16. Let weight of $H_2C_2O_4 = a\,g$ in 1L and weight of $NaHC_2O_4 = b\,g$ in 1L for acid base reaction now

(Meq. of $H_2C_2O_4$ + Meq. of $NaHC_2O_4$) in $10\,mL = 3\times 0.1$

$\therefore$ Meq. of H_2SO_4 + Meq. of $NaHC_2O_4$ in $1L = 3\times 0.1\times 100 = 30$

$\therefore \quad \frac{a}{45}\times 1000 + \frac{b}{112/1}\times 1000 = 30$ .... (i)

For redox change :

$$C_2^{6+} \longrightarrow 2C^{4+} + 2e^-$$

$$Mn^{7+} + 5e^- \longrightarrow Mn^{2+}$$

Meq. of $H_2C_2O_4$ + Meq. of $NaHC_2O_4$ in $10\,mL = 4\times 0.1$

$\therefore$ Meq. of $H_2C_2O_4$ + Meq. of $NaHC_2O_4$ in $1L = 4\times 0.1\times 100 = 40$

($\because$ Eq. wt. of $H_2C_2O_4 = \frac{M}{2}$ and Eq. wt. of $NaHC_2O_4 = \frac{M}{2}$ as reductant)

$\therefore \quad \frac{1000\,a}{45} + \frac{2000\,b}{112} = 40$ .... (ii)

Solving, equations (i) and (ii), we get, $a = 0.9\,g$ and $b = 1.12\,g$

17.(B) Normality of 10 volume $H_2O_2 = 1.78\,N$

Thus, volume strength of 1.78 N solution $= 10$

$\therefore$ Volume strength of 1.5 N $H_2O_2 = 1.5\times\frac{10}{1.78} = \frac{15}{1.78} = 8.4$

18.(C) $2 + 2(2 + x - 4) = 0$ [$\because Ba(H_2PO_2)_2$ is neutral molecule]

or $\quad 2x - 2 = 0$

$\Rightarrow \quad x = +1$

19. $\underset{a\,g}{Pb(NO_3)_2} \longrightarrow PbO + 2NO_2\uparrow + \frac{1}{2}O_2\uparrow$

$\underset{b\,g}{NaNO_3} \longrightarrow NaNO_2 + \frac{1}{2}O_2\uparrow$

$\therefore \quad a + b = 5\,g$ .... (i)

The loss in weight for 5 g mixture $= 5\times\frac{28}{100} = 1.4\,g$

$\therefore$ Residue left $= 5 - 1.4 = 3.6\,g$

The residue contains $PbO + NaNO_2$

$\therefore$ 331 g $Pb(NO_3)_2$ gives = 223 g PbO

$\therefore$ a g $Pb(NO_3)_2$ gives $= \frac{223\times a}{332}$ g PbO

Similarly,

$\therefore$ 85 g $NaNO_3$ gives = 69 g $NaNO_3$

$\because$ b g $NaNO_3$ gives $= \frac{69\times b}{85}$ g $NaNO_2$

$\therefore \quad \frac{223\times a}{331} + \frac{69\times b}{85} = 3.6$ .... (ii)

Solving equation, (i) and (ii) $a = 3.32\,g$ and $b = 1.68\,g$

20. Let 'a' moles of Cu^{2+} and 'b' moles of $C_2O_4^{2-}$ be present in solution

(i) The solution is oxidised by $KMnO_4$ with only $C_2O_4^{2-}$

$$Mn^{7+} + 5e^- \longrightarrow Mn^{2+}$$

$$C_2^{6+} \longrightarrow 2C^{4+} + 2e^-$$

$\therefore$ Meq. of $C_2O_4^{2-}$ = Meq. of $KMnO_4$

$\therefore$ $b \times 2 \times 1000 = 0.02 \times 5 \times 22.6$

$\therefore$ $b = 1.13 \times 10^{-3}$

(ii) After oxidation of $C_2O_4^{2-}$, the resulting solution is neutralized by Na_2CO_3, acidified with dilute CH_3COOH and then treated with excess of KI. The liberated I_2 required $Na_2S_2O_3$ for its neutralization,

i.e. $Cu^{2+} \xrightarrow{KI} I_2 \xrightarrow{Na_2S_2O_3} Na_2S_4O_6 + I^-$

$\therefore$ Meq. of Cu^{2+} = Meq. of I_2 liberated = Meq. of $Na_2S_2O_3$ used

$\therefore$ Meq. of Cu^{2+} = Meq. of $Na_2S_2O_3$ used

$a \times 1 \times 1000 = 11.3 \times 0.5 \times 1$

$\therefore$ $a = 5.65 \times 10^{-3}$

$\therefore$ Molar ratio of $\dfrac{Cu^{2+}}{C_2O_4^{2-}} = \dfrac{a}{b} \Rightarrow \dfrac{5.65 \times 10^{-3}}{1.13 \times 10^{-3}} = \dfrac{5}{1}$

Hence, molar ratio of $Cu^{2+}; C_2O_4^{2-} = 5 : 1$

Involved reactions are : $2MnO_4^- + 5C_2O_4^{2-} + 16H^+ \longrightarrow 2Mn^{2+} + 10CO_2 + 8H_2O$

$$2Cu^{2+} + 4I^- \longrightarrow Cu_2I_2 + I_2$$

$$I_2 + 2S_2O_3^{2-} \longrightarrow 2I^- + S_4O_6^{2-}$$

21. The redox changes are :

For reduction of Fe_2O_3 by zinc dust

$$Fe_2^{6+} + 2e^- \longrightarrow 2Fe^{2+}$$

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

$\text{oxidant} + ne^- \longrightarrow \text{reductant}$

Meq. of Fe_2O_3 in 25 mL

= Meq. of Fe^{2+} formed = Meq. of oxidant used to oxidize Fe^{2+} again

$\therefore$ Meq. of Fe_2O_3 in 25 mL = Meq. of oxidant $= 17 \times 0.0167 \times n$

Where n is the number of electrons gained by 1 molecule of oxidant

$\therefore$ Meq. of Fe_2O_3 in 100 mL $= 17 \times 0.0167 \times n \times \dfrac{100}{25}$

$\therefore$ $\dfrac{1 \times 55.2 \times 1000}{100 \times \dfrac{M}{2}} = 17 \times 0.0167 \times n \times 4$

$\because$ Molecule wt. of $Fe_2O_3 = 160$

$\therefore$ $n = \dfrac{1 \times 55.2 \times 2 \times 1000}{100 \times 160 \times 17 \times 0.0167 \times 4} = 6$

Hence, number of electrons gained by one molecule of oxidant = 6

22. Number of millimoles of KIO_3 in 30 mL of solution = molarity $\times$ volume in mL $= \frac{1}{10} \times 30 = 3$

Given reaction : $KIO_3 + 2KI + 6HCl \longrightarrow 3ICl + 3KCl + 3H_2O$

According to the equation given, 1 mole of KIO_3 is equivalent to 2 moles of KI

$\because$ Number of millimoles of KI in 20 mL of stock solution $= 2 \times 3 = 6$

$\therefore$ Number of millimoles of KI in 50 mL of the same solution $= 6 \times \frac{50}{20} = 15$

Number of millimoles of KIO_3 in 50 mL of solution $= \frac{1}{10} \times 50 = 5$

$\therefore$ Number of millimoles of KI used with $AgNO_3 = 15 - 10 = 5$

$$AgNO_3 + KI \longrightarrow AgI + KNO_3$$

1 mole of $AgNO_3$ reacts with 1 mole of KI. Therefore, number of millimoles of $AgNO_3$ is equal to 5

$\therefore$ Weight of $AgNO_3 = 5 \times 10^{-3} \times 170\,g = 0.85\,g$

$\therefore$ % of $AgNO_3 = \frac{0.85 \times 100}{1.0} = 85.0\,\%$

23.(A) Oxidation reaction : $C_2O_4^{2-} \rightarrow 2CO_2 + 2e^-] \times 5$

Reduction reaction : $MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O] \times 2$

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

24.(3) $Be_nAl_2Si_6O_{18}$

$(2n) + (3 \times 2) + (4 \times 6) + (-2 \times 18) = 0$ or $2n + 30 - 36 = 0$ or $2n = 6$ or $n = 3$

25. As $YBa_2Cu_3O_7$ is neutral $(+3) + 2(+2) + 3(x) + 7(-2) = 0$,

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

$\Rightarrow$ $3x + 7 - 14 = 0$ or $x = +\frac{7}{3}$

26. $H_2O_2 \longrightarrow H_2O + [O]$

$$\frac{2KI + H_2SO_4 + [O] \longrightarrow K_2SO_4 + H_2O + I_2}{2KI + H_2SO_4 + H_2O_2 \longrightarrow K_2SO_4 + 2H_2O + I_2}$$

Liberated moles of $I_2 = \frac{0.508 \times 10^3}{254} = 2$

Meq. of $I_2 = 2 \times 2 = 4$

Meq. of liberated $I_2 =$ Meq. of used H_2O_2

Meq. of $H_2O_2 = 4$

Weight of $H_2O_2 =$ Meq. $\times$ Eq. wt. of $H_2O_2 \times 10^{-3} = 4 \times 17 \times 10^{-3}\,g = 0.068\,g$

Strength of $H_2O_2 = \frac{0.068 \times 1000}{5}\,g/L = 13.6\,g/L$

$\because$ 60.7 g H_2O_2 is used for 20 volume H_2O_2

$\therefore$ 13.6 g/L strength of H_2O_2 is used for $= \frac{20 \times 13.6}{60.7}$ volume $= 4.48$ volume

27. $CO(g) + \frac{1}{2}O_2(g) \longrightarrow CO_2(g)$

$CH_4(g) + 2O_2(g) \longrightarrow CO_2(g) + 2H_2O(\ell)$

'x' is the volume of CO and y is+ the volume of CH_4

Thus, $\frac{1}{2}x + y = 13$ .... (i)

$x + y = 14$ .... (ii)

$\therefore$ By solving eq. (i) & (ii), we get
$x = 2\,cc$; $y = 12\,cc$

Thus, $\%CH_4 = 60$, $\%CO = 10$, $\%He = 30$

28. The following reactions are involved in given data

$Fe_2O_3 + 3H_2SO_4 \longrightarrow Fe_2(SO_4)_3 + 3H_2O$, $FeO + H_2SO_4 \longrightarrow FeSO_4 + H_2O$

$Fe_2(SO_4)_3 + 2KI \longrightarrow 2FeSO_4 + K_2SO_4 + I_2$

$I_2 + 2Na_2S_2O_3 \longrightarrow 2NaI + Na_2S_4O_6$

$2KMnO_4 + 8H_2SO_4 + 10FeSO_4 \longrightarrow K_2SO_4 + 2MnSO_4 + 5Fe_2(SO_4)_3 + 8H_2O$

$\therefore$ 1 mole $Fe_2O_3 \equiv$ 1 mole $Fe_2(SO_4)_3 \equiv$ 1 mole of $I_2 \equiv$ 2 moles of $Na_2S_2O_3$

and 5 moles of $FeSO_4 \equiv$ 1 mole of $KMnO_4$

Number of millimoles of I_2 in $20\,mL = 5.5 \times \frac{1}{2} = 2.75$

So, the number of millimoles of I_2 in $100\,mL = 2.75 \times \frac{100}{20} = 13.75$

Number of millimoles of $Fe_2O_3 = 13.75$

Number of moles of $Fe_2O_3 = 13.75 \times 10^{-3}$

Suppose x moles of Fe_3O_4 and y moles of Fe_2O_3 are present in 3g sample. In this sample Fe_3O_4 is an equimolar mixture of FeO and Fe_2O_3. Therefore, total number of moles of Fe_2O_3 in the mixture $= x + y$

$x + y = 13.75 \times 10^{-3}$ .... (i)

Number of millimoles of $KMnO_4 = 0.25 \times 12.80 = 3.2$

$\therefore$ Number of millimoles of $FeSO_4$ in $50\,mL = 3.2 \times 5 = 16$

and number of millimoles of $FeSO_4$ in $100\,mL = 16 \times \frac{100}{50} = 32$

1 mole Fe_3SO_4 gives 3 moles of $FeSO_4$ and 1 mole of Fe_2O_3 gives 2 moles of $FeSO_4$

$\therefore$ $3x + 2y = 32 \times 10^{-3}$ .... (ii)

On solving equations (i) and (ii)

Number of moles of Fe_3O_4 in the mixture $(x) = 4.5 \times 10^{-3}$

Number of moles of Fe_2O_3 in the mixture $(y) = 9.25 \times 10^{-3}$

$\therefore$ Mass of $Fe_3O_4 = 4.5 \times 10^{-3} \times 232 = 1.044\,g$

and Mass of $Fe_2O_3 = 9.25 \times 10^{-3} \times 160 = 1.480\,g$

$\therefore$ % of $Fe_3O_4 = \frac{1.044}{3.00} \times 100 = 34.8\%$

and % of $Fe_2O_3 = \frac{1.480}{3.0} \times 100 = 49.33\%$

29. $2\,KI + H_2SO_4 + H_2O_2 \longrightarrow K_2SO_4 + 2\,H_2O + I_2$

$2\,Na_2S_2O_3 + I_2 \longrightarrow Na_2S_4O_6 + 2\,NaI$

Meq. of $Na_2S_2O_3 = 20 \times 0.3 = 6$ (Normality $\times$ volume)

Meq. of $Na_2S_2O_3 =$ Meq. of $I_2 = 6$

Meq. of $I_2 =$ Meq. of $H_2O_2 = 6$

Weight of $H_2O_2 =$ Meq. $\times E \times 10^{-3} = 6 \times 17 \times 10^{-3} = 0.102\,g$ $\left(\because \text{ Eq. wt. of } H_2O_2 = \frac{34}{2} = 17\right)$

Strength of $H_2O_2 = \frac{0.102 \times 1000}{25} = 0.408\,g/L$

Molarity of $H_2O_2 = \frac{0.408\,g/L}{\text{mol. wt.}(34)} = 0.012\,M$

$$\underset{\substack{2\,\text{mole} \\ 0.012\,\text{moles}}}{2\,H_2O_2} \longrightarrow 2\,H_2O + \underset{\substack{1\,\text{mole} \\ 0.06\,\text{moles}}}{O_2}$$

$\therefore$ Volume of O_2 at STP $= 0.06 \times 22.4\,L = 1.344\,L$

Hence the volume strength of $H_2O_2 = 1.344\,L$

30.(A) $2\,KMnO_4 + 3\,H_2SO_4 \rightarrow K_2SO_4 + 2\,MnSO_4 + 3\,H_2O + 5[O]$

$$[SO_3^{2-} + [O] \rightarrow SO_4^{2-}] \times 5$$

$$2\,KMnO_4 + 3\,H_2SO_4 + 5\,SO_3^{2-} \rightarrow K_2SO_4 + 2\,MnSO_4 + 3\,H_2O + 5\,SO_4^{2-}$$

or $2\,MnO_4^- + 6\,H^+ + 5\,SO_3^{2-} \rightarrow 2\,Mn^{2+} + 5\,SO_4^{2-} + 3\,H_2O$

Therefore, 5 moles of SO_3^{2-} will require 2 moles of MnO_4^-

1 mole of SO_3^{2-} will require $\frac{2}{5}$ moles of MnO_4^-