2$O$_2$

$H_2O_2 \rightarrow H_2O + [O]$

$2KMnO_4 + 3H_2SO_4 \rightarrow K_2SO_4 \rightarrow K_2SO_4 + 2MnSO_4 + 3H_2O + 5 [O]$

∴ Equivalent wt. of H_2O_2 = Mol. wt./2 = 34/2 = 17

Equivalent wt. of $KMnO_4$ = Mol. wt./5 = 158/5 = 31.6

Let normality of $KMnO_4$ solution = N, then

X ml. of N.$KMnO_4$ = X ml. of N.H_2O_2

$w = X * N * 17/1000$ g of H_2O_2

According to problem $X*17*N/1000$ g of H_2O_2 is present in

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

100 g of H_2O_2 contain X g of H_2O_2

1 g of H_2O_2 contain = $X/100 * 1$ g of H_2O_2 ......(2)

Comparing the two relation (1) and (2)

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

Or $N = X/100 * 1000/17$ $X = 1000/100 * 17 = 10/17$

Hence, normality of $KMnO_4$ solution is 10/17 *N or 0.588* N

ALTERNATIVE SOLUTION:

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

$5H_2O_2 + 2MnO^-_4 + 6H^+ \rightarrow 5O_2 + 2Mn_2 + 2Mn^{2+} + 8H_2O$

Since 34 g of H_2O_2 = 2000 ml of 1N . H_2O_2

(∵ Eq. wt or H_2O_2 = 34/2)

∴ 34 g of H_2O_2 = 2000 ml of 1 N $KMnO_4$ [∵ $N_1V_1 = N_2V_2$]

Or $X/100$ g of H_2O_2 = 2000 * $X/100$ *34 ml of 1 N $KMnO_4$

Therefore the unknown normality = 2000 * $X/34 * 100 * X = 10/17$ or 0.588 N
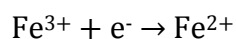
Sol 16.

Balance the reactions by ion electron method.

(i) $Cu_2O + 2H^+ \rightarrow 2CU^{2+} + H_2O + 2e^-] * 3$ ....(i)

$\underline{NO_3^- + 4H^+ + 3e^- \rightarrow NO + 2H_2O] * 2}$ ......(ii)

$3Cu_2O + 14H^+ + 2NO_3^- \rightarrow 6Cu^{2+} + 2NO\ 6 + 7H_2O$

(ii) $K_4[Fe(CN)_6] + 6H_2SO_4 + 6H_2O$

$\rightarrow 2K_2SO_4 + FeSO_4 + 3(NH_4)_2SO_4 + 6CO$

(iii) $C_2H_2OH + 4I_2 + 8OH^-$

$\rightarrow CHI_3 + HCO_3^- + 5I^- + 6H_2O$
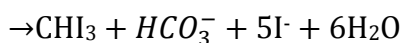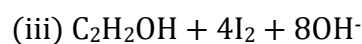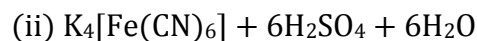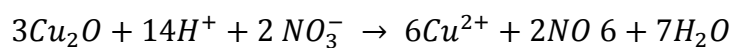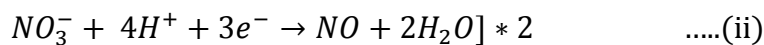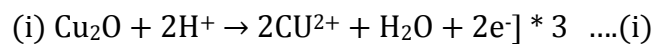
Sol 17.

TIPS/Formulae:

(i) Write balanced reaction for changes.

(ii) M. eq. of Fe^{2+} formed = M. eq. $KMnO_4$ised

$$= V \text{ in ml } * \text{molarity} * x$$

The given redox changes are

$Fe^{3+} + e^- \rightarrow Fe^{2+}$

$2N^- \rightarrow 2N^+ + 2e^-$

[In NH_2OH, O.S. of N = - 1 and in N_2O, O.S. of N = + 1. For two molecules of NH_2OH, electron involved = 4]

$Mn^{7+} + 5e^- \rightarrow Mn^{2+}$

= Meq. Of $KMnO_4$ used = Vol. in ml * Molarity * x

= 12 * 0.02 * 5 =12 [50/10 = 5]

∴Meq.of Fe^{2+} formed by NHH_2OH in 1000 ml of dil. Solution

= 1.2 * 1000/50 = 24

Meq.of original solution

= Meq. of NH_2OH in 1000 ml. of dilute solution

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

$W_{NH\ base\ 2OH} = 24 *16.5/1000 = 0.396$ g
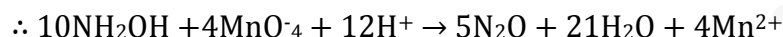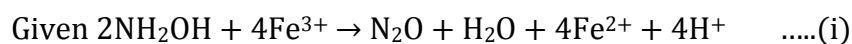
∵ Wt. of NH_2OH in 10 ml. of original solution = 0.396 g

∴ Wt. of NH_2OH in 1 litre of original solution

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

ALTERNATIVESOLTUION:

Given $2NH_2OH + 4Fe^{3+} \rightarrow N_2O + H_2O + 4Fe^{2+} + 4H^+$ .....(i)

And $MnO^-_4 + 5Fe^{2+} + 8H^+ \rightarrow Mn^{2+} + 5Fe^{3+} + 4H_2O$ ...(ii)

∴ $10NH_2OH + 4MnO^-_4 + 12H^+ \rightarrow 5N_2O + 21H_2O + 4Mn^{2+}$

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

Molecular weight of $NH_2OH = 33$

Thus 400 ml of 1M MnO_4^- would react with NH_2OH = 330g

∴ 12 ml of 0.02 M $KMnO_4$ would react with NH_2OH = 330 * 12 *0.02/400 g

∴ Amount of NH_2OH present in 1000 ml of dilute solution 330 *12 *0.02 *1000/400 *50 g

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

∴ A mount of hydroxyl amine in one litre of original solution = 330 *0.02 *12 *1000/4000 *50 * 1000/10 g = 39*6 g

Sol 18.

TIPS/Formulae:

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

(ii) 1 mole of $Na_2S_2O_3$ gives 2 moles of Na^+ and 1 mole $S_2O_3^{2-}$

Molecular wt. of sodium thiosulphate solution $(Na_2S_2O_3)$ = 23 * 2 + 32 * 2 + 16 * 3 = 158

(i) The percentage by weight of $Na_2S_2O_3$

= wt of $Na_2S_2O_3$/wt of solution * 100 = 3 * 158 * 100/100 * 1.25 = 37.92

[wt. of $Na_2S_2O_3$ = Molarity * Molwt]

(ii) Mass of 1 litre solution = 1.25 * 1000 g = 1250 g

[∵ density = 1.25g/l]

Mole fraction of $Na_2S_2O_3$

= Number of moles of $Na_2S_2O_3$/Total number of moles

Moles of water = 1250 – 158 *3/18 = 43.1

Mole fraction of $Na_2S_2O_3$ = 3/3 + 43.1 = 0.065

(iii) 1 mole of sodium thiosulphate ($Na_2S_2O_3$) yields 2 moles

of Na^+ and 1 mole of $S_2O^{2-}_3$

Molality of $Na_2S_2O_3$ = 3 * 1000/776 = 3.87

Molality of Na^+ = 3.87 * 2 = 7.74m

Molality of $S_2O^{2-}_3$ = 3.87m

Sol 19.

One mole of metal carbonate, on heating, decomposes to form 1 mole of oxide with the evolution of 1 mole of CO_2 gas.

$$MCO_3 \xrightarrow{heat} MO + CO_2 \uparrow$$
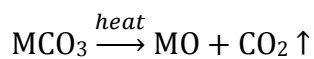
1 mole   1 mole   1 mole

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

From the given data, loss in wt. = 4.08 – 3.64 g = 0.44 g

Conversion of 0.44 g of CO_2 into mole of CO_2

44 of CO_2= 1 mole of CO_2

∴ 0.44 g of CO_2 = 0.44/44 = 0.01 mole

From the equation, it is also obvious that

1 mole of CO_2 ≡ 1 mole of MCO_3=

∴ 0.01 mole of $CO_2 \equiv$ 0.01 mole of MCO_3

Thus the given mixture has 0.01 mole of MCO_3 which will yield 0.01 mole of MO.

From the problem, we also know that

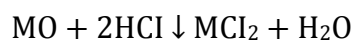16 ml of 2.5 N NaOH $\equiv$ 16 ml of 2.5 n HCl [$N_1V_1 = N_2V_2$]

= 16 * 2.5 ml of N HCI = 40 ml of N HCI

∴ volume of N HCI remain unused = 40 ml

Total volume of N HCI added = 100 ml

∴ Volume of N HCI used = 100 – 40 = 60 ml

Hence 60 ml of N HCI is used in neutralizing BaO and MO according to the following reaction.

$MO + 2HCI \downarrow MCI_2 + H_2O$

Thus 0.01 mole of MO $\equiv$ 0.02 mole of HCI

= 0.02 * 1000 ml of N HCI

= 20 ml of N HCI

∴ Vol. of N HCI used = 60 – 20 = 40 ml

Eq. wt. of BaO = 138 +16/2 = 77

40 ml of N HCI = 40 ml of N BaO = 40 *77/1000 = 3.08 g of BaO

Total wt. of the oxides = 3.64 g

∴ Wt. of MO in the mixture = 3.64 – 3.08 = 0.56 g

But we know that 0.01 mole of MO is present in the residue it means

0.01 mole of MO = 0.56 g of MO

1 mole of MO = 56 g of MO

Suppose the atomic weight of M = a

Then the mol. wt. of MO = a + 16

We also know that 1 mole of MO (i.e. Mol. wt. of Mo) = 56

∴ a + 16 = 56 or a = 56 – 16 = 40

∴ The atomic weight of metal M = 40

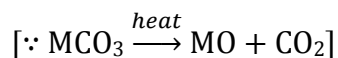Hence, the metal M must be calcium

ALTERNATIVE SOLUTION:

Weight of MCO_3 and BaO = 4.08 g (given)

Weight of residue = 3.64 g (given)

∴ Weight of CO_2 evolved on hating = (4.08 – 3.64) g= 0.44 g

= 0.44/44 = 0.01 mole

Number of moles of MCO_3 ≡ 0.01 mole

$[\because MCO_3 \xrightarrow{heat} MO + CO_2]$
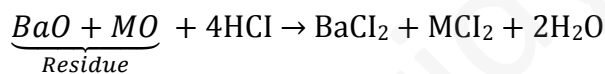
Volume of 1N HCI in which residue is dissolved = 100 ml

Volume of 1N HCI used for dissolution = (100 – 2.5 * 16) ml = 60 ml

= 60/1000 = 0.06 equivalents

The chemical equation for dissolution can be written as

$\underbrace{BaO + MO}_{Residue}$ + 4HCI → $BaCI_2$ + MCI_2 + $2H_2O$

[Number of moles of BaO and MO = 1 + 1 = 2]

Number of moles of BaO + Numebr of moles of MO = 0.06/2 = 0.03

Number of moles of BaO = (0.03 – 0.01)

= 0.02 moles

Molecular weight of BaO = 138 + 16 = 154

∴ Weight of BaO = (0.02 * 154) g

= 30.8 g

Weight of MCO_3 = (4.08 – 3.08) = 1.0 g

Since weight of 0.01 mole of MCO_3 = 1.0 g

$\therefore$ Mol. wt. of $MCO_3 = 1/0.01 = 100$

Hence atomic weight of unknown $M = (100 - 60) = 40$

The atomic weight of metal is 40 so the metal M is Ca
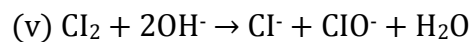
Sol 20.

TIPS/Formulae:

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

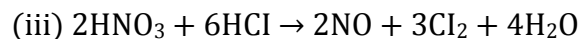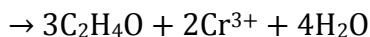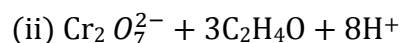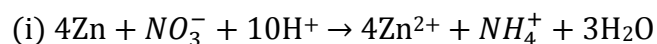While balancing the equations, both the charges and atoms must balance.

(i) $4Zn + NO_3^- + 10H^+ \rightarrow 4Zn^{2+} + NH_4^+ + 3H_2O$

(ii) $Cr_2 O_7^{2-} + 3C_2H_4O + 8H^+$

$\rightarrow 3C_2H_4O + 2Cr^{3+} + 4H_2O$

(iii) $2HNO_3 + 6HCl \rightarrow 2NO + 3Cl_2 + 4H_2O$

(iv) $2Ce^{3+} + S_2O_8^{2-} \rightarrow 2 SO_4^{2-} + 2Ce^{4+}$

(v) $Cl_2 + 2OH^- \rightarrow Cl^- + ClO^- + H_2O$

(vi) $2Mn^{2+} + 5PbO_2 + 4H^+ \rightarrow 2 MnO_4^- + 2H_2O + 5Pb^{2+}$

(vii) $4S + 6OH^- \rightarrow 2S^{2-} + S_2O_3^{2-} + 3H_2O$

(viii) $ClO_3^- + 6I^- + 6H_2SO_4 \rightarrow Cl^- + 6HSO_4^- + 3I_2 + 3H_2O$

(ix) $6Ag^+ + AsH_3 + 3H_2O \rightarrow 6Ag + H_3AsO_3 + 6H^+$
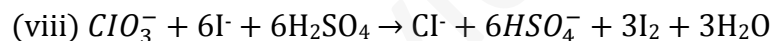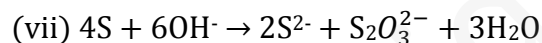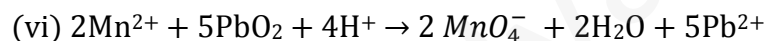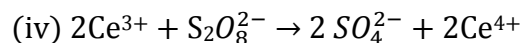
Sol 21.

TIPS/Formulae:

Equivalents of A oxidized = Equivalents of A reduced. Since in acidic medium, A^{n+} is oxidized to AO_3^-, the change in oxidation state from

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

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

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

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

Moles of Mn^-_4 to Mn^{2+}, i.e.

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

[Number of electrons involved $= + 7 – (+2) = 5$]

∴ $1.61 * 10^{-3} * 5 = 2.68 * 10^{-3} * (5 - n)$

$5 – n = 1.61 *5/2.68$ or $n = 5 – 8.05/2.68 = 2$

Sol 22.

TIPS/Formulae:

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

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

(iii) Equivalent of SO_4^{2-} = Equivalents of H_2SO_4 * Eq. wt. of SO_4^{--}

$N * V(ml.) = meq$

Acid mixture contains 5 ml of 8N, HNO_3, 4.8 ml of 5N, HCI

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

$= 5 *8 + 4.8 * 5 + V *34/2000$ [Total volume $= 2 L = 2000$ ml]

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

∵ Eq. of wt. of Na_2CO_3 $10H_2O$ = Mol. wt./2

$= 106 + 180/2 = 143$

N of Na_2CO_3 = Meq. Of Na_2CO_3/Volume of solution (ml)

$= 1/143 /100/1000 = 1/143 * 1000/100 = 0.069N$

$N_1V_1 = N_2V_2$

Or $30 * N_{mixture} = 42.9 * 0.069$

(acid) (sod. carbonate)

∴ $N_{mixture}$ = 42.9 *0.069/30 = 0.0986 N

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   ∴ or V = 133.2/34 = 3.9 ml.

Hence meq. Of H_2SO_4 = V * N of H_2SO_4

= 3.9 * 34 = 132 meq.

= 0.1326 eq. of H_2SO_4

= 0.1326 eq. of SO_4^{2-}

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

(∵ Eq. wt. of SO_4^{2-} = 32 +64/2 = 48)

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

Sol 23.

HI < I_2< ICI < HIO_4; O.N. of I in I_2 = 0, HI = - 1, ICI = + 1, HIO_4 = + 7.

Sol 24.

(i) From the given half-cell reaction,

Here Eq. wt. of $NaBrO_3$ = Mol. wt./6 = 151/6 = 25.17

[∵ number of electron involved = 6]

Now we know that

Meq. = Normally * Vol. in ml. = 85.5 * 0.672 = 57.456

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

= W_{NaBrO_3}/25.17 * 1000

W_{NaBrO_3}/25.17 * 1000 = 57.456 g

∴W_{NaBrO_3} = 1.446 g

Molarity of $NaBrO_3$ = Normality/Valence factor

= 0.672/6 = 0.112 M

(ii) From the given-cell reaction,

Eq. wt. of $NaBrO_3$ = Mol. wt./5 = 151/5 = 30.2

[Number of electron involved per BrO_3^- = 10/2 = 5]

Thus, the amount of $NaBrO_3$ required for preparing 1000 ml. of 1 N $NaBrO_3$ = 30.2 g

∴The amount of $NaBrO_3$ required for preparing 85.5 ml of 0.672 N $NaBrO_3$.

= 30.2 * 0.672 *85.5/1000 = 1.7532 g

Hence, Molality = 0.672/5 = 0.1344 M

Sol 25.

(i) Molal concentration = Molality

= Moles of solute/Mass of solvent in Kg

(ii) Mole fraction of sugar

= Moles of sugar/Total moles in solution

(i) Weight of sugar syrup = 214.2 g

Weight of sugar in the syrup = 34.2 g

∴ Weight of water in the syrup = 214.2 – 34.2 = 180.0 g

Mol. wt. of sugar, $C_{12}H_{22}O_{11}$ = 342

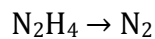∴Molal concentration = 34.2 *1000/342 *180 = 0.56

(ii) Mol. wt. water, H_2O = 18

∴ 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 $KMnO_4$

= No. of equivalents of hydrazine sulphate.

$N_2H_4 \rightarrow N_2$

2　　　0

Change in oxidation state for each N_2H_4 = 2 * 2 = 4

Equivalent weight of $N_2H_6SO_4$ = 130/4 = 32.5

Normality of $KMnO_4$ 5 * 450 ($\because$ valence factor = 5)

Number of equivalents of $KMnO_4$ = 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 or x 32.5/500 = 0.065 g

Hence wt. of $N_2H_6SO_4$ in 10 ml solution = 0.065 g

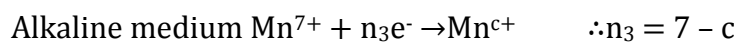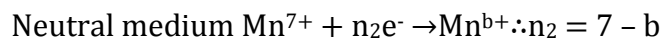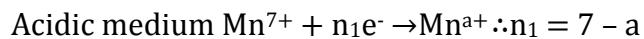$\therefore$ Wt. of $N_2H_6SO_4$ in 1000 ml solution = 6.5 g

Sol 27.

TIPS/Formulae:

No. of equivalents of $KMnO_4$ in neutral medium

= No. of equivalents of reducing agent.

Assuming that $KMnO_4$ shows the following changes during its oxidising nature.

Acidic medium $Mn^{7+} + n_1e^- \rightarrow Mn^{a+} \therefore n_1 = 7 - a$

Neutral medium $Mn^{7+} + n_2e^- \rightarrow Mn^{b+} \therefore n_2 = 7 - b$

Alkaline medium $Mn^{7+} + n_3e^- \rightarrow Mn^{c+}$　　　$\therefore n_3 = 7 - c$

Let V ml. of reducing agent be used for $KMnO_4$ in different medium.

$\therefore$ Meq.of reducing agent

= Meq. of $KMnO_4$ in acid medium

Meq.of $KMnO_4$ in neutral medium

= Meq. of $KMnO_4$ 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 $Mn^{7+} + 5e^- \rightarrow Mn^{a+}$ or $a = +2$

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

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

Further, same volume of reducing agent is treated with $K_2Cr_2O_7$, and therefore

Meq.of reducing agent = Meq. of $K_2Cr_2O_7$

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

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

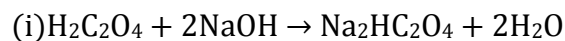## Sol 28.

TIPS/Formulae:

No. of equivalent of $KMnO_4$

= No. of equivalent of reducing agents.

Case I. Reaction of NaOH with $H_2C_2O_4$ and $NaHC_2O_4$.

(i)$H_2C_2O_4 + 2NaOH \rightarrow Na_2HC_2O_4 + 2H_2O$

(ii) $NaHC_2O_4 + NaOH \rightarrow Na_2HC_2O_4 + H_2O$

Number of milliequivalents of NaOH $= N * V = 3.0 * 0.1 = 0.3$

$\therefore$ Combined normality of the mixture titrated with NaOH

$= 0.3/10 = 0.03$

Case II. Reaction of $C_2O_4^-$ ion and $KMnO_4$

(iii) $5C_2O_4^- + MnO_4^- + 16H^+ \rightarrow 2Mn^{2+} + 10CO_2 + 8H_2O$ $KMnO_4$ will react in same manner with both $NaHC_2O_4$ and $H_2C_2O_4$ as it can be seen from the above reaction.

Number of milliequivalents of $KMnO_4 = 4.0 * 0.1 = 0.4$

∴ Combined normality of the mixture titrated with $KMnO_4$

$= 0.4/10 = 0.04$

The difference (0.04N -= 0.03 N = 0.01 N) is due to $NaHC_2O_4$

The total normality of $NaHC_2O_4$ will be $= 0.01 + 0.01 = 0.02$ N

From equation (*ii*) in case I.

Eq. wt. of $NaHC_2O_4 = 112$

Amount of $NaHC_2O_4$ in one litre of solution formed

$= 0.01 * 112 = 1.12$ g and amount of $H_2C_2O_4$

$= 2.02 -$ Wt. of $NaHC_2O_4$ $2.02 - 1.12 = 0.90$ g

Sol 29.

Let the amount of $NaNO_3$ in the mixture $= x$ g

∴ The amount of $Pb(NO_3)_2$ in the mixture $= (5 - x)$ g

Heating effect of sodium nitrate and lead nitrate

$2NaNO_3 \quad \overset{\Delta}{\rightarrow} 2NaNO_2 \quad + \quad O_2$

$2(23+14+48) = 170$ g $\qquad\qquad\qquad 2 * 16 = 32$ g

$2\,Pb(NO_3)_2 \quad \overset{\Delta}{\rightarrow}$

$2(207 +28 +96) = 662$ g

$\qquad\qquad 2PbO_2+ \qquad 4NO_2 \qquad\qquad + \qquad O_2$

$\qquad\qquad\qquad\qquad \underbrace{4(14 + 32) = 184\,g \qquad 2 * 16 = 32\,g}_{216\,g}$
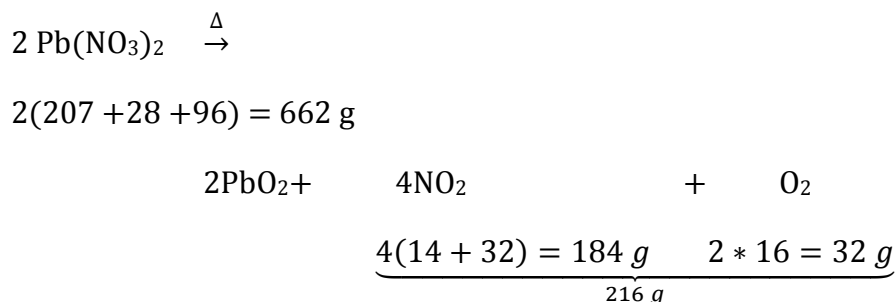
Now since, 170 g of $NaNO_3$ gives $= 32$ g of O_2

∴ x g of $NaNO_3$ gives $= 32/170 * x$ g of O_2

Similarly, 662 g of $Pb(NO_3)_2$ gives = 216 g of gases

(5 - x) g of $Pb(NO_3)_2$ gives = 216/662 * (5 - x) g of gases

$(NO_2 + O_2)$

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

= 5 * 28/100 = 1.4 g

∴ 32 x/170 + 216/662 * (5 -x) = 1.4

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

21184 x + 183600 – 36720 x = 157556

- 15536 x = - 26044

X = 1.676 g

Wt. of $NaNO_3$ = 1.676 g

And Wt. of $Pb(NO_3)_2$ = 5 – 1.676 g = 3.324 g

Sol 30.

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

Mass of H_2SO_4 in 100 ml of 93% H_2SO_4 solution = 93 g

∴ Mass of H_2SO_4 in 1000 ml of the H_2SO_4 solution = 930 g

Mass of 1000 ml H_2SO_4 solution = 1000 * 1.84 = 1840 g

Mass of water in 1000 ml of solution = 1840 – 930 g

$$= 910 g = 0.910 kg$$

Moles of H_2SO_4 = Wt. of H_2SO_4/Mol. wt. of H_2SO_4 = 930/98

∴ Moles of H_2SO_4 in 1 kg of water

= 930/98 * 1/0.910 = 10.43 mol
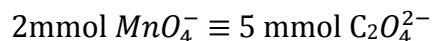
∴ Molality of solution = 10.43m

Sol 31.

In the given problem, a solution containing Cu^{2+} and $C_2O_4^{2-}$ is titrated first with $KMnO_4$ and then with $Na_2S_2O_3$ in presence of KI. In titration with $KMnO_4$, it is the $C_2O_4^{2-}$ ions that react with the $C_2MnO_4^-$ ions. The concerned balanced below may be written as given below.

$2MnO_4^-\ 5\ C_2O_4^{2-} + 16H^+ \rightarrow 2MnO^{2+} + 10CO_2 + 8H_2O$
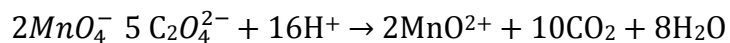
Thus according to the above reaction

2 mmol $MnO_4^- \equiv 5$ mmol $C_2O_4^{2-}$

However,

No. of mmol of MnO_4^- used in titration = Vol. in ml * M

= 22.6 * 0.02 = 0.452 mmol MnO_4^-

since 2 mmol $MnO_4^- \equiv$ mmol $C_2O_4^{2-}$

0.452 mmol $MnO_4^- \equiv 5/2 * 0.452 = 1.130$ mmol $C_2O_4^{2-}$

Titration with $Na_2S_2O_3$ in the presence of KI.

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

$2Cu^{2+} + 2I^- \rightarrow 2Cu^+ + I_2$

$2S_2O_3^{2-} + I_2 \rightarrow 2I^-\ S_4O_6^{2-}$
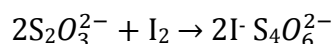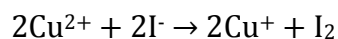
Thus $2Cu^{2+} \equiv I_2 \equiv 2S_2O_3^{2-}$

No. of m mol of $S_2O_3^{2-}$ used in titration

= 0.05 * 11.3 = 0.565 mmol $S_2O_3^{2-}$
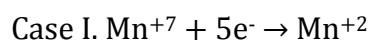
Now since 2 mmol $S_2O_3^{2-} \equiv 2$ mmol Cu^{2+} [From above equation]

0.565 mmol $S_2O_3^{2-} = 2/2 * 0.565$ mmol Cu^{2+}
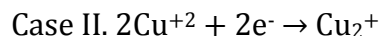
= 0.565 mmol Cu^{2+}

$\therefore$ Molar ratio of Cu^{2+} to $C_2O_4^{2-}$ = 0.565 mmol/1.130 mmol = 1 : 2

Balanced equations in two cases

Case I. $Mn^{+7} + 5e^- \rightarrow Mn^{+2}$

$C_2^{+3} \rightarrow 2C^{+4} + 2e^-$

Case II. $2Cu^{+2} + 2e^- \rightarrow Cu_2^+$

$2I^- \rightarrow I_2 + 2e^-$

and $I_2 + 2e^- \rightarrow 2I^-$

$2S_2^{+2} \rightarrow S_4^{+3/2} + 2e^-$
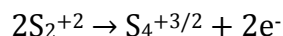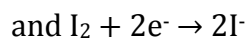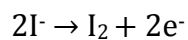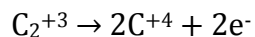
Sol 32.

Mass of Fe_2O_3 in the sample $= 55.2/100 * 1 = 0.552$ g

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

Number of moles of Fe^{3+} ions $= 2 * 3.454 * 10^{-3}$

$$= 6.9 * 10^{-3} mol = 6.90 \ mmol$$

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.

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

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

$= 17 * 4 = 68$ ml.

Amount of oxidation used $= 68 * 0.0167$ mmol

$= 1.1356$ mmol

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

∴ 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 HCI

∴ 2 g of sample require = 150/1.5 ml of M/10 HCI

= 200 ml. of M/10 HCI

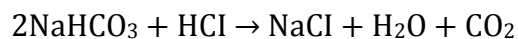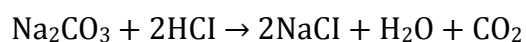On heating, the sample, only $NaNCO_3$ undergoes decomposition as given below.

$2NaHCO_3 \rightarrow Na_2CO_3 + H_2O + CO_2 \uparrow$

2 moles   1 mole   1 mole

2 equ

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

$2NaHCO_3 + HCI \rightarrow NaCI + H_2O + CO_2$

1 eq   1 eq

$Na_2CO_3 + 2HCI \rightarrow 2NaCI + H_2O + CO_2$

1 mole   1 mole

2 eq   2 eq

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

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

Number of moles of CO_2 formed, i.e.

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

Moles of $NaHCO_3$ in the sample (2 g) $= 2 * 0.005 = 0.01$

Equivalent of $NaHCO_3 = 0.01$

Wt. of $NaHCO_3 = 0.01 * 84 = 0.84$ g

% of $NaHCO_3 = 0.84 *100/2 = 42\%$

Equivalent of $Na_2CO_3 = 0.02 – 0.01 = 0.01$

Wt. of $Na_2CO_3 = 0.01 * 53 = 0.53$ g

$\therefore$ % of $Na_2CO_3 = 0.53 *100/2 = 26.5\%$

$\therefore$ % of Na_2SO_3 in the mixture $= 100 – (42 + 26.5) = 31.5\%$

Sol 34.

Reaction involved titration is

$KIO_3 + 2KI + 6HCI \rightarrow 3 ICI + 3KCI + 3H_2O$

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$_3$)$_2$ = 0.25 * 45/1000 = 0.01125

$\therefore$ Initital 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^- = 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) $NO_3^- = 0.0225/70 * 1000 = 0.3214$ M

(iii) $Cr^{3+} = 0.005/70 * 1000 = 0.0714$ 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 Fe^{2+} 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 $Na_2SO_4. 10H_2O$

Molecular mass of $Na_2SO_4. 10H_2O$

= [2 * 23 + 32.1 + 4 * 16] + 10 (1.01 * 2 + 16) = 322.3 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 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^{-3}

$= 1077.2 * 10^3/10^6$ gm cm$^{-3} = 1.0772$ g cm^{-3}

Total weight of sol $= V * d = 1\ dm^3 * d$

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

Weight of water $= 1077.2 – 35.252 = 1041.67$ g
Molality of sol. $0.25/1041.67$ g $* 1000$ g $= 0.2399 = 0.24$ m

Number of moles of water in the solution $= 1041.67/18 = 57.87$
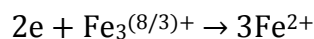
Mole fraction of Na_2SO_4

$=$ No. of moles of Na_2SO_4/Total number of moles $= 0.25/0.25 + 57.87$

$= 0.0043 = 4.3 * 10^{-3}$

Sol 38.

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

For $Fe_3O_4 \rightarrow 3FeO$

$2e + Fe_3^{(8/3)+} \rightarrow 3Fe^{2+}$

Thus, valence factor for Fe_3O_4 is 2 and for FeO is 2/3

For, $Fe_2O_3 \rightarrow 2FeO; 2e + Fe_2^{3+} \rightarrow Fe^{2+}$ …(1)
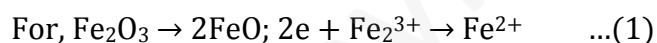
Thus valence factor for Fe_3O_3 is 2 and for FeO is 1.

Let Meq.of Fe_3O_4 and Fe_3O_3 be a and b respectively.

$\therefore$ Meq.of $Fe_3O_4 +$ Meq. $Fe_3O_3 =$ Meq. of I_2 liberated

$=$ Meq. of hypo used

$A + b = 11 * 0.5 * 100/20 = 27.5$

Now, the Fe^{2+} ions are again oxidized to Fe^{3+} by $KMnO_4$.

Note that in the change

$Fe^{2+} \rightarrow Fe^{3+} + e^-$; valence factor of Fe^{2+} is 1.

Thus,

Meq. of Fe^{2+} (from Fe_3O_4) + Meq. of Fe^{2+} (from Fe_3O_3)

= Meq. of $KMnO_4$ used   .....(2)

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

Then Meq. of Fe^{2+} (from Fe_3O_4) = a

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

Then Meq. of Fe^{2+} (from Fe_3O_4) = 3a/2   .....(3)

Similarly, form Eq. (2), Meq. of Fe^{2+} from (Fe_3O_3) = b.

∴ 3a/2 + b = 0.25 * 5 * 12.8 * 100/50 = 32

or 3a + 2b = 64

from Eqs (3) and (4)

Meq.of Fe_3O_4 = a = 9 &Meq. of Fe_3O_3 = b = 18.5

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

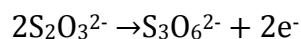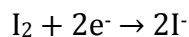And $W_{Fe\ base\ 30\ base\ 3}$ = 18.5 *160/2 *1000 = 1.48 g

∴ % of Fe_3O_4 = 1.044 *100/3 = 34.8

and % of Fe_3O_3 = 1.48 *100/3 = 49.33

Sol 39.

Write the reactions taking place, balance them and equate moles of I_2 and $Na_2S_2O_3$.

KIO_3 + 5KI → $3K_2O$ + $3I_2$

i.e., $2.I^{5+}$ + $10e^-$ → I^0_2

$2I^-$ → I^0_2 + $2e^-$
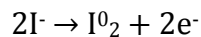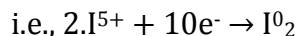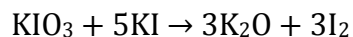
Now liberated I_2 reacts with $Na_2S_2O_3$

I_2 + $2e^-$ → $2I^-$

$2S_2O_3^{2-}$ → $S_3O_6^{2-}$ + $2e^-$

∴millimole ratio of I_2 : S_2O_3 1 : 2

Thus, m mole of I_2 liberated

$= m$ mole of $Na_2S_4O_6$ used $* 1/2 = 45 * M * 1/2$
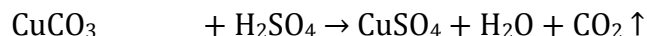
[M is molarity of thiosulphate]

Also m mole of $KIO_3 = 0.1/214 * 1000$

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

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

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

Sol 40.

Use molarity equation to find volume of H_2SO_4 solution.

$CuCO_3 \qquad + H_2SO_4 \rightarrow CuSO_4 + H_2O + CO_2 \uparrow$

$63.5+12+48.98 \qquad 98g$

$= 123.5$ 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

Weight of required$H_2SO_4 = 0.39676$ g

Weight of solute in grams

$=$ Mol. wt. *Molarity *Volume in mL/1000

$0.39676 = 98 *0.5 * V/1000$

or $V = 0.39676 *1000/90 *0.5$ ml

volume of H_2SO_4solution $= 8.097$ 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

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

Volume of virus = $\pi r^2 1$

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

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

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

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

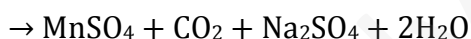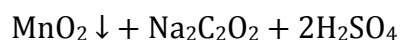∴ Mol. wt. of virus = = $1.178 * 10^{-19} * 6.02 * 10^{23}$

= $7.09 * 10^7$

Sol 42.

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

The given reactions are :

$MnO_2 \downarrow + Na_2C_2O_2 + 2H_2SO_4$

$\rightarrow MnSO_4 + CO_2 + Na_2SO_4 + 2H_2O$

∴ Meq. Of $MnO_2 \equiv$ Meq of $C_2O_4 = 10 * 0.2 * 2 = 4$

∴ mM of $MnO_2 = 4/2 = 2$ [$Mn^{4+} + 2e \rightarrow Mn^{2+}$ ∴ Valance factor of $MnO_2 = 2$]

Now $2KMnO_4 + 3MnSO_4 + 2H_2O$
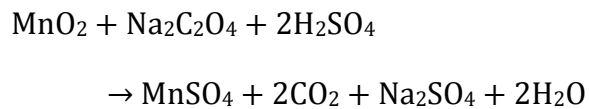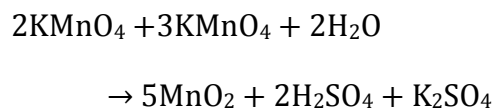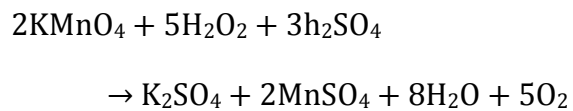
$\rightarrow 5MnO_2 \downarrow + K_2SO_4 + 2H_2O$
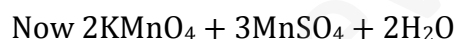
Since eq. wt. of MnO_2 is derived from $KMnO_4$ and $MnSO_4$ both, thus it is better to proceed by mole concept

mM of $KMnO_4 \equiv$ mM of $MnI_2 * (2/5) = 4/5$

also $5H_2O_2 + 2KMnO_4 + 3H_2SO_4$

$\rightarrow 2MnSO_4 + K_2SO_4 + 8H_2O + 5O_2$

∴ mM of $H_2O_2 =$ mM of $KMnO_4 =$ mm OF $KMnO_4 * 5/2 = 4/5 * 5/2 = 2$

∴ $M_{H_2O_2} * 20 = 2$ or $M_{H_2O_2} = 0.1$

$2KMnO_4 + 5H_2O_2 + 3h_2SO_4$

$\rightarrow K_2SO_4 + 2MnSO_4 + 8H_2O + 5O_2$

$2KMnO_4 + 3KMnO_4 + 2H_2O$

$\rightarrow 5MnO_2 + 2H_2SO_4 + K_2SO_4$

$MnO_2 + Na_2C_2O_4 + 2H_2SO_4$

$\rightarrow MnSO_4 + 2CO_2 + Na_2SO_4 + 2H_2O$

Sol 43.

1 litre water = 1 kg i.e. 1000 g water ($\because d = 100$ kg/m^3)

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

So, molarity of water = 55.55M