1. A volume of 12.53 ml of 0.051 M SeO$_3^-$ reacts exactly with 25.5 ml of 0.1 M CrSO$_3^-$, which is oxidised to Cr$^{3+}$. To what oxidation state was the selenium converted by the reaction?

2. In basic solution CrO$_4^{2-}$ ion oxidises S$_2$O$_3^{2-}$ ion to form Cr(OH)$_3$ and SO$_4^{2-}$ ions respectively. How many ml of 0.154 Na$_2$CrO$_4$ solution are required just to react with 40 ml of 0.246 M Na$_2$S$_2$O$_3$ solution.

3. 25 ml of 0.17 M HSO$_3^-$ in strongly acidic solution required the addition of 16.9 ml of 0.1 M MnO$_4^-$ for its complete oxidation to SO$_4^{2-}$. In neutral solution it requires 28.6 ml. Assign oxidation no. of Mn in each of the products.

4. A given amount of Fe$^{3+}$ is oxidised by x mol of MnO$_4^-$ in acidic medium. Calculate mol of CrO$_4^{2-}$ required same amount of Fe$^{3+}$ in acidic medium

5. Calculate mol of (a) MnO$_4^-$ and (b) CrO$_4^{2-}$ to oxidise 1 mol of FeC$_2$O$_4$ (ferrous oxalate) in acidic medium.

6. A mixture of Na$_2$C$_2$O$_4$ and KH$_2$C$_2$O$_4$ required equal volume of 0.1 M KMnO$_4$ and 0.1 M NaOH separately. What is the molar ratio of Na$_2$C$_2$O$_4$ and KH$_2$C$_2$O$_4$ in the mixture?

7. 5.5 gm of a mixture of FeSO$_4$.7H$_2$O and Fe$_2$(SO$_4$)$_3$.9H$_2$O requires 5.4 ml of 0.1 N KMnO$_4$ solution for complete oxidation. Calculate the no. of gm moles of hydrated ferric sulphate in the mixture?

8. 19.6 gm of ferrous ammonium sulphate [FeSO$_4$.NH$_3$.SO$_4$.6H$_2$O] were dissolved and made up to 500 ml with acidified water. 25 ml of this solution required 20 ml and 27.5 ml of the solution A and B of KMnO$_4$, respectively. How many ml of A must be added to 1 litre of B to make N/10 KMnO$_4$ solution.

9. 0.5 gm of an oxalate was dissolved in water and the solution raised to 100 ml. 10 ml of this solution when titrated with N/20 KMnO$_4$ required 10 ml of KMnO$_4$. Calculate the % of oxalate ion in the sample. (K = 39, Mn = 55)

10. Hydroxylamine reduced iron (+3) according to eq. $2\text{NH}_2\text{OH} + 4\text{Fe}^{3+} \rightarrow \text{N}_2\text{O}(g) + 4\text{H}^+ + 4\text{Fe}^{2+}$. Iron (+2) thus produced is estimated by titration with a standard solution of permagnate. The reaction is MnO$_4^-$ + 5Fe$^{2+}$ + 8H$^+$ → Mn$^{2+}$ + 5Fe$^{3+}$ + 4H$_2$O. A 10 ml solution of hydroxylamine solution was boiled to a litre 50 ml of this solution was boiled with an excess of iron (+3) solution. The resulting solution required 10 ml of 0.02 M KMnO$_4$ solution for complete oxidation or iron (+2). Calculate the weight of hydroxylamine in one litre of the original solution.

11. A 10 gm mixture of Cu$_2$S and CuS was treated with 200 ml of 0.75 M MnO$_4^-$ in acid solution, producing SO$_4^-$, Cu$^{2+}$ and Mn$^{2+}$. The SO$_4^-$ was boiled off and the excess of MnO$_4^-$ was titrated with 175 ml of 01.0 M Fe$^{3+}$ solution. Calculate the % CuS in the original solution.

12. A solution of 0.2 gm of a compound containing Cu$^{2+}$ and C$_2$O$_4^{2-}$ ions on titration with 0.02 M KMnO$_4$ in presence of H$_2$SO$_4$ consumed 22.6 ml of the oxidant. The resultant solution is neutralized with Na$_2$CO$_3$, acidified with dilute acetic acid and treated with excess KI. The liberated I$_2$ required 11.3 ml of 0.05 M Na$_2$S$_2$O$_3$ solution for complete reduction. Find out the mole ratio of Cu$^{2+}$ and C$_2$O$_4^{2-}$ in the compound.

13. 5 ml 8N HNO$_3$, 4.8 ml of 5N HCl, 1.4 gm of NaOH and a certain volume of 17 M H$_2$SO$_4$ are mixed together and made upto 2 litres. 50 ml of this solution exactly neutralized 32.9 ml of barium hydroxide solution containing 2.21 gm of Ba(OH)$_2$, 8H$_2$O in 100 ml of solution. Calculate (a) the volume H$_2$SO$_4$, used (b) The amount in grams of sulphate ion in the solution.

14. A polyvalent metal weighing 0.1 gm and having at. wt. 51 reacted with dil. H$_2$SO$_4$ to give 43.9 ml of hydrogen at S.T.P. The solution containing the metal in this lower oxidation state, was found to require 58.9 ml of 0.1 N permagnate for complete oxidation. What are the valencies of the metal.
15. A sample of ferrous sulphate and ferrous oxalate was dissolved in dil. H₂SO₄. The complete oxidation of reaction mixture require 40 ml of N/15 KMnO₄. After the oxidation the reaction mixture was reduced by Zn and H₂SO₄. On again oxidation by same KMnO₄, 25 ml of KMnO₄ was required. Calculate the ratio of Fe atoms in ferrous sulphate and oxide.

16. A sample of Fe₃(O₃)₂ and FeC₂O₄ was dissolved in dil H₂SO₄. The complete oxidation of reaction mixture req. 40 ml of N/16 KMnO₄. After the oxidation mixture was reduced by Zn and dil. H₂SO₄. On again oxidation by same KMnO₄, 60 ml were require. Calculate the ratio of millimoles of Fe₃(O₃)₂ and FeC₂O₄ in mixture.

17. A 6.0 gm sample contained Fe₂O₃, FeO, and inert materials. It was treated with an excess of KI in acid, which reduced all iron to Fe²⁺. The resulting solution was diluted to 50 ml, and a 10 ml sample of it was taken. The liberated iodine in the small sample was titrated with 5.5 ml of 1M Na₂S₂O₃ solution yielding S₂O₃²⁻. The iodine from another 25 ml sample was extracted, after which the Fe²⁺ was titrated with 3.2 ml of 1.0 M MnO₄²⁻ in H₂SO₄ solution. Calculate the percentage of Fe₂O₃ and FeO in the original mixture.

19. A 50.0 cm³ portion of a mixture of H₂SO₄ and H₂C₂O₄ required 48.9 cm³ of 0.15 M NaOH solution for titration. Another 50 cm³ required 38.9 cm³ of 0.10 N KMnO₄ solution for titration. Calculate the masses of H₂SO₄ and H₂C₂O₄ present per dm³ of the solution.

20. A 5.0 cm³ solution of H₂O₂ liberates 0.508g of iodine from an acidified KI solution. Calculate the strength of H₂O₂ solution in terms of volume strength at STP.

21. A 3.00 g sample containing Fe₂O₃, FeO, and an inert impure substance, is treated with excess of KI solution in presence of dilute H₂SO₄. The entire iron is converted into Fe²⁺ along with the liberation of iodine. The resulting solution is diluted to 100 ml. A 20 ml of the diluted solution require 11.0 ml of 0.5 M Na₂S₂O₃ solution to reduce the iodine present. A 50 ml of the diluted solution after complete extraction of the iodine requires 12.80 ml of 0.25 M KMnO₄ solution in dilute H₂SO₄ medium for the oxidation of Fe²⁺. Calculate the percentages of Fe₂O₃ and FeO in the original sample.

22. One litre of a mixture of O₂ and O₃ at NTP was allowed to react with an excess of acidified solution of KI. The iodine liberated required 40 ml of M/10 sodium thiosulphate solution for titration. What is the percent of ozone in the mixture? Ultraviolet radiation of wavelength 300 nm can decompose ozone. Assuming that one photon can decompose one ozone molecule, how many photons would have been required for the complete decomposition of ozone in the original mixture?

23. An aqueous solution containing 0.10 g KIO₃ (formula wt. = 214.0) was treated with an excess of KI solution. The solution was acidified with HCl. The liberated I₂ consumed 45.0 ml of thiosulphate solution to decolourise the blue starch - iodine complex. Calculate the molarity of the sodium thiosulphate solution.

24. How many millilitre of 0.5 M H₂SO₄ are needed to dissolve 0.5 gm of copper II carbonate?

25. Hydrogen peroxide solution (20 ml) reacts quantitatively with a solution of KMnO₄ (20 ml) acidified with dilute H₂SO₄. The same volume of the KMnO₄ solution is just decolorized by 10 ml of MnSO₄ in neutral medium simultaneously forming a dark brown precipitate of hydrated MnO₂. The brown precipitate is dissolved in 10 ml of 0.2 M sodium oxalate under boiling condition in the presence of dilute H₂SO₄. Write the balanced equations involved in the reactions and calculate the molarity of H₂O₂.
**EXERCISE - I**

1. The equivalent weight of MnSO₄ is half its molecular weight when it is converted to:
   (A) Mn₂O₃  (B) MnO₂  (C) MnO⁴⁻  (D) MnO₄²⁻

2. Given the equation $\text{SO}_4^{2-} + 2\text{e}^- \rightarrow \text{SO}_2\text{O}_3^{2-}$, Mn³⁺ + 4H₂O → MnO₄⁻ + 8H⁺ + 5e⁻. How many moles of $\text{SO}_4^{2-}$ ions are required to oxidize 1 mole of Mn³⁺:
   (A) 0.4  (B) 0.5  (C) 2.5  (D) 1.0

3. A solution of 10 ml 0.1 M FeSO₄ was titrated with KMnO₄ solution in acidic medium. The amount of KMnO₄ used will be:
   (A) 5 ml of 0.1 M  (B) 10 ml of 0.1 M  (C) 10 ml of 0.5 M  (D) 10 ml of 0.02 M

4. NH₃·H₂O reacts with ferric sulphate as follows:
   $2\text{NH}_3\cdot\text{H}_2\text{O} + 4\text{Fe}^{3+} \rightarrow \text{N}_2\text{O}_4 + \text{H}_2\text{O} + 4\text{Fe}^{2+} + 4\text{H}^+$. The eq. wt. of NH₃·H₂O in this reaction is:
   (A) (mol. wt.)/1  (B) (mol. wt.)/2  (C) (mol. wt.)/3  (D) (mol. wt.)/4

5. 20 ml of 0.1 M solution of metal ion reacted with 20 ml of 0.1 M SO₄ solution. SO₄ reacted according to the equation: $\text{SO}_4^{2-} + 2\text{H}_2\text{O} \rightarrow \text{SO}_2\text{O}_3^{2-} + 4\text{H}^+ + 2\text{e}^-$. If the oxidation no. of metal ion was +3, the new oxidation number of the metal would be:
   (A) 0  (B) +1  (C) +2  (D) None of these

6. How many ml of 0.150 M Na₂CrO₄ will be required to oxidize 40 ml of 0.5 M Na₂S₂O₃:
   $\text{CrO}_4^{2-} + \text{S}_2\text{O}_3^{2-} + \text{Cr(OH)}_2 + \text{SO}_4^{2-}$:
   (A) 225 ml  (B) 355 ml  (C) 455 ml  (D) 555 ml

7. Number of moles of electrons taken up when 1 mole of NO₃⁻ ions is reduced to 1 mole of NH₃·H₂O is:
   (A) 2  (B) 4  (C) 5  (D) 6

8. The number of moles of thiosulphate ($\text{S}_2\text{O}_3^{2-}$) that will require to react completely with one mole I⁻ in alkaline medium (where it gets oxidised to $\text{SO}_4^{2-}$) is:
   (A) 1/4  (B) 4  (C) 8  (D) 1/8

9. The number of moles of oxalate KH₂C₂O₄, H₂C₂O₄·2H₂O oxidised by one mole of permanganate ion is:
   (A) 3/4  (B) 1  (C) 5/4  (D) 6/4

10. How many equivalents are there per mol of $\text{H}_2\text{S}$ in its oxidation to $\text{SO}_2$?
    (A) 2  (B) 4  (C) 6  (D) 8

11. 3 mol of a mixture of $\text{FeSO}_4$ and $\text{Fe}_2(\text{SO}_4)_3$ required 100 mL of 2M KMnO₄ solution in acidic medium. Hence mol fraction of $\text{FeSO}_4$ in the mixture is:
    (A) 1/3  (B) 2/3  (C) 2/5  (D) 3/5

12. In a reaction 4 moles of electron are transferred to one mole of HNO₃. When acted as an oxidant. The possible reduction product is:
    (A) 1/2 mole of $\text{N}_2$  (B) 1/2 mole of $\text{NO}_2$  (C) 1 mole of $\text{NO}_3^-$  (D) 1 mole of $\text{NH}_3$

13. One mole of $\text{N}_2\text{H}_4$ loses ten moles of electrons to from a new compound $\text{y}$. Assuming that all the nitrogen appears in the new compound. What is the oxidation state of nitrogen in $\text{y}$? There is no change in the oxidation state of hydrogen:
    (A) -1  (B) -3  (C) +3  (D) +5

14. 1 g equivalent of a substance is the weight of that amount of a substance which is equivalent to:
    (A) 0.25 mol of $\text{O}_2$  (B) 0.50 mol of $\text{O}_2$  (C) 1 mol of $\text{O}_2$  (D) 8 mol of $\text{O}_2$

15. Which of the following changes requires reducing agent?
    (A) $\text{CrO}_4^{2-} \rightarrow \text{Cr}_2\text{O}_7^{2-}$  (B) $\text{BrO}_3^- \rightarrow \text{BrO}^-$
    (C) $\text{H}_2\text{O}_2 \rightarrow \text{HAsO}_4^{2-}$  (D) $\text{Al(OH)}_3 \rightarrow \text{Al(OH)}_4^-$

16. Which of the following is a disproportionation reaction?
    (A) $\text{CaCO}_3 \rightarrow \text{Ca}^{2+} + \text{H}_2\text{O} + \text{CO}_2$  (B) $2\text{CrO}_4^{2-} + 2\text{H}^+ \rightarrow \text{Cr}_2\text{O}_7^{2-} + \text{H}_2\text{O}$
    (C) $\text{Cr}_2\text{O}_7^{2-} + 2\text{OH}^- \rightarrow 2\text{CrO}_4^{2-} + \text{H}_2\text{O}$  (D) $\text{Cu}_2\text{O} + 2\text{H}^+ \rightarrow \text{Cu} + \text{Cu}^{2+} + \text{H}_2\text{O}$

17. If equal volumes of 1M KMnO₄ and 1M K₃Cr₂O₇ solutions are allowed to oxidise Fe³⁺ in acidic medium.
    The amount of iron oxidised will be:
    (A) more by KMnO₄ solution  (B) more by K₃Cr₂O₇ solution
    (C) equal in both the cases  (D) cannot be determined

18. In the following reaction (unbalanced), equivalent wt. of As₂S₅ is related to molecular wt. M By:
    As₂S₅ + $\text{H}^+$ + $\text{NO}_3^-$ → NO + $\text{H}_2\text{O}$ + AsO₃²⁻ + $\text{SO}_4^{2-}$
    (A) $\frac{M}{2}$  (B) $\frac{M}{4}$  (C) $\frac{M}{28}$  (D) $\frac{M}{24}$
19. Mass of KHC₂O₄ (potassium acid oxalate) required to reduce 100 mL of 0.02 M KMnO₄ in acidic medium (to Mn²⁺) is x g, and to neutralise 100 mL of 0.05 M Ca(OH)₂ is y g then:
(A) x = y  
(B) 2x = y  
(C) x = 2y  
(D) None is Correct

20. 100 mL of 1 M KMnO₄ oxidise 100 mL of H₂O₂ in acidic medium (when MnO₄⁻ is reduced to Mn²⁺); volume of same KMnO₄ required to oxidise 100 mL of H₂O₂ in basic medium (when MnO₄⁻ is reduced to MnO₂) will be:
(A) (100/3) mL  
(B) (500/3) mL  
(C) (300/5) mL  
(D) 100 mL

21. 1 mol of ferric oxalate is oxidised by x mol of MnO₄⁻ and also 1 mol of ferrous oxalate is oxidised by y mol of MnO₄⁻ in acidic medium. The ratio (x/y) is:
(A) 2 : 1  
(B) 1 : 2  
(C) 3 : 1  
(D) 1 : 3

22. 0.7 gm of Na₂CO₃·xH₂O is dissolved in 100 mL, 20 ml of which required 19.8 ml of 0.1 N HCl. The value of x is:
(A) 4  
(B) 3  
(C) 2  
(D) 1

23. A metal is burnt in oxygen and all the products of combustion are weighed. It is found that the wt. of the metal seems to have increased by 24%. The equivalent wt. of the above metal is:
(A) 25  
(B) 24  
(C) 33.34  
(D) 76

24. When one gm mole of KMnO₄ reacts with H₂O, the volume of chlorine liberated at NTP will be:
(A) 11.2 litre  
(B) 22.4 litre  
(C) 44.8 litre  
(D) 56.0 litre

25. 10.78 g of H₃PO₄ in 550 mL solution is 0.40 N. Thus this acid is:
(A) has been neutralised to HPO₄²⁻  
(B) has been neutralised to PO₄³⁻  
(C) has been reduced to H₂PO₄⁻  
(D) has been neutralised to H₂PO₄⁻

26. When 0.75 gm of a substance was kjeldalised, it produced NH₃. Which neutralizes 30 ml of 0.25 N sulphuric acid. The percentage of nitrogen in the organic compound is:
(A) 14  
(B) 11  
(C) 1  
(D) None

27. 15 mol of KMnO₄ are treated with excess H₂C₂O₄ in H₂SO₄ medium. How many moles of CO₂ will be formed and how many moles of H₂C₂O₄ will be consumed?
(A) 75, 37, 5.  
(B) 3, 15  
(C) 3, 6  
(D) 75, 150

28. An equimolar mixture of NaH₂C₂O₄ and H₂C₂O₄ consumes 20 ml 0.3 M NaOH solution for complete neutralization. The same mixture requires V ml. 0.05 M KMnO₄ solution in acidic medium for oxidation.
The value of V is:
(A) 160 ml  
(B) 32 ml  
(C) 24 ml  
(D) None of these

29. Oxidation number of Fe in Fe₂O₄ is fractional because:
(A) It is a mixed [Fe(+2) – Fe(+4)] oxide  
(B) It is a non-stoichiometric compound  
(C) It is a mixed [Fe(+1) – Fe(+3)] oxide  
(D) None of the above

30. The oxidation state of Oxygen atom in potassium superoxide is:
(A) Zero  
(B) -1  
(C) -1  
(D) -2

31. The oxidation state of tungsten in Na₂W₄O₁₃·10H₂O is:
(A) +7  
(B) +6  
(C) +4  
(D) +4.5

32. Amongst the following identify the species with an atom in +6 oxidation state -
(A) MnO₄⁻  
(B) Cr(CN)₆³⁻  
(C) NiF₂⁻  
(D) Cr₂O₇²⁻

33. In [CrO₂(NH₃)₆(H₂O)]Cl₂, oxidation number of Cr is +3, then O₂ will be in the form:
(A) dioxide  
(B) peroxide  
(C) superoxide  
(D) oxide

34. An example of redox process is -
(A) CuSO₄ + Fe → FeSO₄ + Cu  
(B) Ca(OH)₂ + 2HCl → CaCl₂ + 2H₂O  
(C) CaO + 2HCl → CaCl₂ + H₂O  
(D) CaCO₃ → heat → CaO + CO₂

35. In the reduction of dichromate by Fe(II), the number of electrons involved per chromium atom is:
(A) 3  
(B) 1  
(C) 2  
(D) 4
36. Consider the following statement in the reaction: $\text{KIO}_3 + 5\text{KI} + 6\text{HCl} = 3\text{I}_2 + 6\text{KCl} + 3\text{H}_2\text{O}$
(a) $\text{Kl}$ is oxidised to $\text{I}_2$
(b) $\text{KIO}_3$ is oxidised to $\text{I}_2$
(c) $\text{KIO}_3$ is reduced to $\text{I}_2$
(d) Oxidation number of $\text{I}$ increases from $-1$ in $\text{KI}$ to zero in $\text{I}_2$ of these statements
(A) a, c and d are correct
(B) a, b and d are correct
(C) b and d are correct
(D) a alone is correct

37. Match list - I (compounds) with list - II (Oxidation state of nitrogen) and select the correct answer using the codes given below the lists -

<table>
<thead>
<tr>
<th>List - I</th>
<th>List - II</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A) $\text{NaN}_3$</td>
<td>(a) +5</td>
</tr>
<tr>
<td>(B) $\text{N}_2\text{H}_4$</td>
<td>(b) +2</td>
</tr>
<tr>
<td>(C) $\text{NO}$</td>
<td>(c) -1/3</td>
</tr>
<tr>
<td>(D) $\text{N}_2\text{O}_5$</td>
<td>(d) -2</td>
</tr>
</tbody>
</table>

Codes :-

A  B  C  D
(a)  c  d  b  a
(b)  d  c  b  a
(c)  c  d  a  b
(d)  d  c  a  b

38. In the reaction, $3\text{Br}_2 + 6\text{NaOH} \rightarrow \text{NaBrO}_3 + 5\text{NaBr} + 3\text{H}_2\text{O}$ which element loses as well as gains electrons -
(A) $\text{Na}$
(B) $\text{Br}$
(C) $\text{O}$
(D) $\text{H}$

39. Oxidation number of $\text{S}$ in $\text{H}_2\text{S}_2\text{O}_7$ is -
(A) +4
(B) -6
(C) -5
(D) +6

40. Oxidation number of $\text{S}$ in $\text{H}_2\text{SO}_3$ is 6. This is observed, because -
(A) There are five oxygen atoms in the molecule
(B) The hydrogen atom is directly linked with non-metal
(C) There is peroxide linkage in the molecule
(D) The sulphur atom shows co-ordinate linkage

41. The oxidation number of $\text{S}$ in $\text{Na}_2\text{S}_4\text{O}_6$ is -
(A) +2.5
(B) +2 and +3 (two $\text{S}$ have +2 and other two have +3)
(C) +2 and +3 (three $\text{S}$ have +2 and one $\text{S}$ has +3)
(D) +5 and 0 (two $\text{S}$ have +5 and the other two have 0)

42. The oxidation state of molybdenum in its oxo-complex species $[\text{MoO}_4(\text{C}_2\text{H}_4)_2(\text{H}_2\text{O})_2]^{2-}$ is
(A) +2
(B) +3
(C) +4
(D) +5

43. Which element will have the maximum oxidation number in $\text{K}_2\text{Cr}_2\text{O}_7$ and $\text{KMnO}_4$
(A) $\text{Mn}$
(B) $\text{Cr}$
(C) $\text{O}$
(D) $\text{K}$

44. Select the pair of oxidation processes,
(a) $2\text{Cu}^{2+} \rightarrow \text{Cu}^{+2}$
(b) $\text{MnO}_4^- \rightarrow \text{Mn}^{2+}$
(c) $[\text{Fe(CN)}_6]^{-2} \rightarrow [\text{Fe(CN)}_6]^{-3}$
(d) $2\text{I}^- \rightarrow \text{I}_2$
(A) a, b
(B) c, d
(C) a, d
(D) b, c

45. Carbon is in the lowest oxidation state in -
(A) $\text{CH}_4$
(B) $\text{CCl}_4$
(C) $\text{CF}_4$
(D) $\text{CO}_2$

46. $\text{AB}^{-} + \text{C}^{2+} \rightarrow \text{A}^{2-} + \text{C}^{3+}$
If the O.N. of $\text{B}$ is -2. Choose the true statement for the above change -
(A) O.N. of $\text{A}$ decreases by -5
(B) O.N. of $\text{C}$ decreases by +1
(C) O.N. of $\text{A}$ decreases by +5 and that of $\text{C}$ increases by +1
(D) O.N. of $\text{A}$ decreases by +5 and that of $\text{C}$ decreases by +1

47. Oxygen shows oxidation state of -1 in the compound -
(A) $\text{NO}_3$
(B) $\text{MnO}_2$
(C) $\text{PbO}_2$
(D) $\text{Na}_2\text{O}_2$

48. The oxidation number of $\text{Pt}$ in $[\text{Pt}((\text{C}_2\text{H}_4)\text{Cl})^-]$ is -
(A) +1
(B) +2
(C) +3
(D) +4

49. Which of the following reactions does not involve either oxidation or reduction -
(A) $\text{VO}^{2+} \rightarrow \text{V}_2\text{O}_5$
(B) $\text{Na} \rightarrow \text{Na}^+$
(C) $\text{Zn}^{2+} \rightarrow \text{Zn}$
(D) $\text{CrO}_4^{2-} \rightarrow \text{Cr}_2\text{O}_7^{2-}$

50. Which one is correctly matched:
<table>
<thead>
<tr>
<th>Substance</th>
<th>O.N. of S</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A) $\text{H}_2\text{S}$</td>
<td>+2</td>
</tr>
<tr>
<td>(B) $\text{H}_2\text{SO}_3$</td>
<td>+4</td>
</tr>
<tr>
<td>(C) $\text{H}_2\text{SO}_4$</td>
<td>+4</td>
</tr>
<tr>
<td>(D) $\text{Na}_2\text{S}_4\text{O}_6$</td>
<td>+2.5</td>
</tr>
</tbody>
</table>
EXERCISE – II

Multiple choice Question.

1. In the titration of \(K_2Cr_2O_7\) and ferrous sulphate, following data is obtained: \(V_1\) ml of \(1.0 \text{ M } K_2Cr_2O_7\) requires \(V_2\) ml of \(1.0 \text{ M } FeSO_4\). Which of the following relations is/are true for the above titration?
   (A) \(6M_1V_1 = M_2V_2\)  
   (B) \(M_1V_1 = 6 M_2V_2\)  
   (C) \(N_1V_1 = N_2V_2\)  
   (D) \(M_1V_1 = M_2V_2\)

2. \(Cr_2O_7^{2-}\) is reduced to \(Cr^{3+}\) by \(Fe^{2+}\). Identify the correct statement from the following:
   (A) 6 moles of \(Fe^{2+}\) are oxidised to \(Fe^{3+}\) ions.
   (B) The solution becomes yellow
   (C) The solution becomes green
   (D) 3 moles of \(Fe^{2+}\) get oxidised to \(Fe^{3+}\)

3. 15 g of \(KMnO_4\) in acidic medium equal to
   (A) 0.095 moles
   (B) 0.477 g equivalents
   (C) 9.54 L of 0.05 N \(KMnO_4\)
   (D) 10 ml of 0.05 M \(KMnO_4\)

4. Which of the following statements are correct?
   (A) One mole of \(Cl_2\) means 8 equivalents of chlorine when \(Cl_2 \rightarrow Cl^- + ClO_3^-\)
   (B) One mole of \(Cl_2\) means 6 equivalents of chlorine when \(Cl_2 \rightarrow Cl^- + ClO_2^-\)
   (C) When one mole of \(As_2S_3\) is oxidised to \(As_2O_5 + SO_3\) then it means 22 equivalents of \(As_2S_3\) are oxidised.
   (D) The equivalent weight of \(As_2S_3\) is always = mol. wt./22.

5. 27 g of \(Al\) will react completely with
   (A) 24 g of \(O_3\)  
   (B) 0.75 mole of \(O_2\)  
   (C) 16.8 L of \(O_2\) at STP
   (D) 1 mole of \(O_2\)

6. 10.78 g of \(H_3PO_4\) in 550 ml solution is 0.40 N. Thus this acid
   (A) has been neutralized to \(HPO_4^{2-}\)
   (B) has been neutralized to \(PO_4^{3-}\)
   (C) has been reduced to \(HPO_4^{2-}\)
   (D) has been neutralized to \(H_2PO_4^-\)

7. Which of the following contains equal number of atoms?
   (A) 11.2 ml of \(N_2\) and 0.015 g of nitric oxide
   (B) 22.4 L of nitrous oxide and 22.4 L of \(CO_2\)
   (C) 1 mole of \(HCl\) and 0.5 mole of \(H_2S\)
   (D) 1 mole of \(H_2O_2\) and 1 mole of \(H_2SO_4\)

8. When 100 ml of 0.1 M \(KNO_3\), 400 ml of 0.2 M \(HCl\) and 500 ml of 0.3 M \(H_2SO_4\) are mixed. Then in the resulting solution
   (A) The molarity of \(K^+\) = 0.01 M
   (B) The molarity of \(SO_4^{2-}\) = 0.15 M
   (C) The molarity of \(H^+\) = 0.38 M
   (D) The molarity of \(NO_3^-\) = 0.08 M and \(Cl^-\) = 0.01 M

9. A 110% sample of oleum contains
   (A) 44.4% of \(SO_3\)
   (B) 55.6% of sulphuric acid
   (C) 55.6% of \(SO_3\)
   (D) 44.4% of sulphuric acid

10. A mixture of 1 mole each of \(FeSO_4\) and \(FeC_2O_4\) are taken then:
    (A) \(n_{mole}\) of \(KMnO_4\) required to oxidise \(Fe^{2+}\) to \(Fe^{3+}\) in acidic medium is 0.4
    (B) \(n_{mole}\) of \(KMnO_4\) required to oxidise \(SO_4^{2-}\) is 6/5
    (C) \(n_{mole}\) of \(KMnO_4\) required to oxidise oxalate ion is 0.4
    (D) The total number of moles of \(KMnO_4\) required to completely oxidise the mixture is 0.8

11. 100 ml of 0.06 M \(Ca(NO_3)_2\) is added to 50 ml of 0.06 M \(Na_2C_2O_4\). After the reaction is complete
    (A) 0.003 moles of calcium oxalate will get precipitated
    (B) 0.003 M of excess of \(Ca^{2+}\) will remain in excess
    (C) \(Na_2C_2O_4\) is limiting reagent.
    (D) \(Ca(NO_3)_2\) is excess reagent.

12. To 25 ml of \(H_2O_2\) solution, excess of acidified solution of \(KI\) was added. The iodine liberated required 20 ml of 0.1 N \(Na_2S_2O_3\) solution. Calculate the % of \(H_2O_2\) solution.
    (A) 0.0136 %  
    (B) 0.136 %
    (C) 0.0068 %
    (D) 0.068 %

13. 10 g mixture of \(KI\) and \(NaClO_3\) treated with 200 cc \(HCl\) gives a gas which absorbs in 40 ml of \(\frac{N}{10}\) sodium thiosulphate solution. Then the correct statement is/are
    (A) equivalent weight of iodine in the reaction is M/2
    (B) percentage of \(KI\) in the mixture is 66.4%
    (C) sodium thiosulphate converted into \(Na_2S_2O_6\).
    (D) percentage of \(NaClO_3\) is 66.4%
14. $\text{H}_2\text{C}_2\text{O}_4$ and $\text{NaHC}_2\text{O}_4$ behave as acids as well as reducing agents. Which is/are correct statement(s)?

(A) Equivalent wt. of $\text{H}_2\text{C}_2\text{O}_4$ and $\text{NaHC}_2\text{O}_4$ are equal to their molecular weights when behaving as reducing agent
(B) 100 ml of 1 N solution of each is neutralised by equal volumes of 1 M $\text{Ca(OH)}_2$
(C) 100 ml of 1 N solution of each is neutralised by equal volumes of 1 M $\text{Ca(OH)}_2$
(D) 100 ml of 1 M solution of each is oxidised by equal volumes of 1 M $\text{KMnO}_4$

15. 100 ml of 0.15 N $\text{H}_2\text{O}_2$ is completely oxidized by

(A) 150 ml of 0.1 N $\text{KMnO}_4$ solution
(B) $2.5 \times 10^{-3}$ moles of $\text{K}_2\text{Cr}_2\text{O}_7$ in acidic medium
(C) $15 \times 10^{-3}$ moles of $\text{KMnO}_4$ in basic medium
(D) 15 moles of $\text{O}_3$ in acidic medium

Question No. 16 to 19 (4 questions)

30cc of a solution containing 9.15 gm of salt $K\text{H}_2\text{(C}_2\text{O}_4)_2\cdot \text{H}_2\text{O}$ per litre required 27cc of 0.12 N $\text{NaOH}$ for neutralization. The same quantity of solution was also found to require 36cc of 0.12 N $\text{KMnO}_4$ solution for complete oxidation.

16. What is the value of $X$?

(A) 1
(B) 2
(C) 3
(D) 4

17. What is the value of $Y$?

(A) 4
(B) 3
(C) 2
(D) 1

18. What is the value of $Z$?

(A) 4
(B) 1
(C) 2
(D) 3

19. What is the value of $n$?

(A) 4
(B) 3
(C) 1
(D) 2

Question No. 20 to 22 (3 questions)

A steel sample is to be analysed for Cr and Mn simultaneously. By suitable treatment Cr is oxidized as $\text{Cr}_2\text{O}_7^{2-}$ and the Mn to $\text{MnO}_4^{-}$.

A 10 gm sample of steel is used to produce 250.0 mL of a solution containing $\text{Cr}_2\text{O}_7^{2-}$ and $\text{MnO}_4^{-}$. A 10 ml portion of this solution is added to a $\text{BaCl}_2$ solution and by proper adjustment of the acidity, the chromium is completely precipitated as $\text{BaCrO}_4$; 0.0549 g is obtained.

$$\text{Cr}_2\text{O}_7^{2-} + 6\text{H}^+ \rightarrow 2\text{Cr}^3+ + 3\text{H}_2\text{O}$$

A second 10 ml portion of this solution requires exactly 15.95 mL of 0.0750 M standard $\text{Fe}^{2+}$ solution for its titration (in acid solution)

20. % of chromium in the steel sample

(A) 1.496
(B) 2.82
(C) 1.96
(D) 5

21. Equivalent of $\text{Fe}^{2+}$ required for reduction of $\text{MnO}_4^{-}$ is

(A) $5.44 \times 10^{-4}$
(B) $5.44 \times 10^{-2}$
(C) $1.96 \times 10^{-1}$
(D) $11.96 \times 10^{-4}$

22. Amount of $\text{BaCl}_2$ required for conversion of $\text{Cr}_2\text{O}_7^{2-}$ to $\text{BaCrO}_4$ in steel sample

(A) 0.045
(B) 0.0549
(C) 1.125
(D) 2.82

Question No. 23 to 25 (3 questions)

25 ml from a stock solution containing $\text{NaHCO}_3$ and $\text{Na}_2\text{CO}_3$ was diluted to 250 ml with CO$_2$ free distilled water. 25 ml of the diluted solution when titrated with 0.12 M $\text{HCl}$ required 8 ml., when phenolphthalein was used as an indicator.

$\text{Na}_2\text{CO}_3 + \text{HCl} \rightarrow \text{NaHCO}_3$

When 20 ml of diluted solution was titrated with same acid it required 18 ml when methylorange was used as an indicator.

$\text{Na}_2\text{CO}_3 + 2\text{HCl} \rightarrow 2\text{NaCl} + \text{H}_2\text{O} + \text{CO}_2$

$\text{NaHCO}_3 + \text{HCl} \rightarrow \text{NaCl} + \text{H}_2\text{O} + \text{CO}_2$

23. Concentration of $\text{NaHCO}_3$ in gm/lit.

(A) 0.312
(B) 2.62
(C) 3.12
(D) 26.208

24. Amount of $\text{NaOH}$ that should be added to convert all bicarbonate into carbonate in 100 ml stock solution

(A) 1.248 gm
(B) 0.312 gm
(C) $3.12 \times 10^{-2}$ gm
(D) $7.8 \times 10^{-3}$ gm
25. Millimoles of NaHCO₃ present in stock solution
   (A) 0.624  (B) 2.16
   (C) 1.536  (D) 7.8

   **Question No. 26 to 28 (3 questions)**

1.16 g \( \text{CH}_3(\text{CH}_2)_3 \text{COOH} \) was burnt in excess air and the resultant gases (CO₂ and H₂O) were passed through excess NaOH solution. The resulting solution was divided into two equal parts. One part requires 50 mL of 1 N HCl for neutralization using phenolphthalein as indicator. Another part required 80 mL of 1 N HCl for neutralization using methyl orange as indicator.

26. Produced mole of the CO₂
   (A) 0.1  (B) 0.01
   (C) 0.06  (D) None of these

27. What is the value of \( n \)
   (A) 4  (B) 3
   (C) 2  (D) 1

28. Amount of excess NaOH solution taken initially.
   (A) 3.2 gm  (B) 6.4 gm
   (C) 1.2 gm  (D) None of these

29. The oxidation number of phosphorus in \( \text{Ba(H}_2\text{PO}_4\text{)}_2 \) is - [IIT-1990]
   (A) +3  (B) +2
   (C) +1  (D) -1

30. The compound which could act both as oxidising as well as reducing agent is - [IIT-Screening 1991]
   (A) \( \text{SO}_2 \)  (B) \( \text{KMnO}_4 \)
   (C) \( \text{Al}_2\text{O}_3 \)  (D) \( \text{Cr}_2\text{O}_3 \)

31. The number of electrons to balance the following equation, the value of \( x \) is - [IIT-Screening 1991]
   \[ \text{NO}_3^- + 4\text{H}^+ + xe^- \rightarrow 2\text{H}_2\text{O} + \text{NO} \]
   (A) 5  (B) 4
   (C) 3  (D) 2

32. The oxidation state of molybdenum in its oxo complex species \([\text{MoO}_3\text{O}_2(\text{C}_3\text{H}_4)_2(\text{H}_2\text{O})_2]^2-\) [IIT-Screening 1991]
   (A) 2  (B) 3
   (C) 4  (D) 5

33. The oxidation states of the most electronegative element in the products of the reaction, \( \text{BaO}_2 \) with dilute \( \text{H}_2\text{SO}_4 \) are - [IIT-1991]
   (A) 0 and -1  (B) -1 and -2
   (C) -2 and 0  (D) -2 and +1

34. For the redox reaction,
   \[ \text{MnO}_4^- + \text{C}_2\text{O}_4^{2-} + \text{H}^+ \rightarrow \text{Mn}^{2+} + \text{CO}_2 + \text{H}_2\text{O} \]
   the correct coefficients of the reactants for the balanced reaction are- [IIT-1992]
   \[ \text{MnO}_4^- + \text{C}_2\text{O}_4^{2-} + \text{H}^+ \rightarrow \text{Mn}^{2+} + \text{CO}_2 + \text{H}_2\text{O} \]
   (A) 2 5 16
   (B) 16 5 2
   (C) 5 16 2
   (D) 2 16 5

35. What mass of \( \text{N}_2\text{H}_4 \) can be oxidised to \( \text{N}_2 \) by 24 gm of \( \text{K}_2\text{Cr}_2\text{O}_7 \) which is reduced to \( [\text{Cr(OH)}_4]^+ \).

36. The ion \( \text{A}^{2+} \) is oxidised to \( \text{AO}_4^2- \) by \( \text{MnO}_4^- \) changing to \( \text{Mn}^{2+} \) in acid medium. Given that \( 2.68 \times 10^{-3} \) mole of \( \text{A}^{2+} \) required 1.61 \times 10^{-3} mole of \( \text{MnO}_4^- \). What is the value of \( n \).

37. 2.180 gram of a sample contains a mixture of \( \text{XO}_5 \) and \( \text{X}_2\text{O}_7 \) which are completely oxidised to \( \text{XO}_4^- \) by 0.015 mole of \( \text{K}_2\text{Cr}_2\text{O}_7 \). Calculate the atomic weight of \( \text{X} \) if 0.0187 mole \( \text{XO}_4^- \) is formed.

38. The number of moles of \( \text{KMnO}_4 \) that will be needed to react completely with one mole of ferrous oxalate in acidic solution is [JEE 1996]
   (A) 3/5  (B) 2/5
   (C) 4/5  (D) 1

39. The number of moles of \( \text{KMnO}_4 \) that will be needed to react with one mole of sulphite ions in acidic solution is [JEE 1997]
   (A) 3/5  (B) 3/5
   (C) 4/5  (D) 1
Each of the questions given below consists of Statement-I and Statement-II. Use the following Key to choose the appropriate answer.

(A) If both Statement-I and Statement-II are true, and Statement-II is the correct explanation of Statement-I.

(B) If both Statement-I and Statement-II are true but Statement-II is not the correct explanation of Statement-I.

(C) If Statement-I is true but Statement-II is false.

(D) If Statement-I is false but Statement-II is true.

40. **Statement I**: NaOH + H₃PO₄ → NaH₂PO₄ + H₂O
   in given reaction equivalent weight of H₃PO₄ is \(rac{M}{3}\).
   **Statement II**: H₃PO₄ is tribasic acid.

41. **Statement I**: In CuO equivalent weight of Cu is 63.5 & in Cu₂O equivalent weight of Cu is 31.8.
   **Statement II**: Equivalent weight of any metal is the gm quantity of metal which is combined with 8 gm of oxygen in the formation of metal oxide.

42. **Statement I**: In Pb₃O₄ all Pb has + \(\frac{8}{3}\) oxidation number.
   **Statement II**: Pb₃O₄ is mixed oxide of PbO & PbO₂.

43. **Statement I**: In estimation of FeSO₄₃ K₂MnO₄ along with HCl can be used as oxidising agent.
   **Statement II**: In acidic medium K₂MnO₄ is more powerful oxidant compared to neutral/basic medium.

44. Column-I | Column-II
   | (A) Cr₂O₇²⁻ → Cr³⁺ | (P) \(\frac{M}{7}\) |
   | (B) Fe(NO₃)₃ → Fe (NO₃)₂ | (Q) \(\frac{M}{6}\) |
   | (C) H₂O₂ → O₂ | (R) M |
   | (D) PH₃ + H⁺ → PH₄⁺ | (S) \(\frac{M}{2}\)

45. **Column I** | **Column II**
   | (1) Increase in oxidation number | (a) Loss of electrons number |
   | (2) Decrease in oxidation number | (b) Redox reaction number |
   | (3) Oxidising agent | (c) Fractional oxidation number |
   | (4) Reducing agent | (d) Zero oxidation number |
   | (5) 2Cu⁺ → Cu²⁺ + Cu | (e) Simple neutralisation reaction |
   | (6) MnO₂ + 4HCl → MnCl₂ + Cl₂ + 2H₂O | (f) Gain of electrons |
   | (7) Mn₃O₄ | (g) Disproportionation |
   | (8) CH₂Cl₂ | (h) Oxidation |
   | (9) NaOH + HCl → NaCl + H₂O | (i) Reduction |

46. The normality of 0.3 M phosphorus acid (H₃PO₄) is
   (A) 0.1 (B) 0.9 (C) 0.3 (D) 0.6 [JEE 1999]

47. One mole of calcium phosphate on reaction with excess of water gives [JEE 1999]
   (A) one mole of phosphine
   (B) Two moles of phosphoric acid
   (C) Two moles of phosphate
   (D) One mole of phosphorus pentoxide

48. An aqueous solution of 6.3 gm of oxalic acid dihydrate is made upto 250 ml. The volume of 0.1 N NaOH required to completely neutralize 10 ml of this solution is [JEE 2001]
   (A) 40 ml (B) 20 ml
   (C) 10 ml (D) 4 ml

49. In the standardisation of Na₂S₂O₃ using K₂Cr₂O₇ by iodometry the equivalent mass of K₂Cr₂O₇ is [JEE 2001]
   (A) \(\frac{M \text{Mass}}{2}\) (B) \(\frac{M \text{Mass}}{6}\)
   (C) \(\frac{M \text{Mass}}{3}\) (D) Same as M. Mass.

50. How many litres of a 0.5 N solution of an oxidising agent are reduced by 2 litres of a 2.0 N solution of a reducing agent?
   (A) 8 (B) 4
   (C) 6 (D) 7 litres
### Exercise III

#### Subjective Problems (JEE Advanced)

**Balancing of reactions**

1. Complete and balance the following equations
   
   (a) KMN0₃ + H₂SO₄ + H₂O₂ → K₂SO₄ + MnSO₄ + H₂O + ..........  
   
   (b) Cu²⁺ + I⁻ → Cu⁺ + I₂  

2. Balance the following in basic medium
   
   (i) Cr₂O₇²⁻ + H₂O₂ + H⁺ → Cr₃⁺ + IO₄⁻ + H₂O  
   
   (ii) KOH + K₂Fe(CN)₆ + Ce(NO₃)₃ → Fe(OH)₃ + Ce(OH)₃ + K₂CO₃ + KNO₃ + H₂O  

3. Balance the following equations using desired medium:
   
   (a) SbCl₅ + KIO₃ + HCl → SbCl₃ + ICl + H₂O + KCl  
   
   (b) Fe₂O₃ + K₂MnO₄ + H₂SO₄ → Fe₂(SO₄)₃ + CO₂ + MnSO₄ + K₂SO₄ + H₂O  

4. Balance the following equations using desired medium:
   
   Fe₃O₄ + K₂CO₃ + KClO₃ → Fe₂O₃ + K₂CrO₄ + KCl + CO₂  

5. Balance the following equations using desired medium:
   
   Pb₃(B₄O₇)₂ + Co₂(MnO₄)₃ → CoO + MnO₂ + Pb₂O₃ + NO  

6. Balance the following equations in acidic medium
   
   KClO₃ + H₂SO₄ → KHSO₄ + HClO₄ + CO₂ + H₂O  

7. Balance the following equations in acidic medium
   
   Br⁻ + BrO₃⁻ + H⁺ → Br₂ + H₂O  

8. Balance the following equations in acidic medium
   
   H₂S + Cr₂O₇²⁻ + H⁺ → Cr⁴⁺ + S₈ + H₂O  

9. Balance the following equations in acidic medium
   
   H₂S + Cr₂O₇²⁻ + H⁺ → Cr⁴⁺ + S₈ + H₂O  

10. Balance the following equations in acidic medium
    
    Cu₂O + H⁺ + NO₃⁻ → Cu²⁺ + NO + H₂O  

11. Balance the following equations in acidic medium
    
    [Fe(CN)₆]⁴⁻ + MnO₄⁻ → Fe²⁺ + CO₂ + NO₃⁻ + Mn²⁺  

12. Balance following equations in proper medium
    
    (a) C₆H₅OH + MnO₄⁻ → C₆H₆O₄⁻ + MnO₂(s) + H₂O  

13. Balance following equations in proper medium
    
    Cr⁴⁺ + H₂O₂ → Cr³⁺  

14. Balance following equations in proper medium
    
    P + OH⁻ + H₂O → H₃PO₄⁻ + PH₃  

15. Balance following equations in proper medium
    
    S + OH⁻ → S²⁻ + S₂O₃²⁻  

16. Balance following equations in proper medium
    
    Na₂S₃O₄ + KMnO₄ + H₂O → Na₂S₃O₄ + MnO₂ + KOH + NaOH  

17. Balance following equations in proper medium
    
    Fe₃O₄ + KMnO₄ + H₂SO₄ → Fe₂(SO₄)₃ + CO₂ + MnSO₄ + K₂SO₄ + H₂O  

18. Balance following equations in proper medium
    
    C₆H₅OH + I₂ + OH⁻ → CH₃CO₂⁻ + HCOO⁻ + H₂O + I⁻  

#### Acid Base Titration

19. A solution containing 4.2 g of KOH and Ca(OH), is neutralized by an acid. It consumes 0.1 equivalent of acid, calculate the percentage composition of the sample.  

20. How many ml of 0.1 N HCl are required to react completely with 1 g mixture of Na₂CO₃ and NaHCO₃ containing equimolar amounts of two?  

21. 0.5 g of fuming H₂SO₄ (oleum) is diluted with water. The solution requires 26.7 ml of 0.4 N NaOH for complete neutralization. Find the % of free SO₃ in the sample of oleum.  

22. H₃PO₄ is a tri basic acid and one of its salt is NaH₂PO₄. What volume of 1 N NaOH solution should be added to 12 g of NaH₂PO₄ to convert it into Na₃PO₄?  

#### Double titration

23. A solution contains Na₂CO₃ and NaHCO₃. 20 ml of this solution required 4 ml of 1 N HCl for titration with Ph indicator. The titration was repeated with the same volume of the solution but with MeOH. 10.5 ml of 1 N HCl was required this time. Calculate the amount of Na₂CO₃ & NaHCO₃.
24. A solution contains a mixture of Na₂CO₃ and NaOH. Using Ph as indicator 25 ml of mix required 19.5 ml of 1N HCl for the end point. With MeOH, 25 ml of the solution required 25 ml of the same HCl for the end point. Calculate gms/L of each substance in the mixture.

25. 200 ml of a solution of mixture of NaOH and Na₂CO₃ was first titrated with \( \frac{N}{10} \) HCl with indicator Ph. 17.5 ml of HCl was required for end point. After this MeOH was added and 2.5 ml of same HCl was again required for next end point. Find out amounts of NaOH and Na₂CO₃ in the mixture.

**Redox Titration**

26. It requires 40.05 ml of 1M Ce⁴⁺ to titrate 20 ml of 1M Sn²⁺ to Sn⁴⁺. What is the oxidation state of the cerium in the product.

27. A volume of 12.53 ml of 0.05093 M SeO₃ reacted with exactly 25.52 ml of 0.1 M Cr₂O₇⁴⁻. In the reaction, Cr³⁺ was oxidized to Cr⁴⁺. To what oxidation state was selenium converted by the reaction.

28. Potassium acid oxalate K₂C₂O₄, 3H₂C₂O₄, 4H₂O can be oxidized by MnO₄⁻ in an acid medium. Calculate the volume of 0.1 M KMnO₄ reacting in acid solution with one gram of the acid oxalate.

29. 1 g sample of H₂O₂ solution containing x% H₂O₂ by mass requires x cm³ of a KMnO₄ solution for complete oxidation under acidic conditions. Calculate the normality of KMnO₄ solution.

30. Metallic tin in the presence of HCl is oxidized by K₂Cr₂O₇ to stannic chloride, SnCl₆²⁻. What volume of deci-normal dichromate solution would be reduced by 1 g of tin.

31. 5g sample of brass was dissolved in one litre dil. H₂SO₄. 20 ml of this solution were mixed with KI, liberating I⁻ and Cu⁺ and the I⁻ required 20 ml of 0.0327 N hypo solution for complete titration. Calculate the percentage of Cu in the alloy.

32. 1.0 g sample of Fe₂O₃ solid of 55.2% purity is dissolved in acid and reduced by heating the solution with zinc dust. The resultant solution is cooled and made upto 100.0 mL. An aliquot of 25.0 mL of this solution requires 17.0 mL of 0.0167 M solution of an oxidant for titration. Calculate the number of moles of electrons taken up by the oxidant in the reaction of the above titration.

33. 0.84 gm iron ore containing x percent of iron was taken in a solution containing all iron in ferrous condition. The solution required x ml of a dichromatic solution for oxidizing the iron content to ferric state. Calculate the strength of dichromatic solution.

34. 5 g of pyrolusite (impure MnO₂) were heated with conc. HCl and Cl₂ evolved was passed through excess of KI solution. The iodine liberated required 40 mL of \( \frac{N}{10} \) hypo solution. Find the % of MnO₂ in the pyrolusite.

**Back Titration**

35. 50 gm of a sample of Ca(OH)₂ is dissolved in 50 ml of 0.5 N HCl solution. The excess of HCl was titrated with 0.3N NaOH. The volume of NaOH used was 20cc. Calculate % purity of Ca(OH)₂.

36. One gm of impure sodium carbonate is dissolved in water and the solution is made up to 250ml. To 50ml of this solution, 50ml of 0.1N HCl is added and the mixture after shaking well required 10ml of 0.16N NaOH solution for complete titration. Calculate the % purity of the sample.

37. What amount of substance containing 60% NaCl, 37% KCl should be weighed out for analysis so that after the action of 25 ml of 0.1N AgNO₃ solution, excess of Ag⁺ is back titrated with 5 ml of NH₄SCN solution? Given that 1 ml of NH₄SCN = 1.1 ml of AgNO₃.

\[ \text{[AgNO}_3^- + \text{NaSCN} \rightarrow \text{AgSCN} + \text{NaNO}_3] \]

38. 10 g CaCO₃ were dissolved in 250 ml of 1M HCl. What volume of 2M KOH would be required to neutralise excess HCl?

39. A mixture of FeO and Fe₂O₃ is reacted with acidified KMnO₄ solution having a concentration of 0.2278 M, 100 ml of which was used. The solution was then titrated with Zn dust which converted Fe³⁺ of the solution to Fe²⁺. The Fe²⁺ required 1000 ml of 0.13 M K₂Cr₂O₇, O, solution. Find the % of FeO & Fe₂O₃.
40. 50 ml of a solution, containing 0.01 mole each Na₂CO₃, NaHCO₃, and NaOH was tiritated with N-HCl. What will be the titre readings if
(a) only Ph is used as indicator.
(b) only MeOH is used as indicator from the beginning.
(c) MeOH is added after the first end point with Ph.

41. 0.1 M KMnO₄ solution completely reacts with 0.05 M FeSO₄ solution under acidic conditions. The volume of FeSO₄ used is 25 ml. What volume of KMnO₄ was used?

42. 20 g of a sample of Ba(OH)₂ is dissolved in 50 ml. of 0.1 N HCl solution. The excess of HCl was titrated with 0.1 N NaOH. The volume of NaOH used was 20cc. Calculate the % Ba(OH)₂ in the sample.

43. 1 solution contains a mixture of Na₂CO₃ and NaOH. Using phenolphthalein as indicator. 25ml. of mixture required 19.5 ml. of 0.995 N HCl for the end point. With methyl orange. 25ml. of solution required 25 ml. of the same. HCl for the point. Calculate grams per litre of each substance in the mixture.

44. 5.7 g of bleaching powder was suspended in 500 ml. of water. 25 ml. of this solution on treatment with KI in the presence of HCl liberated iodine which reacted with 24.35 ml. of N/10 Na₂S₂O₃. Calculate the % of 'available' chlorine in the bleaching powder.

45. A solution containing 2.68 x 10⁻³ moles of A⁺⁺ ions requires 1.61 x 10⁻³ moles of MNO₄⁻ for the complete oxidation of A⁺⁺ to AO₄²⁻ in acidic medium. What is the value of n?

46. (i) What is the mass of sodium bromate and the solution necessary to prepare 85.5 ml of 0.672 N solution when the half cell reaction is BrO₃⁻ + 56H⁺ + 6e⁻ → Br⁻ + 3H₂O.
(ii) What would be the mass as well as molarity if the half cell reaction is 2BrO₃⁻ + 12H⁺ + 10e⁻ → Br²⁻ + 6H₂O

47. A mixture of H₂C₂O₄ (oxalic acid) and NaH₂C₂O₄, was dissolved in water and the solution made up to one litre. Ten milliliters of the solution required 3.0 ml of 0.1 N sodium hydroxide solution for complete neutralization. In another experiment 10.0 ml of the same solution, in hot dilute sulphuric acid medium, required 4.0 ml of 0.1 N KMnO₄ solution for complete reaction. Calculate the masses of H₂C₂O₄ and NaH₂C₂O₄ in the mixture.

48. A solution of 0.2 g of a compound containing Cu²⁺ and C₂O₄⁻² ions is titrated with 0.02 M KMnO₄ in presence of H₂SO₄ consumes 22.6 ml of the oxidant. The resultant solution is neutralized with Na₂CO₃, acidified with dilute acetic acid and treated with excess I₂. The liberated iodine requires 11.3 ml of 0.05 N Na₂S₂O₃ solution for complete reduction. Find out the mole ratio of Cu²⁺ to C₂O₄⁻² in the compound. Write down the balanced redox reactions involved in the above titration.

49. A 2.0 g sample of a mixture containing sodium carbonate, sodium bicarbonate and sodium sulphate is heated till the evolution of CO₂ ceases. The volume of CO₂ at 750 mm Hg pressure and at 298 K is measured to be 123.9 ml. A 1.5 g of the sample requires 150 ml of M/10 HCl for complete neutralization. Calculate the percentage composition of the components of the mixture.

50. A solution contains Na₂CO₃ and NaHCO₃ 20 cm³ of this solution requires 5.0 cm³ of 0.1 M H₂SO₄ solution for neutralization using phenolphthalein as the indicator. Methylorange is then added when a further 5.0 cm³ of 0.2 M H₂SO₄ was required. Calculate the masses of Na₂CO₃ and NaHCO₃ in 1 L of this solution.
1. How many grams of $H_2O_2$ are required to convert 0.1 moles PbS to 0.1 moles PbSO$_4$ -
   
   [AIEEE-2002]
   
   (A) 12.8 g  
   (B) 13.6 g  
   (C) 16 g  
   (D) 3.4 g

2. MnO$_4^-$ is good oxidising agent in different medium changing to -
   
   MnO$_4^-$ $\rightarrow$ Mn$^{2+}$
   $\rightarrow$ MnO$_2$
   $\rightarrow$ MnO$_2^-$
   $\rightarrow$ Mn$_2$O$_7$

   Changes in oxidation number respectively are -
   
   [AIEEE-2002]
   
   (A) 1, 3, 4, 5  
   (B) 5, 4, 3, 2  
   (C) 5, 1, 3, 4  
   (D) 2, 6, 4, 3

3. Oxidation number of Cl in CaOCl$_2$ (bleaching powder) is -
   
   [AIEEE-2002]
   
   (A) Zero, since it contains Cl$_2$  
   (B) -1, since it contains Cl$^-$  
   (C) +1, since it contains ClO$^-$  
   (D) +1 and -1 since it contains ClO$^-$ and Cl$^-$

4. Which of the following is a redox-reaction -
   
   [AIEEE-2002]
   
   (A) $2Na[Ag(CN)$_2$] + Zn \rightarrow Na$_2[Zn(CN)$_4$] + 2Ag$  
   (B) BaO$_2$ + $H_2SO_4 \rightarrow BaSO$_4$ + $H_2O_2$  
   (C) $N_2O_5 + H_2O \rightarrow 2HNO$_3$  
   (D) $AgNO_3 + KI \rightarrow AgI + KNO$_3$

5. In the coordination compound, $K_n[Ni(CN)$_2$]_x$, the oxidation state of nickel is -
   
   [AIEEE-2003]
   
   (A) +1  
   (B) +2  
   (C) -1  
   (D) 0

6. What would happen when a solution of potassium chromate is treated with an dilute nitric acid -
   
   [AIEEE-2003]
   
   (A) $CrO_4^{2-}$ is reduced to +3 state of Cr  
   (B) $CrO_4^{2-}$ is oxidized to +7 state of Cr  
   (C) $Cr^{3+}$ and $Cr_2O_7^{2-}$ are formed  
   (D) $Cr_2O_7^{2-}$ and $H_2O$ are formed

7. The oxidation state of Cr in $[Cr(NH_3)$_4$Cl$_2$]^{3+}$ is -
   
   [AIEEE-2005]
   
   (A) +2  
   (B) +3  
   (C) 0  
   (D) +1

8. The oxidation state of chromium in the final product formed by the reaction between KI and acidified potassium dichromate solution is -
   
   [AIEEE-2005]
   
   (A) +6  
   (B) +4  
   (C) +3  
   (D) +2

9. Which of the following chemical reactions depicts the oxidizing behaviour of $H_2SO_4$ -
   
   [AIEEE 2006]
   
   (A) $Ca(OH)$_2 + $H_2SO_4 \rightarrow CaSO$_4$ + 2$H_2O$  
   (B) $NaCl + H_2SO_4 \rightarrow NaHSO$_4$ + $HCl$  
   (C) $2PCI$_5 + $H_2SO$_4 \rightarrow 2$POCl$_3$ + 2$HCl + SO$_2$Cl$_2$  
   (D) $2HI + H_2SO_4 \rightarrow I$_2$ + $SO_2$ + 2$H_2O$
1. Consider a titration of potassium dichromate solution with acidified Mohr's salt solution using diphenylamine as indicator. The number of moles of Mohr's salt required per mole of dichromate is

(A) 3  (B) 4  (C) 5  (D) 6

2. Match the reactions in Column I with nature of the reactions / type of the products in Column II.

<table>
<thead>
<tr>
<th>Column I</th>
<th>Column II</th>
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<tbody>
<tr>
<td>(A) $\text{O}_2 \rightarrow \text{O}_2^+ + \text{O}_2^-$</td>
<td>(P) Redox reaction</td>
</tr>
<tr>
<td>(B) $\text{CrO}_4^{2-} + \text{H}^+ \rightarrow$</td>
<td>(Q) One of the products has trigonal planar structure</td>
</tr>
<tr>
<td>(C) $\text{MnO}_4^- + \text{NO}_3^- + \text{H}^+ \rightarrow$</td>
<td>(R) dimeric bridged tetrahedral metal ion</td>
</tr>
<tr>
<td>(D) $\text{NO}_3^- + \text{H}_2\text{SO}_4 + \text{Fe}^{2+} \rightarrow$</td>
<td>(S) disproportionation</td>
</tr>
</tbody>
</table>

3. White phosphorus on reaction with NaOH gives PH$_3$ as one of the products. This is a

(A) dimerization reaction  (B) disproportionation reaction  (C) condensation reaction  (D) precipitation reaction

4. The reaction of white phosphorus with aqueous NaOH gives phosphine along with another phosphorus containing compound. The reaction type; the oxidation states of phosphorus phosphine and the other product are respectively

(A) redox reaction; $-3$ and $-5$  (B) redox reaction; $+3$ and $+5$  (C) disproportionation reaction; $-3$ and $+5$  (D) disproportionation reaction; $-3$ and $+3$

**Paragraph for Question Nos. 5 and 6**

Bleaching powder and bleach solution are produced on a large scale and used in several household products. The effectiveness of bleach solution is often measured by iodometry.

**[JEE 2012]**

5. 25 mL of household bleach solution was mixed with 30 mL of 0.50 M KI and 10 mL of 4 N acetic acid. In the titration of the liberated iodine, 48 mL of 0.25 N Na$_2$S$_2$O$_3$ was used to reach the end point. The molarity of the household bleach solution is

(A) 0.48 M  (B) 0.96 M  (C) 0.24 M  (D) 0.024 M

6. Bleaching powder contains a salt of an oxoacid as one of its components. The anhydride of that oxoacid is

(A) Cl$_2$O  (B) Cl$_2$O$_7$  (C) ClO$_2$  (D) Cl$_2$O$_6$
## Answer-Key

### Answer Ex-I

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<td>C</td>
<td>34.</td>
<td>A</td>
<td>35.</td>
<td>A</td>
<td>36.</td>
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<td>D</td>
<td>42.</td>
<td>B</td>
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<td>B</td>
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<td>49.</td>
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### Answer Ex-II

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<tr>
<td>33.</td>
<td>B</td>
<td>34.</td>
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<td>3g</td>
<td>36.</td>
<td>n = 2</td>
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<td>41.</td>
<td>D</td>
<td>42.</td>
<td>D</td>
<td>43.</td>
<td>D</td>
<td>44.</td>
<td>A→Q,B→P,C→S,D→R</td>
</tr>
<tr>
<td>47.</td>
<td>C</td>
<td>48.</td>
<td>A</td>
<td>49.</td>
<td>B</td>
<td>50.</td>
<td>A</td>
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</table>
1. (a) $2\text{KMnO}_4 + 3\text{H}_2\text{SO}_4 + 5 \text{H}_2\text{O} \rightarrow$

$$\text{K}_2\text{SO}_4 + 2\text{MnSO}_4 + 8 \text{H}_2\text{O} + 5\text{O}_2$$

(b) $2\text{Cu}^{2+} + 2\text{I}^- \rightarrow 2\text{Cu}^{+} + \text{I}_2$

2. (i) $2\text{Cr}_2 + 27\text{H}_2\text{O} + 10 \text{OH}^- \rightarrow 2\text{CrO}_4^{2-} + 6\text{I}^- + 32\text{H}_2\text{O}$

(ii) $258\text{KOH} + K_2\text{Fe(CN)}_6 + 61\text{Ce(NO}_3)_4 \rightarrow 61\text{Ce(OH)}_3 + \text{Fe(OH)}_3 + 36\text{H}_2\text{O} + 6\text{K}_2\text{CO}_3 + 250\text{KNO}_3$

3. (a) $2\text{SbCl}_3 + \text{KIO}_3 + 6\text{HCl} \rightarrow 2\text{SbCl}_4 + \text{ICl} + 3\text{H}_2\text{O} + \text{KCl}$

(b) $10\text{FeC}_2\text{O}_4 + 6\text{KMnO}_4 + 24\text{H}_2\text{SO}_4 \rightarrow 5\text{Fe}_2\text{(SO}_4)_3 + 20\text{CO}_2 + 6\text{MnSO}_4 + 3\text{K}_2\text{SO}_4 + 24\text{H}_2\text{O}$

4. $6\text{FeCr}_2\text{O}_7 + 12\text{K}_2\text{CO}_3 + 7\text{KClO}_3 \rightarrow 3\text{Fe}_2\text{O}_3 + 12\text{K}_2\text{CrO}_4 + 7\text{KCl} + 12\text{CO}_2$

5. $30\text{Pb(N}_3)_2 + 44\text{Co(MnO}_3)_4 \rightarrow 132\text{MnO}_2 + 44\text{CoO} + 180\text{NO} + 10\text{Pb}_2\text{O}_4$

6. $3\text{KClO}_3 + 3\text{H}_2\text{SO}_4 \rightarrow 3\text{KHSO}_4 + \text{HClO}_3 + 2\text{Cl}_2 + 3\text{H}_2\text{O}$

7. $5\text{Br}^- + \text{BrO}_3^- + 6\text{H}^+ \rightarrow 3\text{Br}_2 + 3\text{H}_2\text{O}$

8. $2\text{H}_2\text{S} + 8\text{Cr}_2\text{O}_7^{2-} + 16\text{H}^+ \rightarrow 8\text{Cr}_2\text{O}_3 + 3\text{S}_8 + 32\text{H}_2\text{O}$

9. $2\text{MnO}_4^{-} + 5\text{C}_2\text{O}_4^{2-} + 16\text{H}^+ \rightarrow 2\text{Mn}^{2+} + 10\text{CO}_2 + 8\text{H}_2\text{O}$

10. $3\text{Cu}_2\text{O} + 14\text{H}^+ + 2\text{NO}_3^- \rightarrow 6\text{Cu}^{2+} + 2\text{NO} + 7\text{H}_2\text{O}$

11. $5[\text{Fe(CN)}_6]^{3-} + 18\text{H}^+ + 61\text{MnO}_4^- \rightarrow 5\text{Fe}^{3+} + 30\text{CO}_2 + 30\text{NO}_3^- + 61\text{Mn}^{2+} + 94\text{H}_2\text{O}$

12. $3\text{C}_2\text{H}_5\text{OH} + 2\text{MnO}_4^- + \text{OH}^- \rightarrow 3\text{C}_2\text{H}_5\text{O}^- + 2\text{MnO}_2(\text{s}) + 5\text{H}_2\text{O}$

13. $\text{Cr}_2\text{O}_7^{2-} + 3\text{C}_2\text{H}_5\text{O} + 8\text{H}^+ \rightarrow 3\text{C}_2\text{H}_5\text{O}_2^- + 2\text{Cr}^{3+} + 4\text{H}_2\text{O}$

14. $8\text{P} + 3\text{OH}^- + 9\text{H}_2\text{O} \rightarrow 3\text{H}_3\text{PO}_4^- + 5\text{PH}_3$

15. $4\text{S} + 6\text{OH}^- \rightarrow 2\text{S}_2\text{O}_3^{2-} + \text{S}_4\text{O}_6^{2-}$
16. $6\text{Na}_2\text{S}_4\text{O}_6 + 2\text{KMnO}_4 + 4\text{H}_2\text{O} \rightarrow 3\text{Na}_2\text{S}_4\text{O}_6 + 2\text{MnO}_2 + 2\text{KOH} + 6\text{NaOH}$

17. $10\text{Fe}_2\text{O}_3 + 6\text{KMnO}_4 + 24\text{H}_2\text{SO}_4 \rightarrow 5\text{Fe}_2(\text{SO}_4)_3 + 20\text{CO}_2 + 6\text{MnSO}_4 + 3\text{K}_2\text{SO}_4 + 24\text{H}_2\text{O}$

18. $\text{C}_2\text{H}_5\text{OH} + 4\text{I}^- + 6\text{OH}^- \rightarrow \text{CH}_2\text{O}^- + 5\text{H}_2\text{O} + 5\text{I}^-$

19. KOH = 35%, Ca(OH)$_2$ = 65%

20. $V = 157.8 \text{ ml}$

21. 20.72%

22. 200 ml

23. 0.424 gm; 0.21 gm

24. 23.32 gm, 22.4 gm

25. 0.06 gm; 0.0265 gm

26. +3

27. zero

28. $V = 31.68 \text{ ml}$

29. 0.588 N

30. 337 ml

31. 41.53%

32. 6.07 × 6

33. 0.15 N

34. 0.174g; 3.48 %

35. 1.406%

36. 90.1 %

37. 0.1281 g

38. $V = 25 \text{ mL}$

39. FeO = 13.34%; Fe$_2$O$_3$ = 86.66%

40. 20 ml; 40 ml; 20 ml

41. 2.5 ml

42. 1.29%

43. 23.3, 24.4

44. 30.33%

45. 2

46. (i) 1.446 g, 0.112 M (ii) 1.735 g, 0.1344 M

47. $\text{H}_2\text{C}_2\text{O}_4 = 0.9 \text{ g}$, NaHCO$_3$ = 1.12 g

48. 1/2

49. NaHCO$_3$ = 42%, Na$_2$CO$_3$ = 26.5%, Na$_2$SO$_4$ = 31.5%

50. 5.3 g, 4.2 g

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**Answer Ex–IV**

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**LEVEL – I**

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1. B

2. C

3. D

4. A

5. D

6. D

7. B

8. C

9. D

**LEVEL – II**

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</table>

1. D

2. (A) P, S ; (B) R ; (C) P, Q ; (D) P

3. B

4. D

5. C

6. A
1. $\text{Mn}^{2+} \rightarrow \text{Mn}^{4+}$  
$E.W. = \frac{M.W.}{2} \Rightarrow nf = 2$

$\Rightarrow$ By option : $\text{MnO}_2$

2. Eq. of $\text{S}_2\text{O}_3^{2-} = \text{Eq. of Mn}^{2+}$

$\text{mole of } \text{S}_2\text{O}_3^{2-} \times 2 = 1 \times 5$

$\text{mole of } \text{S}_2\text{O}_3^{2-} = 5/2$

3. m. eq. of $\text{KMnO}_4 = \text{m.eq. of FeSO}_4$

$\text{Fe}^{2+} \rightarrow \text{Fe}^{3+} \Rightarrow nf(\text{Fe}^{2+}) = 1$

$M_1V_1 \times 5 = 10 \times 0.1 \times 1$

$\Rightarrow M_1V_1 = 2 \times 0.1 = 0.2$ Now check the options

4. $\text{NH}_3\text{OH} \rightarrow \text{N}_2\text{O} \text{ nf = 2}$  
$E.W. = \frac{M.W.}{2}$

5. m.eq. of Metal ion = m.eq. of $\text{SO}_2$

$\Rightarrow 20 \times 0.1 \times \text{nf} = 20 \times 0.1 \times 2$

$\Rightarrow \text{nf} = 2$

$\Rightarrow$ Change $M^{2+} \rightarrow M^{3+} \text{ nf = 2}$

6. $\text{CrO}_3^{2-} \rightarrow \text{Cr}^{3+} \text{ nf = 3}$

$\text{S}_2\text{O}_3^{2-} \rightarrow \text{SO}_4^{2-} \text{ nf = 8}$

Applying Equivalent Concept

$0.15 \times V \times 3 = 40 \times 0.5 \times 8$

$\Rightarrow V = 355 \text{ ml}$

7. $\text{NO}_3^{-} \rightarrow \text{NH}_3\text{OH} \text{ nf = 6}$

8. $\text{S}_2\text{O}_3^{2-} \rightarrow \text{SO}_4^{2-} \text{ nf = 8}$

$I_2 \rightarrow I^- \text{ nf = 2}$

$\Rightarrow 1 \text{ mole } \text{S}_2\text{O}_3^{2-} \text{ require 4 mole } \text{I}_2$

$\Rightarrow$ for 1 mole $\text{I}_2$, 1/4 mole $\text{S}_2\text{O}_3^{2-}$ is required

9. $\text{C}_2\text{O}_4^{2-} \rightarrow \text{CO}_2 \text{ nf = 2}$

Eq. of oxalate = Eq. of $\text{KMnO}_4$

$n \times 4 = 1 \times 5$

$n = 5/4$

10. $\text{H}_2\text{S} \rightarrow \text{SO}_2$

$\text{nf} = 6$

11. $\text{FeSO}_4$ contain $\text{Fe}^{2+}$

and $\text{Fe}_2(\text{SO}_4)_3$ contain $\text{Fe}^{3+}$

only $\text{Fe}^{2+}$ will oxidized

$\text{MnO}_4^- \rightarrow \text{Mn}^{2+}$

m.eq. of $\text{FeSO}_4 = \text{m.eq. of } \text{KMnO}_4$

$x \times 1 \times 1000 = 100 \times 2 \times 5$

$\Rightarrow x = 1$

$\Rightarrow \text{Fe}_{\text{FeSO}_4} = 1/3$

12. $\text{HNO}_3 \rightarrow \text{N}_2\text{O}$

$\Rightarrow$ $\text{N}$ should be in +1 in $\text{N}_2\text{O}$

$\Rightarrow \text{HNO}_3 \rightarrow 1/2 \text{N}_2\text{O}$

(By POAC on $\text{N}$ atom)

13. $\text{N}_2\text{H}_4 \rightarrow \text{Y : N should be in + 3 or - 7}$

$\text{N}^{2-} \rightarrow \text{N}^{3+} + 5 \text{e}^-$

($\text{N}$ can't be in -7, because it should be oxidation)

14. Eq. wt. is the mass combined, liberate 8 g oxygen.

$\Rightarrow \text{O}_2 (\text{mole}) = \frac{8}{32} = 0.25$

15. Reducing agent is required means reactions in option has to be reduction reaction

16. Check all the options -
(A) Non-redox
(B) $\text{Cr}^{4+} \rightarrow \text{Cr}^{3+}$; not disproportionation.
(C) Oxidation

(D) $\text{Cu}^+ \rightarrow \text{Cu} + \text{Cu}^{2+}$; disproportion

17. Equal volume & equal molarity means equal moles are present.

$\Rightarrow$ Now higher the $n_f$ means higher the equivalent.

$\text{KMnO}_4 : n_f = 5$ and $\text{K}_2\text{Cr}_2\text{O}_7 ; n_f = 6$

18. $\text{As}_2\text{S}_3 \rightarrow \text{AsO}_4^{3-} + \text{SO}_4^{2-}$

$\text{As}^{3+} \rightarrow \text{As}^{5+} ; \text{S}^{2-} \rightarrow \text{S}^{4+}$

$\frac{4}{24} n_f = 28$ for $\text{As}_2\text{S}_3$

19. m.eq. of $\text{KMnO}_4 = 2 \times 5 = 10 = $ m.eq. of oxalate

m.eq. of $\text{Ca(OH)}_2 = 5 \times 2 = 10 = $ m.eq. of oxalate

But in both case $n_f$ of $\text{KHC}_2\text{O}_4$ is different

As acid $n_f = 1$; As reducing agent $n_f = 2$

$\frac{y}{M} \times 1 = \frac{x}{M} \times 2 \Rightarrow y = 2x$

20. In Acids Medium

$100 \times 5 = M \times 100 \times 2 \Rightarrow M = 2.5$

In basic medium

$V \times 1 \times 3 = 2.5 \times 100 \times 2 \Rightarrow V = \frac{500}{3} \text{ml}$

21. Ferric oxalate: $\text{Fe}_2(\text{C}_2\text{O}_4)_3 : 3$ mole $\text{C}_2\text{O}_4^{2-}$

Ferrons oxalate: $\text{Fe}(\text{C}_2\text{O}_4) : 1$ mole $\text{C}_2\text{O}_4^{2-}$

$\Rightarrow y \times 5 = 1 \times 2 + 1 \times 1 \Rightarrow x \times 5 = 3 \times 2$

$\Rightarrow y = \frac{3}{5} \Rightarrow x = \frac{6}{5}$

$\Rightarrow \frac{x}{y} = 2$

22. $\frac{0.7}{106} \times \frac{x}{18 \times 5} = \frac{19.8 \times 0.1}{1000}$

$\Rightarrow x = 1.97 = 2$

23. Let metal be 100 g

After combustion Metal oxide = 124 g

$\Rightarrow 24g$ oxygen combined with 100g metal

$\Rightarrow 8g$ oxygen will be combined with $\frac{100}{3}g$ metal

24. $\text{Cr}^+ + e^- \rightarrow \frac{1}{2} \text{Cr}_2$

$\Rightarrow$ mole of $\text{Cr}^+$ by 1 mole $\text{KMnO}_4 = 5$

$\Rightarrow$ mole of $\text{Cr}_2 = \frac{5}{2} \Rightarrow$ volume = 56 L

25. $M = \frac{10.78}{(3 \times 31 + 64) \times 550} \times 1000 = 0.2$

$\Rightarrow n_f = 2$

26. m.eq. of $\text{NH}_3 = 30 \times 0.25$

m.eq. of substance = $30 \times 0.25$

m.mole of $\text{NH}_3 = 30 \times 0.25 = \frac{15}{2}$

m.mole of N = $\frac{15}{2}$

$\Rightarrow$ mass of N = $\frac{15 \times 14}{2 \times 1000} = 0.105$

$\% = \frac{0.105}{0.75} \times 100 = \frac{7}{5} \times 10 = 14$

27. $15 \times 5 = \text{mole} \times 2 \Rightarrow \text{mole} = \frac{75}{2}$

$\text{H}_2\text{C}_2\text{O}_4$

$\text{H}_2\text{C}_2\text{O}_4 (\text{mole}) = \frac{75}{2}$

Eq. of $\text{H}_2\text{C}_2\text{O}_4 = \text{Eq. of CO}_2 \Rightarrow \frac{75}{2} \times 2 = n \times 1$

$\Rightarrow n (\text{mole of CO}_2) = 75$

28. m.mole of $\text{NaHC}_2\text{O}_4 = 2$; m.mole of $\text{H}_2\text{C}_2\text{O}_4 = 2$

m.eq. of $\text{KMnO}_4 = 0.05 \times V \times 5$

$\Rightarrow 0.05 \times V \times 5 = (2 \times 2) - (2 \times 2) = 8$

$\Rightarrow V = \frac{8}{0.05 \times 5} = 32 \text{ml}$
29. FeO Fe₂O₃
30. KO₂
31. 2+4x+13(-2)=0
   x=6
32. (A) Mn → +7
    (B) Cr → +3
    (C) Ni → +4
    (D) Cr → +6
33. 3+x+x(-2)=0
    x=-1
    ⇒ superoxide
34. Cu⁺⁺ → Cu
    Fe → Fe⁺⁺
35. Cr₂O₇²⁻ → CrO₃
    Fe(II) → Fe (III)
36. KI → I₂
    oxidation
    KIO₃ → I₂
    reduction
37. A
38. Br₂ → NaBrO₃
    Br₂ → NaBr
39. 2+2x-14=0
    x=+6
40. HO−S−O−O−H
    0
41. NaO−S−S−S−S−ONa
    0
42. 2x-6=-2
    x=+3
43. Mn → +7
    Cr → +6
44. B
    [Fe(CN)₆]⁴⁻ → [Fe(CN)₆]⁴⁻
    x-6=-4   x-6=-3
    x = +2   x = +3
    increase in oxidation no.
    ↓
    oxidation
    2I⁻  I³
    -2  0
    Increase in oxidation no. → Oxidation.
45. A
    CH₄
    (A) x + 4 = 0
        x = -4
    (B) Cl₂
        x = 4 = 0
        x = +4
    (C) CF₃
        x - 4 = 0
        x = +4
    (D) CO₂
        x - 4 = 0
        x = +4
46. C
47. D
    Na₂O₂ → In it peroxide
    ion present mens oxidation state of oxygen.
    2 × 1 + 2x = 0
    2x = -2
    x = -1
48. B
49. D
50. D
**Exercise - II**

1. Eq. of K₂Cr₂O₇ = Eq. of FeSO₄
   \[ N₁V₁ = N₂V₂ \text{ or } M₂V₂ = M₁V₁ \times 6 \]

3. 15g = \( \frac{15}{158} \) mole KMN0₄ = 0.095 mole
   Equivalent = 0.095 × 5 = 0.475

4. A) \( \text{Cl₂} \rightarrow \text{Cl}^- + \text{ClO}_2^- \) \( nf = \frac{28}{16} \)
   B) \( \text{Cl₂} \rightarrow \text{Cl}^- + \text{ClO}_2^- \) \( nf = \frac{28}{16} \)

For A & B options 1 mole Cl₂ means \( \frac{28}{16} \) equivalent

C) \( \text{As}_₂\text{S}_₃ \rightarrow \text{As}_₂\text{O}_₅ - \text{SO}_₂ \) \( nf = 22 \)
   1 mole As₂S₃ = 22 equivalent of As₂O₅

D) Eq. wt. depend on nf and nf can be in different reactions.

5. 27g \( \text{Ar} = 1 \) mole \( \text{Ar} \)
   \( \text{Ar} + \text{O}_₂ \rightarrow \text{Ar}_₂\text{O}_₃ \) \( nf = 3 \) \( nf = 4 \)
   Eq. of \( \text{Ar} \) = Eq. of \( \text{O}_₂ \) \( n_{\text{Ar}} \times 3 = n_{\text{O}_₂} \times 4 \)
   \( \Rightarrow 1 \times 3 = n_{\text{O}_₂} \times 4 \)
   \( \Rightarrow \frac{3}{4} \text{ mole } \text{O}_₂ \rightarrow \frac{3}{4} \times 24 = 18 \text{ mole } \text{O}_₂ \)
   \( \Rightarrow n_{\text{O}_₂} = 0.75 \)

6. mole of \( \text{H}_₃\text{PO}_₄ \) \( = \frac{10.78}{98} \) mole = 0.11
   \( M = 0.11 \times 1000 = 110 \)
   \( \frac{550}{550} = 0.2 \) \( \Rightarrow n = 0.4 \)
   \( \frac{2}{2} \) \( \Rightarrow \text{H}_₃\text{PO}_₄ \rightarrow 3\text{H}^+ + \text{HPO}_₄²^- \)

7. A) 11.2 ml = \( \frac{1}{2} \times 10^{-3} \) mole \( N₂ = 10^{-3} \) mole \( N \)
   0.015 g \( \text{HNO}_₃ \) = \( \frac{0.015}{63} \) mole = 0.0002
   no. of atoms = 0.0002 \times 5 = 10⁻³

B) \( \frac{22.4}{22.4} = 1 \) mole \( \text{N}_₂ \text{O}_₅ \Rightarrow 3 \) mole atom
   \( \frac{22.4}{22.4} = 1 \) mole \( \text{CO}_₂ \Rightarrow 3 \) mole atom

8. 
   \[
   \begin{align*}
   KNO₃ & = 100 \times 0.1 = 10 \text{mmole} \\
   HCl & = 400 \times 0.2 = 80 \text{mmole} \\
   H₂SO₄ & = 500 \times 0.3 = 150 \text{mmole} \\
   \text{Total Volume} & = 1000 \text{ml} \\
   \text{K}^⁺ & = \frac{10}{1000} = 0.01 M \\
   \text{NO}_₂⁻ & = \frac{10}{1000} = 0.01 \text{M} \\
   \text{SO}_₄²⁻ & = \frac{150}{1000} = 0.15 M \\
   \text{Cl}^- & = \frac{80}{1000} = 0.08 \text{M} \\
   \text{H}⁺ & = \frac{80 \times 300}{1000} = 0.38 M
   \end{align*}
   \]

10. Free \( \text{SO}_₂ \) \( = \frac{10}{18} \times 80% \) = 44.4% 
   \( \text{FeSO}_₄ : nf = 1 ; \text{ FeC}_₂\text{O}_₄ : nf = 3 \)
   \( 1 \) mole \( \text{FeSO}_₄ \) \( 1 \) mole \( \text{FeC}_₂\text{O}_₄ \)
   (A) Eq. of \( \text{Fe}^{2+} \) = Eq. of \( \text{KMN0}_₄ \)
   \( 2 \times 1 = n \times 5 \Rightarrow n = 2/5 = 0.4 \)
   (C) Eq. of oxalate = Eq. of \( \text{KMN0}_₄ \)
   \( 1 \times 2 = n \times 5 \Rightarrow n = 0.4 \)

11. \( \text{Ca(NO}_₃)₂ \) + \( \text{Na}_₂\text{C}_₂\text{O}_₄ \) \( \rightarrow \text{CaC}_₂\text{O}_₄ - 2\text{NaNO}_₃ \)
   m mole \( \frac{3}{3} \times 0 \times 0 \) after reaction \( \frac{3}{3} \times 0 \times 3 \)

12. m.eq. of \( I₂ \) liberated = m.eq. of \( \text{Na}_₂\text{S}_₂\text{O}_₅ \)
   \( = 20 \times 0.1 = 2 \)
   m.eq. of \( I₂ \) liberated = m.eq. of \( \text{KI} \) used
   \( \Rightarrow \text{m.eq. KI used} = \text{m.eq. of } \text{H}_₂\text{O}_₂ \)
   \( \Rightarrow 2 = 25 \times M \times 2 \Rightarrow M = 2/50 = 0.04 \)
   Concentration = 0.04 \times 34 = 1.36 \text{ g/l}
   % \text{w/v} = 0.136

13. In the reaction \( I⁻ \rightarrow I₂ \) eq. wt. (\( I₂ \)) = M/2
   nf = 1 \( \Rightarrow \text{m.eq. of } I₂ \) = \( \frac{10}{10} \times 1 \)
   \( \Rightarrow \text{mole of } \text{KI} = \frac{4 \times 10⁻³}{1} \)
   \( \Rightarrow \text{mass of } \text{KI} = 4 \times 10⁻³ \times 166 = 0.664 \text{ g} \)
   % of \( \text{KI} = \frac{0.664}{10} \times 100 = 6.64 \%
   \Rightarrow % \text{ of } \text{NaClO}_₃ = 93.36\% 

\( \text{H}_₂\text{C}_₂\text{O}_₄ : nf \)
\[2 \text{(Acid)} \quad 2 \text{(R.A)} \]
\[\text{NaHC}_2\text{O}_4 : \quad n_f \]
\[1 \text{(Acid)} \quad 2 \text{(R.A)} \]
\[\text{m.eq. of } H_2O_2 = 100 \times 0.15 = 15 \]

(A) m. eq. of K\text{MnO}_4 = 150 \times 0.1 = 15
(B) m.eq. of K\text{Cr}_2\text{O}_7 = 2.5 \times 10^{-3} \times 10^3 \times 6 = 15
(C) m.eq. of K\text{MnO}_4 = 15 \times 10^{-3} \times 10^{-1} \times 1 = 15

(D) \[ \text{O}_3 \rightarrow \text{O}^{2-} \]
\[n_f = 6 \]
\[\text{m. eq. of } \text{O}_3 = 15 \times 10^3 \times 6 \]

Q. 16 to 19

\[\text{K}_2\text{H}_2\text{(C}_2\text{O}_4)_2 \cdot n\text{H}_2\text{O} \]

By charge balancing \[ x + y = 2z \] ...........(1)

\[\text{K}_2\text{H}_2\text{(C}_2\text{O}_4)_2 \cdot n\text{H}_2\text{O} : \quad 9.15 \text{g} \text{ in } 1 \text{ L.t.} \]

\[\Rightarrow \text{In } 30\text{ml salt} = \frac{9.15 \times 30}{1000} \times 30 \text{g} \]

\[\text{mole of salt in } 30 \text{ml} = \frac{9.15 \times 30}{1000 \times (39x + y + 88z + 18n)} \]

1) Eq. of salt = Eq. of NaOH

\[= \frac{9.15 \times 30}{1000 \times M_{\text{salt}}} \times y = 27 \times 0.12 \times 10^3 \quad \text{..........(2)} \]

\[\text{n factor as acid} \]

2) Eq. of salt = Eq. of K\text{MnO}_4

\[= \frac{9.15 \times 30}{1000 \times M_{\text{salt}}} \times 2z = 36 \times \frac{0.12 \times 10^3}{1000} \quad \text{..........(3)} \]

\[\text{n factor as R.A.} \]

\[\Rightarrow \frac{y}{2z} = \frac{27}{36} \quad \text{from (2) & (3)} \]

\[\frac{y}{2z} = \frac{3}{4} \quad \Rightarrow \quad 2y = 3z \quad \text{..........(4)} \]

\[\text{From } x + y = 2z \quad \& \quad 2y = 3z \]

\[\text{we will have } x + y = 2 \times \frac{2y}{3} \quad \Rightarrow \quad x = \frac{y}{3} \]

\[\text{Now from option if } x = 1 \quad \text{then } y = 3 \quad \text{possible by question} \]
\[\text{if } x = 2 \quad \text{then } y = 6 \quad \text{not in options thats why only value} \]
\[x = 1 \quad ; \quad y = 3 ; \quad \Rightarrow \quad z = 2 \]

\[\Rightarrow \quad \frac{9.15 \times 30}{1000} \times y = 27 \times 0.12 \times 10^3 \]

\[\Rightarrow \quad \frac{9.15 \times 30 \times 3}{218 + 18n} = 27 \times 0.12 \]

\[n = 2.009 \quad \Rightarrow \quad n = 2 \]

20. 21, 22

for 10 ml

\[\text{mole of } \text{BaCrO}_4 = \frac{0.0549}{253} = 2.17 \times 10^{-4} \]

\[\text{Cr}_2\text{O}_7^{2-} \rightarrow \text{BaCrO}_4 \]

By POAC at Cr \[ \Rightarrow \text{mole of } \text{Cr}_2\text{O}_7^{2-} = \frac{2.17 \times 10^{-4}}{2} \]

\[= 1.085 \times 10^{-4} \]

\[\Rightarrow \text{mole of Cr present in } 10\text{ml} = 1.085 \times 10^{-4} \times 2 \]

\[\Rightarrow \text{mole of Cr present in original sample (250ml or 10g)} \]

\[= 2 \times 1.085 \times 10^{-4} \times \frac{250}{10} = 5.425 \times 10^{-3} \text{ mole} \]

\[= 5.425 \times 52 \times 10^{-3} \times 9 = 0.2821 \text{ g} \]

\[\text{% of Cr} = \frac{0.2821}{10} \times 100 = 2.821 \% \]

for 10ml

* m.eq. of Fe\textsuperscript{2-} = m.eq. of Cr\textsubscript{2}O\textsubscript{7}\textsuperscript{2-} + m.eq. of Mn\textsubscript{4}O\textsubscript{4}

\[5.95 \times 10^{-5} \times 1 = 1.085 \times 10^{-4} \times 6 \times 10^{-3} + \text{m.eq. of Mn\textsubscript{4}O\textsubscript{4}} \]

\[n \quad \text{factor} \quad \text{for m.eq.} \]

\[\Rightarrow \text{m.eq. of Mn\textsubscript{4}O\textsubscript{4}} = 1.19625 \times 0.651 = 0.54525 \]

\[\text{eq. of Fe\textsuperscript{2+} required} = 0.54525 \times 10^{-3} = 5.45 \times 10^{-4} \]

* mole of BaCrO\textsubscript{4} produced = 2.17 \times 10^{-4} \text{ for } 10\text{ml} \]

mole of BaCrO\textsubscript{4} for 250ml or 10g steel sample

\[= 2.17 \times 10^{-4} \times \frac{250}{10} \]

\[= 5.425 \times 10^{-3} \text{ mole} \]

\[\Rightarrow \text{mole of BaCr\textsubscript{2} required} = 5.425 \times 10^{-3} \text{ mole} \]

\[\Rightarrow \text{mass of BaCr\textsubscript{2} required} = 5.425 \times 10^{-3} \times 208 \]

\[= 1.128 \text{ g} \]
Q. 23, 24, 25

When HPh is used: \( \text{Na}_2\text{CO}_3 \longrightarrow \text{NaHCO}_3 \)

Eq. of \( \text{Na}_2\text{CO}_3 \) = Eq. of HCl
mole of \( \text{Na}_2\text{CO}_3 \) \times 1 = mole of HCl \times 1

mole of \( \text{Na}_2\text{CO}_3 \) = \( 0.12 \times 8 \times 10^{-3} = 9.6 \times 10^{-4} \) mole

\( \Rightarrow 9.6 \times 10^{-4} \) mole \( \text{Na}_2\text{CO}_3 \) present in 25ml diluted solution

Original mole of \( \text{Na}_2\text{CO}_3 \) present = \( 9.6 \times 10^{-3} \) in 250ml of diluted solution.

When MeOH is used (20ml sol is used)

Eq. of \( \text{Na}_2\text{CO}_3 \) + Eq. of \( \text{NaHCO}_3 \) = Eq. of HCl

\( 9.6 \times 10^{-3} \times \frac{20}{250} \times 2 + \text{mole of } \text{NaHCO}_3 = 0.12 \times 18 \times 10^{-3} \)

mole of \( \text{NaHCO}_3 \) = \( 6.24 \times 10^{-4} \)

\( \Rightarrow 6.24 \times 10^{-4} \) mole \( \text{NaHCO}_3 \) present in 20ml of solution

\( \Rightarrow \) In 250ml \( \text{NaHCO}_3 \) present = \( 6.24 \times 10^{-4} \times \frac{250}{20} = 7.8 \times 10^{-3} \) mole

\( \Rightarrow \) In original 25ml stock the mole of compounds are

\( \text{NaHCO}_3 = 7.8 \times 10^{-3} \) mole = 0.6552 g.

\( \text{Na}_2\text{CO}_3 = 9.6 \times 10^{-3} \) mole = 1.0176 g.

\( \text{NaHCO}_3 \) (g/l) = \( \frac{0.6552 \times 1000}{25} = 26.208 \)

* In 100ml stock

mole of \( \text{NaHCO}_3 = 7.8 \times 10^{-3} \times \frac{100}{25} = 31.2 \times 10^{-3} \)

reaction would be

\( \text{NaHCO}_3 + \text{NaOH} \longrightarrow \text{Na}_2\text{CO}_3 + \text{H}_2\text{O} \)

\( \Rightarrow \text{NaOH} \) required = \( 31.2 \times 10^{-3} \) mole

\( = 31.2 \times 10^{-3} \times 40g = 1.248 \) g

* milimoles of \( \text{NaHCO}_3 \) in stock = mole \times 10^3

\( = 7.8 \times 10^{-3} \times 10^3 = 7.8 \) mili mole

Q. 26, 27, 28

\( \text{CH}_3\text{(CH}_2)_n\text{COOH} \) mol wt. = \( 12(n + 2) \times (2n + 4) \times 32 \)

\( = 60 + 14n \)

\( \text{C}_n\text{H}_{2n+4}\text{O}_2 \text{+ O}_2 \longrightarrow (n + 2)\text{CO}_2 + (n + 2)\text{H}_2\text{O} \)

When \( \text{CO}_2 \) \& \( \text{H}_2\text{O} \) react \( \text{H}_2\text{CO}_3 \) will be formed

\( \Rightarrow \text{H}_2\text{CO}_3 : (n + 2) \) mole if 1 mole of compound is burned in oxygen.

\( \Rightarrow \) mole of \( \text{H}_2\text{CO}_3 \) formed = \( (n + 2) \times \frac{1.16}{60 + 14n} \)

\( \text{H}_2\text{CO}_3 \) when react with excess \( \text{NaOH} \) the resulting solution will be having remaining \( \text{NaOH} \) \& produced \( \text{Na}_2\text{CO}_3 \).

Let initial excess mole of \( \text{NaOH} \) are x.

\( \text{H}_2\text{CO}_3 + 2\text{NaOH} \longrightarrow \text{Na}_2\text{CO}_3 + 2\text{H}_2\text{O} \)

\( \frac{1.16}{60 + 14n} \times (n + 2) \times x = 0 \times \left[ \frac{2(n + 2)}{60 + 14n} \times 1.16 \right] \frac{1.16(n + 2)}{60 + 14n} \)

\( \text{NaOH} \) remaining = \( x - \frac{1.16(n + 2)}{30 + 7n} \)

\( \text{Na}_2\text{CO}_3 \) produced = \( \frac{(n + 2) \times 1.16}{60 + 14n} \)

After two equal partition

Each part now have half of amount present.

\( \Rightarrow \) for 1st part (using HPh)

eq of HCl = eq. of \( \text{NaOH} \) + eq. of \( \text{Na}_2\text{CO}_3 \)
\[
2x50x10^3 = x - \frac{1.16 \times 2 \times (n+2)}{60 + 14n} + \frac{(n+2) \times (1.16)}{60 + 14n} = 100 \times 10^{-3} \quad \quad (1)
\]

\[\Rightarrow \text{for IIInd part (using MeOH)}\]

eq. of HCL = eq. of NaOH + eq. of Na₂CO₃

\[80 \times 10^{-3} \times 2 = x - \frac{2(n+2) \times 1.16}{60 + 14n} + \frac{(n+2) \times (1.16) \times 2}{60 + 14n}\]

\[\Rightarrow x = 160 \times 10^{-3} \quad \quad (2)\]

\[
\begin{align*}
\text{mole of NaOH} &= 0.16 \\
\text{Mass of NaOH} &= 0.16 \times 40 \\
&= 6.4 \text{ g}
\end{align*}
\]

\[\Rightarrow \text{from eq' (1) & (2)}\]

\[
\frac{(n+2) \times 1.16}{60 + 14n} = 160 \times 10^{-3} - 100 \times 10^{-3}
\]

\[
\frac{(n+2) \times 1.16}{60 + 14n} = 60 \times 10^{-3}
\]

\[
(n+2) \times 1.16 = (60 + 14n) \times 0.06
\]

\[
1.16n + 2.32 = 3.6 + 0.84n
\]

\[n = \frac{1.28}{0.32} = 4\]

\[
\text{CO}_2 \text{ produced} = \frac{1.16 \times (n+2)}{60 + 14n} = \frac{1.16 \times 6}{116} = 0.06
\]

29. \[2+x-4=1\]

\[x=+1\]

30. A

32. Balance charge

32. B

33. B

34. \[3\text{MnO}_4^- + 5\text{C}_2\text{O}_4^{2-} + 16\text{H}^+ \rightarrow 3\text{Mn}^{2+} + 10\text{CO}_2 + 8\text{H}_2\text{O}\]

35. \[\text{K}_2\text{Cr}_2\text{O}_7 \rightarrow [\text{Cr(OH)}_2]^-\]

\[\text{N}_2\text{H}_4 \rightarrow \text{N}_2 \Rightarrow \text{mass of N}_2\text{H}_4\]

36. \[\frac{3}{4} \times 24 \times \frac{32}{39 \times 2 - 55 + 64} = 3g\]

38. \[\text{FeC}_2\text{O}_4 \rightarrow \text{Fe}^{3+} + 2\text{CO}_2\]

39. \[\text{SO}_4^{2-} \rightarrow \text{SO}_3^{2-}\]

40. eq. wt. of \(\text{H}_3\text{PO}_4 = M\)

41. eq. wt. of \(\text{Cu in CuO} = \frac{63.5}{2}\)

42. \(2\text{PbO} \rightarrow \text{Pb}_2\text{O}_3\)

43. \(\text{HCl} + \text{KMnO}_4 \text{ gives Cl}_2\)

46. \(\text{HO-PO-HO}\)

47. \(\text{Ca}_3\text{P}_2 \rightarrow 2\text{PH}_3 + 3\text{Ca(OH)}_2\)

48. \(\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O} \rightarrow \text{CO}_2\)

\[
\begin{align*}
2 \times 6.3 \times 10 = \frac{0.1 \times v}{126} \times 250 \times 1000 \times \text{V}\text{=40 ml}
\end{align*}
\]

49. \(\text{Cr}_2\text{O}_7^{2-} \rightarrow \text{Cr}_2\text{O}_4^{2-}\)

\[n = 6\]

50. \(\text{N}_1\text{V}_1 = \text{N}_2\text{V}_2\)

\[\text{V}_1 = \frac{2 \times 2}{0.5} - 8\]
19. \( \text{KOH} = x \text{g} \); \( \text{Ca(OH)}_2 = 4.2 - x \text{ g} \)

Eq. of KOH + Eq. of Ca(OH)_2 = Eq. of Acid

\[
x \times \frac{1}{40} + \frac{(4.2 - x)}{74} \times 2 = 0.1
\]

\( \Rightarrow x = 1.474 \)

\% KOH = \( \frac{1.474}{4.2} \times 100 \approx 35\% \)

20. \( x \text{ mole each} \)

\( \Rightarrow \text{Na}_2\text{CO}_3 = 106x \text{ g and NaHCO}_3 = 84 \text{ x g} \)

\( 106x + 84x = 1 \Rightarrow x = \frac{1}{190} \text{ mole} \)

eq. of Na_2CO_3 + eq. of NaHCO_3 = eq. of HCl

\[
\frac{1}{190} \times 2 + \frac{1}{190} \times 1 = \frac{0.1x}{1000}
\]

\( \Rightarrow \frac{3}{190} = \frac{0.1x}{1000} \Rightarrow V = 157.8 \text{ ml} \)

21. \( \text{H}_2\text{SO}_4 \text{(m.eq.)} = 26.7 \times 0.4 \)

\( \Rightarrow \text{H}_2\text{SO}_4 \text{ (mole)} = \frac{26.7 \times 0.4}{2 \times 1000} = 5.34 \times 10^{-3} \)

\( \Rightarrow \) wt. of H_2SO_4 = 0.523 g

\( \Rightarrow 0.5 \text{ mole produces} 0.523 \text{ g H}_2\text{SO}_4 \)

\( \Rightarrow 100 \text{ g oleum will produce} = \frac{0.523}{0.5} \times 100 = 104.66 \text{ g} \)

\% labelling = 104.66

\( \Rightarrow \text{Free SO}_3 \text{ (\%)} = \left(\frac{104.66 - 100}{100}\right) \times 80 = 20.73\% \)

22. \( \text{NaH}_2\text{PO}_4 + 2\text{NaOH} \rightarrow \text{Na}_2\text{PO}_4 + 2\text{H}_2\text{O} \)

12 g

\( = \frac{12}{120} = 0.1 \text{ mole NaH}_2\text{PO}_4 \)

\( \Rightarrow \text{NaOH required} = 0.2 \text{ mole} \)

\( \Rightarrow 0.2 \times \frac{x}{1000} \Rightarrow V = 200 \text{ ml} \)

23. When HPh used

\( \text{Na}_2\text{CO}_3 + \text{HCl} \rightarrow \text{NaHCO}_3 + \text{NaCl} \)

\( n_{\text{Na}_2\text{CO}_3} = 4 \times 1 \times \frac{1}{1000} \text{ Equivalent concept} \)

\( \Rightarrow n_{\text{Na}_2\text{CO}_3} = 4 \times 10^{-3} \text{ mole} \text{......(1)} \)

When MeOH used

\( \text{Na}_2\text{CO}_3 + 2\text{HCl} \rightarrow \text{H}_2\text{CO}_3 + 2\text{NaCl} \)

\( \text{NaHCO}_3 + \text{HCl} \rightarrow \text{H}_2\text{CO}_3 + \text{NaCl} \)

\( n_{\text{Na}_2\text{CO}_3} \times 2 + n_{\text{NaHCO}_3} \times 1 = \frac{10.5}{1000} \times 1 \text{......(2)} \)

\( \Rightarrow n_{\text{NaHCO}_3} = 2.5 \times 10^{-3} \text{ mole} \)

24. In 25 ml x mole Na_2CO_3 & y mole NaOH

When HPh used

Eq. Concept

\( x + 1 \times y = \frac{19.5}{1000} \text{......(1)} \)

When MeOH is used

\( x \times 2 + y \times 1 = \frac{25 \times 1}{1000} \text{......(2)} \)

from eq* (1) & (2)

\( x = \frac{5.5}{1000} \text{ mole Na}_2\text{CO}_3 \) & \( y = \frac{14}{1000} \text{ mole NaOH} \)

In 25 ml

\( \text{Na}_2\text{CO}_3 = 5.5 \times 10^{-3} \times 106 \text{ g} = 0.583 \text{ g} \)

\( \text{NaOH} = 14 \times 10^{-3} \times 40 \text{ g} = 0.56 \text{ g} \)

In 1000 ml

\( \text{Na}_2\text{CO}_3 = 23.32 \text{ g} \) & \( \text{NaOH} = 22.4 \text{ g} \)

25. \( \text{NaOH} = x \text{ mole and Na}_2\text{CO}_3 = y \text{ mole} \)

HPh used

\( x \times 1 + y \times 1 = 17.5 \times 1 \text{......(3)} \)

MeOH is used after HPh

All the NaOH will be finished and Na_2CO_3 converted in NaHCO_3 = y mole

\( y \times 1 = 2.5 \times \frac{1}{10} \Rightarrow y = 0.25 \text{ mole} \)

\( \Rightarrow x = 1.5 \text{ mole} \)

mass of NaOH = 1.5 \times 10^{-3} \times 40 = 0.06 \text{ g} \)

mass of Na_2CO_3 = 0.25 \times 10^{-3} \times 106 = 0.0265 \text{ g} \)

26. Eq. of Ce^{4+} = Eq. of Sn^{2+}

\( 40.05 \times 1 \times n_f = 20 \times 1 \times 2 \)

\( \Rightarrow n_f \text{ of Ce}^{4+} = 1 \)

ox. state change Ce^{4+} \rightarrow Ce^{3+} for \ n_f = 1
27. Eq. of Se = Eq. of Cr
\[ 12.53 \times 0.05093 \times \text{n.f} = 25.52 \times 0.1 \times 1 \]
\[ \text{n.f} = 4 \]
\[ \text{SeO}_2 \rightarrow \text{Se} \]
for \( \text{n.f} = 4 \) : ox. state = zero

28. \( \text{K}_2\text{C}_2\text{O}_4 \), \( 3\text{H}_2\text{C}_2\text{O}_4 \), \( 4\text{H}_2\text{O} \): \( \text{n.f.} = 8 \) as R.A.
Eq. of oxalate = Eq. of KMnO_4
\[ \frac{1}{\text{K. wt.}} \times 8 = \text{V} \times 0.1 \times 5 \]
\[ \text{Mol. wt. (oxalate)} = 508 \]
\[ \Rightarrow \text{V} = \frac{8}{508 \times 0.1 \times 5} = 0.03168 \text{ L} \]
\[ \Rightarrow \text{V} = 31.68 \text{ ml} \]

29. Eq. of \( \text{H}_2\text{O}_2 \) = Eq. of KMnO_4
\[ \frac{\text{n.f.}}{2} = \frac{\text{n.f.}}{5} \]
\[ \Rightarrow \left( \frac{1}{34} \times \frac{x}{100} \right) \times 2 = \frac{x}{1000} \times \text{N} \]
\[ \Rightarrow \text{N} = 0.588 \]

30. Sn \rightarrow \text{SnCl}_4 :
\[ \text{At. wt. (Sn)} = 118.7 \]
\[ \text{nf} = 4 \]
\[ \text{Eq. of Sn} = \text{Eq. of dichromate} \]
\[ \Rightarrow \frac{1}{118.7} \times 4 = \frac{1}{10} \times \text{V} \]
\[ \Rightarrow \text{V} = \frac{40}{118.7} \text{ L} \]
\[ \Rightarrow \text{V} = 338.96 \text{ ml} \]

31. Eq. of Hypo = Eq. of \( I_2 \)
m.\( \text{20} \times 0.0327 = \) m. eq. of \( I_2 \) = m. eq. of (in 20 ml)
\[ \Rightarrow \text{Cu}^+ \text{ in 1 L} = 20 \times 0.0327 \times \frac{1000}{20} \text{ m.eq.} \]
\[ \Rightarrow \text{Eq. of Cu}^+ = 0.0327 \text{ eq.} \]
\[ \Rightarrow \text{Cu}^+ = 0.0327 \text{ mole} = 0.0327 \times 63.5 \text{ g} = 2.07645 \text{ g} \]
\[ \Rightarrow \% = 2.07645/5 \times 100 = 41.53\% \]

32. \( \text{Fe}_2\text{O}_3 \) \( \times \frac{1}{100} = 0.552 \text{ g} \)
After Zn dust treatment
\[ \text{Fe}^{3+} \rightarrow \text{Fe}^{2+} \]
\[ \downarrow \quad \downarrow \]
\[ \frac{0.552}{160} \times 2\text{ mole} \quad \frac{0.552}{160} \times 2\text{ mole} \]
in 100 ml
\[ \Rightarrow \text{In 25 ml} \]
\[ \frac{0.552 \times 2}{160 \times 4} \text{ mole} ; (\text{nf} = 1) \]
Now eq. of \( \text{Fe}^{2+} \) = Eq. of oxidant
\[ \Rightarrow \frac{0.552 \times 2}{160 \times 4} \times 1 = \frac{17 \times 0.0167}{1000} \times \text{nf} \]
\[ \Rightarrow \text{nf} = 6 \text{ for oxidant} \]
\[ \Rightarrow 6 \text{ mole e}^- \]

33. Iron = \( 0.84 \times \frac{x}{100} \text{ g} \)
Eq. of dichromate = Eq. of \( \text{Fe}^{3+} \)
\[ x \times \frac{N}{1000} = \left( \frac{x \times 0.84}{100} \right) \frac{100}{56} \]
\[ \Rightarrow N = \frac{0.84 \times 1000}{100 \times 56} = 0.15 \]

34. Eq. of \( I_2 \) = Eq. of Hypo
\[ \text{meq of } I_2 = \frac{40}{10} = 4 \]
\[ \Rightarrow \text{m.eq. of } I_2 = \text{m.eq. of } \text{Kl} = \text{m.eq. of } \text{Cl}_2 \]
\[ = \text{m.eq. of } \text{MnO}_2 \]
\[ \Rightarrow \text{m.eq. of } \text{MnO}_2 = 4 \]
\[ \Rightarrow \text{MnO}_2 \rightarrow \text{Mn}^{2+} \]
\[ \text{nf} = 2 \]
\[ \Rightarrow \text{m. mole of } \text{MnO}_2 = 4/2 = 2 \]
\[ \Rightarrow \text{mole of } \text{MnO}_2 = 2 \times 10^{-3} \]
\[ \text{mass} = 2 \times 10^{-3} \times 87 = 0.174 \text{ g} \]
\[ \% = \frac{0.174}{5} \times 100 = 3.48\% \]

35. Total m.eq. of \( \text{HC}l = 0.5 \times 50 = 25 \)
m.eq. of \( \text{NaOH} = 0.3 \times 20 = 6 \)
m.eq. of remaining after rxn with \( \text{Ca(OH)}_2 \)
m.eq. reacted with \( \text{Ca(OH)}_2 = 25 - 6 = 19 \)
\[ \Rightarrow \text{mole of } \text{Ca(OH)}_2 = 19/2 \times 10^{-3} \]
\[ \Rightarrow \text{mass of } \text{Ca(OH)}_2 = \frac{19}{2} \times 10^{-3} \times 74 = 0.703 \text{ g} \]
\[ \text{Purity} = \frac{0.703 \times 100}{1} = 1.406\% \]
36. In 50 ml solution

Total m.eq. of HCl = 50 x 0.1 = 5
m.eq. of NaOH = 10 x 0.16 = 1.6
m.eq. of HCl react with NaOH
⇒ m.eq. of HCl reacted with Na₂CO₃
= 5 - 1.6 = 3.4
⇒ m.eq. of Na₂CO₃ = 3.4
⇒ moles of Na₂CO₃ = \( \frac{3.4}{2} \)

mass of Na₂CO₃ = \( \frac{3.4}{2} \times 10^{-3} \times 106 = 0.1802 \) g

⇒ In 250 ml
mass of Na₂CO₃ = 0.1802 x 5 = 0.901

% Purity = \( \frac{0.901}{1} \times 100 = 90.1\% \)

37. Total m.eq. of Ag NO₃ = 25 x 0.1 = 2.5
Ag⁺ m.eq. reacted with NH₄SCN = m.eq. of NH₄SCN
given 1 ml of NH₄SCN = 1.1 ml of AgNO₃
⇒ Ag NO₃ used = 0.1 x 1.1 x 5 = 0.55
remaining AgNO₃ = 2.5 - 0.55 = 1.95
m.eq. of NaCl + m.eq. of KCl = m.eq. of AgNO₃
⇒ moles of NaCl + moles of KCl = 1.95

Let the mass = x kg of substance
⇒ \( x \times \frac{60}{100} \times \frac{1}{5.85} = x \times \frac{37}{100} \times \frac{1}{74.5} \)
⇒ x = 0.1281 g

38. 2HCl + CaCO₃ → H₂CO₃ + CaCl₂
10 g CaCO₃ = 0.1 mole CaCO₃
mole of HCl required = 0.2

total mole of HCl taken = \( \frac{250}{1000} \times 1 = 0.25 \)

Remaining HCl = 0.25 - 0.2 = 0.05 mole
⇒ KOH required = 0.05 = 2 x (L)
⇒ V = 0.025 L or V = 25 ml

41. 0.1 x V x 5 = 0.05 x 1 x 25
V = 2.5 ml

42. Ba(OH)₂ = \( \frac{(5 - 2)}{20} \) \times \frac{100}{100} \times \frac{(137 + 34)}{2}

= 1%

43. Na₂CO₃ → a mole
NaOH → b mole
(a+b) = 19.5 x 0.995
2a+b = 25 x 0.995
a = 5.5 x 0.995
wt per lit. Na₂CO₃ = 5.5 x 0.994 x 40 x 106
= 23.3
44. \%Cl = \frac{35.5 \times 24.35 \times 20 \times 2}{5.7 \times 1000} = 30.33\%

45. \((5-n) \times 2.68 \times 10^{-3} = 1.61 \times 10^{-3} \times 5\)
   \(n = 2\)

46. \(M = \frac{0.672}{6}\)
   
   (i) mass = \(88.5 \times \frac{0.672}{6}\)

   (ii) \(M = \frac{0.672}{5} = 0.1344\)

47. \(= 30 = 4.2C_2O_4 = 0.9g\)
   
   \(2a + b = 200\)
   
   \(a = 70\)  \(b = 1.12g\)

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**Exercise – IV**

**LEVEL – I**

1. \(\text{PbS} \rightarrow \text{PbSO}_4\)
   
   \(\text{H}_2\text{SO}_3 \rightarrow 2\text{H}_2\text{O}^2\)

   \(\frac{4}{2} = 0.1 \times 34\)

   \(= 13.6 g\)

2. \(\text{MnO}_4^- \rightarrow \text{Mn}^{2+} n = 5\)

   \(\text{MnO}_4^- \rightarrow \text{MnO}_4^{2-} n = 1\)

3. D

4. A

5. \(4x + 4 = 0\)
   
   \(x = 0\)

6. D

7. B

8. C

9. D

**LEVEL – II**

1. Mohr salt : \((\text{NH}_4)_2\text{Fe(SO}_4)_2 \cdot 6\text{H}_2\text{O}\)
   
   Fe is in +2 state

   \(n_f\) of Mohr salt = 1
   
   \(n_f\) of \(\text{K}_2\text{Cr}_2\text{O}_7 = 6\)

   Eq. of Mohr Salt = Eq. of \(\text{K}_2\text{Cr}_2\text{O}_7\)

   \(n \times 1 = 1 \times 6\)

   \(n = 6\)  \(\text{Ans. (D)}\)

2. \(\text{O}_2 \rightarrow \text{O}_2 - \text{O}_2^{2-}\) disproportionation (s)
   
   Redox reaction (p)

   \(\text{B) CrO}_4^{2-} + \text{H}^+ \rightarrow \text{Cr}_2\text{O}_7^{2-}\) Ans. : R

   \(\text{C) MnO}_4^- + \text{NO}_2^- + \text{H}^+ \rightarrow \text{Mn}^{2+} + \text{NO}_3^- + \text{H}_2\text{O}\) (P, Q)

   trigonal planer

   \(\text{D) NO}_2^- + \text{H}_2\text{SO}_4 + \text{Fe}^{3+} \rightarrow \text{Fe}^{3+} + \text{NO}_3^- + \text{SO}_4^{2-} + \text{H}_2\text{O}\) (p)

   (Redox Reaction)

   \(\text{E) P}_4 + \text{NaOH} + \text{H}_2\text{O} \rightarrow \text{PH}_3 + \text{NaH}_2\text{PO}_2\) Ans. : (B)

   (disproportionation Rxn)