Chapter 6: Chemical Equivalence

Q1.

Sol: **No,** In $FeCl_2$, Iron is in Fe^{2+} state.

$$\therefore \text{Eq.wt.} = \frac{\text{At.wt}}{2} = \frac{56}{2} = 28$$

In $FeCl_3$, Iron is in Fe^{3+} state.

$$\therefore \text{Eq. wt.} = \frac{\text{At wt}}{3} = \frac{56}{3}$$

Q2.

Sol: Eq. Wt. of oxide = Eq. Wt. of metal + Eq. Wt. of oxygen

$= 12 + 8 = 20$

[Since Eq. Wt. of compound = (Eq.wt. of cation + Eq. wt. of anion)

Q3.

Sol: From law of gm equivalence

For Oxides

gm eq. of cation = gm eq. of anion

gm eq. of metal = gm eq. of oxygen

$$= \frac{0.2\,g}{8} = \frac{1}{40}$$

Also for chloride

gm eq. of metal = gm eq. of halogen

$$\frac{1}{40} = \frac{3.17}{\text{eq.wt of halogen}}$$

Eq. wt of halogen = $403 \times .17 = 127$ **Ans**

Q4.

Sol: **In first oxide**

gm eq. of oxygen = gm eq. of Arsenic

$$\left(\frac{100-65.2}{8}\right) = \frac{65.2}{\text{eq.wt of Arsenic}}$$

$\therefore$ eq. wt of Arsenic = 15 g **Ans**

In 2nd oxide

gm eq. of oxygen = gm eq. of Arsenic

$$\left(\frac{100-75-7}{8}\right) = \frac{75.7}{\text{eq.wt of arsenic}}$$

$$\therefore \text{Eq. Wt. of Arsenic} = \frac{75.7 \times 8}{24.3} = 24.9\,g \text{ Ans}$$

Q5.

Sol: Metal oxide + $H_2 \longrightarrow$ Metal

From law of chemical equivalence.

gm eq. of metal oxide = gm eq. of H_2

$$\frac{1.80}{\text{eq. wt of oxide}} = \frac{833}{11200}$$

$$\text{eq. wt.of oxide} = \frac{1.80 \times 11200}{833} = 24.2\,\text{g} \quad \textbf{Ans}$$

$\therefore$ Eq. Wt. of oxide = Eq. Wt. of metal = Eq. Wt. of oxygen

24.2 = Eq. Wt. of Metal + 8

Eq. Wt. of metal = 24.2=8 = 16.2 g **Ans**

Q6.

Sol: Metal + Acid $\longrightarrow H_2 \uparrow$

Eq. wt = 18 0.7 lit

gm eq. of metal = gm eq of H_2 evolved

$$\frac{\text{wt of metal}}{\text{Eq. wt of metal}} = \frac{\text{wt of } H_2}{\text{Eq. wt. of } H_2}$$

$$\frac{\text{wt of metal}}{28} = \frac{0.7}{11.2}$$

$$\text{Wt of metal} = \frac{0.7 \times 28}{11.2} = 1.75\,\text{g} \quad \textbf{Ans}$$

Q7.

Sol: From principle of gram equivalence.

gm eq. of metal = gm eq. of oxygen

$$\frac{\text{wt of metal}}{\text{eg. wt of metal}} = \frac{\text{wt of oxygen}}{\text{eg. wt of oxygen}}$$

$$\frac{5}{\text{eq. wt of metal}} = \frac{4.44}{8}$$

$$\text{Eq. wt of metal} = \frac{5 \times 8}{4.44} = 9.01\,\text{g} \quad \textbf{Ans}$$

Q8.

Sol: Metal + sulphuric acid $\longrightarrow$ dissolve

From principle of chemical equivalence

gm equivalent of metal = gm equivalent of sulphuric acid

$$\Rightarrow \frac{\text{wt}}{\text{Eq. wt of metal}} = \frac{\text{wt of } H_2SO_4}{\text{Eq. wt of } H_2SO_4}$$

$$\Rightarrow \frac{\text{wt}}{\text{Eq. wt of metal}} = \frac{\text{wt of } H_2SO_4}{\text{Eq. wt of } H_2SO_4}$$

$$\frac{16.8}{\text{eq. wt of metal}} = \frac{14.7}{98/2}$$

$$\text{Eq. wt of metal} = \frac{16.8 \times 49}{14.7} = 56\,\text{g}$$

Also, gm eq. of H_2 evolved = gm eq. of H_2SO_4

$$\frac{\text{volume at NTP}}{\text{Eq. volume at NTP}} = \frac{14.7}{98/2}$$

Volume at NTP $= \frac{14.7}{49} \times 11.2 = 3.36$ lit **Ans**

Q9.

Sol: $H_3PO_4 + Na \longrightarrow Na_2HPO_4 + H_2 \uparrow$

Since 2 hydrogen are removed from H_3PO_4, so its v.f. = 2

$\therefore$ eq. wt of orthophosphoric acid $= \frac{wt}{v.f} = \frac{98}{2} = 49\,g$ **Ans**

Q10.

Sol: $Ag\frac{\text{dissolved}}{\text{in } AgNO_3} \rightarrow AgNO_3 + HCl \longrightarrow AgCl\downarrow + HNO_3$

gm eq. of Ag = gm eq. of AgCl = gm eq. of chlorine

$$\frac{\text{wt of Ag}}{\text{Eq. wt of Ag}} = \frac{\text{wt of chlorine}}{\text{Eq. wt of } Cl_2}$$

$$\frac{0.501\,g}{\text{eq. wt of Ag}} = \frac{0.6655 - 0.501}{35.5} = \frac{0.1645}{35.5}$$

Eq. wt of Ag $= \frac{0.501}{0.00463} = 108.2\,g$ **Ans**

Q11.

Sol: $Zn + CuCO_4 \longrightarrow ZnSO4 + Cu$

5 g 4.864 g

Gm eq. of Zn = Gm eq of Cu

$$\frac{\text{wt of Zn}}{\text{Eq. wt of Zn}} = \frac{\text{wt of Cu}}{\text{Eq. wt of Cu}}$$

$$\frac{5\,g}{32.5\,g} = \frac{4.846}{\text{eq. wt of Cu}}$$

Eq. wt of Cu $= \frac{4.846 \times 32.5}{5} = 31.5\,g$ **Ans**

Q12.

Sol: (i) - $BrO_3^- + 6H^+ + 6e^- \longrightarrow Br^- + 3H_2O$

Molarity $\times$ valancy factor = Normality

Molarity $= \frac{0.672}{6} = 0.112\,M$ **Ans**

Also no. of moles of Bromate = Molarity $\times$ Vol. (in lit) $= 0.112 \times \frac{85.5}{1000}$

$$\frac{wt}{\text{Mol. wt of } NaBrO_3} = 9.576 \times 10^{-3}$$

$\frac{wt}{151\,g} = 9.576 \times 10^{-3}$ $\rightarrow$ wt = 1.4479 g; **Ans**

(ii) $2BrO_3^- + 12\,H^+ + 10\,e^- \longrightarrow Br_2 + 6\,H_2O$

$$\text{Molarity} = \frac{\text{Normality}}{\text{valancy factor}}$$

$$= \frac{0.672}{10/2}$$ (Since 10 electron taken by 2 BrO_3^-, So 5 electron by one BrO_3^-)

$$= \frac{0.672}{5} = 0.134\,M$$ **Ans**

$$\frac{\text{Weight}}{\text{Mol.wt.}} = 0.134 \times 85.5 \times 10^{-3}$$

$$\text{Weight} = 0.134 \times 85.5 \times 10^{-3} \times 151\ g = 1.7235\ g$$ **Ans**

Q13.

Sol: Metal + Nitric acid $\longrightarrow$ Metal nitrate $\longrightarrow$ Metal chloride

2 g 2.66 g

From principle of chemical equivalence

gm equivalent of metal = gm equivalent of chloride

$$\frac{2g}{\text{eq. wt of metal}} = \frac{2.66g}{\text{eq. wt Metal chloride}}$$

$$\frac{2g}{\text{eq.wt of Metal}} = \frac{2.66g}{\text{eq. wt of Metal} + \text{eq. wt of chlorine}}$$

$$\frac{2g}{E} = \frac{2.66}{E+35.5}$$

(Let eq. wt of Metal = E)

$(2.66-2)\,E = 2 \times 35.5$

$E = 53.78 \times 2 = 107.55\ g$ **Ans**

Q14.

Sol: $BaCl_2 \longrightarrow BaSO_4$

2 g 2.25 g

gm eq. of $BaCl_2$ = gm eq. of $BaSO_4$.

$$\frac{2g}{\text{eq.wt of } BaCl_2} = \frac{2.25g}{\text{eq.wt of } BaSO_4}$$

If E is the equivalent weight of Ba, then

$$\frac{2}{E+35.5} = \frac{2.25}{E+48}$$

$2.25\,E + 2.25 \times 35.5 = 2E + 96 \rightarrow E = \dfrac{96 - 2.25 \times 35.5}{0.25} = 64.5\,g$ **Ans**

Q15.

Sol: Metal chloride contains 47.23% of Metal

$\therefore$ 100 g of Metal chloride contain (100 – 47.23) g of chlorine

In any compound, from principle of gm equivalent;

gm equivalent of cation = gm equation of anion.

$$\frac{47.23}{\text{Eq.wt of M}} = \frac{(100-47.23)}{\text{Eq. wt of chlorine}}$$

$$\frac{47.23\,g}{\text{eq.wt of M}} = \frac{52.77\,g}{35.5\,g}$$

$$\text{eq.wt. of M} = \frac{47.23\times 35.5}{52.77} = 31.77\,g$$

M + compound $\longrightarrow$ N

1 gm 0.88 g

$\therefore$ From principle of chemical equivalence

gm eq of M = gm eq of N

$$\frac{1g}{\text{eq.wt of M}} = \frac{0.88g}{\text{eg.wt of N}}$$

Eq. wt of N = 0.88 × eq. wt of M

= 0.883 × 1.77 = 27.96 g **Ans**

Q16.

Sol: 0.5 lit of 0.01 M Cu (II) Sol-^{n}

moles of Cu(II) = $0.5\times 0.01 = 5\times 10^{-3}$

$\therefore$ moles of Cu (II) = moles of $CuSO_4.5H_2O = 5\times 10^{-3}$

$$\therefore \frac{\text{weight of } CuSO_4.5H_2O}{18\times 5+96+63.5} = 5\times 10^{-3}$$

Wt of $CuSO_4.5H_2O$ = 1.248 g **Ans**

Q17.

Sol:

+4	+5	−1	+6
SO_2 +	$HClO_3$ $\longrightarrow$	HCl +	SO_4^{2-}
V=?	16.9 gm		
V.f=2	V.f. = 6		

(Note: only +6 oxidised state possible for SO_2 because S has only -2, 0, 2, 4, 6 oxid. state possible)

$\therefore$ From principle of chemical equivalence

gm eq. of SO_2 = gm eq. of $HClO_3$

$$\frac{VSO_2}{22.4/2} = \frac{16.9}{84.5/6}$$

VSO_2 = 13.44 lit **Ans**

Q18.

Sol:

-2	+7	+6	+4
H_2S +	$KMnO_4$ $\longrightarrow$	K_2SO_4 +	MnO_2
wt ?	6.32 g		
v.f = 8	v.f = 3		

From principle of chemical equivalence

gm eq. of H_2S = gm eq. of $KMnO_4$

$$\frac{wt}{34/8} = \frac{6.32}{158/3}$$

Wt = 0.511 g **Ans**

Q19.

Sol: $C_6H_{10}O_4 + KOH \longrightarrow$ complete neutralisation

1 g 0.768

v.f = 1

Let n is the no. of ionisable hydrogen in it gm eq. of $C_6H_{10}O_4$ = gm eq. of KOH

$$\frac{1}{146/n} = \frac{0.763}{56/1} \text{ (valancy factor of } C_6H_{10}O_4 = n)$$

$$n = \frac{0.768 \times 146}{56} = 2 \quad \textbf{Ans}$$

Q20.

Sol: oxidised

So R.A

0 +5 +2

$5Zn + V_2O_5 \longrightarrow 5ZnO + 2V$

Reduced So O.A.

V.f = 2 V.f = 10

Wt. in 1 g - equivalent of R.A = Eq. wt of Zn

$$= \frac{\text{At wt}}{\text{v.f}} = \frac{65.4}{2} = 32.7 \text{ g}$$

Wt in 1 gm equivalent of O.A = Eq. Wt. of V_2O_5

$$= \frac{\text{Mol.wt}}{\text{V.f}} = \frac{102+80}{10} = 18.2 \text{ g} \quad \textbf{Ans}$$

Q21.

Sol: +7 +6

(1) $KMnO_4 \longrightarrow Mn^{2+}$ | (2) $K_2Cr_2O_7 \longrightarrow 2Cr^{3+}$

V. f = 5 | V. F = 6

+7 +3 | +5 -1 | +5 -1

(3) $KMnO_4 \longrightarrow MnO_2$ | (4) $KIO_3 \longrightarrow I^-$ | (5) $KClO_3 \longrightarrow Cl^-$

V.f = 3 | V.f = 6 | V. f = 6

$\therefore$ Eq. wt. in each case = $\dfrac{\text{Mol.wt of compound}}{\text{valancy factor}}$

$\therefore$ Calculating for each one-

(1) eq. wt = 31.6 g (2) eq. wt = 49 g

(3) eq. wt = 52.67 g (4) eq. wt = 35.67 g

(5) eq. wt = 52.67 g

$\therefore$ $KClO_3$, $KMnO_4$, KIO_3, $K_2Cr_2O_7$, $KMnO_4$

(5) < (1) < (4) < (2) < (3)

Q22.

Sol: $H_3PO_4 + OH^- \longrightarrow H_2PO_4^- + H_2O$

(v.f = 1)

$\therefore$ eq. wt of $H_3PO_4 = \frac{\text{Mol.wt of } H_3PO_4}{\text{V.f}} = \frac{98}{1} = 98\,g$ **Ans**

$H_3PO_4 + 2OH^- \longrightarrow HPO_4^{2-} + 2H_2O$

$\therefore$ eq. wt of $H_3PO_4 = \frac{\text{Mol.wt of } H_3P_4}{\text{V.f}} = \frac{98}{2} = 49\,g$ **Ans**

$H_3PO_4 + 3OH^- \longrightarrow PO_4^{3-} + 3H_2O$

(v.f = 3)

eq. wt of $H_3PO_4 = \frac{\text{Mol.wt of } H_3PO_4}{3} = \frac{98}{3} = 32.67$ **Ans**

Q23.

Sol: (a) $SO_2 + 2H_2S = 3S + 2H_2O$

(v.f = 4)

Eq. Wt. of $SO_2 = \frac{\text{Mol.wt of } SO_2}{4} = \frac{64}{4} = 16\,g$ **Ans**

(b) $5SO_2 + 2KMnO_4 + 2H_2O = K_2SO_4 + 2MnSO_4 + 2H_2SO_4$

(v.f = 2)

eq. wt of $SO_2 = \frac{\text{Mol. wt of } SO_2}{2} = \frac{64}{2} = 32\,g$ **Ans**

Q24.

Sol: -2 +4

$H_2S \longrightarrow SO_2$

(v.f = 6)

Eq. wt of $H_2S = \frac{34}{6}$

$\therefore$ no. of equivalent = no. of moles $\times$ v.f

$= 1 \times 6 = 6$ **Ans**