Chapter 8

Redox Reactions

Solutions

SECTION - A

Objective Type Questions

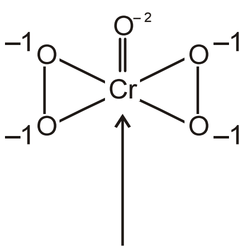
(Oxidation Number, Oxidation, Reduction, Oxidising agent and Reducing agent)

1. Oxidation number of Cr atom in CrO_5 and K_3CrO_8 respectively

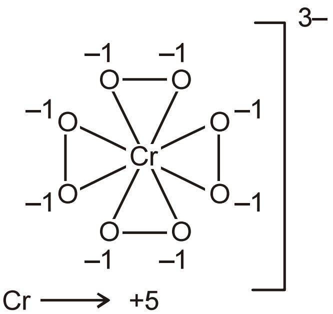
(1) +6, +6 (2) +5, +6

(3) +6, +5 (4) +5, +5

Sol. Answer (3)



Cr ⟶ +6



∴Cr ⟶ +5

2. Find the incorrect statement

(1) Higher reduction potential of non-metal means stronger reducing agent

(2) Lower oxidation potential of a metal means strong oxidising agent

(3) Oxidation state of oxygen in O_3 is –1

(4) All of these

Sol. Answer (4)

Higher reduction potential means higher tendency to get reduced *i.e.* better oxidizing agent.

Lower oxidation potential means higher reduction potential means

⇒ High tendency to get reduced

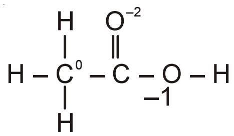
⇒ High tendency to oxidize others

Oxidation state of oxygen in O_3 is 0.

3. In case of CH_3COOH, the oxidation number of carbon of carboxylic group is

(1) –3 (2) Zero (3) +1 (4) +3

Sol. Answer (4)



∴ $x + 0 - 2 - 1 = 0$

⇒ $x = +3$

4. Which compound acts as oxidising agent only?

(1) SO_2 (2) H_2S (3) H_2SO_4 (4) HNO_2

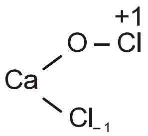
Sol. Answer (3)

In H_2SO_4, sulphur is in its highest possible oxidation state. Hence it can only undergo reduction and oxidize others.

5. The average oxidation state of chlorine in bleaching powder is

(1) –1 (2) +1 (3) Zero (4) –2 as well as +2

Sol. Answer (3)



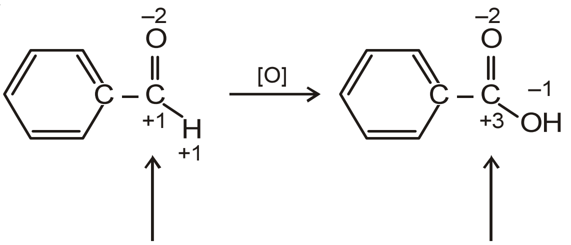
Bleaching powder

∴ Average oxidation state $= \frac{+1-1}{2} = 0$

6. When benzaldehyde is oxidised to give benzoic acid then the oxidation state of carbon of aldehydic group is changed from

(1) +2 to +3 (2) +1 to +3 (3) Zero to +2 (4) No change

Sol. Answer (2)



$x - 2 + 1 = 0$
$\Rightarrow x = +1$

$x - 2 - 1 = 0$
$\Rightarrow x = +3$

∴ Oxidation number changes from +1 to +3.

(Types of Redox reactions, Balancing of Redox reactions)

7. When an alkali metal is reacted with hydrogen then metallic hydride is formed. In this reaction

(1) Hydrogen is oxidised
(2) Hydrogen is reduced
(3) Hydrogen is neither oxidised nor reduced
(4) Hydrogen is oxidised as well as reduced

Sol. Answer (2)

$$2M + H_2^0 \longrightarrow 2M^{+1}H^{-1}$$

$$\therefore \quad H_2^0 \longrightarrow H^{-1} \text{ (Reduction)}$$

8. Cl_2 (g) + $X\bar{O}H \rightarrow YClO_3^- + ZH_2O + 10e^-$

The coefficient X, Y and Z are

(1) 6, 2, 2
(2) 5, 1, 3
(3) 12, 2, 6
(4) 12, 1, 6

Sol. Answer (3)

$$\overset{0}{Cl_2} \longrightarrow 2\overset{+5}{Cl}O_3^- + 10e^-$$

To balance O and H, we first find out side deficient in 'O' atoms.

$$Cl_2 + 6H_2O \longrightarrow 2ClO_3 + 10e^-$$

Then find out side deficient in H and add H_2O, then add equal number of OH^- on opposite side.

$$Cl_2 + 6H_2O \longrightarrow 2ClO_3 + 12H_2O$$

Adding OH^-,

$$Cl_2 + 12OH^- \longrightarrow 2ClO_3 + 6H_2O + 10e^-$$

(Law of equivalence and Titrations, Electrochemical cell)

9. The ratio of number of moles of $KMnO_4$ and $K_2Cr_2O_7$ required to oxidise 0.1 mol Sn^{2+} to Sn^{+4} in acidic medium

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

Sol. Answer (1)

ΔO.N. = 5

$$MnO_4^- + Sn^{2+} \longrightarrow Mn^{2+} + Sn^{4+}$$

ΔO.N. = 2

2 mole of $Sn^{2+} \longrightarrow$ 5 mole of MnO_4^-

Then, $0.1 \longrightarrow \dfrac{5 \times 0.1}{2}$

Since,

$$Cr_2O_7^{2-} \longrightarrow 2Cr^{3+} \quad (\Delta O.N. = 6)$$

$$Sn^{2+} \longrightarrow Sn^{4+} \quad (\Delta O.N. = 2)$$

2 mole of $Sn^{2+} \longrightarrow$ 6 mole of $Cr_2O_7^{2-}$

Then, $0.1 \longrightarrow \frac{6\times0.1}{2}$

Then, ratio $= \frac{MnO_4^-}{Cr_2O_4^{2-}} = \frac{\frac{5\times0.1}{2}}{\frac{6\times0.1}{2}} = 5 : 6$

10. $Cl_2 \xrightarrow{NaOH} NaCl + NaClO_3 + H_2O$

The equivalent mass of Cl_2 in the above reaction is

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

Sol. Answer (4)

$$\left(Cl_2 \xrightarrow{+2e^-} 2Cl^-\right)\times 5 \qquad \ldots(1)$$

$$5Cl_2 \longrightarrow 2\overset{+5}{Cl}O_3 + 10e^- \qquad \ldots(2)$$

Adding (1) and (2), we get

$$6Cl_2 \longrightarrow 10Cl^- + 2ClO_3^-$$

∴ 6 moles of Cl_2 require 10 moles of electrons

∴ 1 mole of Cl_2 require $\frac{10}{6}$ moles of electrons

∴ n factor $= \frac{5}{3}$

∴ Equivalent mass $= \frac{\text{Molar mass}}{\frac{5}{3}} = \frac{3}{5}\times \text{Molar mass}$

11. KCl is used as an electrolyte in salt bridge because

(1) K^+ and Cl^- are isoelectronic

(2) Monovalent ions are required

(3) Both the ions have almost same velocity

(4) They are having similar size

Sol. Answer (3)

KCl is used in salt bridge since K^+ and Cl^- have almost the same ionic velocity.

12. EMF of the given cell

$A_{(s)} \mid A^{2+}_{(aq)} \parallel B^{2+}_{(aq)} \mid B_{(s)}$

Given $E^{\circ}_{A/A^{2+}}$: +1.4 V and $E^{\circ}_{B/B^{2+}}$: –1.4 V

(1) 2.8 V (2) 1.8 V (3) 0 V (4) –1.8 V

Sol. Answer (1)

$$E^0_{cell} = \left(E^0_{cathode}\right)_{SRP} - \left(E^0_{anode}\right)_{SRP}$$

$$= \left(E^0_{anode}\right)_{SOP} - \left(E^0_{cathode}\right)_{SOP}$$

Where SRP is standard reduction potential

and SOP is standard oxidation potential

$\therefore$ E_{Cell} = [1.4 – (–1.4)]V

= +2.8 V

13. Electrode potential depends upon

(1) Size of electrode (2) Surface area of electrode

(3) Temperature (4) Shape of electrode

Sol. Answer (3)

Electrode potential depends upon temperature

$\Delta G = -\,nFE^{\circ}$

and ΔG depends upon temperature

14. Number of electrons involved in the reaction when 0.1 mol NH_3 dissolved in water

(1) 2 (2) 0.4 (3) 0.9 (4) Zero

Sol. Answer (4)

$NH_3 + H_2O \longrightarrow NH_4OH$; not a redox reaction.

15. $\frac{1}{2}F_2 + e^- \longrightarrow F^- \quad E^\circ = +3.02\ V$

Electrode potential for given reaction

$F_2 + 2e^- \longrightarrow 2F^-$

(1) 3.02 V (2) 6.04 V (3) 1.5 V (4) –3.02 V

Sol. Answer (1)

E° is an intensive property, so it does not change with the amount of substance.

$\therefore \quad \frac{1}{2}F_2 + e^- \longrightarrow F^-; E^\circ = +3.02\ V$

$F_2 + 2e^- \longrightarrow 2F ; E^\circ = +3.02\ V$

$1000F_2 + 2000e^- \longrightarrow 2000F^- ; E^\circ = +3.02\ V$

16. Three metals A, B and C are arranged in increasing order of standard reduction electrode potential, hence their chemical reactivity order will be

(1) A < B < C (2) A > B > C (3) B > C > A (4) A = B = C

Sol. Answer (2)

Increasing order of standard reduction potential

A < B < C

∴ Increasing order of standard oxidation potential

A > B > C

Metals have tendency to get oxidized

∴ Higher the tendency to get oxidized, higher the reactivity

∴ Reactivity order:

A > B > C

17. How many moles of $KMnO_4$ are required to oxidise one mole of $SnCl_2$ in acidic medium?

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

Sol. Answer (2)

(ΔO.N. = +2) × 5

$\overset{+7}{Mn}O_4^- + \overset{+2}{Sn}Cl_2 \longrightarrow Mn^{2+} + Sn^{4+}$

(ΔO.N. = –5) × 2

where ΔO.N. = change in oxidation number

$\therefore$ The reaction becomes

$$2MnO_4^- + 5SnCl_2 \longrightarrow 2Mn^{2+} + 5Sn^{4+}$$

5 moles $SnCl_2$ require 2 moles of $KMnO_4$

1 mole $SnCl_2$ requires $\frac{2}{5}$ moles of $KMnO_4$

18. Which of the following is incorrect regarding salt bridge solution?

(1) Solution must be a strong electrolyte

(2) Solution should be inert towards both electrodes

(3) Size of cations and anions of salt should be much different

(4) Salt bridge solution is prepared in gelatin or agar-agar to make it semi-solid

Sol. Answer (3)

In salt bridge, size of cations and anions should not be much different, they should be similar.

19. Standard electrode potentials of redox couples A^{2+}/A, B^{2+}/B, C/C^{2+} and D^{2+}/D are 0.3 V, –0.5 V, –0.75 V and 0.9 V respectively. Which of these is best oxidising agent and reducing agent respectively?

(1) D^{2+}/D and B^{2+}/B (2) B^{2+}/B and D^{2+}/D (3) D^{2+}/D and C^{2+}/C (4) C^{2+}/C and D^{2+}/D

Sol. Answer (1)

Out of the given couples, highest reduction potential means highest tendency to get reduced $\Rightarrow$ Best oxidizing agent (D^{2+}/D)

Similarly lowest reduction potential

$\Rightarrow$ Best reducing agent $\left(B^{2+}/B \longrightarrow -0.5V\right)$

Because $C \longrightarrow C^{2+}$; $E^\circ = -0.75$ V

$\therefore$ $C^{2-1} \longrightarrow C$; $E^\circ = +0.75$ V

20. The number of moles of H_2O_2 required to completely react with 400 ml of 0.5 N $KMnO_4$ in acidic medium are

(1) 0.1 (2) 0.2 (3) 1.0 (4) 0.5

Sol. Answer (1)

(ΔO.N. = –5) × 2

$$\overset{+7}{Mn}O_4^- + H_2\overset{-1}{O_2} \longrightarrow Mn^{2+} + O_2^0$$

(ΔO.N. = +2) × 5

where,

ΔO.N. = Change in oxidation number

∴ Reaction becomes

$$2MnO_4^- + 5H_2O_2 \longrightarrow 2Mn^{2+} + 5O_2$$

In the reaction, for 1 mole of $KMnO_4$,

ΔO.N. = 5

∴ n factor of $KMnO_4$ = 5

Given, normality of $KMnO_4$ = 0.5 N

We know, normality = Molarity × n-factor

∴ Molarity = 0.1 M.

∴ Number of moles of $KMnO_4$ in 400 ml = 0.4 × 0.1 = 0.04 moles

From the reaction,

2 moles of $KMnO_4$ react with 5 moles of H_2O_2

∴ 0.04 moles of $KMnO_4$ react with $\frac{5}{2}\times 0.04$ moles of H_2O_2 = 0.1

SECTION - B

Previous Years Questions

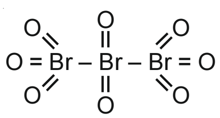
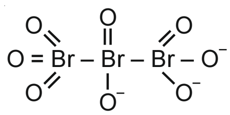
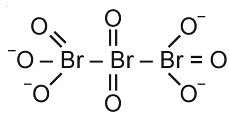
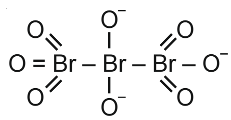
1. The oxidation state of Cr in CrO_6 is **[NEET-2019 (Odisha)]**

(1) +4 (2) –6 (3) +12 (4) +6

Sol. Answer (4*)

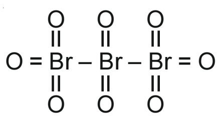
The most appropriate oxidation state of Cr in CrO_6 is +6 although CrO_6 has doubtful existence.

2. The correct structure of tribromooctaoxide is **[NEET-2019]**

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

Sol. Answer (1)

The correct structure of tribromooctaoxide is



3. Which of the following reactions are disproportionation reaction? **[NEET-2019]**

(a) $2Cu^+ \longrightarrow Cu^{2+} + Cu^0$

(b) $3MnO_4^{2-} + 4H^+ \longrightarrow 2MnO_4^- + MnO_2 + 2H_2O$

(c) $2KMnO_4 \xrightarrow{\Delta} K_2MnO_4 + MnO_2 + O_2$

(d) $2MnO_4^- + 3Mn^{2+} + 2H_2O \longrightarrow 5MnO_2 + 4H^+$

Select the correct option from the following

(1) (a) and (b) only (2) (a), (b) and (c) (3) (a), (c) and (d) (4) (a) and (d) only

Sol. Answer (1)

(a) $2\overset{+1}{C}u^{+1} \longrightarrow \overset{+2}{C}u^{2(+)} + \overset{0}{C}u^{0}\}$ Disproportionation

(b) $3\overset{+6}{Mn}O_4^{2-} + 4H^+ \longrightarrow 2\overset{+7}{Mn}O_4^- + \overset{+4}{Mn}O_2 + 2H_2O\}$ Disproportionation

(c) $2K\overset{+7}{Mn}O_4 \xrightarrow{\Delta} K_2\overset{+6}{Mn}O_4 + \overset{+4}{Mn}O_2 + \overset{0}{O_2}\}$ $\therefore$ Not a disproportionation

(d) $2\overset{+7}{Mn}O_4^- + 3\overset{+2}{Mn}^{2+} + 2H_2O \longrightarrow 5\overset{+4}{Mn}O_2 + 4H^+\}$ Comproportionation

4. The correct order of N-compounds in its decreasing order of oxidation states is **[NEET-2018]**

(1) HNO_3, NO, N_2, NH_4Cl

(2) HNO_3, NO, NH_4Cl, N_2

(3) NH_4Cl, N_2, NO, HNO_3

(4) HNO_3, NH_4Cl, NO, N_2

Sol. Answer (1)

$H\overset{+5}{N}O_3$, $\overset{+2}{N}O$, $\overset{0}{N_2}$, $\overset{-3}{N}H_4Cl$

Hence, the correct option is (1).

5. For the redox reaction, $MnO_4^- + C_2O_4^{2-} + H^+ \longrightarrow Mn^{2+} + CO_2 + H_2O$

The correct coefficients of the reactants for the balanced equation are **[NEET-2018]**

	MnO_4^-	$C_2O_4^{2-}$	H^+
(1)	16	5	2
(2)	2	5	16
(3)	5	16	2
(4)	2	16	5

Sol. Answer (2)

Reduction

$\overset{+7}{Mn}O_4^- + \overset{+3}{C_2}O_4^{2-} + H^+ \longrightarrow Mn^{2+} + \overset{+4}{C}O_2 + H_2O$

Oxidation

n-factor of $MnO_4^- \Rightarrow 5$

n-factor of $C_2O_4^{2-} \Rightarrow 2$

Ratio of n-factors of MnO_4^- and $C_2O_4^{2-}$ is 5 : 2 So, molar ratio in balanced reaction is 2 : 5

$\therefore$ The balanced equation is $2MnO_4^- + 5C_2O_4^{2-} + 16H^+ \rightarrow 2Mn^{2+} + 10CO_2 + 8H_2O$

6. Assuming complete ionization, same moles of which of the following compounds will require the least amount of acidified $KMnO_4$ for complete oxidation? **[Re-AIPMT-2015]**

(1) FeC_2O_4

(2) $Fe(NO_2)_2$

(3) $FeSO_4$

(4) $FeSO_3$

Sol. Answer (3)

$MnO_4^- \longrightarrow Mn^{2+}$; Change in O.N. = 5

In option,

(1) $Fe^{2+} \longrightarrow Fe^{3+}$; Change in O.N. = 1 $\Big\}$ 3
$C_2O_4^{2-} \longrightarrow 2CO_2$; Change in O.N. = 2

(2) $Fe^{2+} \longrightarrow Fe^{3+}$; Change in O.N. = 1 $\Big\}$ 5
$2NO_2^- \longrightarrow 2NO_3^-$; Change in O.N. = 4

(3) $Fe^{2+} \longrightarrow Fe^{3+}$; Change in O.N. = 1 $\}$ 1

(4) $Fe^{2+} \longrightarrow Fe^{3+}$; Change in O.N. = 1 $\Big\}$ 3
$SO_3^{2-} \longrightarrow SO_4^{2-}$; Change in O.N. = 2

7. Which of the following processes does not involve oxidation of iron? **[AIPMT-2015]**

(1) Liberation of H_2 from steam by iron at high temperature

(2) Rusting of iron sheets

(3) Decolourization of blue $CuSO_4$ solution by iron

(4) Formation of $Fe(CO)_5$ from Fe

Sol. Answer (4)

8. (a) $H_2O_2+O_3 \rightarrow H_2O + 2O_2$

(b) $H_2O_2 + Ag_2O \rightarrow 2Ag + H_2O + O_2$

Role of hydrogen peroxide in the above reactions is respectively **[AIPMT-2014]**

(1) Oxidizing in (a) and reducing in (b)
(2) Reducing in (a) and oxidizing in (b)
(3) Reducing in (a) and (b)
(4) Oxidizing in (a) and (b)

Sol. Answer (3)

9. In which of the following compounds, nitrogen exhibits highest oxidation state? **[AIPMT (Prelims)-2012]**

(1) N_3H
(2) NH_2OH
(3) N_2H_4
(4) NH_3

Sol. Answer (1)

10. A solution contains Fe^{2+}, Fe^{3+} and I^- ions. This solution was treated with iodine at 35°C. E° for Fe^{3+}/Fe^{2+} is +0.77 V and E° for $I_2/2I^-$ = 0.536 V. The favourable redox reaction is **[AIPMT (Mains)-2011]**

(1) I^- will be oxidised to I_2
(2) Fe^{2+} will be oxidised to Fe^{3+}
(3) I_2 will be reduced to I^-
(4) There will be no redox reaction

Sol. Answer (1)

Favourable redox reaction is one for which E° = +ve because only then

ΔG would be –ve.

$\Delta G° = -\ nFE°$

$$E°_{cell} = E°_{Fe^{3+}/Fe^{2+}} - E°_{I_2/2I^-} [E_{cell} = E_{cathode} - E_{anode}] = +\ 0.234\ V$$

$\therefore$ Cathode (reduction) $\longrightarrow Fe^{3+} \longrightarrow Fe^{2+}$

Anode (oxidation) $\longrightarrow 2I^- \longrightarrow I_2$

11. Oxidation states of P in $H_4P_2O_5$, $H_4P_2O_6$, $H_4P_2O_7$ are respectively **[AIPMT (Prelims)-2010]**

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

Sol. Answer (4)

12. Oxidation numbers of P in PO_4^{3-}, of S in SO_4^{2-} and that of Cr in $Cr_2O_7^{2-}$, are respectively

[AIPMT (Prelims)-2009]

(1) + 3, + 6 and + 5 (2) + 5, + 3 and + 6 (3) – 3, + 6 and + 6 (4) + 5, + 6 and + 6

Sol. Answer (4)

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

[AIPMT (Prelims)-2007]

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

Sol. Answer (4)

14. Standard reduction potentials of the half reactions are given below

$F_{2(g)} + 2e^- \rightarrow 2F^-_{(aq)}$; $E^o = +2.85\ V$

$Cl_{2(g)} + 2e^- \rightarrow 2Cl^-_{(aq)}$; $E^o = +1.36\ V$

$Br_{2(l)} + 2e^- \rightarrow 2Br^-_{(aq)}$; $E^o = +1.06\ V$

$I_{2(s)} + 2e^- \rightarrow 2I^-_{(aq)}$; $E^o = +0.53\ V$

The strongest oxidising and reducing agents respectively are

(1) F_2 and I^- (2) Br_2 and Cl^- (3) Cl_2 and Br^- (4) Cl_2 and I_2

Sol. Answer (1)

Highest reduction potential ⇒ strongest oxidizing agent *i.e.*, F_2 (+2.85 V)

Lowest reduction potential ⇒ strongest reducing agent *i.e.*, I^- ($E° = -\ 0.53\ V$)

15. Standard electrode potential for Sn^{4+}/Sn^{2+} couple is +0.15 V and that for the Cr^{3+}/Cr couple is –0.74 V. These two couples in their standard state are connected to make a cell. The cell potential will be

(1) +1.83 V (2) +1.19 V (3) +0.89 V (4) +0.18 V

Sol. Answer (3)

$E°_{Cell} = E°_{cathode} - E°_{anode} = E°_{reduction} - E°_{oxidation}$

For the cell to be functional, E° must be positive

∴ E° in the formula is always taken in terms $(E°)_{SRP}$ *i.e.* standard reduction potential.

Here E° would be positive when

$Sn^{4+} \longrightarrow Sn^{2+}$; $E° = +\ 0.15\ V$

And $Cr \longrightarrow Cr^{3+}$; $E° = -(-\ 0.74\ V) = +\ 0.74\ V$

↑ Oxidation potential ($E°_{SOP} = -\ E°_{SRP}$)

$$\therefore\quad E° = E°_{Sn^{4+}/Sn^{2+}} - E°_{Cr^{3+}/Cr} = 0.15\ V - (-\ 0.74\ V) = +0.89\ V$$

16. Standard reduction electrode potential of three metals X, Y and Z are –1.2 V, +0.5 V and –3.0 V respectively. The reducing power of these metals will be

(1) X > Y > Z (2) Y > Z > X (3) Y > X > Z (4) Z > X > Y

Sol. Answer (4)

Higher reduction potential ⇒ stronger oxidizing power

⇒ Weaker reducing power

∴ Reducing power : Y < X < Z

17. In the reaction

$2H_2O_2 \rightarrow 2H_2O + O_2$

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

(3) Oxygen is neither oxidised nor reduced (4) Oxygen is both oxidised and reduced

Sol. Answer (4)

$H_2O_2^{-1} \longrightarrow H_2O^{-2} + O_2^0$

Oxygen is both oxidised and reduced.

i.e. this is a disproportion reaction.

18. Which change requires an oxidising agent?

(1) $2S_2O_3^{2-} \rightleftharpoons S_4O_6^{2-}$ (2) $Zn^{2+} \rightleftharpoons Zn$ (3) $ClO^- \rightleftharpoons Cl^-$ (4) $SO_3 \rightleftharpoons SO_4^{2-}$

Sol. Answer (1)

$2S_2O_3^{2-} \rightleftharpoons S_4O_6^{2-}$

$2x - (3 \times 2) = -2$ $4x + (-2 \times 6) = -2$

$\Rightarrow x = +2$ $\Rightarrow x = +2.5$

So, sulphur undergoes oxidation from +2 to +2.5 and hence requires an oxidizing agent.

19. Given the following reactions involving A, B, C and D

(i) $C + B^+ \rightarrow C^+ + B$ (ii) $A^+ + D \rightarrow$ No reaction

(iii) $C^+ + A \rightarrow$ No reaction (iv) $D + B^+ \rightarrow D^+ + B$

The correct arrangement of A, B, C, D in order of their decreasing ability as reducing agent

(1) D > B > C > A (2) A > C > D > B (3) C > A > B > D (4) C > A > D > B

Sol. Answer (4)

From the data, it is concluded that

D cannot reduce A^+

A cannot reduce C^+

⇒ Reducing power $\longrightarrow C > A > D$

Also, It is seen that D reduces B^+

∴ Reducing power $\longrightarrow C > A > D > B$

20. Which element undergoes disproportionation in water?

(1) Cl_2 (2) F_2 (3) K (4) Cs

Sol. Answer (1)

Cl_2 in water disproportionates to give HCl and HOCl

$$Cl_2 + H_2O \longrightarrow HCl + HOCl$$

21. Standard reduction potentials at 25°C of Li^+ / Li, Ba^{2+} / Ba, Na^+ / Na and Mg^{2+} / Mg are –3.05, –2.90, –2.71 and –2.37 volt respectively. Which one of the following is the strongest oxidizing agent?

(1) Ba^{2+} (2) Mg^{2+} (3) Na^+ (4) Li^+

Sol. Answer (2)

Strongest oxidizing agent

$\Rightarrow$ Highest reduction potential

Out of the given values, Mg^{2+} has the highest reduction potential.

22. Which substance is serving as a reducing agent in the following reaction?

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

(1) H^+ (2) $Cr_2O_7^{2-}$ (3) H_2O (4) Ni

Sol. Answer (4)

$$\overset{+6}{Cr} \longrightarrow Cr^{+3} \text{ (Oxidizing agent)}$$

$$Ni \longrightarrow Ni^{2+} \text{ (Reducing agent)}$$

i.e. Ni acts as reducing agent since if reduces Cr^{+6} to Cr^{3+}

23. The oxide, which cannot act as a reducing agent, is

(1) CO_2 (2) ClO_2 (3) NO_2 (4) SO_2

Sol. Answer (1)

CO_2 cannot act as a reducing agent because to reduce others, it itself has to get oxidized. This is not possible because carbon is already in its highest possible oxidation state.

24. Oxidation state of Fe in Fe_3O_4 is

(1) $\frac{5}{4}$ (2) $\frac{4}{5}$ (3) $\frac{3}{2}$ (4) $\frac{8}{3}$

Sol. Answer (4)

Fe_3O_4 $\quad 3x + (-2 \times 4) = 0$

$$\Rightarrow x = \frac{+8}{3}$$

25. Oxidation numbers of A, B, C are +2, +5 and –2 respectively. Possible formula of compound is

(1) $A_2(BC_2)_2$ (2) $A_3(BC_4)_2$

(3) $A_2(BC_3)_2$ (4) $A_3(B_2C)_2$

Sol. Answer (2)

Possible formula for the compound would be $A_3(BC_4)_2$

$A_3 \longrightarrow 3\times+2=+6$

$BC_4 \longrightarrow +5+(-2\times4)=-3$

$2(BC_4)\longrightarrow -3\times2=-6$

Combining A_3 and $2BC_4$, we get net charge of 0 *i.e.* Electrical neutrality of compound is maintained.

In the other options, electrical neutrality is not maintained.

26. The oxidation states of sulphur in the anions SO_3^{2-}, $S_2O_4^{2-}$ and $S_2O_6^{2-}$ follow the order

(1) $S_2O_4^{2-} < SO_3^{2-} < S_2O_6^{2-}$
(2) $SO_3^{2-} < S_2O_4^{2-} < S_2O_6^{2-}$
(3) $S_2O_4^{2-} < S_2O_6^{2-} < SO_3^{2-}$
(4) $S_2O_6^{2-} < S_2O_4^{2-} < SO_3^{2-}$

Sol. Answer (1)

$SO_3^{2-} \longrightarrow x+(-2\times3)=-2 \Rightarrow x=+4$

$S_2O_4^{2-} \longrightarrow 2x+(-2\times4)=-2 \Rightarrow x=+3$

$S_2O_6^{2-} \longrightarrow 2x+(-2\times6)=-2 \Rightarrow x=+5$

$\therefore$ Oxidation state follows the order, $S_2O_6^{2-} > SO_3^{2-} > S_2O_4^{2-}$

27. Electrode potential for the following half-cell reactions are

$Zn \rightarrow Zn^{2+} + 2e^-$; E° = + 0.76 V;

$Fe \rightarrow Fe^{2+} + 2e^-$; E° = + 0.44 V

The EMF for the cell reaction $Fe^{2+} + Zn \rightarrow Zn^{2+} + Fe$ will be

(1) – 0.32 V
(2) + 1.20 V
(3) – 1.20 V
(4) + 0.32 V

Sol. Answer (4)

$$E^\circ_{cell} = \left(E^\circ_{reduction}\right)_{SRP} - \left(E^\circ_{oxidation}\right)_{SRP}$$

$$= -\left(E^\circ_{reduction}\right)_{SOP} + \left(E^\circ_{oxidation}\right)_{SOP}$$

$$= E^\circ_{Zn/Zn^{2+}} - E^\circ_{Fe/Fe^{2+}}$$

$$= (0.76 - 0.44)\ V = +0.32\ V$$

28. In acidic medium, H_2O_2 changes $Cr_2O_7^{-2}$ to CrO_5 which has two (—O—O—) bonds. Oxidation state of Cr in CrO_5 is

(1) +5
(2) +3
(3) +6
(4) –10

Sol. Answer (3)

SECTION - C

Assertion - Reason Type Questions

1. A : Fluorine acts as a stronger oxidising agent than chlorine.

R : Standard reduction potential of fluorine is higher than $Cl_{2.}$

Sol. Answer (1)

Standard reduction potential of F_2 is higher than that of Cl_2

$\therefore$ Fluorine is a stronger oxidizing agent than Cl_2

2. A : Oxidation number of carbon in HCN is +4.

R : Oxidation state and valency is same for carbon.

Sol. Answer (4)

Valency of carbon is 4 while oxidation state of carbon varies from compound to compound.

In HCN, $\overset{+1}{H}-\overset{+2}{C}\equiv\overset{-3}{N}$

$C \longrightarrow +2$ state

3. A : Equivalent weight of $KMnO_4$ in acidic medium is $\frac{M}{5}$.

R : In acidic medium 1 mol of MnO_4^- gains 5 electron.

Sol. Answer (1)

In acidic medium, $\overset{+7}{Mn}O_4^- \xrightarrow{+5e^-} Mn^{2+}$ *i.e.* 1 mole of $KMnO_4$ accepts 5 electrons

$\therefore$ n factor of $KMnO_4$ = 5

4. A : Electrons flow in external circuit of galvanic cell while ions flow in internal circuit.

R : Direction of current flow is reverse that of electron flow.

Sol. Answer (2)

Direction of conventional current is opposite to flow of electrons.

Also, electrons flow in the external circuit while ions flow in the internal circuit.

5. A : Sn^{2+} and Fe^{3+} can't remain together in a solution.

R : Sn^{2+} and Fe^{3+} will react mutually to form Sn^{4+} and Fe^{2+}.

Sol. Answer (1)

Sn^{2+} and Fe^{3+} will react to give Sn^{4+} and Fe^{2+} because $E^\circ_{Fe^{3+}/Fe^{2+}} > E^\circ_{Sn^{4+}/Sn^{2+}}$

So, they cannot remain mutually in a solution.

6. A : The oxidation number of S is +6 in H_2SO_4.

R : H_2SO_4 has one peroxide linkage.

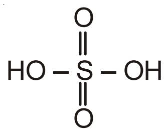
Sol. Answer (3)

In H_2SO_4, +2 + x + (–2 × 4) = 0

$\Rightarrow$ x = +6

Oxidation state of sulphure = + 6

Structure of H_2SO_4 is



If does not have any peroxide linkage.

7. A : HNO_2 acts as reducing agent only.

R : HNO_2 oxidises to HNO_3 only but not reduce by any reducing agent.

Sol. Answer (4)

In HNO_2, oxidation state is +3 for nitrogen.

Hence it can be oxidized to +5 or be reduced upto –3.

$\therefore$ If can act as both reducing as well as oxidizing agent.

8. A : In alkaline medium, $KMnO_4$ acts as powerful oxidising agent.

R : $KMnO_4$ reduces to give Mn^{2+} in alkaline medium.

Sol. Answer (3)

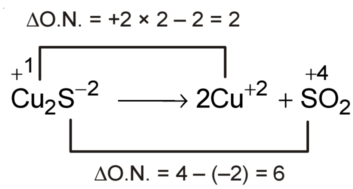
$KMnO_4$ acts as a powerful oxidizing agent in both acidic and alkaline medium.

$KMnO_4$ reduces to Mn^{+6} in alkaline medium.

9. A : When Cu_2S is converted into Cu^+ & SO_2, then equivalent weight of Cu_2S will be M/8 (M = Mol. wt. of Cu_2S)

R : Cu^+ is converted Cu^{++}, during this one electrons is lost.

Sol. Answer (2)



$\therefore$ For 1 mole Cu_2S, net change in oxidation number = 2 + 6 = 8

$\therefore$ n-factor = 8

$\therefore$ Equivalent weight = $\frac{M}{8}$

Also, $Cu^+ \longrightarrow Cu^{2+} + e^-$

$\therefore$ 1 electron is lost.

10. A : I_2 is a mild oxidising agent.

R : I_2 can be used for titrating sodium thiosulphate.

Sol. Answer (2)

I_2 is indeed a mild oxidizing agent. It has positive (low) value of E° = 0.54 V

It is used for titrating sodium thiosulphate

$$I_2 + S_4O_6^{2-} \longrightarrow 2I^- + 4SO_4^{2-}$$

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