9. (a) $\overset{+1}{2CuI} \rightarrow \overset{O}{Cu} + \overset{+2}{CuI_2}$. Oxidation and Reduction both occur so the reaction is redox.

10. (c) $H_2S + X_2(Cl, Br, I = X) \rightarrow 2HX + S$. Here the halogen are reduced.

11. (b) When H_2O_2 reduces with $K_4[Fe(CN)_6]$. It is present in acidic solution.

$$2K_4[Fe(CN)_6 + H_2SO_4 + H_2O_2 \rightarrow$$
$$2K_3[Fe(CN)_6] + K_2SO_4 + 2H_2O$$

13. (b) In the given reaction oxidation state of *Mg* is changing from 0 to +2 while in nitrogen it is changing from 0 to –3. So oxidation of *Mg* and reduction of nitrogen takes place.

14. (b) When sodium metal is dissolved in liquid ammonia to form coloured solution. Dilute solutions are bright blue in colour due to the presence of solvated electrons.

$$Na + (x+y)NH_3 \rightarrow [Na(NH_3)_x]^+ + \underset{\text{Blue Colour}}{[e(NH_3)_y]^-}$$

15. (b) The metallic iron is oxidised to Fe^{+3}.

16. (a)

Oxidation

$$\overset{+2}{SnCl_2} + 2\overset{+1}{HgCl_2} \rightarrow \overset{+4}{SnCl_4} + Hg_2Cl_2(s)$$

Reduction

In this reaction $HgCl_2$ is reduced in Hg.

17. (a) It is the process in which electrons are lost (de-electronation).

18. (b) $4Fe + 3O_2 \rightarrow 4Fe^{3+} + 6O^{2-}$

19. (c) *Cu* is above of *Ag* in electrochemical series and thus $Cu + 2Ag^+ \rightarrow Cu^{2+} + 2Ag$ reaction occurs.

21. (a) $Sn^{2+} \rightarrow Sn^{4+} + 2e^-$. In this reaction Sn^{2+} change in Sn^{4+} it is called an oxidation reaction.

22. (c) $2S_2O_3^{2-} + I_2 \rightarrow S_4O_6^{2-} + 2I^-$.

23. (b) $\overset{2+}{Zn_{(aq)}} + 2e^- \rightarrow \overset{0}{Zn_{(s)}}$ reduction.

24. (b) SO_2 bleaches by reduction while chlorine bleaches colour of flowers by oxidation.

25. (b) It is the process in which electrons are gained (electronation).

26. (c)

Oxidation

$$\overset{o}{Zn} + \overset{o}{I_2} \rightarrow \overset{+2}{Zn}\overset{-1}{I_2}$$

Reduction

In this reaction *Zn* atom oxidised to Zn^{2+} ion and iodine reduced to I^-.

27. (c) $\overset{*}{Cr}O_4^{2-}$

$x + [(-2)\times 4] = -2$

$x = 8 - 2 = +6$

$\overset{*}{Cr_2}O_7^{2-}$

$2x + (-2)\times 7 = -2$

$2x = 14 - 2 = 12$,

$$x = \frac{12}{2} = +6$$

In this reaction oxidation and reduction are not involved because there is no change in oxidation number.

28. (d) $3\overset{0}{Br_2} + 6CO_3^{2-} + 3H_2O \rightarrow 5\overset{-1}{Br^-} + \overset{+5}{BrO_3^-} + 6HCO_3$. In this reaction bromine is oxidised as well as reduced.

29. (a) *P* is oxidized as well as reduced (as in option a).

30. (a)

Reduction

$$\overset{+6}{Cr_2}O_7^{2-} + 14H^+ + 6I^- \rightarrow 2Cr^{3+} + 3H_2O + 3I_2$$

31. (a) In this reaction oxidation occur.

32. (a) Fluorine has highest E^o – value and more reactive than MnO_2.

33. (a) $Fe^{2+} \rightarrow Fe^{3+} + e^-$ oxidation.

34. (d) $MnO_4^- \rightarrow Mn^{2+}$. In this reaction $5e^-$ are needed for the reduction of Mn^{2+} as:

$MnO_4^- + 5e^- \rightarrow Mn^{2+}$.

35. (b)

Oxidation

$$\overset{0}{Zn} + \overset{+2}{Cu}SO_4 \rightarrow ZnSO_4 + \overset{0}{Cu}$$

Reduction

In this reaction Cu^{2+} change in Cu^o, hence it is called as reduction reaction.

36. (d) $4\overset{0}{Fe} + 3O_2 \rightarrow 4\overset{3+}{Fe} + 6O^{2-}$, in this reaction metallic iron is oxidised to Fe^{3+}.

37. (d) $2\overset{0}{N_2} + \overset{0}{O_2} \rightarrow 2\overset{+2}{N}\overset{-2}{O}$

Here O.N. of *N* increases from *O* in N_2 to +2 in *NO*, 2– and that of decreased from *O* in O_2 to –2 in *O*, therefore, it is a redox reaction.

Oxidizing and Reducing agent

1. (c) $H_2\overset{-2}{S} + H_2O_2 \rightarrow \overset{0}{S} + 2H_2O$

Oxidation

The oxidation of *S* shows oxidising nature of H_2O_2.

2. (a) $C_2O_4^{2-} + MnO_4^- + H^+ \rightarrow Mn^{2+} + CO_2 + H_2O$.

In this reaction $C_2O_4^{2-}$ act as a reducing agent.

3. (b) A substance which is capable of reducing other substances and is capable of donating electrons during reduction is called a reducing agent or reductant.

4. (a) Fluorine is a most powerful oxidizing agent because it consist of $E^o = +2.5\ volt$.

5. (d) *HClO* is the strongest oxidising agent. The correct order of oxidising power is $H\overset{+1}{Cl}O > H\overset{+3}{Cl}O_2 > H\overset{+5}{Cl}O_3 > H\overset{+7}{Cl}O_4$.

6. (b) It acts both oxidizing and reducing agent.

7. (c) Prevent action of water and salt.

9. (a) In this reaction H_2O_2 acts as a oxidizing agent.

10. (b) $NaNO_2, SnCl_2$ and HI have reducing and oxidizing properties but $NaNO_3$ have only oxidizing property.

11. (c) Because I_2 is a reducing agent.

13. (a) In this reaction H_2O acts as oxidising agent.

14. (d) I^- act as a more reducing agent than other ions.

15. (a) When sulphur dioxide is react with H_2S here SO_2 act as an oxidising agent and H_2S act as reducing agent.

16. (b) HI (Hydrogen Iodide) is a good reducing agent than other compound.

17. (b) Hydrogen sulphide (H_2S) acts as strong reducing agent as it decomposes by evolving hydrogen.

19. (b) $\overset{o}{Cl_2} + H_2O_2 \to 2H\overset{-1}{Cl} + O_2$. In this reaction chlorine reduced from zero to – 1 oxidation state.

20. (d) $NaCl + H_2O \to NaOH + HCl$

Sodium ion hydrated in water.

21. (a) Potassium has higher negative value of reduction potential hence it shows more reducing properties.

22. (b) The oxidation number of *Ni* changes from 0 to $+1$

23. (d) HNO_2 (Nitrous acid) acid acts as a oxidising, reducing agent and has complex formation properties.

24. (d) CO_2 is an oxidizing agent.

25. (b) Hydrogen peroxide (H_2O_2) act as a both oxidising and reducing agent.

27. (d) $H_2O + \underset{0}{Br_2} \longrightarrow HO\underset{+1}{Br} + H\underset{-1}{Br}$

In the above reaction the oxidation number of Br_2 increases from zero (in Br_2) to +1 (in $HOBr$) and decrease from zero (Br_2) to – 1 (in HBr). Thus Br_2 is oxidised as well as reduced & hence it is a redox reaction.

28. (c) $Cl_2 + H_2O \longrightarrow HCl + HOCl$

$HOCl \longrightarrow HCl + [O]$

$HOCl$ can furnish, nascent oxygen.

29. (a)

Reduction (oxidisingagent)

$$Ag_2O + H_2O_2 \longrightarrow 2Ag + H_2O + O_2$$

Oxidation (reducing agent)

30. (d) Oxidizing agent itself, undergoes reduction during a redox reaction

$$H\overset{+3}{As}O_2 + \overset{+2}{Sn} \longrightarrow \overset{0}{As} + \overset{2+}{Sn} + H_2O$$

Hence, here $HAsO_2$ is acting as oxidizing agent.

31. (d) $NaNO_2$ (Sodium nitrite) act both as oxidising as well as reducing agent because in it N atom is in +3 oxidation state (intermediate oxidation state)

Oxidising property

$$2NaNO_2 + 2KI + 2H_2SO_4 \longrightarrow Na_2SO_4 + K_2SO_4 + 2NO + 2H_2O + I_2$$

Reducing property

$$H_2O_2 + NaNO_2 \longrightarrow NaNO_3 + H_2O.$$

32. (c)

Reduction

$$\overset{0}{P} + NaOH \longrightarrow \overset{-3}{P}H_3 + NaH_2\overset{+1}{P}O_2$$

Oxidation

Oxidation number and Oxidation state

1. (d) $\overset{*}{C}O_2$

$x + 2(-2) = 0$; $x - 4 = 0$; $x = +4$.

3. (b) +2 it is a second group element.

4. (b) In $H\overset{*}{N}O_2$ oxidation number of *N* = + 3

In $H\overset{*}{N}O_3$ oxidation number of *N* = + 5.

5. (d) In case of Cl_2O chlorine shows + 1 oxidation state.

6. (b) $[\overset{*}{Cr}(H_2O)_4Cl_2]^+$

$x + 0 + 2(-1) = +1$; $x - 2 = +1$

$x = +3$ for *Cr* in complex.

7. (c) $\overset{0}{Br_2} \to \overset{+5}{Br}O_3^-$, in this reaction oxidation state change from 0 to + 5.

8. (c) Oxidation state of sulphur in H_2S is –2, while it is zero in 'S' i.e. in this reaction oxidation of sulphur and reduction of chlorine is takes place.

9. (c) $K[\overset{*}{Co}(CO)_4]$

$1 + x + 0 = 0$; $x = -1$.

10. (a) $K_2\overset{+6}{Cr_2}O_7 \to K_2\overset{+6}{Cr}O_4$ .In this reaction no change in oxidation state of chromium.

11. (c) In hypochlorous acid chlorine atom has + 1 oxidation number.

12. (a) $S \to S^{2-}$ *O.N.* of *S* = –2.

13. (d) $(NH_4)_2SO_4 \rightleftharpoons 2NH_4^+ + SO_4^{--}$

$\overset{*}{N}H_4^+$

$x + 4 = +1$; $x = 1 - 4 = -3$.

14. (b) In N_2O nitrogen have +1 oxidation state.

15. (a) If any central metal atom combined with corbonyl group than central metal atom shows always zero oxidation state.

16. (d) $H_2\overset{*}{S}O_4$

$2 + x - 2 \times 4 = 0$, $x = 8 - 2 = +6$.

17. (d) $HCl\overset{*}{O}_4$

$1 + x - 2 \times 4 = 0$; $1 + x - 8 = 0$

$x = 8 - 1 = +7$ oxidation state.

18. (d) $H\overset{*}{N}O_3$; $1 + x - 6 = 0$; $x = +5$.

19. (a) Mn shows + 7 oxidation state in MnO_4^{-1}

$\overset{*}{Mn}O_4^{-1}$

$x+(-2\times 4)=-1$

$x-8=-1$

$x=-1+8=+7$.

20. (c) $Sn^{2+}\rightarrow Sn^{4+}+2e^-$

21. (d) $K_2\overset{*}{Mn}O_4$

$2+x-2\times 4=0$

$x=8-2=+6$.

22. (b) Each molecule always show zero oxidation state.

23. (c) Maximum oxi. state for Cr is + 6.

24. (d) In $[Fe(CO)_5]$, transition metal Fe has zero oxidation state.

25. (a) In (b, c, d) carbon show + 4 oxidation state while in (a) carbon show – 4 oxidation state.

26. (b) $H_2\overset{*}{C}_2O_4$

$2+2x-2\times 4=0$; $2x=8-2=6$

$x=\frac{6}{2}=+3$.

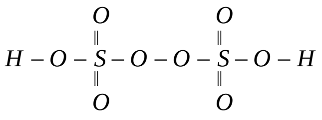
27. (b) In complex $[Pt(C_2H_4)Cl_3]^-$ Pt have + 2 oxidation state.

28. (a) $\overset{*}{C}H_2\,Cl_2$

$x+2-2=0$; $x=0$.

29. (a) Phosphorus shows – 3 to + 5 oxidation state.

31. (c) The chemical structure of $H_2S_2O_8$ is as follows:-



$$\begin{array}{c} \quad\;\; O \qquad\quad\;\; O \\ \quad\;\; \| \qquad\quad\;\; \| \\ H-O-S-O-O-S-O-H \\ \quad\;\; \| \qquad\quad\;\; \| \\ \quad\;\; O \qquad\quad\;\; O \end{array}$$

So the oxidation number of S should be :

$\underset{(\text{for } H)}{2\times(+1)}+\underset{(\text{for } S)}{2\times X}+\underset{(\text{for } O)}{6\times(-2)}+\underset{(\text{for } O-O)}{2\times(-1)}=0$ or $X=+6$.

32. (d) In hydrazoic acid (N_3H) nitrogen shows $-\frac{1}{3}$ oxidation state.

$\overset{*}{N}_3H$

$3x+1=0$, $3x=-1$, $x=-\frac{1}{3}$.

33. (a) Hydrogen have oxidation no. + 1 and – 1.

34. (a) $\left[Cr(NH_3)_4\,Cl_2\right]^+$

$x+4\times(0)-2=1\Rightarrow x+0-2=1$

$\Rightarrow x$ = 1 + 2 = + 3.

35. (b) $\overset{*}{S}O_2=+4$

$H_2\overset{*}{S}O_4=+6$

$Na_2\overset{*}{S}_2O_3=+2$

$Na_2\overset{*}{S}_4O_6=+\frac{5}{2}$.

36. (a) $\overset{*}{Fe}S_2$ $\qquad Fe\overset{*}{S}_2$

$x-4=0 \quad 4+2x=0$

$x=+4 \qquad 2x=-4$

$x=\frac{-4}{2}=-2$.

37. (d) $\overset{*}{N}O_3^-$

$x-2\times 3=-1$; $x=6-1=+5$.

38. (a) Every element always shows zero oxidation state.

39. (d) In benzaldehyde all carbon atoms show – 4 oxidation state.

40. (d) $K\overset{*}{I}O_4$

$1+x-2\times 4=0$; $x=8-1=+7$.

41. (b) $\overset{*}{N}_2H_5^+$

$2x+5=+1$; $2x=1-5$

$2x=-4$; $x=-2$.

42. (b) Oxidation number of C in

$HCHO=0$

$CHCl_3=+2$

$CH_3OH=-2$

$C_{12}H_{22}O_{11}=0$

43. (c) $K\overset{*}{Cl}O_4$

$2+2x-2\times 7=0$

$2x-14+2=0$.

44. (a) $H_4\overset{*}{I}O_6^-$

$4+x-12=-1$; $x=-1+8=+7$.

45. (d) Fluorine always shows – 1 oxidation state.

46. (b) In oxidation process oxidation state always increases.

47. (d) $HNO_3 \rightleftharpoons \overset{*}{N}_2O$

$1+x-6=0 \quad 2x-2=0$

$x=+5 \qquad 2x=2$

$x=\frac{2}{2}=+1$.

48. (d) All free metals always shows zero oxidation state.

49. (a) $MnO_4^-\rightarrow Mn^{2+}+5e^-$.

50. (c) C has oxidation number = 0.

51. (c) Iron has zero oxidation state in carbonyl complexes.

52. (b) In all alkali and alkaline earth metal hydride hydrogen always shows – 1 oxidation state.

53. (b) Iodine shows – 1 to + 7 oxidation state.

Reduction

54. (c) $K_2\overset{+6}{Cr}_2O_7+3SO_2+H_2SO_4\rightarrow$

$K_2SO_4+\overset{+3}{Cr}_2(SO_4)_3+H_2O$

In this reaction chromium change from + 6 to +3 oxidation state.

55. (b) In H_2O_2 oxygen shows = – 1 (peroxide) oxidation state and in $BaSO_4$ oxygen shows = – 2 oxidation state.

56. (b) Mn shows highest oxidation state in $K\overset{+7}{Mn}O_4$.

57. (c) $\overset{*}{C}H_2O$

$x+2-2=0$

$x=0$.

58. (a) In all peroxide oxygen shows – 1 oxidation state.

59. (a) $K_2\overset{*}{Cr}_2O_7$

$2+2x-2\times7=0$; $2x-14+2=0$

$2x=12$; $x=\frac{12}{2}=+6$.

60. (c) Nickle shows zero oxidation state in carbonyl complex.

61. (d) $\overset{*}{Os}O_4$

$x+4(-2)=0$

$x-8=0$

$x=+8$.

62. (a) Al shows + 3 oxidation state.

63. (d) $K_4[\overset{*}{Fe}(CN)_6]$

$1\times4+x+(-1\times6)=0,\ 4+x-6=0$

$x=+2$.

In this complex compound Iron show + 2 oxidation state.

64. (b) In this complex iron is a central metal atom showing + 2 oxidation state.

65. (b) Oxygen shows + 2 oxidation state in F_2O. As F most electronegative element, it always has an O. No. =–1

66. (b) $H_3\overset{*}{P}O_3$

$3+x-2\times3=0$; $x=6-3=+3$.

67. (c) $Mg_2\overset{*}{P}_2O_7$

$4+2x-2\times7=0$; $2x=14-4=10$

$2x=10$; $x=\frac{10}{2}=+5$.

68. (a) $3\times x+1(1)=0$

$3x+1=0$

$3x=-1,\Rightarrow x=-\frac{1}{3}$ in N_3H

$x+2(+1)+1(-2)+1(1)=0$

$x=-1$ in NH_2OH

$x\times2+4(1)=0\ \ x=-\frac{4}{2}=-2$ in N_2H_4

$x+3(1)=0\ \ x=-3\ in\ NH_3$

Hence, highest in N_3H.

69. (a) In $KH_2\overset{*}{P}O_2$

$1+2+x+(-2\times2)=0$

$3+x-4=0$; $x=+1$.

70. (c) Oxygen has 6 electrons in the outer most shell and shows common oxidation state – 2.

71. (d) $H_2\overset{*}{S}O_3=+4$; $\overset{*}{S}O_2=+4$

$H_2\overset{*}{S}O_4=+6$; $H_2\overset{*}{S}=-2$.

72. (a) The oxidation number of sulphur in the sulphur molecule (S_8) is 0 and 2.

73. (b) In ferrous ammonium sulphate Fe shows +2 oxidation state.

74. (b) $\overset{*}{N}H_2OH$

$x+2(+1)-2+1=0$

$x+2-2+1=0$; $x=-1$.

75. (b) $Ba(H_2\overset{*}{P}O_2)_2$; $BaH_4\overset{*}{P}_2O_4$

$2+4+2x-8=0$; $2x=2$

$x=\frac{2}{2}=+1$.

77. (d) $H_2\overset{*}{S}O_4$

$2\times(+1)+x+4\times(-2)=0$

$+2+x-8=0$; $x=8-2=+6$

Electronic configuration of sulphur in H_2SO_4 is

$1s^2,\ 2s^2,\ 2p^6$.

78. (a) $K\overset{*}{Mn}O_4$

$1+x-2\times4=0$; $x=8-1=+7$.

79. (d) H_3AsO_4

$+3+x-2\times4=0$; $x=8-3=+5$.

80. (b) The oxidation state of Xe in both XeO_3 and XeF_6 is + 6

$\overset{*}{X}eO_3$ $\qquad$ $\overset{*}{X}eF_6$

$x-2\times3=0$ $\qquad$ $x-6=0$

$x=+6$ $\qquad$ $x=+6$.

81. (b) $\overset{*}{C}H_3-Cl$

$x+3(+1)+(-1)\times1=0$

$x+3-1=0$; $x+2=0$

$x=-2$.

82. (c) $\overset{*}{Cr}_2O_7^{2-}$

$2x-2\times7=-2$; $2x=14-2=12$

$x=\frac{12}{2}=+6$.

83. (c) $H_2\overset{*}{S}O_3$

$+2+x-2\times3=0$; $x=6-2=+4$.

84. (b) Two Cl atom shows +1 and –1 oxidation state.

85. (c) $HCl\overset{*}{O}_3$

$1+x-2\times3=0$; $x=6-1=+5$.

86. (c) $5\begin{array}{l}COOH\\ |\\ COOH\end{array}+2K\overset{+7}{Mn}O_4+3H_2SO_4\rightarrow$

$K_2SO_4+2\overset{+2}{Mn}SO_4+10CO_2+8H_2O$

In this reaction oxidation state of Mn change from + 7 to + 2.

87. (d) Oxygen have + 2 oxidation state in OF_2 .

89. (b) $\overset{*}{S}_2O_3^{2-}$

$2x+3(-2)=-2$; $x=+2$.

90. (c) $x+2\times(+1)+2(-1)=0$

$x+2-2=0$; $x=0$ in CH_2Cl_2 .

91. (c) In potassium superoxide (KO_2) oxygen shows, $-\frac{1}{2}$ oxidation state.

92. (a) $\overset{*}{S}_2Cl_2$

$2x+2(-1)=0$; $2x-2=0$

$x=+1$.

93. (d) $Na_2\overset{*}{S}_4O_6$

$2+4x-12=0$

$4x=10$ $x=\frac{10}{4}$ $x=\frac{5}{2}$.

94. (c) $\overset{+2}{Cu}SO_4+2KI \rightleftharpoons K_2SO_4+CuI_2$

$2CuI_2 \longrightarrow \overset{+1}{Cu_2}I_2+I_2$

95. (d) $NH_4Cl \rightleftharpoons NH_4{}^+ + Cl^-$

$\overset{*}{N}H_4{}^+$

$x+4=+1$; $x=1-4=-3$.

96. (b) $2\overset{+4}{N}O_2+H_2O\rightarrow HNO_2+H\overset{+5}{N}O_3$. In this reaction oxidation state changes.

97. (d) $\overset{*}{Fe}_3O_4$

$3x+(-8)=0$; $3x-8=0$

$3x=8$; $x=\frac{8}{3}$.

99. (b) $K_2\overset{*}{Mn}O_4$ $\qquad$ $\overset{*}{Mn}SO_4$

$2+x-8=0$ $\qquad$ $x+6-8=0$

$x=+6$ $\qquad$ $x=+2$.

100. (c) Chlorine have oxidation state – 1 to + 7.

101. (a) $[\overset{*}{Co}(NH_3)_4ClNO_2]$

$x+4(0)+1(-1)+1(-1)=0$

$x+0-1-1=0$

$x-2=0$; $x=+2$.

102. (d) $K_4[\overset{*}{Ni}(CN)_4]$

$4\times(+1)+x+4\times(-1)=0$

$+4+x-4=0\Rightarrow x=0$.

103. (a) Fluorine always shows – 1 oxidation state in oxides.

104. (b) $K_3[\overset{*}{Fe}(CN)_6]$

$1\times3+x+(-1\times6)=0$

$3+x-6=0$; $x=+3$.

105. (a) $\overset{*}{N}H_3$

$x+3(+1)=0$, $x=-3$.

106. (a) ${}_{26}Fe\longrightarrow[Ar]3d^6 4S^2$

$Fe^{++}\longrightarrow[Ar]3d^6 4S^0$

$Fe^{+++}\longrightarrow[Ar]3d^5 4S^0$

In +2 state Fe is called Ferrous & in +3 state as ferric.

107. (d) Fluorine is the most electronegative element in the periodic table so it never shows positive oxidation state.

108. (b) Silicon forms silicides with strongly electropositive metals (like Na, Mg, K etc.) In these compounds. It has oxidation number $=-4$.

109. (a) H_2S [O.N. of $H=+1$]

$(+1)\times2+x=0$

$2+x=0$; $x=-2$

110. (b) Let the oxidation number of N in $NaNO_2$ be x

$+1+x+(-2)\times2=0$

$1+x-4=0$; $x=+3$

111. (a) $x=8-2=+6$

112. (d) $K_2Cr_2O_7+6KI+7H_2SO_4\rightarrow4K_2SO_4+Cr_2(SO_4)_3$

$+7H_2O+3I_2$

$\overset{*}{C}r_2(SO_4)_3\rightarrow2\overset{+3}{Cr}+3SO_4^{2-}$

113. (b) Let the oxidation number of I in $IPO_4=x$

Oxidation number of $PO_4=-3$

$x+(-3)=0\Rightarrow x=+3$

Redox reaction and Method for balancing Redox reaction

1. (a) $MnO_4^-+8H^++5e^-\rightleftharpoons Mn^{++}+4H_2O$.

2. (b) The balanced equation is $2C_2H_6+7O_2\rightarrow4CO_2+6H_2O$. Ratio of the coefficients of CO_2 and H_2O is 4 : 6 or 2 : 3.

3. (c) $\underbrace{Cr_2O_7{}^{2-}+3e^-\rightarrow Cr^{3+}}_{\text{Reduction}}$.

In this reaction three electrons are required for the reduction of $Cr_2O_7^{2-}$ into Cr^{3+} .

4. (c) Number of e^- transferred in each case is 1, 3, 4, 5.

5. (a) Starch paper are used for iodine test

as: $I^-+\text{oxidant}\longrightarrow I_2$

$I_2+\text{starch}\longrightarrow\text{blue colour}$

6. (a) $Cr_2O_7^{2-}+14H^++6e^-\rightarrow2Cr^{3+}+7H_2O$

$$(Sn^{2+} \rightarrow Sn^{4+} + 2e^-) \times 3$$

$$Cr_2O_7^{2-} + 14H^+ + 3Sn^{2+} \rightarrow 3Sn^{4+} + 2Cr^{3+} + 7H_2O$$

It is clear from this equation that 3 *moles* of Sn^{2+} reduce one mole of $Cr_2O_7^{2-}$, hence 1 *mol.* of Sn^{2+} will reduce $\frac{1}{3}$ *moles* of $Cr_2O_7^{2-}$.

7. (a) $2MnO_4^{\ominus} + 5H_2O_2 + 6H^+ \rightarrow 2Mn^{2+} + 5O_2 + 8H_2O$.

8. (b)

Reduction

$$\underbrace{2Fe^{3+} + Sn^{2+} \rightarrow 2Fe^{2+} + Sn^{4+}}$$

Oxidation

9. (a) $MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O \times 2$

$$C_2O_4^{2-} \rightarrow 2CO_2 + 2e^- \times 5$$

$$2MnO_4^- + 5C_2O_4^{2-} + 16H^+ \rightarrow 2Mn^{2+} + 10CO_2 + 8H_2O$$

Thus the coefficient of MnO_4^-, $C_2O_4^{2-}$ and H^+ in the above balanced equation respectively are 2, 5, 16.

10. (d). $\overset{0}{Zn} + 2\overset{+1}{Ag}CN \rightarrow 2\overset{0}{Ag} + \overset{+2}{Zn}(CN)_2$.

Reduction

Oxidation

Oxidation Reduction

11. (d) $\overset{o}{Cu} + 2\overset{+1}{Ag}NO_3 \rightarrow \overset{+2}{Cu}(NO_3)_2 + 2\overset{o}{Ag}$. This is a redox reaction.

Oxidation

12. (c) $\overset{0}{H_2} + \overset{0}{Br_2} \rightarrow 2\overset{+}{H} - \overset{-}{Br}$

Reduction

13. (c) Higher is the reduction potential stronger is the oxidising agent. Hence in the given options. MnO_4^- is strongest oxidising agent.

14. (a) $IO_3^- + aI^- + bH \rightarrow cH_2O + dI_2$

Step 1 : $I^- \rightarrow I_2$ (oxidation)

$IO_3^- \rightarrow I_2$ (reduction)

Step 2 : $2IO_3^- + 12H \rightarrow I_2 + 6H_2O$

Step 3 : $2IO_3^- + 12H + 10e \rightarrow I_2 + 6H_2O$

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

Step 4 : $2IO_3^- + 12H + 10e \rightarrow I_2 + 6H_2O$

$[2I^- \rightarrow I_2 + 2e]5$

Step 5 : $2IO_3^- + 10I^- + 12H \rightarrow 6I_2 + 6H_2O$

$IO_3^- + 5I^- + 6H \rightarrow 3I_2 + 3H_2O$

On comparing, $a = 5$, $b = 6$, $c = 3$, $d = 3$

15. (d) *In alkaline medium*

$$2KMnO_4 + KI + H_2O \rightarrow 2MnO_2 + 2KOH + KIO_3.$$

Auto oxidation and Disproportionation

1. (d) $H_2S \rightarrow \overset{0}{S} + 2e$

Equivalent wt. = $\frac{\text{Mol.wt.}}{2} = \frac{34}{2} = 17$.

2. (a) $1.12\,ltr H_2 = 1.2\,g; \therefore 22.4\,ltr H_2 = 24\,g$.

3. (d) $2AgNO_3 \xrightarrow{\Delta} 2Ag + 2NO_2 + O_2$.

4. (b) To prevent rancidification of food material we add anti-oxidant which are called oxidation inhibitor.

6. (b) $Zn^{2+}/Zn.\, E^o = -0.76\,V$

$Al^{3+}/Al \quad E^o = -1.662$

$Sn^{2+}/Sn \quad E^o = -0.136$

$Pb^{2+}/Pb \quad E^o = -0.126$

In galvanizing action Zn is coated over iron.

8. (d) Molecular weight of H_3PO_4 is 98 and change in its valency = 1 equivalent wt. of H_3PO_4

$$= \frac{\text{Molecular weight}}{\text{Change in valency}} = \frac{98}{1} = 98.$$

9. (b) Equivalent mass

$$= \frac{\text{Molecular weight}}{\text{Change in oxidation number per mole}}$$

Suppose molecular weight is M

Oxidation number of I_2 in IO_4^- in

Acidic medium i.e., $I \times (-8) + 1e^- = +7$

So eq. wt. $= M/7$.

10. (c) $2KMnO_4 + 3H_2SO_4 \longrightarrow K_2SO_4 + 2MnSO_4 + 3H_2O + 5O$

$$5H_2O_2 + 5O \longrightarrow 5H_2O + 5O_2$$

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

11. (a) $\frac{\text{Molecular weight}}{2}$ = Equivalent weight of Iodine.

12. (d) $\frac{\text{Molecular weight}}{3}$ Because in KIO_3 effective oxidation number is 3.

13. (a) $6MnO_4^- + I^- + 6OH^- \longrightarrow 6MnO_4^{2-} + IO_3^- + 3H_2O$

14. (c) $ClO_2 \to Cl^-$

$$ClO_2 + 2H_2O + 5e \to Cl^- + 4OH^-$$

$$H_2O_2 \to O_2$$

$$H_2O_2 + 2OH^- \to O_2 + 2H_2O + 2e$$

$$ClO_2 + 2H_2O + 5e \to Cl^- + 4OH^-] \times 2$$

$$H_2O_2 + 2OH^- \to O_2 + 2H_2O + 2e] \times 2$$

$$2ClO_2 + 5H_2O_2 + 2OH^- \to 2Cl^- + 5O_2 + 5H_2O$$

$$2ClO_2 \equiv 5H_2O_2$$

$$\therefore \quad ClO_2 = 2.5H_2O_2$$

Critical Thinking Questions

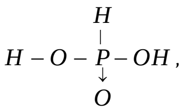
1. (d) HNO_2 shows both oxidation and reduction properties.

2. (c) Al_2O_3 could not act as a oxidising and reducing agent.

3. (a, b) In H_2S sulphur shows –2 oxidation state and in SO_2 shows +4 oxidation state. Hence SO_2 shows both oxidising and reducing properties.

4. (d) All the given statements are true.

5. (a)



$H - O - \underset{\underset{O}{\downarrow}}{\overset{\overset{H}{|}}{P}} - OH$, hence it is dibasic. It acts as reducing agent also.

6. (c) (a) $\overset{*}{N}O_2 ; x - 4 = 0 ; x = +4$

(b) $H\overset{*}{N}O ; 1 + x - 2 = 0 ; x = +1$

(c) $\overset{*}{N}H_3 ;\ x + 3 = 0 ;\ x = -3$

(d) $\overset{*}{N}_2O_5 ;\ 2x - 10 = 0 ; 2x = 10 ;\ x = \frac{10}{2}$; $x = 5$.

7. (c) 2 × No. of e^- losses = Oxi. no.

$2 \times 3e^- = +6$.

8. (a) The ion which is not affected during the course of reaction is known as spectator ion.

9. (a) $H_2\overset{*}{S}_2O_7$

$$2 \times (+1) + 2 \times x + 7 \times (-2) = 0$$

$$+2 + 2x - 14 = 0$$

$$2x = 14 - 2 = 12$$

$$x = \frac{12}{2} = +6 \text{ for } S$$

$$K_4\overset{*}{Fe}(CN)_6$$

$$4 \times (+1)x + 6 \times (-1) = 0$$

$$4 + x - 6 = 0$$

$$x = 6 - 4 = +2 \text{ for } Fe.$$

10. (c) $K\overset{*}{O}_2$, $+1 + 2x = 0,\ x = -\frac{1}{2}$.

11. (a) $N_2^{2-} \to {}_2N^{a+} + 10e^-$

$\therefore\ 2a - [2 \times (-2)] = 10$

$\therefore\ a = +3$.

12. (d) $\overset{*}{Cr}O_2Cl_2$, $x - 4 - 2 = 0, x = +6$.

13. (c) $3x = -1,\ x = -1/3$.

14. (b) $Ba_2\overset{*}{Cu}_3O_7$

$$3 + 2 \times 2 + 3x - (2 \times 7) = 0$$

$$3 + 4 + 3x - 14 = 0$$

$$3x = 7$$

$$x = \frac{7}{3}.$$

15. (a) $\overset{*}{S}_8 = 0$

$\overset{*}{S}_2F_2 = +1$

$H_2\overset{*}{S} = -2$.

16. (d) In reaction $HCl + H_2O \to H_3O^- + Cl^-$, only reduction has taken place not oxidation.

17. (d) Zn can oxidise carbon because heat of combusion of $Zn < C$.

18. (d) $B_2H_6 + 2KOH + 2H_2O \to 2KBO_2 + 6H_2$.

19. (c) The values of x, y, z are 8, 4, 4 respectively hence the reaction is

$$H_2SO_4 + 8HI \to H_2S + 4I_2 + 4H_2O$$

20. (d)

Acid	Base
$HClO_3^-$	ClO_3^{2-}
HS^-	S^{2-}
$H_2PO_4^-$	HPO_4^{2-}

21. (a) MnO_4^{2-} in neutral aqueous medium is disproportionate to $\frac{2}{3}$ mole of MnO_4^- and $\frac{1}{3}$ mole of MnO_2.

22. (d) $\lambda m = \frac{1000\,K}{S} = \frac{1000 \times 3.06 \times 10^{-6}}{S} = 1.53$

$$S = 2 \times 10^{-3} \frac{mol}{litre}$$

$$K_{sp(BaSO_4)} = S^2 = (2 \times 10^{-3})^2 = 4 \times 10^{-6}.$$

23. (a) $2MnO_2 + 4KOH + O_2 \xrightarrow{\Delta} \underset{\text{purple green}}{2K_2MnO_4} + 2H_2O$.

Assertion & Reason

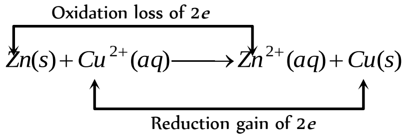
1. (c) It is true that SO_2 and Cl_2 both are bleaching agents. But Cl_2 is an oxidising agent while SO_2 is a reducing agent. Therefore, in this questions assertion is true while reason is false.

2. (b) It is correct that fluorine exists only in –1 oxidation state because it has $1s^2 2p^5$ electronic configuration and thus shows only –1 oxidation state in order to complete its octet. Hence, both assertion and reason are true and reason is not a correct explanation of assertion.

3. (e) Here, assertion is false, because stannous chloiride is a strong reducing agent not strong oxidising agent. Stannous chlorides gives Grey precipitate with mercuric chloride. Hence, reason is true.

4. (b) Both assertion and reason are true but reason is not the correct explanation of assertion. Greater the number of negative atoms present in the oxy-acid make the acid stronger. In general, the strengths of acids that have general formula $(HO)_m ZO_n$ can be related to the value of n. As the value of n increases, acidic character also increases. The negative atoms draw electrons away from the Z-atom and make it more positive. The Z-atom, therefore, becomes more effective in with drawing electron density away from the oxygen atom that bonded to hydrogen. in turn, the electrons of $H-O$ bond are drawn more strongly away from the H -atom. The net effect makes it easier from the proton release and increases the acid strength.

5. (a) Both assertion and reason are true and reason is the correct explanation of assertion.



$$Zn(s)+Cu^{2+}(aq)\longrightarrow Zn^{2+}(aq)+Cu(s)$$

6. (b) Both assertion and reason are true but reason is not the correct explanation of assertion.

Oxidation number can be calculated using some rules. H is assigned +1 oxidation state and 0 has oxidation number –2

$\therefore$ O. No. of C in CH_2O :

O. no. of $C+2(+1)+(-2)=0$

$\therefore$ O. No. of $C=0$

7. (a) Both assertion and reason are true and reason is the correct explanation of assertion.

8. (a) Both assertion and reason are true and reason is the correct explanation of assertion.

Maximum oxidation state of S is +6, it cannot exceed it. Therefore it can't be further oxidised as S^{-2} can't be reduced further.

9. (a) Both assertion and reason are true and reason is the correct explanation of assertion.

$$\overset{0}{N}_2+6e^- \longrightarrow 2N^{3-}$$

$\therefore$ equivalent weight of

$NH_3 = \frac{14+3}{3} = \frac{17}{3}$ (M. wt. of NH_3)

while for $N_2 = \frac{14\times 2}{6} = \frac{28}{6}$