Problem 1 From the following reaction sequence
\[ \text{Cl}_2 + 2\text{KOH} \rightarrow \text{KCl} + \text{KClO} + \text{H}_2\text{O} \]
\[ 3\text{KClO} \rightarrow 2\text{KCl} + \text{KClO}_3 \]
\[ 4\text{KClO}_3 \rightarrow 3\text{KClO}_4 + \text{KCl} \]
Calculate the mass of chlorine needed to produce 100 g of KClO₄.

Problem 2 Calculate the weight of FeO produced from 2 g VO and 5.75 g of Fe₃O₅. Also report the limiting reagent.
\[ \text{VO} + 2\text{Fe}_3\text{O}_5 \rightarrow 2\text{FeO} + \text{V}_2\text{O}_5 \]

Problem 3 A polystyrene, having formula Br₂C₆H₄ (C₆H₄)ₙ was prepared by heating styrene with tribromobenzyl peroxide in the absence of air. If it was found to contain 10.46% bromine by weight, find the value of n.

Problem 4 5 mL of a gaseous hydrocarbon was exposed to 30 mL of O₂. The resultant gas, on cooling, is found to contain 25 mL of which 10 mL are absorbed by NaOH and the remainder by pyrogallol. Determine molecular formula of hydrocarbon. All measurements are made at constant pressure and temperature.

Problem 5 A gaseous alkane is exploded with oxygen. The volume of O₂ for complete combustion to CO₂ formed is in the ratio of 7 : 4. Deduce molecular formula of alkane.

Problem 6 A sample of gaseous hydrocarbon occupying 1.12 litre at NTP, when completely burnt in air produced 2.2 g CO₂ and 1.8 g H₂O. Calculate the weight of hydrocarbon taken and the volume of O₂ at NTP required for its combustion.

Problem 7 16 mL of a gaseous aliphatic compound CₙH₃nOₙ was mixed with 60 mL O₂ and sparked. The gas mixture on cooling occupied 44 mL. After treatment with KOH solution, the volume of gas remaining was 12 mL. Deduce the formula of compound. All measurements are made at constant pressure and room temperature.

Problem 8 In what ratio should you mix 0.2M NaNO₃ and 0.1M Ca(NO₃)₂ solution so that in resulting solution, the concentration of -ve ion is 50% greater than the concentration of +ve ion?

Problem 9 How much BaCl₂ would be needed to make 250 mL of a solution having same concentration of Cl⁻ as the one containing 3.78 g of NaCl per 100 mL?

Problem 10 What is the purity of conc. H₂SO₄ solution (specific gravity 1.8 g/mL), if 5.0 mL of this solution is neutralized by 84.6 mL of 2.0 N NaOH?

Problem 11 A sample of H₂SO₄ (density 1.787 g mL⁻¹) is labelled as 85% by weight. What is molarity of acid? What volume of acid has to be used to make 1 litre of 0.2 M H₂SO₄?

Problem 12 Mole fraction of I₂ in C₆H₆ is 0.2. Calculate molality of I₂ in C₆H₆.

Problem 13 A drop (0.05 mL) of 12 M HCl is spread over a thin sheet of aluminium foil (thickness 0.10 mm and density of Al = 2.70 g/mL). Assuming whole of the HCl is used to dissolve Al, what will be the maximum area of hole produced in foil?

Problem 14 What would be the molarity of solution obtained by mixing equal volumes of 30% by weight H₂SO₄ (d = 1.218 g mL⁻¹) and 75% by weight H₂SO₄ (d = 1.610 g mL⁻¹)? If the resulting solution has density 1.425 g/mL, calculate its molality.

Problem 15 A mixture of Al and Zn weighing 1.67 g was completely dissolved in acid and evolved 1.69 litre of H₂ at NTP. What was the weight of Al in original mixture?

Problem 16 A mixture of FeO and Fe₃O₄ when heated in air to constant weight, gains 5% in its weight. Find out composition of mixture.

Problem 17 25.4 g of I₂ and 14.2 g of Cl₂ are made to react completely to yield a mixture of ICl and ICl₃. Calculate mole of ICl and ICl₃ formed.

Problem 18 A mixture of HCOOH and H₂C₂O₄ is heated with conc. H₂SO₄. The gas produced is collected and on treating with KOH solution the volume of the gas decreases by \( \frac{1}{8} \) th. Calculate molar ratio of two acids in original mixture.
Problem.19 For the reaction, \( \text{N}_2\text{O}_5(g) \rightleftharpoons 2\text{NO}_2(g) + 0.5\text{O}_2(g) \), calculate the mole fraction of \( \text{N}_2\text{O}_5(g) \) decomposed at a constant volume and temperature, if the initial pressure is 600 mm Hg and the pressure at any time is 960 mm Hg. Assume ideal gas behaviour.

Problem.20 0.22 g sample of volatile compound, containing C, H and Cl only on combustion in O\(_2\) gave 0.195 g CO\(_2\) and 0.0804 g H\(_2\)O. If 0.120 g of the compound occupied a volume of 37.24 mL at 105\(^\circ\)C and 768 mm of pressure, calculate molecular formula of compound.

Problem.21 2.0 g sample containing Na\(_2\)CO\(_3\) and NaHCO\(_3\) loses 0.248 g when heated to 300\(^\circ\)C, the temperature at which NaHCO\(_3\) decomposes to Na\(_2\)CO\(_3\) and H\(_2\)O. What is \% of Na\(_2\)CO\(_3\) in mixture?

Problem.22 10 mL of a solution of KCl containing NaCl gave on evaporation 0.93 g of the mixed salt which gave 1.865 g of AgCl by the reaction with AgNO\(_3\). Calculate the quantity of NaCl in 10 mL of solution.

Problem.23 A sample of CaCO\(_3\) and MgCO\(_3\) weighed 2.21 g is ignited to constant weight of 1.152 g. What is the composition of mixture? Also calculate the volume of CO\(_2\) evolved at 0\(^\circ\)C and 76 cm of pressure.

Problem.24 2.0 g of a mixture of carbonate, bicarbonate and chloride of sodium on heating produced 56 mL of CO\(_2\) at NTP. 1.6 g of the same mixture required 25 mL of N HCl solution for neutralization. Calculate percentage of each component present in mixture.

Problem.25 Igniting MnO\(_2\) in air converts it quantitatively to Mn\(_2\)O\(_3\). A sample of pyrolusite has MnO\(_2\) 80%, SiO\(_2\) 15% and rest having water. The sample is heated in air to constant mass. What is the \% of Mn in ignited sample?

Problem.26 A solid mixture 5 g consists of lead nitrate and sodium nitrate was heated below 600\(^\circ\)C until weight of residue was constant. If the loss in weight is 28\%, find the amount of lead nitrate and sodium nitrate in mixture.

Problem.27 Determine the formula of ammonia form the following data:
(i) Volume of ammonia = 25 mL.
(ii) Volume on addition of O\(_2\) after explosion = 71.2 mL.
(iii) Volume after explosion and reaction with O\(_2\) on cooling = 14.95 mL.
(iv) Volume after being absorbed by alkaline pyrogalol = 12.5 mL.

Problem.28 A mixture of ethane (C\(_2\)H\(_6\)) and ethene (C\(_2\)H\(_4\)) occupies 40 litre at 1.00 atm and at 400 K. The mixture reacts completely with 130 g of O\(_2\) to produce CO\(_2\) and H\(_2\)O. Assuming ideal gas behaviour, calculate the mole fractions of C\(_2\)H\(_4\) and C\(_2\)H\(_6\) in the mixture.

Problem.29 0.50 g of a mixture of K\(_2\)CO\(_3\) and Li\(_2\)CO\(_3\) required 30 mL of 0.25 N HCl solution for neutralization. What is \% composition of mixture?

Problem.30 A mixture in which the mole ratio of H\(_2\) and O\(_2\) is 2 : 1 is used to prepare water by the reaction,
\[
2\text{H}_2(g) + \text{O}_2(g) \rightarrow 2\text{H}_2\text{O}(g)
\]
The total pressure in the container is 0.8 atm at 20\(^\circ\)C before the reaction. Determine the final pressure at 120\(^\circ\)C after reaction assuming 80\% yield of water.
EXERCISE – I

OBJECTIVE PROBLEMS (JEE MAIN)

Single correct

1. For the reaction
   \(2x + 3y + 4z \rightarrow 5w\)
   Initially if 1 mole of \(x\), 3 mole of \(y\) and 4 mole of \(z\) is taken. If 1.25 mole of \(w\) is obtained then % yield of this reaction is
   \[(A)\ 50\% \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \ quad
12. \( C_2H_5OH(g) + O_2(g) \rightarrow CO_2(g) + H_2O(l) \)
Magnitude of volume change if 30 ml of \( C_2H_5OH \) (g) is burnt with excess amount of oxygen, is
(A) 30 ml  
(B) 60 ml  
(C) 20 ml  
(D) Data insufficient

13. 10 ml of a compound containing 'N' and 'O' is mixed with 30 ml of \( H_2 \) to produce \( H_2O(l) \) and 10 ml of \( N_2(g) \). Molecular formula of compound if both reactants reacts completely, is
(A) \( N_2O \)  
(B) \( NO \)  
(C) \( N_2O_3 \)  
(D) \( N_2O_4 \)

14. Similar to the % labelling of oleum, a mixture of \( H_3PO_4 \) and \( P_2O_5 \) is labelled as \((100 + x)\% \) where \( x \) is the maximum mass of water which can react with \( P_2O_5 \), present in 100 gm mixture of \( H_3PO_4 \) and \( P_2O_5 \). If such a mixture is labelled as 127\% Mass of \( P_2O_5 \) is 100 gm of mixture, is
(A) 71 gm  
(B) 47 gm  
(C) 83 gm  
(D) 35 gm

15. Mass of sucrose \( C_{12}H_{22}O_{11} \) produced by mixing 84 gm of carbon, 12 gm of hydrogen and 56 lit. \( O_2 \) at 1 atm & 273 K according to given reaction, is \( C(s) + H_2(g) + O_2(g) \rightarrow C_{12}H_{22}O_{11}(s) \)
(A) 138.5  
(B) 155.5  
(C) 172.5  
(D) 199.5

16. If 50 gm oleum sample rated as 118\% is mixed with 18 gm water, then the correct option is
(A) The resulting solution contains 18 gm of water and 118 gm \( H_2SO_4 \)  
(B) The resulting solution contains 9 gm of water and 59 gm \( H_2SO_4 \)  
(C) The resulting solution contains only 118 gm pure \( H_2SO_4 \)  
(D) The resulting solution contains 68 gm of pure \( H_2SO_4 \)

17. In the quantitative determination of nitrogen using Duma's method, \( N_2 \) gas liberated from 0.42 gm of a sample of organic compound was collected over water. If the volume of \( N_2 \) gas collected was \( \frac{100}{11} \) ml at total pressure 860 mm Hg at 250 K, % by mass of nitrogen in the organic compound is
[Aq. tension at 250K is 24 mm Hg and R = 0.08 L atm mol\(^{-1}\) K\(^{-1}\)]
(A) \( \frac{10}{3} \% \)  
(B) \( \frac{5}{3} \% \)  
(C) \( \frac{20}{3} \% \)  
(D) \( \frac{100}{3} \% \)

18. 40 gm of a carbonate of an alkali metal or alkaline earth metal containing some inert impurities was made to react with excess HCl solution. The liberated \( CO_2 \) occupied 12.315 lit. at 1 atm & 300 K. The correct option is
(A) Mass of impurity is 1 gm and metal is Be  
(B) Mass of impurity is 3 gm and metal is Li  
(C) Mass of impurity is 5 gm and metal is Be  
(D) Mass of impurity is 2 gm and metal is Mg

19. The percentage by mole of \( NO_2(g) \) in a mixture \( NO(g) \) having average molecular mass 34 is :
(A) 25\%  
(B) 20\%  
(C) 40\%  
(D) 75\%

20. The minimum mass of mixture of \( A_2 \) and \( B_2 \) required to produce at least 1 kg of each product is :
(Given At. mass of 'A' = 10; At. mass of 'B' = 120)
\( 5A_2 + 2B_2 \rightarrow 2AB_3 + 4A_2B \)
(A) 2120 gm  
(B) 1060 gm  
(C) 560 gm  
(D) 1660 gm

21. The mass of \( CO_2 \) produced from 620 gm mixture of \( C_2H_2O_2 \) & \( O_2 \), prepared to produce maximum energy is
(A) 413.33 gm  
(B) 593.04 gm  
(C) 440 gm  
(D) 320 gm

22. Assuming complete precipitation of \( AgCl \), calculate the sum of the molar concentration of all the ions if 2 lit of 2M \( Ag_2SO_4 \) is mixed with 4 lit of 1 M \( NaCl \) solution is :
(A) 4M  
(B) 2M  
(C) 3M  
(D) 2.5 M

23. 12.5 gm of fuming \( H_2SO_4 \) (labelled as 112\%) is mixed with 100 lit water. Molar concentration of \( H^+ \) in resultant solution is :
[Note: Assume that \( H_2SO_4 \) dissociate completely]
and there is no change in volume on mixing)

(A) \( \frac{2}{700} \)  \quad (B) \( \frac{2}{350} \)  

(C) \( \frac{3}{350} \)  \quad (D) \( \frac{3}{700} \)

24. 74 gm of sample on complete combustion gives 132 gm CO₂ and 54 gm of H₂O. The molecular formula of the compound may be

(A) \( \text{C}_2\text{H}_2 \)  \quad (B) \( \text{C}_2\text{H}_4\text{O} \)  

(C) \( \text{C}_2\text{H}_6\text{O}_2 \)  \quad (D) \( \text{C}_2\text{H}_5\text{O} \)

25. The % by volume of \( \text{C}_2\text{H}_2 \) in a gaseous mixture of \( \text{C}_2\text{H}_2\text{y}, \text{CH}_4 \) and \( \text{CO} \) is 40. When 200 ml of the mixture is burnt in excess of \( \text{O}_2 \). Find volume (in ml) of \( \text{CO}_2 \) produced.

(A) 220  \quad (B) 340  

(C) 440  \quad (D) 560

26. What volumes should you mix of 0.2 M NaCl and 0.1 M CaCl₂ solution so that in resulting solution the concentration of positive ion is 40% lesser than concentration of negative ion. Assuming total volume of solution 1000 ml.

(A) 400 ml NaCl, 600 ml CaCl₂  

(B) 600 ml NaCl, 400 ml CaCl₂  

(C) 800 ml NaCl, 200 ml CaCl₂  

(D) None of these

27. An iodized salt contains 0.5% of NaI. A person consumes 3 gm of salt everyday. The number of iodide ions going into his body everyday is

(A) \( 10^{-4} \)  \quad (B) \( 6.02 \times 10^{-4} \)  

(C) \( 6.02 \times 10^{-9} \)  \quad (D) \( 6.02 \times 10^{21} \)

28. The pair of species having same percentage (mass) of carbon is:

(A) \( \text{CH}_3\text{COOH} \) and \( \text{C}_2\text{H}_3\text{O}_2 \)  

(B) \( \text{CH}_3\text{COOH} \) and \( \text{C}_2\text{H}_5\text{OH} \)  

(C) \( \text{HCOOCH}_3 \) and \( \text{C}_2\text{H}_5\text{O}_2 \)  

(D) \( \text{C}_3\text{H}_5\text{O}_2 \) and \( \text{C}_2\text{H}_5\text{O}_2 \)

29. 200 ml of a gaseous mixture containing CO, CO₂, and N₂ on complete combustion in just sufficient amount of \( \text{O}_2 \) showed contraction of 40 ml. When the resulting gases were passed through KOH solution it reduces by 50% then calculate the volume ratio of \( V_{\text{CO}} : V_{\text{CO}_2} : V_{\text{N}_2} \) in original mixture.

(A) \( 4 : 1 : 5 \)  \quad (B) \( 2 : 3 : 5 \)  

(C) \( 1 : 4 : 5 \)  \quad (D) \( 1 : 3 : 5 \)

30. Density of a gas relative to air is 1.17. Find the mol. mass of the gas. \( M_u = 29 \text{ g/mol} \)

(A) 33.9  \quad (B) 24.7  

(C) 29  \quad (D) 22.3

31. Weight of oxygen in \( \text{Fe}_2\text{O}_3 \) and \( \text{FeO} \) is in the simple ratio for the same amount of iron is:

(A) \( 3 : 2 \)  \quad (B) \( 1 : 2 \)  

(C) \( 2 : 1 \)  \quad (D) \( 3 : 1 \)

32. Two elements X (atomic mass 16) and Y (atomic mass 14) combine to form compounds A, B and C. The ratio of different masses of Y which combines with a fixed mass of X in A, B and C is 1:3:5. If 32 parts by mass of X combines with 84 parts by mass of Y in B, then in C, 16 parts by mass of X will combine with____ parts by mass of Y.

(A) 14  \quad (B) 42  

(C) 70  \quad (D) 84

33. In a textile mill, a double-effect evaporator system concentrates weak liquor containing 4% (by weight) caustic soda to produce a dye containing 25% solids (by weight). Calculate the weight of the water evaporate per 100-kg feed in the evaporator.

(A) 125.0 g  \quad (B) 50.0 kg  

(C) 84.0 kg  \quad (D) 16.0 kg

34. Zinc ore (zinc sulphide) is treated with sulphuric acid, leaving a solution with some undissolved bits of material and releasing hydrogen sulphide gas. If 10.8g of zinc ore is treated with 50.0 ml of sulphuric acid (density 1.153 g/ml), 65.1g of solution and undissolved material remains. In addition, hydrogen sulphide (density 1.393 g/l) is evolved. What is the volume (in liters) of this gas?

(A) 4.3  \quad (B) 3.35  

(C) 4.67  \quad (D) 2.40
35. A sample of an ethanol-water solution has a volume of 54.2 cm\(^3\) and a mass of 49.6 g. What is the percentage of ethanol (by mass) in the solution? (Assume that there is no change in volume when the pure compounds are mixed.) The density of ethanol is 0.80 g/cm\(^3\) and that of water is 1.00 g/cm\(^3\).
(A) 18.4\%  
(B) 37.1\%  
(C) 33.95\%  
(D) 31.2\%

36. A student gently drops an object weighing 15.8 g into an open vessel that is full of ethanol, so that a volume of ethanol spills out equal to the volume of the object. The experimenter now finds that the vessel and its contents weigh 10.5 g more than the vessel full of ethanol only. The density of ethanol is 0.789 g/cm\(^3\). What is the density of the object?
(A) 6.717 g/cm\(^3\)  
(B) 4.182 g/cm\(^3\)  
(C) 1.563 g/cm\(^3\)  
(D) 2.352 g/cm\(^3\)

37. A person needs on average of 2.0 mg of riboflavin (vitamin B\(_2\)) per day. How many gm of butter should be taken by the person per day if it is the only source of riboflavin? Butter contains 5.5 microgram riboflavin per gm.
(A) 363.6 gm  
(B) 2.75 mg  
(C) 11 gm  
(D) 19.8 gm

38. A sample of clay contains 40% silica and 15% water. The sample is partially dried by which it loses 5 gm water. If the percentage of water in the partially dried clay is 8, calculate the percentage of silica in the partially dried clay.
(A) 21.33\%  
(B) 43.29\%  
(C) 75\%  
(D) 50\%

39. The density of quartz mineral was determined by adding a weighed piece to a graduated cylinder containing 51.2ml water. After the quartz was submerged, the water level was 65.7 ml. The quartz piece weighed 38.4 g. What was the density of quartz?
(A) 1.71 gm/ml  
(B) 1.33 gm/ml  
(C) 2.65 gm/ml  
(D) 1.65gm/ml

40. Which has maximum number of atoms or oxygen
(A) 10 ml H\(_2\)O
(B) 0.1 mole of FeO
(C) 12 gm O\(_3\) (g)
(D) 12.044 \(\times\) 10\(^{22}\) molecules of CO\(_2\)

41. Mass of one atom of the element A is 3.9854 \(\times\) 10\(^{-23}\). How many atoms are contained in 1g of the element A?
(A) 2.509 \(\times\) 10\(^{23}\)  
(B) 6.022 \(\times\) 10\(^{23}\)  
(C) 12.044 \(\times\) 10\(^{23}\)  
(D) None

42. The number of atoms present in 0.5 g-atoms of nitrogen is same as the atoms in
(A) 12 g of C  
(B) 32 g of S  
(C) 8 g of oxygen  
(D) 24 g of Mg

43. A graph is plotted for an element, by putting its weight on X-axis and the corresponding number of number of atoms on Y-axis. Determine the atomic weight of the element for which the graph is plotted.

44. The O\(^{18}\)/O\(^{16}\) ratio in some meteorites is greater than that used to calculate the average atomic mass of oxygen on earth. The average mass of an atom of oxygen in these meteorites is (A) equal to  
(B) greater than  
(C) less than  
(D) None of these

45. If isotopic distribution of C\(^{12}\) and C\(^{14}\) is 98.0\% and 2.0\% respectively, then the number of C\(^{14}\) atoms in 12 gm of carbon is
(A) 1.032 \(\times\) 10\(^{22}\)  
(B) 1.20 \(\times\) 10\(^{22}\)  
(C) 5.88 \(\times\) 10\(^{23}\)  
(D) 6.02 \(\times\) 10\(^{23}\)

46. At one time there was a chemical atomic weight scale based on the assignment of the value 16.0000 to naturally occurring oxygen. What would have been the atomic weight, on such a table, of silver, if current information had been available? The atomic weights of oxygen and silver on the present table are 15.9994 and 107.868.
(A) 107.908  
(B) 107.864  
(C) 107.868  
(D) 107.872

47. Two isotopes of an element Q are Q\(^{97}\) (23.4\%
abundance) and Q^{94} (76.6% abundance). Q^{97} is 8.082 times heavier than Cl^{12} and Q^{94} is 7.833 times heavier than Cl^{12}. What is the average atomic weight of the element Q?

(A) 94.702  
(B) 78.913  
(C) 96.298  
(D) 94.695

48. The element silicon makes up 25.7% of the earth’s crust by weight, and is the second most abundant element, with oxygen being the first. Three isotopes of silicon occur in nature: Si^{28} (92.21%), which has an atomic mass of 27.97693 amu; Si^{29} (4.70%), with an atomic mass of 28.97649 amu; and Si^{30} (3.09%), with an atomic mass of 29.97379 amu. What is the atomic weight of silicon?

(A) 28.0856  
(B) 28.1088  
(C) 28.8342  
(D) 29.0012

49. The average atomic mass of a mixture containing 79 mol % of 24 Mg and remaining 21 mol % of 25 Mg and 26Mg, is 24.31. % mole of 26Mg is

(A) 5  
(B) 20  
(C) 10  
(D) 15

50. The oxide of a metal contains 30% oxygen by weight. If the atomic ratio of metal and oxygen is 2 : 3, determine the atomic weight of metal.

(A) 12  
(B) 56  
(C) 27  
(D) 52

### Exercise – II

<table>
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<tr>
<th>OBJECTIONAL PROBLEMS (JEE ADVANCED)</th>
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|1. The average mass of one gold atom in a sample of naturally occurring gold is 3.257 x 10^{-22} g. Use this to calculate the molar mass of gold.

2. A plant virus is found to consist of uniform spherical particles of 150 Å in diameter and 5000 Å long. The specific volume of the virus is 0.75 cm^3/g. If the virus is considered to be a single particle, find its molecular weight. [V = \pi r^3/6]

3. Calculate

(a) Number of nitrogen atoms in 160 amu of NH₄NO₃
(b) Number of gram-atoms of S in 490 kg H₂SO₄
(c) Grams of Al₂(SO₄)₃ containing 32 amu of S.

4. A chemical compound “dioxin” has been very much in the news in the past few years. (It is the by-product of herbicide manufacture and is through to be quite toxic.) Its formula is CₙH₂Cl₂O₂. If you have a sample of dirt (28.3 g) that contains 8.78 x 10^{-4} moles of dioxin, calculate the percentage of dioxin in the dirt sample?

5. Polychlorinated biphenyls, PCBs, known to be dangerous environmental pollutants, are a group of compounds with the general empirical formula CₚₐH₂ₗCl₂ₘO₂ₙ, where m is an integer. What is the value of m, and hence the empirical formula of the PCB that contains 58.9% chlorine by mass?

6. Given the following empirical formulae and molecular weights, compute the true molecular formulae:

<table>
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<tr>
<th>Empirical Formula</th>
<th>Molecular weight</th>
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<tbody>
<tr>
<td>(a) CH₃</td>
<td>84</td>
</tr>
<tr>
<td>(b) CH₂O</td>
<td>150</td>
</tr>
<tr>
<td>(c) HO</td>
<td>34</td>
</tr>
<tr>
<td>(d) HgCl</td>
<td>472</td>
</tr>
<tr>
<td>(e) HF</td>
<td>80</td>
</tr>
</tbody>
</table>

7. What is the empirical formula of a compound 0.2801 gm of which gave on complete combustion 0.9482 gm of carbon dioxide and 0.1939 gm of water?

8. A 5.5 gm sample of an organic compound gave on quantitative analysis 1.4 gm of N and 3.6 gm of C and 0.5 gm of H. If Molecular mass of the compound is 55 then calculate E.F. and M.F.

### Problems Related with Mixture

9. One gram of an alloy of aluminium and magnesium when heated with excess of dil. HCl forms magnesium chloride, aluminium chloride and hydrogen. The evolved hydrogen collected at 0°C has a volume of 1.12 liters at 1 atm pressure. Calculate the composition of the alloy.

10. A sample containing only CaCO₃ and MgCO₃ is ignited to CaO and MgO. The mixture of oxides produced weight exactly half as much as the original sample. Calculate the percentages of CaCO₃ and MgCO₃ in the sample.
11. Determine the percentage composition of a mixture of anhydrous sodium carbonate and sodium bicarbonate from the following data:
   wt of the mixture taken = 2g
   Loss in weight on heating = 0.11 gm

12. A 10 g sample of a mixture of calcium chloride and sodium chloride is treated with Na₂CO₃ to precipitate calcium as calcium carbonate. This CaCO₃ is heated to convert all the calcium to CaO and the final mass of CaO is 1.12 gm. Calculate % by mass of NaCl in the original mixture.

**LIMITING REAGENT**

13. Titanium, which is used to make air plane engines and frames, can be obtained from titanium tetrachloride, which in turn is obtained from titanium oxide by the following process:
   3TiO₂(s) + 4Cl₂(g) → 3TiCl₄(g) + 2CO₂(g) + 2CO(g)

   A vessel contains 4.32 g TiO₂, 5.76 g C and; 6.82 g Cl₂. Suppose the reaction goes to completion as written, how many gram of TiCl₄ and be produced? (Ti = 48)

More than one correct:

14. Two gases A and B which react according to the equation
   aA(g) + bB(g) → cC(g) + dD(g)
   to give two gases C and D are taken (amount not known) in an Eudiometer tube (operating at a constant Pressure and temperature) to cause the above.

   a) If on causing the reaction there is no volume change observed then which of the following statement is/are correct.
      (A) (a + b) = (c + d)
      (B) average molecular mass may increase or decrease if either of A or B is present in limited amount.
      (C) Vapour Density of the mixture will remain same throughout the course of reaction.
      (D) Total moles of all the component of mixture will change.

16. An aqueous solution consisting of 5 M BaCl₂, 58.8% w/v NaCl solution & 2m Na₃X has a density of 1.949 gm/ml. Mark the option(s) which represent correct molarity (M) of the specified ion.
   [Assume 100% dissociation of each salt and molecular mass of X⁻ is 96]
   (A) [Cl⁻] = 20 M
   (B) [Na⁺] = 11 M
   (C) [Total anions] = 20.5 M
   (D) [Total cations] = 15 M

17. A mixture of 100 ml of CO₂, CO and O₂ was sparked. When the resulting gaseous mixture was passed through KOH solution, contraction in volume was found to be 80 ml, the composition of initial mixture may be (in the same order)
   (A) 30 ml, 60 ml, 10 ml
   (B) 30 ml, 50 ml, 20 ml
   (C) 50 ml, 30 ml, 20 ml
   (D) 30 ml, 40 ml, 30 ml

18. A sample of H₂O₂ solution labelled as 56 volume has density of 530 gm/l. Mark the correct option(s) representing concentration of same solution in other units. (Solution contains only H₂O and H₂O₂)
   (A) M_H₂O₂ = 6
   (B) M_H₂O = 17
   (C) Mole fraction of H₂O₂ = 0.25
   (D) m_H₂O₂ = 1000
       _________________
       72

19. Solution(s) containing 30 gm CH₃COOH is/are
   (A) 50 gm of 70% (w/v) CH₃COOH [d_w = 1.4 gm/ml]
   (B) 50 gm of 10 M CH₃COOH [d_w = 1 gm/ml]
   (C) 50 gm of 60% (w/w) CH₃COOH
   (D) 50 gm of 10 m CH₃COOH

20. '2V' ml of 1 M Na₂SO₃, is mixed with 'V' ml of 2M Ba(NO₃)₂ solution.
   (A) Molarity of Na⁺ ion in final solution can't be calculated as V is not known.
   (B) Molarity of BaSO₄ in final solution is 2 M
   (C) Molarity of NO₃⁻ in final solution is 4 M
   (D) Molarity of NO₃⁻ in final solution is 2 M
21. One type of artificial diamond (commonly called YAG for yttrium aluminium garnet) can be represented by the formula \( Y_3Al_2O_12 \); \([Y = 89, \text{ Al} = 27]\)

<table>
<thead>
<tr>
<th>Column I</th>
<th>Column II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Element</td>
<td>Weight percentage</td>
</tr>
<tr>
<td>(A) Y</td>
<td>(P) 22.73%</td>
</tr>
<tr>
<td>(B) Al</td>
<td>(Q) 32.32%</td>
</tr>
<tr>
<td>(C) O</td>
<td>(R) 44.95%</td>
</tr>
</tbody>
</table>

22. The recommended daily dose is 17.6 milligrams of vitamin C (ascorbic acid) having formula \( C_6H_8O_6 \).

Match the following. Given: \( N_A = 6 	imes 10^{23} \)

<table>
<thead>
<tr>
<th>Column I</th>
<th>Column II</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A) O-atoms present</td>
<td>(P) ( 10^{-2} ) mole</td>
</tr>
<tr>
<td>(B) Moles of vitamin C in 1gm</td>
<td>(Q) ( 5.68 \times 10^{-3} )</td>
</tr>
<tr>
<td>(C) Moles of vitamin C in 1gm</td>
<td>(R) ( 3.6 \times 10^{-2} )</td>
</tr>
</tbody>
</table>

23. An evacuated glass vessel weighs 50 gm when empty, 148.0 g when completely filled with liquid of density 0.98 g ml\(^{-1}\) and 50.5 g when filled with an ideal gas at 760 mm at 300 K. Determine the molecular weight of the gas. \([\text{JEE'98,3}]\)

24. At 100° C and 1 atm, if the density of liquid water is 1.0 g cm\(^{-3}\) and that of water vapour is 0.0006 g cm\(^{-3}\), then the volume occupied by water molecules 1 L of steam at that temperature is:

- (A) 6 cm\(^3\)
- (B) 60 cm\(^3\)
- (C) 0.6 cm\(^3\)
- (D) 0.06 cm\(^3\)

25. If one mole of ethanol (\( C_2H_5OH \)) completely burns to form carbon dioxide and water, the weight of carbon dioxide formed is about -

26. The mass of \( CaCO_3 \) produced when carbon dioxide is passed in excess through 500 ml of 0.5 M \( Ca(\text{OH})_2 \) will be -

27. The mass of oxygen that would be required to produce enough \( CO \), which completely reduces 1.6 kg \( Fe_3O_3 \) (at. mass \( Fe = 56 \)) is-

28. 1.5 gm of divalent metal displaced 4 gm of copper (at. wt. = 64) from a solution of copper sulphate. The atomic weight of the metal is-

29. Assuming that petrol is iso-octane (\( C_8H_{18} \)) and has density 0.8 gm/ml, 1.425 litre of petrol on complete combustion will consume oxygen -

30. A mixture containing 100 gm \( H_2 \) and 100 gm \( O_2 \) is ignited so that water is formed according to the reaction, \( 2H_2 + O_2 \rightarrow 2H_2O \); How much water will be formed -
EXERCISE – III

SUBJECTIVE PROBLEMS (JEE ADVANCED)

1. \( \text{A}_2 + 2\text{B}_2 \rightarrow \text{A}_3\text{B}_4 \) and \( \frac{3}{2}\text{A}_2 + 2\text{B}_2 \rightarrow \text{A}_3\text{B}_4 \)

Two substances \( \text{A}_2 \) & \( \text{B}_2 \) react in the above manner when \( \text{A}_2 \) is limited it gives \( \text{A}_3\text{B}_4 \), when in excess gives \( \text{A}_3\text{B}_4 \). \( \text{A}_3\text{B}_4 \) can be converted to \( \text{A}_3\text{B}_4 \) when reacted with \( \text{A}_2 \). Using this information calculate the composition of the final mixture when mentioned amount of \( \text{A}_2 \) & \( \text{B}_2 \) are taken

(i) If 4 moles of \( \text{A}_2 \) & 4 moles of \( \text{B}_2 \) is taken in reaction container

(ii) If \( \frac{1}{2} \) moles of \( \text{A}_2 \) & 2 moles of \( \text{B}_2 \) is taken in reaction container

(iii) If \( \frac{5}{4} \) moles of \( \text{A}_2 \) & 2 moles of \( \text{B}_2 \) is taken

2. How much minimum volume of 0.1 M aluminium sulphate solution should be added to excess calcium nitrate to obtain at least 1 gm of each salt in the reaction.

\[ \text{Al}_2(\text{SO}_4)_3 \cdot 3\text{Ca(NO}_3)_2 \rightarrow 2\text{Al(NO}_3)_3 + 3\text{CaSO}_4 \]

3. A sample of fuming sulphuric acid containing \( \text{H}_2\text{SO}_4 \), \( \text{SO}_3 \), and \( \text{SO}_4 \) weighing 1.00 g is found to require 23.47 ml of 1.00 M alkali (NaOH) for neutralisation. A separate sample shows the presence of 1.50% \( \text{SO}_3 \). Find the percentage of "free" \( \text{SO}_3 \), \( \text{H}_2\text{SO}_4 \), and "combined" \( \text{SO}_4 \) in the sample.

4. Chloride samples are prepared for analysis by using \( \text{NaCl} \), \( \text{KCl} \) and \( \text{NH}_4\text{Cl} \) separately or as mixture. What minimum volume of 5% by weight \( \text{AgNO}_3 \) solution (sp gr., 1.04 g ml\(^{-1}\)) must be added to a sample of 0.3 g in order to ensure complete precipitation of chloride in every possible case?

5. One litre of milk weighs 1.035 kg. The butter fat is 10% (v/v) of milk has density of 875 kg/m\(^3\). The density of fat free skimmed milk is?

6. For a hypothetical chemical reaction represented by

\[ 3\text{A}(g) \rightarrow \text{C}(g) + \text{D}(g) \]

the following informations are known.

Information

(i) At \( t = 0 \), only 1 mole of \( \text{A} \) is present and the gas has V.D. = 60.

(ii) At \( t = 30 \text{ min} \), the gaseous mixture consist of all three gases and has a vapour density = 75.

(iii) Molecular Mass of \( \text{C} \) = 200

Calculate

(a) Molecular weight of \( \text{A} \) and \( \text{D} \).

(b) Moles of each specie at \( t = 30 \text{ min} \).

7. A mixture of \( \text{H}_2 \), \( \text{N}_2 \), & \( \text{O}_2 \) occupying 100 ml underwent reaction so as to from \( \text{H}_2\text{O}(l) \) and \( \text{N}_2\text{H}_2(g) \) as the only products, causing the volume to contract by 60 ml. The remaining mixture was passed through pyrogallol causing a contraction of 10 ml. The remaining mixture excess \( \text{H}_2 \) was added and the above reaction was repeated, causing a reduction in volume of 10 ml. Identify the composition of the initial mixture in mol %.

(No other products are formed)

8. A mixture of three gases an alkane (general formula \( \text{C}_n \text{H}_{2n+2} \)), an alkene (general formula \( \text{C}_n \text{H}_{2n} \)) and \( \text{O}_2 \) was subjected to sparking to cause combustion of both the hydrocarbon at 127°C. After the reaction three gases were present and none of the hydrocarbon remained. On passing the gases through KOH (absorb \( \text{CO}_2 \)), an increment in mass of KOH solution by 132 gm was observed. The remaining gases were passed over white anhydrous \( \text{CuSO}_4 \), and the weight of blue hydrated \( \text{CuSO}_4 \) crystals was found to be 72 gm more than that of white anhydrous \( \text{CuSO}_4 \). Given that initially total 10 moles of the three gases were taken and moles of alkane and alkene were equal and if molecular mass of alkane molecular mass of alkane = 12 i.e. (\( M_{\text{alkane}} - M_{\text{alkene}} = 12 \)), then answer the following questions. (Show calculations)

(a) Which three gases are remained after the combustion reactions.

(b) What are the number of moles of product gases.

(c) What is the molecular formula of the two hydrocarbon.

(d) What is the number of moles of each of the two hydrocarbons and \( \text{O}_2 \) gas taken initially.

9. A chemist wants to prepare diborane by the reaction \( 6\text{LiH} + 8\text{BF}_3 \rightarrow 6\text{LiBF}_4 + \text{B}_2\text{H}_6 \)

If he starts with 2.0 moles each of \( \text{LiH} \) & \( \text{BF}_3 \). How many moles of \( \text{B}_2\text{H}_6 \) can be prepared.

10. Carbon reacts with chlorine to form \( \text{CCl}_4 \). 36 gm of carbon was mixed with 142 g of Cl. Calculate mass of \( \text{CCl}_4 \) produced and the remaining mass of reactant.
MISCELLANEOUS PROBLEM

11. \( \text{P}_2\text{S}_5 + 8\text{O}_2 \rightarrow \text{P}_2\text{O}_{15} + 3\text{SO}_3 \)
Calculate minimum mass of \( \text{P}_2\text{S}_5 \) is required to produce at least 1 gm of each product.

12. By the reaction of carbon and oxygen, a mixture of \( \text{CO} \) and \( \text{CO}_2 \) is obtained. What is the composition by mass of the mixture obtained when 20 grams of \( \text{O}_2 \) reacts with 12 grams of carbon?

13. The chief ore of Zn is the sulphide, ZnS. The ore is concentrated by froth flotation process and then heated in air to convert ZnS to ZnO.

\[ 2\text{ZnS} + 3\text{O}_2 \rightarrow 2\text{ZnO} + 2\text{SO}_2 \]

\[ \text{ZnO} + \text{H}_2\text{SO}_4 \rightarrow \text{ZnSO}_4 + \text{H}_2\text{O} \]

\[ 2\text{ZnSO}_4 + 2\text{H}_2\text{O} \rightarrow 2\text{Zn} + 2\text{H}_2\text{SO}_4 + \text{O}_2 \]

(a) What mass of Zn will be obtained from a sample of ore containing 291 kg of ZnS.

(b) Calculate the volume of \( \text{O}_2 \) produced at 1 atm & 273 K in part (a).

CONCENTRATION TERMS

14. Calculate the molarity of the following solutions:
   (a) 4 g of caustic soda is dissolved in 200 mL of the solution.
   (b) 5.3 g of anhydrous sodium carbonate is dissolved in 100 mL of solution.
   (c) 0.365 g of pure HCl gas is dissolved in 50 mL of solution.

15. Density of a solution containing 13% by mass of sulphuric acid is 1.09 g/mL. Then molarity of solution will be.

16. The density of a solution containing 40% by mass of HCl is 1.2 g/mL. Calculate the molarity of the solution.

17. 15 g of methyl alcohol is present in 100 mL of solution. If density of solution is 0.90 g mL\(^{-1}\), calculate the mass percentage of methyl alcohol in solution.

18. Units of parts per million (ppm) or per billion (ppb) are often used to describe the concentrations of solutes in very dilute solutions. The units are defined as the number of grams of solute per million or per billion grams of solvent. Bay of Bengal has 1.9 ppm of lithium ions. What is the molality of Li\(^+\) in this water?

19. A 6.90 M solution of KOH in water contains 30% by mass of KOH. What is density of solution in gm/mL.

20. A solution of specific gravity 1.6 is 67% by weight. What will be % by weight of the solution of same acid if it is diluted to specific gravity 1.2?

21. Find out the volume of 98% w/w \( \text{H}_2\text{SO}_4 \) (density = 1.8 gm/ml) must be diluted to prepare 12.5 litres of 2.5 M sulphuric acid solution.

22. Determine the volume of diluted nitric acid (d = 1.11 gmL\(^{-1}\), 19% w/v \( \text{HNO}_3 \)) that can be prepared by diluting with water 50 mL of conc. \( \text{HNO}_3 \) (d = 1.42 g ML\(^{-1}\), 69.8% w/v).

23. (a) Find molarity of \( \text{Ca}^{2+} \) and \( \text{NO}_3^- \) in 2 M \( \text{Ca(NO}_3)_2 \) aqueous solution of density 1.328 g/mL.

(b) Also find mole fraction of solute in solution.

24. Calculate molality (m) of each ion present in the aqueous solution of 2M \( \text{NH}_4 \text{Cl} \) assuming 100% dissociation according to reaction.

\[ \text{NH}_4\text{Cl(aq)} \rightarrow \text{NH}_4\text{(aq)} + \text{Cl}^- \text{(aq)} \]

Given : Density of solution = 3.107 gm/ml.

25. 500 ml of 2 M NaCl solution was mixed with 200 ml of 2 M NaCl solution. Calculate the final volume and molarity of NaCl in final solution if final solution has density 1.5 gm/ml.

EXPERIMENTAL METHODS

26. What is the percentage of nitrogen in an organic compound 0.14 gm of which gave by Dumas method 82.1 c.c. of nitrogen collected over water at 27°C and at a barometric pressure of 77.4 mm Hg (aqueous tension of water at 27°C is 14.5 mm)

27. 0.20 gm of an organic compound was treated by Kjeldahl's method and the resulting ammonia was passed into 50 cc of M/4 \( \text{H}_2\text{SO}_4 \). The residual acid was then found to require 40 cc of M/2 NaOH for neutralisation. What is the percentage of nitrogen in the compound?

28. 0.252 gm of an organic compound gave on complete combustion 0.22 gm of carbon dioxide and 0.135 gm of water. 0.252 gm of the same compound gave by Carius method 0.7175 gm of silver chloride. What is the empirical formula of the compound?
29. 0.6872 gm of an organic compound gave on complete combustion 1.466 gm of carbon dioxide and 0.4283 gm of water. A given weight of the compound when heated with nitric acid and silver nitrate gave an equal weight of silver chloride. 0.3178 gm of the compound gave 26.0 cc of nitrogen at 15ºC and 765 mm pressure. Deduce the empirical formula of the compound?

30. 0.80 g of the chloroplatinate of a mono acid base on ignition gave 0.262 g of Pt. Calculate the mol wt of the base.

31. The molecular mass of an organic acid was determined by the study of its barium salt. 2.562 g of salt was quantitatively converted to free acid by the reaction 30 ml of 0.2 M H₂SO₄, the barium salt was found to have two moles of water of hydration per Ba²⁺ ion and the acid is mono basic. What is molecular weight of anhydrous acid? (At mass of Ba = 137)

32. Calculate composition of the final solution if 100 gm oleum labelled as 109% is added with (a) 9 gm water      (b) 18 gm water
     (c) 120 gm water

33. For '44.8 V' H₂O₂ solution having d = 1.136 gm/ml calculate
   (i) Molarity of H₂O₂ solution.
   (ii) Mole fraction of H₂O₂ solution.

34. An oleum sample is labelled as 118%, Calculate
   (i) Mass of H₂SO₄ in 100 gm oleum sample.
   (ii) Maximum mass of H₂SO₄ that can be obtained if 30 gm sample is taken.
   (iii) Composition of mixture (mass of components) if 40 gm water is added to 30 gm given oleum sample.

35. 10ml of a mixture of CO₂, CH₄ and N₂ exploded with excess of oxygen gave a contraction of 6.5 ml. There was a further contraction of 7 ml, when the residual gas treated with KOH. Volume of CO₂, CH₄, and N₂ respectively is

36. When 100 ml of a O₂ – O₂ mixture was passed through turpentine, there was reduction of volume by 20 ml. If 100 ml of such a mixture is heated, what will be the increase in volume?

37. 60 ml of a mixture of nitrous oxide and nitric oxide was exploded with excess of hydrogen. If 38 ml of N₂ was formed, calculate the volume of each gas in the mixture.

38. When a certain quantity of oxygen was ozonised in a suitable apparatus, the volume decreased by 4 ml. On addition of turpentine the volume further decreased by 8 ml. All volumes were measured at the same temperature and pressure. From these data, establish the formula of ozone.

39. 10 ml of ammonia were enclosed in an eudiometer and subjected to electric sparks. The sparks were continued till there was no further increase in volume. The volume after sparking measured 20 ml. Now 30 ml of O₂ were added and sparking was continued again. The new volume then measured 27.5 ml. All volume were measured under identical conditions of temperature and pressure. V.D. of ammonia is 8.5. Calculate the molecular formula of ammonia. Nitrogen and Hydrogen are diatomic.

40. 10 ml of gaseous organic compound contain C, H and O only was mixed with 100 ml of O₂ and exploded under identical conditions and then cooled. The volume left after cooling was 90 ml. On treatment with KOH a contraction of 20 ml was observed. If vapour density of compound is 23, derive molecular formula of the compound.
Exercise – IV

Level – I

1. The weight of $2.01 \times 10^{23}$ molecules of CO is -
   (A) 9.3 gm (B) 7.2 gm (C) 1.2 gm (D) 3 gm
   [AIEEE-2002]

2. In an organic compound of molar mass 108 gm mol$^{-1}$ C, H and N atoms are present in 9:1:3.5 by weight. Molecular formula can be -
   (A) $C_9H_9N_3$ (B) $C_7H_{12}N$ (C) $C_5H_8N_3$ (D) $C_4H_{12}N_3$
   [AIEEE-2002]

3. Number of atoms in 560 gm of Fe (atomic mass 56 g mol$^{-1}$) is -
   (A) is twice that of 70 gm N (B) is half that of 20 gm H
   (C) both are correct (D) None is correct
   [AIEEE-2003]

4. 6.02 $\times 10^{20}$ molecules of urea are present in 100 ml of its solution. The concentration of urea solution is -
   [AIEEE-2004]

Level – II

1. How many moles of $e^-$ weigh one Kg
   (A) $6.023 \times 10^{23}$ (B) $1 \frac{1}{9.08} \times 10^{21}$ (C) $6.023 \times 10^{24}$ (D) $\frac{1}{9.108} \times 6.023 \times 10^{24}$
   [JEE 2002 (Scr), 1]

2. Calculate the molarity of pure water using its density to be 1000 kg m$^{-3}$. [JEE' 2003]

3. One gm of charcoal absorbs 100 ml 0.5 M CH$_2$COOH to form a monolayer, and there by the molarity of CH$_2$COOH reduces to 0.49. Calculate the surface area of the charcoal adsorbed by each molecule of acetic acid. Surface area of charcoal = 3.01 $\times 10^2$ m$^2$/gm. [JEE' 2003]

4. Calculate the amount of Calcium oxide required when it reacts with 852 gm of $P_2O_5$. [JEE 2005]

5. 20% surface sites have adsorbed $N_2$. On heating $N_2$ gas evolved from sites and were collected at 0.001 atm and 298 K in a container or volume is 2.46 cm$^3$. Density of surface sites is 6.023 $\times$

PREVIOUS YEARS

JEE Main

5. How many moles of magnesium phosphate, $Mg_3(PO_4)_2$ will contain 0.25 mole of oxygen atoms?
   (A) $3.125 \times 10^{-2}$ (B) $1.25 \times 10^{-2}$
   (C) $2.5 \times 10^{-2}$ (D) $0.02$
   [AIEEE 2006]

6. In the reaction,
   $2Al(s) + 6HCl(aq) \rightarrow 2Al^{3+} (aq) + 6Cl^-(aq) + 3H_2(g)$
   (A) 6L HCl(aq) is consumed for every 3L H$_2$(g) produced
   (B) 33.6 L H$_2$(g) is produced regardless of temperature and pressure for every mole Al that reacts
   (C) 67.2 L H$_2$(g) at STP is produced for every mole Al that reacts
   (D) 11.2 L H$_2$(g) at STP is produced for every mole HCl(aq) consumed
   [AIEEE 2007]

JEE Advanced

6. Dissolving 120 g of urea (mol. wt. 60) in 1000 g of water gave a solution of density 1.15 g/mL. The molarity of the solution is: [JEE 2011]
   (A) 1.78 M (B) 2.00 M (C) 2.05 M (D) 2.22 M

7. Reaction of Br$_2$ with Na$_2$CO$_3$ in aqueous solution gives sodium bromide and sodium bromate with evolution of CO$_2$ gas. The number of sodium bromide molecules involved in the balanced chemical equation is: [JEE 2011]

8. A decapeptide (Mol. wt. 796) on complete hydrolysis gives glycine (Mol. Wt. 75), alanine and phenylalanine. Glycine contributes 47.0% to the total weight to the hydrolysed products. The number of glycine units present in the decapeptide: [JEE 2011]
# ANSWER-KEY

## Answer Ex-I

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<tr>
<td>33.</td>
<td>C</td>
<td>34.</td>
<td>D</td>
<td>35.</td>
<td>B</td>
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<td>42.</td>
<td>C</td>
<td>43.</td>
<td>B</td>
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<td>45.</td>
<td>B</td>
<td>46.</td>
<td>D</td>
<td>47.</td>
<td>D</td>
<td>48.</td>
<td>A</td>
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<tr>
<td>49.</td>
<td>C</td>
<td>50.</td>
<td>B</td>
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## OBJECTIVE PROBLEMS (JEE MAIN)

### Answer Ex-II

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<tbody>
<tr>
<td>1.</td>
<td>196.169 gm</td>
<td>2.</td>
<td>7.092 x 10^2</td>
<td>3.</td>
<td>(a) 4 ; (b) 5000 moles ; (c) 1.89 x 10^-2 gm</td>
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<tr>
<td>4.</td>
<td>1.0 x 10^-4 %</td>
<td>5.</td>
<td>m = 4, C,H,Cl,</td>
<td>6.</td>
<td>(a) C,H, , (b) C,H, ,O, , (c) H, ,O, , (d) Hg, Cl, , (e) H,F ,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>CH</td>
<td>8.</td>
<td>C,H,N, C,H,N</td>
<td>9.</td>
<td>Al = 60% ; Mg = 40%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>CaCO, = 28.4% ; MgCO, = 71.6%</td>
<td>11.</td>
<td>NaHCO, = 14.9% ; Na,CO, = 85.1%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>29.</td>
<td>125</td>
<td>30.</td>
<td>113</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

## OBJECTIVE PROBLEMS (JEE ADVANCED)

### Answer Ex-III

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>(i) A, = 1, A, B, = 2 ; (ii) B, = 1 A, B, = 1/2 ; (iii) A, B, = 0.5 A, B, = 0.5</td>
<td>2.</td>
<td>24.51 ml</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>H,SO, = 35.38% , Free SO, = 63.1% , combined SO, = 28.89%</td>
<td>4.</td>
<td>18.38 ml</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
5. 1.052 gm/ml  
6. (a) $m_x = 120$, $m_y = 160$; (b) $n_a = \frac{2}{5}$, $n_c = \frac{1}{5}$, $n_d = \frac{1}{5}$  
7. $N_2 = 30$ ml, $H_2 = 40$ ml

8. (a) CO, H$_2$O and O$_2$; (b) $^9$CO$_2 = 3$, $^1$H$_2$O = 4; (c) C$_2$H$_4$ and CH$_4$ are the H.C.; (d) $^8$O$_2 = 8$

9. 0.25 mole  
10. $w_i = 24$ gm; $^3$CCl$_4 = 154$ gm  
11. 1.1458  
12. 21 : 11

13. (a) 117 kg; (b) $20.16 \times 10^4$ lit.  
14. (a) 0.5 M, (b) 0.5 M, (c) 0.2 M  
15. 1.445  
16. 13.15

17. 16.66\%  
18. $2.7 \times 10^{-4}$  
19. 1.288  
20. 29.77  
21. 1.736 litre  
22. 183.68 ml

23. (a) $[Ca^{2+}] = 2$ molar $[NO_3^-] = 4$ molar; (b) 0.965  
24. 0.6667, 0.6667  
25. 2M

26. 66.67\%  
27. 35\%  
28. CH$_2$Cl  
29. C$_2$H$_5$NCl  
30. 92.70  
31. 128

32. (a) pure H$_2$SO$_4$ (109 gm); (b) 109 gm H$_2$SO$_4$, 9 gm H$_2$O; (c) 109 gm H$_2$SO$_4$, 111 gm H$_2$O

33. (i) 4M; (ii) 0.06  
34. (i) 20 gm H$_2$SO$_4$; (ii) 35.4 gm H$_2$SO$_4$; (iii) H$_2$SO$_4 = 35.4$ gm, H$_2$O = 34.6 gm

35. 5 ml, 2ml, 3ml  
36. 10 ml  
37. NO = 44 ml; N$_2$O = 16 ml  
38. O$_2$  
39. NH$_3$

40. C$_2$H$_6$O

---

**Answer Ex–IV**

<table>
<thead>
<tr>
<th>PREVIOUS YEARS PROBLEMS</th>
</tr>
</thead>
</table>

**LEVEL – I**

<table>
<thead>
<tr>
<th>JEE MAIN</th>
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</thead>
</table>

**LEVEL – II**

<table>
<thead>
<tr>
<th>JEE ADVANCED</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. D</td>
</tr>
<tr>
<td>2. 55.5 mol L$^{-1}$</td>
</tr>
<tr>
<td>3. $5 \times 10^{-10}$ m$^3$</td>
</tr>
<tr>
<td>4. 1008 gm</td>
</tr>
<tr>
<td>5. 0002</td>
</tr>
<tr>
<td>6. C</td>
</tr>
<tr>
<td>7. 0005</td>
</tr>
<tr>
<td>8. 0006</td>
</tr>
</tbody>
</table>
**EXERCISE 1**

**SINGLE CORRECT (OBJECTIVE QUESTIONS)**

**Sol.1** 1 moles of X will give \( \frac{5}{2} = 2.5 \) mol

But yield = \( \frac{1.25 \times 100}{2.5} = 50\% \)

**Sol.2** Molality = \( \frac{X_b}{X_a \times M_a} \times 1000 \)

\( m_b = 75 \) m

\( M = \frac{M \times 1000}{d \times 1000 - M \times M_1} \)

M = 30

**Sol.3** NaOH = \( \frac{125 \times 1 \times 8}{40} \) mole

\( HCl = \frac{125 - 10}{100} = 0.34 \) mole

\( HCl > NaOH \)

Acidic

**Sol.4**

\( H_2SO_4 \)

32

so total molecular mass = 98

\( \frac{1}{3} (A_3(SO_4)_3) \)

114

\( \frac{98}{114} = 0.86 \)

**Sol.5** Let mole of B = x

V.D = 25  mole of A = 100 x

Mol. mass = 50

\( 250 = \frac{80x + 40(100 - x)}{100} \)

\( x = \frac{100}{4} = 25 \)

**Sol.6** Limiting reactant is A

Ideally with 2 moles of A, D formed = 3 moles

But yield = 25%

So, moles of D formed

= \( 3 \times 0.25 = 0.75 \) mol

**Sol.7** \( m = \frac{0.0125}{4} \times 1000 \)

\( Na_2CO_3 \) mole = \( \frac{0.0125}{4} \)

= 0.33 g

\( x_{Na_2CO_3} = \frac{0.0125 \times 250}{4} \)

= \( 2.25 \times 10^{-4} \)

**Sol.8** Both have equal volume = V

\( HCl = \frac{(v \times 10)}{36.5} \times d_{HCl} \) mole

\( NaOH = \frac{(v \times 10)}{40} \times 1.5 \times d_{HCl} \) mole

NaOH mole > HCl mole

Basic Solution

**Sol.9** \( C_xH_y + \left( x - \frac{Y}{4} \right)O_2 \rightarrow xCO_2 + \frac{Y}{2}H_2O \ (g) \)

\( \left( x + \frac{Y}{4} \right) \)

\( \left( x + \frac{Y}{2} \right) \)

\( \frac{600}{700} \)

\( x + 7 = \frac{5y}{4} \)

by option (A)

**Sol.10** B

\( w_{salt} = 1 \) gm

\( w_{Ag} = 0.5934 \) gm

Let wt. % of H = x

Let wt. % of C = 8x

Let wt. % of O = 16x

Since its dibasic acid

\( \therefore 1 \) mole salt = 2 moles Ag
Moles of Ag = $\frac{0.5934}{108}$

... moles of salt /acid = $\frac{0.5934}{108} \times \frac{1}{2}$

Given wt of salt = 1 gm

So, Molecular wt. of salt = $\frac{1}{0.5934} \times 108 \times 2$

= 364 gm/mol

Now $x + 8x + 16x = 364$

$x = 14.5$ gm

wt. of H present = 14.5 gm

Moles of H present = 14.5

wt. of C present = $8 \times 14.5$

Moles of C present = $8 \times 14.5 = 9.7$

wt. of O present = $16 \times 14.5$

Moles of O present = $16 \times 14.5 = 14.5$

Hence H and O are present in same ratio. These for option (B) satisfy this criteria.

**Sol. 11**

$\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}$

Max. Heat obtained when reactants are present in their stoichiometric ratio.

For 1 mole $\text{CH}_4$ required $\text{O}_2$ = 2 moles

Total no. of moles = $n_{\text{O}_2} + n_{\text{H}_2} + n_{\text{CH}_4}$

= 2 + 8 + 1

= 11

Mole fraction $\text{O}_2$ = $\frac{2}{11}$

Mole fraction $\text{N}_2$ = $\frac{8}{11}$

Mole fraction $\text{CH}_4$ = $\frac{1}{11}$

**Sol. 12**

$\text{C}_2\text{H}_5\text{OH} + 7\text{O}_2 \rightarrow 6\text{CO}_2 + 3\text{H}_2\text{O}(l)$

30 ml

$6 \times 30 = 180$ ml of $\text{CO}_2$ is produced

Volume used initially

= 30 + 210 = 240

(for $\text{C}_2\text{H}_5\text{OH}$)

(for $\text{O}_2$)

change in volume = 240 – 180 = 60 ml

**Sol. 13**

$\text{N}_x\text{O}_y + y\text{H}_2 \rightarrow y\text{H}_2\text{O}(l) + x/2\text{N}_2(g)$

$\frac{x}{2} = 10$

$\frac{y}{30} = y$

$x = 2$

$y = 3$

**Sol. 14 A**

$\text{P}_4\text{O}_{10} + 6\text{H}_2\text{O} \rightarrow 4\text{H}_3\text{PO}_4$

284 gm 108 gm 392 gm

108 gm water reacts with $\text{P}_4\text{O}_{10} = 284$ gm

27 gm water will react with $\text{P}_4\text{O}_{10} = \frac{284}{108} \times 27$

= 71 gm

**Sol. 15**

C = 84/12 = 7 mole

$\text{H}_2 = 12$ g = 6 mole

$\text{O}_2 = \frac{56}{22.4} = 5/2$ mole

$12\text{C} + 11\text{H}_2 + 11/2\text{O}_2 \rightarrow \text{C}_12\text{H}_{22}\text{O}_{11}$

L.R. = $\text{O}_2$

11/2 mole $\text{O}_2$ produce 1 mole sucrose

5/2 mole $\text{O}_2$ will for 5/11 mole sucrose

mass of sucrose = $5/11 \times (\text{mol. mass})$

= $5/11 \times 342$

= 155.45 g

**Sol. 16**

118% $\Rightarrow$ 100 g sample uses 18 g water

$\Rightarrow$ 50 g sample need 9 g water

(50 g + 18 g water)

$\Rightarrow$ 59 g $\text{H}_2\text{SO}_4 + 9$ g water

**Sol. 17**

Mole of $\text{N}_2 = \frac{PV}{RT}$

$P = 860 - 24 = 836$ mm Hg

Mole of $\text{N}_2 = \left(\frac{836}{760}\right) \times \left(\frac{100}{0.08 \times 250}\right)$

= $5 \times 10^{-4}$ mole

mass of $\text{N}_2 = 0.014$ g

% of $\text{N} = 0.014 \times 100 = \frac{10}{3}$ %

**Sol. 18 B**

$\text{M}_2(\text{CO}_3)_n + 2\text{HCl} \rightarrow n\text{CO}_2 + 2\text{MCl}_n + \text{H}_2\text{O}$
balancing O atom
3n = 2n + 1
n = 1

**Sol. 19 A**

\[ 46x + 30(100-x) = 34 \times 100 \]
Let % by mole of NO\(_2\) be \(x\).
\[ \frac{\%_1 \times MM_1 + \%_2 \times MM_2}{100} \]
\[ 34 \times \frac{x \times 46 + (100-x) \times 30}{100} \]
\[ x = 25\% \]

**Sol. 20 A**

5A\(_2\) + 2B\(_4\) → 2AB\(_2\) + 4A\(_2\)B
5 \times 20 2 \times 480 2 \times 250 4 \times 140
500 gm 560 gm
Here limiting product is AB\(_2\) = 500 gm

Mol. req. of AB\(_2\) = \frac{1000}{250} = 4
So, A\(_2\) needed = 10 \times 20 = 200 gm
B\(_2\) needed = 480 \times 4 = 1920 gm
Total mass of mixture = 2120 gm

**Sol. 21** C\(_2\)H\(_4\)O\(_2\) + 2O\(_2\) → 2CO\(_2\) + 2H\(_2\)O
n mol \times 2n mol for max. energy
68 gm or 2n \times 33 gram
\[ \Rightarrow 60 n \text{ gram } 64 n \text{ gram} \]
\[ \Rightarrow 60 n + 64 n = 620 \Rightarrow n = 5 \]
produced CO\(_2\) = 2n = 10 mole
CO\(_2\) mass produced = 10 \times 44 = 440 gram

**Sol. 22 B**

2NaCl + Ag\(_2\)SO\(_4\) → 2AgCl + Na\(_2\)SO\(_4\)
Initially
No. of moles of Ag\(_2\)SO\(_4\) = 2 \times 2 = 4
No. of moles of NaCl = 4 \times 1
AgCl formed = 4 moles
No. of moles of Ag\(_2^+\) left = 4 \times 2 - 4 = 4
No. of moles of Cl\(^-\) left = 0
No. of moles of Na\(^+\) = 4
No. of moles of SO\(_4^{2-}\) = 4

Sum of molar conc. = \frac{12}{6} = 2 M

**Sol. 23 A**

100 gm oleum gives H\(_2\)SO\(_4\) = 112 gm
12.5 gm will give \[ \frac{112}{100} \times 12.5 = 14 \text{ gm} \]
No. of moles of H\(_2\)SO\(_4\) = \frac{14}{98}
Conc. of H\(^+\) ions = \frac{14}{2} = 2.85 \times 10\(^{-3}\) M

**Sol. 24** CO\(_2\) = 132 g = \frac{132}{44} \text{ mole } = 3 \text{ mole}
H\(_2\)O = 54 g = \frac{54}{18} \text{ mole } = 3 \text{ mole}
\(\Rightarrow\) C atoms = 3 mole
H atoms = 6 mole
by option C

**Sol. 25** C\(_4\)H\(_{10}\) = 80 ml
CH\(_4\) = xml CO = y ml
x + y = 120 ml
C\(_4\)H\(_{10}\) → 4 CO\(_2\),
80 ml 320 ml,
CO → CO\(_2\)
y ml y ml
CH\(_4\) → CO\(_2\),
x ml x ml
total CO\(_2\) volume
= 320 + x + y ml
= 320 + 120
= 440 ml

**Sol. 26** V\(_1\) ml 0.2 M NaOH, V\(_2\) ml 0.1 M CaCl\(_2\)
(+ve ion) = 0.2 V\(_1\) = 0.1 V\(_2\) mole
(-ve ion) = 0.2 V\(_1\) + 0.1 \times 2V\(_2\)
= 0.2V\(_1\) + 0.2 V\(_2\) mole
by equation
(+ve) = (-ve) - (-ve) \times \frac{40}{100}
= (-ve) \times \frac{60}{100}
\[ 0.2 \, V_1 + 0.1 \, V_2 = 0.2 \, (V_1 + V_2) \times \frac{6}{10} \]
\[ 2V_1 + V_2 = 1.2 \, V_1 + 1.2 \, V_2 \]
\[ 0.8 \, V_1 = 0.2 \, V_2 \Rightarrow 4V_1 = V_2 \]
\[ V_1 = 200 \, ml, \, V_2 = 800 \, ml \]

**Sol.27 C**

\[ \text{NaI mass} = \frac{3 \times 0.5}{100} = 0.015 \, gm \]

\[ \text{No. of moles of NaI} = \frac{0.015}{150} = 1 \times 10^{-4} \]

\[ \text{No. of I}^- \text{ions} = 10^{-4} \times 6.023 \times 10^{23} = 6.023 \times 10^{19} \]

**Sol.28**

Same empirical formula

\[ x + y + z = 200 \]

\[ \frac{x}{y} + \frac{z}{x} = 200 \text{ ml; } \frac{y}{z} + \frac{z}{y} = 200 \text{ ml} \]

**Sol.29 CO**

\[ x + y + z = 200 \text{ ml; } \frac{x}{y} + \frac{z}{x} = 200 \text{ ml} \]

**Sol.30 1.17**

\[ \frac{M_{\text{gas}}}{M_{w}} = \frac{1.17}{29} \]

\[ M_{\text{gas}} = 29 \times 1.17 = 33.9 \]

\[ \text{Sol.31 A} \]

\[ \frac{\text{Fe}_2\text{O}_3}{3} \times 56 = \frac{7 \times 3}{2} \]

\[ \frac{\text{FeO}}{16} = \frac{7}{2} \]

\[ \text{Fe}_2\text{O}_3 : \text{FeO} = \frac{7 \times 3}{2} = 3 : 2 \]

**Sol.32 C**

\[ A : B : C = 1 : 3 : 5 \]

\[ b \Rightarrow x : y = 32 : 84 \text{ by mass} \]

\[ = 1 : 3 \text{ by mole} \]

\[ c \Rightarrow x : y = 16 : 5 = 16 : 70 \]

**Sol.33 C**

Water initial = 96 kg

Water final = \[ \frac{75}{100} (100 - x) \]

\[ 96 - x = 75 - \frac{3x}{4} \]

\[ x = 84 \, kg \]

**Sol.34 D**

ZnS + H\text{}_2\text{SO}_4 \rightarrow \text{ZnSO}_4

\[ H_2S = 10.8 + 50 \times 1.153 \]

\[ = 65.1 \]

\[ = 3.35 \, g \]

Vol of H\text{}_2\text{S} = 2.4 \, l \]

**Sol.35 B**

0.8v + (54.2 - v) \times 1 = 49.6

\[ V = 4.6 \]

\[ V = \frac{23 \times 0.8}{49.6} \times 100 = 37.1\% \]

**Sol.36 D**

15.8 - 10.5 = 0.789 \times V

\[ 8 = \frac{105.8}{V} \times 5.3 \times 0.789 \]

\[ = 2.352 \, g/cm^3 \]

**Sol.37 A**

Amount of butter = \[ \frac{2 \times 10^{-3}}{5.5 \times 10^{-6}} \]

\[ = 3.636 \, gm \]

**Sol.38 B**

Let initial = xg

\[ \frac{0.15x - 5}{x - 5} = \frac{8}{100} \Rightarrow x = \frac{460}{7} \, g \]

\[ 0.4x \]

\[ \frac{x - 5}{x - 5} \times 100 = 43.29\% \]
Sol.39 C

\[
P = \frac{M}{V_f - V_i} = 8.533
\]

Sol.40 C

(A) \( n = \frac{10 \times 1}{18} = 0.55 \)

(B) \( n = 0.1 \times 5 = 0.5 \)

(C) \( n = \frac{12}{48} \times 3 = 0.75 \)

(D) \( n = \frac{N}{NA} = 0.2 \times 2 = 0.4 \)

Sol.41 D

No. of atoms = \( \frac{10^{23}}{3.9854} = 2.509 \times 10^{22} \)

Sol.42 C

(A) \( n = \frac{12}{12} = 1 \)

(B) \( n = \frac{8}{16} = 0.5 \)

(C) \( n = \frac{32}{32} = 1 \)

(D) \( n = \frac{24}{24} = 1 \)

Sol.43 B

\[
\text{moles} = \frac{0.15}{6} \]

molar mass = \( \frac{600}{75} = 40 \)

Sol.44 B

Sol.45 B

\[
N = 6.023 \times 10^{23} \times \frac{2}{100} = 1.20 \times 10^{22}
\]

Sol.46 C

\[
\frac{\Delta x}{x} = \frac{\Delta y}{y}
\]

Sol.47

\[
M_{\text{avg}} = \frac{8.082 \times 12 \times 0.234 + 7.833 \times 12 \times 0.766}{1}
\]

Sol.48 S_{10} = 0.9221 \times 27.97693 + 0.047 \times
28.47647 + 0.0309 \times 29.97379 = 25.7975 +
1.361845 + 0.92619 = 28.0856

Sol.49 C

\[
0.79 \times 24 + x + 26 + (21 - x) \times 25 = 24.31
\]

\[
x = 0.1
\]

\[
\therefore \% \text{ Mg}^{2+} = 10\%
\]

Sol.50 B

\[
\text{M}_2\text{O}_3 : 0.30 \times (2M + 48) = 48
\]

\[
0.6M = 0.7 \times 48
\]

\[
M = 7 \times 8 = 56
\]
**EXERCISE - II**

### MULTIPLE CORRECT (OBJECTIVE QUESTIONS)

**Sol.1** Molar mass = \( N_A \times 3.257 \times 10^{-22} \) gm

**Sol.2** Volume of virus
\[
= \pi (75 \times 10^{-10})^2 (5 \times 10^{-7}) m^3
\]
Mass (in gm) = \( \frac{\text{Volume of virus}}{0.75 \times 10^{-6}} \) mole wt. = mass \( \times N_A \)

**Sol.3** 160 amu \( \Rightarrow \frac{160}{80} = 2 \) molecule \( \rightarrow 4N \) atom

\[
\text{490000 g} = \frac{490000}{98} = 5000 \text{ mole} \rightarrow 5000 \text{ mole of } S
\]
32 amu of \( S \rightarrow 1 \) atom of \( S \)
\[
\Rightarrow \frac{1}{3} \text{ mole of } Al_2(SO_4)_3
\]
\( N_A \) molecules = 342 g
\[
\frac{1}{3} \text{ molecules} = \frac{342}{N_A} \times \frac{1}{3}
\]

**Sol.4** \( C_{12}H_4ClO_7 \rightarrow \) molecular wt. = 322 mole = \( 8.78 \times 10^{-6} \)
\[
\text{weight} = 8.78 \times 10^{-6} \times 322
\]
\[
\% = \frac{8.78 \times 10^{-6} \times 322 \times 100}{28.3} = 10^{-4}
\]

**Sol.5** \( C_{12}H_nCl_{10-m} \)
\[
\text{% by wt. Cl} = \frac{35.5 (10-m) \times 100}{12 \times 12 + 1 \times m + 35.5 (10 - m)} \]
\( m = 4 \)

**Sol.6** (a) E. F. = CH₂
M. wt = 84
E. F. M. = 12 + 2 = 14
\[
n = \frac{84}{14} = 6
\]
M. F. = 6(CH₂) \( C_6H_{12} \)
(b) E. F. = CH₂O
M. wt = 150
E. F. M. = 12 + 2 + 16 = 30
\[
n = \frac{150}{30} = 5
\]

**Sol.7** CO₂ = C
\[
44 \text{ gm} \quad 12 \text{ gm}
\]
\[
0.9428 \text{ gm} \quad ?
\]
\[
\frac{0.9428}{44} \times 12 = 0.2586 \text{ gm}
\]
\[
\% \text{ by mass so C} = \frac{0.2586 \times 100}{0.2801} = 92.32\%
\]
\( H_2O = 2H \)
18 - 2
0.1939 - ?
\[
= 0.0219 \text{ gm}
\]
\% mass of H = 7.68%

<table>
<thead>
<tr>
<th>Element</th>
<th>% by wt.</th>
<th>Mole</th>
<th>S. R.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>92.32</td>
<td>12/32/2 = 7.68</td>
<td>1</td>
</tr>
<tr>
<td>H</td>
<td>7.68</td>
<td>7.68/1 = 7.68</td>
<td>1</td>
</tr>
</tbody>
</table>

E. F. = CH

**Sol.8** N = 1.4 gm
C = 3.6 gm
H = 0.5 gm
M. M = 55
\[
\% \text{ by mass of N} = \frac{1.4}{5.5} \times 100 = 25.45\%
\]
\[
\% \text{ mass of C} = \frac{3.6}{5.5} \times 100 = 65.45\%
\]
\[
\% \text{ mass of H} = \frac{0.5}{5.5} \times 100 = 9.09\%
\]
<table>
<thead>
<tr>
<th>Element</th>
<th>% by wt.</th>
<th>Mole</th>
<th>S. R.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>5.45</td>
<td>5.4</td>
<td>3</td>
</tr>
<tr>
<td>N</td>
<td>25.35</td>
<td>1.8</td>
<td>1</td>
</tr>
<tr>
<td>H</td>
<td>9.09</td>
<td>9.09</td>
<td>5</td>
</tr>
</tbody>
</table>

E. F. = C₃H₅N₁
n = \frac{55}{55} = 1
M. F. = C₃H₅N₁

**Sol.9**  
\( x + y = 1 \) .......(1)  
\( \text{Al} + 3\text{HCl} \rightarrow \text{AlCl}_3 + 3/2 \text{H}_2 \)
\( x/27 \)
\( \text{Mg} + 2\text{HCl} \rightarrow \text{MgCl}_2 + \text{H}_2 \)
\( y/24 \)

**Total H₂ produced**
\( n = \frac{1.12}{22.4} \)
\( y/27 \)
\( \frac{x}{18} \text{ mol H₂} \)
\( \frac{y}{24} \text{ mol H₂} \)

**Total no. of H₂ =** \( \frac{x}{18} + \frac{y}{24} = \frac{1}{20} \)

\( y = 0.4 \text{ gm} \)
\( x = 60 \% \) \( y = 60 \% \)

**Sol.10**  
\( x + y = w \)
\( \frac{x}{100} \times 56 - \frac{y}{24} \times 40 = \frac{w}{2} \)

\( \text{CaCO}_3 \xrightarrow{\Delta} \text{CaO} + \text{CO}_2 \)

\( \text{MgCO}_3 \xrightarrow{\Delta} \text{MgO} + \text{CO}_2 \)

\( 14x + 10y \)
\( 25 \)
\( 588x + 500y = 525w \)
\( -588x + 588y = -588w \)

\(-88y = -63w \)
\( y = \frac{63}{88}w \)
\( x + 0.715w = w \)
\( x = w - 0.715w \)
\( x = 0.284w \)
\( y = 0.715w \)

\% wt of \text{CaCO}_3 = \frac{0.284}{100} \times 100 = 28.4 \% \)

\% wt of \text{MgCO}_3 = \frac{0.715w}{w} \times 100 = 71.5 \% \)

**Sol.11** \( \text{Na}_2\text{CO}_3 = xg \)  
\( \text{NaHCO}_3 = 2 - xg \)

\( \text{Na}_2\text{CO}_3 \) shows not heating effect only \( \text{NaHCO}_3 \)  will decompose on heating

\( 2\text{NaHCO}_3(s) \rightarrow \text{Na}_2\text{CO}_3(s) + \text{H}_2\text{O}(g) + \text{CO}_2(g) \)

wt. in loss is due to \( \text{H}_2\text{O} \) & \( \text{CO}_2 \)

**Sol.12** \( \text{CaCl}_2 \) - \( x \) gm

\( \text{NaCl} - y \) gm \( x + y = 10 \)

\( \text{CaCl}_2 + \text{Na}_2\text{CO}_3 \rightarrow \text{CaCO}_3 + 2\text{Na} \)

\( \text{CaCO}_3 \xrightarrow{\Delta} \text{CaO} + \text{CO}_2 \)

let \( a \) be wt of \( \text{CaCO}_3 \)

\( \frac{a}{100} = 112 \)

\( a = 2 \) gm

\( \frac{x}{111} \times 100 = 2 \) gm

\( x = 2.22 \) gm

\( y = 7.78 \)

\( \% \text{ by wt. of } \text{NaCl} = \frac{7.78}{10} \times 100 \)

\( = 77.8 \% \)

**Sol.13**

<table>
<thead>
<tr>
<th>Reactant</th>
<th>Required</th>
<th>Available</th>
</tr>
</thead>
<tbody>
<tr>
<td>TiO₂</td>
<td>340 gm</td>
<td>4.32 gm</td>
</tr>
<tr>
<td>TiCl₃</td>
<td>48 gm</td>
<td>5.78 gm</td>
</tr>
<tr>
<td>TiCl₄</td>
<td>426 gm</td>
<td>6.82 gm</td>
</tr>
</tbody>
</table>

On comparing we clearly found out that \( \text{Cl}_2 \) is the limiting reagent.

So, 426 gm of \( \text{Cl}_2 \) gives 570 gm of \( \text{TiCl}_4 \)

\( \Rightarrow 6.82 \times 570 = 9.12 \) gm of \( \text{TiCl}_4 \)

**Sol.14** No volume change

\( \Rightarrow a + b = x + d \)
(1) Total mole remain same  
(2) \( \Rightarrow M_{\text{gas}} \) remain same  
(3) \( \Rightarrow V.D. \) remain same  
(A) & (C)  

**Sol.15** Check each and every of option carefully  

**Sol.16** Let volume of solution = 1000 ml  
\[ [\text{Ba}^2+] = 5 \text{ M}; [\text{Cl}^-] = 10 \text{ M} \]  
\[ [\text{Na}^+] = 10 \text{ M} \]  

1000 ml solution = 1949 g solution  
solute \( \Rightarrow \text{BaCl}_2, \text{NaCl} \) & \( \text{Na}_2\text{X} \)  
\[ \text{BaCl}_2 = 5 \text{ mole} = 1040 \text{ g} \]  
\[ \text{NaCl} = 588 \text{ g} ; \text{Na}_2\text{X} = \text{mole of Na}_2\text{X} \times 142 \]  
Solvent = 1949 - (1040 + 588 + 142n\(_{\text{Na}_2\text{X}}\))  
\[ = 321 - 142n_{\text{Na}_2\text{X}} \]  

\[ m_{\text{Na}_2\text{X}} = \frac{n_{\text{Na}_2\text{X}}}{321 - 142n_{\text{Na}_2\text{X}}} \times 1000 = 2 \]  
\[ n_{\text{Na}_2\text{X}} = 0.5 \]  

**Sol.17** Check of all the option  

**Sol.18** First of all balance reaction and then check the option  

**Sol.19** Check all the option one by one  

**Sol.20** BaSO\(_4\) is insoluble in water  
\( \Rightarrow \) molarity of BaSO\(_4\) can’t be calculated.  
\[ [\text{Na}^+] = \frac{(2v \times 1) \times 2}{2v + v} = \frac{4}{3} \]  
\[ [\text{NO}_3^-] = \frac{(2v \times v) \times 2}{2v + v} = \frac{4}{3} \]  

**Sol.21** A-R, B-P, C-Q  
mole wt. (89 \times 3) + (27 \times 5) + (16 \times 12) = 594  
\[ y = \frac{89 \times 3}{594} \times 100 = \frac{267}{594} \times 100 = 44.95 \% \]  
\[ Al = \frac{27 \times 5}{594} \times 100 = 22.73 \% \]  
\[ O = \frac{16 \times 12}{594} \times 100 = 32.32 \% \]  

**C\(_6\)H\(_8\)O\(_6\) = 72 + 8 + 96 = 176 mol. wt.**  
\[ \text{mole of C}_6\text{H}_8\text{O}_6 = \frac{17.6 \times 10^{-4}}{176} = 10^{-4} \text{ mole} \]  
\[ (A) \ O \longrightarrow 10^{-4} \times N \quad x \text{6 atoms} \]  
176 g vitamin C \( \longrightarrow \) 1 mole  
\[ (B) 1 \text{ g vitamin C} = \frac{1}{176} \text{ mole} \]  

**Sol.23**  
148 - 50 = 98 gm of liquid  
d = 0.98 gm/ml  
Volume of glass = \( \frac{98}{0.98} = 100 \text{ ml} \)  
\[ PV = nRT \]  
\[ \Rightarrow \frac{760}{1} = \frac{0.5}{160} \times \frac{0.0821 \times 300}{M} \]  
\[ M = 123 \text{ g/mol} \]  

**Sol.24** Volume occupied by steam = 1000 ml  
Mass of water molecules in steam = 1000 \times 0.006  
\[ = 0.6 \text{ gm} \]  
Volume occupied by water molecules = \( \frac{0.6}{1} \)  
\[ = 0.6 \text{ cm}^3 \]  

**Sol.25** 1  
**Sol.26** moles = 0.5 \times 0.5  
\[ = 0.25 \]  
mass = 100 \times 0.25  
\[ = 25 \text{ g} \]  

**Sol.27** Fe\(_2\)O\(_3\) + 3CO \( \longrightarrow \) 2FeO + \( \frac{3}{2} \) CO\(_2\)  
\[ C + \frac{1}{2} \text{O}_2 \longrightarrow \text{CO} \]  
mass of O = 15 \times 32 = 480 g  
\[ \frac{1.5}{M} \times 2 = \frac{4}{64} \times 2 \]  
M = 24g  

**Sol.28**  
\[ \text{mass of C}_8\text{H}_18 = 0.8 \times 1000 \times 1.425 \]  
\[ = 1140 \]  
\[ \text{mass of C}_8\text{H}_18 = \frac{1140}{114} = 10 \]  
mass of O\(_2\) = 10 \times \frac{25}{2} \times 32 = 4 \text{ kg}  
\[ = 125 \text{ moles} \]  

**Sol.30**  
\[ 2 \text{H}_2 + \text{O}_2 \longrightarrow 2\text{H}_2\text{O} \]  
\[ \begin{array}{ccc} 100 & 100 & 100 \\ 2 & 32 & 16 \\ \text{H}_2\text{O} & = 6.25 \text{ mol} \\ & = 113 \text{ gm} \end{array} \]
EXERCISE – III

SUBJECTIVE QUESTIONS

Sol. 1 From reaction (1) & (2)
\[ A_2B_4 + \frac{1}{2} A_2 \rightarrow A_2B_4 \] ....(3)
solve question by reaction (1) and (3)

Sol. 2 \[ Al_2(SO_4)_3 + 3Ca(NO_3)_2 \rightarrow 2Al(NO_3)_3 + \]
\[ \frac{138}{3CaSO_4} \]
213 x 2 = 426 / 136 x 3 = 408
Here limiting product is CaSO_4.
1 mole Al_2(SO_4)_3 produces CaSO_4 = 408
For 1 gm CaSO_4 will need. Al_2(SO_4)_3 moles
\[ \frac{1}{408} \]
\[ M_1V_1 = \frac{1}{408} \]
0.1 x V_1 = \frac{1}{408}
V_1 = 0.02451 L = 24.5 ml

Sol. 3 H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O
\[ x/98 \]
SO_4 + 2NaOH \rightarrow Na_2SO_4 + H_2O
1/86
SO_4 + 2NaOH \rightarrow Na_2SO_3 + H_2O

According to problem
Total mass balance \( x + y + 2 = 1 \)
Balancing NaOH \( \frac{23.47}{1000} \times 1 = \frac{2}{98} \times y + \frac{2}{64} \)

Given z = 0.015
solving we get
\( x = 35.36 \%) y = 63.13 \% \)
\( z = 1.5 \% \)
Free SO_3 = 63.13 \%
Combined SO_3 is SO_3 present in H_2SO_4
\[ \left( \frac{0.3536}{98} \times 80 \right) \times 100 = 28.89 \% \]

Sol. 4 Let V / volume of AgNO_3 solution added
100 gm solution has 5 g AgNO_3
\[ \frac{100}{1.04} \text{ ml solution has 5 g AgNO_3} \]

V x 1000 ml solution will be having
\[ \frac{5}{100} \times 1.04 \times V \times 1000 \text{ g AgNO}_3 \]

= \frac{5 \times 10.4}{170} \text{ V mole AgNO}_3
= 0.305 V mole AgNO_3
for precipitation
Mole of AgNO_3 = Mole of Cl^- ion
\[ \frac{x \text{ g NaCl}}{58.5} \text{ mole Cl}^- \]
\[ \frac{y \text{ g KCl}}{74.5} \text{ mole Cl}^- \]
\[ \frac{z \text{ g NH}_4\text{Cl}}{53.5} \text{ mole Cl}^- \]
\( \Rightarrow \text{flr max. mole of Cl}^- \rightarrow \text{ less mol. wt. of species} \)
\[ \text{pure NH}_4\text{Cl} \Rightarrow z = 0.3 \]
\[ \Rightarrow 0.305 V = 0.3 / 53.5 \Rightarrow V = 0.01838 L \]
= 18.38 ml.

Sol. 5 1000 ml of Solution weights = 1035 gm
100 ml is fat in this solution which weights = 0.875 x 100 = 87.5 gm
Density of fat free skimmed milk
\[ \frac{1035 - 87.5}{900} = 1.0527 \text{ gm/ml} \]

Sol. 6 3A (g) \rightarrow C(g) + D (g)
t = 0 1
\[ t = 30 \ 1 - 3x \times x \]
mol. wt. of A = 2 x V.D = 2 x 60 = 120
Total mole of mixture
\[ = 1 - 3x + x + x = 1 - x \]
V.D. = 75 & M. w. of C = 200
\[ \Rightarrow \text{M.wt.} 75 \times 2 = 150 \]
\[ \Rightarrow 150 \]
\[ = (1 - 3x) \times 120 + x \times 200 + x \times M.w.D \]
\[ \Rightarrow 150 (1 - x) = 120 - 360 x \]
\[ + 200 x + M.w.D x \]
\[ \Rightarrow 30 = -10x + M.w.D x = x(M.w.D - 10) \ldots(1) \]

Mass conservation
Initially 1 mole A = 120 g
120 = (1 - 3x) 120 + x + M.w.D x
120 = 120 - 360 x + 200 x + M.w.D x
\[ \Rightarrow x(-360 + 200 + M.w.D) = 0 \]
\[ \Rightarrow M.w.D = 160 \]

\[ \Rightarrow \text{fro eq. (1)} \]
\[ 30 = x(160 - 10) \Rightarrow x = 1 / 5 \]
At 30 minutes

\[ n_A = 1 - 3x = \frac{2}{5}, \quad n_C = \frac{1}{5} \quad \& \quad n_O = \frac{1}{5} \]

**Sol.7** Let initial composition of

- \( H_2 = a \) ml
- \( N_2 = b \) ml
- \( O_2 = c \) ml

**Initial composition**

Now, \( a + b + c = 100 \) ...............(1)

\[
\begin{align*}
H_2 + O_2 &\rightarrow H_2O_2 \\
x &\times \ \\
N_2 + H_2 &\rightarrow N_2H_2 \\
y &\times \ \\
y &\times
\end{align*}
\]

Since \( O_2 \) was absorbed by pyragallal this
means \( O_2 \) was in excess hence \( H_2 \) was LR.

Also, in second reaction more \( H_2 \) was added to
carry forward reaction this means, \( N_2 \) was in excess and \( H_2 \) is LR.

From both reactions

\[ x + y = a \] ...............(2)

Also, given in 1st step volume contraction is 60.

\[
\begin{align*}
2x + 2y - (y) = 60 \\
2x + y = 60 \quad \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldOTS
Sol.10  \[ C + 2Cl_2 \rightarrow CCl_4 \]
Req. wt. 12 142 154
Given wt 36 142 154 (calculated)
Left 24 0 -
Thus wt. left of C is 24 gm and CCl_4 produced is 154 gm.

Sol.11 \[ P_2S_3 + 8 O_2 \rightarrow P_4O_{10} + 3SO_2 \]
\[ \frac{1}{284} \approx \frac{1}{64} \]
Every mole of \( P_2S_3 \) (220 gm) produces 284 gm \( P_4O_{10} \) and 192 gm \( SO_2 \).

Sol.12 Let no. of moles of CO formed are \( a \) moles and no. of moles of \( CO_2 \) formed be \( b \) moles.
we will balance moles of C and O separately to form 2 equations and 2 variable
Hence,
\[ a + b = 1 \text{ (no. of moles of C = 1)} \]
\[ a + 2b = \frac{20}{32} \times 2 \text{ (no. of atoms)} \]
solving we get
\[ a = 75\% , \ b = 25\% \]
Now this is the ratio of no. of moles of CO and \( CO_2 \) formed.
To find out ratio we will multiply with their molecular masses.
So,
Ratio of mass of CO : \( CO_2 \) = \[ \frac{75 \times 28}{25 \times 44} = \frac{21}{11} \]

Sol.13 \[ 2ZnS + 3O_2 \rightarrow 2ZnO + 2SO_2 \]
\[ \begin{array}{l}
ZnO + H_2SO_4 \quad \text{100\%} \\
2ZnSO_4 + 2H_2O \quad \text{80\%}
\end{array} \]
Mole of \( ZnS \) = \[ \frac{291 \times 10^3}{97.4} = 2987.7 \text{ mole} \]
Mole of \( Zn \) produced = \[ 2987.7 \times \frac{75}{100} \times \frac{80}{100} \]
mass of \( Zn \) produced = \[ 1792.6 \times 65.4 \text{ g} \]
\( O_2 \) produce = \[ \frac{1792.62}{2} \text{ mole} \]

Sol.14 (a) \[ M = \frac{4/40}{290} \times 1000 = 0.5 \text{ M} \]
(b) \[ M = \frac{5.3/106}{100} \times 1000 = 0.5 \text{ M} \]

(c) \[ M = \frac{0.365/36.5}{50} \times 1000 = 0.2 \text{ M} \]

Sol.15 \[ d = 1.09 \text{ gm/ml} \]
13\% by mass \( H_2SO_4 \)
\[ M = \frac{\text{NH}_2\text{SO}_4 \times 1000}{V(\text{ml})} \]
\[ = \frac{13/98}{100/1.09} \times 1000 \]
\[ = 1.446 \text{ M} \]

Sol.16 \[ M = \frac{40/36.5}{100/1.20} \times 1000 = 13.15 \text{ M} \]

Sol.17 Mass of 100 ml solution
\[ = 100 \times 0.9 = 90 \text{ gm} \]
Mass of solvent = 90 - 15 = 75 gm
\% by mass \( CH_3OH = \frac{15}{90} \times 100 = 16.67\% \)

Sol.18 1.9 gm of \( Li^+ \) ions is present in \( 10^6 \) gm water.
Molality (m) = \[ \frac{1.9 \times 10^3}{7} \]
\[ = 2.7 \times 10^{-4} \]

Sol.19 d = \[ \frac{\text{Mass of solution}}{\text{Volume of solution}} \]
1 L of solution contains KOH = 386.4 gm
1000 gm solution contains KOH = 300 gm
Mass of solvent = 1000 - 300 = 700 gm
when 300 gm of solute is present solvent = 700 gm
So 386.4 gm of solute is present in
\[ \frac{386.4 \times 700}{300} = 910.6 \]
d = \[ \frac{\text{Mass of solute} + \text{mass of solvent}}{\text{volume of solution}} \]
\[ d = \frac{386.4 \times 910.6}{1000} = 1.288 \text{ gm/ml} \]

Sol.20 Let 100 g solution = \[ \frac{100}{1.6} \text{ ml} \]
**Sol.21** No. of moles of $\text{H}_2\text{SO}_4$ in $12.5\ \text{L}$ of $2.5\ \text{M}$ $\text{H}_2\text{SO}_4$ solution

$12.5 \times 2.5 = 31.25$ moles

1 mole or $98\ \text{gm}$ $\text{H}_2\text{SO}_4$ is present in solution = $100\ \text{gm}$

$100\ \text{gm}$ solution = $\frac{1000}{1.8} = 55.56\ \text{ml}$

For $31.25$ mole solution required = $55.56 \times \frac{1}{1.25} = 1.7362$

**Sol.22** $100\ \text{ml}$ of solution contains $\text{HNO}_3 = 19\ \text{gm}$

wt. of $\text{HNO}_3$ in $50\ \text{ml}$ solution = $\frac{69.8}{2}\ \text{gm}$

Total volume of solution to be $19\%$ w/v containing

$\frac{69.8}{2} \times 100 = 183.68\ \text{ml}$

**Sol.23** $\text{Ca}^{2+} = 2\text{M}$

$\text{NO}_3^- = 4\ \text{M}$

$m = \frac{1000 \times 2}{1326 - 2 \times 164} = 2$

$x_{\text{solute}} = \frac{m \times \text{mol wt. solvent}}{1000 + m \times \text{mol wt. solvent}}$

**Sol.24**

$m = \frac{1000 \times 2}{3107 - 53.5 \times 2}$

$m = \frac{2000}{3000} = \frac{2}{3}$

$m_{\text{Cl}} = \frac{2}{3}$

$\text{NH}_4^+ = \frac{2}{3} \times m$

**Sol.25**

$M_1V_1 + M_2V_2 = M_3(V_1 + V_2) $ (in ideal case)

$2 \times 500 + 2 \times 200 = M_3 \left(500 + 200 \right)$

$M_3 = 2$

Volume of solution = $700\ \text{ml}$

**Sol.26**

$PV = nRT$

Pressure of $N_2 = 774.5 - 14.5 = 770.5\ \text{mm Hg}$

$\frac{770.5 \times 82.1}{760 \times 1000} = n \times 0.084 \times 300$

$n = 0.00338\ \text{mol}$

$\% \text{ of } N = \frac{n \times 28}{0.14} \times 100 = 67.6\%$

**Sol.27**

$35\%$ organic compound + $\text{H}_2\text{SO}_4 \rightarrow (\text{NH}_4)_2\text{SO}_4$

$2(\text{NH}_3)$

$\rightarrow 2\ \text{mol} \text{NaOH neutralizes by one mol} \ \text{H}_2\text{SO}_4$

$\text{no. of moles of }$ $\text{H}_2\text{SO}_4 = \frac{2 \times \text{acid} \times \text{base}}{\text{acid} - \text{base}}$

$= 0.0025\ \text{mol}$

$0.0025 \times 28 \times 100$

$= 35\%$

**Sol.28**

$	ext{CH}_3\text{Cl}$

**Sol.29**

$C = \frac{0.033}{0.0047} = 7$

$H = \frac{0.047}{0.0047} = 10$

$\text{Cl} = \frac{0.004}{0.0047} = 1$

$N = \frac{0.0047}{0.0047} = 1$
**Sol.30**

\[ M_{\text{sat}} = 595.42 \text{ gm/mol.} \]

\[ M_{\text{sat}} = 2\text{MB} + M_{\text{P}2\text{Cl}_{6}} \]

\[ 595.42 = 2 \text{ MB} + 410 \]

\[ M_{\text{P}} = 92.7 \text{ gm/mol.} \]

**Sol.31**

(RCOO)_2Ba salt

molecular wt. of salt = 2x + 137

x \to for RCOO^- graph

(RCOO)_2Ba. 2H_2O + H_2SO_4

\[ \rightarrow 2\text{RCOOH} + \text{BaSO}_4 \]

\[ (\text{RCOO})_2\text{Ba. 2H}_2\text{O} = \left( \frac{2.562}{137 + 2x + 36} \right) \text{ mole} \]

\[ H_2\text{SO}_4 = \left( \frac{30}{1000} \times 0.2 \right) \text{ mole} \]

\[ \frac{30 \times 0.2}{1000} = \frac{2.562}{173 + 2x} \Rightarrow x = 127 \]

Molecular wt. of acid (RCOOH) = x + 1

= 128

**Sol.32**

(a) 100 g sample + 9 g H_2O

\[ \Rightarrow 109 \text{ g H}_2\text{SO}_4 \]

(b) 109 g H_2SO_4 + 9 g water

(c) 109 g H_2SO_4 + 111 g water

**Sol.33**

\[ M = \frac{44.8}{11.2} = 4 \]

\[ m = \frac{1000 \times x}{1136 - 4 \times 34} \]

\[ = \frac{4000}{1000} \times x \]

\[ m = \frac{x}{18 \times 1000} \]

\[ x = \frac{72}{1072} \]

**Sol.34**

(i) 20 gm H_2SO_4

(ii) 35.4 gm H_2SO_4

(iii) H_2SO_4 = 35.4 gm, H_2O = 35.4 gm

**Sol.35**

\[ \text{CO} + \frac{1}{2} \text{O}_2 \rightarrow \text{CO}_2 \]

x x/2 x

CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O (r)

y 2y y x

N_2 \rightarrow N_2

z z

x + y + z = 10 \hspace{1cm} (1)

Volume contraction = volume consumed - volume product

6.5 = (x + x/2) + (y + 2y) - (x + y)

6.5 = x/2 + 2y

13 = x + 4y \hspace{1cm} (2)

Also volume contraction after passing through with KOH will be due to CO_2

\[ x + y = 7 \hspace{1cm} (3) \]

Solving we get

\[ x = 5 \text{ ml} \quad y = 2 \text{ ml} \quad z = 3 \text{ ml} \]

**Sol.36**

\[ 20 \text{ ml} \rightarrow 30 \text{ ml} \]

Let volume of O_2 present be x and O_2 be y ml

Turpentine absorb O_2

\[ \Rightarrow \text{Volume of O}_2 \text{ present = 20 ml} \]

volume of O_2 present = 80 ml

20 ml of O_2 produces O_2 = 30 ml

volume increase = volume formed - volume condens

= 30 - 20 = 10 ml

**Sol.37**

\[ \text{N}_2\text{O} + \text{H}_2 \rightarrow \text{N}_2 + \text{H}_2\text{O} \]

x x x

\[ \text{NO} + \text{H}_2 \rightarrow 1/2\text{N}_2 + \text{H}_2\text{O} \]

y y y/2 x

x + y = 60

x + y/2 = 38

Solving we get

x = 16 ml, y = 44 ml

**Sol.38**

\[ 2 \text{O}_2 \rightarrow 2\text{O}_3 \]

ax = 2a

Volume concentration is 4

x - 2a \hspace{1cm} (1)

Turpentine absorbs O_2

2a = 8 \hspace{1cm} (2)

Putting (1) we get

x = 3 Hence O_3 = O_2

**Sol.39**

\[ \text{N}_x\text{H}_y \rightarrow x/2\text{N}_2 + y/2\text{H}_2 \]

10 ml 5x ml 5y ml

Given after 1st step final volume = 20 ml

5x + 5y = 20

x + y = 4 \hspace{1cm} (1)

Also given V. D. = 8.5

Molecular wt. = 8.5 \times 2 = 17

14 x + y = 17 \hspace{1cm} (2)

Solving we get

x = 1, y = 3 Hence formal is NH_3

**Sol.40**

\[ \text{C}_{12}\text{H}_{2n}\text{Cl}_{10-m} \]

% by wt. Cl = \[ \frac{35.5(10 - m) \times 100}{12 \times 12 + 1 \times m + 35.5(10 - m)} \]

m = 4
Sol.1 A
\[ \text{wt} = \frac{2.01 \times 10^{23}}{6.02 \times 10^{23}} \times 28 \]
\[ = \frac{28}{3} = 9.3 \text{ gm} \]

Sol.2 A
C : H : N = 9 : 1 : 3.5
\[ \therefore \text{mole ratio} = \frac{9}{12} : \frac{1}{1} : \frac{3.5}{14} \]
\[ = 3 : 4 : 1 \]
\((C_3H_4N)x \Rightarrow x = 2 \Rightarrow C_6H_8N_2\)

Sol.3 C
Fe = 10 mole
(A) N = 5 mole
(B) H = 20 mole
\(\therefore (C) \text{ Both}\)

Sol.4 B
\[ [\text{urea}] = \frac{6.02 \times 10^{20}}{6.02 \times 10^{23}} = 10^{-3} \text{ mol} \]
\[ \therefore [\text{urea}] = \frac{10^{-3}}{0.1} = 0.01 \text{ M} \]

Sol.5 A
\[ n = \frac{0.25}{8} = 0.03125 \text{ mol} \]
\[ = 3.125 \times 10^{-2} \]

Sol.6 B
No relation between (aq) & (g)
\[ H_2 = 33.6 l = 1.5 \text{ mole} \]
\[ Ar = 1 \text{ mole} \]
\[ Ar : H_2 = 2 : 3 \]
**EXERCISE – II**

**Sol.1**

D

wt. of 1 e\(^-\) = 9.108 \times 10\(^{-31}\) kg

1 kg will contain e\(^-\)s = \frac{1}{9.108 \times 10\(^{-31}\)}

No. of moles of e\(^-\)s = \frac{1}{9.108 \times 10\(^{-31}\) \times 6.023 \times 10\(^{23}\)}

= \frac{1}{9.108 \times 6.023} \times 10^8

Sol.2

M = \frac{18}{1000} = 55.56 M

Sol.3

Moles of CH\(_3\)COOH absorbed = (0.5 – 0.49)\times 0.1 = 0.001 moles

Surface area of 1 gm charcoal = 3.10 \times 10^2 m\(^2\)

Surface area of charcoal absorbed by each molecule of CH\(_3\)COOH

= \frac{3.01 \times 10^2}{0.001 \times 6.023 \times 10^{23}}

Sol.4

6 CaO + P\(_4\)O\(_{10}\) → 2Ca\(_3\) (PO\(_4\))\(_3\)

56 284

284 gm P\(_4\)O\(_{10}\) requires CaO = 336 gm

852 gm P\(_4\)O\(_{10}\) will require

= \frac{336}{284} \times 852

= 1008 gms

Sol.5

No. of moles of N\(_2\)

⇒ 0.001 \times \frac{2.46}{1000} = n \times 0.821 \times 298

⇒ nN\(_2\) = 10\(^{-7}\) moles

Total no. of sites occupied by N\(_2\) molecules

= 6.023 \times 10^{14} \times 1000 \times \frac{20}{100}

No. of sites/molecules of N\(_2\)

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\[
\left( \frac{10^{-7} \times N_A}{\text{Total No. of sites occupied by N}_2 \text{ molecule}} \right) = 2
\]

Sol.6

Mole of urea = \frac{120}{60} = 2

total mass of solution = 1000 + 120 = 1120 g

Volume = \frac{1120}{973.9} ml = 973.9 ml

Molarity = \frac{2}{973.9} \times 1000

= 2.05 M

Sol.7

3Br\(_2\) + 3 Na\(_2\)CO\(_3\) → 5NaBr + NaBrO\(_3\) + 3CO\(_2\)