Stoichiometry: Answer

ANSWER KEY

Conceptual Questions

1. (B)	2. (A)	3. (D)	4. (A)	5. (C)	6. (A)
7. (B)	8. (D)	9. (A)	10. (C)		

SINGLE CORRECT CHOICE

Level I

1.	(B)	2.	(D)	3.	(C)	4.	(A)	5.	(A)
6.	(B)	7.	(D)	8.	(B)	9.	(A)	10.	(B)
11.	(B)	12.	(B)	13.	(B)	14.	(B)	15.	(B)
16.	(B)	17.	(C)	18.	(D)	19.	(D)	20.	(A)
21.	(C)	22.	(A)	23.	(B)	24.	(C)	25.	(A)

Level II

26.	(B)	27.	(B)	28.	(C)	29.	(B)	30.	(D)
31.	(A)	32.	(B)	33.	(B)	34.	(C)	35.	(C)
36.	(C)	37.	(C)	38.	(A)	39.	(B)	40.	(C)
41.	(C)	42.	(D)	43.	(D)	44.	(D)	45.	(A)
46.	(A)	47.	(A)	48.	(A)	49.	(D)	50.	(C)

Level III

51.	(D)	52.	(D)	53.	(D)	54.	(D)	55.	(D)
56.	(D)	57.	(B)	58.	(B)	59.	(A)	60.	(B)

MORE THAN ONE CORRECT CHOICE

Level I

1.	(A,B)	2.(A,C)	3.(A,B,C,D)	4.	(B,C,D)
5.	(A,C,B,D)	6.(A,B,D)	7.(A,B,D)	8.	(B,D)
9.	(B,C)	10.(BC)	11.(ABC)	12.	(B,D)
13.	(ABD)	14. (ACD)	15.(ABCD)	16.	(AB)
17.	(ABC)	18.(ABD)	19.(AC)	20.	(ABC)

Level II

21.	(CD)	22.	(ABC)	23.	(BCD)	24.	(ABD)	25.	(AC)
26.	(AC)	27.	(BC)	28.	(ABC)	29.	(BC)	30.	(ABC)

Level III

31.	(BCD)	32.	(ABC)	33.	(BCD)	34.	(BCD)	35.	(ABD)

Comprehension

Passage-1	1.	(A)	2.	(D)	3.	(A)
Passage 2	4.	(B)	5.	(A)	6.	(B)
Passage 3	7.	(A)	8.	(C)	9.	(B)
Passage 4	10.	(D)	11.	(B)	12.	(D)

Matrix Matching

1. A - r,t B - p,t, C - q, D - s
2. A - r, B - t, C - p, D - s
3. A - q,t, B - p, C - r,t, D - s,t

Assertion Reason

1.	(A)	2	(B)	3.	(A)	4.	(D)	5.	(C)
6.	(B)	7.	(B)	8.	(C)	9.	(A)	10.	(B)

Integer Type Questions

1. 4 2. 2 3. 4 4. 1 5. 2

6. 6 7. 1 8. 3 9. 10.

Subjective Type Questions

1. 241.66 ml; 2. 0.30625; 3. 42%, 26.5%, 31.5% 4. 1.2 X 10^{21} 5. 130.16. 1.847 g 7. 1.847 X 10^{-3}% 8. 14.09% 9. 0.1875% 10. 75.9, 16.2, 7.9 11. 82.32% 12. 18, 26 13. 13.64g/litre 14. 2.2415. 79%

Previous Year IIT-JEE Question

1.	(B)	2.	(B)	3.	(B)	4.	(A)	5.	(A)
6.	(D)	7.	(C)	8.	(D)	9.	(C)	10.	(A)
11.	(C)	12.	(D)	13.	(A)	14.	(A)	15.	(B)
16.	(D)								

HINT AND SOLUTIONS

CONCEPTUAL QUESTIONS

1. (B) 6 moles KHC_2O_4 = 2 moles $K_2Cr_2O_7$
   1 moles KHC_2O_4 º 2/6 = 1/3 moles of $K_2Cr_2O_7$
2. (A) In H_2SO_4, sulphur has + 6 oxidation state.
3. In carbonyl compounds metal has zero oxidation state.
4. (i) $\overset{+3}{C_2}O_4^{--} \rightarrow 2\overset{+4}{C}O_2$ oxidation

   (ii) $\overset{+6}{S}O_4^{--} \rightarrow \overset{+4}{S}O_3^{--}$ reduction

   (iii) $\overset{+6}{Mn}O_4^{--} \rightarrow \overset{+7}{Mn}O_4^{-}$ oxidation

   (iv) $Fe^{+3} \rightarrow Fe^{+2}$ reduction

5. $\overset{0}{Cl_2} + OH^- \rightarrow \overset{-1}{Cl^-} + \overset{+5}{Cl}O_3^- + H_2O$
6. (D) HNO_2 can get oxidized and reduced .
7. $3\overset{0}{Cl_2} + 6OH^- \rightarrow 5\overset{-1}{Cl^-} + \overset{+5}{Cl}O_3^- + 3H_2O$
8. $3\overset{0}{Br_2} + 6CO_3^{--} + 3H_2O \rightarrow 5\overset{-1}{Br^-} + \overset{+5}{Br}O_3^- + 6HCO_3^-$
9. $\overset{0}{Cl_2} + OH^- \rightarrow \overset{+1}{Cl}O^- + \overset{-1}{Cl^-} + H_2O$

   $\overset{+1}{Cu_2}O + 2H^+ \rightarrow \overset{0}{Cu} + \overset{+2}{Cu^{+2}} + H_2O$

   $2H\overset{+1}{Cu}Cl_2 \rightarrow \overset{0}{Cu} + \overset{+2}{Cu^{+2}} + 4Cl^- + 2H^+$

10. $2FeS_2 + \frac{11}{2}O_2 \rightarrow Fe_2O_3 + 4SO_2$

    ∵ two moles of FeS_2 losing $22e^-$
    ∵ n-factor of FeS_2 = 11

SINGLE CORRECT CHOICE

LEVEL - I

1. $CaCl_2 + 2AgNO_3 \rightarrow 2AgCl + Ca(NO_3)_2$

$$n = \frac{4.31}{143.5}$$

moles of $CaCl_2 = \frac{4.31}{143.5} \times \frac{1}{2} = 0.015$

2. $CaCO_3 + 2HCl \rightarrow CaCl_2 + CO_2 + H_2O$

$$n = \frac{25 \times 0.75}{1000}$$

Moles of $CaCO_3$ required = $\frac{25 \times 0.75}{1000} \times \frac{1}{2}$

Mass of $CaCO_3 = \frac{25 \times 0.75}{1000} \times \frac{1}{2} \times 100 = 0.9375gm$

3. $4HCl + MnO_2 \rightarrow MnCl_2 + Cl_2 + 2H_2O$

$$n = \frac{5}{87}$$

Moles of HCl reacted $= \frac{5}{87} \times 4 = 0.05747$

Mass of HCl $= 0.05747 \times 36.5 = 8.4gm$

4. I_2 + $2Cl_2$ ® ICl + ICl_3
254 gm 142 gm 1 : 1
25.4 gm 14.2 gm 0.1 : 0.1
but Cl_2 given is only 12.2 gm (less than normal ratio hence limiting reagent)
14.2 gm Cl_2 produces ® 0.1moles of each

12.2 gm ® = $\frac{0.1}{14.2} \times 12.2 = 0.086$ mole of each

hence molar ratio remain equal (1 : 1)

5. 2Fe + $3H_2O \longrightarrow Fe_2O_3 + 3H_2$
54 gm $H_2O(g)$ convert 112 gm Fe to it's oxide

189 m ® $\frac{112}{54} \times 18 = 37.3\,gm$

6. ClO^- + $Cr_2OX \longrightarrow Cl^-$ + $Cr_2O_7^{2-}$
2(6-x) +6 ´2
no. of eq. of ClO^- = no. of eq. of Cr_2OX

0.15 ´ 2 = $\frac{12.6}{(104+16x)} \times 2(6-x)$
or 31.2 + 4.8 x = 151.2 – 25.2 x
x = 4
hence formula = Cr_2O_4 or CrO_2

7. S + $O_2 \longrightarrow SO_2$
moles of SO_2 produced from 8 gm of sulphur = 16/64 = 0.25
SO_2 + Cl_2 water $\longrightarrow SO_4^{2-}$ + $2Cl^-$
moles of SO_4^{2-} produced = moles of SO_2 = 0.25

now SO_4^{2-} + $BaCl_2 \longrightarrow BaSO_4 + 2Cl^-$

moles of $BaSO_4$ produced = moles of SO_4^{2-} = 0.25

8. $AgNO_3 + HCl \longrightarrow AgCl + H + NO_3^-$

170 gm 143.5 gm

$\because$ 143.5 gm AgCl is produced by 170 gm of $AgNO_3$

$\therefore$ 2.125 gm AgCl is produced by $\frac{170 \times 2.125}{143.5}$ = 2.517 of $AgNO_3$

Now for the reaction eq. of $AgNO_3$ = eq. of HCl

or $\frac{2.517}{170} = \frac{25}{1000} \times N$ = 0.6

Hence N = 0.6

9. $2H_2 + O_2 \rightarrow 2H_2O$

10 5

2 vol. H_2 give 2 vol. of H_2O vapours

$\therefore$ 10 vol. H_2O vapour will form

10. Let the mass of $CaCl_2$ in sample = x gm

$CaCl_2 + Na_2CO_3 \longrightarrow CaCO_3 + 2NaCl$

111 gm 100 gm

$\therefore$ 111 gm $CaCl_2$ produces $\longrightarrow$ 100 gm $CaCO_3$

x gm $CaCl_2$ produces $\longrightarrow \frac{100x}{111} gm$ $CaCO_3$

$CaCO_3 \xrightarrow{\Delta} CaO + CO_2$

100 gm 56 gm

$\therefore$ 100 gm $CaCO_3$ produces $\longrightarrow$ 56gm CaO

$\left(\frac{100x}{111}\right) gm$ $CaCO_3$ produces $\longrightarrow \frac{56}{100} \times \frac{100}{111} gm$ CaO = $\frac{56x}{111}$ gm CaO

since mass of CaO finally produced = 1.62 gm = 56x/111

x = 3.21 gm

% of CaO in sample = $\frac{3.21}{10} \times 100 = 32.1\%$

11. mass of oxide = 2gm
mass of metal = 1.6gm
mass of oxygen = 0.4gm

Eq. wt of metal = $\frac{1.6 \times 8}{0.4} = 32$

12. $2\overset{-1}{N}H_2OH \rightarrow \overset{0}{N}_2$

n-factor = 1

$\overset{+3}{F}e_2(SO_4)_3 \rightarrow 2\overset{+2}{F}eSO_4$

n-factor =2

Eq. wt = $mw/2$

13. $\overset{+6}{C}rO_5 \rightarrow \overset{+3}{C}r_2(SO_4)_3$

No. of moles of electron required = 3

14. In acidic medium

$MnO_4^- \longrightarrow Mn^{+2}$ nf = 5/mole

$Cr_2O_7^{2-} \longrightarrow 2Cr^{+3}$ nf = 6/mole

hence the amount of Fe(II) oxidized is more with $Cr_2O_7^{2-}$

15. Meq. of H_2SO_4 = 100 ´ 0.2 ´ 2 = 40

Meq. of NaOH = 100 ´ 0.2 ´ 1 = 20

m. eq. of H_2SO_4 remains non neutralized = 20

no. of gm eq of H_2SO_4 = N ´ V

$\frac{20}{100} = N \times \frac{200}{1000}$, N = 0.1

16. (B) $K\overset{7+}{Mn}O_4 \longrightarrow \overset{4+}{Mn}O_2$

n = 3

Molarity = $\frac{\text{Normality}}{\text{n} - \text{factor}} = \frac{1.8}{3} = 0.6$

17. (C) $2NaOH + H_2SO_4$ ® $Na_2SO_4 + 2H_2O$ (acid base reaction)

18. (D)

n-factor of $H_2O_2 = 2$

n-factor of $K_4[Fe(CN)_6] = 61$

$\because \frac{\text{mole of } H_2O_2}{1 \text{mole of } K_4Fe(CN)_6} = \frac{61}{2}$

$\therefore$ mole of $H_2O_2 = \frac{61}{2} \times 1 = 30.5$

19. (D)

$BaCO_3 \rightarrow BaO + CO_2 \uparrow$

Molecular weight of $BaCO_3 = 137 + 12 + 3 \times 16 = 197$

$\because$ 197 gm $BaCO_3$ produces 22.4 L CO_2 (g) at S.T.P.

$\therefore$ 9.85 gm produces $\frac{22.4}{197} \times 9.85 = 1.12L$ at S.T.P.

20. (D)

meq. of HCl = 27.15 × 0.245

$\therefore$ meq. of $Ba(OH)_2$ = N × 20 = 27.15 × 0.245

$$N = \frac{27.15 \times 0.245}{20} = 0.333N$$

as n-factor of $Ba(OH)_2$ is 2 $\therefore$ M = 0.333/2 = 0.166

21. (C)

Moles of $N_2 = \frac{PV}{RT} = \frac{1 \times 36.9}{0.0821 \times 1000 \times 300}$

$= 1.5 \times 10^{-3}$

$\therefore$ moles of salt $= 1.5 \times 10^{-3}$

lit of salt $= 1.5 \times 10^{-3} \times 140.5$

$= 210.75 \times 10^{-3}$ mg

= 210 mg

22. (a)

4% of NaOH is 100 gm solution → 4 gm NaOH

so 1000 gm solution → 40 gm NaOH

→ 1 mole NaOH

So 1000 ml solution → 1.2 mole NaOH

Molarity = 1.2

23. (b)

4% NaOH is 100 ml solution → 4 gm NaOH

so 1000 ml solution → 40 gm NaOH → 1 mole NaOH

so molarity = 1

24. (c)

Three replaceable H so molarity × 3 = Normality

25. (a)

100 × 0.01 × 2 = v × 0.2 × 2

v = 5 ml

Level-III

26. Let the number of sulphate ions in $FeSO_4$ be x

The number of Fe^{2+} will be = number of sulphate = x

The number of sulphate ions in $Fe_2(SO_4)_3$ = x

The number of Fe^{3+} per SO_4^{2-} = 2/3
The number of Fe^{3+} for x SO_4^{2-} = 2/3 x
Ratio = x : 2/3 x = 3 : 2
Hence ans is B

27. Mass of nitrogen given = 7 g
Mass of nitrogen reacted = 80% of 7 g = 5.6 g
$N_2 + 3/2\ O_2 \rightarrow N_2O_3$
28 g N_2 reacts with 48 g O_2 to give N_2O_3
5.6 g of N_2 will react with $\frac{48}{28}\times 5.6$ g of O_2
16 g O_2 has 6.022× 10^{23} atoms
$\frac{48}{28}\times 5.6$ g of O_2 has $\frac{6.022\times 10^{23}}{16}\times\frac{48}{28}\times 5.6$ atoms of O_2 = 3.6 × 10^{23} atoms
Hence the answer is B

28. $\because$ 10L vol. at STP = 11.6gm
$\therefore$ 22.4L vol. = $\frac{11.6\times 22.4}{10}$
M.W = 26
EF = CH, MF= C_2H_2

29. (A) 2 gm atom of nitrogen = 28 gm
(B) 6 × 10^{23} atoms of C has mass = 12 gm
3 × 10^{23} atoms of C has mass = $\frac{12\times 3\times 10^{23}}{6\times 10^{23}} = 6\,gm$
(C) 1 mole of S has mass = 32 gm
(D) 7.0 gm of Ag
So, lowest mass = 6 gm of C.

30. $BaCO_3 \longrightarrow BaO + CO_2\uparrow$
Molecular weight of $BaCO_3$ = 137 + 12 + 3 × 16 = 197
197 gm produces 22.4 L at S.T.P. $\therefore$ 9.85 gm produces at S.T.P., $\frac{22.4}{197}\times 9.85 = 1.12$

31. $NV = N_1V_1 + N_2V_2$
0.2 × 2 = 0.5 x + 0.1(2 – x)
0.4 = 0.5 x + 0.2 - 0.1 x $\Rightarrow$ 0.2 = 0.4 x
x = $\frac{1}{2}L = 0.5L$

32. 22400 cc of gas at STP has 6 × 1023 molecules
∴ 1.12 × 10^{-7} of gas at STP has

$$\frac{6\times10^{23}\times1.12\times10^{-7}}{22400}=0.3\times10^{14}=3\times10^{12}$$

33. $Ba(OH)_2 + CO_2 \longrightarrow BaCO_3 + H_2O$
Atomic wt. of $BaCO_3$ = 137 + 12 + 16 × 3 = 197

No. of mole = $\frac{\text{wt. of substance}}{\text{mol wt.}}$

1 mole of $Ba(OH)_2$ gives 1 mole of $BaCO_3$
∴ 205 mole of $Ba(OH)_2$ will give .205 mole of $BaCO_3$
∴ wt. of 0.205 mole of BaCO3 will be = 40.5

34. (a) $\overset{+2}{V_0} ® \overset{+5/2}{V}{}_0 O_5$

(b) $Na ® Na^{+}$ $\substack{\text{oxidation}\\\text{oxidation}}$

(c) $\overset{+6}{Cr}O_4^{-2} ® \overset{+6}{C}r_2O_7^{-2}$

(d) Zn^{2+} ® Zn (Reduction)

35. $\overset{+7}{Mn}O_4^{-} ® \overset{+6}{Mn}O_4^{-2}$ = n = 1

$\overset{+7}{Mn}O_4^{-} ® \overset{+6}{Mn}O_2$ = n = 3

$\overset{+7}{Mn}O_4^{-} ® \overset{+3}{Mn}O_3$ = n = 4

$\overset{+7}{Mn}O_4^{-} ® Mn^{+2}$ = n = 5

then 1, 3, 4, 5 then (C) is correct)

36. $\overset{0}{Cl_2} ® Cl^{-} + \overset{+5}{Cl}O_3^{-}$
This is the example of disproportionation (C) is correct.

37. 1 mole of $\overset{-2}{N_2}H_4 ® \overset{+y}{N} + 10e^{-}$
= 10 = change in oxidation number
= 10 = 2(y + 2)
= 10 = 2y + 4
2y = 6
= y = +3
(C) is correct.

38. 1 mole $Fe_2(C_2O_4)_3$ º x mole of MnO_4^{-} in acidic medium

= gm eq. of $Fe_2(C_2O_4)_3$ = gm eq. of MnO_4^{-}
= 1 × 6 = x + 5

$$x = \frac{6}{5}\text{mole}$$

the ratio is x : y = 2 : 1

1 mole $FeC_2O_4 \equiv$ y mole MnO_4^-

1 × 3 = y × 5 = y = 3/5

(A) is correct.

39. 3×10^{-3} mole of $K_2Cr_2O_7 \equiv 4.5 \times 10^{-3}$ mole of X^{+n}

$$K_2Cr_2O_7 + X^{+n} \rightarrow \overset{+5}{X}O_3^- + Cr^{+3}$$

gm eq. of $K_2Cr_2O_7$ = gm eq. of X^{+n}

$$3 \times 10^{-3} \times 6 = 4.5 \times 10^{-3} \times (5-n) = (5-n)$$

= 4 = 5 – n

= n = 5 – 4 = (+1)

the (B) is correct

40. X^{+n} is oxidized to XO_4^{-2} and XO_4^-

$$X^{+n} \xrightarrow[I]{} \overset{+6}{X}O_4^{-2} \xrightarrow[II]{} \overset{+7}{X}O_4^{-2}$$

For I, the change in oxidation number

= (6 – n)

(6 – n) = 4 × n factor of oxidising agent

For II, the change in oxidation number = 7 - 6 = 1

= 1 X n factor of oxidizing agent.

hence the n-factor of the oxidizing agent = 1

Hence 6 - n = 4 X 1

Hence n = 2

(C) is correct.

41. $\overset{+3}{As_2}\overset{-2}{S_3} + H^+ + NO_3^- \rightarrow NO + H_2O + \overset{+5}{A}sO_4^{-3} + \overset{+6}{S}O_4^{-2}$

n-factor of As_2S_3 = 2 × 2 \ 4 | 8 × 3 + 24 + 4 = 28.

n = 28

$$E = \frac{M}{28}$$

(C) is correct

42. In chemical reaction

$$2\overset{+2}{C}uSO_4 + 4KI \rightarrow \overset{+1}{C}u_2I_2 + 2K_2SO_4 + I_2$$

n = 1

(D) is correct

43. Volume m of HCl neutralized by NaOH = (Caustic soda) = V_1
$N_1V_1 = N_2V_2$; $0.1 \times V_1 = 0.2 \times 30$; $V_1 = 60$ ml = 40 ml
40 ml 0.1 HCl is now neutralized by
KOH (0.25 N) $\longrightarrow$ (HCl) $N_1V_1 = N_2V_2$ (KOH)
$0.1 \times 40 = 0.25 \times V_2$; $V_2 = 16$ ml

44. 10 ml 0.1 M $FeSO_4$ ° $KMnO_4$ in acidic medium
gm. of $FeSO_4$ = gm eq. of $KMnO_4$
Mill eq.n of 10 ml of 0.02 M
$= 10 \times 0.02 \times 5$
$= 10 \times 0.1 = 1$
(D) is correct

45. 1 M $KMnO_4$ mol 1 M $K_2Cr_2O_7$
For the oxidation of Fe^{2+} in acidic medium.
gm eq. of 1 M $KMnO_4$ = gm eq. of Fe^{2+}
$1 \times 1 \times v = 1 \times 5 = \times v$
= 1/5 = Volume of $KMnO_4$,
gm eq. of 1 M $K_2Cr_2O_7$ = gm eq. of Fe^{2+}
$= 1 \times 6 \times v = 1 \times 1 \times v$
Volume = 1/6
of $K_2Cr_2O_7$
then more amount of Fe^{2+} oxidized by '$KMnO_4$' then (a) is correct

46. $KMnO_4$ ° 100 mg of FeC_2O_4 in acidic solution?
gm eq. of $KMnO_4$ = gm eq. of FeC_2O_4

$$\frac{0.1\acute{}\ V\acute{}\ 5}{1000} = \frac{100\acute{}\ 10^{-3}\acute{}\ 3}{M} \quad (Q\ FeC_2O_4)$$

$$= \frac{0.1\acute{}\ V\acute{}\ 5}{1000} = \frac{0.1\acute{}\ 3}{144}$$

$$C = \frac{0.1\acute{}\ 3\acute{}\ 1000}{0.1\acute{}\ 144\acute{}\ 5} = \frac{600}{144} = \frac{150}{36} = 4.1 \text{ ml}$$

(A) is correct

47. 60 ml of 0.1 M $KMnO_4$ ° excess of FeC_2O_4 in H_2SO_4
gm eq. of $KMnO_4$ = gm eq. of FeC_2O_4

$$= \frac{60\acute{}\ 0.1\acute{}\ 5}{1000} = \text{Moles}\acute{}\ 3$$

$$= \text{Moles} = \frac{60\acute{}\ 0.1\acute{}\ 5}{1000\acute{}\ 3} = \frac{0.5\acute{}\ 6}{3\acute{}\ 100} = 10^{-2} \text{ mole}$$

1 mole FeC_2O_4 given 2 mole

then $\frac{1}{100}$ moles gives = $\frac{2}{100}$ more

Volume of CO_2 = $\frac{2}{100} \times$ 22.4 litre

$= \frac{2}{100} \times 22.400$ ml

= 448 ml

(A) is correct

48. 10.78 gm of H_3PO_4 in 550 ml of 0.4 N

$$N = \frac{w \times 1000}{E \times \text{Volume}}$$

$$= 0.4 = \frac{10.78 \times 1000}{E \times 550}$$

$$E = \frac{10.78 \times 1000}{550 \times 0.4} = \frac{1078}{55 \times 0.4}$$

E = 49

$$E = \frac{M}{E} = \frac{98}{49} = 2$$

= (n = 2)

that means this acid H_3PO_4 has been neutralised by to ' HPO_4^{-2}

Hence (A) is correct.

49. 1 vol. = 0.303 % $\therefore$ 20 vol. = 20 × 0.303 % = 6.06%

50. Let the volume the of H_2O_2 = x mL
Then m eq. of H_2O_2 = m eq. of O_2

x mL × $\frac{22.4}{5.6}N = \frac{2240}{22400} \times 4 \times 1000$ x = 100 mL

Level-III

51. n-factor of FeC_2O_4 = 3
and n-factor of $Fe(SCN)_2$ = 33
Let the vol. of FeC_2O_4 required for oxidation = x mL, then
m eq. of FeC_2O_4 = m eq. of $Fe(SCN)_2$
x × 1 × 3 = 100 × 1 × 33
x = 1100 mL = 1.1 litre

52. m eq. of hypo= m eq. of Cu^{2+}
= 25 m eq of Cu^{2+} (n = 1) = 25 mole of Cu^{2+}

$$\frac{\text{m mole of } \begin{matrix}\text{COOH}\\ |\\ \text{COOH}\end{matrix}}{\text{m mole of KMnO}_4} = \frac{5}{2}$$ $\therefore$ m mole of oxalic acid = $\frac{5}{2}\times 10 = 25$

$$\Rightarrow \frac{\text{m mole of Cu}^{+2}}{\text{m mole of oxalic acid}} = \frac{25}{25} = 1 \Rightarrow \frac{\text{mole of Cu}^{+2}}{\text{mole of oxalic acid}} = 1:1$$

53. n-factor of $Ba(MnO_4)_2$ = 10
n-factor of $K_4[Fe(CN)_6]$ = 61

$\because \frac{\text{mole of Ba(MnO}_4)_2}{1\,\text{mole of K}_4\text{Fe(CN)}_6} = \frac{61}{10}$ $\therefore$ mole of $Ba(MnO_4)_2$ = $\frac{61}{10}$ 1 = 6.1

54. 109% labeled oleum will contain 9 g H_2O, 40 g free SO_3, 60 g H_2SO_4

40 g (free)SO_3 = $\frac{1}{2}\,\text{mole}\,SO_3\,\text{(free)} = y$

60 g (H_2SO_4) = $\frac{60}{98} = x$ mole H_2SO_4 = x $\Rightarrow \frac{x+y}{x-y} = 9.9$

55. 366 ppm of HCO_3^- ions means

= $\frac{366}{61}m$ moles of HCO_3^- ions per litre solution = 6 m moles of HCO_3^- ions per litre solution

= 3 m moles of $Ca(HCO_3)_2$ = 3 mole of $Ca(OH)_2$ is required

= 3 × 74 mg of $Ca(OH)_2$ per litre required = $\frac{3\times 74}{2}$ mg of $Ca(OH)_2$ per 500 mL solution is required

= 0.111g

56. m eq. of $Ba(MnO_4)_2$ reacted = m eq. of H_2O_2 reacted = $\frac{56\times 100}{5.6}$ = 1000 m eq. of H_2O_2 = 1 eq. of H_2O_2

$\therefore$ moles of $Ba(MnO_4)_2$ (n-factor = 10) = 0.1 mole
$\therefore$ wt. of $Ba(MnO_4)_2$ = 0.1 × 375 g = 37.5 g

% purity of $Ba(MnO_4)_2$ = $\frac{37.5}{55}\times 100 = 68.18\%$

57. moles of I_2 formed = 3 × moles of KIO_3 = 3 × $\frac{0.57}{214}$

m eq. of I_2 formed (n f = 2) = 3 × $\frac{0.57}{214}\times 2\times 1000$

58.

Element	%(a)	At. wt. (b)	a/b	Ratio
X	50	10	5	2
Y	50	20	2.5	1

Simplest formula = X_2Y

59. Density = 1 g/ml for water hence for water 1 g = 1 ml
0.0018 ml = 0.0018 gm

No. of moles = $\frac{weight}{Molecular\ weight} = \frac{0.0018}{18} = 1\times10^{-4}$

$\therefore$ No. of water molecules = 6.023 × 10^{23} × 1 × 10^{-4} = 6.023 × 10^{19}

60. $CaCO_3 \longrightarrow CaO + CO_2$
10 gm

90% pure 9 gm = $\frac{9}{100} mole$

$CaCO_3 \equiv CO_2$ = 0.09 mole
At NTP vol. CO_2 = 0.09 × 22.4 = 2.016 L

MORE THAN ONE ANSWER QUESTIONS

Level-I

1. (A), (B)

(A) $N = \frac{3\times1000\times1}{60\times250} = 0.2$

(B) $N = \frac{5.7\times1000\times6}{342\times500} = 0.2$

(C) $0.2 \times 2 = 0.4$

(D) $\frac{0.2\times1000}{500} = 0.4$

2. (A), (C)

(A) $K_4[Fe(CN)_6] \rightarrow K^+ + Fe^{3+} + CO_2 + NO_3^-$ (n_f= 61)

(B) $Cu_2S \rightarrow Cu^{2+} + SO_3$ (n_f = 10)

(C) $Fe(SCN)_3 \rightarrow Fe^{3+} + SO_3 + CO_2 + NO_3^-$ (n_f= 48)

(D) $K_2[Cu(CN)_4] \rightarrow K^+ + Cu^{2+} + CO_2 + NO_3^-$ (n_f = 40)

3. (A), (B), (C), (D)

$K_2CrO_4 \Rightarrow 2 + x - 8 = 0 \Rightarrow x = +6$

$K_2Cr_2O_7 \Rightarrow 2 + 2x - 14 = 0 \Rightarrow x = +6$

$KCrO_3Cl \Rightarrow 1 + x - 6 - 1 = 0 \Rightarrow x = +6$

$Cr(O_2)_2O \Rightarrow x - 2\times2 - 2 = 0 \Rightarrow x = +6$

4. (B), (C), (D)

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

(a) $x : y = \frac{3}{1} \Rightarrow 3:1$

(b) x + y + z = 3 + 1 + 14 = 18

(c) $\frac{a}{b} = \frac{3}{2} \Rightarrow 3:2$

(d) z – c = 14 – 7 = 7

5. (A), (B), (C), (D)

6. (A), (B), (D)

7. (A), (B), (D)

8. (B), (D)

9. (B), (C)

Meq of NaOH = 0.01 (x – y)

and meq. of Na_2CO_3 = 0.02y

$\therefore$ B and C are possible.

10. $3Sn^{2+} + Cr_2O_7^{2-} + 14H^+ \rightarrow 3Sn^{3+} 2Cr^{3+} + 7H_2O$

11. $2\overset{+7}{Mn}O_4^- + 4H^+ + \overset{0}{B}r_2 \rightarrow 2\overset{+2}{Mn}^{+2} + 2\overset{+5}{B}rO_3^- + 2H_2O$

n-factor for $MnO_4^- = 5$

Eq. Wt = $M_x / 5$

n-factor for $Br_2 = 10$

Eq. Wt = $M_y / 10$

Ratio of n-factor $\overset{+2}{Mn}^{+2} \rightarrow \overset{+7}{Mn}O_4^-$

$2\overset{+5}{B}rO_3^- \rightarrow \overset{0}{B}r_2 \quad = 1:1$

12. $Fe_{0.95}O + O_2 \rightarrow Fe_2O_3$

Let x is the fraction of Fe^{+3} in the compound then $Fe^{+2} = (0.95 - x)$

$x \times 3 + (0.95 - x) \times 2 - 2 = 0$ $\qquad x = 0.1$

13. $2FeS_2 + \frac{11}{2}O_2 \rightarrow Fe_2O_3 + 4SO_2$

n-factor = 11
Eq. Wt = $M/11$

14. $NaOH$ and $NaHCO_3$ in solution react together

$$NaOH + NaHCO_3 \rightarrow Na_2CO_3 + H_2O$$
$$40gm \quad 84gm$$

$$\frac{40}{40} = 1mol \quad \frac{84}{84} = 1mol$$

After reaction solution will have two moles of Na_2CO_3 in 1 litre

For phenolphthalein m.Eq of Na_2CO_3 = m.Eq of HCl

$$20 \times 2 \times 1 = V \times 1 \Rightarrow V = 40mL$$

For methyl orange after first end point

m.Eq of $NaHCO_3$ = m.Eq of Na_2CO_3 = m.Eq of HCl

$$2 \times 20 \times 1 = 1 \times V \Rightarrow V = 40mL$$

For methyl orange if used from very beginning

m.Eq Na_2CO_3 + m.Eq of $NaHCO_3$ = m.Eq of HCl

2 x m.Eq of Na_2CO_3 = m.Eq of HCl

$$2 \times 20 \times 2 = 1 \times V \Rightarrow V = 80mL$$

15. $Ba(\overset{+7}{Mn}O_4)_2 \rightarrow 2\overset{+2}{Mn}^{++}$

n-factor = 10

m.Eq of $Ba(MnO_4)_2$ in 150mL $\Rightarrow 150 \times 10 \times \frac{1}{10} = 150$ m.Eq

m.Eq of 1M $Fe^{++} \rightarrow Fe^{++}$ = 150 x 1 = 150m.Eq

m.Eq of 50mL 1M $FeC_2O_4 \rightarrow Fe^{+++} + 2CO_2 = 50 \times 3 = 150$ m.Eq

m.Eq of 75mL 1M $C_2O_4^{--} \rightarrow 2CO_2 = 75 \times 2 = 150$ m.Eq

m.Eq of 25mL 1M $Cr_2O_7^{--} \rightarrow 2Cr^{+3} = 25 \times 6 = 150$ m.Eq

16. $\because$ molarity and normality involves the use of volume of solution. Volume changes with temperature hence normality and molarity change with temperature.

17. H_3PO_4 + $Ca(OH)_2$ $\longrightarrow$ $CaHPO_4$ + $2H_2O$

n-factor for H_3PO_4 = 2 (since $2H^+$ ions are replaced)

eq. wt. = $\frac{M}{2} = \frac{98}{2} = 49$

resulting solution of $CaHPO_4$ have only one replaceable H^+
so nf = 1

hence no. of eq = 1 for 1 mole so can be neutralized by 1 mole of KOH
eq of $CaHPO_4$ = eq. of KOH
For complete neutralization - no. of eq. of H_3PO_4 = no. of eq. of $Ca(OH)_2$
1 × 3 = 1.5 × 2
can be neutralized.

18. no. of eq. of H_2SO_4 = moles × n factor
= 1 × 2 = 2
no. of eq. of $Ca(OH)_2$ = 1 × 2 = 2 (neutralized)
no. of eq. of NaOH = 2 × 1 = 2 (neutralized)
no. of eq. of NH_3 = 2 × 1 = 2 (neutralized)
$H_2SO_4 + Ca(OH)_2 = CaSO_4 + 2H_2O$
$2NaOH + H_2SO_4 \longrightarrow Na_2SO_4 + 2H_2O$
$2NH_3 + H_2SO_4 \longrightarrow 2NH_4^+ + SO_4^{2-}$

19. In presence of phenolphthalein to detect I[st] end point.
$NaOH + HCl \longrightarrow NaCl + H_2O$ (Full eq. of NaOH)
$Na_2CO_3 + HCl \longrightarrow NaHCO_3 + NaCl$ (1/2 eq. of Na_2CO_3)
methyl orange is used to detect final end point. Where rest of 1/2 eq of Na_2CO_3 will be neutralized
$NaHCO_3 + HCl \longrightarrow NaCl + H_2CO_3 \longrightarrow (H_2O + CO_2)$

20. $3\overset{+1}{Cl}O^- \rightarrow \overset{+5}{Cl}O_3^- + 2\overset{-1}{Cl}^-$
It is a disproportionation reaction, which incluces both oxidation and reduction of same element

Level-II

21. (C,D)
$CO + CO_2$
a b
$\therefore$ $a + b = 1$
$CO_2 + 2NaOH \rightarrow Na_2CO_3 + H_2O$
Meq. of CO_2 = Meq. of NaOH = 1 × 1000

$\therefore$ Mole of $CO_2 = \frac{1\times1000}{2\times1000} = 0.5$ (n.f. of $CO_2 = 2$)

$CO + \frac{1}{2}O_2 \rightarrow CO_2$

$\therefore$ 0.5 CO_2 is formed more.
$\therefore$ NaOH required more = 2 litre of 1/2 M NaOH = 56 g KOH = 1 mole KOH.

22. (ABC) $\underset{a}{H_2SO_4} + \underset{b}{SO_3}$

$\therefore$ a + b = 2 .....(i)

Also, Meq. of H_2SO_4 + Meq. of SO_3 = Meq. of NaOH

$$\frac{a}{49}\times 1000 + \frac{b}{40}\times 1000 = 0.1\times 432.5$$

$\therefore$ 4a + 49b = 84.77 ......(ii)

$\therefore$ a = 1.47 b = 0.53 $\therefore$ Equivalent of $H_2SO_4 = \frac{1.47}{49} = 0.03$

$\therefore$ $SO_3 + H_2O \rightarrow H_2SO_4$ Eq. of $SO_3 = \frac{0.53}{40} = 0.01325$

Weight of H_2O to react with $SO_3 = \frac{0.53\times 18}{80} = 0.11925$

$\therefore$ 108.11% oleum = 100 g H_2SO_4 + 8.11 g H_2O $= 100 g H_2SO_4 + \frac{8.11\times 80}{18}$

= 100 g H_2SO_4 + 36 g SO_3 = 1.36 g oleum

136 g oleum has 36 g SO_3

$\therefore$ 2g oleum has $\frac{36\times 2}{136} = 0.53$ g SO_3

$\therefore$ % of free $SO_3 = \frac{0.53\times 100}{2} = 26.5$

23. (BCD) $2V^{2+} \rightarrow (V^{5+})_2 + 6e$

$2e + (Fe^{3+})_2 \rightarrow 2Fe^{2+} \times 3$

$\therefore$ $2VO + 3Fe_2O_3 \rightarrow 6FeO + V_2O_5$ $E = \frac{M}{3}$ $E = \frac{M}{2}$ $E = \frac{M}{3/2}$ $E = \frac{M}{6}$

24. (ABD) H_3PO_3 is dibasic acid.

25. (AC) $[SO_2Cl_2] = \frac{2.70\times 1000}{135\times 100} = 0.2M$

$SO_2Cl_2 + 2H_2O \rightarrow H_2SO_4 + 2HCl$

100 × 0.2		
= 20	0	0
0	20	20

$\therefore$ $M_{H_2SO_4} = \frac{20}{1000}$; $M_{HCl} = \frac{40}{100}$

26. (AC) $3.42 \text{ ppm } Al_2(SO_4)_3 \equiv \frac{96\times3\times3.42}{342} \text{ ppm } [SO_4^{2-}] = 2.88 \text{ ppm } SO_4^{2-}$

$$\equiv \frac{27\times2\times3.42}{342} \text{ ppm } Al^{3+} = 0.54 \text{ ppm } Al^{3+}$$

$$1.42 \text{ ppm } Na_2SO_4 \equiv \frac{96\times1.42}{142} \text{ ppm } SO_4 = 0.96 \text{ ppm } SO_4^{2-}$$

$$\equiv \frac{46\times1.42}{142} \text{ ppm } Na^+ = 0.46 \text{ ppm } Na^+$$

$$\therefore \quad [Al^{3+}] = \frac{0.54\times10^3}{27\times10^6} = 2.0\times10^{-5} M$$

$$[SO_4^{2-}] = \frac{(2.88+0.96)\times10^3}{96\times10^6} = 4\times10^{-5} M$$

$$[Na^+] = \frac{0.46\times10^3}{23\times10^6} = 2\times10^{-5} M$$

27. (BC) Meq. of $NaHC_2O_4$ = 100 × 0.1 = 10
Meq. of NaOH required = 10 = V_1 × 0.1 × 1 (v.f. NaOH = 1)
Meq. of $KMnO_4$ required = 10 = V_2 × a × 5 (v..f. of $KMnO_4$ = 5)

$$\therefore \quad V_2 = \frac{10}{5a} \qquad \therefore \quad \frac{V_1}{V_2} = \frac{100\times5a}{10}$$

If $M_{KMnO_4} = 0.1M$, then $10 = V_2 \times 0.1 \times 5 \therefore V_2 = 20$ mL

28. (ABC) Meq. of $KMnO_4$ = 100 × 0.1 × 5 = 50 = Meq. of $Na_2C_2O_4$ + Meq. of $H_2C_2O_4$
a + b

∴ a + b = 50
Meq. of NaOH = 50 × 0.2 = 10 = Meq. of $H_2C_2O_4$
∴ b = 10
∴ a = 40

m moles of $Na_2C_2O_4 = \frac{a}{2}$ ∴ m moles of $C_2O_4 = \frac{a}{2} + \frac{b}{2} = \frac{a+b}{2} = \frac{40+10}{2} = 25$

m moles of $H_2C_2O_4 = \frac{b}{2}$

29. (A) HNO_3 also oxides Fe^{2+} whereas $KMnO_4$ oxidises HCl.

30. (ABC) $2Fe^{2+} \rightarrow (Fe^{3+}) + 2e$ Eq. wt. of $FeS_2 = \frac{M}{22/2} = \frac{M}{11}$

$2(S^{-1})_2 \rightarrow 4(S^{4+}) + 20e$ Eq. wt. of $SO_2 = \frac{M}{20/4} = \frac{M}{5}$

$\therefore$ $4e + O_2^0 \rightarrow 2(O^{-2})$

$\therefore$ $4FeS_2 + 7O_2 \rightarrow 2Fe_2O_3$

S has –1 oxidation state.

Level-III

31. (BCD Molar mass of gas $= \frac{0.220}{112} \times 22400 = 44$

32. (ABC)

33. (BCD) $2Na_3PO_{4(aq)} + 3Ba(NO_3)_{2(aq)} \rightarrow Ba_3(PO_4)_{2(s)} + 6NaNO_{3(aq)}$

Na_3PO_4 is the limiting reactant and is completely consumed.

Mol. of $Ba_3(PO_4)_2$ formed $= \frac{0.2}{2}$ =0.1 mol of $Ba(NO_3)_2 = \frac{3}{2} \times 0.2 = 0.3$

Mol of unreacted $Ba(NO_3)_2 = 0.5 - 0.3 = 0.2$ = mol of Ba^{2+} ion

Mol of Na^+ in solution = 0.2 × 3 = 0.6 ; Mol of NO_3^- in solution = 0.5 × 2 = 1

34. (BCD) $NaNO_2 + NH_4Cl \rightarrow NH_4NO_2 + NaCl$; $NH_4NO_2 \rightarrow N_2 + 2H_2O$

$NaNO_2$ is limited reactant.

Mol of N_2 formed = mol of NH_4NO_2 formed = 0.5

Volume of N_2(STP) = 0.5 × 22.4 = 11.2 L; mass of N_2 = 0.5 × 28 = 14 g

35. (ABD) $2CO + O_2 \rightarrow 2CO_2$ The residual gas is CO.

Volume of CO oxidized = 2 × 30 = 60 ml; volume of CO = 60 + 10 = 70 ml

Volume of CO_2 initially present in the mixture = 100 – 70 = 30 ml

Volume of CO_2 formed = 60 ml; Volume of CO_2 absorbed by KOH = 30 + 60 = 90 ml

Passage-I

1. In aq. solution iodine exist in polyiodide ion (I_3^-)

2. $2\overset{+2}{C}uSO_4 \rightarrow \overset{+1}{C}u_2I_2$, n-factor = 1

3. Eq. of $CuSO_4$ = Eq. of I_2 = Eq. of hypo

$$\frac{Wt}{Eq.Wt\ CuSO_4} \times 1000 = 100 \times 1 \times 1$$

Wt. of $CuSO_4 = \frac{100}{1000} \times 159.5$ = 15.95 gm

% purity = 10%

4. Eq. of Hypo = Eq. of $CuSO_4.5H_2O$

$$100\times0.1=\frac{x}{249.5}\times1000$$, x = 2.5 gm

5. Eq. of NaOH = Eq. of KHP

$$23.48\times N=\frac{0.5468}{204}\times1000$$

Normality = 0.114 N ; molarity = 0.114M

6. Eq. of $KMnO_4$ = Eq. of $FeSO_4$

$$16.42\times0.1327\times5=\frac{W}{152}\times1000$$

W = 1.66 gm; no. of moles = $\frac{1.66}{152}=1.09\times10^{-2}$

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

8. $\because$ 100 gm solution has 98 gm H_2SO_4

$$V=\frac{m}{\rho}=\frac{100}{1.84}=54.34\,mL\ ;\ M=\frac{98\times1000}{98\times54.34}=18.4$$

$$M_1V_1=M_2V_2\Rightarrow18.4\times V_1=5000\times0.5$$

V_1 = 135.85 mL

9. m eq. of $CuSO_4$ reacted = m eq. of $Na_2S_2O_3$ reacted (n – f = 8) = 50 ´ 1 ´ 8 = 400

$$\frac{Wt}{Eq.Wt.}\times1000=400\Rightarrow\frac{Wt}{149.5}\times1000=400$$

Wt. = 59.8 gm; % purity $\Rightarrow\frac{59.8}{79.75}\times100=75\%$

10. 214 g KIO_3 = 1 mole of KIO_3
= 3 mole of I_2 (in the balanced chemical reaction) = 6 eq. of I_2 (n f = 2) = 6000 m eq. of I_2
Let the vol. of $Na_2S_2O_3$ = x mL, then
(x ´ 1) ´ 8 = 6000 x = 750 mL

11. m mole of $KMnO_4$ used = 50 ´ $\frac{1}{10}=5$

m eq. of $KMnO_4$ used (n f = 5) = 25 m eq. of $C_2O_4^{-2}$

m mole of $C_2O_4^{-2}$ (n = 2) = $\frac{25}{2}=12.5$

m eq. of $Na_2S_2O_3$ = 2.5 = m eq. of Cu^{2+} (n = 1) m eq. of Cu^{2+} (n = 1) = 2.5
Difference in number of m moles of Cu^{2+} and $C_2O_4^{2-}$ = 12.5 – 2.5 = 10

12. $5KI + KIO_3 + 6HCl \rightarrow 3I_2 + 6KCl + 3H_2O$

$\frac{1.66}{166} = 10^{-2} mol$

moles of KIO_3 reacted = $\frac{1}{5} \times 10^{-2} = 2 \times 10^{-3}$

moles of I_2 formed = $3 \times 2 \times 10^{-3} = 6 \times 10^{-3}$

Match the Column

1. (a - r,t), (b - p,t), (c - q), (d - s)

$\overset{-3}{N}H_3 \rightarrow \overset{+5}{N}O_3^-$ n-factor =8, Eq.Wt = $Mw/8$

$\overset{+2}{F}e\overset{+3}{C_2}O_4 \rightarrow \overset{+3}{F}e^{+++} + 2\overset{+4}{C}O_3^{--}$ n-factor = 3, Eq.Wt = Mw / 3

$H_2\overset{+6}{S}O_5 \rightarrow \overset{0}{S_8}$ n-factor = 6, Eq. Wt = Mw / 6

$KMnO_4 \rightarrow \overset{+2}{Mn^{++}}$ n-factor = 5, Eq. Wt = Mw / 5

2. (a - r), (b - t), (c - p), (d - s)

H_3PO_4 is tribasic acid (n = 3); H_3PO_3 is dibasic acid (n = 2); H_3BO_3 is monobasic acid (n = 1) and EDTA is tetrabasic acid (n = 4)

3. (a – q,t), (b – p), (c – r,t), (d – s,t)

$K\overset{+7}{Mn}O_4 \rightarrow \overset{+2}{Mn}^{+2}$ (n-factor = 5)

$Mg\overset{+3}{C_2}O_4 \rightarrow Mg^{+2} + 2\overset{+4}{C}O_2$ (n-factor = 2)

$K_2\overset{+6}{Cr_2}O_7 \rightarrow 2\overset{+3}{C}r^{+3}$ (n-factor = 6)

$\overset{+6}{Cr}O_5 \rightarrow \overset{+3}{Cr_2}O_3$ (n-factor = 3)

ASSERTION/ REASON

1. $Na_2CO_3 + HCl \longrightarrow NaHCO_3 + NaCl$

$NaHCO_3 + HCl \longrightarrow NaCl + H_2O + CO_2$

From the above reactions it is clear that two moles of HCl are required for complete neutralization of Na_2CO_3. The titre value with methyl orange correspond to complete neutralization of Na_2CO_3 and with phenolphthalein correspond to half neutralization of Na_2CO_3.

2. Molality does not depend upon volume thus it does not depend upon temperature.

3. $\overset{2+}{Fe}\overset{1-}{S_2} \xrightarrow{O_2} \overset{3+}{Fe_2} O_3 + \overset{4+}{S}O_2$

4. Density change means m = d ´ v mass of solution per unit volume changed hence mass of solute per unit volume changed and therefore molarity and morality will be changed.

5. n factor of P will be $\frac{2y}{x}$ and atomic mass = equivalent mass of P × n-factor of

P $= E_p \times \frac{2y}{x}$

6. Industrial H_2SO_4 is Oleum $(H_2S_2O_7)$ in which concentration is represented by this method.
9gm water is added

$SO_3 + H_2O \rightarrow H_2SO_4$

0.5ml 0.5ml

SO_3 also present as 0.5mol or 40gm

6. Eq. Wt = M. W / valence factor

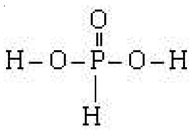
7. Urea is H_2NCONH_2

% of N = $\frac{28}{60}100 = 46.6\%$

Urea is a covalent compound

8. M = $\frac{10Dx}{M_s}$

where D = density of solution
x = % by mass M_s = molar mass of solute.

9. 

, thus only Na_2HPO_3 and NaH_2PO_3 salts are possible.

10. meq. = N × V (ml) = $\frac{wt.}{Eq.\ wt} \times 1000$. No doubt N decrease with dilution but V increases and thus meq. remain constant

INTEGER ANSWER TYPE QUESTIONS

1. $0.01 \times$ n-f = 0.06×3
   n-f = 18
   $18 = \left(\frac{2}{n} + 4\right) \times n$ n = 4

2. MnO_4^- would convert to Mn^{2+}. Therefore its 'n' factor would be 5.
   $\therefore$ Equivalents of MnO_4^- = $1.61 \times 10^{-3} \times 5 = 8.05 \times 10^{-3}$
   Equivalents of A^{n+} = 8.05×10^{-3}
   'n' factor of A^{n+} = 5 – n
   $\therefore$ $(5 - n) \times 2.68 \times 10^{-3} = 8.05 \times 10^{-3}$
   n=2

3. $\because$ 100 g Haemoglobin has = 0.25 g Fe
   $\therefore$ 86600 g Haemoglobin has = $\frac{0.25 \times 86600}{100}$ gFe = 224 g Fe
   i.e., 1 mole or N molecules of Haemoglobin has = $\frac{224}{56}$ g atom Fe = 4 g atom Fe
   $\therefore$ 1 molecule of Haemoglobin has 4 atom of Fe.

4. Let valencies of Cu in two oxides be x and y, then I oxide is $Cu_2O_{x;}$ II oxide is Cu_2O_y
   In I oxide : Equivalent of Cu = equivalent of oxygen $\frac{w}{A/x} = \frac{a}{8}$ . . . . .(1)
   where w, x, A and a are weight of Cu, at. wt. of Cu, valency of Cu and weight of oxygen.
   In II oxide : $\frac{w}{A/y} = \frac{a}{2 \times 8}$ . . . .(2) ($\because$ Oxygen used half of I)
   By eqs. (1) and (2)
   $\frac{x}{y} = \frac{2}{1}$ 2/y = 2/1 $\Rightarrow$ y = 1
   the valency of Cu second oxide is 1

5. Meq. of oxalic acid in 16.68 mL = Meq of NaOH = $25 \times \frac{1}{15}$
   $\therefore$ Meq of oxalic acid in 250 mL = $25 \times \frac{1}{15} \times \frac{250}{16.68} = 24.98$
   $\therefore$ $\frac{1.575}{(90 + 18x)/2} \times 1000 = 24.98$ $\therefore$ x $\approx$ 2

6. 6
   Let the ox. no. of Cr in $K_2Cr_2O_7$ be x.
   We know that, ox. No. of K = +1
   ' ox. No. of O = –2
   So, 2(ox. no. K) + 2(ox. no.Cr) + 7(ox. No. O) = 0
   2(+1) + 2(x) + 7(–) = 0
   $\Rightarrow$ x = +6

7. 1

$N_1V_1 = N_2V_2$
(Acid) (NaOH)

$N_1 \times 2 = \frac{1}{5} \times 10$

$N_1 = \frac{1}{5} \times \frac{10}{2} = 1$

8. 3

$\text{Number of moles of } KMnO_4 = \frac{MV}{1000} = \frac{0.145 \times 46.9}{1000} = 6.8 \times 10^{-3}$

Number of moles of $H_2O_2 = 6.8 \times 10^{-3} \times 2.5 = 0.017$
Mass of $H_2O_2 = 0.017 \times 34 = 0.578$

Mass % of $H_2O_2 = \frac{0.578}{20} \times 100 = 2.9$

SUBJECTIVE QUESTIONS

1. $MnO_2 + 4\,HCl \longrightarrow MnCl_2 + 2H_2O + Cl_2$

Number of moles of $Cl_2 = \frac{1.78}{22.4} = 0.07946$

Number of moles of $MnO_2 = 0.07946$
$\therefore$ Mass of $MnO_2 = 0.0794 \times 87$
$= 6.913$ g
$\therefore$ Number of moles of HCl = 4 x 0.07946 = 0.3178
mass of HCl = 0.3176 × 36.5
Let the volume of HCl = V ml

$\therefore$ $V \times 1.2 \times \frac{4}{100} 4 \times 0.317 \times 36.5 = 241.66$ ml

2. m. Eq of H_2O_2 in 10mL = me of $KMnO_4$ $= 0.0245 \times 5 \times 25 = 3.0625$
In 100mL = 30.625 m.Eq
$\because$ 100mL solution contains 30.625×10^{-3} eq
$\therefore$ 1000mL ....

$= 30.625 \times 10^{-3} \times \frac{1000}{100} = 30.625 \times 10^{-2} = 0.30625N$

3. Out of Na_2CO_3 $NaHCO_3$ and Na_2SO_4 only $NaHCO_3$ decomposes on heating to give CO_2 gas, according to the equation $2NaHCO_3 \longrightarrow Na_2CO_3 + CO_2 + H_2O$

moles of $CO_2 = \frac{PV}{RT} = \frac{750 \times 123.9}{760 \times 1000 \times 0.082 \times 298} = 5 \times 10^{-3}$

$\therefore$ moles of $NaHCO^3$ $= 2 \times 5 \times 10^{-3} = 0.01$

Equivalents of HCl used = $\frac{150\times(1/10)}{1000}=1.5\times10^{-2}$

Equivalents of $NaHCO_3$ in 1.5 g = 0.01 × $\frac{1.5}{2}$

= 7.5×10^{-3}

∴ Equivalents of Na_2CO_3 = $1.5 \times 10^{-2} - 7.5 \times 10^{-3} = 7.5 \times 10^{-3}$

Moles of Na_2CO_3 = $\frac{7.5\times10^{-3}}{2}$

(when Na_2CO_3 reacts with HCl it gives NaCl, CO_2 and H_2O. No atom undergoes change in oxidation state. ∴ 'n' factor of Na_2CO_3 = 2)

= 3.75×10^{-3}

Mass of $NaHCO_3$ in 1.5 g = $7.5 \times 10^{-3} \times 84 = 0.63$ g

Mass of Na_2CO_3 in 1.5 g = $3.75 \times 10^{-3} \times 106 = 0.3975$ g

∴ mass of Na_2SO_4 = 1.5 – 0.63 – 0.3975

= 0.4725 g

Percentage of $NaHCO_3$ = $\frac{0.63}{1.5}\times100=42\%$

Percentage of Na_2CO_3 = $\frac{0.3975}{1.5}\times100=26.5\%$

Percentage of Na_2SO_4 = $\frac{0.4725}{1.5}\times100=31.5\%$

4. Total moles of the mixture = $\frac{1}{22.4}=0.0446=4.46\times10^{-2}$

Equivalents of $Na_2S_2O_3$ solution = $\frac{40}{1000}\times\frac{1}{10}=4\times10^{-3}$

Equivalents of I_2 = 4×10^{-3}

equivalents of KI = 4×10^{-3}

equivalents of O_3 = 4×10^{-3}

when O_3 reacts with KI it converts to O_2 and O^{-2}

∴ the 'n' factor for O_3 in this reaction is 2

moles of O_3 = $\frac{4\times10^{-3}}{2}=2\times10^{-3}$

moles of O_2 = $4.46 \times 10^{-2} - 2 \times 10^{-3} = 4.26 \times 10^{-2}$

∴ mass percent of ozone in the mixture = $\frac{2\times10^{-3}\times48}{2\times10^{-3}\times48+4.26\times10^{-2}\times32}\times100$ = 6.57%

number of O_3 molecules = $2 \times 10^{-3} \times 6.023 \times 10^{23} = 1.2 \times 10^{21}$

∴ number of photons required = 1.2×10^{21}

5. Potassium selenate is isomorphous to K_2SO_4 and thus its molecular formula is K_2SeO_4.

Now molecular weight of K_2SeO_4 = (39 × 2 + a + 4 × 16)

= (142 + a)

where a is atomic weight of Se

(142 + a)g K_2SeO_4 has Se = ag

$\therefore$ 100g K_2SeO_4 has Se = $\frac{a \times 100}{142 + a}$

$\because$ % of Se = 45.52

$\therefore$ = 45.52

$\therefore$ a = 118.2

Also equivalent of K_2SeO_4 = $\frac{Mol.\ \text{wt.}}{2} = \frac{2 \times 39 + 118.2 + 64}{2}$ = **130.1**

6. $\left(\text{Molarity} = \frac{\text{Normality}}{\text{No. of replaceable } OH^-} \right)$

N = M × 2

Thus Meq. of borax in solution = 50 ´ 0.2 ´ 2 = 20

$\therefore \frac{w}{M/2} \times 1000 = 20$

$\therefore \frac{w}{382/2} \times 1000 = 20$ \ w = 3.82g

For neutralization of HCl

Meq. of HCl = Meq. of borax

$$25 \times 0.1934 = \frac{w}{382/2} \times 1000$$

$\therefore$ Weight of borax = 0.09235g

For neutralization of H_2SO_4

Meq. of borax = Meq. of H_2SO_4

$$\frac{w}{382/2} \times 1000 = 25 \times 0.1934 \times 2$$

$\therefore$ Weight of borax = **1.847g**

7. The reactions are

$H_2O + 2KI + O_3 \longrightarrow 2KOH + I_2 + O_2$

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

And $2S_2^{2+} \longrightarrow S_4^{+5/2} + 2e^-$

$\therefore$ Meq. of I_2 = Meq. of $Na_2S_2O_3$ = 1.5 × 0.01 = 1.5 × 10^{-2}

or mM of I_2 = = 7.5 × 10^{-3}

$\therefore$ mM of O_3 = mM of I_2 = 7.5 × 10^{-3}

(Mole ratio of $O_{-3} : I_2$ :: 1: 1)

$P_{O_3} = \frac{7.5 \times 10^{-6} \times 0.0821 \times 300}{10}$ = 184.725 × 10^{-7} atm

$\therefore$ Volume % of O_3 = 184.725 x 10^{-7} × 100 = 1.847 × 10^{-3} %

8. $n_{CaCO_3} + n_{BaCO_3}$ = $\frac{168}{22400}$ = = 7.5 × 10^{-3} —— (1)

$2BaCO_3 \longrightarrow 2BaCrO_4 \longrightarrow BaCr_2O_7 \longrightarrow I_2 + Na_2S_2O_3$

eq. of $Na_2S_2O_3$ = eq. of I_2 = eq of $BaCr_2O_7$ $= \dfrac{20\times10^{-3}\times0.05\times100}{10}$ = 1×10^{-2}

Moles of $BaCr_2O_7$ = $\dfrac{1}{6} \times 10^{-2}$

Moles of $BaCrO_4$ = $\dfrac{2}{6}(1 \times 10^{-2})$

Moles of $BaCO_3$ = $\dfrac{1}{3} \times 10^{-2} = 3.33 \times 10^{-3}$ —— (2)

Weight of $BaCO_3$ = 0.650 gm
From equation (1) and (2) we get
 = 4.17×10^{-3}

weight of $CaCO_3$ = $100\times4.17\times10^{-3}$ = 0.417 g

weight of CaO = 1.249 - 0.656 – 0.417 = 0.176

% of CaO = $\dfrac{0.176}{1.249}\times100$ = 14.09%

9. Meq. of alkali added = 30 × 0.04 = 1.2
Meq. of alkali left = 22.48 × 0.024 = 0.54
$\therefore$ Meq. of alkali for SO_2 and H_2O_2 = 1.2 – 0.54 = 0.66

$\therefore$ Weight of alkali used = $\dfrac{0.66\times40}{1000}$ = 0.0264

80g NaOH reacts with 64g SO_2

$\therefore$ 0.0264g NaOH reacts = $\dfrac{64\times0.0264}{80}$ = 0.021g SO_2

Now 64g SO_2 required = 32g S

$\therefore$ 0.021g SO_2 required = $\dfrac{32\times0.021}{64}$ = 0.0105g

$\therefore$ % of S = $\dfrac{0.0105}{5.6}\times100$ = 0.1875%

10. Let Al, Mg and Cu be a, b and c g respectively.

$2Al + 2NaOH \longrightarrow 2NaAlO_2 + 3H_2$

$Mg + 2HCl \longrightarrow MgCl_2 + H_2$

$Cu + HCl \longrightarrow$ No reaction

i.e., only Al reacts with NaOH and then only Mg reacts with HCl

$\therefore$ a + b + c = 8.72
b + c = 2.10 (Residue left after alkali treatment)
c = 0.69 (Residue left after acid treatment)
$\therefore$ b = 6.62g

$\therefore$ % of Al = $\dfrac{6.62}{8.72}\times100$ = 75.9

% of Mg = $\frac{1.41}{8.72}\times100$ = 16.2

% of Cu = $\frac{0.69}{8.72}\times100$ = 7.9

11. $2KClO_3 + 12HCl \longrightarrow 2KCl + 6H_2O + 6Cl_2$

$Cl_2 + 2KI \longrightarrow 2KCl + I_{-2}$

Also Meq. of Cl_2 = Meq. of Hypo = 100 × 1

$\left[\because N_{Hypo} 12.3 = 24.6\times0.5;\ \therefore N_{Hypo} = 1\right]$

Also $\text{mM of } KClO_3 = \frac{2\times \text{mM of } Cl_2}{6} = \frac{2\times50}{6} = \frac{50}{3}$

Also $\frac{w}{122.5}\times1000 = \frac{50}{3}$ $\left[\text{milli-mole (mM)}=\frac{\text{Wt.}\times1000}{\text{mol. wt.}}\right]$ $W_{KClO_3} = 2.042$

$\% \text{ of } KClO_3 = \frac{2.042}{2.48}\times100 = 82.32\%$

12. Let atomic weight of P and Q are a and b respectively

$\therefore$ Molecular weight of P_2Q_3 = 2a + 3b and Molecular weight of PQ_2 = a + 2b

Now given that 0.15 mole of P_2Q_3 weigh 15.9g

$(2a+3b) = \frac{15.9}{0.15}$ $\left(\therefore \frac{\textbf{wt.}}{mol.\text{ wt.}} = mole\right)$

Similarly, $(a+2b) = \frac{9.3}{0.15}$

Solving these two equations
b = 18, a = 26

13. Redox changes are

Case I: $Fe^{2+} \xrightarrow{\text{Zn dust}+H_2SO_4} Fe^{2+}$ (i.e. no change)

$2e + Fe_2^{3+} \xrightarrow{\text{Zn dust + }H_2SO_4} 2Fe^{2+}$

Zn dust is used as reducing agent and thus,
Let a meq. of Fe^{2+} and b Meq. of Fe^{3+} be present in 25 mL solution. In case I, after reduction with Zn.
Meq. of Fe^{2+} + Meq. of Fe^{2+} from Fe^{3+} = a + b
Now these are oxidized by $K_2Cr_2O_7$
Total meq. of Fe^{2+} = Meq. of $K_2Cr_2O_7$

$a + b = 34.25\times\frac{1}{10}$

a + b = 3.425 …(1)
Case II: If reduction is not made, the solution contains Fe^{2+} and Fe^{3+} of which only Fe^{2+} are oxidized by $K_2Cr_2O_7$.
Meq. of Fe^{2+} = Meq. of $K_2Cr_2O_7$

a = $22.45\times\frac{1}{10}$, a = 2.245

By equation (1) b = 3.425 – 2.245 = 1.18

Meq. of $FeSO_4$ = a = 2.245 (in 25 mL)

Meq. of $Fe_2(SO_4)_3$ = b = 1.18 (in 25 mL)

Milli equivalent of H_2O_2 = milli equivalent of I_2 = milli equivalent of $Na_2S_2O_3$

Milli equivalent of H_2O_2 = milli equivalent of $Na_2S_2O_3$

$\therefore$ Meq. of $FeSO_4$ = a = 2.245 Meq. of $Fe_2(SO_4)_3$ = b = 1.18

$\because$ Meq. of $FeSO_4 = a = 2.245$ $\therefore \frac{w}{M/2}\times 1000 = 1.18$

$\therefore \frac{w}{M/1}\times 1000 = 2.245$ $\because$ M. wt. of $Fe_2(SO_4)_3 = 400$

$\because$ M. wt. of $FeSO_4 = 152$ $\therefore$ Wt. of $Fe_2(SO_4)$ in 25 mL=0.236g

$\therefore$ Wt. of $FeSO_4$ in 25 mL = 0.341g $\therefore$ Strength of $Fe_2(SO_4)_3 = 9.45g/\text{litre}$

$\therefore$ Strength of $FeSO_4 = 13.64g/\text{litre}$

14. me of H_2O_2 in 50mL = me of hypo = 40 x 0.5 = 20me

Normality = $\frac{20}{50} = 0.4N$; Molarity = $\frac{0.4}{2} = 0.2M$

$(n = 2)$

Vol. Strength = M x 11.2 = 0.2 x 11.2

15. $K\underline{\overset{+7}{Mn}}O_4 \longrightarrow \underline{\overset{+2}{Mn}}SO_4$, $H_2\underline{\overset{+3\times2}{C_2}}O_4 \longrightarrow 2\underline{\overset{+4}{C}}O_2$ $K_2\underline{\overset{+6\times2}{Cr_2}}O_7 \longrightarrow \underline{\overset{+3\times2}{Cr_2}}(SO_4)_3$

n-factor = 7 – 2 = 5 n-factor = 6 – 4 = 2 n-factor = 2(6 – 3) = 6

So, 0.5 M oxalic acid = 2 × 0.5 i.e. 1 N oxalic acid

0.1 M $K_2Cr_2O_7$ = 6 × 0.1 i.e. 0.6N $K_2Cr_2O_7$

No. of milli equiv. of $KMnO_4$ in the sample

= No. of milli equivalents of oxalic acid reacted with it

= (no. of milli equivalents of oxalic acid taken) –

(no. of milli equivalents of oxalic acid remained unreacted)

= (no. of milli equivalents of oxalic acid taken) –

(no. of milli equivalents of $K_2Cr_2O_7$ consumed.

= 62 × 1 – 20 × 0.6 = 50

No. of milli equivalents $KMnO_4$ = Weight of $KMnO_4$

= 10 × 10^{-3} × 158 = 1.58g. Hence i.e. 79%

PREVIOUS YEAR IIT-JEE QUESTIONS

Previous IIT-JEE Questions Solutions

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

   or $x = 2 - 1 \Rightarrow x = +1$

2. (B) Tips/Formula

   (i) Write balance chemical equation for given change.

   (ii) Identify most electronegative element and find its oxidation state.

   Method :

   $$BaO_2 + H_2SO_4 \rightarrow BaSO_4 + H_2O_2$$

   Oxygen being the most electronegative element in the reaction has the oxidation states of –1 (in H_2O_2) and –2 (in $BaSO_4$).

3. Write reaction for titration between Na_2CO_3 and HCl.

   Method :

   $$\underset{\text{(Yellow colour with HPh)}}{Na_2CO_{3(aq)}} + HCl_{(aq)} \rightarrow \underset{\text{(no colour with HPh)}}{NaHCO_3} + \underset{\text{(Half neutralisation)}}{NaCl_{(aq)}}$$

   From this reaction it is clear that

   (i) 2 moles of HCl are required for complete neutralization of Na_2CO_3.

   (ii) Titre value using phenolphthalein corresponds only to neutralization of Na_2CO_3 to $NaHCO_3$, i.e. half of the value required Na_2CO_3 solution.

   (iii) Titre value using methyl orange corresponds to complete neutralization of Na_2CO_3

   Both S and E are correct but S is not correct explanation of E.

4. Balance the reaction by ion electron method.

   Oxidation reaction : $C_2O_4^{2-} \rightarrow 2CO_2 + 2e^-] \times 5$

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

   Net reaction : $2MnO_4^- + 16H^+ + 5C_2O_4^{2-} \rightarrow 10CO_2 + 8H_2$

5. MnO_4^- oxides both Fe^{2+} and $C_2O_4^{2-}$

   FeC_2O_4 ƒ $Fe^{2+} + C_2O_4^{2-}$

   $Fe^{2+} + C_2O_4^{2-}$ ® $Fe^{3+} + 2CO_2 + 3e^-$;

   $MnO_4^- + 5e^-$ ® Mn^{2+}

$$5FeC_2O_4 \equiv 3MnO_4^- \text{ or } 1FeC_2O_4 \equiv \frac{3}{5}MnO_4^-$$

6. (i) H_3PO_3 is dibasic acid

(ii) Normality = Molarity × Basicity of acid

Normality = 0.3 × 2 = 0.6

7. In an ion sum of oxidation states of all atoms is equal to charge on ion and in a compound sum of oxidation states of all atoms is always zero.

Oxidation state of Mn in $MnO_4^- = +7$

Oxidation state of Cr in $Cr(CN)_6^{3-} = +3$

Oxidation State of Ni in $NiF_6^{2-} = +4$

Oxidation state of Cr in $CrO_2Cl_2 = +6$

9. (i) Oxidation is loss of electron and oxidation number increases during oxidation. Where as reduction is gain of electron and oxidation number decreases during reduction

(ii) In a disproportionation reaction same element undergoes oxidation and reduction during the reaction.

(iii) In decomposition reaction; a molecule breaks down in more than one atoms or molecules.

$$2\overset{+1}{Cl}O^-_{(aq)} \rightarrow \overset{+5}{Cl}O_3 + 2\overset{-1}{Cl}^-_{(aq)}$$

It is disproportionation reaction because Cl is both oxidized (+1 to +5) and reduced (+ 1 to –1) during reaction.

10. Eq. wt. of $H_2C_2O_4.2H_2O$ = Eq. wt. of NaOH

Strength of $H_2C_2O_4.2H_2O$ (in g/L)

$$= \frac{6.3}{250/1000} = 25.2\,g/L$$

$$\text{Normality of } H_2C_2O_4.2H_2O = \frac{\text{Strength}}{\text{Eq. wt}} = \frac{25.3}{126/2} = 0.4\,N$$

$$V_2 = \frac{0.4 \times 10}{01} = 40ml$$

11. (i) Find change in oxidation number of Cr atom

(ii) $\text{Eq. wt.} = \frac{\text{Molecular wt.}}{\text{change in O.N.}}$

In iodometry, $K_2Cr_2O_7$ liberates I_2 from iodides (NaI or KI) which is titrated with $Na_2S_2O_3$ solution

$$K_2Cr_2O_7 + I^- + H^+ \rightarrow Cr^{3+} + I_2$$

Here, one mole of $K_2Cr_2O_7$ accepts 6 mole of electrons.

$\therefore$ Equivalent weight $= \dfrac{\text{Molecular weight}}{6}$.

12. (i) Mass of one electron = 9.108×10^{-31} kg

(ii) 1 mole of electron = 6.023×10^{23} electrons

Weight of 1 mole of electron

= Mass of electron × Avogadro Number

= $9.108 \times 10^{-31} \times 6.023 \times 10^{23}$

$\therefore$ No. of moles of electrons in 1 kg

$$= \frac{1}{9.108 \times 10^{-31} \times 6.023 \times 10^{23}} = \frac{1}{9.108 \times 6.023} \times 10^{8}$$

13. Molecular weight in gms = 6.023×10^{23} atoms

(i) Number of atoms in 24 g of C

$$= \frac{24}{12} \times 6.023 \times 10^{23} = 2 \times 6.023 \times 10^{23} \text{ atoms}$$

(ii) Number of atoms in 56 g of Fe

$$= \frac{56}{56} \times 6.023 \times 10^{23} = 6.023 \times 10^{23} \text{ atoms}$$

(iii) Number of atoms in 27 g of Al

$$= \frac{27}{27} \times 6.023 \times 10^{23} = 6.023 \times 10^{23} \text{ atoms}$$

(iv) Number of atoms in 108 g of Ag

$$= \frac{108}{108} \times 6.023 \times 10^{23} = 6.023 \times 10^{23} \text{ atoms}$$

$\therefore$ 24 g of C has maximum number of atoms.

14. Write the reaction for chemical change during reaction and equate moles.

Given mixture x = 0.02 mol of $[Co(NH_3)_5SO_4]$ Br and 0.02 mol of $[Co(NH_3)_5Br]$ SO_4

Volume = 2 L

$\because$ Mixture x has 0.02 mol. of $[Co(NH_3)_5SO_4]$ Br and 0.2 mol of $[Co(NH_3)_5Br]$ SO_4 in 2 L

$\therefore$ Conc. of $[Co(NH_3)_5SO_4]$ Br and $[Co(NH_3)_5Br]SO_4$ = 0.01 mol/L for each of them

(i) 1 L mixture of X + excess $AgNO_3 \rightarrow$ Y

$$\underset{0.1\ \text{mol/L soluble}}{[Co(NH_3)_5SO_4]Br} + \underset{\text{excess }0.01\text{ mol}}{AgNO_3} \rightarrow [Co(NH_3)_5SO_4]NO_3 + \underset{(Y)}{AgBr}$$

$\therefore$ No. of moles of Y = 0.01

(ii) 1 L mixture of Y + excess $BaCl_2 \rightarrow$ Z

$$\underset{0.1\ \text{mol/L soluble}}{[Co(NH_3)_5Br]SO_4} + \underset{\text{excess }0.01\text{ mol}}{BaCl_2} \rightarrow [Co(NH_3)_5Br]Cl_2 + \underset{(Z)\ 0.01\ \text{mol/L}}{BaSO_4}$$

$\therefore$ moles of z = 0.01.

15. The sum of oxidation states of all atoms in compound is equal to zero and sum of oxidation states of all atoms in an ion is equal to charge on the ion.

(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,

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

(iii) TiO_3, O.N. of Ti = 6, MnO_2 O.N. of Mn = + 4

MnO_3, O.N. of Mn = +6

16. $6Fe^{2+} + Cr_2O_7^{2-} + 14H^+ \rightarrow 6Fe^{3+} + 2Cr^{3+} + 7H_2O$ Mohr's salt $(FeSO_4.(NH_4)_2SO_4.6H_2O)$ and dichromate reacts in 6 : 1 molar ratio.

Subjective Questions

1. Let the amount of $NaNO_3$ in the mixture = x g

$\therefore$ The amount of $Pb(NO_3)_2$ in the mixutre = (5 – x)g

Heating effect of sodium nitrate and hlead nitrate

$$\underset{2(23+14+48)=170\text{g}}{2NaNO_3} \xrightarrow{\Delta} 2NaNO_2 + \underset{2\times16=32\text{g}}{O_2}$$

$$\underset{2(207+28+96)=662\text{g}}{2Pb(NO_3)_2} \xrightarrow{\Delta} 2PbO_2 + \underbrace{\underset{4(14+32)=184\text{g}}{4NO_2} + \underset{2\times16=32\text{g}}{O_2}}_{216\text{g}}$$

Thus, 170 g of $NaNO_3$ gives = 32 g of O_2

$\therefore$ x g of $NaNO_3$ gives = $\frac{32}{170} \times$ x g of O_2

Similarly, 662 g of $Pb(NO_3)_2$ gives = 216 g of gases

(5 – x) g of $Pb(NO_3)_2$ gives = $\frac{216}{662} \times (5 - x)$ g of gases

Actual, loss, on heating, is 28% of 5 g of mixture

$$= \frac{5 \times 28}{100} = 1.4\text{g}$$

\ $\frac{32x}{170} + \frac{216}{662} = (5 - x) = 1.4$

32x + 662 + 216 (5 – x) × 170 = 1.4 × 170 × 662

21184 x + 183600 – 36720 x = 157556 – 15536x = 26044

x = 1.676 g

wt. of $NaNO_3$ = 1.676 g

and wt. of $Pb(NO_3)_2$ = 5 – 1.676 = 3.324 g

2. $\text{Molarity} = \frac{\text{Mass of solute / M.wt. solute}}{\text{Mass of solvent in kg}}$

Mass of H_2SO_4 in 100 ml of 93% H_2SO_4 solution = 93 g

\ Mass of H_2SO_4 in 1000 ml of the H_2SO_4 solution = 93- g

Mass of 1000 ml H_2SO_4 solution = 1000 × 1.84 = 1840 g = 910 g = 0.910 kg

Moles of $H_2SO_4 = \frac{\text{Wt. of } H_2SO_4}{\text{Mol. wt. of } H_2SO_4} = \frac{930}{98}$

\ Moles of H_2SO_4 in 1 kg of water

$$= \frac{930}{98} \times \frac{1}{0.910} = 10.43 \text{ mol.}$$

\ Molality of 1 litre solution = 10.43

3. In the given problem, a solution containing Cu^{2+} and $C_2O_4^{2-}$ is titrated first with $KMnO_4$ and then with $Na_2S_2O_3$ in presence of KI. In titration with $KMnO_4$, it is the $C_2O_4^{2-}$ ions that react with the MnO_4^- ions. The concerned balanced equation may be written as below.

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

Thus according to the above reaction

$$2 \text{ mol } MnO_4^- \equiv 5 \text{ mol of } C_2O_4^{2-}$$

However,

No. of mmol of MnO_4^- and used in titration = Vol. in ml × M = 22.6 × 0.02 = 0.452 mmol MnO_4^-

\ Molar ratio of Cu^{2+} to $C_2O_4^{2-} = \frac{0.565 \text{ mmol}}{1.130 \text{ mmol}} = 1:2$

4. Mass of Fe_2O_3 in the sample $= \frac{55.2}{100} \times 1 = 0.552g$

Number of moles of $Fe_2O_3 = \frac{55.2}{159.8} = 3.454 \times 10^{-3}$

Number of moles of Fe^{3+} ions $= 2 \times 3.454 \times 10^{-3} = 6.9 \times 10^{-3}$ mol = 6.90 mmol

Since there is only 1 electron is exchanged in the conversion of Fe^{3+} to Fe^{2+}, the molecular mass is the same as equivalent mass.

$\therefore$ Amount of Fe^{2+} ion in 100 ml. of sol. = 6.90 meq.

Volume of oxidant used for 100 ml of Fe^{2+} sol. $= 17 \times 4 = 68$ ml.

Amount of oxidant used $= 68 \times 0.0167$ mmol = 1.1356 mmol

Let the number of electrons taken by the oxidant = n

$\therefore$ No. of meq. of oxidant used $= 1.1356 \times n$

Thus $1.1356 \times n = 6.90$

$$n = \frac{6.90}{1.1356} = 6$$

5. 1.5 g of sample require = 150 ml. of $\frac{M}{10}$ HCl

$\therefore$ 2 g of sample require $= \frac{150 \times 2}{1.5}$ ml. of $\frac{M}{10}$ HCl

$= 200$ ml. of $\frac{M}{10}$ HCl

On heating, the sample, only $NaHCO_3$ undergoes decomposition as below :

$$2NaHCO_3 \rightarrow Na_2CO_3 + H_2O + CO_2 \uparrow$$

2 moles 1 mole

2 equ. 1 mole

Neutralization of the sample with HCl takes place as below.

$$NaHCO_3 + HCl \rightarrow NaCl + H_2O + CO_2$$

1 eq. 1 eq.

$$Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$$

1 mole 2 mole

2 eq. 2 eq.

Hence, 2 g sample $\equiv$ 200 ml. of M/10 HCl

= 200 ml. of N/10 HCl = 20 meq. = 0.020 eq.

Number of moles of CO_2 formed, i.e.

$$n = \frac{PV}{RT} = \frac{750}{760} \times \frac{123.9}{1000} \times \frac{1}{0.082 \times 298} = 0.005$$

Moles of $NaHCO_3$ in the sample (2g) = 2 × 0.005 = 0.01

Equivalent of $NaHCO_3$ = 0.01

Wt. of Na_2CO_3 = 0.01 × 53 = 0.53 g

$\therefore$ $\% \text{ of } Na_2CO_3 = \frac{0.53 \times 100}{2} = 26.5\%$

$\therefore$ % of Na_2SO_4 in the mixture = 100 – (42 + 26.5) = 31.5%

6. Reaction involved titration is

$KIO_3 + 2KI + 6HCl \rightarrow 3ICl + 3KCl + 3H_2O$

1 mole 2 mole

20 ml. of stock KI solution = 30 ml. of $\frac{M}{10}$ KIO_3 solution

Molarity of KI solution $= \frac{30 \times 1 \times 2}{20 \times 10} = \frac{3}{10}$

Millimoles in 50 ml. of KI solution $= 50 \times \frac{3}{10} = 15$

Millimoles of KI left unreacted with $AgNO_3$ solution $= 2 \times 50 \times \frac{1}{10} = 10$

$\therefore$ Millimoles of KI reacted with $AgNO_3$

Millimoles of $AgNO_3$ present $AgNO_3$ solution = 5

Molecular weight of $AgNO_3$

$\therefore$ Wt. of $AgNO_3$ in the solution = 5 × 10^{-3} × 170 = 0.850 g

% $AgNO_3$ in the sample $= \frac{0.850}{1} \times 100 = 85\%$

7. Calculation of number of moles in 45 ml of 0.025 M $Pb(NO_3)_2$

Moles of $Pb(NO_3)_2$ $= 0.25 \times \frac{45}{1000} = 0.01125$

$\therefore$ Initial moles of Pb^{2+} = 0.01125

Moles of $NO_3^- = 0.01125 \times 2 = 0.02250$

Calculation of number of moles in 25 ml. of 0.1 M chromic sulphate

Moles of chromic sulphate $Cr_2(SO_4)_3 = 0.1' \frac{25}{1000} = 0.0025$ moles

Moles of SO_4^{2-} =0.0025 × 3 = 0.0075

Moles of $PbSO_4$ formed = 0.0075

Moles of Pb^{2+} left = 0.01125 – 0.0075 = 0.00375

Moles of NO_3^- left = 0.02250

Moles of chromium ions = 0.0025 × 2 = 0.005

Total volume of the solution = 45 + 25 = 70 ml.

\ Molar concentration of the species left.

(i) $Pb^{2+} = \frac{0.00375}{70}' \ 1000 = 0.05357\,M$

(ii) $NO_3^- = \frac{0.225}{70}' \ 1000 = 0.3214\,M$

(iii) $Cr^{3+} = \frac{0.005}{70}' \ 1000 = 0.0714\,M$

8. In pure iron oxide (FeO), iron and oxygen are present in the ratio 1 : 1.

However, here number of Fe^{2+} present = 0.93

or No. of Fe^{2+} ions missing = 0.07

Since each Fe^{2+} ion has 2 positive charge, the total number of charge due to missing (0.07) Fe^{2+} ions = 0.07 × 2 = 0.14.

To maintain electrical neutrality, 0.14 positive charge is replacement of one Fe^{2+} ion by one Fe^{3+} ions. Now since, replacement of one Fe^{2+} ion by one Fe^{3+} ion increases one positive charge, 0.14 positive charge must be compensated in short, 0.93 Fe^{2+} ions have 0.14 Fe^{3+} ions.

$100Fe^{2+}$ ions have $= \frac{0.14}{0.93}' \ 100 = 15.05\%$