Chapter 8

Redox Reactions

Solutions

SECTION - A

Objective Type Questions (One option is correct)

1. 12.53 ml of 0.051 M SeO_2 reacted with 25.52 ml of 0.1 M $CrSO_4$ solution. In the reaction Cr^{2+} was oxidised to Cr^{3+}. The oxidation state at which selenium was converted is

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

Sol. Answer (4)

$$\overset{+4}{Se}O_2 + \overset{+2}{Cr}SO_4 \longrightarrow Cr^{+3} + \overset{x}{Se}$$

$nf = 4 - x$ $nf = 3 - 2$

$= 1$

Number of meq. of SeO_2 = Number of meq. of $CrSO_4$

$[0.051 \times (4 - x)] \times 12.53 = (0.1 \times 1) \times 25.52$

$$4 - x = \frac{0.1 \times 1 \times 25.52}{0.051 \times 12.53}$$

$4 - x = 3.99$

$x \simeq 0$

2. A sample of $NaHCO_3 + Na_2CO_3$ required 20 ml of HCl using phenolphthalein as indicator and 35 ml more required if methyl orange is used as indicator. Then molar ratio of $NaHCO_3$ to Na_2CO_3 is

(1) $\frac{1}{2}$ (2) $\frac{2}{3}$ (3) $\frac{3}{4}$ (4) $\frac{1}{3}$

Sol. Answer (3)

Let there are x_1 meq. of $NaHCO_3$ and x_2 meq. of Na_2CO_3.

HPh : $\frac{1}{2}$ meq. of Na_2CO_3 = meq. of HCl

$\frac{1}{2} x_2 = 20 \times N$

$x_2 = 40$ N …(i)

MeOH : meq. of $NaHCO_3$ + meq. of Na_2CO_3 = meq. of HCl

$x_1 + x_2 = 55$ N

$x_1 = 15$ N

$n_1 \times 1 = 15$ N

$n_1 = 15$ N

$x_2 = 40$ N

$n_2 \times 2 = 40$ N

$n_2 = 20$ N

$n_1 : n_2 = 15$ N : 20 N

$= 3 : 4$

3. A sample of $FeSO_4$ and FeC_2O_4 is dissolved in H_2SO_4. The complete oxidation of sample required 8/3 eq. of $KMnO_4$. After oxidation, the reaction mixture was reduced by Zn. On again oxidation by $KMnO_4$ required $\frac{5}{3}$ eq. The mole ratio of $FeSO_4$ and FeC_2O_4 is

(1) $\frac{3}{7}$ (2) $\frac{7}{3}$ (3) $\frac{5}{7}$ (4) $\frac{7}{5}$

Sol. Answer (2)

$$\underset{nf=1}{\overset{n_1 \text{ mole}}{FeSO_4}} + \underset{nf=3}{\overset{n_2 \text{ mole}}{FeC_2O_4}} + KMnO_4 \longrightarrow Fe^{+3} + \overset{+4}{CO_2} + Mn^{+2}$$

Number of eq. of $FeSO_4$ + Number of eq. of FeC_2O_4 = number of eq. of $KMnO_4$

$n_1 \times 1 + n_2 \times 3 = \frac{8}{3}$

$n_1 + 3n_2 = \frac{8}{3}$ …(i)

$n_1 + n_2 = \frac{5}{3}$ …(ii)

By solving (i) and (ii),

$n_2 = \frac{7}{6}$ and $n_2 = \frac{1}{2}$

$\frac{n_1}{n_2} = \frac{7/6}{1/2} = \frac{7}{3}$

4. During the oxidation of arsenite ion, AsO_3^{-3} to arsenate AsO_4^{3-} in alkaline medium, the numbers of moles of hydroxide ions consumed per mole of arsenite ion are

(1) 2 (2) 3 (3) 2/3 (4) 3/2

Sol. Answer (1)

5. The coefficients of I^-, IO_3^- and H^+ in the following reaction, $I^- + IO_3^- + H^+ \longrightarrow I_2 + H_2O$ in a balanced state would be respectively

(1) 5, 1, 6 (2) 1, 5, 6 (3) 6, 1, 5 (4) 5, 6, 1

Sol. Answer (1)

$6H^+ + 5I^- + IO_3^- \rightarrow 3I_2 + 3H_2$

6. The chromate ion present in water sample is reduced to insoluble chromium hydroxide, $Cr(OH)_3$ by dithionation, in basic solution.

$$S_2O_4^{2-} + CrO_4^{2-} + 2H_2O \longrightarrow 2SO_3^{2-} + Cr(OH)_3 + OH^-$$

100 L of water requires 387 g of $Na_2S_2O_4$. The molarity of CrO_4^{2-} in waste water is

(1) 0.0448 (2) 4.448 (3) 0.0148 (4) 0.0224

Sol. Answer (3)

Balanced redox reaction is

$$2H_2O + 3S_2O_4^{-2} + 2CrO_4^{-2} \longrightarrow 6SO_3^{-2} + 2Cr^{+3} + 4OH^-$$

$M_{Na_2S_2O_4} = 387$

Now $2 \times n_{S_2O_4^{-2}} = 3 \times n_{CrO_4^{-2}}$

$$\therefore \quad n_{CrO_4^{-2}\,(\text{in } 100\,\ell)} = \frac{2 \times 174}{387} \times \frac{1}{3} = 1.48$$

$\therefore$ nCO_4^{-2} in 1 L H_2O = 0.0148

7. A sample which contains exactly 0.5 g of uranium in the form of U^{4+}. The total uranium is allowed to oxidized by 50 ml of $KMnO_4$. The reaction taking place is

$$U^{4+} + KMnO_4 + H_2O \longrightarrow UO_2^{2+} + Mn^{2+} + H_3O^+$$

Find the concentration of $KMnO_4$ required for the above purpose [U = 238]

(1) 0.0336 M (2) 0.0084 M (3) 0.0168 M (4) 0.0672 M

Sol. Answer (3)

On balancing redox reaction

$5U^{+4} + 2MnO_4^- \rightarrow 5UO_2^{+2} + 2Mn^{+2}$

n = 2 n = 5

Equivalents of $KMnO_4$ = Equivalents of U^{+4}

$$N \times \frac{50}{1000} = \frac{0.5}{\left(\frac{238}{2}\right)}$$

$\therefore$ N = 0.084

Hence $M_{KMnO_4} = \frac{N}{5} = \frac{0.084}{5} = 0.0168$ M

8. A 50 ml of a 20% (w/w) solution of density 1.2 g/ml is diluted until its strength becomes 6% (w/w). Determine the mass of water added

(1) 88 g (2) 120 g (3) 140 g (4) 180 g

Sol. Answer (3)

$$\%\frac{w}{w} = \frac{\text{Wt. of solute}}{\text{Wt. of solution}} \times 100$$

9. 1.245 g of $CuSO_4.xH_2O$ was dissolved in water and H_2S gas was passed through it till CuS was completely precipitated. The H_2SO_4 produced in the filtrate required 100 ml of 0.1 M NaOH solution. Calculate x (approximately)

(1) 5 (2) 6 (3) 7 (4) 8

Sol. Answer (3)

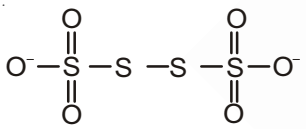
$$\text{Eq. of } H_2SO_4 = \text{Eq. of NaOH}$$

$$\text{Eq. of } H_2SO_4 = \text{Eq. of } CuSO_4 \cdot xH_2O$$

10. Which of the following set correctly represents the actual oxidation state of S atoms present in tetrathionate ion ($S_4O_6^{2-}$)?

(1) 0 and +2.5 (2) +1 and +4 (3) +2 and +3 (4) 0 and +5

Sol. Answer (4)



11. Consider the reaction and the statements that follow

$$(NH_4)_2\,Cr_2O_7 \xrightarrow{\Delta} N_2 + Cr_2O_3 + 4H_2O$$

S-I : The above reaction is an example of disproportionation reaction

S-II : Equivalent weight of $(NH_4)_2\,Cr_2O_7$ is $\dfrac{\text{Molecular weight}}{12}$

Choose the correct option.

(1) S-I is true, S-II is false (2) S-I is false, S-II is true

(3) S-I and S-II are both true (4) S-I and S-II are both false

Sol. Answer (4)

Reaction is an intermolecular redox reaction

$$\text{Equivalent weight} = \frac{\text{Mol.wt}}{6}$$

12. Consider the given reaction/process

(I) $Zn + NaOH \rightarrow$

(II) $NH_4NO_3 \xrightarrow{\Delta}$

(III) $CH_4(g) + H_2O(g) \xrightarrow[Ni]{1270\ K}$

Then the reaction(s) or process in which hydrogen is not formed is

(1) (I) and (III) only (2) (II) only (3) (II), (III) only (4) (III) only

Sol. Answer (2)

$NH_4NO_3 \xrightarrow{\Delta} N_2O + 2H_2O$

13. Consider the reaction of Pb_3O_4 with two different acids HCl and HNO_3 and choose the incorrect statement.

(1) Reaction with HCl includes a redox reaction

(2) Reaction with HNO_3 includes acid base reaction

(3) PbO_2 is passive to both Cl^- as well as NO_3^-

(4) PbO is reactive towards both Cl^- as well as NO_3^-

Sol. Answer (3)

$Pb_3O_4 + 8HCl \rightarrow 3PbCl_2 + Cl_2 + 4H_2O$

$Pb_3O_4 + 4HNO_3 \rightarrow 2Pb(NO_3)_2 + PbO_2 + 2H_2O$

14. 0.859 g of a mixture of CuS and Cu_2S was titrated with 25 ml of 0.5 M acidified potassium permanganate solution producing cupric ions and SO_2. The SO_2 produced was boiled off and excess of MnO_4^- required 29 ml of 0.5 M Fe^{2+} solution. The molar ratio of CuS : Cu_2S in the original mixture taken is

(1) 6 : 5 (2) 7 : 4 (3) 4 : 7 (4) 4 : 3

Sol. Answer (4)

$\underset{(x=8)}{Cu_2S} \xrightarrow{KMnO_4} Cu^{2+} + SO_2$

$\underset{(x=6)}{CuS} \xrightarrow{KMnO_4} Cu^{2+} + SO_2$

Let m moles of CuS be a and that of Cu_2S be b

$\therefore$ a(95.5) + b(159) = 859

and meq of CuS + meq of Cu_2S + meq of Fe^{2+}

= meq of $KMnO_4$

$\therefore$ a × 6 + b × 8 + 29 × 0.5 × 1 = 25 × 0.5 × 5

6a + 8b + 14.5 = 62.5

6a + 8b = 48

on solving a = 4, b = 3

15. When a metal (M) is burnt in presence of oxygen, it gains a weight equal to 0.32 times its initial weight. If the molar mass of the metal be 50 g/mole then the empirical formula of its oxide from the following can be

(1) MO (2) MO_2 (3) MO_3 (4) MO_4

Sol. Answer (1)

Let 100 g metal be taken

so mass of oxide = 132 g

$\therefore$ Equivalent mass of metal = 25 g

as 8 gm of oxygen reacts with 25 g of the metal

$\therefore$ Valency of metal = n-factor of metal

= 2

The compound formed is MO

16. 5.68 g of a mixture of $CaCO_3$ and $MgCO_3$ was dissolved in 800 ml of 0.4 M HCl and the solution was diluted to 1 lit. 20 ml of this solution was neutralised by 20 ml of 0.1 M Na_2CO_3. The percentage of $MgCO_3$ in the mixture is (approx.)

(1) 29.6% (2) 42% (3) 57% (4) 84%

Sol. Answer (1)

Let m moles of $CaCO_3$ be x and m moles of $MgCO_3$ be y

$\therefore$ x × 100 + y × 84 = 5680

and, meq of acid = meq of base

$$20 \times 0.1 \times 2 + 20\left(\frac{x+y}{1000}\right)\times 2 = \frac{0.4\times 800}{1000}\times 20$$

$$\Rightarrow \ 0.4 \times 10 + 0.4\left(\frac{x+y}{10}\right) = 0.4\times 16$$

$$\Rightarrow \ 10 + \frac{x+y}{10} = 16$$

$\Rightarrow$ x + y = 160 – 100

$\Rightarrow$ x + y = 60

and 100x + 84y = 5680

16y = 320

$\Rightarrow$ y = 20

$\Rightarrow$ x = 40

$\therefore$ mass of $MgCO_3$ = 20 × 84 mg

$$\therefore \ \%\ MgCO_3 = \frac{20\times 84}{5680}\times 100\% = 29.6\%$$

17. $K_2Cr_2O_7$ is used as an oxidising agent. In one such reaction, a monobasic acid HX is allowed to react with $K_2Cr_2O_7$ which converts the X^- ions to X_2 and is itself reduced to Cr^{+3}. How many moles of HX are required in balanced equation involving one mole of $K_2Cr_2O_7$?

(1) 6 (2) 4 (3) 8 (4) 14

Sol. Answer (4)

$$\left(2X^- \rightarrow X_2 + 2e^-\right)3$$

$$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$$

$$14H^+ + 6X^- + Cr_2O_7^{2-} \rightarrow 2Cr^{3+} + 3X_2 + 7H_2O$$

$$+8X^- + 2K^+ \qquad +8X^- + 2K^+$$

$$14HX + K_2Cr_2O_7 \rightarrow 2CrX_3 + 2KX + 7H_2O + 3X_2$$

18. Species like $Fe(HC_2O_4)_3$ and $Ca(HC_2O_4)_2$ can act both as acids as well as reducing agents. Consider the following and select the correct statement.

(1) $Fe(HC_2O_4)_3$ has a lesser equivalent weight as an acid than as a reducing agent

(2) The equivalent weight of $Ca(HC_2O_4)_2$ is equal on reaction with both NaOH as well as $Na_2Cr_2O_7$

(3) $Fe(HC_2O_4)_3$ has a lesser equivalent weight than $Ca(HC_2O_4)_2$ on reaction with NaOH

(4) $Fe(HC_2O_4)_3$ has a greater equivalent weight than $Ca(HC_2O_4)_2$ on reaction with $Na_2Cr_2O_7$

Sol. Answer (3)

	As an Acid	As a reducing agent
$Fe(HC_2O_4)_3$	x = 3	x = 6
	E = 107.6	E = 53.83
$Ca(HC_2O_4)_2$	x = 2	x = 4
M = 218	E = 109	E = 54.5

19. Analysis for detection of alcohol in blood uses the concept of redox, titrations according to reaction (unbalanced)

$$C_2H_5OH + Cr_2O_7^{2-} \rightarrow CO_2 + H_2O + Cr^{3+}$$

In one such experiment, 10 ml of 0.05 M $K_2Cr_2O_7$ is required to completely neutralise 10 gm sample of blood. What is the percentage by weight of alcohol in blood?

(1) 1.15 (2) 0.0115 (3) 0.115 (4) 11.5

Sol. Answer (3)

$$\underset{(n=12)}{C_2H_5OH} + \underset{(n=6)}{Cr_2O_7^{2-}} \rightarrow CO_2 + Cr^{3+}$$

$\therefore$ meq of C_2H_5OH = meq of $Cr_2O_7^{2-}$

$$1000 \times 12 \times \frac{x}{46} = 10 \times 0.05 \times 6$$

$$x = 0.0115$$

$\therefore$ Percentage by weight = $\frac{0.0115}{10} \times 100 = 0.115\%$

20. Consider following hypothetical reaction $SnCl_2 \rightarrow SnO_2 + ClO_3^-$

Select the correct statement about given reaction.

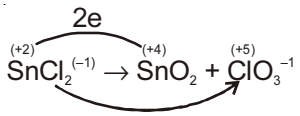
(1) It is an example of decomposition reaction

(2) n-factor of the reactant in above reaction is 2

(3) Molecular weight of reactant is equal to fourteen time of its equivalent weight

(4) n-factor of reactant in above reaction is not defined

Sol. Answer (3)



$6 \times 2 = 12$

n factor = 12 + 2 = 14

$$\text{Eq. wt} = \frac{\text{Molecular wt.}}{14}$$

21. In which of the following pairs of compounds oxygen atoms present have different oxidation states in both molecules

(1) CrO_5 and H_2SO_5 (2) $KMnO_4$ and $K_2Cr_2O_7$

(3) $K_2Cr_2O_7$ and K_2CrO_4 (4) H_2SO_3 and SO_2Cl_2

Sol. Answer (1)

Cr^{+10} and S^{+8} are not possible so all oxygen atoms are not in a state of –2.

22. During the balancing of the following reaction

$$Au + KCN + H_2O + O_2 \rightarrow KAu(CN)_4 + KOH$$

If the stoichiometric coefficient of Au is maintained as 1 than the sum of the stoichiometric coefficients of all the species present is

(1) 8.75 (2) 11.25 (3) 10 (4) 12.65

Sol. Answer (2)

$4Au + 16KCN + 6H_2O + 3O_2 \rightarrow 4KAu(CN)_4 + 12KOH$

Sum = 4 + 16 + 6 + 3 + 4 + 12

= 45

But coefficient of Au is to be made equal to

$$\text{so , sum} = \frac{45}{4}$$

23. Certain mass of HCN completely oxidised by 40 ml acidified $KMnO_4$ solution. The products obtained are CO_2 and NO_3^-. The CO_2 obtained above is bubbled through lime water and 2 g $CaCO_3$ is obtained. Select the incorrect statement among the following.

(1) The molarity of $KMnO_4$ used is 0.5 M (2) The mass of HCN taken initially is 0.54 gm

(3) The milliequivalent of NO_3^- produced is 160 (4) n-factor of HCN in the above conversion is 10

Sol. Answer (1)

POAC on carbon

m moles of $CaCO_3 = \frac{2}{100} \times 1000 = 20$

$\therefore$ m moles of HCN = 20

mass of HCN = $20 \times 27 \times 10^{-3} = 0.54$ g

Also, m moles of N = 20 = moles of NO_3^-

$\therefore$ m equivalents of $NO_3^- = 20 \times 8 = 160$

Now, meq of HCN = meq of $KMNO_4$, x = 2 + 8 = 10

$\Rightarrow$ $20 \times 10 = 40 \times 5 \times M$

$\Rightarrow$ M = 1

24. A 1 L solution is prepared by dissolving 14.7 g of phosphoric acid (H_3PO_4) in water. The solution is titrated against NaOH only up to the second equivalence point. The equivalent weight of H_3PO_4 in the neutralisation reaction is

(1) 32.67 (2) 49 (3) 98 (4) 65.66

Sol. Answer (2)

$H_3PO_4 + NaOH \longrightarrow Na_2HPO_4 + H_2O$

Equivalent weight of $H_3PO_4 = \frac{\text{Molecular weight}}{\text{No. of } H^+ \text{ ion replaced}}$

25. What is the equivalent weight of Cl_2 in gm/equivalent in following unbalanced reaction?

$Cl_2 \longrightarrow Cl^- + ClO_3^-$

(1) 35.5 (2) 42.6 (3) 71 (4) 68

Sol. Answer (2)

n-factor of $Cl_2 = \frac{2 \times 10}{12} = \frac{20}{12}$

Eq. weight $= \frac{MM}{n_f} = \frac{71 \times 12}{20} = 42.6$ g

26. 2 g impure sample of $KMnO_4$ required 40 ml of 0.5 M ferrous oxalate for complete reduction. Find out the percentage purity of $KMnO_4$.

(1) 80.5% (2) 56.4% (3) 72.3% (4) 94.8%

Sol. Answer (4)

$\frac{wt.}{158} \times 5 \times 1000 = 40 \times 0.5 \times 3$

wt. = 1.896

% Purity = $\frac{1.896}{2} \times 100 = 94.8\%$

27. Which one of the following underlined elements has lowest oxidation number?

(1) $K_2\underline{S}O_4$ (2) $\underline{Cr}O_5$ (3) $K_3\underline{Cr}O_8$ (4) $H\underline{N}O_2$

Sol. Answer (4)

$H\underline{N}O_2$ O·S = +3

K_3CrO_8 is tetraperoxo compound

+ 3 + x – 8 = 0

x = + 5

SECTION - B

Objective Type Questions (More than one options are correct)

1. Regarding the compound CrO_5 which of the following statement is/are correct?

(1) Oxidation number of Cr is (+6)

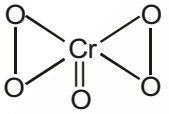
(2) 4-oxygen atoms are present in form of peroxide

(3) Oxidation number of Cr is + 10

(4) 2-oxygen atoms are present in form of peroxide

Sol. Answer (1, 2)

Structure of CrO_5 is

2-peroxide linkage 

∴ 4-oxygen atoms are present in peroxide linkage and oxidation number is + 6.

2. Which of the following can acts as a reducing agent?

(1) H_2S (2) HNO_3 (3) $FeSO_4$ (4) $SnCl_2$

Sol. Answer (1, 3, 4)

$S^{2-} \longrightarrow S + 2e^-$ (oxidation)

$Fe^{2+} \longrightarrow Fe^{3+} + e^-$ (oxidation)

$Sn^{2+} \longrightarrow Sn^{4+} + 2e^-$ (oxidation)

3. Which of the following can act as a reducing as well as an oxidising agent?

(1) HNO_3 (2) H_2SO_4 (3) H_2O_2 (4) HNO_2

Sol. Answer (3, 4)

Disproportionation reaction

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

In HNO_2 also N is in +3 O.S. which can oxidize to +5 as well as can reduce to minimum –3

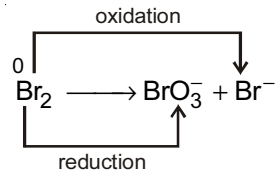
4. Which of the following statements are correct regarding this equation

$Br_2 \longrightarrow BrO_3^- + Br^-$?

(1) Bromine is oxidised (2) Bromine is reduced

(3) It is an example of disproportionation reaction (4) Bromine is neither oxidised nor reduced

Sol. Answer (1, 2, 3)



When the same substance undergoes oxidation and reduction simultaneously it is termed as disproportionate.

5. Which of the following is/are disproportionation reactions?

(1) $6NaOH + 3Cl_2 \longrightarrow NaClO_3 + 5NaCl + 3H_2O$

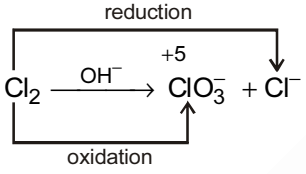
(2) $2NaOH + Cl_2 \longrightarrow NaOCl + NaCl + H_2O$

(3) $H_2O_2 \longrightarrow H_2O + \frac{1}{2}O_2$

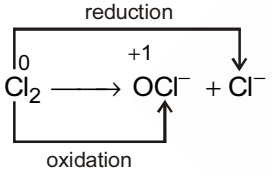
(4) $2KClO_3 \longrightarrow 2KCl + 3O_2$

Sol. Answer (1, 2, 3)

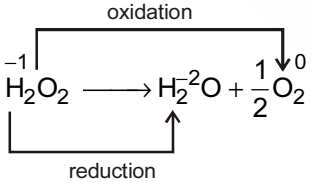
(1)



(2)



(3)



6. Which of the following statements regarding H_2SO_5 is/are correct?

(1) The oxidation number of sulphur is +6

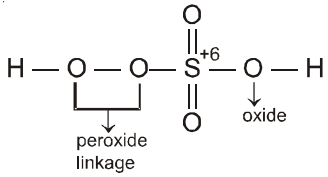
(2) Two oxygen atoms are present in form of peroxide

(3) Three oxygen atoms are present in form of oxide

(4) The oxidation state of sulphur is + 8

Sol. Answer (1, 2, 3)

Structure is



7. Which of the following can act as an oxidising agent?

(1) H_2SO_4 (2) HNO_3 (3) $KMnO_4$ (4) $K_2Cr_2O_7$

Sol. Answer (1, 2, 3, 4)

In all options oxidation number of central metal can decrease.

8. The oxidation number of carbon is zero in

(1) HCHO (2) CH_2Cl_2 (3) $C_{12}H_{22}O_{11}$ (4) $CHCl_3$

Sol. Answer (1, 2, 3)

It is based on simple application of common oxidation states of H and oxygen.

$HCHO \Rightarrow H-\overset{\overset{O}{\|}}{\underset{-1}{\overset{+2}{C}}}-H$ net charge = 0

Similarly in CH_2Cl_2 and $C_{12}H_{22}O_{11}$ (sugar)

9. 150 ml $\frac{M}{10}$ $Ba(MnO_4)_2$ in acidic medium can oxidise completely

(1) 150 ml 1M Fe^{2+} (2) 50 ml 1M FeC_2O_4 (3) 100 ml 1M $C_2O_4^{2-}$ (4) 75 ml 1M $K_2Cr_2O_7$

Sol. Answer (1, 2)

Alternative solution

Valency factors n for

$Ba(MnO_4)_2 = 10$

$Fe^{+2} = 1$

$FeC_2O_4 = 3$

$C_2O_4^{-2} = 2$

$K_2Cr_2O_7 = 6$

Now on calculating

Meq. $Ba(MnO_4)_2 = 150 \times \frac{1}{10} \times 10 = 150$

Meq. of $Fe^{+2} = 150 \times 1 \times 1 = 150$

Meq. of $FeC_2O_4 = 50 \times 1 \times 3 = 150$

Meq. of $C_2O_4^{-2} = 100 \times 1 \times 2 = 200$

Meq. of $K_2Cr_2O_7 = 75 \times 1 \times 6 = 450$

10. The strength of "20 volume" H_2O_2 is equal to

(1) 60.86 g/L (2) 3.58 N (3) 1.79 M (4) 3.035%

Sol. Answer (1, 2, 3)

20 volume H_2O_2

$1NH_2O_2 = 5.6$ volume

1 volume $H_2O_2 = \frac{1}{5.6}$ NH_2O_2

20 volume H_2O_2 = $\frac{20}{5.6}$ NH_2O_2 = 3.57 N

Strength in g/L = NE

= 3.57 × 17 = 60.71 g/L

N = M × n factor

3.57 = M × 2

M = 1.786 ≈ 1.79 M

1, 2, 3 are correct options.

volume strength = 5.6 × N

$\therefore \quad N = \frac{20}{5.6} = 3.57$

Volume strength = 11.2 × M

$\therefore \quad M = \frac{20}{11.2} = 1.78$

S = N × E = 3.58 × 17 = 60.86 g/L

11. When 1 mole of $KMnO_4$ is reacted with FeC_2O_4 in acidic medium, then the reacted amount of FeC_2O_4 is

(1) $\frac{5}{3}$ moles (2) 5 equivalents (3) $\frac{3}{5}$ moles (4) 3 equivalents

Sol. Answer (1, 2)

$\overset{+7}{K}MnO_4 + FeC_2O_4 \longrightarrow Fe^{+3} + CO_2 + Mn^{+2}$

$nf = 7 - 2 \qquad nf = (3-2) + 2\times(4-3)$

$= 1 + 2 = 3$

Number of eq. of $KMnO_4$ = Number of eq. of FeC_2O_4

$n_{KMnO_4} \times nf = n_{FeC_2O_4} \times nf$

$1 \times 5 = n_{FeC_2O_4} = \frac{5}{3}$

$n_{FeC_2O_4} = \frac{5}{3}$

Number of eq. of FeC_2O_4 = 1 × 5 = 5 equivalents

12. For the following balanced redox reaction, $2MnO^-_4 + 4H^+ + Br_2 \rightleftharpoons 2Mn^{2+} + 2BrO^-_3 + 2H_2O$. If the molecular weight of MnO^-_4 and Br_2 are x & y respectively then

(1) Equivalent weight of MnO_4^- is $\frac{x}{5}$ (2) Equivalent weight of Br_2 is $\frac{y}{5}$

(3) Equivalent weight of Br_2 is $\frac{y}{10}$ (4) n-factor ratio of MnO_4^- and Br_2 is 2 : 1

Sol. Answer (1, 3)

$$\overset{+7}{2MnO_4^-} + 8H^+ + \overset{0}{Br_2} \rightleftharpoons 2Mn^{+2} + 2\overset{+5}{BrO_3^-} + 2H_2O$$

nf = 1 × (7 – 2) nf = 2 × (5 – 0)

= 5 = 10

$$E_{MnO_4^-} = \frac{x}{5}$$

$$E_{Br_2} = \frac{y}{10}$$

n factor of MnO_4^- and Br_2

= 5 : 10

= 1 : 2

Options 1, 3 are correct.

13. Consider the reaction,

$aFeS_2 + bO_2 \rightarrow cFe_2O_3 + dSO_2$

Which is correct for the above reaction?

(1) n-factor for FeS_2 is 11

(2) The ratio of moles of a : b is 4 : 11

(3) The ratio of moles of a : b is 11 : 4

(4) The ratio of moles of c : d is 1 : 4

Sol. Answer (1, 2, 4)

$$a\overset{+2\ -1}{Fe}S_2 + bO_2 \longrightarrow c\overset{+3}{Fe_2}O_3 + d\overset{+4}{S}O_2$$

n factor of FeS_2 = $\underbrace{1\times(3-2)}_{Fe} + \underbrace{2\times[4-(-1)]}_{S}$

= 1 + 10

= 11

n factor of O_2 = 2 × 2 = 4

For balancing n factors are interchanged

$$4FeS_2 + 11O_2 \longrightarrow 2Fe_2O_3 + 8SO_2$$

a = 4 b = 11 c = 2 d = 8

a : b = 4 : 11

c : d = 2 : 8 = 1 : 4

So options 1, 2, 4 are correct.

14. When $Na_2S_2O_3$ is reacted with I_2 to form $Na_2S_4O_6$ and NaI then which statement is correct?

(1) n-factor for $Na_2S_2O_3$ is one

(2) n-factor for I_2 is two

(3) 2 moles of $Na_2S_2O_3$ is reacted with one mole of I_2

(4) n-factor for $Na_2S_4O_6$ is one

Sol. Answer (1, 2, 3)

$$2\overset{+2}{Na_2}\overset{}{S_2}O_3 + \overset{0}{I_2} \longrightarrow \overset{}{Na_2}\overset{+2.5}{S_4}O_6 + 2\overset{-1}{NaI}$$

nf = 2 × (2.5 – 2) nf = 2 × 1

= 2 × 0.5 = 2

= 1

n factor of $Na_2S_4O_6$ = 4(2.5 – 2)

= 4 × 0.5 = 2

Hence options 1, 2, 3 are correct.

15. Choose the correct statement regarding following reaction

$HNO_2 \longrightarrow HNO_3 + NO\uparrow$

(1) It is an example of disproportionation reaction

(2) Equivalent weight of $HNO_3 = \frac{3M}{2}$

(3) Equivalent weight of HNO_3 = M

(4) It is an example of intramolecular redox reaction

Sol. Answer (1, 2)

$$HNO_2 + HNO_2 \longrightarrow HNO_3 + \dot{N}O$$

This is an example of disproportionation reaction.

16. 31.26 ml of a 0.165 M solution of $Ca(OH)_2$ is required to just neutralise 25 ml of citric acid $H_3C_6H_5O_7$. Then correct regarding this is/are

(1) n-factor of citric acid is 3 (2) Molarity of citric acid is 0.138 M

(3) Molarity of citric acid is 0.029 M (4) n-factor of citric acid is 2

Sol. Answer (1, 2)

Equivalent of acid = equivalents of base

$$\frac{31.26}{1000}\times 2\times 0.165 = \frac{25}{1000}\times N \Rightarrow N = \frac{31.226}{25}\times 2\times 0.165 = 0.412$$

17. With 4 mole of KI one mole of Cl_2 is treated to yield a solution, which is then treated with hypo solution, then correct regarding this is/are

(1) Equivalent weight of I_2 is $\frac{M}{1}$

(2) To react completely with a solution, 1 mole of hypo solution is required

(3) n-factor of hypo solution is 1

(4) n-factor of Cl_2 is 2

Sol. Answer (3, 4)

$2KI + Cl_2 \longrightarrow 2KCl + I_2$ ...(i)

$I_2 + KI \rightleftharpoons KI_3$ ...(ii)

$2Na_2S_2O_3 + I_2 \longrightarrow Na_2S_4O_6 + 2NaI$ ...(iii)

As per above reactions n-factor of Cl_2 (as per reaction (i), I_2 (as per reaction (iii) and $Na_2S_2O_3$ (as per reaction (iii)) is 2, 2 and 1 respectively.

18. Choose the correct regarding indicator

	Titration	Indicator
(1)	NaOH vs. CH_3COOH	Phenolphthalein
(2)	$KMnO_4$ vs. FeC_2O_4	$KMnO_4$
(3)	I_2 vs. $Na_2S_2O_3$	Starch
(4)	$K_2Cr_2O_7$ vs. $FeSO_4$	$K_3[Fe(CN)_6]$ as external indicator

Sol. Answer (1, 2, 3, 4)

$KMnO_4$ acts as self indicator.

SECTION - C

Linked Comprehension Type Questions

Comprehension-I

Redox is a reaction in which both oxidation and reduction will take place simultaneously. It is obvious that if one substance gives electron there must be another substance to accept these electrons. In some reactions same substance is reduced as well as oxidised, these reactions are termed as disproportionation reactions.

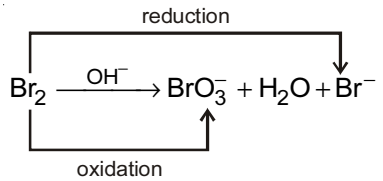
For calculating equivalent mass in redox reaction change in oxidation number is related to n-factor which is reciprocal of molar ratio.

1. This reaction is an example of

$Br_2 + OH^- \rightarrow BrO_3^- + H_2O + Br^-$

(1) Oxidation reaction only
(2) Reduction reaction only
(3) Neutralization reaction
(4) Disproportionation reaction

Sol. Answer (4)



$\because$ Br_2 is oxidized and reduced both.

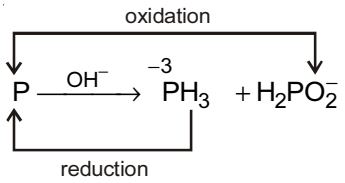
$\therefore$ It is disproportionation reaction.

2. When P reacts with NaOH, the products are PH_3 and NaH_2PO_2, which of the following statement is correct?

(1) P is oxidised only (2) P is reduced only

(3) P is oxidised as well as reduced (4) P is neither reduced nor oxidised

Sol. Answer (3)



3. How many moles of $KMnO_4$ are reacted with one mole of ferrous oxalate in acidic medium?

(1) $\frac{2}{5}$ (2) $\frac{1}{5}$ (3) $\frac{3}{5}$ (4) $\frac{5}{3}$

Sol. Answer (3)

$MnO_4^- + FeC_2O_4 \longrightarrow Mn^{2+} + Fe^{3+} + CO_2$

$3 \times MnO_4^- + 5e^- + 8H^+ \longrightarrow 4Mn^{2+} + H_2O$

$5 \times FeC_2O_4 \longrightarrow Fe^{3+} + 2CO_2 + 3e^-$

$3MnO_4^- + 5FeC_2O_4 + 24H^+ \longrightarrow 3Mn^{2+} + 5Fe^{3+} + 12H_2O + 10CO_2$

$\because$ 5 moles of FeC_2O_4 reacts with 3 moles of $KMnO_4$

$\therefore$ 1 mole of FeC_2O_4 reacts with $\frac{3}{5}$ mole $KMnO_4$

4. The equivalent weight of Cu_2S in the following reaction is $Cu_2S + O_2 \rightarrow Cu^{+2} + SO_3$

(1) $\frac{M.wt}{1}$ (2) $\frac{M.wt}{10}$ (3) $\frac{M.wt}{8}$ (4) $\frac{M.wt}{11}$

Sol. Answer (2)

$\overset{+1}{Cu_2}\ \overset{-2}{S} + O_2 \longrightarrow 2Cu^{2+} + \overset{+6}{SO_3} + 10e^-$

$\therefore$ n-factor = 10

$\therefore$ Equivalent mass = $\frac{M}{10}$

5. Which of the following is an example of redox reaction?

(1) $2NO_2 \rightarrow N_2O_4$ (2) $NH_4OH \rightarrow NH_4^+ + OH^-$

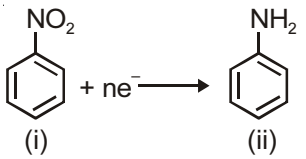
(3) $2NO_2 + H_2O \rightarrow HNO_3 + HNO_2$ (4) $N_2O_5 + H_2O \rightarrow 2HNO_3$

Sol. Answer (3)

$NO_2 + H_2O \longrightarrow HNO_3 + HNO_2$

This is an example of disproportionation reaction.

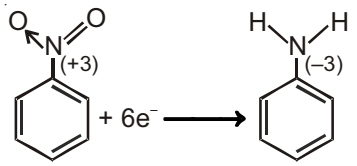
$\therefore$ It is a redox reaction.

6. 

For converting one mole of nitrobenzene to aniline, how many moles of electrons are transferred?

(1) 2 (2) 3 (3) 6 (4) 8

Sol. Answer (3)



Comprehension-II

The strength of H_2O_2 is expressed in many ways like molarity, normality, % strength and volume strengths. But out of all these form of strengths, volume strength has great significance for chemical reactions.

The decomposition of H_2O_2 is shown as under :

$$H_2O_2(l) \rightarrow H_2O(l) + \frac{1}{2}O_2(g).$$

'x' volume strength of H_2O_2 means one volume (litre or ml) of H_2O_2 releases x volume (litre or ml) of O_2 at NTP.

1 litre H_2O_2 release x litre of O_2 at NTP

$$= \frac{x}{22.4} \text{ moles of } O_2$$

From the equation,

1 mole of O_2 produces from 2 moles of H_2O_2.

$\frac{x}{22.4}$ moles of O_2 produces from $2\times\frac{x}{22.4}$ moles of H_2O_2

$$= \frac{x}{11.2} \text{ moles of } H_2O_2$$

So, molarity of $H_2O_2 = \frac{\frac{x}{11.2}}{1} = \frac{x}{11.2}M$

Normality = n-factor × molarity

$$= 2\times\frac{x}{11.2} = \frac{x}{5.6}N$$

1. What is the percentage strength of "15 volume" H_2O_2?

(1) 6.086% (2) 4.55% (3) 3.03% (4) 1.5%

Sol. Answer (2)

1 volume = 0.303%

15 volume = 15× 0.303

= 4.55%

2. 30 g $Ba(MnO_4)_2$ sample containing inert impurity is completely reacting with 100 ml of "28 volume" strength of H_2O_2 in acidic medium then what will be the percentage purity of $Ba(MnO_4)_2$ in the sample? (Ba = 137, Mn = 55, O = 16)

(1) 10% (2) 40% (3) 62.5% (4) 80%

Sol. Answer (3)

$$N_{H_2O_2} = \frac{\text{Volume strength}}{5.6} = \frac{28}{5.6} = 5$$

Eq. of H_2O_2 = Eq. of $Ba(MnO_4)_2$

$$5 \times \frac{100}{1000} = \frac{W}{375} \times 10$$

$\therefore$ WBa $(MnO_4)_2$ = 18.75 g

$$\therefore \text{ \% purity } = \frac{18.75 \times 100}{30} = 62.5$$

3. What volume of H_2O_2 solution of "11.2 volume" strength is required to liberate 2240 ml of O_2 at NTP?

(1) 300 ml (2) 500 ml (3) 100 ml (4) 200 ml

Sol. Answer (4)

11.2 volume H_2O_2 means

1 vol H_2O_2 gives 11.2 vol O_2

$\Rightarrow$ 11.2 ml O_2 obtained from 1 ml H_2O_2

$$\Rightarrow \text{ 2240 ml } O_2 \text{ obtained from } = \frac{2240 \times 1}{11.2} = 200 \text{ ml}$$

Comprehension-III

2 g of brass containing Cu and Zn only reacts with 3 M HNO_3 solution. Following are the reactions taking place

$Cu(s) + HNO_3(aq) \rightarrow Cu^{2+}(aq) + NO_2(g) + H_2O(l)$

$Zn(s) + H^+(aq) + NO_3^-(aq) \rightarrow NH_4^+(aq) + Zn^{2+}(aq) + H_2O(l)$

The liberated $NO_2(g)$ was found to be 1.04 L at 25°C and 1 atm [Cu = 63.5, Zn = 65.4]

1. The percentage by mass of Cu in brass was

(1) 67% (2) 70% (3) 80% (4) 90%

Sol. Answer (1)

$$Cu + 4HNO_3 \longrightarrow Cu(NO_3)_2 + 2NO_2 + 2H_2O$$

$$n_{NO_2} = \frac{PV}{RT} = \frac{1 \times 1.04}{0.0821 \times 298} = 0.042$$

$\therefore$ $n_{Cu} = 0.021$

$\therefore$ $W_{Cu} = 1.335$ g

$\therefore$ $\%\ Cu = \frac{1.335 \times 100}{2} = 66.67\ \%$

2. The volume of HNO_3 consumed during the reaction with brass is

(1) 9.52 ml (2) 14.5 ml (3) 16.25 ml (4) 10.5 ml

Sol. Answer (2)

3. How many grams of NH_4NO_3 will be obtained in the above reaction?

(1) 0.405 g (2) 0.0428 g (3) 0.2018 g (4) 0.358 g

Sol. Answer (3)

$NO_3^- \xrightarrow{[H]} NH_3$

$NH_3 + H^+ \longrightarrow NH_4^+$

SECTION - D

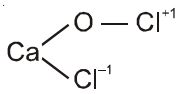
Matrix-Match Type Questions

1. Match Column-I with Column-II

Column-I	Column-II
(A) $CaOCl_2$ (Oxidation state of Cl)	(p) + 6, + 6
(B) $S_2O_3^{2-}$ (Oxidation state of S)	(q) + 1, –1
(C) NH_4NO_3 (Oxidation state of N)	(r) Peroxy linkage is present
(D) H_2SO_5 and $H_2S_2O_8$ (Oxidation state of S)	(s) –3, + 5
	(t) –2, + 6

Sol. Answer A(q), B(t), C(s), D(p, r)

(A) Structure of $CaOCl_2$ is

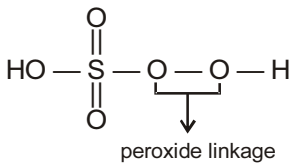


(B) $S_2O_3^{2-}$, $2x - 6 = -2$

$x = +2$

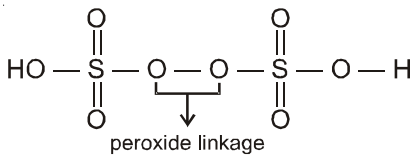
(C) NH_4NO_3 may written as NH_4^+,

$\therefore$ oxidation no. of N = – 3 and in NO_3^-, oxidation no. of N = +5

(D) $H_2SO_5 \Rightarrow$ 

and oxidation no. = +6

For $H_2S_2O_8$, structure is



and oxidation no. = +6

2. Match the following

Column-I	Column-II
(A) $XI_2 + YNO_3^{\ominus} \longrightarrow IO_3^- + NO_2$ (Acidic med)	(p) X > Y
(B) $XClO^- + YCrO_2^- \rightarrow Cl^- + CrO_4^{--}$ (alkaline)	(q) X < Y
(C) $XN_2O_4 + YBrO_3^{\ominus} \rightarrow Br^- + NO_3^-$ (Acidic)	(r) n-factor (oxidant) > n-factor (Reductant)
(D) $XAsO_3^{-3} + YMnO_4^- \rightarrow AsO_4^{-3} + MnO_2$ (Acidic)	(s) n-factor (Reductant) > n-factor (Oxidant)
	(t) Oxidant has highest O.N. among the oxidants involved in the reactions

Sol. Answer A(q, s), B(p, s), C(p, r), D(p, r, t)

(A) $I_2 + 10NO_3^- + 8H^+ \longrightarrow 2IO_3^- + 10NO_2 + 4H_2O$

(B) $3ClO^- + 2CrO_2^- + 2OH^- \longrightarrow 3Cl^- + 2CrO_4^{--} + H_2O$

(C) $3N_2O_4 + BrO_3^- + 3H_2O \longrightarrow 6NO_3^- + Br^- + 6H^{\oplus}$

(D) $3AsO_3^{-3} + 2MnO_4^- \longrightarrow 3AsO_4^{-3} + 2MnO_2 + 2H_2O$

3. Match the following

Column-I	Column-II (n-factor)
(A) $KMnO_4$ in acidic medium	(p) 10
(B) $Ba(MnO_4)_2$ in acidic medium	(q) 6
(C) $S_2O_3^{2-}$ in alkaline medium	(r) 5
(D) $K_2Cr_2O_7$ in acidic medium	(s) 8

Sol. Answer A(r); B(p); C(s); D(q)

(A) $KMnO_4 \longrightarrow Mn^{2+}$ $n_f = 5$

(B) $Ba(MnO_4)_2 \longrightarrow Mn^{2+}$ $n_f = 10$

(C) $S_2O_5^{2-} \longrightarrow SO_4^{2-}$ $n_f = 8$

(D) $Cr_2O_7^{2-} \longrightarrow Cr^{3+}$ $n_f = 6$

4. Match the following

Column-I	**Column-II (n-factor of reactants)**
(A) $S_2O_3^{2-}$ in different medium	(p) 8
(B) $KMnO_4$ in different medium	(q) 5
(C) FeC_2O_4 is converted into Fe^{3+} and CO_2	(r) 3
(D) Cu_2S is converted into Cu^{2+} and SO_2	(s) 1

Sol. Answer A (p, s); B (q, r, s); C (r); D (p)

(A) $S_2O_3^{2-}$ → Acidic medium (nf = 1) → $S_4O_6^{2-}$

$S_2O_3^{2-}$ → Basic medium (nf = 8) → SO_4^{2-}

(B) $KMnO_4$ → Acidic medium (nf = 5) → Mn^{2+}

$KMnO_4$ → Neutral medium (nf = 3) → $\overset{+4}{MnO_2}$

$KMnO_4$ → Basic medium (nf = 1) → $\overset{+6}{MnO_4^{2-}}$

(C) $\overset{2+}{Fe}\ \overset{+3}{C_2O_4} \longrightarrow Fe^{3+} + \overset{+4}{CO_2}$

$-1\ e^-$

$-2 \times 1\ e^-$

So, total 3 e^- are loosed by one molecule of FeC_2O_4. Hence, n-factor for FeC_2O_4 is 3.

(D) $\overset{+1}{Cu_2}\ \overset{-2}{S} \longrightarrow Cu^{2+} + \overset{+4}{SO_2}$

$-2 \times 1\ e^-$

$-6\ e^-$

So, total 8 e^- are loosed by one molecule of Cu_2S. Hence, n-factor for Cu_2S is 8.

5. 3.48 g of MnO_2 is added to 500 ml of 0.1 M oxalic acid solution. The resulting solution is then titrated against either 0.02 M $KMnO_4$ or 0.02 M $K_2Cr_2O_7$ solution.

Column I	Column II
(A) $KMnO_4$ solution	(p) N = 0.1
(B) MnO_2	(q) n_{factor} = 2
(C) Oxalic acid	(r) Vol = 167 ml
(D) $K_2Cr_2O_7$ solution	(s) Vol = 200 ml
	(t) n_{factor} = 6

Sol. Answer A(p, s), B(q), C(q), D(r, t)

$MnO_2 \rightarrow Mn^{2+} + 2e^-$

$2e^- + H_2C_2O_4 \longrightarrow CO_2 + H_2O$

$\therefore$ n_f (MnO_2 and oxalic acid) = 2

Equivalent of $MnO_2 = \frac{3.48}{87} \times 2 = 0.08$

Equivalent of oxalic acid = 0.1

Equivalents of oxalic acid left = 0.02

Equivalents of oxalic acid = Equivalents of $KMnO_4$

0.02 = 0.02 × 5 × V

$V_{KMnO_4} = \frac{1}{5}$ litre = 200 ml.

Volume of $K_2Cr_2O_7$ required = 1/6 L = 167 ml

SECTION - E

Assertion-Reason Type Questions

1. STATEMENT-1 : $KMnO_4 \xrightarrow{\text{acidic medium}} Mn^{2+}$, n factor of $KMnO_4$ is 5.

and

STATEMENT-2 : Equivalent mass of $KMnO_4$ in acidic medium is $\frac{M}{5}$ (M = molecular mass of $KMnO_4$).

Sol. Answer (1)

$\text{Equivalent mass} = \frac{\text{Molar mass}}{\text{n} - \text{factor}}$

$MnO_4^- + 5e^- + 8H^+ \longrightarrow Mn^{2+} + 4H_2O$

$\therefore$ n-factor = 5

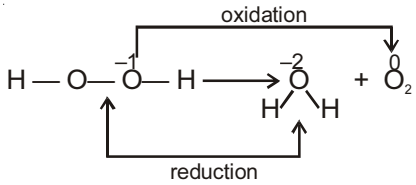
and equivalent mass = $\frac{M}{5}$

2. STATEMENT-1 : $H_2O_2 \longrightarrow H_2O + \frac{1}{2}O_2$. This is an example of disproportionation reaction.

and

STATEMENT-2 : H_2O_2 can act as a oxidising as well as reducing agent.

Sol. Answer (1)



$\because$ H_2O_2 is oxidized as wall as reduced.

$\therefore$ Its an example of disproportionation reaction.

3. STATEMENT-1 : Oxidation number of oxygen in OF_2 compound is +2.

and

STATEMENT-2 : An element has a fixed oxidation state.

Sol. Answer (3)

In OF_2, $x - 2 = 0$

$x = +2$

and an element can have variable oxidation state.

4. STATEMENT-1 : Oxidation state of carbon in its compound is always +4.

and

STATEMENT-2 : An element can show variable oxidation numbers.

Sol. Answer (4)

Carbon can show –4 and many more oxidation states also

e.g., CH_4, CO, CH_2Cl_2 etc.

5. STATEMENT-1 : Equivalent mass of $KMnO_4$ in different mediums are different.

and

STATEMENT-2 : $KMnO_4$ can act as a oxidising agent.

Sol. Answer (2)

In acidic medium $KMnO_4$ is reduced to Mn^{2+}.

$\therefore$ It is an oxidising agent.

6. STATEMENT-1 : In the reaction : $Cl_2 + OH^- \longrightarrow Cl^- + ClO_4^-$ chlorine is oxidised only.

and

STATEMENT-2 : Oxidation and reduction cannot take place alone.

Sol. Answer (4)

$\overset{0}{Cl_2} + OH^- \longrightarrow \overset{-1}{Cl} + \overset{+7}{ClO_4^-}$

In above reaction, Cl_2 is oxidized as well as reduced both because for redox reaction both oxidation and reduction reactions are required.

7. STATEMENT-1 : The equivalent mass of $KMnO_4$ in acidic medium is $\frac{M}{5}$ where M = Molecular mass of $KMnO_4$.

and

STATEMENT-2 : Equivalent mass is equal to product of molecular mass and change in oxidation number.

Sol. Answer (3)

$$K\overset{+7}{M}nO_4 \xrightarrow[\text{medium}]{\text{acidic}} Mn^{+2}$$

nf = 7 – 2 = 5

$$E = \frac{M}{nf} = \frac{M}{5}$$

$$\text{Equivalent mass} = \frac{\text{Molecular mass}}{\text{Total change in oxidation number}}$$

8. STATEMENT-1 : For the reaction $NaOH + H_2CO_3 \rightarrow NaHCO_3 + H_2O$ equivalent weight of H_2CO_3 is 62.

and

STATEMENT-2 : n factor of H_2CO_3 is 1 (in above reaction) and equivalent mass = $\frac{\text{Molecular mass}}{\text{n factor}}$.

Sol. Answer (1)

$$NaOH + H_2CO_3 \longrightarrow NaHCO_3 + H_2O$$

Since only one H atom is being replaced from H_2CO_3 in above reaction hence

n factor of H_2CO_3 = 1

$$E = \frac{M}{1} = \frac{2\times1+12+3\times16}{1} = \frac{62}{1} = 1 \quad \text{equivalent mass} = \frac{\text{Molecular mass}}{\text{n factor}}$$

SECTION - F

Integer Answer Type Questions

1. 0.144 g of pure FeC_2O_4 was dissolved in dilute H_2SO_4 and the solution was diluted to 100 ml. What volume in ml of 0.1 M $KMnO_4$ will be needed to oxidise FeC_2O_4 solution?

Sol. Answer (6)

$$\text{meq. of } FeC_2O_4 = \text{meq of } KMnO_4$$

$$\frac{W}{E}\times1000 = N.V.$$

$$\text{or, } \frac{0.144}{144/3}\times1000 = 0.1\times5\times V$$

or V = 6 ml

2. 2.48 g of $Na_2S_2O_3$. xH_2O is dissolved per litre solution. 20 ml of this solution required 10 ml 0.01 M iodine solution. What is value of x?

Sol. Answer (5)

Meq. of $Na_2S_2O_3 \times H_2O$ = meq of I_2

$$\frac{2.48}{M} \times 20 = 10 \times 0.01 \times 2$$

$\Rightarrow$ M = 248

$\Rightarrow$ 248 = 158 + 18x

$\Rightarrow$ x = 5

3. 1.245 g of $CuSO_4.xH_2O$ was dissolved in water and H_2S was passed into it till CuS was completely precipitated. The H_2SO_4 produced in the filtrate required 10 ml of N-NaOH solution for complete neutralisation. What is value of x?

Sol. Answer (5)

$$CuSO_4.xH_2O \xrightarrow{H_2S} CuS + H_2SO_4$$

$H_2SO_4 \equiv NaOH$

Meq. of $CuSO_4$ xH_2O = meq. of H_2SO_4 = meq. of NaOH

$$\frac{W}{E} \times 1000 = N.V.$$

or $$\frac{1.245 \times 2}{159.5 + 18x} = 10 \times 1 \qquad \text{or } x = 5$$

4. In the reaction VO + $Fe_2O_3 \rightarrow$ FeO + V_2O_5, what is the n-factor for V_2O_5 ?

Sol. Answer (6)

$$\underbrace{\overset{+2}{VO} + Fe_2O_3 \longrightarrow FeO + \overset{+5}{V_2O_5}}_{6e^- \text{ involved per mole}}, \quad nF\ (V_2O_5) = 6$$

5. In the reaction $A^{+x} + MnO_4^{\ominus} \longrightarrow AO_3^{\ominus} + Mn^{++} + \frac{1}{2}O_2$, if one mole of $MnO_4^{\ominus}$ oxidises 1.67 moles of A^{+x} to $AO_3^{\ominus}$, then what will be the value of x?

Sol. Answer (2)

$$MnO_4^- + 5e^- \longrightarrow Mn^{++}$$

These 5 moles of e^- are lost by A^{+x} ion & gained by $MnO_4^{\ominus}$.

$\therefore$ 1 mole A^{+x} will lose e^- = 5/1.67 = 3 moles (approx.)

Now $A^{+x} \rightarrow AO_3^{\ominus}$

$\therefore$ Oxidation state of A,

x = +5 – 3 = +2

6. A 0.1 mol of a metal is burnt in air to form oxide. The same oxide is then reduced by 0.05 M, 4 litre $S_2O_3^{2-}$ (acidic medium) to +3 oxidation state of metal. What is the oxidation state of metal in oxide?

Sol. Answer (5)

$$\underset{0.1\ mol}{M_1} + O_2 \longrightarrow \underset{0.1\ mol}{M^{x+}}$$

$0.1 \times n = 0.05 \times 1 \times 4$

$n = 2$

$\therefore \quad x = +5$

7. 100 ml of $Na_2S_2O_3$ solution is divided into two equal parts A and B. A part requires 12.5 ml of 0.2 M I_2 solution (acidic medium) and part B is diluted x times and 50 ml of diluted solution requires 5 ml of 0.8 M I_2 solution in basic medium. What is value of x?

Sol. Answer (5)

Part A

$1 \times M \times 50 = 2 \times 12.5 \times 0.2 \qquad \ldots(1)$

Part B

$8 \times M_1 \times 50 = 2 \times 5 \times 0.8 \qquad \ldots(2)$

Dividing (1) by (2) we get

$$\frac{M}{8M_1} = \frac{12.5 \times 2}{5 \times 8} \qquad M = 5M_1$$

$\therefore$ M is 5 times diluted.

8. For a given reductant, ratio of volumes of 0.2 M $KMnO_4$ and 1 M $K_2Cr_2O_7$ in acidic medium will be

Sol. Answer (6)

$V_1M_1n_1(KMnO_4) = V_2M_2n_2(K_2Cr_2O_7)$

$$\frac{V_1}{V_2} = \frac{M_2n_2}{M_1n_1} = \frac{1 \times 6}{0.2 \times 5} = 6$$

9. A solution contains 2 g of NaOH, 0.53 g of Na_2CO_3 and 0.42 g $NaHCO_3$. The solution is titrated with 1.3 N HCl in presence of methyl orange indicator. What is the volume of HCl in ml required for the titration?

Sol. Answer (50)

meq of NaOH = $\frac{2}{40} \times 1000 = 50$

meq of $Na_2CO_3 = \frac{0.53}{106} \times 2 \times 1000 = 10$

meq of $NaHCO_3 = \frac{0.42}{84} \times 1000 = 5$

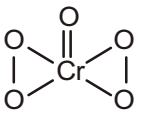
meq of Base = meq of Acid

$65 = 1.3 \times V$

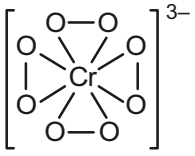
$V = 50$ ml

10. Chromate ion on reaction with H_2O_2 in the acidic medium and the basic medium respectively produce CrO_5 and $Cr_3O_8^{3-}$. The oxidation number of Cr in CrO_5 is x and $Cr_3O_8^{3-}$ is y. The value of (x + y) is

Sol. Answer (11)



x = 6



y = 5

❑ ❑ ❑