SOLVED EXAMPLES

Ex. 1 The weight of sodium bromate required to prepare 55.5 mL of 0.672 N solution for cell reaction,

$BrO_3^- + 6H^+ + 6e^- \longrightarrow Br^- + 3H_2O$, is

(A) 1.56 g **(B)** 0.9386 g **(C)** 1.23 g **(D)** 1.32 g

Sol. Meq. of $NaBrO_3 = 55.5 \times 0.672 = 37.296$

Let weight of $NaBrO_3 = W$

$$\therefore \frac{W}{M_{NaBrO_3}} \times 6 \times 1000 = 37.296 \text{ (equivalent weight} = M/6) \text{ of n-factor} = 6$$

$$\therefore \frac{M}{151} \times 6 \times 1000 = 37.296$$

$$\therefore W = 0.9386 \text{ g}$$

Hence, **(B)** is the correct answer.

Ex. 2 $NaIO_3$ reacts with $NaHSO_3$ according to equation

$IO_3^- + 3HSO_3^- \longrightarrow I^- + 3H^+ + 3SO_4^{2-}$

The weight of $NaHSO_3$ required to react with 100 mL of solution containing 0.68 g of $NaIO_3$ is

(A) 5.2 g **(B)** 0.2143 g **(C)** 2.3 g **(D)** none of the above

Sol. Meq. of $NaHSO_3$ = Meq. of $NaIO_3 = N \times V = \dfrac{0.68}{198} \times 6 \times 1000 \; (I^{5+} + 6e^- \rightarrow I^-)$

$$\therefore \frac{W_{NaHSO_3}}{M_{NaHSO_3}} \times 2 \times 1000 = \frac{0.68}{198} \times 6 \times 100$$

$$W_{NaHSO_3} = \frac{0.68 \times 6 \times 100 \times 104}{198 \times 1000} = 0.2143$$

Hence **(B)** is the correct answer.

Ex. 3 If 0.5 moles of $BaCl_2$ is mixed with 0.1 moles of Na_3PO_4, the maximum amount of $Ba_3(PO_4)_2$ that can be formed is

(A) 0.7 mol **(B)** 0.5 mol **(C)** 0.2 mol **(D)** 0.05 mol

Sol. Let us first solve this problem by writing the complete balanced reaction.

$3BaCl_2 + 2Na_3PO_4 \longrightarrow Ba_3(PO_4)_2\downarrow + 6NaCl$

We can see that the moles of $BaCl_2$ used are $\dfrac{3}{2}$ times the moles of Na_3PO_4. Therefore, to react with 0.1 mol of Na_3PO_4, the moles of $BaCl_2$ required would be $0.1 \times \dfrac{3}{2} = 0.15$. Since $BaCl_2$ is 0.5 mol, we can conclude that Na_3PO_4 is the limiting reagent. Therefore, moles of $Ba_3(PO_4)_2$ formed is $0.1 \times \dfrac{3}{2} = 0.05$ mol.

Hence, **(D)** is the correct answer.

Ex. 4 A 0.1097 g sample of As_2O_3 required 36.10 mL of $KMnO_4$ solution for its titration. The molarity of $KMnO_4$ solution is.

(A) 0.02 **(B)** 0.04 **(C)** 0.0122 **(D)** 0.3

Sol.

n-factor = 5

$$As_2O_3 + MnO_4^- \qquad 2AsO_4^{3-} + Mn^{2+}$$

n-factor = 4

Let, molarity of $KMnO_4$ solution be M

$\therefore$ Eq. of As_2O_3 = Eq. of $KMnO_4$ solution

$$\frac{0.1097}{198} \times 4 = \frac{36.10 \times M \times 5}{1000} \quad \left(\text{Equivalent weight } As_2O_3 = \frac{198}{4}\right)$$

Molarity = 0.0122 M

Hence, **(C)** is the correct answer.

Ex. 5 In basic medium, CrO_4^{2-} oxidize $S_2O_3^{2-}$ to form SO_4^{2-} and itself changes to $Cr(OH)_4^-$. How many mL of 0.154 M CrO_4^{2-} are required to react with 40 mL of 0.246 M $S_2O_3^{2-}$?

(A) 200 mL **(B)** 156.4 mL **(C)** 170.4 mL **(D)** 190.4 mL

Sol. $40 \times 0.246 \times 8 = V \times 0.154 \times 3$ (Meq. of $S_2O_3^{2-}$ = Meq. of CrO_4^{2-})

$\therefore$ V = 170.4 mL

Hence, **(C)** is the correct answer.

Ex. 6 10 mL of 0.4 M $Al_2(SO_4)_3$ is mixed with 20 mL of 0.6 M $BaCl_2$. Concentration of Al^{3+} ion in the solution will be.

(A) 0.266 M **(B)** 10.3 M **(C)** 0.1 M **(D)** 0.25 M

Sol.	$Al_2(SO_4)_3$	+	$BaCl_2$	$\longrightarrow$	$BaSO_4\downarrow$	+	$AlCl_3$
Initial Meq.	$10 \times 0.4 \times 6$ $= 24$		$20 \times 0.6 \times 2$ $= 24$		0		0
Final Meq.	0		0		24		24

$$[Al^{3+}] = \frac{24}{30 \times 3} = 0.266\ M$$

Hence **(A)** is the correct answer.

Ex. 7 0.52 g of a dibasic acid required 100 mL of 0.2 N NaOH for complete neutralization.

The equivalent weight of acid is

(A) 26 **(B)** 52 **(C)** 104 **(D)** 156

Sol. Meq. of Acid = Meq. of NaOH

$$\frac{0.52}{E} \times 1000 = 100 \times 0.2$$

$\therefore$ E = 26

Hence **(A)** is the correct answer.

Ex. 8 34 g hydrogen peroxide is present in 1120 mL of Solution : This solution is called

(A) 10 volume **(B)** 20 volume **(C)** 30 volume **(D)** 32 volume

Sol. Wt. of H_2O_2 in 1 mL $= \frac{34}{1120}$ g

$$H_2O_2 \rightarrow H_2O + \frac{1}{2}O_2$$

34 g of H_2O_2 gives 11200 mL of O_2 at STP

$$\therefore \frac{34}{1120} \text{ g of } H_2O_2 \equiv \frac{11200}{34} \times \frac{34}{1120} = 10 \text{ mL of } O_2 \text{ at STP.}$$

Hence, **(A)** is the correct answer.

Ex. 9 The number of moles of $KMnO_4$ that will be required to react with 2 mol of ferrous oxalate is

(A) $\frac{6}{5}$ **(B)** $\frac{2}{5}$ **(C)** $\frac{4}{5}$ **(D)** 1

Sol. $Mn^{7+} + 5\,e^- \to Mn^{2+}\,] \times 3$

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

$C_2O_4^{2-} \to 2CO_2 + 2e^-$

3 moles of $KMnO_4$ = 5 moles of FeC_2O_4

$\therefore$ 2 mol of ferrous oxalate $\equiv \frac{6}{5}$ mole of $KMnO_4$

Hence, **(A)** is the correct answer.

Ex. 10 The minimum quantity of H_2S needed to precipitate 63.5 g of Cu^{2+} will be nearly.

(A) 63.5 g **(B)** 31.75 g **(C)** 34 g **(D)** 2.0 g

Sol. Meq. of H_2S = Meq. of Cu^{2+}

$$\therefore \frac{W_{H_2S}}{34/2} \times 1000 = \frac{63.5}{63.5/2} \times 1000$$

$\therefore W_{H_2S} = 34$ g

Hence, **(C)** is the correct answer.

Ex. 11 Which of the following is / are correct?

(A) g mole wt. = mol. wt. in g = wt. of 6.02×10^{23} molecules

(B) mole = N molecule = 6.02×10^{23} molecules

(C) mole = g molecules

(D) none of the above

Sol. **(A)**, **(B)** and **(C)**

Ex. 12 8 g of O_2 has the same number of molecules as

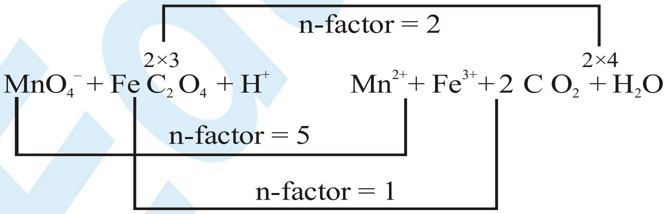
(A) 7 g of CO **(B)** 14 g of CO **(C)** 28 g of CO **(D)** 11 g of CO_2

Sol. **(A)** and **(D)**

Ex. 13 What volume of 0.1 M $KMnO_4$ is needed to oxidize 100 mg of FeC_2O_4 in acid solution ?

(A) 4.1 mL **(B)** 8.2 mL **(C)** 10.2 mL **(D)** 4.6 mL

Sol. Meq. of $KMnO_4$ = Meq. of FeC_2O_4



$MnO_4^- + Fe\,C_2O_4 + H^+ \qquad Mn^{2+} + Fe^{3+} + 2\,CO_2 + H_2O$

$\therefore$ V = 4.1 mL

Hence, **(A)** is the correct answer.

Ex. 14 What volume of 6 M HNO_3 is needed to oxidize 8 g of Fe^{2+} to Fe^{3+}, HNO_3 gets converted to NO?

(A) 8 mL **(B)** 7.936 mL **(C)** 32 mL **(D)** 64 mL

Sol. Meq. of HNO_3 = Meq. of Fe^{2+}

$$\text{or } 6 \times 3 \times V = \frac{8}{56} \times 1000$$

$V = 7.936$ mL

n-factor = 3

$$(\overset{+5}{NO_3^-} \quad \overset{2+}{NO})$$

Hence, **(B)** is the correct answer.

Ex. 15 0.5 g of fuming H_2SO_4 (oleum) is diluted with water. This solution is completely neutralized by 26.7 mL of 0.4 N KOH. The percentage of free SO_3 in the sample is

(A) 30.6% **(B)** 40.6% **(C)** 20.6% **(D)** 50%

Sol. Meq. of H_2SO_4 + Meq.of SO_3 = Meq. of KOH

$$\therefore \frac{(0.5 - x)}{98/2} \times 1000 + \frac{x}{80/2} \times 1000 = 26.7 \times 0.4$$

$$\therefore x = 0.103$$

$$\therefore \% \text{ of } SO_3 = \frac{0.103}{0.5} \times 100 = 20.6\%$$

Hence, **(C)** is the correct answer.

Ex. 16 The eq. wt. of a substance is the weight which either combines or displaces.

(A) 8 part of O **(B)** 2 part of H **(C)** 35.5 part of Cl **(D)** none of the above

Sol. **(A)** and **(C)**

Ex. 17 'A' g of a metal displaces V mL of H_2 at NTP. Eq. wt of metal E is / are :

(A) $E = \frac{A}{\text{Wt. of } H_2 \text{ displaced}} \times$ Eq. wt. of H

(B) $E = \frac{A \times 1.008 \times 22400}{\text{Volume of } H_2 \text{ displaced} \times 2} \times$ Eq. wt. of H

(C) $E = \frac{A \times 1.008}{\text{Volume of } H_2 \text{ displaced} \times 0.0000897}$

(D) none of the above

Sol. **(A)**, **(B)** and **(C)**

Ex. 18 Which of the following is/are redox reaction (s)?

(A) $BaO_2 + H_2SO_4 \rightarrow BaSO_4 + H_2O_2$ **(B)** $2BaO + O_2 \rightarrow 2BaO_2$

(C) $2KClO_3 \rightarrow 2KCl + 3O_2$ **(D)** $SO_2 + 2H_2S \rightarrow 2H_2O + 3S$

Sol. **(B)**, **(C)** and **(D)**

Ex. 19 Which of the following statements is/are true if 1 mol of H_3PO_x is completely neutralized by 40 g of NaOH?

(A) x = 2 and acid is monobasic **(B)** x = 3 and acid is dibasic

(C) x = 4 and acid is tribasic **(D)** x = 2 and acid does not form acid salt

Sol. **(A)** and **(D)**.

Ex. 20 In the reaction,

$3Br_2 + 6CO_3^{2-} + 3H_2O \rightarrow 5Br^- + BrO_3^- + 6HCO_3^-$

(A) bromine is oxidized and carbonate is reduced

(B) bromine is oxidized

(C) bromine is reduced

(D) it is disproportionation reaction or autoredox change

Sol. **(B)**, **(C)** and **(D)**

Ex. 21 A 20 g sample of only CuS and Cu_2S was treated with 100 mL of 1.25 M $K_2Cr_2O_7$. The products obtained were Cr^{3+}, Cu^{2+} and SO_2. The excess oxidant was reacted with 50 mL of Fe^{2+} Solution : 25 mL of the same Fe^{2+} solution required 0.875 M $KMnO_4$ under acidic condition, the volume of $KMnO_4$ used was 20 mL. Find the % of CuS and Cu_2S in the sample.

Sol. Equivalents of dichromate initially $= \dfrac{1.25 \times 6 \times 100}{1000} = 0.75$

Equivalents of Fe^{2+} in 25 mL $= \dfrac{0.875 \times 5 \times 5 \times 20}{1000} = 0.0875$

Equivalents of Fe^{2+} in 50 mL $= 0.0875 \times 2 = 0.175$

Equivalents of excess dichromate = 0.175

$\therefore$ Equivalents of dichromate consumed by (CuS and Cu_2S)

$= 0.75 - 0.175 = 0.575$

If x g is the mass of CuS, the mass of Cu_2S is (10 – x) g

$$\frac{x}{95.5} \times 6 + \frac{(10 - x)}{159} \times 8 = 0.575$$

$\therefore x = 5.74$ g

$$\% \text{ CuS} = \frac{5.74}{20} \times 100 = 28.7\ \%$$

$\%\ Cu_2S = 71.3\ \%$

Ex. 22 2.249 g of a sample of pure $BaCO_3$ and impure $CaCO_3$ containing some CaO was treated with dil. HCl and it evolved 168 mL of CO_2 at N.T.P. From this solution, $BaCrO_4$ was precipitated filtered and washed. The precipitate was dissolved in dil. H_2SO_4 and diluted to 100 mL. 10 mL of this solution when treated with KI solution liberated iodine which required exactly 20 mL of 0.05 N $Na_2S_2O_3$. Calculate the percentage of CaO in the sample.

Sol. Let, weight of $BaCO_3$, $CaCO_3$ and CaO are x,y and z respectively.

$\therefore x + y + z = 2.249$

$BaCO_3 \longrightarrow BaCrO_4$

Redox change $\quad Cr^{6+} + 3e^- \longrightarrow Cr^{3+}$

$\quad 2I^- \longrightarrow I_2 + 2e^-$

Meq. of $BaCO_3$ = Meq. of $BaCrO_4$ = Meq. of I_2

$$\therefore \frac{x}{197/3} \times 1000 = 20 \times 0.05 \times \frac{100}{10}$$

$\therefore x = 0.657$ g ....(1)

The equivalent weight of $BaCrO_4$ is M/3, therefore for $BaCO_3$, it should be M/3 also because mole ratio of $BaCO_3$ and $BaCrO_4$ is 1 : 1.

Applying POAC for C atom,

Moles of C in $BaCO_3$ + Moles of C in $CaCO_3$ = Moles of C in CO_2

$\therefore \quad \frac{x}{197} + \frac{y}{100} = \frac{168}{22400}$

$\Rightarrow \quad 200x + 294y = 295.5$ ....(2)

From equation (1) and (2)

$y = 0.416$ g

$\therefore \quad 0.657 + 0.416 + z = 2.249$

$z = 1.176$

$\% \text{ of CaO} = \frac{1.176}{2.249} = 52.29\,\%$

Ex. 23 For estimating ozone in the air, a certain volume of air is passed through an alkaline KI solution when O_2 is evolved and iodide is oxidized to iodine. When such a solution is acidified, free iodine is evolved which can be titrated with standard $Na_2S_2O_3$ Solution : In an experiment, 10 L of air at 1 atm and 27°C were passed through an alkaline KI solution, and at the end, the iodine was entrapped in a solution which on titration as above required 1.5 mL of 0.02 N $Na_2S_2O_3$ solution. Calculate volume percentage of ozone in the sample.

Sol. The chemical reaction is, $H_2O + KI + O_3 \longrightarrow I_2 + O_2 + KOH$

Milliequivalents of iodine = Milliequivalents of KI = Milliequivalents of O_3 reacted

Milliequivalents of $Na_2S_2O_3 = 1.5 \times 0.02 = 3 \times 10^{-2}$

Millimoles of iodine $= \frac{3 \times 10^{-2}}{2} = 1.5 \times 10^{-2}$ [✈ n-factor for iodine = 2]

Millimoles of ozone $= 1.5 \times 10^{-2}$

Volume of ozone $= \frac{nRT}{P} = \frac{1.5 \times 10^{-5} \times 0.0821 \times 300}{1} = 36.945 \times 10^{-5}$ litre

Volume percent of ozone $= \frac{36.945 \times 10^{-5}}{10} \times 100 = 3.6945 \times 10^{-3}$

Ex. 24 What volume of 0.40 M H_2SO_4 is required to produce 34.0 g of H_2S by the reaction,

$8\,KI + 5\,H_2SO_4 \rightarrow 4\,K_2SO_4 + 4\,I_2 + H_2S + 4\,H_2O$?

Sol. 1 mole of $H_2S \equiv 5$ moles of H_2SO_4

34 g of $H_2S \equiv 5$ moles of H_2SO_4

$0.40 \times V_{H_2SO_4} = 5$

$\therefore \; V_{H_2SO_4} = \frac{5}{0.40} = 12.5$ litre

Ex. 25 To 50 L of 0.2 N NaOH, 2.5 L of 2N HCl and 15 L of 0.1 N $FeCl_3$ solutions are added. What weight of Fe_2O_3 can be obtained from the precipitate? Also report the normality of NaOH left in resultant solution :

Sol. Eq. of NaOH = $50 \times 0.2 = 10$

Eq. of HCl = $2.5 \times 2 = 5$

Eq. of NaOH left after reaction with HCl = $10 - 5 = 5$

$FeCl_3 + NaOH \rightarrow Fe(OH)_3\downarrow \xrightarrow{\Delta} Fe_2O_3$

$FeCl_3$ reacts with NaOH to give $Fe(OH)_3$ which on ignition gives Fe_2O_3

$\therefore$ Eq. of NaOH used for $FeCl_3$ = Eq. of $Fe(OH)_3$

= Eq. of Fe_2O_3

$= 15 \times 0.1 = 3.5$

$\therefore$ Eq. of NaOH left finally = 5 – 1.5 = 3.5

Normality of NaOH in the resultant solution = $\frac{3.5}{70} = 0.05$

$\frac{W_{Fe_2O_3}}{M_{Fe_2O_3}} \times 6 = 1.5$ (n-factor for $Fe_2O_3 = 6$)

$W_{Fe_2O_3} = \frac{1.5 \times 160}{6} = 40g$

Ex. 26 One litre of a mixture of O_2 and O_3 at NTP was allowed to react with an excess of acidified solution of KI. The iodine liberated required 30 mL of M/10 $Na_2S_2O_3$ solution for titration. What is the weight percent of ozone in the mixture ? Ultraviolet radiation of wavelength 300 mm can decompose ozone. Assuming that one photon can decompose one ozone molecule, how many photons would have been required for the complete decomposition of ozone in the original mixture?

Sol. $O_3 + 2\,KI + H_2O \rightarrow 2KOH + I_2 + O_2$

$2Na_2S_2O_3 + I_2 \rightarrow Na_2S_4O_6 + 2NaI$

Millimoles of O_3 = Millimoles of I_2 = ½ × Millimoles of $Na_2S_2O_3$

= ½ × 30 × 1/10 = 1.5 millimoles

= 0.0015 moles

Total moles of O_3 and O_2 in the mixture

PV = n RT

1 × 1 = n × 0.0821 × 273

$\therefore$ n = 0.044

Moles of O_2 = 0.044 – 0.0015 = 0.0425

$W_{O_2} = 0.0425 \times 32\,g = 1.36\,g$

$W_{O_3} = 0.0015 \times 48\,g = 0.072\,g$

$\therefore$ % of $O_3 = \frac{0.072}{1.432} \times 100 = 5.028\,\%$

No. of photons required for decomposition of Ozone molecules = $0.0015 \times 6.023 \times 10^{23} = 0.90 \times 10^{21}$

Ex. 27 A 2.18 g sample contains a mixture of XO and X_2O_3. It reacts with 0.015 moles of $K_2Cr_2O_7$ to oxidize the sample completely to form XO_4^- and Cr^{3+}. If 0.0187 mole of XO_4^- is formed, what is the atomic mass of X ?

Sol. $XO + K_2Cr_2O_7 \longrightarrow Cr^{3+} + XO_4^-$

$X_2O_3 + K_2Cr_2O_7 \longrightarrow Cr^{3+} + XO_4^-$

Let, wt. of XO in the mixture be x g

Equivalent of $K_2Cr_2O_7$ consumed by the mixture= 0.015 × 6

Equivalents of XO = $\frac{x}{x+16} \times 5$

Equivalents of X_2O_3 = $\frac{2.18 - x}{2x + 48} \times 8$

$$\therefore \frac{x}{x+16} \times 5 + \frac{2.18 - x}{2x - 148} \times 8 = 0.015 \times 6$$

Since 1 mole of XO gives 1 mole XO_4^- and 1 mole of X_2O_3 gives 2 moles of XO_4^-,

$$\therefore \frac{x}{x+16} + \frac{2x(2.18-x)}{2x+48} = 0.0187$$

On solving, x = 99

Ex. 28 An aqueous solution containing 0.10 g KIO_3 (formula wt. = 214.0) was treated with an excess of KI Solution : The solution was acidified with HCl. The liberated I_2 consumed 55 mL of thiosulphate solution to decolourize the blue starch-iodine complex. Calculate molarity of the sodium thiosulphate solution :

Sol. Moles of $KIO_3 = \frac{0.1}{214} = 0.00047$

$\therefore$ Moles of I_2 liberated from $KIO_3 = \frac{0.00047}{2} = 0.000235$

Moles of KI reacting = 0.00047 × 5 = 0.00235 (∵ n-factor for KIO_3 and KI are 5 and 1 respectively)

Moles of I_2 produced from KI $= \frac{0.00235}{2} = 0.001175$

Total moles of I_2 produced and reacted = 0.000235 + 0.001175 = 0.00141 equivalents of I_2 reacted = 0.00141 × 2 = 0.00282 = equivalents of thiosulphate Solution :

Molarity $= \frac{0.00282 \times 1000}{55}$ = 0.0512 M (For thiosulphate n-factor = 1)

Ex. 29 Mg can reduce NO_3^- to NH_3 in basic medium.

$NO_3^- + Mg(s) + H_2O \rightarrow Mg(OH)_2(s) + OH^-(aq.) + NH_3(g)$

A 25.0 mL sample of NO_3^- solution was treated with Mg. The NH_3 (g) was passed into 100 mL of 0.15 N HCl. The excess of HCl required 32.10 mL of 0.10 N NaOH for neutralization. What was the molarity of NO_3^- ions in the original sample ?

Sol. Meq. of NH_3 formed = Meq. of HCl used

= 100 × 0.15 – 32.10 × 0.10

= 11.79

Here, n-factor of NH_3 is 1 (acid - base reaction)

For redox change,

$$\overset{+5}{NO_3^-} \xrightarrow{+8e^-} \overset{-3}{NH_3} \quad (\text{n - factor} = 8)$$

$\therefore$ Meq. of NH_3 for n-factor 8 = 8 × 11.79

$\therefore$ Normality of $NO_3^- = \frac{94.32}{25} = 3.77$

Molarity of $NO_3^- = \frac{3.77}{8} = 0.47125$

Ex. 30 Chile salt peter a source of $NaNO_3$ also contains $NaIO_3$. The $NaIO_3$ can be used as a source of iodine produced in the following reactions :

Step 1 : $IO_3^- + 3HSO_3^- \longrightarrow I^- + 3H^+ + 3SO_4^{2-}$

Step 2 : $5I^- + IO_3^- + 6H^+ \longrightarrow 3I_2 + 3H_4O$

One litre of chile salt peter solution containing 6.80 g $NaIO_3$, is treated with stoichiometric quantity of $NaHSO_3$. Now additional amount of same solution is added to the reaction mixture to bring about the second reaction. How many grams of $NaHSO_3$ are required in step 1 and what additional volume of chile salt peter must be added in step 2 to bring in complete conversion of I^- to I_2 ?

Sol. Meq. of $NaHSO_3$ = Meq. of $NaIO_3$ = $N \times V = \frac{6.8}{198} \times 6 \times 1000$

$I^{5+} + 6e^- \longrightarrow I^-$ (For KIO_3, n-factor = 6)

$\therefore$ Meq. of $NaHSO_3$ = 206.06

$$\frac{W_{NaHSO_3}}{M/2} \times 1000 = 206.06$$

$$\Rightarrow W_{NaHSO_3} = \frac{206.06 \times 104}{2 \times 1000} = 10.715\text{ g}$$

Also, Meq. of I^- formed using n-factor 6 = 206.06

In step 2, n-factor I^- is 1 and n-factor for IO_3^- is 5

Meq. of I^- formed using n-factor 1 = $\frac{206.06}{6}$

Meq. of $NaIO_3$ used in 2nd step = $\frac{206.06}{6}$

$$\Rightarrow \frac{6.8}{198} \times 5 \times V = \frac{206.06}{6}$$

$\therefore V_{NaIO_3}$ = 199.99 mL

Ex. 31 1 g sample of $AgNO_3$ is dissolved in 50 mL of water. It is titrated with 50 mL of KI Solution : The AgI precipitated is filtered off. Excess of KI in filtrate is titrated with M/10 KIO_3 in presence of 6 M HCl till all I^- converted into ICI. It requires 50 ml of M/10 KIO_3 Solution : 20 mL of the same stock solution of KI require 30 mL of M/10 KIO_3 under similar conditions. Calculate % of $AgNO_3$ in the sample. The reaction is :

$KIO_3 + 2KI + 6HCl \longrightarrow 3ICI + 3KCl + 3H_2O$.

Sol. $AgNO_3 + KI \longrightarrow AgI\downarrow + KNO_3$

As present in $AgNO_3$ is removed as AgI by adding 50 mL of KI solution of which 20 mL requires 30 mL of M/10 KIO_3

Meq. of KI in 20 mL = Meq. of KIO_3 = $30 \times \frac{1}{10} \times 4$

For KIO_3, $I^{5+} + 4e^- \rightarrow I^+$

$I_{-} \rightarrow I^{1+} + 2e^-$

$\therefore$ Eq. wt. of KI = $\frac{M}{2}$

$\therefore$ Meq. of KI in 50 mL added to $AgNO_3$ $= \frac{30 \times 4 \times 50}{10 \times 20} = 30$

Meq. of KI left unused by $AgNO_3$ = $50 \times \frac{1}{10} \times 4 = 20$

$\therefore$ Meq. of KI used for $AgNO_3 = 30 - 20 = 10$

$\therefore$ Meq. of $AgNO_3 = 10$

$$\frac{W_{AgNO_3}}{170} \times 2 \times 1000 = 10$$

$\therefore$ $W_{AgNO_3} = 0.85\ g = 85\%$

$$\frac{\text{Mole of } AgNO_3}{\text{Mole of KI}} = \frac{1}{1}$$

$\therefore$ If equivalent weight of KI $= \frac{M}{2}$

Equivalent weight of $AgNO_3 = \frac{M}{2}$

Ex. 32 A sample of Mg was burnt in air to give a mixture of MgO and Mg_3N_2. The ash was dissolved in 60 Meq. of HCl and the resulting solution was back titration with NaOH. 12 Meq. of NaOH were required to reach the end point. An excess of NaOH was then added and the solution was distilled. The ammonia released was then trapped in 10 Meq. of acid. Back titration of this solution required 6 Meq. of base. Calculate the % of Mg burnt to the nitride.

Sol. Let, total moles of Mg used for MgO and Mg_3N_2 be a and b respectively

$2Mg + O_2 \longrightarrow 2MgO$

a 0

0 a

$3Mg + N_2 \longrightarrow Mg_3N_2$

b 0

0 b/3

Now a, $\frac{b}{3}$ moles respectively of MgO and Mg_3N_2 are present in the mixture.

$MgO + 2HCl \longrightarrow MgCl_2 + H_2O$

$Mg_3N_2 + 8HCl \longrightarrow 3MgCl_2 + 2NH_4Cl$

or solution contains **(A)** moles of $MgCl_2$ from MgO and **(B)** moles of $MgCl_2$ from Mg_3N_2 and $\frac{2b}{3}$ moles of NH_4Cl.

Now, moles of HCl or Meq. of HCl (monobasic) $= 30 - 12 = 48$

$$2a + \frac{8b}{3} = 48 \qquad \text{..........(1)}$$

Moles of NH_4Cl formed = Moles of NH_3 liberated = Moles of HCl used for absorbing NH_3.

$$\frac{2b}{3} = (10 - 6) = 4 \qquad \text{..........(2)}$$

From (1), $2a + \frac{8 \times 6}{3} = 48$ or $a = 16$

$\therefore$ % of Mg used for $Mg_3N_2 = \frac{6}{(6+16)} \times 100 = 27.27\%$

Ex. 33 30 mL of a solution containing 9.15 g/litre of an oxalate $K_xH_y(C_2O_4)_z.nH_2O$ are required for titrating 27 mL of 0.12 N NaOH and 36 mL of 0.12 N $KMnO_4$ separately. Calculate x,y,z and n. Assume all H atoms (except H_2O) are replaceable and x,y,z are in the simple ratio of g atoms.

Sol. Let molecular weight of oxalate salt is M

(i) n - factor in acid - base reaction = 2

(ii) n - factor in redox titration = 2 × z

$(C_2O_4^{2-} \longrightarrow 2CO_2 + 2e)$

$\therefore$ Meq. of acid in 30 mL = Meq. of NaOH used

$$30 \times \frac{9.15}{M} \times y = 27 \times 0.12 \qquad \text{...(1)}$$

Also, $30 \times \frac{9.15}{M} \times (2z) = 36 \times 0.12$ ...(2)

From equations (1) and (2) $\frac{y}{2z} = \frac{27}{36} \Rightarrow \frac{y}{z} = \frac{3}{2}$ ...(3)

Also, total cationic charge = total anionic charge

$\therefore x + y = 2z$ ...(4)

By equations (3) and (4)

$x : y : z :: 1 : 3 : 2$

These are in simplest ratio and molecular formula is $KH_3(C_2O_4)_2.nH_2O$

Molecular weight of salt = 39 + 3 + 176 + 18n = 218 + 18n

From equation (1), $M = \frac{30 \times 9.15 \times 3}{27 \times 0.12} = 254.16$

$\therefore 218 + 18n = 254.15$

$\therefore n = 2$

$\therefore$ **Oxalate salt is $KH_3(C_2O_4)_2.2H_2O$**

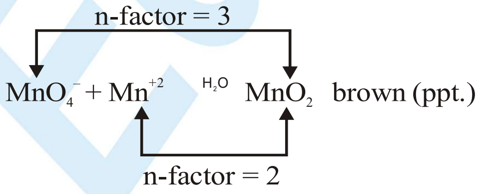
Ex. 34 Hydrogen peroxide solution (20 mL) reacts quantitatively with a solution of $KMnO_4$ (20 mL) acidified with dilute H_2SO_4. The same volume of the $KMnO_4$ solution is just decolourized by 10 mL of $MnSO_4$ in neutral medium simultaneously forming a dark brown precipitate of hydrated MnO_2. The brown precipitate is dissolved in 20 mL of 0.2 M sodium oxalate under boiling condition in the presence of dilute H_2SO_4. Write the balanced equations involved in the reactions and calculate the volume strength of H_2O_2.

Sol. Meq. of MnO_2 = Meq. of $Na_2C_2O_4$

$= 20 \times 0.2 \times 2 = 8$

$(C_2O_4^{2-} \rightarrow 2CO_2$, n-factor = 2)

Millimoles of $MnO_2 = \frac{8}{2} = 4$



or $2MnO_4^- + 3Mn^{2+} \rightarrow 5MnO_2$ (Mole ratio is reciprocal of n-factor ratio)

$$\frac{\text{Millimoles of } MnO_4^-}{\text{Millimoles of } MnO_2} = \frac{2}{5}$$

$$\text{Millimoles } MnO_4^- = \frac{2}{5} \times \text{Millimoles of } MnO_2$$

$$= \frac{2}{5} \times 4 = \frac{8}{5}$$

$2KMnO_4 + 5H_2O_2 + 3H_2SO_4 \rightarrow 2\,MnSO_4 + K_2SO_4 + 8H_2O + 5O_2$

$$\frac{\text{Millimoles of } H_2O_2}{\text{Millimoles of } MnO_4^-} = \frac{5}{2}$$

$$\therefore \text{Millimoles of } H_2O_2 = \frac{5}{2} \times \frac{8}{5} = 4$$

$N_{H_2O_2} \times 20 = 4 \times 2$ (n-factor for $H_2O_2 = 2$)

$\therefore N_{H_2O_2} = 0.4$

Volume strength of $H_2O_2 = 5.6 \times N_{H_2O_2}$

$= 5.6 \times 0.4 = 2.24$

Ex. 35 1.0 g of moist sample of mixture of potassium chlorate ($KClO_3$) and potassium chloride (KCl) was dissolved in water and solution made upto 250 mL. This solution was treated with SO_2 to reduce all ClO_3^- to Cl^- and excess of SO_2 was removed by boiling. The total chloride was precipitated as silver chloride. The weight of precipitate was found to be 1.435 g. In another experiment, 25 mL of the original solution was heated with 30 ml 0.2 N $FeSO_4$ and unused $FeSO_4$ required 37.5 mL of 0.08 N $KMnO_4$ solutions.

Calculate the molar ratio of the ClO_3^- to the given mixture.

Given that, $ClO_3^- + 6Fe^{2+} + 6H^+ \longrightarrow Cl^- + 6Fe^{3+} + 3H_2O$

$3SO_2 + ClO_3^- + 3H_2O \longrightarrow Cl^- + 3SO_4^{2-} + 6H^+$

Sol. ClO_3^- is reduced to Cl^- by SO_2 and ClO_3^- is also reduced to Cl^- by Fe^{2+}, hence AgCl is formed due to total Cl^-

Meq. of Fe^{2+} initially taken $= 30 \times 0.2 = 6$

Meq. of Fe^{2+} unused $= 37.5 \times 0.08 = 3$

$\therefore$ Meq. of $Fe^{2+} = 6.0 - 3.0 = 3.0$

Thus, Meq. of ClO_3^- in 25 mL = 3.0

$$\text{Moles of } ClO_3^- \text{ in 25 mL} = \frac{3.0}{1000 \times 6} = 0.0005$$

$\overset{+5}{ClO_3^-} \longrightarrow \overset{-1}{Cl^-}$ (n-factor = 6)

O.N. 5 −1

Thus, moles of ClO_3^- in 25 mL solution = 0.0005

ClO_3^- is also reduced to Cl^- by SO_2 in first experiment and precipitated as AgCl.

Thus, Cl^- formed from ClO_3^- = AgCl from ClO_3^- = 1.435 g

Total AgCl formed both from actual and Cl^- from ClO_3^- = 1.435 g

$$= \frac{1.435}{143.5} = 0.01 \text{ mol}$$

Thus, AgCl formed due to Cl^- only $= 0.01 - 0.0005 = 0.0095$ mol

Thus, ClO_3^- and Cl^- are in molar ratio = **1 : 19**

Exercise # 1

[Single Correct Choice Type Questions]

1. Which reaction does not represent autoredox or disproportionation :-

(A) $Cl_2 + OH^- \longrightarrow Cl^- + ClO_3^- + H_2O$ **(B)** $2H_2O_2 \longrightarrow H_2O + O_2$

(C) $2Cu^+ \longrightarrow Cu^{+2} + Cu$ **(D)** $(NH_4)_2Cr_2O_7 \longrightarrow N_2 + Cr_2O_3 + 4H_2O$

2. Match List-I (Compounds) with List-II (Oxidation states of nitrogen) and select answer using the codes given below the lists :-

	List-I		List-II
(A)	NaN_3	1.	+5
(B)	N_2H_2	2.	+2
(C)	NO	3.	–1/3
(D)	N_2O_5	4.	–1

Code :	(A)	(B)	(C)	(D)
(A)	3	4	2	1
(B)	4	3	2	1
(C)	3	4	1	2
(D)	4	3	1	2

3. Which of the following is a redox reaction :-

(A) $2\,CrO_4^{2-} + 2H^+ \rightarrow Cr_2O_7^{2-} + H_2O$ **(B)** $CuSO_4 + 4\,NH_3 \rightarrow [Cu(NH_3)_4]\,SO_4$

(C) $Na_2S_2O_3 + I_2 \rightarrow Na_2S_4O_6 + NaI$ **(D)** $Cr_2O_7^{2-} + 2OH^- \rightarrow 2\,CrO_4^{2-} + H_2O$

4. 50 mL of 0.1 M solution of a salt reacted with 25 mL of 0.1 M solution of sodium sulphite. The half reaction for the oxidation of sulphite ion is :-

$$SO_3^{2-}\ (aq) + H_2O\,(\bullet) \longrightarrow SO_4^{2-}\ (aq) + 2H^+(aq) + 2e^-$$

If the oxidation number of metal in the salt was 3, what would be the new oxidation number of metal :

(A) zero **(B)** 1 **(C)** 2 **(D)** 4

5. An element A in a compound ABD has oxidation number A^{n-}. It is oxidised by $Cr_2O_7^{2-}$ in acid medium. In the experiment 1.68×10^{-3} moles of $K_2Cr_2O_7$ were used for 3.26×10^{-3} moles of ABD. The new oxidation number of A after oxidation is

(A) 3 **(B)** 3 – n **(C)** n – 3 **(D)** +n

6. The incorrect order of decreasing oxidation number of S in compounds is :-

(A) $H_2S_2O_7 > Na_2S_4O_6 > Na_2S_2O_3 > S_8$ **(B)** $H_2SO_5 > H_2SO_3 > SCl_2 > H_2S$

(C) $SO_3 > SO_2 > H_2S > S_8$ **(D)** $H_2SO_4 > SO_2 > H_2S > H_2S_2O_8$

7. In which of the following reaction is there a change in the oxidation number of nitrogen atoms :-

(A) $2\,NO_2 \rightarrow N_2O_4$ **(B)** $NH_3 + H_2O \rightarrow NH_4^+ + OH^-$

(C) $N_2O_5 + H_2O \rightarrow 2HNO_3$ **(D)** none

8. In the reaction

$xHI + yHNO_3 \longrightarrow NO + I_2 + H_2O$

(A) x = 3, y = 2 **(B)** x = 2, y = 3 **(C)** x = 6, y = 2 **(D)** x = 6, y = 1

9. For the redox reaction :

$MnO_4^- + C_2O_4^{2-} + H^+ \longrightarrow Mn^{2+} + CO_2 + H_2O$

the correct stoichiometric coefficients of MnO_4^-, $C_2O_4^{2-}$ and H^+ are respectively

(A) 2,5,16 **(B)** 16,5,2 **(C)** 5,16,2 **(D)** 2,16,5

10. A certain weight of pure $CaCO_3$ is made to react completely with 200 mL of an HCl solution to give 224 mL of CO_2 gas at STP. The normality of the HCl is :-

(A) 0.05 N **(B)** 0.1 N **(C)** 1.0 N **(D)** 0.2 N

11. The volume of 1.5 M H_3PO_4 solution required to neutralize exactly 90 mL of a 0.5 M $Ba(OH)_2$ solution is :-

(A) 10 mL **(B)** 30 mL **(C)** 20 mL **(D)** 60 mL

12. Volume V_1 mL of 0.1 M $K_2Cr_2O_7$ is needed for complete oxidation of 0.678 g N_2H_4 in acidic medium. The volume of 0.3 M $KMnO_4$ needed for same oxidation in acidic medium will be :-

(A) $\frac{2}{5}V_1$ **(B)** $\frac{5}{2}V_1$ **(C)** 113 V_1 **(D)** can't say

13. Which of the following relations is incorrect :-

(A) 3 N $Al_2(SO_4)_3$ = 0.5 M $Al_2(SO_4)_3$ **(B)** 3 M H_2SO_4 = 6 N H_2SO_4

(C) 1 M H_3PO_4 = 1/3 N H_3PO_4 **(D)** 1 M $Al_2(SO_4)_3$ = 6 N $Al_2(SO_4)_3$

14. The mass of oxalic acid crystals ($H_2C_2O_4 . 2H_2O$) required to prepare 50 mL of a 0.2 N solution is :-

(A) 4.5 g **(B)** 6.3 g **(C)** 0.63 g **(D)** 0.45 g

15. 125 mL of 63% (w/v) $H_2C_2O_4 . 2H_2O$ is made to react with 125 mL of a 40% (w/v) NaOH solution. The resulting solution is :-

(A) neutral **(B)** acidic **(C)** strongly acidic **(D)** alkaline

16. If equal volumes of 0.1 M $KMnO_4$ and 0.1 M $K_2Cr_2O_7$ solutions are allowed to oxidise Fe^{2+} to Fe^{3+} in acidic medium, then Fe^{2+} oxidised will be :-

(A) more by $KMnO_4$ **(B)** more by K_2CrO_7

(C) equal in both cases **(D)** can't be determined

17. If 10 g of V_2O_5 is dissolved in acid and is reduced to V^{2+} by zinc metal, how many mole I_2 could be reduced by the resulting solution if it is further oxidised to VO^{2+} ions ?
[Assume no change in state of Zn^{2+} ions] (V = 51, O = 16, I = 127) :

(A) 0.11 mole of I_2 **(B)** 0.22 mole of I_2 **(C)** 0.055 mole of I_2 **(D)** 0.44 mole of I_2

18. Given that 50.0 mL of 0.01 M $Na_2S_2O_3$ solution and 5×10^{-4} mole of Cl_2 react according to equation,

$$Cl_2(g) + S_2O_3^{2-} \longrightarrow SO_4^{2-} + Cl^- + S$$

Answer the following :

(i) The balanced molecular equation is :

(A) $Cl_2 + H_2O + Na_2S_2O_3 \longrightarrow Na_2SO_4 + S + 2HCl$ **(B)** $Cl_2 + Na_2S_2O_3 \longrightarrow 2NaCl + Na_2SO_4$

(C) $Cl_2 + S_2O_3^{2-} \longrightarrow SO_4^{2-} + S + Cl^-$ **(D)** none of these

(ii) How many moles of $S_2O_3^{2-}$ are in the above sample :-

(A) 0.00050 **(B)** 0.0025 **(C)** 0.01 **(D)** 0.02

(iii) How many equivalents of oxidising agents are in this sample for the above reaction :-

(A) 0.001 **(B)** 0.080 **(C)** 0.020 **(D)** 0.010

(iv) What is the molarity of Na_2SO_4 in this solution :-

(A) 0.080 M **(B)** 0.040 M **(C)** 0.020 M **(D)** 0.010 M

19. One gram of Na_3AsO_4 is boiled with excess of solid Kl in presence of strong HCl. The iodine evolved is absorbed in Kl solution and titrated against 0.2 N hyposolution. Assuming the reaction to be

$$AsO_4^{3-} + 2H^+ + 2I^- \longrightarrow AsO_3^{3-} + H_2O + I_2,$$

calculate the volume of thiosulphate hypo consumed. [Atomic weight of As = 75]

(A) 48.1 mL **(B)** 38.4 mL **(C)** 24.7 mL **(D)** 30.3 mL

20. Which of the following samples of reducing agents is/are chemically equivalent to 25 mL of 0.2 N $KMnO_4$ to be reduced to Mn^{2+} and water :-

(A) 50 mL of 0.2 M $FeSO_4$ to be oxidized to Fe^{3+}
(B) 50 mL of 0.1 M H_3AsO_3 to be oxidized to H_3AsO_4
(C) 50 mL of 0.1 M H_2O_2 to be oxidized to H^+ and O_2
(D) 25 mL of 0.1 M $SnCl_2$ to be oxidized to Sn^{4+}

21. Find the volume of strength of H_2O_2 solution prepared by mixing of 250 mL of 3N H_2O_2 & 750 mL of 1N H_2O_2 solution

(A) 1.5 V **(B)** 8.4 V **(C)** 5.6 V **(D)** 11.2 V

22. 0.3 g of an oxalate salt was dissolved in 100 mL solution. The solution required 90 mL of N/20 $KMnO_4$ for complete oxidation. The % of oxalate ion in salt is :-

(A) 33% **(B)** 66% **(C)** 70% **(D)** 40%

23. A 0.518 g sample of limestone is dissolved in HCl and then the calcium is precipitated as CaC_2O_4. After filtering and washing the precipitate, it requires 40.0 mL of 0.250 N $KMnO_4$ solution acidified with H_2SO_4 to titrate it as. The percentage of CaO in the sample is :-

$$MnO_4^- + H^+ + C_2O_4^{2-} \longrightarrow Mn^{2+} + CO_2 + 2H_2O$$

(A) 54.0 % **(B)** 27.1 % **(C)** 42 % **(D)** 84 %

24. In the reaction $CrO_5 + H_2SO_4 \rightarrow Cr_2(SO_4)_3 + H_2O + O_2$ one mole of CrO_5 will liberate how many moles of O_2 :-

(A) 5/2 **(B)** 5/4 **(C)** 9/2 **(D)** 7/2

25. 25 mL of 0.50 M H_2O_2 solution is added to 50 mL of 0.20 M $KMnO_4$ in acid solution. Which of the following statement are true :-

(A) 0.010 mole of oxygen is liberated
(B) 0.005 mole of $KMnO_4$ are left
(C) 0.030 g atom of oxygen gas is evolved
(D) 0.0025 mole H_2O_2 does not react with $KMnO_4$

26. Hydrogen peroxide in aqueous solution decomposes on warming to give oxygen according to the equation

$$2H_2O_2\,(aq) \longrightarrow 2H_2O\,(\bullet) + O_2\,(g)$$

Under conditions where 1 mole of gas occupies 24 dm^3. 100 cm^3 of XM solution of H_2O_2 produces 3 dm^3 of O_2. Thus X is :-

(A) 2.5 **(B)** 1 **(C)** 0.5 **(D)** 0.25

27. Bottle **(A)** contain 320 mL of H_2O_2 solution & labeled with 10 V H_2O_2 & Bottle **(B)** contain 80 mL H_2O_2 having normality 5N. If bottle **(A)** & bottle **(B)** mixed & solution filled in bottle **(C)**. Select the correct lable for bottle **(C)** in term of volume strength & in term of g / litre. :-

(A) 13.6 "V" & 41.285 g/L
(B) 11.2 "V" & 0.68 g/L
(C) 5.6 "V" & 0.68 g/L
(D) 5.6 "V" & 41.285 g/L

28. Temporary hardness is due to HCO_3^- of Mg^{2+} and Ca^{2+}. It is removed by addition of CaO.

$$Ca(HCO_3)_2 + CaO \rightarrow 2CaCO_3 + H_2O$$

Mass of CaO required to precipitate 2 g $CaCO_3$ is :-

(A) 2.00 **(B)** 0.56 g **(C)** 0.28 g **(D)** 1.12 g

29. An ore of iron, Wustite has the formula $F_{0.93}O_{1.00}$. The mole fraction of total iron present in the form of Fe(II) is :-

(A) 0.82 **(B)** 0.85 **(C)** 0.15 **(D)** 0.37

30. HNO_3 oxidises NH_4^+ ions to nitrogen and itself gets reduced to NO_2. The moles of HNO_3 required by 1 mol of $(NH_4)_2SO_4$ is :-

(A) 4 **(B)** 5 **(C)** 6 **(D)** 2

31. 25 mL of a 0.1 M solution of a stable cation of transition metal Z reacts exactly with 25 ml of 0.04 mL acidified $KMnO_4$ solution. Which of the following is most likely to represent the change in oxidation state of Z correctly :-

(A) $Z^+ \rightarrow Z^{2+}$ **(B)** $Z^{2+} \rightarrow Z^{3+}$ **(C)** $Z^{3+} \rightarrow Z^{4+}$ **(D)** $Z^{2+} \rightarrow Z^{4+}$

32. 1 mol of iron (Fe) reacts completely with 0.65 mol O_2 to give a mixture of only FeO and Fe_2O_3. Mole ratio of ferrous oxide to ferric oxide is :-

(A) 3 : 2
(B) 4 : 3
(C) 20 : 13
(D) none of these

33. The molar ratio of Fe^{++} to Fe^{+++} in a mixture of $FeSO_4$ and $Fe_2(SO_4)_3$ having equal number of sulphate ion in both ferrous and ferric sulphate is :-

(A) 1 : 2
(B) 3 : 2
(C) 2 : 3
(D) can't be determined

34. If a piece of iron gains 10% of its weight due to partial rusting into Fe_2O_3. The percentage of total iron that has rusted is :-

(A) 23
(B) 13
(C) 23.3
(D) 25.67

35. How many litres of Cl_2 at S.T.P. will be liberated by oxidation of NaCl with 10 g $KMnO_4$:-

(A) 3.54 litres
(B) 7.08 litres
(C) 1.77 litres
(D) none of these

36. During the disproportionation of iodine to iodide and iodate ions, the ratio of iodate and iodide ions formed in alkaline medium is :-

(A) 1 : 5
(B) 5 : 1
(C) 3 : 1
(D) 1 : 3

37. $28\,NO_3^- + 3As_2S_3 + 4H_2O \rightarrow 6AsO_4^{3-} + 28\,NO + 9SO_4^{2-} + H^+$

What will be the equivalent mass of As_2S_3 in above reaction

(A) $\frac{\text{M.wt.}}{2}$
(B) $\frac{\text{M.wt.}}{4}$
(C) $\frac{\text{M.wt.}}{24}$
(D) $\frac{\text{M.wt.}}{28}$

38. CN^- is oxidised by NO_3^- in presence of acid :

$$a\,CN^- + b\,NO_3^- + c\,H^+ \longrightarrow (a+b)\,NO + a\,CO_2 + \frac{c}{2}\,H_2O$$

What are the values of a, b, c in that order :

(A) 3,7,7
(B) 3,10,7
(C) 3,10,10
(D) 3,7,10

39. Which of the following solutions will exactly oxidize 25 mL of an acid solution of 0.1 M Fe (II) oxalate :-

(A) 25 mL of 0.1 M $KMnO_4$
(B) 25 mL of 0.2 M $KMnO_4$
(C) 25 mL of 0.6 M $KMnO_4$
(D) 15 mL of 0.1 M $KMnO_4$

40. 4.9 gm of $K_2Cr_2O_7$ is taken to prepare 0.1 L of the solution. 10 mL of this solution is further taken to oxidise Sn^{2+} ion into Sn^{4+} ion Sn^{4+} so produced is used in 2nd reaction to prepare Fe^{3+} ion then the millimoles of Fe^{3+} ion formed will be (assume all other components are in sufficient amount) [Molar mass of $K_2Cr_2O_7$ = 294 g].

(A) 5
(B) 20
(C) 10
(D) none of these

41. When ZnS is boiled with strong nitric acid, the products are zinc nitrate, sulphuric acid and nitrogen dioxide. What are the changes in the oxidation numbers of Zn, S and N.

(A) +2, +4, –1
(B) +2, +6, –2
(C) 0, +4, –2
(D) 0, +8, –1

42. When arsenic sulphide is boiled with NaOH, sodium arsenite and sodium thioarsenite are formed

$x\,As_2S_3 + y\,NaOH \longrightarrow Na_3AsO_3 + x\,Na_3AsS_3 + \frac{y}{2}\,H_2O$. What are the values of x and y ?

(A) 1, 6
(B) 2, 8
(C) 2, 6
(D) 1, 4

43. An element forms two different sulphates in which its weight % is 28 and 37. What is the ratio of oxidation numbers of the element in these sulphates ?

(A) 1 : 2
(B) 1 : 3
(C) 2 : 1
(D) 3 : 2

44. The following equations are balanced atomwise and chargewise.

(i) $Cr_2O_7^{2-} + 8H^+ + 3H_2O_2 \longrightarrow 2Cr^{3+} + 7H_2O + 3O_2$
(ii) $Cr_2O_7^{2-} + 8H^+ + 5H_2O_2 \longrightarrow 2Cr^{3+} + 9H_2O + 4O_2$
(iii) $Cr_2O_7^{2-} + 8H^+ + 7H_2O_2 \longrightarrow 2Cr^{3+} + 11H_2O + 5O_2$

The precise equation/equations representing the oxidation of H_2O_2 is /are :

(A) (i) only
(B) (ii) only
(C) (iii) only
(D) all the three

45. 35 mL sample of hydrogen peroxide gives of 500 mL of O_2 at 27°C and 1 atm pressure. Volume strength of H_2O_2 sample will be :-

(A) 10 volume **(B)** 13 volumes **(C)** 11 volume **(D)** 12 volume

46. 20 mL of 0.1 M solution of compound $Na_2CO_3.NaHCO_3.2H_2O$ is titrated against 0.05 M HCl, x mL of HCl is used when phenolphthalein is used as an indicator and y mL of HCl is used when methyl orange is the indicator in two separate titrations. Hence (y – x) is :-

(A) 40 mL **(B)** 80 mL **(C)** 120 mL **(D)** none of these

47. A mixture of H_2SO_4 and $H_2C_2O_4$ (oxalic acid) and some inert impurity weighing 3.185 g was dissolved in water and the solution made up to 1 litre, 10 mL of this solution required 3 mL of 0.1 N NaOH for complete neutralization. In another experiment 100 mL of the same solution in hot condition required 4 mL of 0.02M $KMnO_4$ solution for complete reaction. The wt. % of H_2SO_4 in the mixture was :-

(A) 40 **(B)** 50 **(C)** 60 **(D)** 80

48. 0.80 g of sample of impure potassium dichromate was dissolved in water and made upto 500 mL solution. 25 mL of this solution treated with excess of KI in acidic medium and I_2 liberated required 24 mL of a sodium thiosulphate solution. 30 mL of this sodium thiosulphate solution required 15 mL of N/20 solution of pure potassium dichromate. What was the percentage of $K_2Cr_2O_7$ in given sample?

(A) 73.5 % **(B)** 75.3 % **(C)** 36.75 % **(D)** none of these

49. 0.10 g of a sample containing $CuCO_3$ and some inert impurity was dissolved in dilute sulphuric acid and volume made up to 50 mL. This solution was added into 50 mL of 0.04 M KI solution where copper precipitates as CuI and I^- is oxidized into I_3^-. A 10 mL portion of this solution is taken for analysis, filtered and made up free I_3^- and then treated with excess of acidic permanganate solution. Liberated iodine required 20 mL of 2.5 mM sodium thiosulphate solution to reach the end point.

Determine weight percentage of $CuCO_3$ in the original sample.

(A) 7.41 **(B)** 74.1 **(C)** 61.75 **(D)** none of these

50. A 150 mL of solution of I_2 is divided into two unequal parts. I part reacts with hypo solution in acidic medium. 15 mL of 0.4 M hypo was consumed. II part was added with 100 mL of 0.3 M NaOH solution. Residual base required 10 mL of 0.3 M H_2SO_4 solution for complete neutralization. What was the initial concentration of I_2 ?

(A) 0.08 M **(B)** 0.1 M **(C)** 0.2 M **(D)** none of these

Exercise # 2

Part # I [Multiple Correct Choice Type Questions]

1. In the titration of $K_2Cr_2O_7$ and ferrous sulphate , following data is obtained :
V_1 mL of $K_2Cr_2O_7$ solution of molarity M_1 requires V_2 mL of $FeSO_4$ solution of molarity M_2.
Which of the following relations is/are true for the above titration :

(A) $6\,M_1V_1 = M_2V_2$ **(B)** $M_1V_1 = 6\,M_2V_2$ **(C)** $N_1V_1 = N_2V_2$ **(D)** $M_1V_1 = M_2V_2$

2. Choose the correct statement(s) :

(A) 1 mole of MnO_4^- ion can oxidise 5 moles of Fe^{2+} ion in acidic medium.
(B) 1 mole of $Cr_2O_7^{2-}$ ion can oxidise 6 moles of Fe^{2+} ion in acidic medium.
(C) 1 mole of Cu_2S can be oxidised by 1.6 moles of MnO_4^- ion in acidic medium.
(D) 1 mole of Cu_2S can be oxidised by 1.33 moles of $Cr_2O_7^{2-}$ ion in acidic medium.

3. Which of the following samples of reducing agents is /are chemically equivalent to 25 mL of 0.2 N $KMnO_4$ to be reduced to Mn^{2+} and water :

(A) 25 mL of 0.2 M $FeSO_4$ to be oxidized to Fe^{3+}
(B) 50 mL of 0.1 M H_3AsO_3 to be oxidized to H_3AsO_4
(C) 25 mL of 0.1 M H_2O_2 to be oxidized to H^+ and O_2
(D) 25 mL of 0.1 M $SnCl_2$ to be oxidized to Sn^{4+}

4. 0.1 M solution of KI reacts with excess of H_2SO_4 and KIO_3 solutions, according to equation

$5I^- + IO_3^- + 6H^+ \longrightarrow 3I_2 + 3H_2O$; which of the following statements is/are correct :

(A) 200 mL of the KI solution react with 0.004 mole KIO_3.
(B) 100 mL of the KI solution reacts with 0.006 mole of H_2SO_4.
(C) 0.5 litre of the KI solution produced 0.005 mole of I_2.
(D) Equivalent weight of KIO_3 is equal to $\left(\dfrac{\text{Molecular Weight}}{5}\right)$.

5. Consider the redox reaction $2S_2O_3^{2-} + I_2 \longrightarrow S_4O_6^{2-} + 2\,I^-$:

(A) $S_2O_3^{2-}$ gets reduced to $S_4O_6^{2-}$ **(B)** $S_2O_3^{2-}$ gets oxidised to $S_4O_6^{2-}$
(C) I_2 gets reduced to I^- **(D)** I_2 gets oxidised to I^-

6. There are two sample of HCl having molarity 1N and 0.25 N. Find volume of these sample taken in order to prepare 0.75 N HCl solution. (Assume no water is used) :

(A) 20 mL, 10 mL **(B)** 100 mL, 50 mL **(C)** 40 mL, 20 mL **(D)** 50 mL, 25 mL

7. To a 25 ml H_2O_2 solution excess acidified solution of KI was added. The iodine liberated 20 ml of 0.3 N sodium thiosulphate solution. Use these data to choose the correct statements from the following :

(A) The weight of H_2O_2 present in 25 ml solution is 0.102 g
(B) The molarity of H_2O_2 solution is 0.12 M
(C) The weight of H_2O_2 present in 1 L of the solution is 0.816 g
(D) The volume strength of H_2O_2 is 1.344 L

8. $A + B \rightarrow A_3B_2$ (unbalanced)

$A_3B_2 + C \rightarrow A_3B_2C_2$ (unbalanced)

Above two reactions are carried out by taking 3 moles each of A and B and one mole of C. Then which option is/are correct ?

(A) 1 mole of $A_3B_2C_2$ is formed

(B) $1/2$ mole of $A_3B_2C_2$ is formed

(C) 1/2 mole of A_3B_2 is formed

(D) 1/2 mole of A_3B_2 is left finally

9. Consider the redox reaction $2S_2O_3^{2-} + I_2 \longrightarrow S_4O_6^{2-} + 2\,I^-$:

(A) $S_2O_3^{2-}$ gets reduced to $S_4O_6^{2-}$

(B) $S_2O_3^{2-}$ gets oxidised to $S_4O_6^{2-}$

(C) I_2 gets reduced to I^-

(D) I_2 gets oxidised to I^-

10. If 100 ml of 1M H_2SO_4 solution is mixed with 100 ml of 9.8%(w/w) H_2SO_4 solution (d = 1 g/ml) then :

(A) concentration of solution remains same

(B) volume of solution become 200 ml

(C) mass of H_2SO_4 in the solution is 98 gm

(D) mass of H_2SO_4 in the solution is 19.6 gm

11. Equal volume of 0.1M NaCl and 0.1M $FeCl_2$ are mixed with no change in volume due to mixing. Which of the following will be true for the final solution. (No precipitation occurs). Assume complete dissociation of salts and neglect any hydrolysis.

(A) $[Na^+] = 0.05$ M

(B) $[Fe^{2+}] = 0.05$M

(C) $[Cl^-] = 0.3$M

(D) $[Cl^-] = 0.15$M

12. Silver metal in ore is dissolved by potassium cyanide solution in the presence of air by the reaction

$$4\,Ag + 8\,KCN + O_2 + 2H_2O \longrightarrow 4\,K[Ag\,(CN)_2] + 4\,KOH$$

(A) The amount of KCN required to dissolve 100 g of pure Ag is 120 g.

(B) The amount of oxygen used in this process is 0.742 g (for 100 gm pure Ag)

(C) The amount of oxygen used in this process is 7.40 g (for 100 gm pure Ag)

(D) The volume of oxygen used at STP is 5.20 litres.

13. If 27 g of Carbon is mixed with 88 g of Oxygen and is allowed to burn to produce CO_2 , then :

(A) Oxygen is the limiting reagent.

(B) Volume of CO_2 gas produced at NTP is 50.4 L.

(C) C and O combine in mass ratio 3 : 8.

(D) Volume of unreacted O_2 at STP is 11.2 L.

14. Equal masses of SO_2 and O_2 are placed in a flask at STP choose the correct statement.

(A) The number of molecules of O_2 are more than SO_2

(B) Volume occupied at STP is more for O_2 than SO_2

(C) The ratio of number of atoms of SO_2 and O_2 is 3 : 4.

(D) Moles of SO_2 is greater than the moles of O_2 .

15. For the reaction $2P + Q \rightarrow R$, 12 mol of P and 8 mol of Q are taken then

(A) 3 mol of R is produced

(B) 6 mol of R is produced

(C) 25% of Q is left behind

(D) 25% of Q has reacted

16. The molality of a sulphuric acid solution is 0.2. Calculate the total weight of the solution having 1000 gm of solvent.

(A) 1000 g **(B)** 1098.6 g **(C)** 980.4 g **(D)** 1019.6g

17. If H_2SO_4 is formed from it's elements by taking 6.023×10^{23} atom of 'O' 5.6 litre of H_2 gas at STP and 8 gm S then

(A) 0.125 moles of H_2SO_4 are formed **(B)** 0.25 moles of H_2SO_4 are formed

(C) no moles of 'S' are left **(D)** 1/4 mole of O_2 is left

18. A 5L vessel contains 2.8 g of N_2 . When heated to 1800 K , 30% molecules are dissociated into atoms.

(A) Total no. of moles in the container will be 0.13

(B) Total no. of molecules in the container will be close to 0.421×10^{23}.

(C) Total no. of moles in the container will be 0.098.

(D) All of these are correct.

19. The density of air is 0.001293 g/cm^3 at STP. Identify which of the following statement is correct

(A) Vapour density is 14.48

(B) Molecular weight is 28.96

(C) Vapour density is 0.001293 g/cm^3

(D) Vapour density and molecular weight cannot be determined.

20. Which of the following has same mass

(A) 1.0 mole of O_2 **(B)** 3.01×10^{23} molecules of SO_2

(C) 0.5 moles of CO_2 **(D)** 1 g atom of sulphur

Part # II [Assertion & Reason Type Questions]

These questions contains, Statement I (assertion) and Statement II (reason).

(A) Statement-I is true, Statement-II is true ; Statement-II is correct explanation for Statement-I.

(B) Statement-I is true, Statement-II is true ; Statement-II is NOT a correct explanation for statement-I

(C) Statement-I is true, Statement-II is false

(D) Statement-I is false, Statement-II is true

1. **Statement-I :** Oxidation involves loss of electrons and reduction involves gain of electrons.

Statement-II : The overall reaction in which oxidation and reduction occur simultaneously is called redox reaction.

2. **Statement-I :** The oxidation state of superoxide ion in KO_2, CsO_2 and RbO_2 is –1/2.

Statement-II : Since the oxidation state of an alkali metal in any compound is always +1, the oxidation state of oxygen is –1/2 in the O_2^- ion.

3. **Statement-I :** Among Br^-, O_2^{2-}, H^- and NO_3^-, the ions that could not act as oxidising agents are Br^- and H^-.

Statement-II : $Br^{\ominus}$ and H^- could not be reduced.

4. **Statement-I :** H_2SO_4 cannot act as reducing agent.

Statement-II : Sulphur cannot increase its oxidation number beyond +6.

5. **Statement-I :** In the redox reaction

$$8\,H^+\,(aq) + 4\,NO_3^- + 6\,Cl^- + Sn\,(s) \rightarrow SnCl_6^{2-} + 4\,NO_2 + 4\,H_2O$$

the reducing agent is Sn (s),

Statement-II : In balancing half reaction, $S_2O_3^{2-} \rightarrow S(s)$, the number of electrons added on the left is 4.

6. **Statement-1 :** The molality and molarity of very dilute aqueous solutions differ very little.

Statement-2 : The density of water is about 1.0 g cm^{-3} at room temperature.

7. **Statement-1 :** For calculating the molality or the mole fraction of solute, if the molarity is known, it is necessary to know the density of the solution.

Statement-2 : Molality, molarity and the mole fraction of solute can be calculated from the weight percentage and the density of the solution

8. **Statement-1 :** Laboratory reagents are usually made up to a specific molarity rather than a given molality.

Statement-2: The volume of a liquid is more easily measured than its mass.

9. **Statement-1 :** Molality and mole fraction concentration units do not change with temperature.

Statement-2 : These units are not defined in terms of any volume.

10. **Statement-1 :** A one molal solution prepared at 20°C will retain the same molality at 100°C, provided there is no loss of solute or solvent on heating.

Statement-2 : Molality is independent of temperature.

11. **Statement-1 :** In the reaction, $MnO_4^- + 5Fe^{2+} + 8H^+ \longrightarrow Mn^{2+} + 5Fe^{3+} + 4H_2O$, MnO_4^- acts as oxidising agent.

Statement-2 : : In the above reaction, n-factor for MnO_4^- is 5.

12. **Statement-1 :** If 200 mL of 0.1N NaOH is added to 200 mL of 0.1N H_2SO_4 solution, then the resulting solution is acidic.

Statement-2 : If milliequivalents of acid is greater than milliequivalents of base, then upon mixing the solution is acidic.

13. **Statement-1 :** Equivalent weight of FeC_2O_4 in the reaction,

$$FeC_2O_4 + \text{Oxidising agent} \longrightarrow Fe^{3+} + CO_2$$

is M/3, where M is molar mass of FeC_2O_4.

Statement-2 : In the above reaction, total two moles of electrons are given up by 1 mole of FeC_2O_4 to the oxidising agent.

Exercise # 3 Part # I [Matrix Match Type Questions]

1.

	Column-I		Column-II
(A)	$\text{Eq. wt.} = \dfrac{\text{Molecular weight}}{33}$	**(p)**	When CrI_3 oxidises into $Cr_2O_7^{2-}$ and IO_4^-
(B)	$\text{Eq. wt.} = \dfrac{\text{Molecular weight}}{27}$	**(q)**	When $Fe(SCN)_2$ oxidises into Fe^{3+}, SO_4^{2-}, CO_3^{2-} and NO_3^-
(C)	$\text{Eq. wt.} = \dfrac{\text{Molecular weight}}{28}$	**(r)**	When NH_4SCN oxidizes into SO_4^{2-}, CO_3^{2-} and NO_3^-
(D)	$\text{Eq. wt.} = \dfrac{\text{Molecular weight}}{24}$	**(s)**	When As_2S_3 oxidises into AsO_3^- and SO_4^{2-}

2.

	Column-I		Column-II
(A)	When Bi_2S_3 converted into Bi^{5+} and S	**(p)**	18
(B)	When $Al_2(Cr_2O_7)_3$ reduced into Cr^{3+} in acidic medium	**(q)**	11
(C)	When FeS_2 converted into Fe_2O_3 and SO_2	**(r)**	2
(D)	When $Mn(NO_3)_2$ converted into MnO_4^{2-} and NO	**(s)**	10

3.

	Column-I		Column-II
(A)	$\underline{P_2H_4} \longrightarrow PH_3 + P_4H_2$	**(p)**	$E = \dfrac{3M}{4}$
(B)	$\underline{I_2} \longrightarrow I^- + IO_3^-$	**(q)**	$E = \dfrac{3M}{5}$
(C)	$\underline{MnO_4^-} + Mn^{2+} + H_2O \longrightarrow Mn_3O_4 + H^+$	**(r)**	$E = \dfrac{15M}{26}$
(D)	$\underline{H_3PO_2} \longrightarrow PH_3 + H_3PO_3$	**(s)**	$E = \dfrac{5M}{6}$

4.

	Column-I		Column-II
(A)	Molarity	**(p)**	Dependent on temperature
(B)	Molality	**(q)**	$\dfrac{M_A \times n_A}{n_A M_A + n_B M_B}$ x 100
(C)	Mole fraction	**(r)**	Independent of temperature
(D)	Mass %	**(s)**	$\dfrac{X_A}{X_B M_B} \times 1000$

Where M_A , M_B are molar masses, n_A , n_B are no of moles & X_A , X_B are mole fractions of solute and solvent respectively.

5.

Column-I	**Column-II**
(A) 100 ml of 0.2 M $AlCl_3$ solution + 400 ml	**(p)** Total concentration of cation**(s)** = 0.12 M of 0.1 M HCl solution
(B) 50 ml of 0.4 M KCl + 50 ml H_2O	**(q)** $[SO_4^{2-}] = 0.06$ M
(C) 30 ml of 0.2 M K_2SO_4 + 70 ml H_2O	**(r)** $[SO_4^{2-}] = 2.5$ M
(D) 200 ml 24.5% (w/v) H_2SO_4	**(s)** $[Cl^-] = 0.2$ M

6.

Column-I	**Column-II**
(A) 4.1 g H_2SO_3	**(p)** 200 mL of 0.5 N base is used for complete neutralization
(B) 4.9 g H_3PO_4	**(q)** 200 millimoles of oxygen atoms
(C) 4.5 g oxalic acid ($H_2C_2O_4$)	**(r)** Central atom is in its highest oxidation number
(D) 5.3 g Na_2CO_3	**(s)** May react with an oxidising agent

7.

Column-I	**Column-II**
(A) Sn^{+2} + MnO_4^- (acidic) 3.5 mole 1.2 mole	**(p)** Amount of oxidant available decides the number of electrons transfer
(B) $H_2C_2O_4$ + MnO_4^- (acidic) 8.4 mole 3.6 mole	**(q)** Amount of reductant available decides the number of electrons transfer
(C) $S_2O_3^{-2}$ + I_2 7.2 mole 3.6 mole	**(r)** Number of electrons involved per mole of oxidant > Number of electrons involved per mole of reductant
(D) Fe^{+2} + $Cr_2O_7^{-2}$ (acidic) 9.2 mole 1.6 mole	**(s)** Number of electrons involved per mole of oxidant < Number of electrons involved per mole of reductant.

Part # II [Comprehension Type Questions]

Comprehension # 1

The strength of H_2O_2 is expressed in several ways like molarity, normality, % (w/V), volume strength, etc. The strength of "10 V" means 1 volume of H_2O_2 on decomposition gives 10 volumes of oxygen at STP or 1 litre of H_2O_2 gives 10 litre of O_2 at STP. The decomposition of H_2O_2 is shown as under :

$$H_2O_2\,(aq) \longrightarrow H_2O\,(\bullet) + \frac{1}{2}\,O_2\,(g)$$

H_2O_2 can acts as oxidising as well as reducing agent, as oxidizing agent H_2O_2 converted into H_2O and as reducing agent H_2O_2 converted into O_2, both cases it's n-factor is 2.

∴ Normality of H_2O_2 solution = 2 × Molarity of H_2O_2 solution

1. What is the molarity of "11.2 V" of H_2O_2 ?

(A) 1 M **(B)** 2 M **(C)** 5.6 M **(D)** 11.2 M

2. What is the percentage strength (% w/V) of "11.2 V" H_2O_2 ?

(A) 1.7 **(B)** 3.4 **(C)** 34 **(D)** none of these

3. 20 mL of H_2O_2 solution is reacted with 80 mL of 0.05 M $KMnO_4$ in acidic medium then what is the volume strength of H_2O_2 ?

(A) 2.8 **(B)** 5.6 **(C)** 11.2 **(D)** none of these

4. 40 g $Ba(MnO_4)_2$ (mol. wt. = 375) sample containing some inert impurities in acidic medium is completely reacted with 125 mL of "33.6 V" of H_2O_2. What is the percentage purity of the sample ?

(A) 28.12 % **(B)** 70.31 % **(C)** 85 % **(D)** none of these

Comprehension # 2

Oleum is considered as a solution of SO_3 in H_2SO_4, which is obtained by passing SO_3 in solution of H_2SO_4. When 100 g sample of oleum is diluted with desired weight of H_2O then the total mass of H_2SO_4 obtained after dilution is known as % labelling in oleum.

For example, a oleum bottle labelled as '109% H_2SO_4' means the 109 g total mass of pure H_2SO_4 will be formed when 100 g of oleum is diluted by 9 g of H_2O which combines with all the free SO_3 present in oleum to form H_2SO_4 as $SO_3 + H_2O \longrightarrow H_2SO_4$

1. What is the % of free SO_3 in an oleum that is labelled as '104.5 % H_2SO_4'?

(A) 10 **(B)** 20 **(C)** 40 **(D)** none of these

2. 9.0 g water is added into oleum sample labelled as '112% H_2SO_4' then the amount of free SO_3 remaining in the solution is :

(A) 14.93 L at STP **(B)** 7.46 L at STP **(C)** 3.73 L at STP **(D)** 11.2 L at STP

3. If excess water is added into a bottle sample labelled as '112 % H_2SO_4' and is reacted with 5.3 g Na_2CO_3, then find the volume of CO_2 evolved at 1 atm pressure and 300 K temperature after the completion of the reaction :

(A) 2.46 L **(B)** 24.6 L **(C)** 1.23 L **(D)** 12.3 L

4. 1 g of oleum sample is diluted with water. The solution required 54 mL of 0.4 N NaOH for complete neutralization. The % of free SO_3 in the sample is :

(A) 74 **(B)** 26 **(C)** 20 **(D)** none of these

Comprehension # 3

$$\text{Equivalent weight} = \frac{\text{Molecular weight / Atomic weight}}{\text{n – factor}}$$

n-factor is very important in redox as well as non-redox reactions. With the help of n-factor we can predicts the molar ratio of the reactant species taking part in reactions. The reaciprocal of n-factor's ratio of the reactants is the molar ratio of the reactants.

In general n-factor of acid/base is number of moles of H^+ /OH^- furnished per mole of acid/base. n-factor of a reactant is no. of moles of electrons lost or gained per mole of reactant.

Example 1

1. In acidic medium : $KMnO_4\ (n = 5) \longrightarrow Mn^{2+}$
2. In basic medium : $KMnO_4\ (n = 3) \longrightarrow Mn^{2+}$
3. In neutral medium : $KMnO_4\ (n = 1) \longrightarrow Mn^{6+}$

Example 2 $FeC_2O_4 \longrightarrow Fe^{3+} + 2CO_2$

Total no. of moles of e^- lost by 1 mole of $FeC_2O_4 = 1 + 1 \times 2 \Rightarrow 3$

$\therefore$ n-factor of $FeC_2O_4 = 3$

1. n-factor of $Ba(MnO_4)_2$ in acidic medium is :

(A) 2 **(B)** 6 **(C)** 10 **(D)** none of these

2. For the reaction,

$$H_3PO_2 + NaOH \longrightarrow NaH_2PO_2 + H_2O$$

What is the equivalent weight of H_3PO_2 ? (mol. wt. is M)

(A) M **(B)** M/2 **(C)** M/3 **(D)** none of these

3. For the reaction, $Fe_{0.95}O$ (molar mass : M) $\longrightarrow Fe_2O_3$. What is the eq. wt. of $Fe_{0.95}O$?

(A) $\frac{M}{0.85}$ **(B)** $\frac{M}{0.95}$ **(C)** $\frac{M}{0.8075}$ **(D)** none of these

4. In the reaction, $xVO + yFe_2O_3 \longrightarrow FeO + V_2O_5$. What is the value of x and y respectively ?

(A) 1, 1 **(B)** 2, 3 **(C)** 3, 2 **(D)** none of these

Comprehension # 4

Some amount of "20V" H_2O_2 is mixed with excess of acidified solution of KI. The iodine so liberated required 200 mL of 0.1 N $Na_2S_2O_3$ for titration.

1. The volume of H_2O_2 solution is :

(A) 11.2 mL **(B)** 37.2 mL **(C)** 5.6 mL **(D)** 22.4 mL

2. The mass of $K_2Cr_2O_7$ needed to oxidise the above volume of H_2O_2 solution is :

(A) 3.6 g **(B)** 0.8 g **(C)** 4.2 g **(D)** 0.98 g

3. The volume of O_2 at STP that would be liberated by above H_2O_2 solution is :

(A) 56 mL **(B)** 112 mL **(C)** 168 mL **(D)** 224 mL

Comprehension # 5

Equivalent Mass

The equivalent mass of a substance is defined as the number of parts by mass of it which combine with or displace 1.0078 parts by mass of hydrogen, 8 parts by mass of oxygen and 35.5 parts by mass of chlorine.

The equivalent mass of a substance expressed in grams is called **gram equivalent mass.**

The equivalent mass of a substance is not constant. It depends upon the reaction in which the substance is participating. A compound may have different equivalent mass in different chemical reactions and under different experimental conditions.

(A) Equivalent mass of an acid

It is the mass of an acid in grams which contains 1.0078 g of replaceable H^+ ions or it is the mass of acid which contains one mole of replaceable H^+ ions. It may be calculated as :

$$\text{Equivalent mass of acid} = \frac{\text{Molecular mass of acid}}{\text{Basicity of acid}}$$

Basicity of acid = number of replaceable hydrogen atoms present in one molecule of acid

(B) Equivalent mass of a base

It is the mass of the base which contains one mole of replaceable OH^- ions in molecule.

$$\text{Equivalent mass of base} = \frac{\text{Molecular mass of base}}{\text{Aciditiy of base}}$$

Acidity of base = Number of replaceable OH^- ions present in one molecule of the base

Equivalent mass of an oxidising agent

(a) Electron concept : Equivalent mass of oxidising agent = $\dfrac{\text{Molecular mass of oxidising agent}}{\text{Number of electrons gained by one molecule}}$

(b) Oxidation number concept : Equivalent mass of oxidising agent = $\dfrac{\text{Molecular mass of oxidising agent}}{\text{Total change in oxidation number per molecule of oxidising agent}}$

1. Equivalent mass of $Ba(MnO_4)_2$ in acidic medium is : (where M stands for molar mass)
(A) M/5 **(B)** M/6 **(C)** M/10 **(D)** M/2

2. Equivalent mass of $Fe_{0.9}O$ in reaction with acidic $K_2Cr_2O_7$ is : (M = Molar mass)
(A) 7 M/10 **(B)** 10 M/7 **(C)** 7 M/9 **(D)** 9 M/7

3. Equivalent weight of oxalic acid salt in following reaction is : (Atomic masses : O = 16, C = 12, K = 39)
$H_2C_2O_4 + Ca(OH)_2 \longrightarrow CaC_2O_4 + H_2O$
(A) 90 **(B)** 45 **(C)** 64 **(D)** 128

Exercise # 4

[Subjective Type Questions]

1. $KMnO_4$ oxidizes X^{n+} ion to XO_3^-, itself changing to Mn^{2+} in acid medium. 2.68×10^{-3} mole of X^{n+} requires 1.61×10^{-3} mole of MnO_4^-. What is the value of n? Also calculate the atomic mass of X, if the weight of 1 g equivalent of XCl_n is 56.

2. In a quantitative determination of iron in an ore, an analyst converted 0.40 g, of the ore into its ferrous. This required 40.00 mL of 0.1 N solution of $KMnO_4$ for titration.

(i) How many milliequivalents of $KMnO_4$ does 40.00 mL of 0.1 N solution represent?

(ii) How many equivalents of iron were present in the sample of the ore taken for analysis?

(iii) How many grams of iron were present in the sample?

(iv) What is the percentage of iron in the ore?

(v) What is the molarity of $KMnO_4$ solution used?

(vi) How many moles of $KMnO_4$ were used for titration ? (Fe = 56)

3. The mixture of CuS (molar weight = M_1) and Cu_2S (molecular weight = M_2) oxidised by $KMnO_4$ (molecular weight = M_3) in acidic medium, the product obtained are Cu^{2+}, SO_2. Find the equivalent weight of CuS, Cu_2S and $KMnO_4$ respectively.

4. Calculate the oxidation number of underlined elements in the following compounds :

(a) $K[\underline{Co}(C_2O_4)_2.(NH_3)_2]$ **(b)** $K_4\underline{P}_2O_7$ **(c)** $\underline{Cr}O_2Cl_2$

(d) $Na_2[\underline{Fe}(CN)_5NO^+]$ **(e)** $\underline{Mn}_3O_4$ **(f)** $Ca(\underline{Cl}O_2)_2$

(g) $[\underline{Fe}(NO)(H_2O)_5]SO_4$ **(h)** $\underline{Z}nO_2^{2-}$ **(c)** $\underline{Fe}_{0.93}O$

5. Write balanced net ionic equation for the following reactions in acidic solution.

(a) $S_4O_6^{2-}\ (aq) + Al\ (s) \longrightarrow H_2S\ (aq) + Al^{3+}\ (aq)$

(b) $S_2O_3^{2-}\ (aq) + Cr_2O_7^{2-}\ (aq) \longrightarrow S_4O_6^{2-}\ (aq) + Cr^{3+}\ (aq)$

(c) $ClO_3^-\ (aq) + As_2S_3\ (s) \longrightarrow Cl^-\ (aq) + H_2AsO_4^-\ (aq) + HSO_4^-\ (aq)$

(d) $IO_3^-\ (aq) + Re\ (s) \longrightarrow ReO_4^-\ (aq) + I^-\ (aq)$

(e) $HSO_4^-\ (aq) + As_4\ (s) + Pb_3O_4\ (s) \longrightarrow PbSO_4\ (s) + H_2AsO_4^-\ (aq)$

(f) $HNO_2\ (aq) \longrightarrow NO_3^- + NO\ (g)$

6. Write balanced net ionic equations for the following reactions in basic solution :

(a) $C_4H_4O_6^{2-}(aq) + ClO_3^-(aq) \longrightarrow CO_3^{2-}\ (aq) + Cl^-\ (aq)$

(b) $Al\ (s) + BiONO_3\ (s) \longrightarrow Bi\ (s) + NH_3\ (aq) + Al\ (OH)_4^-(aq)$

(c) $H_2O_2\ (aq) + Cl_2O_7\ (aq) \longrightarrow ClO_2^-\ (aq) + O_2\ (g)$

(d) $Tl_2O_3\ (s) + NH_2OH\ (aq) \longrightarrow TlOH\ (s) + N_2\ (g)$

(e) $Cu(NH_3)_4^{2+}\ (aq) + S_2O_4^{2-}\ (aq) \longrightarrow SO_3^{2-}\ (aq) + Cu\ (s) + NH_3\ (aq)$

(f) $Mn(OH)_2\ (s) + MnO_4^-(aq) \longrightarrow MnO_2\ (s)$

7. Consider the reaction $H^+ + IO^-_4 + I^- \rightarrow I_2 + H_2O$. Find the ratio of coefficients of IO_4^-, I^- and I_2.

8. A dilute solution of H_2SO_4 is made by adding 5 mL of 3N H_2SO_4 to 245 mL of water. Find the normality and molarity of the solution.

9. What volume at NTP of gaseous ammonia will be required to be passed into 30 cc of N – H_2SO_4 solution to bring down the acid strength of the latter to 0.2 N.

10. 10 g $CaCO_3$ were dissolved in 250 mL of M HCl and the solution was boiled. What volume of 2 M KOH would be required to equivalence point after boiling? Assume no change in volume during boiling.

11. H_3PO_4 is a tri basic acid and one of its salt is NaH_2PO_4. What volume of 1 M NaOH solution should be added to 12 g of NaH_2PO_4 to convert it into Na_3PO_4?

12. 1.64 g of mixture of $CaCO_3$ and $MgCO_3$ was dissolved in 50 mL of 0.8 M HCl. The excess of acid required 16 mL of 0.25 M NaOH for neutralization. Calculate the percentage of $CaCO_3$ and $MgCO_3$ in the sample.

13. A solution containing 4.2 g of KOH and $Ca(OH_2)$ is neutralized by an acid. It consums 0.1 equivalent of acid, calculate the percentage composition of the sample.

14. How many mL of 0.1 N HCl are required to react completely with 1 g mixture of Na_2CO_3 and $NaHCO_3$ containing equimolar amounts of two?

15. 0.5 g of fuming H_2SO_4 (oleum) is diluted with water. The solution requires 26.7 mL of 0.4N NaOH for complete neutralization. Find the % of free SO_3 in the sample of oleum.

16. 1.5 g of chalk were treated with 10 mL of 4N – HCl. The chalk was dissolved and the solution made to 100 mL, 25 mL of this solution required 18.75 mL of 0.2 N – NaOH solution for complete neutralisation. Calculate the percentage of pure $CaCO_3$ in the sample of chalk?

17. A solution contains Na_2CO_3 and $NaHCO_3$. 20 mL of this solution required 4 mL of 1N – HCl for titration with Ph indicator. The titration was repeated with the same volume of the solution but with MeOH. 10.5 mL of 1 – N HCl was required this time. Calculate the amount of Na_2CO_3 & $NaHCO_3$.

18. A solution contains a mix of Na_2CO_3 and NaOH. Using Ph as indicator 25 mL of mixture required 19.5 mL of 0.995 N HCl for the end point. With MeOH, 25 mL of the solution required 25 mL of the same HCl for the end point. Calculate g/L of each substance in the mixture.

19. It required 40.05 mL of 1 M Ce^{4+} to titrate 20 mL of 1 M Sn^{2+} to Sn^{4+}. What is the oxidation state of the cerium in the product.

20. A volume of 12.53 mL of 0.05093 M SeO_2 reacted with exactly 25.52 mL of 0.1 M $CrSO_4$. In the reaction, Cr^{2+} was oxidized to Cr^{3+}. To what oxidation state was selenium converted by the reaction.

21. Pottasium acid oxalate $K_2C_2O_4.3H_2C_2O_4.4H_2O$ can be oxidized by MnO_4 in acid medium. Calculate the volume of 0.1 M $KMnO_4$ reacting in acid solution with one gram of the acid oxalate.

22. 200 mL of a solution of mixture of NaOH and Na_2CO_3 was first titrated with Ph and $\frac{N}{10}$ HCl. 17.5 mL of HCl was required for end point. After this MeOH was added and 2.5 mL of same HCl was again required for next end point. Find out amounts of NaOH and Na_2CO_3 in the mix.

23. A solution contains Na_2CO_3 and $NaHCO_3$. 10 mL of this requires 2 mL of 0.1 M H_2SO_4 for neutralisation using Ph indicator. MeOH is then added when a further 2.5 mL of 0.2 M H_2SO_4 was needed. Calculate strength of Na_2CO_3 and $NaHCO_3$.

24. A sample containing Na_2CO_3 & NaOH is dissolved in 100 mL solution. 10 mL of this solution requires 25 mL of 0.1 N HCl when Ph is used as indicator. If MeOH is used as indicator 10 mL of same solution requires 30 mL of same HCl. Calculate % of Na_2CO_3 and NaOH in the sample.

25. A 1.0 g sample of H_2O_2 solution containing x% H_2O_2 by mass requires x cm^3 of a $KMnO_4$ solution for complete oxidation under acidic conditions. Calculate the normality of $KMnO_4$ solution.

26. Metallic tin in the presence of HCl is oxidized by $K_2Cr_2O_7$ to stannic chloride, $SnCl_4$. What volume of deci-normal dichromate solution would be reduce by 1 g of tin.

27. 5 g sample of brass was dissolved in one litre dil. H_2SO_4. 20 mL of this solution were mixed with KI, liberating I_2 and Cu^+ and the I_2 required 20 mL of 0.0327 N hypo solution for complete titration. Calculate the percentage of Cu in the alloy.

28. One g of impure sodium carbonate is dissolved in water and the solution is made up to 250 mL. To 50 mL of this made up solution, 50 mL of 0.1 N – HCl is added and the mix after shaking well required 10 mL of 0.16 N – NaOH solution for complete titration. Calculate the % purity of the sample.

29. What amount of substance containing 60% NaCl, 37% KCl should be weighed out for analysis so that after the action of 25 mL of 0.1 N $AgNO_3$ solution, excess of Ag^+ is back titrates with 5 mL of NH_4SCN solution. Given that 1 mL of NH_4SCN = 1.1. mL of $AgNO_3$.

30. A bottle labelled with "12 V H_2O_2" contain 700 mL solution. If a student mix 300 mL water in it what is the g/litre strength & normality and volume strength of final solution.

31. 0.84 g iron ore containing x percent of iron was taken in a solution containing all the iron in ferrous condition. The solution required x mL of a dichromatic solution for oxidizing the iron content to ferric state. Calculate the strength of dichromatic solution.

32. The neutralization of a solution of 1.2 g of a substance containing a mixture of $H_2C_2O_4.2H_2O$, $KHC_2O_4.H_2O$ and different impurities of a neutral salt consumed 18.9 mL of 0.5 N NaOH solution. On titration with $KMnO_4$ solution, 0.4 g, of the same substance needed 21.55 mL of 0.25 N $KMnO_4$. Calculate the % composition of the substance.

33. 50 g of a sample of $Ca(OH)_2$ is dissolved in 50 mL of 0.5 N HCl solution. The excess of HCl was titrated with 0.3 N – NaOH. The volume of NaOH used was 20cc. Calculate % purity of $Ca(OH)_2$.

34. 50 mL of an aqueous solution of H_2O_2 were treated with an excess of KI solution and dilute H_2SO_4, the liberated iodine required 20 mL of 0.1 N $Na_2S_2O_3$ solution for complete interaction. Calculate the concentration of H_2O_2 in g/●.

35. 100 kg hard water contains 5 g $MgSO_4$. Find hardness.

36. One litre hard water contains 1 mg $CaCl_2$ and 1 mg $MgSO_4$. Find hardness.

37. Calculate the amount of lime $Ca(OH)_2$ required to remove the hardness in 60 litre of pond water containing 1.62 mg of calcium bicarbonate per 100 mL of water.

38. 10 g sample of bleaching powder was dissolved into water to make the solution one litre. To this solution 35 mL of 1.0 M Mohr salt solution was added containing enough H_2SO_4. After the reaction was complete, the excess Mohr salt required 30 mL of 0.1 M $KMnO_4$ for oxidation. Find out the % of available Cl_2 approximately is (mol wt. 71).

39. Calculate the amount (in milligrams) of SeO_3^{-2} in solution on the basis of following data 20 mL of M/60 solution of $KBrO_3$ was added to a definite volume of SeO_3^{-2} solution. The bromine evolved was removed by boiling and excess of $KBrO_3$ was back titrated with 5 mL of M/25 solution of $NaAsO_2$. The reactions are given below. (Atomic mass of K = 39, Br = 80, As = 75, Na = 23, O = 16, Se = 79)

(a) $SeO_3^{-2} + BrO_3^- + H^+ \longrightarrow SeO_4^{-2} + Br_2 + H_2O$

(b) $BrO_3^- + AsO_2^- + H_2O \longrightarrow Br^- + AsO_4^{-3} + H^+$

40. Calculate the hardness of water sample which contains 0.001 mol $MgSO_4$ per litre of water.

41. A solution of a 0.4 g sample of H_2O_2 reacted with 0.632 g of $KMnO_4$ in the presence of sulphuric acid. Calculate the percentage purity of the sample of H_2O_2.

42. 5 litre of a solution of H_2O_2 with x N strength is diluted to 5.5 litre. This 5.5 litre H_2O_2 solution gives 28 litre O_2 at NTP. Find the value of x.

43. A 1.0 g sample of Fe_2O_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 moles of electrons taken up by the oxidant in the reaction of the above titration.

44. 25 mL of a solution containing HCl was treated with excess of M/5 KIO_3 and KI solution of unknown concentration where I_2 liberated is titrated against a standard solution of 0.021 M $Na_2S_2O_3$ solution whose 24 mL were used up. Find the strength of HCl and volume of KIO_3 solution consumed :

45. 0.6213 g of sample contains an unknown amount of As_2O_3. The sample was treated with HCl resulting information of $AsCl_3$ (g) which was distilled into a beaker of water. The hydrolysis reaction is as follows :

$$AsCl_3 + 2H_2O \rightarrow HAsO_2 + 3H^+ + 3Cl^-$$

The amount of $HAsO_2$ was determined by titration with 0.04134 M I_2, requiring 23.04 mL to reach the equivalence point. The redox products in the titration were H_3AsO_4 and I^-. Find the amount of $KMnO_4$ needed to oxidize As in As_2O_3 to its maximum possible oxidation state in acidic medium.

46. A sample of steel weighing 0.6 g and containing S as an impurity was burnt in a stream of O_2, when S was converted to its oxide SO_2.SO_2 was then oxidized to $SO_4^{- -}$ by using H_2O_2 solution containing 30 mL of 0.04 M NaOH. 22.48 mL of 0.024 M HCl was required to neutralize the base remaining after oxidation. Calculate the % of S in the sample :

47. 1.2475 g of crystalline copper sulphate was dissolved in water and excess of KI was added. The liberated iodine consumed 50 mL N/10 $Na_2S_2O_3$ solution to reach the end point of the titration. Calculate the number of water molecules of hydration in crystalline copper sulphate salt.

48. A 1g sample of $K_2Cr_2O_7$ containing some inert material was entirely reduced with conc. HCl. The chlorine liberated was passed through hot solution of NaOH at 80^0C, and it completely dipproportionates to form ClO_3^- and Cl^-. This $NaClO_3$ was isolated and its reduction with KI (aq) liberated iodine, giving Cl^-.The iodine thus liberated required 100 mL of decinormal hypo solution for complete titration. What is the percentage purity of the dichromate sample?

49. 2.5g of mixture of crystalline oxalic acid ($H_2C_2O_4 . 2H_2O$) and sodium oxalate ($Na_2C_2O_4$) was dissolved in 100 mL of water. 50 mL of this solution was titrated against N/10 NaOH solution when 119.05 mL of the base was found necessary to reach the end point with phenolphthalein as the indicator. 1g of the mixture was dissolved in water and the solution titrated against N/10 $KMnO_4$ in the presence of dil. H_2SO_4. What is the volume of $KMnO_4$ needed for getting the end point with 0.5g of the mixture?

50. In the presence of fluoride ion, Mn^{2+} can be titrated with MnO_4^-, both reactants being converted to a complex of Mn(III). A 0.545 g sample containing Mn_3O_4 was dissolved and all manganese was converted to Mn^{2+}. Titration in the presence of fluoride ion consumed 31.1 mL of $KMnO_4$ that was 0.177 N against oxalate.

(a) write a balanced chemical equation for the reaction, assuming that the complex is MnF_4^-.

(b) what was the % of Mn_3O_4 in the sample ?

51. A mixture of two gases, H_2S and SO_2 is passed through three beakers successively. The first beaker contains Pb^{2+} ions, which absorbs S^{2-} forming PbS. The second beaker contains 25 mL of 0.0396 N I_2 to oxidize SO_2 to SO_4^{2-}. The third contains 10 mL of 0.0345 N thiosulphate solution to retain any I_2 carried over from the second absorber. A 25 L gas sample was passed through the apparatus followed by an additional amount of N_2 to sweep last traces of SO_2 from first and second absorber. The solution from the first absorber was made acidic and treated with 20 mL of 0.0066 M $K_2Cr_2O_7$ which converted S^{2-} to SO_2. The excess dichromate was reacted with solid KI and the liberated iodine required 7.45 mL of 0.0345 N $Na_2S_2O_3$ solution. The solutions in the second and third absorbers were combined and the resultant iodine was titrated with 2.44 mL of the same thiosulphate solution. Calculate the concentrations of SO_2 and H_2S in mg/L of the sample :

52. 1 g of a moist sample of a mixture of $KClO_3$ and KCl was dissolved in water and made upto 250 mL. 25 mL of this solution was treated with SO_2 to reduced chlorate into chloride and the excess SO_2 was boiled off. When the total chloride was precipitated, 0.1435 g of AgCl was obtained. In another experiment 25 mL of the original solution was treated with 30 mL of 0.2 N solution of $FeSO_4$ and unreacted $FeSO_4$ required 37.5 mL of 0.08 N solution of an oxidizing agent for complete oxidation. Calculate the molar ratio of chlorate and chloride in the given mixture. Fe^{2+} reacts with ClO_3^- according to equation :

$$ClO_3^- + 6Fe^{2+} + 6H^+ \rightarrow Cl^- + 6Fe^{3+} + 3H_2O$$

Also calculate the mass percent of moisture present in the moist sample.

53. A 1 g sample containing NaOH as the only basic substance and some inert impurity was left exposed to atmosphere for a very long time so that part of NaOH got converted into Na_2CO_3 by absorbing CO_2 from atmosphere. The resulting sample was dissolved in water and volume made upto 100 mL. A 20 mL portion of this solution required 16 mL 0.25 M HCl solution to reach the equivalence point when methyl orange was used as indicator. In a separate analysis, 20 mL portion of the same solution was taken along with phenolphthalein indicator and mixed with 50 mL of 0.1 M HCl solution. An additional 9.00 mL 0.1 M $Ba(OH)_2$ solution was required to just restore the pink colour of solution. Determine mass percentage of NaOH in the original sample and mass percentage of Na_2CO_3 in the sample after exposure to atmosphere.

54. A steel sample is to be analysed for Cr and Mn simultaneously. By suitable treatment the Cr is oxidized to $Cr_2O_7^{2-}$ and the Mn to MnO_4^-. A 10.00 g sample of steel is used to produce 250.0 mL of a solution containing $Cr_2O_7^{2-}$ and MnO_4^-. A 10.00 mL portion of this solution is added to a $BaCl_2$ solution and by proper adjustment of the acidity, the chromium is completely precipitated as $BaCrO_4$; 0.0549 g is obtained. A second 10.00 mL portion of this solution requires exactly 15.95 mL of 0.0750 M standard Fe^{2+} solution for its titration (in acid solution). Calculate the % of Mn and % of Cr in the steel sample.

55. 1.16 g $CH_3(CH_2)_nCOOH$ was burnt in excess air and the resultant gases (CO_2 and H_2O) were passed through excess NaOH solution. The resulting solution was divided in two equal parts. One part required 50 mL of 1 N HCl for neutralization using phenolphthalein as indicator. Another part required 80 mL of 1 N HCl for neutralization using methyl orange as indicator. Find the value of n and the amount of excess NaOH solution taken initially.

56. A 1.5 g sample containing oxalic acid and some inert impurity was dissolved in enough water and volume made up to 250 mL. A 20 mL portion of this solution was then mixed with 30 mL of an alkali solution. The resulting solution was then treated with stoichiometric amount of $CaCl_2$ just needed for precipitation of oxalate as CaC_2O_4. Solution was filtered off and filtrate was finally titrated against 0.1 M HCl solution. 8.0 mL of acid was required to reach the equivalence point. At last, the above neutral solution was treated with excess of $AgNO_3$ solution and AgCl obtained was washed, dried and weighed to be 0.4305 g. Determine mass percentage of oxalic acid in the original sample :

Exercise # 5

Part # I [Previous Year Questions] [AIEEE/JEE-MAIN]

1. The oxidation state of Cr in $[Cr(NH_3)_4Cl_2]^+$ is - **[AIEEE-05]**

(1) +2 **(2)** +3 **(3)** 0 **(4)** +1

2. The oxidation state of chromium in the final product formed by the reaction between Kl and acidified potassium dichromate solution is - **[AIEEE-05]**

(1) +6 **(2)** +4 **(3)** +3 **(4)** +2

3. Which of the following chemical reaction depicts the oxidizing behaviour of H_2SO_4 ? **[AIEEE-06]**

(1) $Ca(OH)_2 + H_2SO_4 \rightarrow CaSO_4 + 2H_2O$ **(2)** $NaCl + H_2SO_4 \rightarrow NaHSO_4 + HCl$

(3) $2PCl_5 + H_2SO_4 \rightarrow 2POCl_3 + 2HCl + SO_2Cl_2$ **(4)** $2HI + H_2SO_4 \rightarrow I_2 + SO_2 + 2H_2O$

4. Which of the following reactions is an example of a redox reaction? **[JEE Main-2017]**

(1) $XeF_4 + O_2F_2 \rightarrow XeF_6 + O_2$ **(2)** $XeF_2 + PF_5 \rightarrow [XeF]^+ + PF_6^-$

(3) $XeF_6 + H_2O \rightarrow XeOF_4 + 2HF$ **(4)** $XeF_6 + 2H_2O \rightarrow XeO_2F_2 + 4HF$

5. Hydrogen peroxide oxidises $[Fe(CN)_6]^{4-}$ to $[Fe(CN)_6]^{3-}$ in acidic medium but reduces $[Fe(CN)_6]^{3-}$ to $[Fe(CN)_6]^{4-}$ in alkaline medium. The other products formed are, respectively: **[JEE Main-2018]**

(1) $(H_2O + O_2)$ and $(H_2O + OH^-)$ **(2)** H_2O and $(H_2O + O_2)$

(3) H_2O and $(H_2O + OH^-)$ **(4)** $(H_2O + O_2)$ and H_2O

Part # II [Previous Year Questions][IIT-JEE ADVANCED]

1. In basic medium I^- oxidises by MnO_4^-. In this process I^- replaces by : **[JEE 2004]**

(A) IO_3^- **(B)** I_2 **(C)** IO_4^- **(D)** IO^-

2. Amongst the following, the pair having both the metals in their highest oxidation state is : **[JEE 2004]**

(A) $[Fe(CN)_6]^{3-}$ and $[Co(CN)_6]^{3-}$ **(B)** $[CrO_2Cl_2]$ and $[MnO_4^-]$

(C) TiO_2 and MnO_2 **(D)** $[MnCl_4]^{2-}$ and $[NiF_6]^{-2}$

3. O_3 does not oxidise : **[JEE 2005]**

(A) KI **(B)** $FeSO_4$ **(C)** $KMnO_4$ **(D)** K_2MnO_4

4. A 5.0 cm^3 solution of H_2O_2 liberates 0.508 g of iodine from an acidified KI solution. Calculate the strength of H_2O_2 solution in terms of volume strength at STP. **[JEE' 1995]**

5. A 3.00 g sample containing Fe_3O_4, Fe_2O_3 and an inert impure substance, is treated with excess of KI solution in presence of dilute H_2SO_4. The entire iron is converted into Fe^{2+} along with the liberation of iodine. The resulting solution is diluted to 100 mL. A 20 mL of the diluted solution require 11 mL of 0.5 M $Na_2S_2O_3$ solution to reduce the iodine present. A 50 mL of diluted solution after complete extraction of the iodine requires 12.80 mL of 0.25 $KMnO_4$ solution in dilute H_2SO_4 medium for the oxidation of Fe^{2+}. Calculate the percentages of Fe_2O_3 and Fe_3O_4 in the original sample. **[JEE 2000]**

6. One litre of a mixture of O_2 and O_3 at NTP was allowed to react with an excess of acidified solution of KI. The Iodine liberated required 40 mL of M/10 sodium thiosulphate solution for titration. What is the percent of ozone in the mixture ? Ultraviolet radiation of wavelength 300 nm can decompose ozone. Assuming that one photon can decompose one ozone molecule, how many photons would have been required for the complete decomposition of ozone in the original mixture? **[JEE 97,5]**

7. A sample of hard water contains 96 ppm of SO_4^{2-} and 183 ppm of HCO_3^-, with Ca^{2+} as the only cation. How many moles of CaO will be required to remove HCO_3^- from 1000 kg of this water? If 1000 kg of this water is treated with the amount of CaO calculate above, what will be the concentration (in ppm) of residual Ca^{2+} ions (Assume $CaCO_3$ to be completely insoluble in water)? If the Ca^{2+} ions in one litre of the treated water are completely exchanged with hydrogen ions, what will be its pH (one ppm means one part of the substance in one million part of water, weight / weights)? **[JEE' 1997]**

8. An aqueous solution containing 0.10 g KIO_3 (formula wt. 214.0) was treated with an excess of KI solution. The solution was acidified with HCl. The liberated I_2 consumed 45.0 mL of thiosulphate solution to decolourise the blue starch – iodine complex. Calculate the molarity of the sodium thiosulphate solution. **[JEE 1998]**

9. How many millilitre of 0.5 M H_2SO_4 are needed to dissolve 0.5 g of copper II carbonate ? **[JEE 1999]**

10. Hydrogen peroxide solution (20 mL) reacts quantitatively with a solution of $KMnO_4$ (20 mL) acidified with dilute H_2SO_4. The same volume of $KMnO_4$ solution is just decolorized by 10 mL of $MnSO_4$ in neutral medium simultaneously forming a dark brown precipitate of hydrated MnO_2. The brown precipitate is dissolved in 10 mL of 0.2 M sodium oxalate under boiling condition in the presence of dilute H_2SO_4. Write the balanced equations involved in the reactions and calculate the molarity of H_2O_2. **[JEE 2001]**

11. For the reaction :

$I^- + ClO_3^- + H_2SO_4 \longrightarrow Cl^- + HSO_4^- + I_2$

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

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

12. Hydrogen peroxide in its reaction with KIO_4 and NH_2OH respectively, is acting as a

(A) reducing agent, oxidising agent
(B) reducing agent, reducing agent
(C) oxidising agent, oxidising agent.
(D) oxidising agent, reducing agent

13. In dilute aqueous H_2SO_4, the complex diaquodioxalatoferrate(II) is oxidized by MnO_4^-. For this reaction, the ratio of the rate of change of $[H^+]$ to the rate of change of $[MnO_4^-]$ is. **[JEE 2015]**

MOCK TEST

SECTION - I : STRAIGHT OBJECTIVE TYPE

1. The number of moles of $KMnO_4$ that will be needed to react completely with one mole of ferrous oxalate in acid solution is

(A) 3/5 **(B)** 2/5 **(C)** 4/5 **(D)** 1

2. The number of moles of $KMnO_4$ that will be needed to react with one mole of sulphite ions in acidic solution is

(A) 2/5 **(B)** 3/5 **(C)** 4/5 **(D)** 1

3. The normality of 0.3 M phosphorus acid (H_3PO_3) is

(A) 0.1 **(B)** 0.9 **(C)** 0.3 **(D)** 0.6

4. An aqueous solution of 6.3 gm of oxalic acid dihydrate is made upto 250 ml. The volume of 0.1 N NaOH required to completely neutralize 10 ml of this solution is

(A) 40 ml **(B)** 20 ml **(C)** 10 ml **(D)** 4 ml

5. Consider a titration of potassium dichromate solution with acidified Mohr's salt solution using diphenylamine as indicator. The number of moles of Mohr's salt required per mole of dichromate is

(A) 3 **(B)** 4 **(C)** 5 **(D)** 6

SECTION - II : MULTIPLE CORRECT ANSWER TYPE

6. Consider the redox reaction $2S_2O_3^{2-} + I_2 \longrightarrow S_4O_6^{2-} + 2\,I^-$:

(A) $S_2O_3^{2-}$ gets reduced to $S_4O_6^{2-}$ **(B)** $S_2O_3^{2-}$ gets oxidised to $S_4O_6^{2-}$

(C) I_2 gets reduced to I^- **(D)** I_2 gets oxidised to I^-

7. There are two sample of HCl having molarity 1N and 0.25 N. Find volume of these sample taken in order to prepare 0.75 N HCl solution. (Assume no water is used) :

(A) 20 mL, 10 mL **(B)** 100 mL, 50 mL **(C)** 40 mL, 20 mL **(D)** 50 mL, 25 mL

8. To a 25 ml H_2O_2 solution excess acidified solution of KI was added. The iodine liberated 20 ml of 0.3 N sodium thiosulphate solution. Use these data to choose the correct statements from the following :

(A) The weight of H_2O_2 present in 25 ml solution is 0.102 g
(B) The molarity of H_2O_2 solution is 0.12 M
(C) The weight of H_2O_2 present in 1 L of the solution is 0.816 g
(D) The volume strength of H_2O_2 is 1.344 L

SECTION - III : ASSERTION AND REASON TYPE

Each question has 5 choices (A), (B), (C), (D) and (E) out of which only one is correct.

(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.
(C) Statement-1 is True, Statement-2 is False.
(D) Statement-1 is False, Statement-2 is True.
(E) Statement-1 and Statement-2 both are False.

9. **Statement-1 :** In the redox reaction $8\,H^+(aq) + 4\,NO_3^- + 6\,Cl^- + Sn(s) \longrightarrow SnCl_6^{2-} + 4\,NO_2 + 4\,H_2O$, the reducing agent is Sn(s).

Statement-2 : In balancing half reaction, $S_2O_3^{2-} \longrightarrow S(s)$, the number of electrons added on the left is 4.

10. **Statement-1 :** Among Br^-, O_2^{2-}, H^- and NO_3^-, the ions that cannot act as oxidising agents are Br^- and H^-
Statement-2 : Br^- and H^- cannot be reduced.

SECTION - IV : COMPREHENSION TYPE

Read the following comprehensions carefully and answer the questions.

Comprehension # 1

Chromium exists as $FeCr_2O_4$ in the nature and it contains $Fe_{0.95}O$ & other impurity. To obtain pure chromium from $FeCr_2O_4$, the ore is fused with KOH and oxygen is passed through the mixture when K_2CrO_4 and Fe_2O_3 are produced.

$$FeCr_2O_4 + KOH + O_2 \longrightarrow K_2CrO_4 + Fe_2O_3$$
$$Fe_{0.95}O + O_2 \longrightarrow Fe_2O_3$$

2 g of ore required 270 mL of O_2 at 273 K and 1 atm for complete oxidation of ore. K_2CrO_4 is precipitated as $BaCrO_4$ when Barium salt is added . To remaining solution 10 mL of 1 M $K_4Fe(CN)_6$ is added when Fe^{3+} ions react with it to form $KFe[Fe(CN)_6]$, often called 'Prussian Blue'. To determine excess of $K_4Fe(CN)_6$ in solution 7mL of 0.2 N of Fe^{2+} is added when all the $K_4Fe(CN)_6$ is precipitated as $K_2Fe[Fe(CN)_6]$.

11. Weight of $BaCrO_4$ precipitated
(A) 1.64 **(B)** 6.29 **(C)** 0.82 **(D)** 3.29

12. % by mass of $Fe_{0.95}O$ in the ore
(A) 9.6% **(B)** 10.1% **(C)** 8.55% **(D)** 20.2%

13. n factor for $Fe_{0.95}O$
(A) 0.9 **(B)** 0.85 **(C)** $\frac{2}{0.95}$ **(D)** 1.8

14. Weight of impurities present in the ore
(A) 0.421 **(B)** 0.123 **(C)** 0.341 **(D)** 0.206

SECTION - V : MATRIX - MATCH TYPE

15.

Column I			**Column II**
(A) Sn^{+2} 3.5 mole	+	MnO_4^- (acidic) 1.2 mole	**(p)** Amount of oxidant available decides the number of electrons transfer
(B) $H_2C_2O_4$ 8.4 mole	+	MnO_4^- (acidic) 3.6 mole	**(q)** Amount of reductant available decides the number of electrons transfer
(C) $S_2O_3^{-2}$ 7.2 mole	+	I_2 3.6 mole	**(r)** Number of electrons involved per mole of oxidant > Number of electrons involved per mole of reductant
(D) Fe^{+2} 9.2 mole	+	$Cr_2O_7^{-2}$ (acidic) 1.6 mole	**(s)** Number of electrons involved per mole of oxidant < Number of electrons involved per mole of reductant.

SECTION - VI : SUBJECTIVE TYPE

16. H_2O_2 is reduced rapidly by Sn^{2+}, the products being Sn^{4+} & water. H_2O_2 decomposes slowly at room temperature to yield O_2 & water. Calculate the volume of O_2 produced at 273K & 1.00 atm when 200g of 10.0 % by mass H_2O_2 in water is treated with 88.2 ml of 1 M Sn^{2+} & then the mixture is allowed to stand until no further reaction occurs.

17. 80 gm of a sample of Anhydrous $CuSO_4$ was dissolved in water and made to 250ml. 25 ml of this solution after taking usual precautions was treated with a little excess of KI solution. A white ppt. of Cu_2I_2 and iodine was evolved. The iodine so evolved required 40 ml of 1 M of hypo solution. What is the approximate purity of $CuSO_4$ solution.[Mol. wt. of $CuSO_4$ = 160]

ANSWER KEY

EXERCISE - 1

1. D **2.** A **3.** C **4.** C **5.** B **6.** D **7.** D **8.** C **9.** A **10.** B **11.** C **12.** A **13.** C
14. C **15.** A **16.** B **17.** A **18. (i)** A **(ii)** A **(iii)** A **(iv)** D **19.** A **20.** D **21.** B **22.** B
23. A **24.** D **25.** B **26.** A **27.** A **28.** B **29.** B **30.** C **31.** D **32.** B **33.** B **34.** C **35.** A
36. A **37.** D **38.** D **39.** D **40.** C **41.** D **42.** A **43.** D **44.** A **45.** B **46.** B **47.** A **48.** A
49. B **50.** B

EXERCISE - 2 : PART # I

1. A, C **2.** A, B, C, D **3.** A, C, D **4.** A, B, D **5.** B, C **6.** A, B, C, D
7. A, B, D **8.** B, D **9.** B, C **10.** A, B, D **11.** A, B, D **12.** A, C, D
13. B, C, D **14.** A, B, C **15.** B, C **16.** D **17.** C **18.** A, B
19. A, B **20.** A, B, D

PART # II

1 B **2** A **3** A **4** A **5** B **6** A **7** B **8** A **9** A **10** A **11** B **12** D **13** C

EXERCISE - 3 : PART # I

1. A → (q), B → (p), C → (s), D → (r)
2. A → (s), B → (p), C → (q), D → (r)
3. A → (s), B → (q), C → (r), D → (p)
4. A → (p), B → (r,s), C → (r), D → (r, q)
5. A → (p, s), B → (s), C → (p, q), D → (r)
6. A → (p, s), B → (q, r), C → (p, q, s), D → (r)
7. A → (p, r), B → (q, r), C → (p, q, r), D → (q, r)

PART # II

Comprehension # 1 : **1.** A **2.** B **3.** B **4.** B

Comprehension # 2 : **1.** B **2.** C **3.** C **4.** B

Comprehension # 3 : **1.** C **2.** A **3.** C **4.** B

Comprehension # 4 : **1.** C **2.** D **3.** B

Comprehension # 5 : **1.** C **2.** B **3.** C

EXERCISE - 5 : PART # I

1. 2 **2.** 3 **3.** 4 **4.** 1 **5.** 2

PART # II

1. A **2.** B **3.** C **4.** 4.48 **5.** Fe_2O_3 = 49.33 %, Fe_3O_4 = 34.8% **6.** 6.57% O_3 (by weight), 1.2 × 10^{21} photons

7. 1.5, 40 ppm, pH = 2.6989 **8.** 0.0623 M **9.** 8.097 mL **10.** 0.1 M **11.** (A), (B), (D) **12.** (A) **13.** 8

MOCK TEST

1. A **2.** A **3.** D **4.** A **5.** D **6.** B,C **7.** A,B,C,D **8.** A,B,D **9.** C **10.** B **11.** D **12.** B

13. B **14.** C **15.** A → (p,r), B → (q,r), C → (p,q,r), D → (q,r) **16.** 5.6 L **17.** 80%