HINTS & SOLUTIONS

EXERCISE - 1

Single Choice

1. $(NH_4)_2Cr_2O_7 \longrightarrow N_2 + Cr_2O_3 + 4H_2O$

Decomposition R × N

2. $NaN_3 \longrightarrow N_3^- \longrightarrow N \longrightarrow -1/3$

$N_2H_2 \longrightarrow N \longrightarrow -1$

$NO \longrightarrow N \longrightarrow +2$ $\Rightarrow$ 5(A)

$N_2O_5 \longrightarrow N \longrightarrow +5$

3. $S_2O_5^{-2} + I_2 \longrightarrow S_4O_6^{-2} + I^-$

$\Rightarrow$ Redox R × N $I_2^{\circ} \xrightarrow{\text{Redn}} I^-$

$S_2O_3^{-2} \xrightarrow{\text{Oxd.}} S_4O_6^{-2}$

(4, 0) (5, 0, 0, 5)

4. No. of equivalent = mole × n-factor

$SO_3^{-2} + H_2O \longrightarrow SO_4^{-2} + 2H^+ + 2e^-$ ...(1)

n-factor for R × N (1) is (2)

$\Rightarrow$ $50 \times .1 \times n = 25 \times .1 \times 2$

$n = \dfrac{2.5 \times 2}{5}$

n = 1

$\Rightarrow$ Final oxidation state will be (3 – 1) = 2

5. Meq. of $K_2Cr_2O_7$ = Meq. of ABD

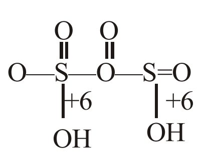
n-factor of $K_2Cr_2O_7$ in acidic medium = 6.

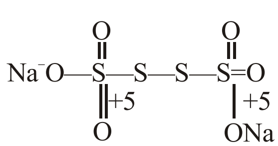
$6 \times 1.68 \times 10^{-3} = x \times 3.26 \times 10^{-3}$

x = 3

$\Rightarrow$ New oxidation state of A^{-n} will be = –n + 3

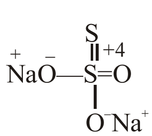
6. (A)





$H_2S_2O_7$ (6, 6) $Na_2S_4O_6$ (5, 0, 0, 5)

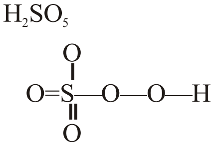
(B)



$Na_2S_2O_3$

(4, 0)

H_2SO_5



(6)

(C) $SO_3 > SO_2 > H_2S > S_8$

↓ ↓ ↓ ↓

+6 +4 –2 0

(D) $H_2SO_4 > SO_2 > H_2S > H_2S_2O_8$.

+6 +4 –2 (6, 6)

8. $xHI + yHNO_3 \longrightarrow NO + I_2 + H_2O$

$(2I^- \longrightarrow I_2 + 2e) \times 3$ .....(1)

$(\overset{+5}{N}O_3^- + 3C \longrightarrow \overset{+2}{N}O) \times 2$ .....(2)

Adding (1) and (2)

$\Rightarrow$ $6I^- + 2NO_3^- \longrightarrow 2NO + 3I_2$

$6HI + 2HNO_3 \longrightarrow 2NO + 3I_2 + 4H_2O$

$\Rightarrow$ x = 6 , y = 2

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

(Mn: 5; C: 2×1)

$2MnO_4^- + 5C_2O_4^{-2} + H^+(6) \rightarrow 2Mn^{+2} + 10CO_2 + 8H_2O$

$\Rightarrow$ (A) 2, 5, 16

10. $CaCO_3 + HCl \rightarrow CaCl_2 + H_2O + CO_2$ (224 mL)

CO_2 mole $= \dfrac{224}{22400} = 10^{-2}$

HCl M = HCl N $= \dfrac{10^{-2}}{200 \times 10^{-3}} = \dfrac{1}{20} = .05$

M. eq. of H_3PO_4 = M. eq. of $Ba(OH)_2$

$1.5 \times v \times 3 = 90 \times .5 \times 2$

$v = \dfrac{90 \times 2 \times .5}{3 \times 1.5} = 20$ mL

12. $KMnO_4$ n factor in Acidic medium = 5

$K_2Cr_2O_7$ n factor in acidic medium = 6

$6 \times 0.1 \times V_1 = 5 \times 0.3 \times V_2$

$\dfrac{6}{15} V_1 = V_2$

$V_2 = \dfrac{2}{5} V_1$

13. Molarity $= \dfrac{\text{Normality}}{\text{n factor}}$

$\Rightarrow$ (e) 1 M H_3PO_4 = 1/3 M H_3PO_4

14. $M = \dfrac{\text{No. of equivalent}}{\text{Volume of sol}}$

$\Rightarrow$ Meq. $= 50 \times 2 = 10$

M mole $= \dfrac{10}{2} = 5$

$M_{H_2C_2O_4.2H_2O} = 24 + 16 \times 4 + 2 + 2 \times 18 = 126\text{gm}.$

$\Rightarrow$ Mass of $H_2C_2O_4.2H_2O$

$= 126 \times 5 \times 10^{-3} = .63\text{gm}$

15. 63 % (w/v) $H_2C_2O_4.2H_2O$

$\Rightarrow$ 100 mL contain = 63 gm

$125\text{ mL} \longrightarrow = \dfrac{63}{100} \times 125\text{gm}$

Mole of $H_2C_2O_4 = \dfrac{63 \times 125}{126 \times 100} = \left(\dfrac{5}{8}\right)$

$\dfrac{40}{100} = \dfrac{x}{125}$

Mole of NaOH $= \dfrac{125 \times 40}{100 \times 40} = \left(\dfrac{5}{4}\right)$

$H_2C_2O_4 + 2NaOH \longrightarrow Na_2C_2O_4 + 2H_2O$

2 × mole of Acid = Mole of NaOH

$2 \times \dfrac{5}{8} = \dfrac{5}{4}$

And will have $\left(\dfrac{5}{4}\right)$ mole of NaOH

$\Rightarrow$ Sol. is neutral

16. $K_2Cr_2O_7$ have greater n factor as compaire $KMnO_4$ so same volume of $K_2Cr_2O_7$ will oxidise more amount of Fe^{+2}.

17. Mole of $V_2O_5 = \dfrac{10}{51 \times 2 + 5 \times 16} = \dfrac{10}{102 + 80} = \dfrac{10}{182} = .055$

Mole of V^{+2} $= .055 \times 2$

$= .1098 \text{ mole} \simeq 0.11$

$V^{+2} \longrightarrow \overset{+4}{V}O^{+2} + 2e$

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

$\Rightarrow$ Mole of I_2 = Mole of $V^{+2} = .11$

18. $Cl_2 + S_2O_3^{-2} \longrightarrow SO_4^{-2} + Cl^- + S$

$50 \times .01 \times \text{n factor} = 5 \times 10^{-4} \times 2 \times 10^3$

n factor $S_2O_3^{-2} = \dfrac{10 \times 10^{-4} \times 10^3}{.5} = 2 \times 10^{-3} \times 10^3$

n factor = 2

$\Rightarrow$ **(i)** $Cl_2 + H_2O + Na_2S_2O_3 \longrightarrow Na_2SO_4 + S + 2HCl$

Balanced equation

(ii) Mole of $S_2O_3^{-2} = 50 \times 10^{-3} \times 10^{-2} = .0005$

(iii) Equivalent of oxidising agent $= 5 \times 10^{-4} \times 2 = .001$

(iv) Molarity of $Na_2SO_4 = \dfrac{5 \times 10^{-4}}{50 \times 10^{-3}}$

$= 10^{-2} = .01$ M

19. $\overset{+3}{As}O_4^{-3} + 2H^+ + 2I^- \quad \overset{+3}{As}O_3 + H_2O + I_2$ (change = 2)

molar mass Na_3AsO_4

$= 23 \times 3 + 75 + 15 \times 4$

molar mass = 208

eq. of $AsO_4^- = \dfrac{1}{\left(\dfrac{208}{2}\right)} = \left(\dfrac{1}{104}\right)$

equivalent of Na_3AsO_4 = equivalent of I_2

= equivalent of $Na_2S_2O_3$.

$\dfrac{1}{104} = .2 \times V$

$\dfrac{1}{104 \times .2}\text{L} = V = 48.1\text{ mL}$

20. M eq. of $KMnO_4 = 25 \times .2 = 5$

(A) M eq. of $FeSO_4 = \dfrac{25 \times .2}{1} = 5$

(C) M eq. of $H_2O_2 = 25 \times .1 \times 2 = 2.5 \times 2 = 5$

(D) M eq. of $SnCl_2 = 25 \times .1 \times 2 = 5$

21. $N = \left(\dfrac{N_1V_1 + N_2V_2}{V_1 + V_2}\right) = \dfrac{3 \times 250 + 750 \times 1}{1000} = \dfrac{1500}{1000} = 1.5$

Molarity $= \dfrac{1.5}{2} = 0.75 = \dfrac{3}{4}$

$\Rightarrow$ $H_2O_2 \longrightarrow H_2O + \dfrac{1}{2}O_2$

1L H_2O_2, 1 Mole H_2O_2 give O_2 = 11.2 L

1L H_2O_2, 0.75 $H_2O_2 \longrightarrow = 11.2 \times \dfrac{3}{4}$

$\longrightarrow = 8.4\text{ V } O_2$

$\Rightarrow$ Volume strength = 8.4 V

Alternative $V_S = 5.6 \times N = 5.6 \times 1.5 = 8.4V$

22. M eq. of $KMnO_4$ = M eq. of $C_2O_4^{-2}$

$90 \times \frac{1}{20} = 100 \times N_{C_2O_4^{-2}}$

M mole of oxalate = $\frac{9}{2 \times 2} = \frac{9}{4}$

Wt of oxalate = $\frac{9}{4} \times 88 \times 10^{-3} = 22 \times 9 \times 10^{-3} = 198 \times 10^{-3}$

$\% \ C_2O_4^{-2} = \frac{.198}{.300} \times 100 = 66 \%$

23. M eq. of $KMnO_4$ = M eq. of $C_2O_4^{-2}$ = M eq. of $CaCO_3$
40 × .25 = M eq. of CaO

$\frac{10 \times 10^{-3}}{2}$ = Mole of CaO

% CaO = $\frac{5 \times 10^{-3} \times 56 \times 100}{.518}$

CaO = 54 %

24. $2CrO_5 + 3H_2SO_4 \longrightarrow Cr_2(SO_4)_3 + 3H_2O + 7/2O_2$
1 mole CrO_5 Liberate $\longrightarrow$ 7/4 mole of O_2

25. M eq. of $KMnO_4$ = .2 × 50 × 5 = 50
M eq. of H_2O_2 = 2 × 25 × .5 = 25
M eq. of $KMnO_4$ remaining = (50 – 25) = 25

Mole of $KMnO_4 = \frac{25}{5} \times 10^{-3} = 5 \times 10^{-3} = .005$

26. $\frac{100x}{1000} = \left(\frac{3}{24}\right) \times 2$

$x = \frac{20}{8} = 2.5$

27. (320 mL, 10V H_2O_2) + (80 mL, 5NH_2O_2)
(A) (B)

$N_A = \left(\frac{10}{5.6}\right)$

$\Rightarrow N_C = \frac{N_A V_A + N_B V_B}{V_A + V_B} = \frac{\frac{10}{5.6} \times 320 + 5 \times 80}{320 + 80}$

$N_C = \frac{400 + \frac{1000 \times 4}{7}}{400} = 11 + \frac{10}{7} = (17/7)$

$\Rightarrow V_S = 5.6 \times \frac{17}{7} \qquad V_S = 13.6V$

$M_C = \frac{17}{7 \times 2}$ Mol/L $\qquad M_C = \frac{17}{14}$ Mole / L

$C = \frac{17 \times 34}{14}$ gm / Ltr.

Concentration = 41.285 gm/Ltr.

28. $Ca(HCO_3)_2 + CaO \longrightarrow 2CaCO_3 + H_2O$

2 × 100
56 gm 2 gm

$\frac{200}{56} = \frac{2}{x}$

x = .56 gm

30. $HNO_3 + NH_4^+ \longrightarrow N_2 + NO_2$
Meq of HNO_3 = Meq of NH_4^+
mole × n-factor = mole × n-factor
1 × mole = 1 × 6
mole of HNO_3 = 6

31 $Z^{+x} + KMnO_4 \xrightarrow{H^+} Mn^{2+} + Z^{+y}$

Meq of Z^{+x} = Meq of $KMnO_4$
25 × 0.1 × (y – x) = 25 × 0.04 × 5

$(y - x) = \frac{0.04 \times 5}{0.1} = 2$

$Z^{2+} \longrightarrow Z^{4+}$

(4 – 2) = 2

32.

Fe	+	$\frac{1}{2}O_2$	$\longrightarrow$ FeO
1		0.65	
0		0.15	1

2FeO	+	$\frac{1}{2}O_2$	$\longrightarrow$ Fe_2O_3
1		0.15	
(1–0.60)			0.30
0.4			0.30

Mole ratio $\frac{FeO}{Fe_2O_3} = \frac{0.40}{0.30} \Rightarrow \frac{4}{3}$

33. $FeSO_4$
1 mole of SO_4^{2-} than 1 mole Fe^{2+}
In $Fe_2(SO_4)_3$
3 mole of SO_4^{2-} than = 2 mole Fe^{3+}

1 mole of SO_4^{2-} than = $\frac{2}{3}$ mole Fe^{3+}

ratio = $\frac{Fe^{2+}}{Fe^{3+}} = \frac{1}{\frac{2}{3}} = \frac{3}{2}$

34. $2Fe + \frac{3}{2}O_2 \longrightarrow Fe_2O_3$

Let assume n mole of Iron

Initial n 0

$n - x \qquad \left(\frac{x}{2}\right)$

wt. $(n-x) \times 56 + \left(\frac{x}{2}\right) \times 160 = n \times 56 \times 1.1$

$24x = 5.6\,n$

$\left(\frac{x}{n}\right) = 0.2323$

% total Iron = 23.3%

35. $Cl^- + KMnO_4 \longrightarrow Mn^{2+} + Cl_2$

Meq of NaCl = Meq of $KMnO_4$

mole × n-factor = $\frac{10}{158} \times \frac{5}{2}$

mole × 1 = $\frac{10}{158} \times \frac{5}{2}$

volume of $Cl_2 = \frac{10}{158} \times \frac{5}{2} \times 22.4 = 3.54$ L

36. $I_2 \longrightarrow I^- + IO_3^-$

$I_2 \rightarrow 2I^-$ | $I_2 \longrightarrow 2IO_3^-$

$2e^- + I_2 \rightarrow 2I^- \times 5$ | $I_2 + 6H_2O \longrightarrow 2IO_3^-$

$10e^- + 5I_2 \rightarrow 10I^-$ | $I_2 + 6H_2O + 12OH^- \longrightarrow 2IO_3^- + 12H_2O$

$I_2 + 12OH^- \longrightarrow 2IO_3^- + 6H_2O + 10e^-$

$12OH^- + 6I_2 \longrightarrow 10I^- + 2IO_3^- + 6H_2O$

ratio of $\frac{IO_3^-}{I^-} = \frac{2}{10} = 1:5$

37. Eq. mass

$= \frac{\text{molecular mass}}{n - \text{factor}}$

$\overset{+3}{As_2} \longrightarrow 2\overset{+5}{As}$ n-factor 4

$\overset{-2}{S_3} \longrightarrow 3\overset{+6}{S}$ 24

total n-factor = 28

Eq. mass = $\frac{\text{m.wt.}}{28}$

38. From Hit and trial method

$3H_2O + CN^- \longrightarrow NO + CO_2 + 6H^+ + 7e^-$ ...**(i)**

$3CN^- + 9H_2O \longrightarrow 3NO + 3CO_2 + 18H^+ + 21e^-$

$21e^- + 7NO_3^- + 28H^+ \longrightarrow 7NO + 14H_2O$

Balance equation

$3CN^- + 7NO_3^- + 10H^+ \rightarrow 10NO + 3CO_2 + 5H_2O$

40. $K_2Cr_2O_7 + Sn^{2+} \longrightarrow Sn^{4+} + Cr^{3+}$

$Sn^{4+} + Fe^{2+} \longrightarrow Fe^{3+}$

meq. of Sn^{4+} = meq of $K_2Cr_2O_7$

meq. of Sn^{4+} = meq of Fe^{3+}

meq. of Fe^{3+} = meq of $K_2Cr_2O_7$

$N_{K_2Cr_2O_7} = \frac{4.9 \times 6}{294 \times 0.1} = 1$

millimol × n-factor = 1 × 10

millimol = 10

41. $\overset{+2}{Zn}\overset{-2}{S} + H\overset{+5}{N}O_3 \longrightarrow \overset{+2}{Zn}(\overset{+5}{N}O_3)_2 + H_2\overset{+6}{S}O_4 + \overset{+4}{N}O_2$

change in O.N. of Zn

Zn = 0

S = 6–(–2) = 8

N = 5 – 4 = 1

45. Vol. of O_2 at NTP

$V_{O_2} = \frac{500 \times 1 \times 273}{300}$

$V_{O_2} = 455$ mL

35 mL of H_2O_2 gives 455 mL at N.T.P.

$\therefore$ 1 mL of H_2O_2 gives $= \frac{455}{35} = 13$

= 13 mL of O_2 at NTP

hence volume strength of H_2O_2 = '13 V'

46. Half meq of salt (Na_2CO_3) in neutralize using Hph indicator

$\frac{1}{2}$ meq of salt = meq of HCl

$\frac{1}{2}(20 \times 0.1 \times 2) = 0.05\,x$ ....**(i)**

complete meq of salt ($Na_2CO_3 \cdot NaHCO_3 \cdot 2H_2O$) is neutralise using MeOH indicator

Meq. of salt = Meq of HCl

$20 \times 0.1 \times 3 = 0.05\,y$ ....**(ii)**

eq **(ii)** – eq **(i)**

$0.05\,(y - x) = (6 - 2)$

$(y - x) = \frac{4}{0.05}$ $\quad (y - x) = 4 \times 20$

$(y - x) = 80$ mL

47. Let a gm H_2SO_4 and (3.185 – a) g $H_2C_2O_4$

Meq of 10 mL mixture = 0.3

meq of 1000 mL mixture = 0.3 × 1000 = 30

meq of H_2SO_4 + meq of $H_2C_2O_4$ = 30

$$\frac{a}{49}\times 1000+\frac{(3.185-a)}{45}\times 1000 = 30 \quad ......(i)$$

In another ex.

meq of 100 mL mixture = meq of $KMnO_4$

= 4 × 0.02 × 5

meq of 100 mL mixture = 0.4

meq of 1000 mL mixture = 4

meq of $H_2C_2O_4$ = 4

$$\frac{3.185-a}{45}\times 1000 = 4 \quad ....(ii)$$

48. $K_2Cr_2O_7 + KI \longrightarrow I_2 + Cr^{3+}$

$I_2 + Na_2S_2O_3 \longrightarrow I_2 + S_4O_6^{2-}$

$Na_2S_2O_3 + K_2Cr_2O_7 \longrightarrow$

meq of $Na_2S_2O_3 \longrightarrow$ meq. of $K_2Cr_2O_7$

$30 \times N = 15 \times \frac{1}{20} \qquad N = \frac{1}{40}$

meq. of I_2 = meq. of Hypo

meq. of I_2 = meq. of KI

meq of KI = meq. of $K_2Cr_2O_7$

$24 \times \frac{1}{40}$ = meq. of 25 mL $K_2Cr_2O_7$

meq. of 500 mL $K_2Cr_2O_7 = \frac{24}{40}\times\frac{500}{25}$

$\frac{w\times 6}{294}\times 1000 = 12 \qquad w = 0.588$

$$\% \text{ purity} = \frac{0.588}{0.8}\times 100 = 73.5\%$$

49. Meq of I_2 = Meq of Hypo solution

$= 20 \times 2.5 \times 10^{-3}$

Meq of 10ml I^- = Meq of $I_2 = 20 \times 2.5 \times 10^{-3} = 0.05$

Meq of 100 mL I^- = 0.5

Meq of $CaCO_3$ = 0.5

$\frac{w}{123.5}\times 1000 = 0.5 \qquad w = 0.06175$

$$\% = \text{purity} = \frac{0.06175}{0.1}\times 100 = 61.75\%$$

50. $I_2 + Na_2S_2O_3 \rightarrow I^- + S_4O_6^{2-}$

let x mL of I_2 react with Hypo

meq of I_2 = meq of Hypo

xN = 15 × 0.4 $\qquad$ xN = 6 $\qquad$ ....(i)

meq of H_2SO_4 used by base = 10 × 0.3 × 2 = 6

meq of NaOH used by I_2 = (30 – 6)

(150 – x) N = 24 ..(ii)

from eq (i) & eq (ii)

$\frac{150-x}{x} = 4 \quad \Rightarrow \quad 5x = 150$

x = 30 mL

30 N = 6

$N = \frac{1}{5} \qquad N = M \times \text{n-factor}$

$\frac{1}{5} = M \times 2$

$M = \frac{1}{10} = 0.1$

EXERCISE - 2

Part # I : Multiple Choice

1. **(A)** $6\,M_1V_1 = M_2V_2$

$[\because \text{ For } K_2Cr_2O_7\text{, Eq. wt.} = \frac{M.wt}{6}]$

(C) $N_1V_1 = N_2V_2$

(B) and **(D)** are not possible.

2. equivalent of oxidising agent = equivalents of reducing agent.

$Eq_{MnO_4^-} = Eq_{Fe^{2+}}$

$n_{MnO_4^-} \times 5 = n_{Fe^{2+}} \times 1$

$Eq_{Cr_2O_7^{2-}} = Eq_{Fe^{2+}}$

$n_{Cr_2O_7^{2-}} \times 6 = n_{Fe^{2+}} \times 1$

$Eq_{MnO_4^-} = Eq_{Cu_2S}$

$n_{MnO_4^-} \times 6 = n_{Cu_2S} \times 8$

$Eq_{Cr_2O_7^{2-}} = Eq_{Cu_2S}$

$n_{Cr_2O_7^{2-}} \times 6 = n_{Cu_2S} \times 8$

4. $5I^- + IO_3^- + 6H^+ \longrightarrow 3I_2 + 3H_2O$

$$\frac{\text{moles of KI used}}{\text{moles of } KIO_3 \text{ used}} = 5$$

(A) For 0.004 mole KIO_3, moles of KI required = $0.004 \times 5 = 0.02 = 0.1 \times V_L$

$\therefore \quad V_L = 0.2\ L = 200\ mL$

(B) For 0.006 mole H_2SO_4 (0.012 mole H^+), moles of KI required $= \frac{0.012 \times 5}{6} = 0.01 = 0.1 \times V_L$

$\therefore \quad V_L = 0.1\ L = 100\ mL$

(C) From 0.5 L of KI solution ($n_{KI} = 0.05$), moles of I_2 produced $= \frac{0.05 \times 3}{5} = 0.03$

(D) Valency factor of $KIO_3 = 5$ ($IO_3^- \longrightarrow I_2$)

$\therefore \quad E_{KIO_3} = \frac{\text{mol. wt.}}{5}$

5. S undergoes increase in oxidation number from +2 to +2.5, while I undergoes decrease in oxidation number from 0 to –1.

6. For HCl N = M

Final molarity $= \frac{V_1 \times 1 + V_2 \times 0.25}{(V_1 + V_2)} = 0.75$

$0.75\,(V_1 + V_2) = V_1 + V_2 \times 0.25$

$0.75\,V_1 + 0.75\,V_2 = V_1 + V_2 \times 0.25$

$0.5\,V_2 = 0.25\,V_1$

$\frac{V_1}{V_2} = 2$ (All options are possible)

7. No. of equivalents of $S_2O_3^{2-} = 20 \times 0.3 \times 10^{-3}$

$= 6 \times 10^{-3}$ eq.

No. of equivalents of I_2 produced $= 6 \times 10^{-3}$ eq.

No. of equivalents of $H_2O_2 = 6 \times 10^{-3}$ eq.

Wt of H_2O_2 present in 25 ml of solution $= 6 \times 10^{-3} \times 17$

($\because$ Eq. wt $H_2O_2 = 17$) $= 0.102$ g

Statement **(A)** is correct.

Wt of H_2O_2 in 1L of the solution $= \frac{0.102 \times 1000}{25}$

$= 4.08$ g

Statement **(C)** is wrong.

$\therefore$ molarity of H_2O_2 solution $= \frac{4.08}{34} = 0.12$ M

8.

	3A	+	2B	$\longrightarrow$	A_3B_2
initial mole	3		3		0
final mole	0		3–2		1

	A_3B_2	+	2C	$\longrightarrow$	$A_3B_2C_2$
initial mole	1		1		0
final mole	$1 - \frac{1}{2}$		0		$\frac{1}{2}$

10. **(A)** Molarity of second solution is $= \frac{10 \times d \times x}{M} = 1$ M

(B) Volume = 100 + 100 = 200 ml

(D) Mass of $H_2SO_4 = \frac{200 \times 1}{1000} \times 98 = 19.6$ gm.

12. **(A)**, **(C)** and **(D)** Explanation :

$4Ag + 8KCN + O_2 + 2H_2O \longrightarrow 4K[Ag(CN)_2] + 4KOH$

$\Rightarrow$ 4 × 108 g of Ag reacts with 8 × 65 g of KCN

100 g of Ag reacts with

$$\frac{8 \times 65}{4 \times 108} \times 100 = 120$$

Hence ,, to dissolve 100 g of Ag , the amount of KCN required = 120 g

Hence , statement **(A)** is correct.

$\Rightarrow$ 4 × 108 g of Ag require 32 g of O_2

1 g of Ag require $\frac{32}{4 \times 108} = 0.0740$ g

$\Rightarrow$ 100 g of Ag require = 7.4 g

Hence, choice **(C)** is correct.

Hence, volume of O_2 required $= \frac{7.4}{32} \times 22.4 = 5.20$ litre

Hence, **(A)**, **(C)**, **(D)** are correct while **(B)** is incorrect.

14. Let W gas of SO_2 and O_2 are taken

moles of $SO_2 = \frac{W}{64}$; moles of $O_2 = \frac{W}{32}$;

molecules of $O_2 = \frac{WN_A}{32}$; molecules of $SO_2 = \frac{WN_A}{64}$

hence molecules of O_2 > molecules of SO_2

since moles of O_2 > moles of SO_2 , hence volume of O_2 at STP > volume of SO_2 at STP.

15.

	2P	+	Q	$\longrightarrow$	R
initial mole	12		8		0
final mole	0		8 – 6		6

$\therefore$ moles of R formed = 6

% of Q left behind = $\frac{2}{8} \times 100 = 25\%$

16. m = 0.2 mole / kg
weight of solvent = 1000 gram
weight of solute = 0.2 × 98 = 19.6 gram
Total weight of solution = 1000 + 19.6 = 1019.6 ml.

17. $H_2 + S + 2O_2 \rightarrow H_2SO_4$

$n_{H_2} = \frac{5.6}{22.4} = \frac{1}{4}$ $\quad n_s = \frac{8}{32} = \frac{1}{4}$ $\quad n_{O_2} = \frac{1}{2}$

As all reactants are in stoichiometric ratios, none will be left behind.

Hence $\frac{1}{4}$ mole of H_2SO_4 is formed.

18. **(A)** and **(B)** Explanation : 30% of molecule dissociated $N_2 \rightarrow 2N$

Amount of N_2 left = $\frac{2.8}{28} \times \frac{70}{100} = 0.1 \times 0.7 = 0.07$ (in moles)

No. of moles of N atoms formed = $2 \times \frac{30}{100} \times 0.1 = 0.06$

(A) Total no . of moles = 0.07 + 0.06 = 0.13
(B) Total number of molecules = $0.07 \times 6.023 \times 10^{23}$
= 4.2×10^{22} molecule
= 0.421×10^{23}

$\because$ We have to calculate molecule of nitrogen not atoms.

19. **(A)** and **(B)** Explanation : M. Wt. = 0.001293 × 22400 = 28.96
M.Wt. = d × volume of 1 mole of gas at STP

$$V.D = \frac{28.96}{2} = 14.48$$

So **(A)** and **(B)** are correct answer.

20. **(A)**, **(B)** and **(D)**. Explanation : **(A)** 1.0 mol of O_2 = 32 g
(B) 6.02×10^{23} molecules of SO_2 = 64 g , 3.01×10^{23} molecules of SO_2 = 32 g
(C) 0.5 mole of CO_2 = 0.5 × 44 = 22 g is not correct answer.
(D) 1 g atom of sulphur = 32 g

Part # II : Assertion & Reason

7. Molality & mole fraction are mass dependent terms while molarity is volume dependent term.

9. Due to temperature change volume get changed. Hence concentration units dependent on volume get changed.

12. meq of NaOH = N × V = 0.1 × 200 = 20 ; meq of H_2SO_4 = N × V = 0.1 × 200 = 20.
$\therefore$ Resulting solution is neutral.

EXERCISE - 3

Part # I : Matrix Match Type

5. **(A)** Molarity of cation = $\frac{M_1V_1 + M_2V_2}{V_1 + V_2}$

$$= \frac{0.2 \times 100 + 0.1 \times 400}{500} = \frac{0.6}{5} = 0.12$$

Molarity of Cl^- = $\frac{3(0.2)100 + 0.1 \times 400}{500}$

$$= \frac{0.6 + 0.4}{5} = 0.2$$

(B) Molarity of cation = $\frac{50 \times 0.4 + 0}{100} = 0.2$

Molarity of Cl^- = $\frac{0.4 \times 50 + 0}{100} = 0.2$

(C) Molarity of cation = $\frac{2(0.2)30 + 0}{100} = 0.12$

Molarity of SO_4^{2-} = $\frac{30 \times 0.2}{100} = 0.06$

(D) 24.5 gm H_2SO_4 in 100 ml solution

$$\text{Molarity} = \frac{\frac{25.4}{98}}{0.1} = 2.5$$

$\therefore$ Concentration of cation = 2 × 2.5 M
Concentration of SO_4^{2-} = 2.5 M.

6. **(A)** Eq. of base = $N \times V_L$ = 0.5 × 0.2 = 0.1

Eq. of H_2SO_3 = $\frac{4.1}{82} \times 2 = 0.1$

Millimoles of O-atoms = (Millimoles of H_2SO_3) × 3

$$= \left(\frac{4.1}{82} \times 1000\right) \times 3 = 150$$

S is in + 4 oxidation state (Max = + 6)
It may react with an oxidising agent and S may get oxidised from + 4 to + 6.

(B) Eq of H_3PO_4 = $\frac{4.9}{98} \times 3 = 0.15$

Millimoles of O-atoms = (Millimoles of H_3PO_4) × 4

$$= \left(\frac{4.9}{98}\times 1000\right)\times 4 = 200$$

P is in + 5 oxidation state (Max = +5)

It will not react with an oxidising agent as P is already in max O.S.

(C) Eq of $H_2C_2O_4 = \frac{4.5}{90}\times 2 = 0.1$.

Millimoles of O-atoms = (Millimoles of $H_2C_2O_4$) × 4

$$= \left(\frac{4.5}{90}\times 1000\right)\times 4 = 200$$

C is in + 3 oxidation state (Max = + 4).

It may react with an oxidising agent and C may get oxidised from + 3 to + 4.

(D) Na_2CO_3 is itself basic in nature, so it will not react with a base.

Millimoles of O-atoms = (Millimoles of Na_2CO_3) × 3

$$= \left(\frac{5.3}{106}\times 1000\right)\times 3 = 150.$$

C is in + 4 oxidation state (Max = + 4).

It will not react with an oxidising agent as C is already in max oxidation state.

7. **(A)** Eq of Sn^{2+} = Moles × v.f. = 3.5 × 2 = 7.

Eq of MnO_4^- = Moles × v.f. = 1.2 × 5 = 6.

Since MnO_4^- (O.A) is the LR, so the amount of oxidant available decides the number of electron transfer.

Also, electron involved per mole of OA (5) > electron involved per mole of RA (2).

(B) Eq of $H_2C_2O_4$ = Moles × v.f. = 8.4 × 2 = 16.8.

Eq of MnO_4^- = Moles × v.f. = 3.6 × 5 = 18.

Since $H_2C_2O_4$ (RA) is the LR, so the amount of reductant available decides the number of electron transfer.

Also, electron involved per mole of OA (5) > electron per mole of RA (2).

(C) Eq of $S_2O_3^{2-}$ = Moles × v.f. = 7.2 × 1 = 7.2.

Eq of I_2 = Moles × v.f. = 3.6 × 2 = 7.2.

Since $S_2O_3^{2-}$ (RA) and I_2 (OA) both completely get consumed, so both the amount of reductant and oxidant decides the number of electron transfer.

Also, electron involved per mole of OA (2) > electron involved per mole of RA (1).

(D) Eq of Fe^{2+} = Moles × v.f. = 9.2 × 1 = 9.2.

Eq of $Cr_2O_7^{2-}$ = Moles × v.f. = 1.6 × 6 = 9.6.

Since Fe^{2+} (RA) is the LR, so the amount of reductant available decides the number of electron transfer.

Also, electron involved per mole of OA (6) > electron involved per mole RA (1).

Part # II : Comprehension

Comprehension # 1 :

1. 1 L of H_2O_2(aq) provide 11.2 L of O_2 at STP

moles of $O_2 = \frac{11.2}{22.4} = 0.5$

$n_{H_2O_2}$ required 0.5 × 2

$$M_{H_2O_2} = \frac{n_{H_2O_2}}{V_{solution}} = 1M$$

2. Strength in percentage mean how many g H_2O_2 present per 100 mL

∵ M ⇒ 1 and mol. wt. of H_2O_2 = 34

∴ 34 H_2O_2 present per litre of solution or 3.4 H_2O_2 present per 100 mL of solution.

3. m.eq. of H_2O_2 = m.eq. of $KMnO_4$

20 × N = 0.05 × 5 × 80 ⇒ N = 1

$$N = \frac{\text{volume strength of } H_2O_2}{5.6}$$

⇒ volume strength of H_2O_2 = 5.6

4. m-eq. of $Ba(MnO_4)_2$ = m. eq. of H_2O_2

$$\left(\because M = \frac{33.6}{11.2} \Rightarrow 3\right)$$

$$\frac{w}{375}\times 10\times 1000 = 3\times 125\times 2\ ;\ w = 28.125$$

$$\%\ \text{purity} = \frac{w}{40}\times 100 = \frac{28.125}{40}\times 100 = 70.31$$

Comprehension # 2 :

1. $H_2O + SO_3 \longrightarrow H_2SO_4$;

18 g water combines with 80 g SO_3

∴ 4.5 g of H_2O combines with 20 g of SO_3

∴ 100 g of oleum contains 20 g of SO_3 or 20% free SO_3

2. Initial moles of free SO_3 present in oleum $= \frac{12}{18} = \frac{2}{3}$ moles

$=$ moles of water that can combines with SO_3 combined with water $= \frac{9}{18} = \frac{1}{2}$ mole

$\therefore$ moles of free SO_3 remains $= \frac{2}{3} - \frac{1}{2} = \frac{1}{6}$ mole

$\therefore$ volume of free SO_3 at STP $= \frac{1}{6} \times 22.4 = 3.73L$

3. $Na_2CO_3 + H_2SO_4 \longrightarrow Na_2SO_4 + H_2O + CO_2$

moles of CO_2 formed = moles of Na_2CO_3 reacted $= \frac{5.3}{106}$

$= 0.05$

volume of CO_2 formed at 1 atm pressure and 300 K $= 0.05 \times 24.63 = 1.23$ L

4. eq. of H_2SO_4 + eq. of SO_3 = eq. of NaOH

$$\frac{x}{98} \times 2 + \frac{(1-x) \times 2}{80} = 54 \times 0.4 \times 10^{-3}$$

$$\% \text{ of free } SO_3 = \frac{1 - 0.74}{1} \times 100 = 26\%$$

Comprehension # 3 :

1. n-factor = 5 × 2 = 10

2. H_3PO_2 is a monobasic acid

$\therefore$ n-factor = 1

3. n-factor $= \left(3 - \frac{2}{0.95}\right) \times 0.95 = 0.8075$

$\therefore$ eq. wt. $= \frac{M}{0.8075}$

4. n-factor of VO = 3; Fe_2O_3 = 1 × 2 = 2 ;

$\therefore$ x and y are 2 and 3

Comprehension # 4 :

1. Let V mL of H_2O_2 is taken

Normality $= \frac{20}{5.6}$

meq of H_2O_2 = meq of I_2 liberated = meq of $Na_2S_2O_3$

$$V \times \frac{20}{5.6} = 200 \times 0.1 \quad \Rightarrow \quad V = 5.6 \text{ mL}$$

2. meq of H_2O_2 = meq of $K_2Cr_2O_7$

$$5.6 \times \frac{20}{5.6} = \frac{x}{294} \times 6 \times 1000$$

$$x = \frac{20 \times 294}{6 \times 1000} = 0.98$$

$\therefore$ Mass of $K_2Cr_2O_7$ needed
x = 0.98 g

3. 1000 mL $H_2O_2 \longrightarrow$ liberates 20 L O_2 at STP

$\therefore$ 1 mL $H_2O_2 \longrightarrow \frac{20}{1000} \times 1000$ mL O_2

$\therefore$ 5.6 $\longrightarrow$ 20 × 5.6 mL of O_2 = 112 mL of O_2

Comprehension # 5 :

2. $Fe_{0.9}O + K_2Cr_2O_7 \longrightarrow Fe^{+3} + Cr^{+3}$

n factor of $Fe_{0.9}O = 0.9\left(3 - \frac{2}{0.9}\right) = 0.7$

$\therefore$ Eq mass $= \frac{M}{0.7} = \frac{10M}{7}$

EXERCISE - 4

Subjective Type

1. $KMnO_4 + X^{+n} \longrightarrow XO_3^- + Mn^{+2}$
1.61×10^{-3} mole 2.63×10^{-3} mole
Eq. of $KMnO_4$ = Eq. of X^{+n}
$1.61 \times 10^{-3} \times 5 = 2.63 \times 10^{-3} \times (5 - n)$

$n = 2 \quad \Rightarrow \quad 56 = \frac{M}{2} + 35.5 \qquad M = 41$

2. **(i)** 4.0, **(ii)** 0.0040, **(iii)** 0.224, **(iv)** 56.00%, **(v)** 0.02M, **(vi)** 0.0008 mol

3. $CuS + Cu_2S + KMnO_4 \longrightarrow Mn^{+2} + Cu^{+2} + SO_2$
6   8   5
Eq. wt. of CuS = $M_1/6$
Eq. wt. of Cu_2S = $M_2/8$
Eq. wt. of $KMnO_4$ = $M_3/5$

4. **(a)** +3 **(b)** +5 **(c)** +6 **(d)** +2 **(e)** 8/3 or (2 and 3)
(f) +3 **(g)** +2 **(h)** +2 **(i)** 200/93 = 2.15

5. **(a)** $S_4O_6^{2-}(aq) + 6Al(s) + 20H^+ \longrightarrow 4H_2S(aq) + 6Al^{3+}(aq) + 6H_2O$

(b) $6S_2O_3^{2-}(aq) + Cr_2O_7^{2-}(aq) + 14H^+ \longrightarrow 3S_4O_6^{2-}(aq) + 2Cr^{3+}(aq) + 7H_2O$

(c) $14ClO_3^-(aq) + 3As_2S_3(s) + 18H_2O \longrightarrow 14Cl^-(aq) + 6H_2AsO_4^-(aq) + 9HSO_4^-(aq) + 15H^+$

(d) $7IO_3^-(aq) + 6Re(s) + 3H_2O \longrightarrow 6ReO_4^-(aq) + 7I^-(aq) + 6H^+$

(e) $30HSO_4^-(aq) + As_4(s) + 10Pb_3O_4(s) + 26H^+ \longrightarrow 30PbSO_4(s) + 4H_2AsO_4^-(aq) + 24H_2O$

(f) $3HNO_2(aq) \longrightarrow HNO_3 + 2NO(g) + H_2O$

6. **(a)** $3C_4H_4O_6^{2-}(aq) + 5ClO_3^-(aq) + 18OH^- \longrightarrow 12CO_3^{2-}(aq) + 5Cl^-(aq) + 15H_2O$

(b) $11Al(s) + 3BiONO_3(s) + 21H_2O + 11OH^- \longrightarrow 3Bi(s) + 3NH_3(aq) + 11Al(OH)_4^-(aq)$

(c) $4H_2O_2(aq) + Cl_2O_7(aq) + 2OH^- \longrightarrow 2ClO_2^-(aq) + 4O_2(g) + 5H_2O$

(d) $Tl_2O_3(s) + 4NH_2OH(aq) \longrightarrow 2TlOH(s) + 2N_2(g) + 5H_2O$

(e) $Cu(NH_3)_4^{2+}(aq) + S_2O_4^{2-}(aq) + 4OH^- \longrightarrow 2SO_3^{2-}(aq) + Cu(s) + 4NH_3(aq) + 2H_2O$

(f) $3Mn(OH)_2(s) + 2MnO_4^-(aq) \longrightarrow 5MnO_2(s) + 2H_2O + 2OH^-$

7. 1 : 7 : 4

8. $N = \left(\frac{5\times 3}{250}\right) = 0.06$

n-factor = 2

$M = \frac{0.06}{2} = 0.03$

9. $H_2SO_4 + 2NH_3 \longrightarrow (NH_4)_2SO_4$

(30 – 25) Meq.   25 Meq.

(30 × 0.2) Meq.

$V_{NH_3} = 25 \times 10^{-3} \times 22400 = 537.6$ ml

10. $CaCO_3 + 2HCl \longrightarrow CaCl_2 + CO_2 + H_2O$

0.1 mole 0.25

–   0.05

$HCl + KOH \longrightarrow KCl + H_2O$

0.05   2 × V

$V = \frac{0.05}{2}L = 25$ mL

11. $2NaOH + NaH_2PO_4 \longrightarrow Na_3PO_4 + 2H_2O$

1 × V $\frac{12}{120} = 0.1$ Mole

V × 1 = 0.1 × 2

V = 0.2 lit = 200 ml.

12. $CaCO_3 + 2HCl \longrightarrow CaCl_2 + H_2O + CO_2$

x mole   2x

$MgCO_3 + 2HCl \longrightarrow MgCl_2 + H_2O + CO_2$

y mole   2y

$2x+2y = \frac{(50\times 0.8 - 16\times 0.25)}{1000} \Rightarrow x+y=0.018$ ...(1)

$x \times 100 + y \times 84 = 1.64$ ...(2)

$\% CaCO_3 = \frac{x\times 100}{1.64}\times 100 = 48.78\%$

$\% MCO_3 = 51.22\%$

13. $n_1 \times 56 + n_2 \times 74 = 4.2$ ....(1)

$n_1 \times 1 + n_2 \times 2 = 0.1$ ....(2)

% of KOH $= \frac{n_1 \times 56}{4.2} \times 100 = 35\%$

$Ca(OH)_2 = 65\%$

14. n × 106 + n × 84 = 1 ....(1)

n × 2 + n × 1 = 0.1 × V × 1000 ....(2)

V = 157.89 ml

15. Eq. of H_2SO_4 = Eq. of NaOH

n × 2 = 0.0267 × 0.4

n = [0.0267 × 0.2] mole of H_2SO_4 total.

[N × 98 – 0.5] = mass of H_2O added

mole of H_2O = mole of SO_3

% of SO_3 = 20.72 %

16. M Eq. of $CaCO_3$ = M Eq. of HCl – M Eq. of NaOH

$\frac{w}{(100/2)} \times 1000 = 10 \times 4 - 4 \times 18.75 \times 0.2 = 25$

w = 1.25 gm

$\% CaCO_3 = \left(\frac{1.25}{1.5}\right) \times 100 = 83.33\%$

17. $Na_2CO_3 + NaHCO_3$

x   g milli mole

x = 4 × 1 ....(1)

2x + 4 = 10.5

y = 2.5,   x = 4

Na_2CO_3 = 4 × 106 mg = 0.424 mg

$NaHCO_3$ = 0.21 gm

18. Na_2CO_3 NaOH

x   y   m mole

x + y = 19.5 × 0.995 = 19.4025 ... (1)

2x + y = 25.0.995 = 24.875 ... (2)

x = 5.4775 m mole

$Na_2CO_3 = \frac{5.4725\times 106}{25} = 23.2$ gm/lit.

NaOH = 22.28 gm/lit.

19. $Ce^{+4} + Sn^{+2} \longrightarrow Sn^{+4} + Ce^{+2}$
40.05 + 20 ml
1 M   1 M
Meq. of Ce^{+4} = Meq. Sn^{+2}
$40.05 \times 1 \times (4 - n) = 20 \times 1 \times 2$
$$(4 - n) = \frac{20 \times 2}{40.05} \simeq 1$$
n = 3

20. $\overset{+4}{SeO_2} + CrSO_4 \longrightarrow Cr^{+3} + Se^{+2}$
Meq. of SeO_2 = Meq. of $CrSO_4$
$12.53 \times 0.05093 \times (4 - n) = 25.52 \times .1 \times 1$
$4 - n \simeq 4 \Rightarrow n = 0$

21. $K_2C_2O_4.3H_2C_2O_4.4H_2O + MnO_4^- \rightarrow Mn^{+2} + \overset{+4}{CO_2}$
V ml, 0.1 M
$$\left[\frac{1}{508}\right] \times 8 \times 1000 = V \times 0.1 \times 5$$
$\Rightarrow V = 31.68$ ml

22. NaOH + Na_2CO_3
x   y   m mole
$$x + y = \frac{1}{10} \times 17.5 = 1.75 \quad \text{... (1)}$$
y = 0.25 ... (2)   x = 1.5, y = 0.25 m mole
$$\left.\begin{array}{l} NaOH = \dfrac{1.5 \times 40}{1000}\text{ gm} = 0.06\text{ gm} \\ Na_2CO_3 = \dfrac{0.25 \times 106}{1000} = 0.0265\text{ gm} \end{array}\right\}$$

23. Na_2CO_3 $NaHCO_3$
x   y   Meq.
$x = 2 \times 0.2 = 0.4$ ... (1)
$y + x = 2.5 \times 0.4$ ... (2)
= 1
y = 0.6   x = 0.4

24. Same as 19.

25. $H_2O_2 + KMnO_4 \longrightarrow Mn^{+2} + O_2$
$$\frac{1 \times x / 100}{(34/2)} \times 1000 = x \times N$$
$$N = \frac{20}{34} = 0.5882$$

26. Sn + $K_2Cr_2O_7 \longrightarrow SnCl_4 + Cr^{+3}$
1   0.1 N   V ml
$$\left(\frac{1}{M/4}\right) \times 1000 = 0.1 \times V \Rightarrow V = 337\text{ ml}$$

27. $$\text{Meq. of Cu} = \frac{1000}{20}[20 \times 0.0327] = 32.7$$
$$\frac{w}{(63.5/1)} \times 1000 = 32.7 \Rightarrow w = 2.07645\text{ gm}$$
$$\%\text{ Cu} = \frac{2.07645}{5} \times 100 = 41.53\%$$

28. Meq. of Na_2CO_3 = Meq of HCl
$$\frac{w}{106/2} \times 1000 = 50 \times 0.1 - 10 \times 0.16$$
$$\%\text{ purity} = \frac{w}{1} \times 100 = 90.1\%$$

29. x gm substance
0.6 x gm NaCl, 0.37 x gm KCl
$$\left(\frac{0.6x}{58.5} + \frac{0.37x}{74.5}\right) \times 1000 = 25 \times 0.1 - 5.5 \times 0.1$$
x = 0.1281 gm

30. $12 = 5.6 \times N \Rightarrow N = 2.1428.57$
$700 \times 2.1428 = 1000 \times N$
$N_1 = 1.5 = M_1 \times 2$
$M_1 = 0.75$ $\Rightarrow$ gm/lit $= 0.75 \times 34 = 25.5$
Volume strength of final solution $= 5.6 \times 1.5 = 8.4$

31. Meq. of Fe = Meq. of $K_2Cr_2O_7$
$$\frac{0.84 \times x / 100}{56} \times 1000 = x \times N$$
N = 0.15

32. $H_2C_2O_4.2H_2O + KHC_2O_4.H_2O + NaOH \rightarrow$ product
x mole   y mole   18.9ml, 0.5 N
$H_2C_2O_4.2H_2O + KHC_2O_4.H_2O + KMnO_4 \rightarrow Mn^{+2} + CO_2$
$\frac{x}{4}$ mol $\frac{y}{4}$ mol   21.55ml, 0.25N
$$x \times 2 + y \times 1 = \frac{18.9 \times 0.5}{1000} \quad \text{.... (1)}$$
$$\left(\frac{x}{4} + \frac{y}{4}\right) \times 2 \times 1000 = 21.55 \times 0.25 \quad \text{....(2)}$$
$\% H_2C_2O_4.2H_2O = 14.36\%$
$\% KH_2C_2O_4.H_2O = 81.7\%$

33. Meq. of $Ca(OH)_2$ = Meq of HCl
$$\left(\frac{w}{74/2}\right) \times 1000 = (50 \times 0.5 - 0.3 \times 20)$$
$$\%\ Ca(OH)_2 = \frac{w}{50} \times 100 = 1.406$$

34. $50 \times N = 20 \times 0.1$
$N = 0.04 = M \times 2$
$M = 0.02 \Rightarrow gm/\ell = 0.02 \times 34$
$gm/\ell = 0.68$

35. $\frac{5}{100\times10^3}\times10^6 = 41.66$ ppm

36. $\frac{\left(\frac{1}{111}+\frac{1}{120}\right)\times10^{-3}\times100}{1000}\times10^6 = 1.734$ ppm

37. $100\text{ ml} \longrightarrow 1.62\text{ mg}\quad Ca(HCO_3)_2$
$60\times10^3\text{ ml}\longrightarrow \frac{1.62}{100}\times60\times10^3 = 972\text{ mg}$
$Ca(OH)_2 + Ca(HCO_3)_2 \longrightarrow 2\,CaCO_3 + 2\,H_2O$
$\frac{w}{74} = \left[\frac{0.972}{162}\right]$
$w = \left(\frac{0.972}{162}\right)\times 74 = 0.444\text{ gm}$

38. Bleaching powder + Mohr salt excess $\longrightarrow$ product.
Mohr salt + $KMnO_4 \rightarrow$ product

39. Meq. of SeO_3^{-2} = Meq. of BrO_3^- used
$\frac{w}{M}\times2\times1000 = \left[20\times\frac{1}{60}\times5 - 5\times\frac{1}{25}\times2\right]$
$w = 0.084\text{ gm} = 84\text{ mg}$

40. $\frac{0.001\times100}{1000}\times10^6 = 100$ ppm

41. Meq. of H_2O_2 = Meq. of $KMnO_4$
$\frac{x}{34/2} = \frac{0.632}{158/5}$
% Purity $= \frac{x}{0.4}\times100 = 85\%$

42. $5\times x = 5.5\times N \qquad \frac{28}{5.5} = 5.6\times N$
$5\times x = 5.5\times0.909 \qquad N = 0.909$
$x = 1$

43. $\frac{1\times0.552}{M}\times1000 = \frac{100}{25}\times17\times0.0167\times n$
$n = 6$ = No. of electron taken up by oxidant.

44. First HCl will react with KIO_3 to from I_2 & Cl_2 then this Cl_2 produced will again react with KI to form I_2.
Let initially x moles of KIO_3 were mixed with y moles of HCl then

$$2IO_3^- + 10Cl^- \longrightarrow I_2 + 5Cl_2$$
x y
– $\frac{y}{10}$ $\frac{y}{2}$

$$Cl_2 + 2KI \longrightarrow I_2 + 2KCl$$
$\frac{y}{2}$
– $\frac{y}{2}$

Total moles of I_2 formed $= \frac{y}{10}+\frac{y}{2} = \frac{3y}{5}$

so $\frac{3y}{5} = \frac{0.021\times24\times10^{-3}}{2} \Rightarrow y = 0.00042$ mole

so concentration of HCl $= \frac{0.00042}{0.025} = 0.0168\text{ M} = 0.0168\text{ N}$

moles of KIO_3 consumed $= \frac{0.00042}{5}$

volume of KIO_3 consumed $= \frac{0.00042\times5}{5} = 0.00042$ L
$= 0.42$ mL

45. $As_2O_3 + 6HCl \longrightarrow 2AsCl_3 + 3H_2O$
$AsCl_3 + 2H_2O \longrightarrow HAsO_2 + 3H^+ + 3Cl^-$
gram equivalent of I_2 = gram Eq. of $HAsO_2$
= gram Eq. of $AsCl_3$
= gram Eq. of As_2O_3
gram equivalent of $As_2O_3 = 2\times0.04134\times23.04\times10^{-3}$
$= 0.9524\times10^{-3}\times2$
gram equivalent of $KMnO_4 = 0.9524\times10^{-3}\times2$
Let amount of $KMnO_4$ used = w g then
$\frac{w\times5}{158.5} = 0.9524\times10^{-3}\times2$
$w = 0.06$ g

46. $4OH^- + 2H_2O + SO_2 \longrightarrow SO_4^{2-} + 4H_2O + 2e^-$
$4OH^- + SO_2 \longrightarrow SO_4^{2-} + 2H_2O + 2e^-$ ...(1)
$2H_2O + H_2O_2 + 2e^- \longrightarrow 2H_2O + 2OH^-$
$H_2O_2 + 2e^- \longrightarrow 2OH^-$ ...(2)
Eq. (1) + (2)
$2OH^- + H_2O_2 + SO_2 \longrightarrow SO_4^{2-} + 2H_2O$ ...(3)

∵	NaOH	+ HCl ⟶	NaCl	+ H_2O
Meq.	30×0.04		0.024	$\times$ 22.48
	1.2		~	0.53952
	0.66048×10^{-3}		–	

From equation (3)

$2OH^- + H_2O_2 + SO_2 \longrightarrow SO_4^{2-} + 2H_2O$

0.66048×10^{-3} 0.33024×10^{-3}

$\therefore$ moles of $SO_2 = 0.33024 \times 10^{-3}$

wt. $= 0.33024 \times 10^{-3} \times 32 = 10.5676\times10^{-3}$

% of S sample $= \dfrac{10.5676\times10^{-3}}{0.6}\times100 = 1.76\%$

47. meq. of Hypo = 5 = meq. of I_2

moles of I_2 = 2.5 m moles

$2CuSO_4 + 4KI \longrightarrow Cu_2I_2 + 2K_2SO_4 + I_2$

from reaction moles of $CuSO_4$ = 2.5 × 2 = 5 m moles

M_w of hydrated $CuSO_4$

= 159.5 + 18x

so $\dfrac{1.2475}{159.5+18x} = 5 \times 10^{-3}$ x = 5.

48. meq. of Hypo = $100 \times \dfrac{1}{10}$ = 10 = meq. of I_2

meq of ClO_3^- = 10

m moles of ClO_3^- = 2

$6H_2O + 6Cl_2 \longrightarrow 10Cl^- + 2ClO_3 + 12H^+$

2 m moles

so moles of Cl_2 = 6 m moles

$6e^- + 14H^+ + Cr_2O_7^{-2} \longrightarrow 2Cr^{+3} + 7H_2O$

$(2Cl^- \longrightarrow Cl_2 + 2e^-)\ 3$

$14H^+ + Cr_2O_7^{-2} + 6Cl^- \longrightarrow 3Cl_2 + 2Cr^{+3} + 7H_2O$

6 m moles

m moles of $Cr_2O_7^{-2}$ = 2 m moles

wt. of $Cr_2O_7^{-2} = 2 \times 10^{-3} \times 294 = 0.588$ g

% purity = 58.8 %

49. Let $H_2C_2O_4 . 2H_2O \rightarrow$ x g in 100 mL

On reaction with NaOH with phenolphthalein

g Eq. of acid in 50 mL $= \dfrac{x\times2}{2\times126}$

g Eq. of NaOH $= \dfrac{1}{10}\times0.11905$

so $\dfrac{x\times2}{2\times126} = \dfrac{0.11905}{10} \Rightarrow x = 1.5$ g

so mass of $Na_2C_2O_4$ = 2.5 – 1.5 = 1 g

Now, in 0.5g of same mixture

$H_2C_2O_4 . 2H_2O \longrightarrow 0.3$ g

$Na_2C_2O_4 \longrightarrow 0.2$ g

g Eq. of $H_2C_2O_4.2H_2O$

$= \dfrac{0.3\times2}{126}$

g Eq. of $Na_2C_2O_4 = \dfrac{0.2\times2}{134}$

g Eq. of $KMnO_4 = \dfrac{V}{10}\times10^{-3}$

so $\dfrac{0.3\times2}{126} + \dfrac{0.2\times2}{134} = \dfrac{V\times10^{-3}}{10}$ V = 77.46 mL

50. $(Mn^{2+} \longrightarrow Mn^{3+} + e^-)$ ... (1)

$4e^- + 8H^+ + MnO_4^- \rightarrow Mn^{3+} + 4H_2O$ ... (2)

equation (1) × 4 + equation (2)

$8H^+ + 4Mn^{2+} + MnO_4^- \longrightarrow 4Mn^{3+} + Mn^{3+} + 4H_2O$

or $8H^+ + 4Mn^{2+} + MnO_4^- \longrightarrow 5Mn^{3+} + 4H_2O$ ...(1)

$2e^- + 8H^+ + Mn_3O_4 \longrightarrow 3Mn^{2+} + 4H_2O$ ...(2)

from equation (1) milli equivalent of MnO_4^- = N×V

= M × V.f. × V = 31.1 × 11.7 × 5 = 0.72774

milli equivalent of Mn^{2+} = milli equivalent of MnO_4^- × 4

= 0.72774 × 4 = 2.91096

from equation (3) milli eq. of $Mn_3O_4 = \dfrac{1}{3}$ milli equivalent of Mn^{2+}

$= \dfrac{1}{3}\times2.91096 = 0.97032$

$\therefore$ equivalent of $Mn_3O_4 = 0.97032 \times 10^{-3}$

$\dfrac{W}{229} = 0.97 \times 10^{-3}$

$W = 222.20 \times 10^{-3}$

% of Mn_3O_4 in the sample $= \dfrac{222.20}{0.545}\times10^{-3}\times100 = 40.77\%$

51. $H_2S + SO_2$

x y

$S^{-2} \longrightarrow SO_4^{2-}$ (n -factor = 6)

for H_2S $\dfrac{x}{34}\times6 = 0.534975\times10^{-3}$

$= (20 \times 0.0066\times 6 - 7.45 \times 0.0345) \times 10^{-3}$

$x = 3.031525 \times 10^{-3}$

$SO_2 \longrightarrow SO_4^{2-}$ (n -factor = 2)

for SO_2 $\dfrac{y}{64}\times2$

$\dfrac{2y}{64} = (25 \times 0.396 - 12.44 \times 0.0345) \times 10^{-3}$

$\dfrac{2y}{64} = 0.56082\times10^{-3}$

y = 17.94624 g

concentration of H_2S

$= \dfrac{3.031525}{25}\times10^{-3} = 0.1212$mg

concentration of SO_2

$= \dfrac{17.94624}{25} = 0.7178$ mg SO_2/L

52. Let mass of $KClO_3 \rightarrow xg$

Let mass of $KCl \rightarrow yg$

$KClO_3 \longrightarrow x/122.5$ AgCl $= 108 + 35.5$

$KCl \longrightarrow y/74.5$ $= 143.5$

$6e^- + 6H^+ + ClO_3^- \longrightarrow Cl^- + 3H_2O$

$$\frac{x}{1225} + \frac{y}{745} = \frac{0.1435}{143.5} = 0.001 \quad \text{... (i)}$$

for complete oxidation of an oxidizing agent = reacted $FeSO_4$ solution – unreacted $FeSO_4$

$= N_1V_1 - N_2V_2$

$= 30 \times 0.6 - 37.5 \times 0.8$ N = 3 milli eq.

$$\frac{x}{1225} = \frac{0.003}{6} = 0.0005$$

put above value in eq. (i)

$$\frac{y}{745} = 0.0005 \quad \text{... (ii)}$$

moisture $= 1 - (1225+745) \times 0.0005 = 0.015g$

53 In presence of methyl orange, the whole NaOH and Na_2CO_3 are neutralized

⇒ meq of HCl = 16 × 0.25 = 4 = meq of ($NaOH + Na_2CO_3$) = meq. of NaOH original

⇒ Total meq of NaOH in original 1.0 g sample = 4 × 5 = 20

⇒ mass % of NaOH (original) $= \frac{20 \times 40 \times 100}{1000} = 80$

Now, let us assume that in 20 mL, x m mol of NaOH has got converted to Na_2CO_3

⇒ In 20 mL, m mol of NaOH = 4 – x

m mol of $Na_2CO_3 = \frac{x}{2}$

In 2nd titration, HCl used in titration of $NaOH + Na_2CO_3$ = 5 × 0.1 – 9 × 0.2 = 3.2

⇒ upto phenolphthalein end point, m mol of HCl required

$= 4 - x + \frac{x}{2} = 4 - \frac{x}{2} = 3.2$

⇒ x = 1.6

⇒ Total Na_2CO_3 formed $= \frac{x}{2} \times 5 = \frac{5x}{2} = 4$

m mol of NaOH left unreacted = 20 – 4 × 2 = 12

⇒ weight of 1.0 g of exposed sample

$$= 1 - \frac{8 \times 40}{1000} + \frac{4 \times (106 + 18)}{1000} = 1.176 \text{ g}$$

⇒ weight % of Na_2CO_3 in exposed sample

$$= \frac{4 \times 106}{1000 \times 1.176} \times 100 = 36.05\ \%$$

54. $BaCrO_4 \longrightarrow 0.0549$ g

$$Cr \rightarrow \frac{0.0549}{253} \times 52 \times 25 = 0.282 \text{ g}$$

$$\%\text{ of Cr} = 0.282 \times \frac{100}{10} = 2.82\%$$

$$Cr_2O_7^{-2} \longrightarrow \frac{0.282}{52 \times 2} = 0.002711 \text{ mole}$$

g Eq. of $MnO_4^- = 15.95 \times 10^{-3} \times 0.075 \times 25 - 0.002711 \times 6$
$= 0.01364$

$$\text{wt.} = 0.01364 \times \frac{158.5}{5} = 0.432388$$

$$\text{wt. of Mn} = \frac{0.01364}{5} \times 55 = 0.15 \text{ g}$$

$$\%\text{ of Mn} = 0.15 \times \frac{100}{10} = 1.5\%$$

55. $CH_3(CH_2)_nCOOH + O_2 \longrightarrow (n+2)CO_2 + H_2O$

a (n + 2)a

$CO_2 + 2NaOH \longrightarrow Na_2CO_3$

(n + 2)a b

– b – 2(n + 2)a (n + 2)a

solution has =

NaOH → b – 2(n + 2)a

Na_2CO_3 → (n + 2)a

On dividing in equal part moles get halfed.

Part - I :

$$\frac{b - 2(n+2)a}{2} + \frac{(n+2)a}{2} = 0.05 \quad \text{... (i)}$$

Part - II :

$$\frac{b - 2(n+2)a}{2} + 2 \times \frac{(n+2)a}{2} = 0.08 \quad \text{... (ii)}$$

(ii) – (i)

$$\frac{(n+2)a}{2} = 0.03$$

$(n+2)a = 0.06$ ... **(iii)**

and $\frac{1.16}{60+14n} = a$ ... **(iv)**

from equation **(iii)** & **(iv)**

$$\frac{1.16}{60+14n} = \frac{0.06}{(n+2)}$$

$19.33n + 38.66 = 60 + 14\,n$

$5.33n = 21.33 \Rightarrow n = 4$

from equation **(iii)**

$6a = 0.06$

$a = 0.01$

from equation **(i)**

$$\frac{b}{2} - 0.06 + 0.03 = 0.05$$

$$\frac{b}{2} = 0.08 \text{ moles of NaOH}$$

$b = 0.16$

mass $= 0.16 \times 40 = 6.4$ g

56. Total m mol of AgCl from 20 mL solution $= \frac{0.4305 \times 1000}{143.5} = 3$

m moles of AgCl from HCl = 0.8 $\Rightarrow$ m moles of AgCl from $CaCl_2 = 2.2$

$\Rightarrow$ 1.1 m mole of $CaCl_2$ was consumed for precipitation of oxalate from 20 mL solution.

Hence, total m mol of oxalic acid in 250 mL solution =

$$\frac{1.1}{20} \times 250 = 13.75$$

$$\text{m \% of oxalic acid} = \frac{13.75 \times 10^{-3} \times 90}{1.5} \times 100 = \mathbf{82.5}$$

EXERCISE - 5

Part # I : AIEEE/JEE-MAIN

1. $x + 4(0) - 2 = +1$

$x = 3$

2. Final product will be Cr_2O_3 in this oxidation state of Cr is +3

4. In the reaction

$$\overset{+4}{X}eF_4 + \overset{+1}{O_2}F_2 \longrightarrow \overset{+6}{X}eF_6 + O_2^0$$

Xenon undergoes oxidation while oxygen undergoes reduction.

5. (i) $[Fe^{+2}(CN)_6]^{4-} + H_2O_2^{-1} + 2H^+$

$\downarrow$

$[Fe^{+3}(CN)_6]^{3-} + 2H_2O^{-2}$

(ii) $[Fe^{+3}(CN)_6]^{3-} + H_2O_2^{-1} + 2OH^-$

$\downarrow$

$[Fe^{+2}(CN)_6]^{4-} + O_2^{0} + 2H_2O$

Part # II : IIT-JEE ADVANCED

2. **TIPS/Formulae**

The highest O.S. of an element is equal to the number of its valence electrons

(i) $[Fe(CN)_6]^{3-}$, O.N. of Fe = +3

$[Co(CN)_6]^{3-}$, O.N. Of Co = +3

(ii) CrO_2Cl_2, O.N. of Cr = +6,

(Highest O.S. of Cr)

$[MnO_4]^-$ O.N. of Mn = +7,

(Highest O.S. of Mn)

(iii) TiO_3, O.N. of Ti = +6,

MnO_2 O.N. of Mn = +4

(iv) $[Co(CN)_6]^{3-}$, O.N. of Co = +3

MnO3, O.N. of Mn = +6

9. **TIPS/formulae**

Use molarity equation to find volume of H_2SO_4 solutions.

$$\underset{\substack{63.5+12+48.98 \\ =123.5\,g}}{CuCO_3} + \underset{98\,g}{H_2SO_4} \longrightarrow CuSO_4 + H_2O + CO_2\uparrow$$

$\therefore$ For 123.5 gms of Cu(II) carbonate 98 g of H_2SO_4 are required. For 0.5 gms of Cu(II) carbonate weight of H_2SO_4

reqd. $= \frac{98 \times 0.5}{123.5}$ g $= 0.39676$ g H_2SO_4

Weight of required $H_2SO_4 = 0.39676$ g

Weight of solution in grams

$$= \frac{\text{mol. wt.} \times \text{Molarity} \times \text{Volume in mL}}{1000}$$

$$0.39676 = \frac{98 \times 0.5 \times V}{1000}$$

$$\text{or } V = \frac{0.39676 \times 1000}{90 \times 0.5} \text{ ml}$$

Volume of H_2SO_4 solution = 8.097 ml

11. $6I^- + ClO_3^- + 6H_2SO_4 \rightarrow Cl^- + 6HSO_4^- + 3I_2 + 3H_2O$

Hence, I^- is oxidised to I_2

Coefficient of $HSO_4^- = 6$

and H_2O is one of the product.

Hence **(A)**, **(B)**, **(D)**

12. $KIO_4 + H_2O_2 \rightarrow KIO_3 + H_2O + O_2$

H_2O_2 acts as a reductant

$2NH_2OH + H_2O_2 \rightarrow N_2 + 4H_2O$

H_2O_2 acts as a oxidant.1

13. $[Fe(H_2O)_2(C_2O_4)]^{-2} + MnO_4^-$

$$\downarrow \text{Acidic}$$

$$Mn^{+2}$$

$[fe(H_2O)_2(C_2O_4)_2]^{2-} + MnO_4^-$

$\longrightarrow Mn^{+2} + Fe^{+3} + CO_2$

If = 5 If = 5

$[Fe(H_2O)_2(C_2O_4)_2]^{2-} \longrightarrow Fe^{+3} + 4CO_2 + 2H_2O + 5e^-$

$8H^+ + MnO_4 + 5e^- \longrightarrow Mn^{+2} + 4H_2O$

$8H^+ + [Fe(H_2O)_2(C_2O_4)_2]^{2-} + MnO_4 \longrightarrow$

$Mn^{+2} + Fe^{+3} + 4CO_2 + 6H_2O$

$$\frac{1}{8} - \frac{d[H^+]}{dt} = \frac{d[MnO_4^-]}{dt} = 8$$