

Chapter

Some Basic Concepts of

Chemistry



Topic-1: Measurement, Mole Concept and Percentage Composition



1 MCQs with One Correct Answer

- Which has maximum number of atoms? [2003S]
 - 24 g of C (12)
 - 56 g of Fe (56)
 - 27 g of Al (27)
 - 108 g of Ag (108)
- How many moles of electron weigh one kilogram? [2002S]
 - 6.023×10^{23}
 - $\frac{1}{9.108} \times 10^{31}$
 - $\frac{6.023}{9.108} \times 10^{54}$
 - $\frac{1}{9.108 \times 6.023} \times 10^8$
- If two compounds have the same empirical formula but different molecular formulae they must have
 - different percentage composition [1987 - 1 Mark]
 - different molecular weight
 - same viscosity
 - same vapour density
- The largest number of molecules is in [1979]
 - 36 g of water
 - 28 g of carbon monoxide
 - 46 g of ethyl alcohol
 - 54 g of nitrogen pentoxide
- The total number of electrons in one molecule of carbon dioxide is [1979]
 - 22
 - 44
 - 66
 - 88
- A gaseous mixture contains oxygen and nitrogen in the ratio of 1 : 4 by weight. Therefore, the ratio of their number of molecules is [1979]
 - 1 : 4
 - 1 : 8
 - 7 : 32
 - 3 : 16
- 27 g of Al will react completely with how many grams of oxygen? [1978]
 - 8 g
 - 16 g
 - 32 g
 - 24 g
- A compound was found to contain nitrogen and oxygen in the ratio 28 g and 80 g respectively. The formula of compound is [1978]
 - NO
 - N₂O₃
 - N₂O₅
 - N₂O₄



3 Numeric / New Stem Based Questions

- If the value of Avogadro number is $6.023 \times 10^{23} \text{ mol}^{-1}$ and the value of Boltzmann constant is $1.380 \times 10^{-23} \text{ J K}^{-1}$, then the number of significant digits in the calculated value of the universal gas constant is [Adv. 2014]

- Calculate the molarity of water if its density is 1000 kg/m^3 . [2003 - 2 Marks]

- The composition of a sample of Wurtzite is $\text{Fe}_{0.93}\text{O}_{1.00}$. What percentage of the iron is present in the form of Fe (III)? [1994 - 2 Marks]
- A compound contains 28 percent of nitrogen and 72 percent of metal by weight. 3 atoms of metal combine with 2 atoms of N. Find the atomic weight of metal. [1980]



4 Fill in the Blanks

- The weight of 1×10^{22} molecules of $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ is [1991 - 1 Mark]
- The modern atomic mass unit is based on [1980]
- The total number of electrons present in 18 mL of water is [1980]



6 MCQs with One or More than One Correct Answer

- To check the principle of multiple proportions, a series of pure binary compounds (P_mQ_n) were analyzed and their composition is tabulated below. The correct option(s) is (are) [Adv. 2022]

Compound	Weight % of P	Weight % of Q
1	50	50
2	44.4	55.6
3	40	60

- If empirical formula of compound 3 is P_3Q_4 , then the empirical formula of compound 2 is P_3Q_5 .
- If empirical formula of compound 3 is P_3Q_2 and atomic weight of element P is 20, then the atomic weight of Q is 45.
- If empirical formula of compound 2 is PQ, then the empirical formula of the compound 1 is P_5Q_4 .
- If atomic weight of P and Q are 70 and 35, respectively, then the empirical formula of compound 1 is P_2Q .





10 Subjective Problems

17. A plant virus is found to consist of uniform cylindrical particles of 150 Å in diameter and 5000 Å long. The specific volume of the virus is $0.75 \text{ cm}^3/\text{g}$. If the virus is considered to be a single particle, find its molar mass. [1999 - 3 Marks]
18. (a) One litre of a sample of hard water contains 1 mg of CaCl_2 and 1 mg of MgCl_2 . Find the total hardness in terms of parts of CaCO_3 per 10^6 parts of water by weight.
- (b) A sample of hard water contains 20 mg of Ca^{++} ions per litre. How many milli-equivalent of Na_2CO_3 would be required to soften 1 litre of the sample?
- (c) 1 g of Mg is burnt in a closed vessel which contains 0.5 g of O_2 .
- (i) Which reactant is left in excess?
 (ii) Find the weight of the excess reactants?
 (iii) How many milliliters of 0.5 N H_2SO_4 will dissolve the residue in the vessel. [1980]
19. A hydrocarbon contains 10.5 g of carbon per gram of hydrogen. 1 litre of the vapour of the hydrocarbon at 127 °C and 1 atmosphere pressure weighs 2.8 g. Find the molecular formula. [1980]
20. Find [1980]
- (i) The total number of neutrons and
 (ii) The total mass of neutron in 7 mg of ^{14}C .
 (Assume that mass of neutron = mass of hydrogen atom)



Topic-2: Stoichiometry, Equivalent Concept, Neutralization and Redox Titration



1 MCQs with One Correct Answer

1. In a metal deficient oxide sample, $\text{M}_x\text{Y}_2\text{O}_4$ (M and Y are metals), M is present in both +2 and +3 oxidation states and Y is in +3 oxidation state. If the fraction of M^{2+} ions present in M is $\frac{1}{3}$, the value of X is _____. [Adv. 2024]
 (a) 0.25 (b) 0.33 (c) 0.67 (d) 0.75
2. Mixture X = 0.02 mol of $[\text{Co}(\text{NH}_3)_5\text{SO}_4]\text{Br}$ and 0.02 mol of $[\text{Co}(\text{NH}_3)_5\text{Br}]\text{SO}_4$ was prepared in 2 litre of solution. 1 litre of mixture X + excess $\text{AgNO}_3 \rightarrow \text{Y}$. 1 litre of mixture X + excess $\text{BaCl}_2 \rightarrow \text{Z}$. No. of moles of Y and Z are [2003S]
 (a) 0.01, 0.01 (b) 0.02, 0.01
 (c) 0.01, 0.02 (d) 0.02, 0.02
3. An aqueous solution of 6.3 g oxalic acid dihydrate is made up to 250 mL. The volume of 0.1 N NaOH required to completely neutralize 10 mL of this solution is [2001S]
 (a) 40 mL (b) 20 mL
 (c) 10 mL (d) 4 mL
4. In the standardization of $\text{Na}_2\text{S}_2\text{O}_3$ using $\text{K}_2\text{Cr}_2\text{O}_7$ by iodometry, the equivalent weight of $\text{K}_2\text{Cr}_2\text{O}_7$ is [2001S]
 (a) (molecular weight)/2 (b) (molecular weight)/6
 (c) (molecular weight)/3 (d) same as molecular weight
5. The normality of 0.3 M phosphorous acid (H_3PO_3) is, [1999 - 2 Marks]
 (a) 0.1 (b) 0.9 (c) 0.3 (d) 0.6
6. The equivalent weight of MnSO_4 is half of its molecular weight when it is converted to: [1988 - 1 Mark]
 (a) Mn_2O_3 (b) MnO_2
 (c) MnO_4^- (d) MnO_4^{2-}
7. In which mode of expression, the concentration of a solution remains independent of temperature? [1988 - 1 Mark]
 (a) Molarity (b) Normality
 (c) Formality (d) Molality
8. A molal solution is one that contains one mole of a solute in: [1986 - 1 Mark]
 (a) 1000 g of the solvent
 (b) one litre of the solvent
 (c) one litre of the solution
 (d) 22.4 litres of the solution
9. If 0.50 mole of BaCl_2 is mixed with 0.20 mol of Na_3PO_4 , the maximum number of moles of $\text{Ba}_3(\text{PO}_4)_2$ that can be formed is [1981 - 1 Mark]
 (a) 0.70 (b) 0.50
 (c) 0.20 (d) 0.10
10. M is molecular weight of KMnO_4 . The equivalent weight of KMnO_4 when it is converted into K_2MnO_4 is [1980]
 (a) M (b) M/3
 (c) M/5 (d) M/7
11. 2.76 g of silver carbonate on being strongly heated yields a residue weighing [1979]
 (a) 2.16 g (b) 2.48 g
 (c) 2.32 g (d) 2.64 g



2 Integer Value Answer

12. The stoichiometric reaction of 516 g of dimethyldichlorosilane with water results in a tetrameric cyclic product X in 75% yield. The weight (in g) of X obtained is _____. [Adv. 2023]
 [Use, molar mass (g mol^{-1}): H = 1, C = 12, O = 16, Si = 28, Cl = 35.5]
13. H_2S (5 moles) reacts completely with acidified aqueous potassium permanganate solution. In this reaction, the number of moles of water produced is x, and the number of moles of electrons involved is y. The value of (x + y) is _____. [Adv. 2023]



3 Numeric / New Stem Based Questions

Question Stem for Question Nos. 14 and 15

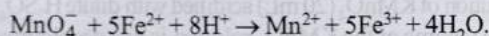
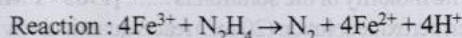
A sample (5.6 g) containing iron is completely dissolved in cold dilute HCl to prepare a 250 mL of solution. Titration of 25.0 mL of this solution requires 12.5 mL of 0.03 M KMnO_4 solution to reach the end point. Number of moles of Fe^{2+} present in 250 mL solution is $x \times 10^{-2}$ (consider complete dissolution of FeCl_2). The amount of iron present in the sample of $y\%$ by weight.

(Assume : KMnO_4 reacts only with Fe^{2+} in the solution)

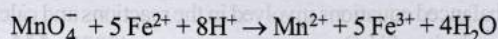
Use : Molar mass of iron as 56 g mol^{-1})

14. The value of x is _____. [Adv. 2021]
15. The value of y is _____. [Adv. 2021]
16. The ammonia prepared by treating ammonium sulphate with calcium hydroxide is completely used by $\text{NiCl}_2 \cdot 6\text{H}_2\text{O}$ to form a stable coordination compound. Assume that both the reactions are 100% complete. If 1584 g of ammonium sulphate and 952 g of $\text{NiCl}_2 \cdot 6\text{H}_2\text{O}$ are used in the preparation, the combined weight (in grams) of gypsum and the nickel-ammonia coordination compound thus produced is _____.
(Atomic weights in g mol^{-1} : H = 1, N = 14, O = 16, S = 32, Cl = 35.5, Ca = 40, Ni = 59) [Adv. 2018]
17. Galena (an ore) is partially oxidized by passing air through it at high temperature. After some time, the passage of air is stopped, but the heating is continued in a closed furnace such that the contents undergo self-reduction. The weight (in kg) of Pb produced per kg of O_2 consumed is _____.
(Atomic weights in g mol^{-1} : O = 16, S = 32, Pb = 207) [Adv. 2018]
18. How many millilitres of 0.5 M H_2SO_4 are needed to dissolve 0.5 g of copper(II) carbonate? [1999 - 3 Marks]
19. One gram of commercial AgNO_3 is dissolved in 50 mL of water. It is treated with 50 mL of a KI solution. The silver iodide thus precipitated is filtered off. Excess of KI in the filtrate is titrated with (M/10) KIO_3 solution in presence of 6M HCl till all I^- ions are converted into ICl . It requires 50 mL of (M/10) KIO_3 solution. 20 mL of the same stock solution of KI requires 30 mL of (M/10) KIO_3 under similar conditions. Calculate the percentage of AgNO_3 in the sample. (Reaction : $\text{KIO}_3 + 2\text{KI} + 6\text{HCl} \rightarrow 3\text{ICl} + 3\text{KCl} + 3\text{H}_2\text{O}$) [1992 - 4 Marks]
20. A 1.0 g sample of Fe_2O_3 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 electrons taken up by the oxidant in the reaction of the above titration. [1991 - 4 Marks]
21. Calculate the molality of 1 litre solution of 93% H_2SO_4 (weight/volume). The density of the solution is 1.84 g/mL. [1990 - 1 Marks]
22. A sample of hydrazine sulphate ($\text{N}_2\text{H}_6\text{SO}_4$) was dissolved in 100 mL of water, 10 mL of this solution was reacted with excess of ferric chloride solution and warmed to complete

the reaction. Ferrous ion formed was estimated and it required 20 mL of M/50 potassium permanganate solution. Estimate the amount of hydrazine sulphate in one litre of the solution. [1988 - 3 Marks]



23. Hydroxylamine reduces iron (III) according to the equation: $2\text{NH}_2\text{OH} + 4\text{Fe}^{3+} \rightarrow \text{N}_2\text{O}(\text{g}) \uparrow + \text{H}_2\text{O} + 4\text{Fe}^{2+} + 4\text{H}^+$ Iron (II) thus produced is estimated by titration with a standard permanganate solution. The reaction is :



- A 10 mL sample of hydroxylamine solution was diluted to 1 litre. 50 mL of this diluted solution was boiled with an excess of iron (III) solution. The resulting solution required 12 mL of 0.02 M KMnO_4 solution for complete oxidation of iron (II). Calculate the weight of hydroxylamine in one litre of the original solution. (H = 1, N = 14, O = 16, K = 39, Mn = 55, Fe = 56) [1982 - 4 Marks]
24. A 1.00 g sample of H_2O_2 solution containing X per cent H_2O_2 by weight requires X mL of a KMnO_4 solution for complete oxidation under acidic conditions. Calculate the normality of the KMnO_4 solution. [1981 - 3 Marks]
25. 4.215 g of a metallic carbonate was heated in a hard glass tube and the CO_2 evolved was found to measure 1336 mL at 27°C and 700 mm pressure. What is the equivalent weight of the metal? [1979]
26. What weight of AgCl will be precipitated when a solution containing 4.77 g of NaCl is added to a solution of 5.77 g of AgNO_3 ? [1978]
27. Igniting MnO_2 converts it quantitatively to Mn_3O_4 . A sample of pyrolusite is of the following composition : MnO_2 80%, SiO_2 and other inert constituents 15%, rest being water. The sample is ignited in air to constant weight. What is the percentage of Mn in the ignited sample? [1978] [O = 16, Mn = 54.9]



9 Assertion and Reason Statement Type Questions

Each question contains **STATEMENT-1 (Assertion)** and **STATEMENT-2 (Reason)**. Each question has 4 choices (a), (b), (c) and (d) out of which ONLY ONE is correct. Mark your answer as

- (a) If both Statement -1 and Statement -2 are correct, and Statement -2 is the correct explanation of the Statement -1.
 - (b) If both Statement -1 and Statement -2 are correct, but Statement -2 is not the correct explanation of the Statement -1.
 - (c) If Statement -1 is correct but Statement -2 is incorrect.
 - (d) If Statement -1 is incorrect but Statement -2 is correct.
28. Read the following statement and explanation and answer as per the options given below :
- Statement-1** : In the titration of Na_2CO_3 with HCl using methyl orange indicator, the volume required at the equivalence point is twice that of the acid required using phenolphthalein indicator.
- Statement-2** : Two moles of HCl are required for the complete neutralization of one mole of Na_2CO_3 . [1991 - 2 Marks]



10 Subjective Problems

29. 3 g of a salt of molecular weight 30 is dissolved in 250 g of water. The molality of the solution is [1983 - 1 Mark]
30. Hydrogen peroxide solution (20 mL) reacts quantitatively with a solution of KMnO_4 (20 mL) acidified with dilute H_2SO_4 . The same volume of the KMnO_4 solution is just decolourised by 10 mL of MnSO_4 in neutral medium simultaneously forming a dark brown precipitate of hydrated MnO_2 . The brown precipitate is dissolved in 10 mL of 0.2 M sodium oxalate under boiling condition in the presence of dilute H_2SO_4 . Write the balanced equations involved in the reactions and calculate the molarity of H_2O_2 . [2001 - 5 Marks]
31. An aqueous solution containing 0.10 g KIO_3 (formula weight = 214.0) was treated with an excess of KI solution. The solution was acidified with HCl . The liberated I_2 consumed 45.0 mL of thiosulphate solution to decolourise the blue starch-iodine complex. Calculate the molarity of the sodium thiosulphate solution. [1998 - 5 Marks]
32. A 3.00 g sample containing Fe_3O_4 , Fe_2O_3 and an inert impure substance, is treated with excess of KI solution in presence of dilute H_2SO_4 . The entire iron is converted into Fe^{2+} along with the liberation of iodine. The resulting solution is diluted to 100 mL. A 20 mL of the diluted solution requires 11.0 mL of 0.5 M $\text{Na}_2\text{S}_2\text{O}_3$ 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 KMnO_4 solution in dilute H_2SO_4 medium for the oxidation of Fe^{2+} . Calculate the percentages of Fe_2O_3 and Fe_3O_4 in the original sample. [1996 - 5 Marks]
33. 8.0575×10^{-2} kg of Glauber's salt is dissolved in water to obtain 1 dm^3 of a solution of density 1077.2 kg m^{-3} . Calculate the molarity, molality and mole fraction of Na_2SO_4 in the solution. [1994 - 3 Marks]
34. Upon mixing 45.0 mL of 0.25 M lead nitrate solution with 25.0 mL of 0.10 M chromic sulphate solution, precipitation of lead sulphate takes place. How many moles of lead sulphate are formed? Also, calculate the molar concentrations of the species left behind in the final solution. Assume that lead sulphate is completely insoluble. [1993 - 3 Marks]
35. A 2.0 g sample of a mixture containing sodium carbonate, sodium bicarbonate and sodium sulphate is gently heated till the evolution of CO_2 ceases. The volume of CO_2 at 750 mm Hg pressure and at 298 K is measured to be 123.9 mL. A 1.5 g of the same sample requires 150 mL of (M/10) HCl for complete neutralisation. Calculate the % composition of the components of the mixture. [1992 - 5 Marks]
36. A solution of 0.2 g of a compound containing Cu^{2+} and $\text{C}_2\text{O}_4^{2-}$ ions on titration with 0.02 M KMnO_4 in presence of H_2SO_4 consumes 22.6 mL of the oxidant. The resultant solution is neutralized with Na_2CO_3 , acidified with dil. acetic acid and treated with excess KI . The liberated iodine requires 11.3 mL of 0.05 M $\text{Na}_2\text{S}_2\text{O}_3$ solution for complete reduction. Find out the molar ratio of Cu^{2+} to $\text{C}_2\text{O}_4^{2-}$ in the compound. Write down the balanced redox reactions involved in the above titrations. [1991 - 5 Marks]
37. A mixture of $\text{H}_2\text{C}_2\text{O}_4$ (oxalic acid) and NaHC_2O_4 weighing 2.02 g was dissolved in water and solution made upto one litre. Ten millilitres 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, require 4.0 mL of 0.1 N potassium permanganate solution for complete reaction. Calculate the amount of $\text{H}_2\text{C}_2\text{O}_4$ and NaHC_2O_4 in the mixture. [1990 - 5 Marks]
38. A solid mixture (5.0 g) consisting of lead nitrate and sodium nitrate was heated below 600°C until the weight of the residue was constant. If the loss in weight is 28.0 per cent, find the amount of lead nitrate and sodium nitrate in the mixture. [1990 - 4 Marks]
39. An equal volume of a reducing agent is titrated separately with 1M KMnO_4 in acid neutral and alkaline media. The volumes of KMnO_4 required are 20 mL in acid, 33.4 mL in neutral and 100 mL in alkaline media. Find out the oxidation state of manganese in each reduction product. Give the balanced equations for all the three half reactions. Find out the volume of 1M $\text{K}_2\text{Cr}_2\text{O}_7$ consumed; if the same volume of the reducing agent is titrated in acid medium. [1989 - 5 Marks]
40. A sugar syrup of weight 214.2 g contains 34.2 g of sugar ($\text{C}_{12}\text{H}_{22}\text{O}_{11}$). Calculate: (i) molal concentration and (ii) mole fraction of sugar in the syrup. [1988 - 2 Marks]
41. (i) What is the weight of sodium bromate and molarity of solution necessary to prepare 85.5 mL of 0.672 N solution when the half-cell reaction is
- $$\text{BrO}_3^- + 6\text{H}^+ + 6\text{e}^- \rightarrow \text{Br}^- + 3\text{H}_2\text{O}$$
- (ii) What would be the weight as well as molarity if the half-cell reaction is:
- $$2\text{BrO}_3^- + 12\text{H}^+ + 10\text{e}^- \rightarrow \text{Br}_2 + 6\text{H}_2\text{O}$$
- [1987 - 5 Marks]
42. Five mL of 8N nitric acid, 4.8 mL of 5N hydrochloric acid and a certain volume of 17M sulphuric acid are mixed together and made upto 2litre. Thirty mL of this acid mixture exactly neutralise 42.9 mL of sodium carbonate solution containing one gram of $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$ in 100 mL of water. Calculate the amount in gram of the sulphate ions in solution. [1985 - 4 Marks]
43. 2.68×10^{-3} moles of a solution containing an ion A^{n+} require 1.61×10^{-3} moles of MnO_4^- for the oxidation of A^{n+} to AO_3^- in acid medium. What is the value of n ? [1984 - 2 Marks]
44. The density of a 3 M sodium thiosulphate solution ($\text{Na}_2\text{S}_2\text{O}_3$) is 1.25 g per mL. Calculate (i) the percentage by weight of sodium thiosulphate, (ii) the mole fraction of

- sodium thiosulphate and (iii) the molalities of Na^+ and $\text{S}_2\text{O}_3^{2-}$ ions. [1983 - 5 Marks]
45. 4.08 g of a mixture of BaO and an unknown carbonate MCO_3 was heated strongly. The residue weighed 3.64 g. This was dissolved in 100 mL of 1 N HCl. The excess acid required 16 mL of 2.5 N NaOH solution for complete neutralization. Identify the metal M. [1983 - 4 Marks] (At. wt. H = 1, C = 12, O = 16, Cl = 35.5, Ba = 138)
46. (i) A sample of $\text{MnSO}_4 \cdot 4\text{H}_2\text{O}$ is strongly heated in air. The residue is Mn_3O_4 .
 (ii) The residue is dissolved in 100 mL of 0.1 N FeSO_4 containing dilute H_2SO_4 .
 (iii) The solution reacts completely with 50 mL of KMnO_4 solution.
 (iv) 25 mL of the KMnO_4 solution used in step (iii) requires 30 mL of 0.1 N FeSO_4 solution for complete reaction. Find the amount of $\text{MnSO}_4 \cdot 4\text{H}_2\text{O}$ present in the sample. [1980]
47. A mixture contains NaCl and unknown chloride MCl.
 (i) 1 g of this is dissolved in water. Excess of acidified AgNO_3 solution is added to it. 2.567 g of white ppt. is formed.
- (ii) 1 g of original mixture is heated to 300 °C. Some vapours come out which are absorbed in acidified AgNO_3 solution, 1.341 g of white precipitate was obtained. Find the molecular weight of unknown chloride. [1980]
48. 5 mL of a gas containing only carbon and hydrogen were mixed with an excess of oxygen (30 mL) and the mixture exploded by means of an electric spark. After the explosion, the volume of the mixed gases remaining was 25 mL. On adding a concentrated solution of potassium hydroxide, the volume further diminished to 15 mL of the residual gas being pure oxygen. All volumes have been reduced to N.T.P. Calculate the molecular formula of the hydrocarbon gas. [1979]
49. One gram of an alloy of aluminium and magnesium when treated with excess of dil. HCl forms magnesium chloride, aluminium chloride and hydrogen. The evolved hydrogen, collected over mercury at 0 °C has a volume of 1.20 litres at 0.92 atm. pressure. Calculate the composition of the alloy. [H = 1, Mg = 24, Al = 27] [1978]

? Answer Key

Topic-1 : Measurement, Mole Concept and Percentage Composition

1. (a) 2. (d) 3. (b) 4. (a) 5. (a) 6. (c) 7. (d) 8. (c) 9. (4) 10. (55.55)
 11. (15.05) 12. (24) 13. (4.14) 14. (Carbon (C-12)) 15. (6.02×10^{24}) 16. (b,c)

Topic-2 : Stoichiometry, Equivalent Concept, Neutralization and Redox Titration

1. (d) 2. (a) 3. (a) 4. (b) 5. (d) 6. (b) 7. (d) 8. (a) 9. (d) 10. (a)
 11. (a) 12. (222) 13. (18) 14. (1.875) 15. (18.75) 16. (2992) 17. (6.47) 18. (8.09) 19. (85) 20. (6.0)
 21. (10.43) 22. (6.5) 23. (39.6) 24. (0.58) 25. (12.15) 26. (4.87) 27. (59.33) 28. (b)

Hints & Solutions



Topic-1: Measurement, Mole Concept and Percentage Composition

1. (a) Atomic weight in gms = 6.023×10^{23} atoms = 1 Mole atoms

(a) Number of atoms in 24 g of C

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

 = 2 mole atoms

(b) Number of atoms in 56 g of Fe

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

 = 1 mole atoms

(c) Number of atoms in 27 g of Al

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

 = 1 mole atoms

(d) Number of atoms in 108 g of Ag

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

 = 1 mole atoms

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

2. (d) (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 one electron \times Avogadro Number

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

 \therefore No. of moles of electrons in 1 kg

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

3. (b) Molecular Formula = $n \times$ Empirical formula

Solution : Since the molecular formula is n times the empirical formula, therefore, different compounds having the same empirical formula must have different molecular weights.

4. (a) (a) 18 g of H_2O = 6.02×10^{23} molecules of H_2O
 \therefore 36 g of H_2O = $2 \times 6.02 \times 10^{23}$ molecules of H_2O

$$= 12.04 \times 10^{23} \text{ molecules of } \text{H}_2\text{O}$$

 (b) 28 g of CO = 6.02×10^{23} molecules of CO

(c) 46 g of $\text{C}_2\text{H}_5\text{OH}$ = 6.02×10^{23} molecules of $\text{C}_2\text{H}_5\text{OH}$

(d) 108 g of N_2O_5 = 6.02×10^{23} molecules of N_2O_5

\therefore 54 g of N_2O_5 = $\frac{1}{2} \times 6.02 \times 10^{23}$ molecules of N_2O_5

$$= 3.01 \times 10^{23} \text{ molecules of } \text{N}_2\text{O}_5$$

\therefore 36 g of water has highest number of molecules.

5. (a) No. of e^- in C = 6 and in O = 8

\therefore Total no. of e^- in CO_2 = $6 + 8 \times 2 = 22$

6. (c) Let mass of oxygen = 1g, Then mass of nitrogen = 4g

Mol. wt. of N_2 = 28g, Mol. wt. of O_2 = 32g

28 g of N_2 has = 6.02×10^{23} molecules of nitrogen

4 g of N_2 has = $\frac{6.02 \times 10^{23}}{28} \times 4$ molecules of nitrogen

$$= \frac{6.02 \times 10^{23}}{7} \text{ molecules of nitrogen}$$

32 g of O_2 has = 6.02×10^{23} molecules of oxygen

\therefore 1g of O_2 has = $\frac{6.02 \times 10^{23}}{32} \times 1$

$$= \frac{6.02 \times 10^{23}}{32} \text{ molecules of oxygen}$$

Thus, ratio of molecules of oxygen : nitrogen

$$= \frac{6.02 \times 10^{23} / 32}{6.02 \times 10^{23} / 7} = 7 : 32$$

7. (d) $4\text{Al} + 3\text{O}_2 \longrightarrow 2\text{Al}_2\text{O}_3$

At. wt. of Al = 27

Thus 4×27 g of Al reacts with oxygen = 3×32 g

\therefore 27 g of Al reacts with oxygen = $\frac{3 \times 32}{4 \times 27} \times 27 \text{ g} = 24 \text{ g}$

8. (c) No. of nitrogen atoms = $\frac{\text{Mass in grams}}{\text{Atomic wt.}} = \frac{28}{14} = 2$

No. of oxygen atoms = $\frac{\text{Mass in grams}}{\text{Atomic wt.}} = \frac{80}{16} = 5$

\therefore Formula of compound is N_2O_5 .

9. (4) $R = N_A \times k$

$$= 6.023 \times 10^{23} \times 1.380 \times 10^{-23}$$

$$= 8.312 \text{ which has 4 significant figures}$$

10. (55.55) 1 litre water = 1 kg i.e. 1000 g water ($\therefore d = 1000 \text{ kg/m}^3$)

$$\text{m}^3 = \frac{1000}{18} = 55.55 \text{ moles of water}$$
 So, molarity of water = **55.55M**
11. (15.05) 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 = $0.07 \times 2 = 0.14$
 To maintain electrical neutrality, 0.14 positive charge is compensated by the presence of 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 by the presence of 0.14 Fe^{3+} ions.
 In short, 0.93 Fe^{2+} ions have 0.14 Fe^{3+} ions

$$100 \text{ Fe}^{2+} \text{ ions have} = \frac{0.14}{0.93} \times 100 = \mathbf{15.05\%}$$
12. (24) According to problem, three atoms of M combine with 2 atoms of N.
 \therefore Formula of compound is M_3N_2 (Where M is the metal)
 Equivalent wt of N = $\frac{14}{3}$ (\therefore valency of N in compound is 3)
 \therefore 28 g N combines with = 72 g metal
 \therefore 14/3 g N combines with = $\frac{72}{28} \times \frac{14}{3} = 12 \text{ g}$
 \therefore Eq. wt. of metal = 12
 At wt of metal = Eq. wt \times valency = $12 \times 2 = \mathbf{24}$
 [Valency of metal = 2]
13. (4.14 g) 1 Mole = 6.023×10^{23} molecules = Molecular weight in gms.
 Weight of 6.023×10^{23} (Avogadro's number) molecules of $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ = Molecular wt. of $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ = 249 g.
 \therefore Weight of 1×10^{22} molecules of $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$

$$= \frac{249 \times 1 \times 10^{22}}{6.023 \times 10^{23}} = \mathbf{4.14 \text{ g}}$$
14. Carbon (C-12)
15. (6.02 $\times 10^{24}$)
 18 mL H_2O = 18 g H_2O (\therefore density of water = 1 g/cc)
 = 1 mole of H_2O .
 1 Mole of H_2O = $10 \times 6.02 \times 10^{23}$ electrons
 (\therefore Number of electrons present in one molecule of water = $2 + 8 = 10$)
 = 6.02×10^{24} electrons
16. (b, c)
 Let M represents the respective molecular mass.
 (a) If empirical formula of compound 3 is P_3Q_4 ,

$$\frac{3M_P}{3M_P + 4M_Q} = \frac{40}{100} \Rightarrow 9M_P = 8M_Q$$
 If empirical formula of compound 2 is P_3Q_5 ,

$$\% \text{ of P} = \frac{3M_P}{3M_P + 5M_Q} \times 100 = \frac{8/3M_Q}{8/3M_Q + 5M_Q} \times 100$$
 = 34.78
 Hence, option (a) is incorrect.
- (b) If empirical formula of compound 3 is P_3Q_2 ,

$$\frac{3M_P}{3M_P + 2M_Q} = \frac{40}{100} \Rightarrow 4M_Q = 9M_P \Rightarrow M_Q = \frac{9}{4} \times 20 = 45$$
 Hence, option (b) is correct.
 (c) If empirical formula of compound 2 is PQ,

$$\frac{M_P}{M_P + M_Q} = \frac{44.4}{100} \Rightarrow 5M_P = 4M_Q$$
 If empirical formula of compound 1 is P_5Q_4 then weight % of P : Q = 1 : 1
 Hence, option (c) is correct.
 (d) If empirical formula of compound 1 is P_3Q ,

$$\% \text{ P} = \frac{2M_P}{2M_P + M_Q} \times 100 = 50 \Rightarrow 2M_P = M_Q$$
 Hence, atomic weight of P and Q cannot be 70 and 35, respectively.
17. (i) Volume of virus = $\pi r^2 \ell$ (Volume of cylinder)
 (ii) Mass of single virus = $\frac{\text{Volume}}{\text{Sp. volume}}$
 (iii) Molecular mass of virus = Mass of single virus $\times 6.02 \times 10^{23}$
 Volume of virus = $\pi r^2 \ell$

$$= \frac{22}{7} \times \frac{150}{2} \times \frac{150}{2} \times 10^{-16} \times 5000 \times 10^{-8}$$

$$= 0.884 \times 10^{-16} \text{ cm}^3$$
 Weight of one virus = $\frac{0.884 \times 10^{-16}}{0.75} \text{ g}$

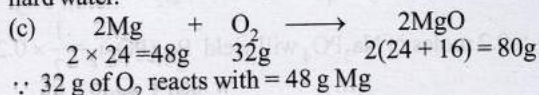
$$= 1.178 \times 10^{-16} \text{ g}$$
 \therefore Mol. wt. of virus = $1.178 \times 10^{-16} \times 6.02 \times 10^{23}$

$$= \mathbf{7.09 \times 10^7}$$
18. (a) $\text{CaCl}_2 \equiv \text{CaCO}_3 \equiv \text{MgCl}_2$
 M.wt. 111 100 95
 From this it is evident, that
 111 mg CaCl_2 will give $\text{CaCO}_3 = 100 \text{ mg}$
 \therefore 1 mg CaCl_2 will give $\text{CaCO}_3 = \frac{100}{111} \text{ mg} = 0.90 \text{ mg}$
 95 mg MgCl_2 gives $\text{CaCO}_3 = 100 \text{ mg}$
 \therefore 1 mg MgCl_2 gives $\text{CaCO}_3 = \frac{100}{95} \text{ mg} = 1.05 \text{ mg}$
 \therefore Total CaCO_3 formed by 1 mg CaCl_2 and 1 mg MgCl_2

$$= 0.90 + 1.05 = 1.95 \text{ mg}$$
 \therefore Amount of CaCO_3 present per litre of water = 1.95 mg
 \therefore wt of 1 mL of water = $1 \text{ g} = 10^3 \text{ mg}$
 \therefore wt of 1000 mL of water = $10^3 \times 10^3 = 10^6 \text{ mg}$
 \therefore Total hardness of water in terms of parts of CaCO_3 per 10^6 parts of water by weight = **1.95 parts.**
- (b) Eq wt of $\text{Ca}^{++} = \frac{\text{Mol. wt}}{\text{Charge}} = \frac{40}{2} = 20$

$$\text{Ca}^{2+} + \text{Na}_2\text{CO}_3 \longrightarrow \text{CaCO}_3 + 2\text{Na}^+$$
 1 milliequivalent of $\text{Ca}^{2+} = 20 \text{ mg}$

1 milliequivalent of Na_2CO_3 is required to soften 1 litre of hard water.

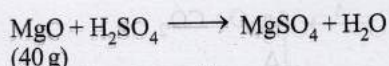


\therefore 32 g of O_2 reacts with = 48 g Mg

$$\therefore 0.5 \text{ g of } \text{O}_2 \text{ reacts with} = \frac{48}{32} \times 0.5 = 0.75 \text{ g}$$

Weight of unreacted Mg = $1.00 - 0.75 = 0.25 \text{ g}$
Thus, Mg is left in excess.

$$\text{Weight of MgO formed} = \frac{80}{48} \times 0.75 = 1.25 \text{ g}$$



(40 g)

According to reaction,

\therefore 40 g MgO is dissolved in 1000 mL of 1 N H_2SO_4

\therefore 40 g MgO is dissolved in 2000 mL 0.5 N H_2SO_4

\therefore 1.25 g MgO is dissolved in

$$= \frac{2000 \times 1.25}{40} \text{ mL of } 0.5 \text{ N } \text{H}_2\text{SO}_4$$

$$= 62.5 \text{ mL of } 0.5 \text{ N } \text{H}_2\text{SO}_4$$

19. Given $P = 1 \text{ atm}$, $V = 1 \text{ L}$, $T = 127^\circ\text{C} = 127 + 273 = 400 \text{ K}$
 $PV = nRT$ (Ideal gas equation)

$$\text{or } n = \frac{PV}{RT} = \frac{1 \times 1}{0.082 \times 400} = 0.0304$$

$$\text{Mol. wt} = \frac{\text{Mass}}{\text{Moles}} = \frac{2.8}{0.0304} = 92.10$$

Element	wt. of element	Relative no. of atoms	Ratio of atoms	Wholeno. of atoms
C	10.5	$10.5/12 = 0.875$	$0.875/0.875 = 1$	$1 \times 7 = 7$
H	1.0	$1.0/1 = 1$	$1/0.875 = 1.14$	$1.14 \times 7 = 8$

\therefore Empirical formula = C_7H_8

Empirical formula wt = $12 \times 7 + 1 \times 8 = 92$

$$n = \frac{\text{Molecular wt}}{\text{Empirical formula wt}} = \frac{92.10}{92} = 1$$

Molecular formula = $n \times$ empirical formula
 $= 1(\text{C}_7\text{H}_8) = \text{C}_7\text{H}_8$

20. (i) No. of C atoms in 14g of $^{14}\text{C} = 6.02 \times 10^{23}$

\therefore No. of C atom in 7 mg (7/1000g) of ^{14}C

$$= \frac{6.02 \times 10^{23} \times 7}{14 \times 1000} = 3.01 \times 10^{20}$$

No. of neutrons in 1 carbon atom = 7

\therefore Total no. of neutrons in 7 mg of $^{14}\text{C} = 3.01 \times 10^{20} \times 7 = 21.07 \times 10^{20}$

Wt of 1 neutron = wt of 1 hydrogen atom

$$= \frac{1}{6.02 \times 10^{23}} \text{ g}$$

\therefore Wt of $3.01 \times 10^{20} \times 7$ neutrons

$$= \frac{3.0 \times 10^{20} \times 7}{6.02 \times 10^{23}} = 3.5 \times 10^{-3} \text{ g}$$

Topic-2: Stoichiometry, Equivalent Concept, Neutralization and Redox Titration

1. (d) Let the fraction of M^{2+} and M^{3+} be:-

$$\text{M}^{2+} = \frac{X}{3}, \text{M}^{3+} = \frac{2X}{3}$$

So, total of O.N. of all atoms would be :

$$\left[\frac{X}{3} (+2) + \frac{2X}{3} (+3) \right] + 2 (+3) + 4 (-2) = 0$$

$$\Rightarrow \frac{2X}{3} + 2X + 6 - 8 = 0$$

$$\Rightarrow \frac{8X}{3} = 2$$

$$\Rightarrow X = \frac{6}{8} = \frac{3}{4} = 0.75$$

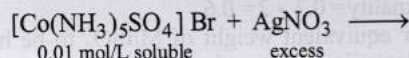
2. (a) Write the reaction for chemical change during reaction and equate moles of products formed.

$[\text{Co}(\text{NH}_3)_5\text{SO}_4] \text{Br}$ has ionisable Br^- ions & $[\text{Co}(\text{NH}_3)_5\text{Br}] \text{SO}_4$ has ionisable SO_4^{2-} ion.

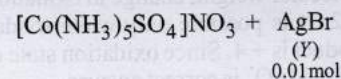
Mixture X has 0.02 mol. of $[\text{Co}(\text{NH}_3)_5\text{SO}_4] \text{Br}$ and 0.02 mol of $[\text{Co}(\text{NH}_3)_5\text{Br}] \text{SO}_4$ in 2 L of solution

\therefore Conc. of $[\text{Co}(\text{NH}_3)_5\text{SO}_4] \text{Br}$ and $[\text{Co}(\text{NH}_3)_5\text{Br}] \text{SO}_4 = 0.01 \text{ mol/L}$ for each of them.

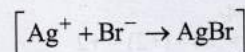
- (i) 1 L mixture of X + excess $\text{AgNO}_3 \rightarrow \text{Y}$



0.01 mol/L soluble excess

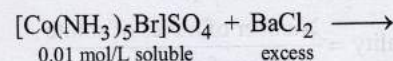


(Y)
0.01 mol

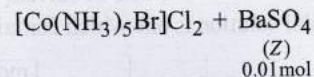


\therefore No. of moles of Y = 0.01

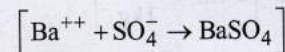
- (ii) Also 1 L mixture of X + excess $\text{BaCl}_2 \rightarrow \text{Z}$



0.01 mol/L soluble excess



(Z)
0.01 mol



\therefore moles of Z = 0.01.

3. (a) Equivalents of $\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O} =$ Equivalents of NaOH (At equivalence point)

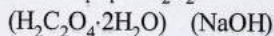
$$\text{Strength of } \text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O} \text{ (in g/L)} = \frac{6.3}{250/1000} = 25.2 \text{ g/L}$$

$$\text{Normality of } \text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O} = \frac{\text{Strength}}{\text{Eq. wt}} = \frac{25.2}{63} = 0.4 \text{ N}$$

$$\left\{ \text{Eq. wt. of oxalic acid} = \frac{\text{Mol. wt}}{2} = \frac{126}{2} = 63 \right\}$$

Using normality equation :

$$N_1 V_1 = N_2 V_2$$

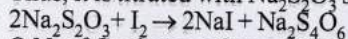


$$0.4 \times 10 = 0.1 \times V_2 \text{ or } V_2 = \frac{0.4 \times 10}{0.1} = 40 \text{ mL.}$$

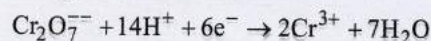
4. (b) (i) Find change in oxidation number of Cr atom.

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

In iodometry, $\text{K}_2\text{Cr}_2\text{O}_7$ liberates I_2 from iodides (NaI or KI). Thus, it is titrated with $\text{Na}_2\text{S}_2\text{O}_3$ solution.



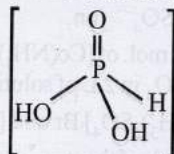
O.N. of Cr changes from +6 (in $\text{K}_2\text{Cr}_2\text{O}_7$) to +3. i.e. +3 change for each Cr atom



Thus, one mole of $\text{K}_2\text{Cr}_2\text{O}_7$ accepts 6 mole of electrons.

$$\therefore \text{Equivalent weight} = \frac{\text{Molecular weight}}{6}$$

5. (d) (i) H_3PO_3 is dibasic acid as it contains two -OH groups.



(ii) Normality = Molarity \times basicity of acid.

(iii) Basicity of $\text{H}_3\text{PO}_3 = 2$

$$\therefore \text{Normality} = 0.3 \times 2 = 0.6$$

6. (b) For equivalent weight of MnSO_4 to be half of its molecular weight, change in oxidation state must be equal to 2. It is possible only when oxidation state of Mn in product is +4. Since oxidation state of Mn in MnSO_4 is +2. So, MnO_2 is correct answer.

In MnO_2 , O.S. of Mn = +4

$$\therefore \text{Change in O.S. of Mn} = +4 - (+2) = +2$$

7. (d) Molality - Moles of solute/mass of solvent in kg
 \therefore Molality does not involve volume term.
 \therefore It is independent of temperature.

8. (a) Molality = $\frac{\text{Number of moles of solute}}{\text{Mass of solvent in kg}}$

A molal solution is one which contains one mole of solute

$$\text{per 1000 g of solvent. } \left\{ \therefore 1\text{m} = \frac{1 \text{ mole}}{1 \text{ kg}} \right\}$$

9. (d)
 (i) Write balanced chemical equation for chemical change.
 (ii) Find limiting reagent.
 (iii) Amount of product formed will be determined by amount of limiting reagent.
 The balanced equation is :



$$\begin{array}{ccc} \text{No. of} & 0.5 & 0.2 \\ \text{moles :} & 3 \text{ mole} & 2 \text{ mole} & 1 \text{ mole} \end{array}$$

Limiting reagent is Na_3PO_4 (0.2 mol), BaCl_2 is in excess.

From the above equation :

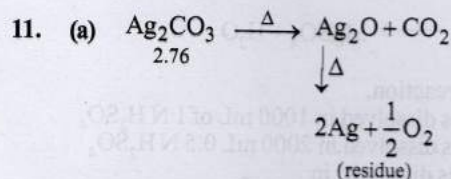
2.0 moles of Na_3PO_4 yields $\text{Ba}_3(\text{PO}_4)_2 = 1$ mole

$$\therefore 0.2 \text{ moles of } \text{Na}_3\text{PO}_4 \text{ will yield } \text{Ba}_3(\text{PO}_4)_2 = \frac{1}{2} \times 0.2 = 0.1 \text{ mol.}$$

10. (a) The change involved is $\text{MnO}_4^- + \text{e}^- \rightarrow \text{MnO}_4^{2-}$
 i.e. it involves only one electron

$$\text{Eq. wt.} = \frac{\text{Mol. wt.}}{\text{No. of e}^- \text{ involved}} = \frac{M}{1} = M$$

[\therefore Mol. wt. = M]



Ag_2O is thermally unstable and decompose on heating liberating oxygen.

Mol. wt. of $\text{Ag}_2\text{CO}_3 = 108 \times 2 + 12 + 16 \times 3 = 276$ g

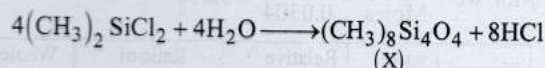
$\therefore 276$ g of Ag_2CO_3 on heating gives residue

$$= 2 \times 108 = 216 \text{ g of Ag}$$

$\therefore 2.76$ g of Ag_2CO_3 on heating gives

$$= \frac{216}{276} \times 2.76 = 2.16 \text{ g of Ag}$$

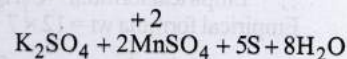
12. (222)



4 moles of $(\text{CH}_3)_2\text{SiCl}_2$ produces, 0.75 mol of X.

\therefore mass of product 'X' = $0.75 \times 296 = 222$ g

13. (18) $2\text{KMnO}_4 + 5\text{H}_2\text{S} + 3\text{H}_2\text{SO}_4 \rightarrow$

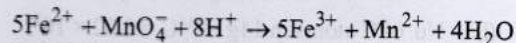


$x = 8$ (moles of H_2O produced)

$y = 14 - 4 = 10$ (number of electrons involved)

$$x + y = 10 + 8 = 18$$

14. (1.875)



For 25 mL

meq of $\text{Fe}^{2+} = \text{meq of } \text{MnO}_4^-$

$$= 12.5 \times 0.03 \times 5$$

For 250 mL

$$\text{M moles of } \text{Fe}^{2+} = \frac{12.5 \times 0.03 \times 5 \times 250}{25}$$

$$\text{Moles of } \text{Fe}^{2+} = \frac{18.75}{1000} \text{ mol}$$

$$= 18.75 \times 10^{-3} = 1.875 \times 10^{-3}$$

$$x = 1.875$$

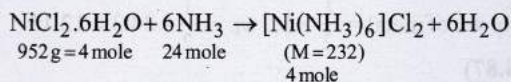
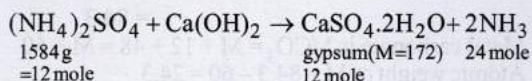
$$\text{Weight of } \text{Fe}^{2+} = 1.875 \times 10^{-2} \times 56 = 1.05 \text{ g}$$

$$\% \text{ Purity of } \text{Fe}^{2+} = \frac{1.05}{5.6} \times 100 = 18.75\%$$

$$y = 18.75$$

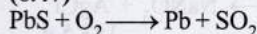
15. (18.75)

16. (2992)



Total mass = $12 \times 172 + 4 \times 232 = 2992 \text{ g}$

17. (6.47)



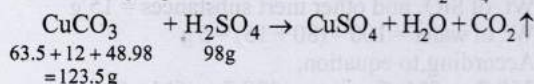
$$\text{No. of moles of O}_2 = \frac{10^3}{32}$$

$$\text{Moles of Pb formed} = \frac{10^3}{32}$$

$$\begin{aligned} \therefore \text{Mass of Pb formed} &= \frac{10^3}{32} \times 207 = 6468.75 \text{ g} \\ &= 6.46875 \text{ kg} \\ &= 6.47 \text{ kg} \end{aligned}$$

18. (8.09)

Use molarity equation to find volume of H_2SO_4 solution.



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

For 0.5 gms of Cu(II) carbonate weight of H_2SO_4 reqd.

$$= \frac{98 \times 0.5}{123.5} \text{ g} = 0.39676 \text{ g H}_2\text{SO}_4$$

Weight of required $\text{H}_2\text{SO}_4 = 0.39676 \text{ g}$

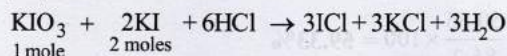
Weight of solute in grams

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

$$0.39676 = \frac{98 \times 0.5 \times V}{1000} \quad \text{or} \quad V = \frac{0.39676 \times 1000}{90 \times 0.5} \text{ mL}$$

Volume of H_2SO_4 solution = **8.097 mL**

19. (85) Reaction involved titration is



20 mL. of stock KI solution \equiv 30 mL. of $\frac{M}{10}$ KIO_3 solution

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

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

Millimoles of KI left unreacted with AgNO_3 solution

$$= 2 \times 50 \times \frac{1}{10} = 10$$

\therefore Millimoles of KI reacted with $\text{AgNO}_3 = 15 - 10 = 5$

Millimoles of AgNO_3 present in AgNO_3 solution = 5

Molecular weight of $\text{AgNO}_3 = 170$

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

$$\% \text{AgNO}_3 \text{ in the sample} = \frac{0.850}{1} \times 100 = 85\%$$

20. (6.0) Mass of Fe_2O_3 in the sample = $\frac{55.2}{100} \times 1 = 0.552 \text{ g}$

$$\text{Number of moles of Fe}_2\text{O}_3 = \frac{0.552}{159.8} = 3.454 \times 10^{-3}$$

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

Since, 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.

$$= 17 \times 4 = 68 \text{ mL.}$$

Amount of oxidant used = $68 \times 0.0167 \text{ mmol}$

$$= 1.1356 \text{ mmol}$$

Let the number of electrons taken by the oxidant = n

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

$$\text{Thus } 1.1356 \times n = 6.90 \Rightarrow n = \frac{6.90}{1.1356} = 6$$

21. (10.43)

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

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

\therefore Mass of H_2SO_4 in 1000 ml of the H_2SO_4 solution = 930 g

Mass of 1000 ml H_2SO_4 solution = $1000 \times 1.84 = 1840 \text{ g}$

Mass of water in 1000 ml of solution = $1840 - 930 \text{ g}$
= 910 g = 0.910 kg

$$\text{Moles of H}_2\text{SO}_4 = \frac{\text{Wt. of H}_2\text{SO}_4}{\text{Mol. wt. of H}_2\text{SO}_4} = \frac{930}{98}$$

\therefore Moles of H_2SO_4 in 1 kg of water

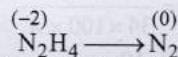
$$= \frac{930}{98} \times \frac{1}{0.910} = 10.43 \text{ mol}$$

\therefore Molality of solution = **10.43 m**

22. (6.5)

No. of equivalents of KMnO_4

= No. of equivalents of hydrazine sulphate.



Change in oxidation state for each $\text{N}_2\text{H}_4 = 2 \times 2 = 4$

$$\text{Equivalent weight of N}_2\text{H}_6\text{SO}_4 = \frac{130}{4} = 32.5$$

Normality of $\text{KMnO}_4 = 5 \times 450$ (\therefore valence factor = 5)

Number of equivalents of KMnO_4

$$= n\text{-factor} \times \text{no. of moles} = 5 \times \frac{20}{50 \times 1000} = \frac{1}{500}$$

and if weight of hydrazine sulphate be $x \text{ g}$ then equivalents

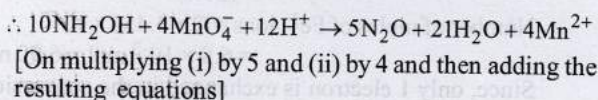
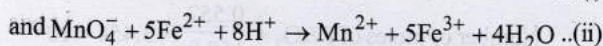
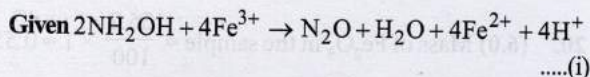
$$\text{of hydrazine sulphate} = \frac{x}{32.5}$$

$$\therefore \frac{1}{500} = \frac{x}{32.5} \quad \text{or} \quad x = \frac{32.5}{500} = 0.065 \text{ g}$$

Hence, wt. of $N_2H_6SO_4$ in 10 mL solution = 0.065 g

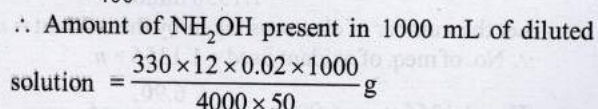
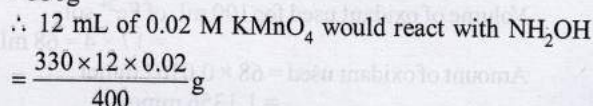
∴ Wt. of $N_2H_6SO_4$ in 1000 mL solution = 6.5 g

23. (39.6)



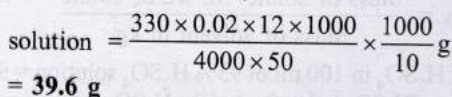
Molecular weight of NH_2OH = 33

Thus 4000 mL of 1M MnO_4^- would react with NH_2OH = 330g

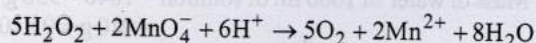


Since, 10 mL of sample of hydroxylamine is diluted to one litre

∴ Amount of hydroxyl amine in one litre of original



24. (0.58) The complete oxidation under acidic conditions can be represented as follows:

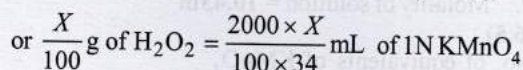


Since 34 g of H_2O_2 = 2000 mL of 1N H_2O_2

$$\left(\because \text{Eq. wt of } H_2O_2 = \frac{34}{2} \right)$$

∴ 34 g of H_2O_2 = 2000 mL of 1N $KMnO_4$

$$[\because N_1V_1 = N_2V_2]$$



$$\text{Therefore the unknown normality} = \frac{2000 \times X}{34 \times 100 \times X} = \frac{10}{17} \text{ or } 0.588 \text{ N}$$

25. (12.15)

(i) Find the volume of CO_2 at NTP

(ii) Find molecular wt. of metal carbonate

(iii) Find the wt. of metal

(iv) Calculate equivalent weight of metal

Given $P_1 = 700 \text{ mm}$, $P_2 = 760 \text{ mm}$, $V_1 = 1336 \text{ mL}$, $V_2 = ?$
 $T_1 = 300 \text{ K}$, $T_2 = 273 \text{ K}$

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}, \text{ or } V_2 = \frac{P_1V_1T_2}{P_2T_1} = \frac{700 \times 1336 \times 273}{760 \times 300}$$

$$= 1119.78 \text{ mL} = 1.12 \text{ L at NTP}$$

∴ 1.12 L of CO_2 is given by carbonate = 4.215 g

$$\text{Molecular weight of metal carbonate} = \frac{4.215}{1.12} \times 22.4 = 84.3$$

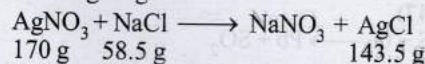
Metal carbonate is $MCO_3 = M + 12 + 48 = M + 60$

Atomic weight of $M = 84.3 - 60 = 24.3$

$$\text{Eq. wt. of metal} = \frac{1}{2} \times M. \text{ wt.} = \frac{1}{2} \times 24.3 = 12.15$$

26. (4.87)

Write the balance chemical equation and use mole concept for limiting reagent.



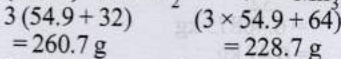
From the given data, we find $AgNO_3$ is limiting reagent as $NaCl$ is in excess.

∴ 170.0 g of $AgNO_3$ precipitates $AgCl = 143.5 \text{ g}$

∴ 5.77 g of $AgNO_3$ precipitates $AgCl$

$$= \frac{143.5}{170.0} \times 5.77 = 4.87 \text{ g}$$

27. (59.33) $3MnO_2 \longrightarrow Mn_3O_4 + O_2$



$$= 260.7 \text{ g} \quad = 228.7 \text{ g}$$

Let the amount of pyrolusite ignited = 100.00 g

∴ Wt. of $MnO_2 = 80 \text{ g}$ (80% of 100 g = 80 g)

Wt. of SiO_2 and other inert substances = 15 g

Wt. of water = 100 - (80 + 15) = 5 g

According to equation,

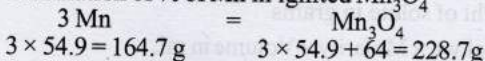
260.7 g of MnO_2 gives = 228.7 g of Mn_3O_4

$$\therefore 80 \text{ g of } MnO_2 \text{ gives} = \frac{228.7}{260.7} \times 80 = 70.2 \text{ g of } Mn_3O_4$$

During ignition, H_2O present in pyrolusite is removed while silica and other inert substances remain as such.

∴ Total wt. of the residue = 70.2 + 15 = 85.2 g

Calculation of % of Mn in ignited Mn_3O_4



Since, 228.7 g of Mn_3O_4 contains 164.7 g of Mn

$$70.2 \text{ g of } Mn_3O_4 \text{ contains} = \frac{164.7}{228.7} \times 70.2 = 50.55 \text{ g of Mn}$$

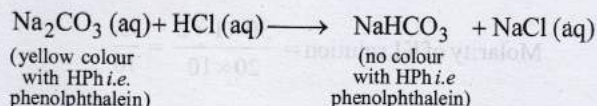
Weight of residue = 85.2 g

Hence, percentage of Mn in the ignited sample

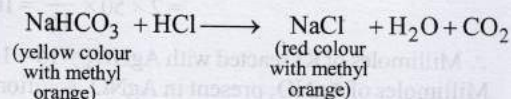
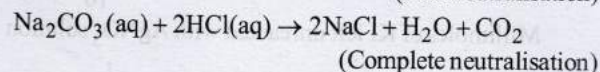
$$= \frac{50.55}{85.2} \times 100 = 59.33\%$$

28. (b) Write reaction for titration between Na_2CO_3 and HCl .

Method:



(Half neutralisation)



From these 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 neutralisation of Na_2CO_3 to NaHCO_3 , i.e. half of value required by Na_2CO_3 solution.
 - (iii) Titre value using methyl orange corresponds to complete neutralisation of Na_2CO_3 .
- \therefore Both S and E are correct but S is not correct explanation of E.

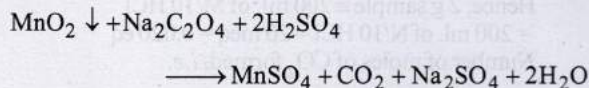
29. Molality = $\frac{\text{Moles of solute}}{\text{Mass of solvent in kg}}$

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

Molality = $\frac{3/30}{250/1000} = 0.4\text{m}$

30. Write the balanced chemical reaction for change and apply mole concept.

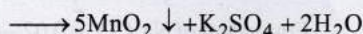
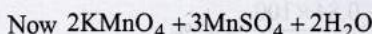
The given reactions are



\therefore Meq. of $\text{MnO}_2 \equiv$ Meq. of $\text{Na}_2\text{C}_2\text{O}_4 = 10 \times 0.2 \times 2 = 4$

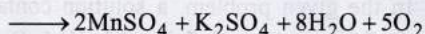
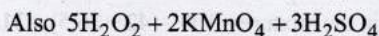
\therefore mM of MnO_2

$$= \frac{4}{2} = 2 \left[\begin{array}{l} \text{Mn}^{4+} + 2e \rightarrow \text{Mn}^{2+} \\ \therefore \text{Valance factor of } \text{MnO}_2 = 2 \end{array} \right]$$



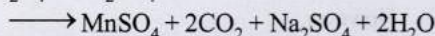
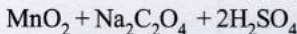
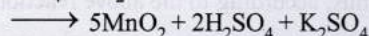
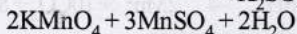
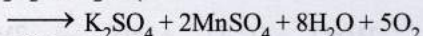
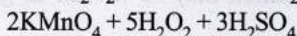
Since, eq. wt. of MnO_2 is derived from KMnO_4 and MnSO_4 both, thus it is better to proceed by mole concept

mM of $\text{KMnO}_4 \equiv$ mM of $\text{MnO}_2 \times (2/5) = 4/5$

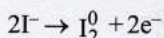
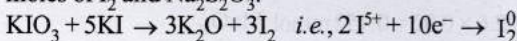


\therefore mM of $\text{H}_2\text{O}_2 =$ mM of $\text{KMnO}_4 \times \frac{5}{2} = \frac{4}{5} \times \frac{5}{2} = 2$

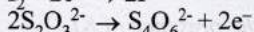
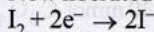
$\therefore M_{\text{H}_2\text{O}_2} \times 20 = 2$ or $M_{\text{H}_2\text{O}_2} = 0.1$



31. Write the reactions taking place, balance them and equate moles of I_2 and $\text{Na}_2\text{S}_2\text{O}_3$.



Now liberated I_2 reacts with $\text{Na}_2\text{S}_2\text{O}_3$



\therefore millimole ratio of $\text{I}_2 : \text{S}_2\text{O}_3 = 1 : 2$

Thus, m mole of I_2 liberated

= m mole of $\text{Na}_2\text{S}_4\text{O}_6$ used $\times \frac{1}{2} = 45 \times M \times \frac{1}{2}$
 [M is molarity of thiosulphate]

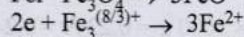
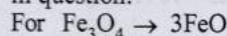
Also m mole of $\text{KIO}_3 = \frac{0.1}{214} \times 1000$

Now m mole ratio of $\text{KIO}_3 : \text{I}_2 = 1 : 3$

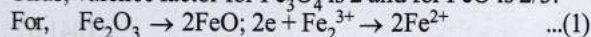
Thus, $\frac{(0.1/214) \times 1000}{(45M/2)} = \frac{1}{3}$

$\therefore M = \frac{0.1 \times 1000 \times 3 \times 2}{214 \times 45} = 0.062$

32. Find the milliequivalents and equate them as per data given in question.



Thus, valence factor for Fe_3O_4 is 2 and for FeO is 2/3.



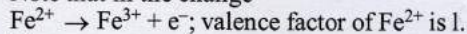
Thus, valence factor for Fe_2O_3 is 2 and for FeO is 1.

Let Meq. of Fe_3O_4 and Fe_2O_3 be a and b respectively.

\therefore Meq. of $\text{Fe}_3\text{O}_4 +$ Meq. of $\text{Fe}_2\text{O}_3 =$ Meq. of I_2 liberated
 = Meq. of hypo used

$a + b = \frac{11 \times 0.5 \times 100}{20} = 27.5$

Now, the Fe^{2+} ions are again oxidised to Fe^{3+} by KMnO_4 . Note that in the change



Thus,

Meq. of Fe^{2+} (from Fe_3O_4) + Meq. of Fe^{2+} (from Fe_2O_3) = Meq. of KMnO_4 used ... (2)

If valence factor for Fe^{2+} is 2/3 from Eq. (1),

then Meq. of Fe^{2+} (from Fe_3O_4) = a

If valence factor for Fe^{2+} is 1

then Meq. of Fe^{2+} (from Fe_2O_3) = 3a/2 ... (3)

Similarly, from Eq. (2), Meq. of Fe^{2+} from (Fe_2O_3) = b.

$\therefore 3a/2 + b = 0.25 \times 5 \times 12.8 \times 100/50 = 32$

or $3a + 2b = 64$... (4)

From Eqs. (3) and (4)

Meq. of $\text{Fe}_3\text{O}_4 = a = 9$ & Meq. of $\text{Fe}_2\text{O}_3 = b = 18.5$

$\therefore W_{\text{Fe}_3\text{O}_4} = \frac{9 \times 232}{2 \times 1000} = 1.044 \text{ g}$

and $W_{\text{Fe}_2\text{O}_3} = \frac{18.5 \times 160}{2 \times 1000} = 1.48 \text{ g}$

\therefore % of $\text{Fe}_3\text{O}_4 = \frac{1.044 \times 100}{3} = 34.8$

and % of $\text{Fe}_2\text{O}_3 = \frac{1.48 \times 100}{3} = 49.33$

33. The formula of Glauber's salt is $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$

Molecular mass of $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$

= $[2 \times 23 + 32.1 + 4 \times 16] + 10(1.01 \times 2 + 16)$

= 322.3 g mol^{-1}

Weight of the Glauber's salt taken = 80.575 g

Out of 80.575 g of salt, weight of anhydrous Na_2SO_4

$$= \frac{142.1}{322.3} \times 80.575 = 35.525 \text{ g}$$

Number of moles of Na_2SO_4 per dm^3 of the solution

$$= \frac{35.525}{142.1} = 0.25$$

Molarity of the solution = **0.25 M**

Density of solution = 1077.2 kgm^{-3}

$$= \frac{1077.2 \times 10^3}{10^6} \text{ gm cm}^{-3} = 1.0772 \text{ g cm}^{-3}$$

Total weight of sol = $V \times d = 1 \text{ dm}^3 \times d$

$$= 1000 \text{ cm}^3 \times 1.0772 \text{ gcm}^{-3} = 1077.2 \text{ g}$$

Weight of water = $1077.2 - 35.525 = 1041.67 \text{ g}$

$$\text{Molality of sol.} = \frac{0.25}{1041.67 \text{ g}} \times 1000 \text{ g} = 0.2399 = \mathbf{0.24 \text{ m}}$$

$$\text{Number of moles of water in the solution} = \frac{1041.67}{18}$$

$$= 57.87$$

Mole fraction of Na_2SO_4

$$= \frac{\text{No. of moles of } \text{Na}_2\text{SO}_4}{\text{Total number of moles}} = \frac{0.25}{0.25 + 57.87}$$

$$= 0.0043 = \mathbf{4.3 \times 10^{-3}}$$

34. Calculation of number of moles in 45 mL of 0.025 M $\text{Pb}(\text{NO}_3)_2$

$$\text{Moles of } \text{Pb}(\text{NO}_3)_2 = 0.025 \times \frac{45}{1000} = 0.01125$$

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

$$\text{Moles of } \text{NO}_3^- = 0.01125 \times 2 = 0.02250$$

$$[1 \text{ mole } \text{Pb}(\text{NO}_3)_2 \equiv 2 \text{ moles of } \text{NO}_3^-]$$

Calculation of number of moles in 25 mL of 0.1 M chromic sulphate

Moles of chromic sulphate $\text{Cr}_2(\text{SO}_4)_3$

$$= 0.1 \times \frac{25}{1000} = 0.0025 \text{ moles}$$

$$\text{Moles of } \text{SO}_4^{2-} = 0.0025 \times 3 = 0.0075 [1 \text{ Mole of chromic sulphate} \equiv 3 \text{ moles of } \text{SO}_4^{2-}]$$

Moles of PbSO_4 formed = **0.0075** [SO_4^{2-} is totally consumed]

$$\text{Moles of } \text{Pb}^{2+} \text{ left} = 0.01125 - 0.0075 = 0.00375$$

$$\text{Moles of } \text{NO}_3^- \text{ left} = 0.02250 [\text{NO}_3^- \text{ remain unreacted}]$$

$$\text{Moles of chromium ions} = 0.0025 \times 2 = 0.005$$

$$\text{Total volume of the solution} = 45 + 25 = 70 \text{ mL}$$

\therefore Molar concentration of the species left

$$(i) \text{ Pb}^{2+} = \frac{0.00375}{70} \times 1000 = \mathbf{0.05357 \text{ M}}$$

$$(ii) \text{ NO}_3^- = \frac{0.0225}{70} \times 1000 = \mathbf{0.3214 \text{ M}}$$

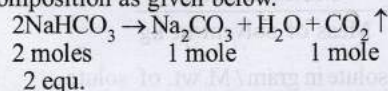
$$(iii) \text{ Cr}^{3+} = \frac{0.005}{70} \times 1000 = \mathbf{0.0714 \text{ M}}$$

$$35. \text{ 1.5 g of sample require} = 150 \text{ mL of } \frac{\text{M}}{10} \text{ HCl}$$

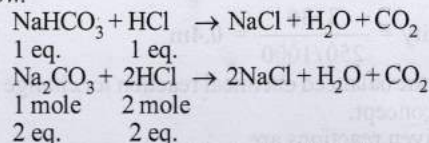
$$\therefore 2 \text{ g of sample require} = \frac{150 \times 2}{1.5} \text{ mL of } \frac{\text{M}}{10} \text{ HCl}$$

$$= 200 \text{ mL of } \frac{\text{M}}{10} \text{ HCl}$$

On heating, the sample, only NaHCO_3 undergoes decomposition as given below.



Neutralisation of the sample with HCl takes place as given below.



Hence, 2 g sample \equiv 200 mL of $\text{M}/10$ HCl

$$= 200 \text{ mL of } \text{N}/10 \text{ HCl} = 20 \text{ meq} = 0.020 \text{ eq}$$

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 (2 g) = $2 \times 0.005 = 0.01$

Equivalent of $\text{NaHCO}_3 = 0.01$

$$\text{Wt. of } \text{NaHCO}_3 = 0.01 \times 84 = 0.84 \text{ g}$$

$$\% \text{ of } \text{NaHCO}_3 = \frac{0.84 \times 100}{2} = \mathbf{42\%}$$

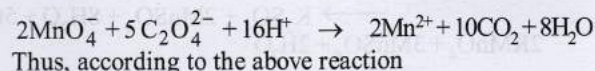
Equivalent of $\text{Na}_2\text{CO}_3 = 0.02 - 0.01 = 0.01$

$$\text{Wt. of } \text{Na}_2\text{CO}_3 = 0.01 \times 53 = 0.53 \text{ g}$$

$$\therefore \% \text{ of } \text{Na}_2\text{CO}_3 = \frac{0.53 \times 100}{2} = \mathbf{26.5\%}$$

\therefore % of Na_2SO_4 in the mixture = $100 - (42 + 26.5) = \mathbf{31.5\%}$

36. In the given problem, a solution containing Cu^{2+} and $\text{C}_2\text{O}_4^{2-}$ is titrated first with KMnO_4 and then with $\text{Na}_2\text{S}_2\text{O}_3$ in presence of KI . In titration with KMnO_4 , it is the $\text{C}_2\text{O}_4^{2-}$ ions that react with the MnO_4^- ions. The concerned balanced equation may be written as given below.



$$2 \text{ mmol } \text{MnO}_4^- \equiv 5 \text{ mmol } \text{C}_2\text{O}_4^{2-}$$

However,

$$\text{No. of mmol of } \text{MnO}_4^- \text{ used in titration} = \text{Vol. in ml} \times \text{M}$$

$$= 22.6 \times 0.02 = 0.452 \text{ mmol } \text{MnO}_4^-$$

$$\text{Since } 2 \text{ mmol } \text{MnO}_4^- \equiv 5 \text{ mmol } \text{C}_2\text{O}_4^{2-}$$

$$0.452 \text{ mmol } \text{MnO}_4^- \equiv \frac{5}{2} \times 0.452 = 1.130 \text{ mmol } \text{C}_2\text{O}_4^{2-}$$

Titration with $\text{Na}_2\text{S}_2\text{O}_3$ in the presence of KI .

Here Cu^{2+} react and the reactions involved during titration are:

$$\therefore \text{Molal concentration} = \frac{34.2 \times 1000}{342 \times 180} = 0.56$$

$$(ii) \text{ Mol. wt. of water, H}_2\text{O} = 18$$

$$\therefore \text{Mole fraction of sugar} = \frac{34.2/342}{180/18 + 34.2/342}$$

$$= \frac{0.1}{10 + 0.1} = \frac{0.1}{10.1} = 0.0099$$

41. (i) From the given half-cell reaction,

$$\text{Here, Eq. wt. of NaBrO}_3 = \frac{\text{Mol. wt.}}{6} = \frac{151}{6} = 25.17$$

$$[\because \text{ number of electron involved} = 6]$$

Now we know that

$$\text{Meq.} = \text{Normality} \times \text{Vol. in mL} = 85.5 \times 0.672 = 57.456$$

$$\text{Also, Meq.} = \frac{W_{\text{NaBrO}_3}}{\text{Eq. wt. NaBrO}_3} \times 1000$$

$$\Rightarrow \frac{W_{\text{NaBrO}_3}}{25.17} \times 1000 = 57.456 \text{ g}$$

$$\therefore W_{\text{NaBrO}_3} = 1.446 \text{ g}$$

$$\text{Molarity of NaBrO}_3 = \frac{\text{Normality}}{\text{Valence factor}}$$

$$= \frac{0.672}{6} = 0.112 \text{ M}$$

- (ii) From the given half-cell reaction,

$$\text{Eq. wt. of NaBrO}_3 = \frac{\text{Mol. wt.}}{5} = \frac{151}{5} = 30.2$$

$$[\text{Number of electron involved per BrO}_3^- = \frac{10}{2} = 5]$$

Thus, the amount of NaBrO₃ required for preparing 1000 mL of 1 N NaBrO₃ = 30.2 g

\therefore The amount of NaBrO₃ required for preparing 85.5 mL of 0.672 N NaBrO₃

$$= \frac{30.2 \times 0.672 \times 85.5}{1000} = 1.7532 \text{ g}$$

$$\text{Also, Molarity} = \frac{0.672}{5} = 0.1344 \text{ M}$$

42. (i) Find normality of acid mixture and Na₂CO₃ · 10H₂O. Equate them to find volume of H₂SO₄.

$$(ii) \text{ Meq. of H}_2\text{SO}_4 = V \times N = \frac{V \times N}{1000} \text{ eq.}$$

$$(iii) \text{ Equivalent of SO}_4^{2-} = \text{equivalents of H}_2\text{SO}_4 \times \text{Eq. wt. of SO}_4^{2-}$$

$$N \times V(\text{mL.}) = \text{meq.}$$

Acid mixture contains 5 mL of 8N, HNO₃, 4.8 mL of 5N, HCl and say, 'V' mL of 17 M = 34 N, H₂SO₄.
[1M H₂SO₄ = 2NH₂SO₄]

$$N \text{ of the acid mixture} = \frac{\text{meq. (total) of acid}}{\text{mL. of solution}}$$

$$= \frac{5 \times 8 + 4.8 \times 5 + V \times 34}{2000} \quad [\text{Total volume} = 2 \text{ L} = 2000 \text{ mL}]$$

$$\text{or, } N_{\text{mixture}} = \frac{64 + 34V}{2000}$$

$$\therefore \text{Eq. of wt. of Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O} = \frac{\text{Mol. wt.}}{2} = \frac{106 + 180}{2} = 143$$

$$N \text{ of Na}_2\text{CO}_3 = \frac{\text{Meq. of Na}_2\text{CO}_3}{\text{Volume of solution (mL)}}$$

$$= \frac{1}{100} = \frac{1}{143} \times \frac{1000}{100} = 0.069 \text{ N}$$

$$N_1 V_1 = N_2 V_2$$

$$\text{or } 30 \times N_{\text{mixture}} = 42.9 \times 0.069$$

(acid) (sod. carbonate)

$$\therefore N_{\text{mixture}} = \frac{42.9 \times 0.069}{30} = 0.0986 \text{ N}$$

$$\text{Hence } \frac{64 + 34V}{2000} = 0.0986$$

$$64 + 34V = 0.0986 \times 2000, 64 + 34V = 197.2$$

$$34V = 197.2 - 64.0 = 133.2 \quad \therefore \text{or } V = \frac{133.2}{34} = 3.9 \text{ mL.}$$

$$\text{Hence, meq. of H}_2\text{SO}_4 = V \times N \text{ of H}_2\text{SO}_4$$

$$= 3.9 \times 34 = 132.6 \text{ meq.}$$

$$= 0.1326 \text{ eq. of H}_2\text{SO}_4$$

$$= 0.1326 \text{ eq. of SO}_4^{2-}$$

$$= 0.1326 \times 48 \text{ g of SO}_4^{2-}$$

$$\left(\because \text{Eq. wt. of SO}_4^{2-} = \frac{32 + 64}{2} = 48 \right)$$

= 6.3648 g of SO₄²⁻ are in 3.9 mL of 17M H₂SO₄

43. Equivalents of A oxidised = Equivalents of A reduced. Since in acidic medium, Aⁿ⁺ is oxidised to AO₃⁻, the change in oxidation state from

$$(+5) \text{ to } (+n) = 5 - n \quad [\because \text{O.S. of A in AO}_3^- = +5]$$

\therefore Total number of electrons that have been given out during oxidation of 2.68×10^{-3} moles of Aⁿ⁺

$$= 2.68 \times 10^{-3} \times (5 - n)$$

Thus the number of electrons added to reduce 1.61×10^{-3} moles of MnO₄⁻ to Mn²⁺, i.e.

$$(+7) \text{ to } (+2) = 1.61 \times 10^{-3} \times 5$$

$$[\text{Number of electrons involved} = +7 - (+2) = 5]$$

$$\therefore 1.61 \times 10^{-3} \times 5 = 2.68 \times 10^{-3} \times (5 - n)$$

$$5 - n = \frac{1.61 \times 5}{2.68} \quad \text{or} \quad n = 5 - \frac{8.05}{2.68} \approx 2$$

44. (i) Mole fraction = $\frac{\text{Moles of substance}}{\text{Total moles}}$

(ii) 1 mole of Na₂S₂O₃ gives 2 moles of Na⁺ and 1 mole of S₂O₃²⁻

Molecular wt. of sodium thiosulphate solution ($\text{Na}_2\text{S}_2\text{O}_3$)
 $= 23 \times 2 + 32 \times 2 + 16 \times 3 = 158$

(i) The percentage by weight of $\text{Na}_2\text{S}_2\text{O}_3$

$$= \frac{\text{wt of Na}_2\text{S}_2\text{O}_3}{\text{wt of solution}} \times 100 = \frac{3 \times 158 \times 100}{1000 \times 1.25} = 37.92$$

[Wt. of $\text{Na}_2\text{S}_2\text{O}_3$ = Molarity \times Mol wt]

(ii) Mass of 1 litre solution = $1.25 \times 1000 \text{ g} = 1250 \text{ g}$
 [\therefore density = 1.25 g/l]

Mole fraction of $\text{Na}_2\text{S}_2\text{O}_3$

$$= \frac{\text{Number of moles of Na}_2\text{S}_2\text{O}_3}{\text{Total number of moles}}$$

$$\text{Moles of water} = \frac{1250 - 158 \times 3}{18} = 43.1$$

$$\text{Mole fraction of Na}_2\text{S}_2\text{O}_3 = \frac{3}{3 + 43.1} = 0.065$$

(iii) 1 mole of sodium thiosulphate ($\text{Na}_2\text{S}_2\text{O}_3$) yields 2 moles of Na^+ and 1 mole of $\text{S}_2\text{O}_3^{2-}$.

$$\text{Molality of Na}_2\text{S}_2\text{O}_3 = \frac{3 \times 1000}{776} = 3.87$$

$$\text{Molality of Na}^+ = 3.87 \times 2 = 7.74 \text{ m}$$

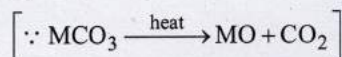
45. Weight of MCO_3 and $\text{BaO} = 4.08 \text{ g}$ (given)

Weight of residue = 3.64 g (given)

\therefore Weight of CO_2 evolved on heating = $(4.08 - 3.64) \text{ g}$

$$= 0.44 \text{ g} = \frac{0.44}{44} = 0.01 \text{ mole}$$

Number of moles of $\text{MCO}_3 = 0.01 \text{ mole}$

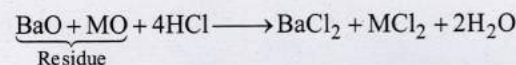


Volume of 1 N HCl in which residue is dissolved = 100 mL

Volume of 1 N HCl used for dissolution = $(100 - 2.5 \times 16) \text{ mL} = 60 \text{ mL}$

$$= \frac{60}{1000} = 0.06 \text{ equivalents}$$

The chemical equation for dissolution can be written as



[Number of moles of BaO and $\text{MO} = 1 + 1 = 2$]

$$\text{Number of moles of BaO} + \text{Number of moles of MO} = \frac{0.06}{2} = 0.03$$

Number of moles of $\text{BaO} = (0.03 - 0.01) = 0.02 \text{ moles}$

Molecular weight of $\text{BaO} = 138 + 16 = 154$

\therefore Weight of $\text{BaO} = (0.02 \times 154) \text{ g} = 3.08 \text{ g}$

Weight of $\text{MCO}_3 = (4.08 - 3.08) = 1.0 \text{ g}$

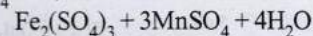
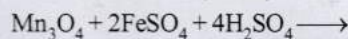
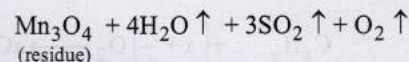
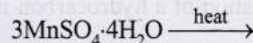
Since weight of $0.01 \text{ mole of MCO}_3 = 1.0 \text{ g}$

$$\therefore \text{Mol. wt. of MCO}_3 = \frac{1}{0.01} = 100$$

Hence, atomic weight of unknown $\text{M} = (100 - 60) = 40$

The atomic weight of metal is 40 so the metal M is Ca .

46. Following reactions take place-



Milliequivalents of FeSO_4 in 30 mL of 0.1 N FeSO_4

$$= 30 \times 0.1 = 3 \text{ m. eq.}$$

According to problem step (iv)

25 mL of KMnO_4 reacts with = 3 m eq of FeSO_4

Thus in step (iii) of the problem,

$$50 \text{ mL of KMnO}_4 \text{ reacts with} = \frac{3}{25} \times 50 \text{ m. eq. of FeSO}_4 = 6 \text{ meq of FeSO}_4$$

Milli eq. of 100 mL of $0.1 \text{ N FeSO}_4 = 100 \times 0.1 = 10 \text{ m eq.}$

FeSO_4 which reacted with $\text{Mn}_3\text{O}_4 = (10 - 6) = 4 \text{ m eq.}$

Milli eq of $\text{FeSO}_4 =$ Milli eq. of Mn_3O_4

(\therefore Milli eq of oxidising agent and reducing agent are equal)

$$\therefore \text{Mn}_3\text{O}_4 = 3\text{MnSO}_4 \cdot 4\text{H}_2\text{O}$$

$$\therefore 1 \text{ Meq of Mn}_3\text{O}_4 = 3 \text{ Meq of MnSO}_4 \cdot 4\text{H}_2\text{O}$$

$$\therefore 4 \text{ Meq of Mn}_3\text{O}_4 = 12 \text{ Meq of MnSO}_4 \cdot 4\text{H}_2\text{O}$$

$$\text{Eq. wt of MnSO}_4 \cdot 4\text{H}_2\text{O} = \frac{\text{Mol wt.}}{2} = \frac{223}{2} = 111.5$$

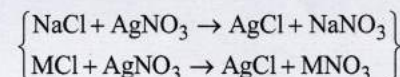
$$\text{Wt of MnSO}_4 \cdot 4\text{H}_2\text{O in sample} = 12 \times 111.5 = 1338 \text{ mg} = 1.338 \text{ g.}$$

47. Weight of AgCl formed = 2.567 g

Amount of AgCl formed due to $\text{MCl} = 1.341 \text{ g}$

(\therefore NaCl does not decompose on heating to 300°C)

$$\therefore \text{Weight of AgCl formed due to NaCl} = 2.567 - 1.341 = 1.226 \text{ g}$$



$\therefore 143.5 \text{ g}$ of AgCl is obtained from $\text{NaCl} = 58.5 \text{ g}$

$\therefore 1.226 \text{ g}$ of AgCl is obtained from NaCl

$$= \frac{58.5}{143.5} \times 1.226 = 0.4997 \text{ g}$$

\therefore Wt of MCl in 1 g of mixture = $1.000 - 0.4997 = 0.5003 \text{ g}$

$\therefore 1.341 \text{ g}$ of AgCl is obtained from $\text{MCl} = 0.5003 \text{ g}$

$\therefore 143.5 \text{ g}$ of AgCl is obtained from MCl

$$= \frac{0.5003}{1.341} \times 143.5 = 53.53 \text{ g}$$

\therefore Molecular weight of $\text{MCl} = 53.53$

48. Volume of oxygen taken = 30 mL ,

Volume of unused oxygen = 15 mL

Volume of O_2 used = Volume of O_2 added - Volume of O_2 left
 $= 30 - 15 = 15 \text{ mL}$

Volume of CO_2 produced

= Volume of gaseous mixture after explosion -

Volume of unused oxygen

or Volume of CO_2 produced = $25 - 15 = 10 \text{ mL}$

