Redox Reactions

1. Find the sum of oxidation number of nitrogen in $(NH_4)_2SO_4$. N_2H_4 and N_2O_4.
2. Among NH_3, HNO_3, NaN_3 and Mg_3N_2. Find the number of molecules having nitrogen in negative oxidation state.
3. When $K_2Cr_2O_7$ is converted into K_2CrO_4. What will be the change in oxidation number of chromium?
4. Find the ratio of oxidation numbers of P in PO_4^{3-} and Cr in $Cr_2O_7^{2-}$.
5. In a balance equation $H_2SO_4 + xHI \rightarrow H_2S + yI_2 + zH_2O$, find the ratio of $x + y : y + z$
6. One mole of N_2H_4 loses 10 moles of electrons to form a new compound, y. Assuming that all nitrogen appear in the new compound, what is the oxidation state of nitrogen in y (there is no change in the oxidation state of hydrogen)?
7. Balance the redox reaction and find the sum of coefficient of MnO_4^- and Mn^{2+}.

   $MnO_4^- + C_2O_4^{2-} + H^+ \rightarrow Mn^{2+} + CO_2 + H_2O$
8. The equivalent weight of a metal is 36. What weight of the metal would give 9.322 gm. of its chloride ?
9. Find the ratio of equivalent weight of MnO_4^- in acidic and basic media.
10. Find the number of moles of $K_2Cr_2O_7$ reduced by three mole of Sn^{2+} ions.
11. Find the equivalent weight of barium in $BaCrO_4$ which is used as an oxidising agent in acidic medium.
    (At wt. of Ba = 137.34)
12. 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:

    $SO_3^{2-}(aq) + H_2O(l) \rightarrow SO_4^{2-}(aq) + 2H^+(aq) + 2e^-$

    If the oxidation number of metal in the salt was 3, what would be the new oxidation number of metal ?
13. $N_2 + 3H_2 \longrightarrow 2NH_3$, molecular weight and equivalent weight of NH_3 and N_2 are 17.03 g, 14 g and Y_1, Y_2 respectively. Find the value of $(Y_1 - Y_2)$.
14. An element A in a compound ABD has oxidation number A^{2-}. It is oxidised by $Cr_2O_7^{2-}$ in acidic medium. In the experiment 1.68×10^{-3} moles of $K_2Cr_2O_7$ were used for 3.26×10^{-3} moles of ABD. What would be new oxidation number of A after oxidation.
15. Find the oxidation state of Fe in $(Fe_4[Fe(CN)_6]_3$.

SOLUTIONS

1. **(–1)** Let O.N. of N be x
In $(NH_4)_2SO_4$; $x = -3$
In N_2H_4 ; $x = -2$
In N_2O_4 ; $x = -4$
Sum of oxidation numbers of N $= -3 + (-2) + 4$
$= -1$

2. **(3)** Calculating the oxidation state of nitrogen in given molecules;
Oxidation state of N in NH_3 is
$x + 3 \times (+1) = 0$ or $x = -3$
Oxidation state on N in $NaNO_3$ is
$1 + x + 3 \times (-2) = 0$ or $x = +5$
Oxidation state of N in NaN_3 is
$+1 + 3x = 0$ or $x = -\frac{1}{3}$
Oxidation state of N in Mg_3N_2 is
$3 \times 2 + 2x = 0$ or $x = -3$
Thus 3 molecules (i.e. NH_3, NaN_3 and Mg_3N_2, have nitrogen in negative oxidation state.

3. **(0)** O.N. of Cr in $K_2Cr_2O_7$: $2 + 2x - 14 = 0$
$2x = 12,\ x = 6$
O.N. of Cr in K_2CrO_4 : $2 + x - 8 = 0$
$x = 6$
$\therefore$ Change in O.N. of Cr $= 6 - 6 = 0$

4. **(1)** $PO_4^{3-} = x + 4(-2) = -3; x - 8 = -3; x = +5$
$Cr_2O_7^{2-} = 2x + 7(-2) = -2; 2x - 14 = -2;$
$2x = 12;\ x = +6$
Ratio $= \frac{+6}{+6} = 1$

5. **(1.5)** The value of x, y, z are 8, 4, 4 respectively hence the reaction is
$H_2SO_4 + 8HI \rightarrow H_2S + 4I_2 + 4H_2O$
$\therefore\ x + y = 12$ and $y + z = 8$.
Here ratio $x + y : y + z = 3 : 2$

6. **(+3)** $N_2H_4 \xrightarrow{\text{loss of } 10e^-} Y$
Oxidation number of nitrogen in $N_2O_4 = -2$
According to given information in the question
$N_2H_4 \longrightarrow N_2$
$\therefore\ Y = N_2$
Oxidation number of nitrogen in compound
$Y = +3$

7. **(4)** The balanced equation is
$2MnO_4^- + 5C_2O_4^{2-} + 16H^+ \longrightarrow 2Mn^{2+} + 10CO_2 + 8H_2O$
Sum of coefficient of MnO_4^- and Mn^{2+} is 4.

8. **(9.322)** The equivalent wt. of metal = 36
The equivalent wt. of chlorine = 35.5
Equivalent wt. of metal chloride = 71.5
71.5 gm. metal chloride contain 36 gm of metal
9.322 gm metal chloride contain
$\frac{36}{71.5} \times 9.322$ gm of metal
$= 4.6935$ gm of metal
$\therefore$ 4.6935 gm metal give 9.322 gm metal chloride.

9. **(0.6)** $MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$
(Acidic medium)
$MnO_4^- + 2H_2O + 3e^- \rightarrow MnO_2 + 4OH$
(Besic medium)
If M is mol. wt. of $KMnO_4$, then its Eq. wt. in acidic, basic are
$\frac{M}{5} : \frac{M}{3}$ or $3 : 5 = 0.6$

10. **(1)** $Cr_2O_7^{2-} + 14H^+ + 6e^- \longrightarrow 2Cr^{3+} + 7H_2O$
$3Sn^{2+} - 6e^- \longrightarrow 3Sn^{4+}$
Hence $Cr_2O_7^{2-} + 14H^+ + 3Sn^{2+} \longrightarrow$
$2Cr^{3+} + 7H_2O + 3Sn^{4+}$
$\therefore$ 3 moles of Sn^{2+} reduces 1 mole of $K_2Cr_2O_7$.

11. **(45.7)** In acidic medium $BaCrO_4$ is converted into $BaCr_2O_7$
$2CrO_4^{2-} + 2H^+ \longrightarrow Cr_2O_7^{2-} + H_2O$
$Cr_2O_7^{2-} + 14H^+ + 6e^- \longrightarrow 2Cr^3 + 7H_2O$
$2BaCrO_4 \equiv 6e^-$ or $BaCrO_4 \equiv 3e^-$
$\therefore$ Eq. wt. of $Ba^{2+} = \frac{1}{3} \times$ At. wt
$= \frac{1}{3} \times 137.34 = 45.78$

12. **(+2)** Meq. of sodium sulphite = Meq. of salt
$25 \times 0.1 \times 2 = 50 \times 0.1 \times n$
$\therefore\ n = 1$
(Where n represents valence factor for metal involving no. of electrons gained)
Thus, $M^{3+} + e^- \longrightarrow M^{2+}$.

13. **(3.34)** $6e^- + N_2 \longrightarrow 2N^{3-}$
$\therefore\ E_{N_2} = \frac{14}{6} = Y_2$
$\therefore\ E_{NH_3} = \frac{17.03}{3} = Y_1$
$\therefore\ Y_1 - Y_2 = \frac{17.03}{3} - \frac{X_2}{6} = 5.67 - 2.33 = 3.34$

14. **(1)** $A^{2-} \longrightarrow A^{a+} + (a+2)\,e^-$
$6e^- + (Cr^{6+})_2 \longrightarrow 2Cr^{3+}$
Also Meq. of A = Meq. of $K_2Cr_2O_7$
$3.26 \times 10^{-3}(a+2) = 1.68 \times 10^{-3} \times 6$
$\therefore\ a + 2 = 3,\ \Rightarrow\ a = 3 - 2 = 1$

15. **(+2)** $4 \times (+3) + [3x + 18(-1)] = 0 \Rightarrow x = +2$