EXERCISE (O-I)

INTRODUCTION OF CONCENTRATION TERMS

1. 8 g NaOH is dissolved in one litre of solution, its molarity is :

(A) 0.8 M (B) 0.4 M (C) 0.2 M (D) 0.1 M

2. H_2O_2 solution used for hair bleaching is sold as a solution of approximately 5.0 g H_2O_2 per 100 mL of the solution. The molecular mass of H_2O_2 is 34. The molarity of this solution is approximately:-

(A) 0.15 M (B) 1.5 M (C) 3.0 M (D) 3.4 M

3. If 18 g of glucose is present in 1000 g of solvent, the solution is said to be :

(A) 1 molar (B) 0.1 molar (C) 0.5 molar (D) 0.1 molal

4. How much grams of CH_3OH should be dissolved in water for preparing 150 ml. of 2.0 M CH_3OH solution

(A) 9.6 (B) 2.4 (C) 9.6×10^3 (D) 4.3×10^2

5. Equal weight of NaCl and KCl are dissolved separately in equal volumes of solutions molarity of the two solutions will be –

(A) Equal

(B) That of NaCl will be less than that of KCl

(C) That of NaCl will be more than that of KCl Solution

(D) That of NaCl will be half of that of KCl solution

6. Which one of the following modes of expressing concentration of solution is independent of temperature–

(A) Molarity (B) Molality (C) % w/v (D) Grams per litre

7. A molal solution is one that contains one mole of a solute in

(A) 1000 g of the solvent (B) one litre of the solution

(C) one litre of the solvent (D) 22.4 litres of the solution

8. Which of the following solution has maximum mass of pure NaOH ?

(I) 50 g of 40% (W/W) NaOH

(II) 50 mL of 40% (W/V) NaOH (d_{sol} = 1.2 g/ml).

(III) 50 g of 12 M NaOH (d_{sol} = 1 g/ml).

(A) I (B) II (C) III (D) III = II = I.

9. Mole fraction of $C_3H_5(OH)_3$ (glycerin) in a solution of 36 g of water and 46 g of glycerin is :

(A) 0.46 (B) 0.36 (C) 0.20 (D) 0.40

10. The mole fraction of oxygen in a mixture of 7g of nitrogen and 8g of oxygen is :

(A) $\frac{8}{15}$ (B) 0.5 (C) 0.25 (D) 1.0

11. 1000 g aqueous solution of $CaCO_3$ contains 10 g of calcium carbonate concentration of the solution is :

(A) 10 ppm (B) 100 ppm (C) 1000 ppm (D) 10,000 ppm

12. The molarity of pure water is :

(A) 100 M (B) 55.5 M (C) 50 M (D) 18M

13. Molarity of liquid HCl if density of solution is1.17 g/cc. :

(A) 36.5 (B) 18.25 (C) 32.05 (D) 42.10

INTERCONVERSION OF CONCENTRATION TERMS

14. The molarity of 98% by wt. H_2SO_4 (d = 1.8 g/ml) is

(A) 6 M (B) 18 M (B) 10 M (D) 4 M

15. Mole fraction of A in H_2O is 0.2. The molality of A in H_2O is :

(A) 13.9 (B) 15.5 (C) 14.5 (D) 16.8

16. The molarity of the solution containing 2.8%w/v solution of KOH is :

(Given atomic mass of K = 39) is :

(A) 0.1 M (B) 0.5 M (C) 0.2 M (D) 1 M

17. Calculate the molality of 40% weight by volume solution of MgO if the density of the solution is 2 g/mL:-

(A) 5 (B) 10 (C) 6.25 (D) 12.5

18. If the mole fraction of NaCl is same as that of water then molality of NaCl (aq.) solution is

(A) 5.55 (B) 55.55 (C) 0.18 (D) 58.5

PROBLEMS RELATED WITH MIXING & DILUTION

19. How much volume of 3.0 M H_2SO_4 is required for the preparation of 1.0 litre of 1.0 M solution?

(A) 300 ml (B) 320 ml (C) 333.3 ml (D) 350.0 ml

20. How much water should be added to 200 cc of semi molar solution of NaOH to make it exactly Decimolar:

(A) 1000 cc (B) 400 cc (C) 800 cc (D) 600 cc

21. The molarity of a solution made by mixing 50 ml of conc. H_2SO_4 (18 M) with 50 ml. of water, is:

(A) 36 M (B) 18 M (C) 9 M (D) 6M

22. 100 ml of 0.3 M HCl solution is mixed with 200 ml of 0.3 M H_2SO_4 solution what is the molarity of H^+ in resultant solution.

(A) 0.9 (B) 0.6 (C) 0.4 (D) 0.5

23. 60 g of solution containing 40% by mass of NaCl are mixed with 100 g of a solution containing 15% by mass NaCl. Determine the mass percent of sodium chloride in the final solution.

(A) 24.4% (B) 78% (C) 48.8% (D) 19.68%

24. 125 ml of 8% w/w NaOH solution (sp. gravity 1) is added to 125 ml of 10% w/v HCl solution. The nature of resultant solution would be _____.

(A) basic (B) neutral (C) acidic (D) can't be predicted.

25. Equal volumes of 10% (v/v) of HCl is mixed with 10% (v/v) NaOH solution. If density of pure NaOH is 1.5 times that of pure HCl then the resultant solution be.

(A) basic (B) neutral (C) acidic (D) can't be predicted.

SOME TYPICAL CONCENTRATION TERMS

26. A fresh H_2O_2 solution is labeled as 11.35 V. Calculate its concentration in %w/v ?

(A) 2.5% (B) 3.4% (C) 4.2% (D) 5.4%

27. 100 ml each of 2M H_2O_2 and 11.35 V H_2O_2 solution are mixed then find the strength of final solution in g/L.

(A) 25 (B) 51 (C) 42 (D) 54

28. 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 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

EUDIOMETRY

29. For a chemical reaction occurring at constant pressure and temperature.

$$2A(g) + 5B(g) \longrightarrow C(g) + 2D(g)$$

(A) Contraction in volume is double the volume of A taken if B is taken in excess.

(B) Contraction in volume is more than the volume of B taken if A is in excess.

(C) Volume contracts by 20 mL if 10 mL A is reacted with 20 mL B.

(D) No change in volume due to reaction

30. One litre of CO_2 passed over hot coke the volume becomes 1.4 litres then the composition of products will not be (At STP)

(A) $V_{CO_2} : V_{CO} = 3 : 4$ (B) $V_{CO_2} = 1.6$ ltr. (C) $n_{CO_2} : n_{CO} = 3 : 4$ (D) % v/v of CO = $\frac{400}{7}$

31. $C_6H_5OH\ (g) + O_2\ (g) \longrightarrow CO_2\ (g) + H_2O\ (l)$

Magnitude of volume change if 30 ml of C_6H_5OH (g) is burnt with excess amount of oxygen, is

(A) 30 ml (B) 60 ml (C) 20 ml (D) 10 ml

32. A mixture of C_2H_2 and C_3H_8 occupied a certain volume at 80 mm Hg. The mixture was completely burnt to CO_2 and H_2O(l). The pressure of CO_2 was found to be 230 mm Hg at the same temperature and volume. The fraction of C_2H_2 in mixture is

(A) 0.125 (B) 0.5 (C) 0.85 (D) 0.25

33. The % by volume of C_4H_{10} in a gaseous mixture of C_4H_{10}, CH_4 and CO is 40. When 200 ml of the mixture is burnt in excess of O_2. Find volume (in ml) of CO_2 produced.

(A) 220 (B) 340 (C) 440 (D) 560

34. 20 mL of a gaseous hydrocarbon was exploded with 120 mL of oxygen. A contraction of 60 mL was observed, and a further contraction of 60 mL took place when KOH was added. What is the formula of the hydrocarbon :

(A) C_3H_6 (B) C_3H_8 (C) C_2H_6 (D) C_4H_{10}

35. A definite amount of gaseous hydrocarbon was burnt with just sufficient amount of O_2. The volume of all reactants was 600 ml, after the explosion the volume of the products [CO_2(g) and H_2O(g)] was found to be 700 ml under the similar conditions. The molecular formula of the compound is

(A) C_3H_8 (B) C_3H_6 (C) C_3H_4 (D) C_4H_{10}

36. 10 ml of a compound containing 'N' and 'O' is react completely 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 react completely, is

(A) N_2O (B) NO_2 (C) N_2O_3 (D) N_2O_5

EXERCISE (S-I)

INTRODUCTION OF CONCENTRATION TERMS

1. Calculate the molarity of the following solutions:

(a) 4g 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.

2. 0.115 gm of sodium metal was dissolved in 500 ml of the solution in distilled water. Calculate the molarity of the solution?

3. The average concentration of Na^+ ion in human body is 3 to 4 gm per litre. The molarity of Na^+ ion is about.

4. What is the concentration of chloride ion, in molarity, in a solution containing 10.56 gm $BaCl_2.8H_2O$ per litre of solution? (Ba = 137)

5. How much $BaCl_2$ (in gm) would be needed to make 250 ml of a solution having the same concentration of Cl^- as one containing 1.825 gm HCl per 100 ml ? (Ba = 137)

6. Equal moles of H_2O and NaCl are present in a solution. Find molality of solution?

7. What is the quantity of water (in g) that should be added to 16 gm methanol to make the mole fraction of methanol as 0.25:

8. If 0.5 M methanol undergo self dissociation like $CH_3OH \rightleftharpoons CH_3O^- + H^+$ & if concentration of H^+ is 2.5×10^{-4} M then calculate % dissociation of methanol.

INTERCONVERSION OF CONCENTRATION TERMS

9. Density of a solution containing 13% by mass of sulphuric acid is 0.98 g/ml. Then molarity of solution will be

10. 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

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

12. The concentration of a solution of NaOH is 8% (w/w) and 10% (w/v). Calculate density (in gm/mλ) of solution?

13. The mole fraction of solute in aqueous urea solution is 0.2. Calculate the mass percent of solute?

14. Calculate molality (m) of Cl^- (aq) present in the aqueous solution of 2M NH_4Cl assuming 100% dissociation according to reaction.

$$NH_4Cl\ (aq) \longrightarrow NH_4^+\ (aq) + Cl^-\ (aq)$$

Given : Density of solution = 3.107 gm / ml.

15. The concentration of $Ca(HCO_3)_2$ in a sample of hard water is 405 ppm. The density of water sample is 1.0 gm/ml. Calculate the molarity of solution ?

16. 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 ?

PROBLEMS RELATED WITH MIXING & DILUTION

17. Find molarity of Na^+ ions if 500 mL of 0.2 M $NaCl_{(aq)}$ solution is mixed with 500 mL 0.5 M Na_2SO_4 $_{(aq)}$ solution ?

18. Find out the volume of 98% w/w H_2SO_4 (density = 1.8 gm/ ml), must be diluted to prepare 12.5 litres of 2.5 M sulphuric acid solution

19. Determine the volume (in mL) of diluted nitric acid 20% w/v HNO_3 that can be prepared by diluting 50 mL of conc. HNO_3 with water 69.8% w /v.

20. When V ml of 2.2 M H_2SO_4 solution is mixed with 10 V ml of water, the volume contraction of 2% take place. Calculate the molarity of diluted solution ?

21. 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.

22. Calculate the amount of the water "in ml" which must be added to a given solution of concentration of 40 mg silver nitrate per ml, to yield a solution of concentration of 16 mg silver nitrate per ml ?

23. What volume (in ml) of 0.8 M $AlCl_3$ solution should be mixed with 50 ml of 0.2M $CaCl_2$ solution to get solution of chloride ion concentration equal to 0.6 M ?

24. A mixture containing equimolar amounts of $Ca(OH)_2$ and $Al(OH)_3$ requires 0.5 L of 4.0 M HCl to react with it completely. Total moles of the mixture are :

25. How would you prepare exactly 3.0 litre of 1.0 M NaOH by mixing proportions of stock solution of 2.50 M NaOH and 0.40 M NaOH. No water is to be used. Find the ratio of the volume (v_1/v_2).

26. 20 mL of 0.2M $Al_2(SO_4)_3$ is mixed with 30 mL of 0.6 M $BaCl_2$. Calculate the mass of $BaSO_4$ formed in solution.

$$BaCl_2 + Al_2(SO_4)_3 \longrightarrow BaSO_4 + AlCl_3$$

SOME TYPICAL CONCENTRATION TERMS

27. 50 ml of '20V' H_2O_2 is mixed with 200 ml, '10V' H_2O_2. Find the volume strength of resulting solution?

28. 500 ml of a H_2O_2 solution on complete decomposition produces 2 moles of H_2O. Calculate the volume strength of H_2O_2 solution? **[Given: Volume of O_2 is measured at 1atm and 273 K]**

29. An oleum sample is labeled as 118 %, Calculate

(i) Mass of H_2SO_4 in 100 gm oleum sample.

(ii) Maximum mass of H_2SO_4 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.

30. A mixture is prepared by mixing 10 gm H_2SO_4 and 40 gm SO_3 calculate,

(a) mole fraction of H_2SO_4 (b) % labeling of oleum

EUDIOMETRY

31. Calculate the volume of CO_2 evolved by the combustion of 50 ml of a mixture containing 40% C_2H_4 and 60% CH_4 (by volume)

32. A gaseous hydrocarbon (C_xH_y) requires volume of O_2 for complete combustion which is 6 times of its own volume & produces volume of CO_2 which is 4 times of its own volume. Find X + Y.

33. When 20 ml of mixture of O_2 and O_3 is heated, the volume becomes 29 ml and disappears in alkaline pyrogallol solution. What is the volume percent of O_2 in the original mixture?

(A) 90% (B) 10% (C) 18% (D) 2%

34. 20 ml of a mixture of C_2H_2 and CO was exploded with 30 ml of oxygen. The gases after the reaction had a volume of 34 ml. On treatment with KOH, 8 ml of oxygen remained. Calculate the volume of C_2H_2 in the mixture.

EXERCISE (0-II)

SINGLE CORRECT QUESTIONS

1. Calculate the mass percent (w/w) of sulphuric acid in a solution prepared by dissolving 4 g of sulphur trioxide in a 100 ml sulphuric acid solution containing 80 mass percent (w/w) of H_2SO_4 and having a density of 1.96 g/ml. (molecular weight of H_2SO_4 = 98). Take reaction $SO_3 + H_2O \rightarrow H_2SO_4$

(A) 80.8% (B) 84% (C) 41.65% (D) 20%

2. What volumes should you mix of 0.2 M NaCl and 0.1 M $CaCl_2$ 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 $CaCl_2$ (B) 600 ml NaCl, 400 ml $CaCl_2$

(C) 800 ml NaCl, 200 ml $CaCl_2$ (D) None of these

3. 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) 3 M (D) 2.5 M

4. One mole mixture of CH_4 & air (containing 80% N_2 20% O_2 by volume) of a composition such that when underwent combustion gave maximum heat (assume combustion of only CH_4). Then which of the statements are correct, regarding composition of initial mixture.(X presents mole fraction)

(A) $x_{CH_4} = \frac{1}{11}$, $x_{O_2} = \frac{2}{11}$, $x_{N_2} = \frac{8}{11}$ (B) $x_{CH_4} = \frac{3}{8}$, $x_{O_2} = \frac{1}{8}$, $x_{N_2} = \frac{1}{2}$

(C) $x_{CH_4} = \frac{1}{6}$, $x_{O_2} = \frac{1}{6}$, $x_{N_2} = \frac{2}{3}$ (D) Date insufficient

5. 12.5gm 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) $\frac{2}{700}$ (B) $\frac{2}{350}$ (C) $\frac{3}{350}$ (D) $\frac{3}{700}$

6. Similar to the % labelling of oleum, a mixture of H_3PO_4 and P_4O_{10} is labelled as (100 + x) % where x is the maximum mass of water which can react with P_4O_{10} present in 100 gm mixture of H_3PO_4 and P_4O_{10}. If such a mixture is labelled as 127 %. Mass of P_4O_{10} in 100 gm of mixture, is

(A) 71 gm (B) 47 gm (C) 83 gm (D) 35 gm

ONE OR MORE THAN ONE MAY BE CORRECT

7. Solution(s) containing 40 gm NaOH is/are

(A) 50 gm of 80% (w/w) NaOH

(B) 50 gm of 80% (w/v) NaOH [$d_{soln.}$ = 1.2 gm/ml]

(C) 50 gm of 20 M NaOH [$d_{soln.}$ = 1 gm/ml]

(D) 50 gm of 5m NaOH

8. For 7 molal NaOH solution. Select the correct statement -

(A) $\%\left(\frac{w}{w}\right) = 21.7$ (B) $\%\left(\frac{w}{w}\right) = 72$

(C) $X_{H_2O} = \frac{7}{47}$ (D) $X_{NaOH} = \frac{7}{47}$

9. The incorrect statement(s) regarding 2M $MgCl_2$ aqueous solution is/are ($d_{solution}$ = 1.09 gm/ml)

(A) Molality of Cl^- is 4.44 m (B) Mole fraction of $MgCl_2$ is exactly 0.035

(C) The conc. of $MgCl_2$ is 19% w/v (D) The conc. of $MgCl_2$ is 19×10^4 ppm

10. A sample of H_2O_2 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 H_2O and H_2O_2)

(A) $M_{H_2O_2}$ = 6 (B) $\%\frac{W}{V}$ = 17

(C) Mole fraction of H_2O_2 = 0.25 (D) $m_{H_2O_2} = \frac{1000}{72}$

11. 100 mL of 0.06 M $Ca(NO_3)_2$ is added to 50 mL of 0.06 M $Na_2C_2O_4$. After the reaction is complete (CaC_2O_4 is precipitated)

(A) 0.003 moles of calcium oxalate will get precipitated

(B) 0.003 M Ca^{2+} will remain in excess

(C) $Na_2C_2O_4$ is the limiting reagent

(D) Oxalate ion ($C_2O_4^{2-}$) concentration in final solution is 0.003 M

12. A mixture of 100 ml of CO, CO_2 and O_2 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

COMPREHENSION

Comprehension 13 and 14 (2 questions)

2 litre of 9.8 % w/w H_2SO_4 (d = 1.5 gm/ml) solution is mixed with 3 litre of 1 M KOH solution.

13. The number of moles H_2SO_4 added are

(A) 1 (B) 2 (C) 3 (D) 0.5

14. The concentration of H^+ if solution is acidic or concentration of OH^- if solution is basic in the final solution is

(A) 0 (B) $\frac{3}{10}$ (C) $\frac{3}{5}$ (D) $\frac{2}{5}$

Comprehension 15 and 16 (2 questions)

30 gm H_2SO_4 is mixed with 20 gram SO_3 to form mixture.

15. Find mole fraction of SO_3 .

(A) 0.2 (B) 0.45 (C) 0.6 (D) 0.8

16. Determine % labelling of oleum solution.

(A) 104.5 (B) 106 (C) 109 (D) 110

Comprehension 17 and 18 (2 questions)

Estimation of halogens :

Carius method : A known mass of compound is heated with conc. HNO_3 in the presence of $AgNO_3$ contained in a hard glass tube known as Carius tube in a furnace. C and H are oxidised to CO_2 and H_2O. The halogen forms the corresponding AgX. It is filtered, dried, and weighed.

Estimation of sulphur : A known mass of compound is heated with fuming HNO_3 or sodium peroxide (Na_2O_2) in the presence of $BaCl_2$ solution in Carius tube. Sulphur is oxidised to H_2SO_4 and precipitated as $BaSO_4$. It is filtered, dried and weighed.

17. 0.15gm of an organic compound gave 0.12 gm of silver bromide by the Carius method. Find the percentage of bromine in the compound.

(A) 34.0 (B) 40 (C) 17 (D) 68

18. 0.2595 gm of an organic substance when treated by Carius method gave 0.35gm of $BaSO_4$. Calculate the percentage of sulphur in the compound.

(A) 9 (B) 30.4 (C) 18.52 (D) 40.52

Comprehension 19 and 20 (2 questions)

Estimation of phosphorous :

A known mass of compound is heated with fuming HNO_3 or sodium peroxide (Na_2O_2) in Carius tube which converts phosphorous to H_3PO_4. Magnesia mixture ($MgCl_2$ + NH_4Cl) is then added, which gives the precipitate of magnesium ammonium phosphate ($MgNH_4.PO_4$) which on heating gives magnesium pyrophosphate ($Mg_2P_2O_7$), which is weighed.

19. 0.12 gm of an organic compound containing phosphorus gave 0.22 gm of $Mg_2P_2O_7$ by the usual analysis. Calculate the percentage of phosphorous in the compound.

(A) 25 (B) 9.25 (C) 80.1 (D) 51.20

20. An organic compound has 6.2% of phosphorus. On sequence of reaction the phosphorous present in the 10gm of organic compound is converted to $Mg_2P_2O_7$. Find wt. of $Mg_2P_2O_7$ formed.

(A) 2.22 (B)10.2 (C) 15 (D) 20

Comprehension 21 and 24 (4 questions)

Estimation of nitrogen : There are two methods for the estimation of nitrogen (i) Dumas method and (ii) Kjeldahl's method.

Duma's method : A known mass of compound is heated with copper oxide (CuO) in an atmosphere of CO_2, which gives free nitrogen along with CO_2 and H_2O.

$$C_xH_yN_z + (2x + y/2)\ CuO \rightarrow xCO_2 + y/2\ (H_2O) + z/2\ (N_2) + (2x + y/2)\ Cu.$$

The gaseous mixture is passed over a heated copper gauze which converts traces of nitrogen oxides formed to N_2. The gaseous mixture is collected over an aqueous solution of KOH which absorbs CO_2, and nitrogen is collected in the upper part of the graduated tube.

ii. Kjeldahl's method : A known mass of organic compound (0.5 gm) is mixed with K_2SO_4 (10 gm) and $CuSO_4$. (1.0 gm) or a drop of mercury (Hg) and conc. H_2SO_4 (25 ml) , and heated in Kjeldahl's flask. $CuSO_4$ or Hg acts as a catalyst, while K_2SO_4 raises the boiling point of H_2SO_4. The nitrogen in the organic compound is quantitatively converted to ammonium sulphate. The resulting mixture is then distilled with excess of NaOH solution and the NH_3 evolved is passed into a known but excess volume of standard HCl or H_2SO_4. The acid left unused is estimated by titration with some standard alkali. The amount of acid used against NH_3 can thus be known and from this the percentage of nitrogen is calculated.

(a) $C + H + S \xrightarrow[H_2SO_4]{conc.} CO_2 + H_2O + SO_2$

(b) $N \xrightarrow[H_2SO_4]{conc.} (NH_4)_2SO_4$

(c) $(NH_4)_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2NH_3 + 2H_2O$

(d) $2NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$

iii. This method is not applicable to compounds containing N in nitro and azo groups, and N present in the ring (e.g. , pyridine) as N of these compounds does not change to $(NH_4)_2SO_4$ (ammonium sulphate) under these reaction conditions.

21. 0.30 gm of an organic compound gave 50 ml of nitrogen collected at 300K and 715 mm pressure in Duma's method. Calculate the percentage of nitrogen in the compound. (Vapour pressure of water or aqueous tension of water at 300K is 15 mm.

(A) 10.2 (B) 17.46 (C) 24 (D) 34

22. 0.50 gm of an organic compound was treated according to Kjeldahl's method. The ammonia evolved was absorbed in 50 ml of 0.5M H_2SO_4. The residual acid required 60 ml of M/2 NaOH solution. Find the percentage of nitrogen in the compound.

(A) 50 (B) 56.0 (C) 66 (D) 40

23. 0.4 gm of an organic compound was treated according to Kjeldahl's method. The ammonia evolved was absorbed in 50 ml of 0.5M M H_3PO_3. The residual acid required 30 ml of 0.5M $Ca(OH)_2$. Find the percentage of N_2 in the compound.

(A) 20 (B) 50 (C) 70 (D) 90

24. 0.002 gm of an organic compound was treated according to Kjeldahl's method. 0.2×10^{-4} mol of H_2SO_4 was required to neutralise NH_3. Calculate the percentage of N_2.

(A) 50 (B) 28 (C) 70 (D) 18

MATCH THE COLUMN

25.

	Column I		**Column II**
(A)	10 M MgO ($d_{solution}$= 1.20 gm/ml) Solute : MgO Solvent: H_2O	(P)	$W_{solvent}$ = 120 gm per 100 ml of solution
(B)	40% w/v NaOH ($d_{solution}$ = 1.6 gm/ml) Solute : NaOH Solvent: H_2O	(Q)	$W_{solution}$ = 150 gm per 100 gm solvent
(C)	8 m $CaCO_3$ Solute : $CaCO_3$ Solvent: H_2O	(R)	W_{solute} = 120 gm per 100 gm of solvent
(D)	0.6 mol fraction of 'X' (Molecular mass = 20) in 'Y' (molecular mass 25) Solute : X Solvent : Y	(S)	$W_{solvent}$ = 125 gm per 100 gm of solute

26. Match the column:

	Column I		**Column II**
(A)	20 V H_2O_2	(P)	2.5 M
(B)	24.5 % w/v H_2SO_4	(Q)	1.78 M
(C)	Pure water	(R)	1.5 M
(D)	5% w/w NaOH ($d_{solution}$= 1.2 gm/ml)	(S)	55.5 M

27.

	Column-I		**Column-II**
(A)	120 g CH_3COOH in 1 L solution d_{sol} = 1.2 g/mL	(P)	M = 2
(B)	120 g glucose dissolved in 1 L solution (d_{sol} = 1.2 g/mL)	(Q)	10% w/w solution
(C)	$x_{NH_2CONH_2}$ = 1/31 (aqueous solution)	(R)	12% w/v solution
(D)	19.6% (w/v) H_2SO_4 solution → ($d_{solution}$ = 1.2 g/mL)	(S)	m = 1.85
		(T)	m = 0.617

EXERCISE (S-II)

1. 120 gm of solution containing 40% by mass of NaCl are mixed with 200 gm of a solution containing 15% by mass NaCl.

(a) Determine the mass percent of sodium chloride in the final solution.

(b) What is the molality of the above solution.

(c) What is the mole fraction of the solute.

(d) What is the molarity of solution if density of solution in 1.6 gm/ml.

(e) %c w/ v of NaCl present in the solution.

2. 500 gm of urea solution of mole fraction 0.2 is diluted to 1500 gm. Calculate the mole fraction of solute in the diluted solution ?

3. What volume of 0.2 M NaOH (in ml) solution should be mixed to 500 ml of 0.5 M NaOH solution so that 300 ml of final solution is completely neutralised by 20 ml of 2 M H_3PO_4 solution. [Assuming 100% dissociation]

4. How much minimum volume (in ml) 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.

$$Al_2(SO_4)_3 + 3Ca(NO_3)_2 \longrightarrow 2Al(NO_3)_3 + 3CaSO_4$$

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 (in gm/ml) of fat free skimed milk is ?

6. 100 ml of 0.1 M solution of AB (d = 1.5 gm/ml) is mixed with 100 ml of 0.2 M solution of CB_2 (d = 2.5 gm/ml). Calculate the molarity of B^- in final solution if the density of final solution is 4 gm/ml. Assuming AB and CB_2 are non reacting & dissociates completely into A^+, B^-, C^{+2}.

7. 60 ml of a "x" % w/w alcohol by weight (d = 0.6 g/cm^3) must be used to prepare 200 cm^3 of 12% alcohol by weight (d = 0.90 g/cm^3). Calculate the value of "x"?

8. 1120 gm of 2 'm' urea solution is mixed with 2480 gm of 4 'm' urea solution. Calculate the molality of the resulting solution?

9. To 100 ml of 5 M NaOH solution (density 1.2 g/ml) were added 200 ml of another NaOH solution which has a density of 1.5 g/ml and contains 20 mass percent of NaOH. What will be the volume of the gas (at STP) in litres liberated when aluminium reacts with this (final) solution.

The reaction is $Al + NaOH + H_2O \longrightarrow NaAlO_2 + H_2$

10. 500 ml of 2M CH_3COOH solution is mixed with 600 ml 12% w/v CH_3COOH solution then calculate the final molarity of solution.

11. 10 mL of gaseous organic compound contain C, H and O only was mixed with 100 mL of O_2 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, if molecular formula of the compound is $C_xH_yO_z$, then find (x + y + z).

12. 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, if formula of ozone is O_x then find x.

13. 10 ml of a mixture of CH_4, C_2H_4 and CO_2 were exploded with excess of air. After explosion and further cooling, there was contraction of 17 ml and after treatment with KOH, there was further reduction of 14 ml. What is the composition of the mixture?

EXERCISE (JEE-MAIN)

1. On complete combustion 0.30 g of an organic compound gave 0.20 g of carbon dioxide and 0.10 g of water. The percentage of carbon in the given organic compound is _____ (Nearest integer). **[JEE Main, June 2022]**

2. Chlorophyll extracted from the crushed green leaves was dissolved in water to make 2 L solution of Mg of concentration 48 ppm. The number of atoms of Mg in this solution is $x \times 10^{20}$ atoms. The value of x is ___ . (Nearest Integer)

(Given: Atomic mass of Mg is 24 g mol^{-1}, N_A= 6.02 × 1023 mol^{-1}) **[JEE Main, July 2022]**

3. A 0.166 g sample of an organic compound was digested with cone. H_2SO_4 and then distilled with NaOH. The ammonia gas evolved was passed through 50.0 mL of 0.5 N H_2SO_4. The used acid required 30.0 mL of 0.25 N NaOH for complete neutralization. The mass percentage of nitrogen in the organic compound is____. **[JEE Main, June 2022]**

4. 100 mL of Na_3PO_4 solution contains 3.45 g of sodium. The molarity of the solution is ____$\times 10^{-2}$ mol L^{-1}. (Nearest integer)

[Atomic Masses - Na : 23.0 u, O : 16.0 u, P : 31.0 u] **[JEE Main, August 2021]**

5. The mole fraction of a solute in a 100 molal aqueous solution _____ $\times 10^{-2}$.
(Round off to the Nearest Integer).
[Given : Atomic masses : H : 1.0 u, O : 16.0 u] **[JEE Main, March 2021]**

6. The number of moles of CuO, that will be utilized in Dumas method for estimation nitrogen in a sample of 57.5g of N, N-dimethylaminopentane is _____ $\times 10^{-2}$. (Nearest integer)

[JEE Main, August 2021]

7. In Duma's method of estimation of nitrogen, 0.1840 g of an organic compound gave 30 mL of nitrogen collected at 287 K and 758 mm of Hg pressure. The percentage composition of nitrogen in the compound is _____. (Round off to the Nearest Integer).

[Given : Aqueous tension at 287 K = 14 mm of Hg] **[JEE Main, March 2021]**

8. In Carius method, halogen containing organic compound is heated with fuming nitric acid in the presence of: **[JEE Main, July 2021]**

(1) HNO_3 (2) $AgNO_3$ (3) $CuSO_4$ (4) $BaSO_4$

9. In the sulphur estimation, 0.471 g of an organic compound gave 1.44 g of barium sulphate. The percentage of sulphur in the compound is ____%. (Nearest integer)

(Atomic Mass of Ba = 137 u) **[JEE Main, August 2021]**

10. 0.8 g of an organic compound was analysed by Kjeldahl's method for the estimation of nitrogen. If the percentage of nitrogen in the compound was found to be 42%, then_____ mL of 1 M H_2SO_4 would have been neutralized by the ammonia evolved during the analysis.

[JEE Main, July 2021]

11. At 300 K and 1 atmospheric pressure, 10 mL of a hydrocarbon required 55 mL of O_2 for complete combustion, and 40 mL of CO_2 is formed. The formula of the hydrocarbon is:

(1) C_4H_7Cl (2) C_4H_{10} (3) C_4H_8 (4) C_4H_6

[Jee Main, April 2019]

12. 8g of NaOH is dissolved in 18g of H_2O. Mole fraction of NaOH in solution and molality (in mol kg^{-1}) of the solutions respectively are : **[Concentration Terms]**

(1) 0.2, 22.20 (2) 0.167,22.20 (3) 0.167, 11.11 (4) 0.2, 11.11

[Jee Main, Jan 2019]

13. The volume strength of 1M H_2O_2 is:

(Molar mass of H_2O_2 = 34 g mol^{-1})

(1) 16.8 (2) 11.35 (3) 22.4 (4) 5.6

[Jee Main, Jan 2019]

14. On treatment of 100 mL of 0.1 M solution of $CoCl_3 . 6H_2O$ with excess $AgNO_3$; 1.2×10^{22} ions are precipitated. The complex is : **[JEE(Main)-2017]**

(A) $[Co(H_2O)_4 Cl_2]Cl.2H_2O$ (B) $[Co(H_2O)_3Cl_3].3H_2O$

(C) $[Co(H_2O)_6]Cl_3$ (D) $[Co(H_2O)_5Cl]Cl_2.H_2O$

15. 3g of activated charcoal was added to 50 mL of acetic acid solution (0.06N) in a flask. After an hour it was filtered and the strength of the filtrate was found to be 0.042N. The amount of acetic acid adsorbed (per gram of charcoal) is: **[JEE(Main)-2015]**

(A) 18 mg (B) 36 mg (C) 42 mg (D) 54 mg

16. For the estimation of nitrogen, 1.4 g of an organic compound was digested by Kjeldahl's method and the evolved ammonia was absorbed in 60 mL of $\frac{M}{10}$ sulphuric acid. The unreacted acid required 20 mL of $\frac{M}{10}$ sodium hydroxide for complete neutralisation. The percentage of nitrogen in the compound is : **[JEE(Main-online)-2014]**

(A) 3% (B) 5% (C) 6% (D) 10%

17. The amount of $BaSO_4$ formed upon mixing 100 mL of 20.8% $BaCl_2$ solution with 50 mL of 9.8% H_2SO_4 solution will be : **[JEE(Main-online)-2014]**

(Ba = l37, Cl = 35.5, S=32, H = l and O = 16)

(A)33.2 g (B) 11.65 g (C) 23.3 g (D) 30.6 g

18. The density of 3M solution of sodium chloride is 1.252 g mL^{-1}. The molality of the solution will be (molar mass, NaCl = 58.5 g mol^{-1}) **[JEE(Main-online)-2013]**

(A) 2.18 m (B) 3.00 m (C) 2.60 m (D) 2.79 m

19. 10 mL of 2(M) NaOH solution is added to 200 mL of 0.5 (M) of NaOH solution. What is the final concentration ? **[JEE(Main-online)-2013]**

(A) 0.57 M (B) 5.7 M (C) 11.4 M (D) 1.14 M

20. The density of a solution prepared by dissolving 120 g of urea (mol. mass = 60 u) in 1000 g of water is 1.15 g/mL. The molarity of this solution is **[AIEEE-2012]**

(A) 2.05 M (B) 0.50 M (C) 1.78 M (D) 1.02 M

21. The concentrated sulphuric acid that is peddled commercially is 95% H_2SO_4 by weight. If the density of this commerical acid is 1.834 g cm^{-3}, the molarity of this solution is :– **[AIEEE-2012]**

(A) 17.8 M (B) 15.7 M (C) 10.5 M (D) 12.0 M

22. A 5.2 molal aqueous solution of methyl alcohol, CH_3OH, is supplied. What is the mole fraction of methyl alcohol in the solution ? **[AIEEE-2011]**

(A) 0.086 (B) 0.050 (C) 0.100 (D) 0.190

23. 6.02×10^{21} molecules of urea are present in 100 ml of its solution. The concentration of urea solution is **[AIEEE-2004]**

(A) 0.001 M (B) 0.01 M (C) 0.02 M (D) 0.1 M

EXERCISE (JEE-ADVANCED)

1. 5.00 mL of 0.10M oxalic acid solution taken in a conical flask is titrated against NaOH from a burette using phenolphthalein indicator. The volume of NaOH required for the appearance of permanent faint pink color is tabulated below for five experiments. What is the concentration, in molarity, of the NaOH solution? **[JEE 2020]**

Exp. No.	Vol. of NaOH(mL)
1	12.5
2	10.5
3	9.0
4	9.0
5	9.0

2. The mole fraction of urea in an aqueous urea solution containing 900 g of water is 0.05. If the density of the solution is 1.2 g cm^{-3}, the molarity of urea solution is ___
(Given data : Molar masses of urea and water are 60 g mol^{-1} and 18 g mol^{-1}, respectively)

[JEE 2019]

3. The mole fraction of a solute in a solution is 0.1. At 298 K, molarity of this solution is the same as its molality. Density of this solution at 298 K is 2.0 g cm^{-3}. The ratio of the molecular weights of the solute and solvent, $\left(\frac{MW_{solute}}{MW_{solvent}}\right)$ is : **[JEE 2016]**

4. A compound H_2X with molar weight of 80 g is dissolved in a solvent having density of 0.4 g /ml, Assuming no change in volume upon dissolution, the molality of a 3.2 molar solution is.

[JEE 2014]

5. 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

6. One gm of charcoal absorbs 100 ml 0.5 M CH_3COOH to form a monolayer, and thereby the molarity of CH_3COOH reduces to 0.49. Calculate the surface area of the charcoal adsorbed by each molecule of acetic acid. Surface area of charcoal = 3.01×10^2 m^2/gm. **[JEE'2003]**

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

ANSWER KEY

EXERCISE (O-I)

1.	(C)	2.	(B)	3.	(D)	4.	(A)	5.	(C)	6.	(B)	7.	(A)
8.	(C)	9.	(C)	10.	(B)	11.	(D)	12.	(B)	13.	(C)	14.	(B)
15.	(A)	16.	(B)	17.	(C)	18.	(B)	19.	(C)	20.	(C)	21.	(C)
22.	(D)	23.	(A)	24.	(C)	25.	(A)	26.	(B)	27.	(B)	28.	(B)
29.	(A)	30.	(B)	31.	(B)	32.	(A)	33.	(C)	34.	(B)	35.	(A)
36.	(C)												

EXERCISE (S-I)

1. (a) (0.5 M) (b) (0.5 M) (c) (0.2 M)
2. (0.01M) 3. (0.15 M) 4. (0.06 M) 5. (13gm)
6. (55.55m) 7. (27)
8. (0.05) 9. (1.3) 10. (16.66%) 11. (1.2888)
12. (1.25gm/ml) 13. (45.45%) 14. (0.67)
15. (2.5×10^{-3}M) 16. (2.7×10^{-4}) 17. (0.6M) 18. (1.736litre)
19. (174.5ml) 20. (0.204M) 21. (2M) 22. (1.5ml)
23. (5.56ml) 24. (0.8) 25. (0.4) 26. (2.796)
27. (12) 28. (44.8)
29. ((i) 20gm H_2SO_4 (ii) 35.4 gm H_2SO_4 (iii) $H_2SO_4 = 35.4$ gm, $H_2O = 34.6$ gm,)
30. ((a) 0.169 (b) 118%) 31. (70 ml) 32. (012) 33. ((B) 10%)
34. ($C_2H_2 = 6$ml, $CO = 14$ml)

EXERCISE (O-II)

1.	(A)	2.	(D)	3.	(B)	4.	(A)	5.	(A)	6.	(A)		
7.	(AC)	8.	(A)	9.	(BD)	10.	(BD)	11.	(AC)	12.	(B)		
13.	(C) 3	14.	(C) 3/5			15.	(B) 0.45	16.	(C) 109				
17.	(34%)	18.	(C) 18.52			19.	(D)	20.	(A)	21.	(B)		
22.	(B)	23.	(C)	24.	(B)	25.	(A→Q, B→P, C→S, D→R)						
26.	(A→Q, B→P, C→S, D→R)					27.	(A→PQRS, B→QRT, C→QS, D→P)						

EXERCISE (S-II)

1. (a) 24.4%
   (b) 5.5 m
   (c) 0.09
   (d) 6.6 M
   (e) 39%

2. (0.05) 3. (250) 4. (24.51 ml) 5. (1.052)

6. (0.5) 7. (60) 8. (3.33 m) 9. (68.1L) 10. (2)

11. (C_2H_6O) 12. (O_3) 13. ($CH_3 = 4.5$ ml, $CO_2 = 1.5$ ml)

JEE MAIN

1. (18) 2. (24) 3. (63) 4. (50) 5. (64) 6. (1125)

7. (19) 8. (B) 9. (42) 10. (12) 11. (D) 12. (C) 13. (B)

14. (A) 15. (A) 16. (D) 17. (B) 18. (D) 19. (A) 20. (A)

21. (A) 22. (A) 23. (D)

JEE ADVANCED

1. (0.11) 2. () 3. (9) 4. (8) 5. (C) 6. $5 \times 10^{-19} m^2$

7. 55.56 mol/L

SOLUTIONS

EXERCISE (O-I)

1. $M = \frac{8}{40\times1} = 0.2$

The correct option is (C)

2. $M = \frac{5\times1000}{34\times100}$

M = 1.5

correct option is (B)

3. $m = \frac{18\times1000}{180\times1000}$

$\Rightarrow$ molality = .1

correct option is (D)

4. $2 = \frac{w\times1000}{32\times150}$

$\Rightarrow \quad w = \frac{2\times32\times150}{1000}$

$\Rightarrow \quad w = 9.6$

the correct option is (A)

5. $\text{Molarity}_{(NaCl)} = \frac{w}{58.5\times V}$ ...(1)

$\text{Molarity}_{(KCl)} = \frac{w}{74.5\times V}$ ...(2)

$\Rightarrow$ Molarity of NaCl will be more than that of KCl

$\Rightarrow$ correct option is (C)

6. Molality is independent of temperature correct option is (B)

8. (I) mass of pure NaOH = 20 gm
(II) mass of pure NaOH = 20 gm
(III) mass of pure NaOH = 24 gm

$\Rightarrow$ maximum mass of pure NaOH is in solution (III)

9. $X_{glycerin} = \dfrac{46/92}{46/92+36/18}$

$= \dfrac{0.5}{0.5+2}$

$= \dfrac{0.5}{2.5}$

$\simeq 0.20$

10. $X_{O_2} = \dfrac{8/32}{8/32+7/28} = \dfrac{0.25}{0.25+0.25} = 0.5$

11. ppm $= \frac{10}{1000} \times 10^6$

$= 10^4$ or 10,000 ppm

12. Molarity of pure water $= \dfrac{1000}{18\times1} \simeq 55.55$

13. $M = \dfrac{1170}{36.5\times1} = 32.05$

14. $m = \left(\dfrac{98\times1.8\times1000}{98\times100}\right) = 18\ m$

15. $m = \left(\dfrac{0.2\times1000}{.8\times18}\right) = 13.9$

16. $m = \left(\dfrac{2.8\times1000}{56\times100}\right) = 0.5$

17. Given $\dfrac{w}{V}\%$ of MgO solution = 40

i.e. 100 ml solution contains 40 gm MgO

Mass of 100ml solution = 100 × 2 = 200gm

Mass of solvent = 200 – 40 = 160 gm

Molality of solution = $\dfrac{\text{No. of moles of solute}}{\text{Mass of solvent (in gm)}} \times 1000$

$$\Rightarrow m = \frac{40/40}{160} \times 1000 = 6.25$$

18. In aqueous solution of NaCl, mole fraction of NaCl and H_2O are equal

$\therefore$ If total number of moles of NaCl and H_2O = 1

Then moles of NaCl = $\frac{1}{2}$ and moles of H_2O = $\frac{1}{2}$

$$\text{Molality} = \frac{\text{No. of moles of NaCl}}{\text{Mass of } H_2O (\text{in gm})} \times 1000$$

$$= \frac{1/2}{\frac{1}{2} \times 18} \times 1000 = \frac{1000}{18} = 55.55$$

19. $m_1v_1 = m_2v_2$

$3 \times v_1 = 1 \times 1 \quad \Rightarrow v_1 = \frac{1}{3}$ lit.

or 333.3 ml

correct option is (C)

20. $m_1v_1 = m_2v_2$

i.e. $200 \times \frac{1}{2} = \frac{1}{10} \times v_{final} \Rightarrow v_{final} = 1000$ ml $\Rightarrow$ water added = 1000 – 200

i.e. 800 cc correct option is (C)

21. $m_1v_1 = m_2v_2$

$18 \times 50 = m_2 \times 100$

$\Rightarrow m_2 = \frac{18 \times 50}{100} \quad \Rightarrow m_2 = 9$

22. $[H^+] = \frac{100x.3 + 200x.3 \times 2}{300}$

$= 0.5$

23. $\%\frac{w}{w} = \frac{24+15}{160} \times 100 \simeq 24.4\%$

24. $NaOH + HCl \rightarrow NaCl + H_2O$

moles: $\left(\frac{8\times1\times1000}{40\times100}\right)$ $\left(\frac{10\times1000}{36.5\times125}\right)$

$\simeq 2$ $\simeq 2.2$

$\Rightarrow$ resultant solution will be acidic.

25. The resultant solution will be basic

26. 11.35 V means 1 lit of H_2O_2 will produce 11.35 lits of O_{23} at S.T.P.

$\Rightarrow$ molarity = $\frac{v.s/11.35}{1} \simeq 1$

Now, % $\frac{w}{v} = \frac{34}{1000} \times 100 \simeq 3.4\%$

27. Strength of final solution in g/lit = $\frac{(0.2+0.1)\times34}{200}\times1000 \simeq 51 g/lit$

28. $\frac{\text{for 118\% oleum}}{118 = 100 + \frac{18x}{80}}$, Let mass of SO_3 = xg $\Rightarrow$ x = 80 gm

$\Rightarrow$ In 50 g oleum sample SO_3 is 40 gm & H_2SO_4 is 10 gm

SO_3	+	H_3O	$\rightarrow$	H_2SO_4
80g		18g		98 gm
40		9g		49 gm

$\Rightarrow$ Resulting solution contains 9 gm H_2O

59 gm H_2SO_4

29. $2A + 5B \rightarrow C + 2D$

Contraction in volume double the volume of A taken.

If B is taken in excess

30.

CO_2 (g)	+ C (s)	$\longrightarrow$	2 CO (g)
v_i	1		0
v_f	1 – v		2v
	0.6		0.8
	1 + 2v – v = 1.4		$\Rightarrow$ v = 0.4

Vol. of CO_2 : Vol. of CO

0.6 : 0.8

3 : 4

n_{CO_2} : n_{CO}

3 : 4

31. $C_6H_5OH\ (g) + 7O_2\ (g) \longrightarrow 6\ CO_2\ (g) + 3H_2O\ (\ell)$

v_i	30 mL	v	0	0
v_f	0	v – 210	180	–

$\Delta v = (30 + v) - (v - 210 + 180)$

$= 30 + 30 = 60$ mL

33. $C_4H_{10} + \frac{13}{2}O_2 \longrightarrow 4\ CO_2 + 5\ H_2O$

80 mL 320 mL

$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$

x mL x mL

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

120 – x 120 – x

Total Vol. of CO_2 = 320 + x + 120 – x

= 440 mL

34. $C_xH_y + \left(x + \frac{y}{4}\right)O_2 \longrightarrow xCO_2 + \frac{y}{2}H_2O$

20 120

0 [120 –20 (x+ y/4)] 20x

20x = 60

x = 3

{(20 + 120) – (20x + 120 – 20(x + y/4)} = 60

y = 8

36. $N_x O_y + y\,H_2 \longrightarrow \frac{x}{2} N_2 + y\,H_2O$

v_i	10 mL	$y \times 10$	
v_f	0	0	$10 \times \frac{x}{2}$

$10y = 30$

$y = 3$

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

$x = 2$

$\rightarrow \therefore N_2O_3$

EXERCISE (S-I)

1. (a) $M = \frac{4\times1000}{40\times200} = 0.5$ M

(b) $M = \frac{5.3\times1000}{106\times100} = 0.5$ M

(c) $M = \frac{0.365\times1000}{36.5\times50} = 0.2$ M

2. $M = \frac{0.115\times1000}{23\times500} = 0.01$ M

3. Molarity of $Na^+ = \frac{3.5}{23}$

i.e. 0.15 M

4.

Molarity of $BaCl_2 \cdot SH_2O = \frac{10.56}{352\times1} = 0.03$ M

$\Rightarrow$ Concentration of chloride ion = 2 × 0.03 M = 0.06 M

5. $M_{HCl} = \frac{1.825\times1000}{36.5\times100} = 0.5\ M$ $\Rightarrow [Cl^-] = 0.5\ M$

Now, $[BaCl_2] = \frac{[Cl^-]}{2}$

Let weight of $BaCl_2$ be x gm

$\Rightarrow \frac{x\times1000}{208\times250}\times2 = 0.5$ $\Rightarrow x = \frac{0.5\times208\times250}{2\times1000}$

$\Rightarrow$ x = 13 gm $\Rightarrow$ Weight of $BaCl_2$ required is 13 gm.

6. Let the moles of H_2O & NaCl be 1

Molality, $M = \frac{1\times1000}{18\times1}$

$\Rightarrow$ m = 55.55

7. Let mass of H_2O added be x gm

$$x_{CH_3OH} = \frac{n_{CH_3OH}}{n_{CH_3OH}+n_{H_2O}}$$

$$0.25 = \frac{\frac{16}{32}}{\frac{16}{32}+\frac{x}{18}}$$

$$\Rightarrow 0.25\left(0.5+\frac{x}{18}\right) = 0.5$$

$$\Rightarrow 0.25\times\frac{x}{18} = 0.5 - 0.125$$

$\Rightarrow x = \frac{0.375\times18}{0.25}$ $\Rightarrow$ x = 27 gm

8. $CH_3OH \rightleftharpoons CH_3O^- + H^+$

0.5	0	0
0.5–0.5α	0.5α	0.5α

Let α be the degree of dissociation

$\Rightarrow [H^+] = 0.5\alpha = 2.5\times10^{-4}$

$\Rightarrow$ % α = 0.05

9. $M = \frac{13\times0.98\times1000}{98\times100} = 13 \times 10^{-1}$

10. $\%\ \frac{W}{W}$ of $CH_3OH = \left(\frac{15}{100\times0.90}\times100\right) = 16.66\ \%$

11. $6.90 = \frac{30\times d\times1000}{56\times100}$

$\Rightarrow \quad d = \frac{6.90\times56\times100}{30\times1000} \quad \Rightarrow\ d = 1.288\ g/ml$

12. $8\ \%\ \frac{W}{W}$ i.e. weight of solution i.e. NaOH = 8 gm

weight of solution = 100 gm

$10\ \%\ \frac{W}{V}$ i.e. weight of NaOH = 10 gm

Volume of solution = 100 ml

Now, $M = \frac{10\times1000}{40\times100} \Rightarrow 2.5$

Now, $2.5 = \frac{8\times d\times1000}{40\times100} \Rightarrow d = \frac{2.5\times40\times100}{8\times1000} \Rightarrow d = 1.25\ gm/ml$

13. $0.2 = \frac{n_{solute}}{n_{solute}+55.55}$

$0.2 \times n_{solute} + 0.2 \times 55.55 = n_{solute}$

$\Rightarrow \quad 0.8 \times n_{solute} = 0.2 \times 55.55 \quad \Rightarrow \quad n_{solute} = 13.88$

$\%$ w/w of solute $= \frac{833.25}{1833.25}\times100 = 45.45\ \%$

14. $NH_4Cl \longrightarrow NH_4^+ + Cl^-$

2 0 0

0 2 2

molality of $Cl^- = \frac{2\times1000}{(1000\times3.107-2\times(18+35.5))} = \frac{2000}{3000} = 0.66$

15. Weight of solute = 405×10^{-4}

$$M = \frac{405\times10^{-4}\times1000}{162\times100} \quad \Rightarrow \quad M = 2.5 \times 10^{-3}$$

16. Weight of solute = 1.9×10^{-4}

$$\Rightarrow \quad M = \frac{1.9\times10^{-4}\times1000}{7\times100}$$

$$\Rightarrow \quad 2.7 \times 10^{-4}$$

17. Molarity of Na^+ i.e. $[Na^+] = \frac{500\times0.2+500\times.5\times2}{1000}$

$$= \frac{600}{1000} = 0.6 \text{ M}$$

18. $M_1V_1 = M_2V_2$

$$\Rightarrow \quad \frac{98\times1.8\times1000}{98\times100}\times V_1 = 2.5 \times 12.5$$

$$\Rightarrow \quad V_1 = 1.736 \text{ liter}$$

19. $$\frac{20\times1000}{63\times100}\times V_1 = \frac{69.8\times1000}{63\times100}\times50$$

$$\Rightarrow \quad V_1 = \frac{69.8\times500}{63}\times\frac{63}{200}$$

$$\Rightarrow \quad V_1 = 174.5 \text{ ml}$$

20. Molarity of diluted solution $= \frac{2.2V}{11V\times0.98}$

$$= \frac{20}{98} = .204 \text{ M}$$

21. $[NaCl]_{mix.} = \frac{500\times2+200\times2}{700}$

$$= \frac{1400}{700} = 2 \text{ M}$$

22. Let amount of H_2O added be V.

$$\Rightarrow \quad \frac{40}{170(1+V)} = \frac{16}{170}$$

$$\Rightarrow \quad V = 1.5 \text{ ml}$$

23.

Let volume of .8 M $AlCl_3$ be V ml

$$0.6 = \frac{.8\times V\times 3+50\times .2\times 2}{50+V}$$

$$\Rightarrow \quad V = \frac{100}{18}$$

i.e. $V = 5.56\,ml$

24. $Ca(OH)_2 + 2HCl \longrightarrow CaCl_2 + 2H_2O$

n 2n

$Al(OH)_3 + 3HCl \longrightarrow AlCl_3 + 3H_2O$

n 2n

$\Rightarrow$ Total moles of HCl = 5n

$\Rightarrow$ $5n = .5 \times 4$

$\Rightarrow$ n = 0.4 moles

$\Rightarrow$ Total moles of mixture = 0.8

25. Let volume of 2.50 M NaOH be V_1
& volume of 0.40 M NaOH be V_2

$\Rightarrow$ $2.50\ V_1 + 0.40\ V_2 = 3$ .....(1)

& $V_1 + V_2 = 3$ .....(2)

Solving (1) & (2)

We get, $\left(\frac{V_1}{V_2} = 0.4\right)$

26. $3BaCl_2 + Al_2(SO_4)_3 \longrightarrow 3BaSO_4 + 2AlCl_3$
moles: $(0.6 \times 30 \times 10^{-3})$ $(20 \times .2 \times 10^{-3})$

$\Rightarrow$ $Al_2(SO_4)$ is L.R.

So, mass of $BaSO_4$ formed = $(3 \times 20 \times .2 \times 10^{-3}) \times 233 = 2.796$ gm

27. Volume strength of resulting solution = $\frac{\frac{20}{1000}\times 50+\frac{10}{1000}\times 200}{\frac{250}{1000}}$ = 12 V

28. $H_2O_2 \longrightarrow H_2O + \frac{1}{2}O_2$

mole: $\frac{500}{22.4}$ 2 1

Volume of O_2 produced from 1 lit H_2O_2 = 2 mole

= 2 × 22.4

= 44.8 liters

29. (i) Let mass of SO_3 be x gm & mass of H_2SO_4 be (100 – x) gm

$\Rightarrow$ $118 = 100 + \frac{18x}{80}$

$\Rightarrow$ x = 80 gm

$\Rightarrow$ mass of H_2SO_4 = 20 gm

(ii) $SO_3 + H_2O \longrightarrow H_2SO_4$

80 gm 18gm 98 gm

24 gm $\left(\frac{98\times24}{80}\right)$

$\Rightarrow$ maximum mass of H_2SO_4 obtained

$= 6+\left(\frac{98\times24}{80}\right) = 35.4$ gm

(iii) If 40 gm water is added

Amount of H_2SO_4 = 35.4 gm

Amount of H_2O = 34.6 gm

30. (a) $x_{H_2SO_4} = \frac{\frac{10}{98}}{\frac{10}{98}+\frac{40}{80}} = 0.169$

(b) % strength of oleum = $100+\frac{18\times80}{80}$ = 118%

31. $C_2H_4 + 3O_2 \longrightarrow 2CO_2 + 2H_2O$

20 mL 40 mL

$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$

30 mL 30 mL

Vol. of CO_2 = 70 mL

32. Let volume of C_xH_y = 'a' ml

$$C_xH_y + \left(x + \frac{y}{4}\right)O_2 \longrightarrow xCO_2 + \frac{y}{2}H_2O$$

Vol. of O_2 req. = $a\left(x + \frac{y}{4}\right)$

Given: Volume of O_2 = 6a

$$\therefore\ 6a = a\left(x + \frac{y}{4}\right)$$

$$\Rightarrow x + \frac{y}{4} = 6 \qquad ...(1)$$

Volume of CO_2 produced = ax

Given: Volume of CO_2 produced = 4a

4a = ax

$\Rightarrow$ x = 4

Putting values of x in equation (1)

$$4 + \frac{y}{4} = 6$$

$\Rightarrow$ y = 8

$\therefore$ x + y = 4 + 8 = 12

33. $2O_3 \longrightarrow 3O_2$

v_i	v	20 – v
v_f	0	20 – v + 1.5v

20 – v + 1.5 v = 29

0.5v = 9 $\Rightarrow$ v = 18 mL

Volume of O_3 = 18 mL Volume of O_2 = 2 mL

Vol. % of O_2 $= \frac{2}{20} \times 100 = 10\%$

34. $C_2H_2 + \frac{5}{2}O_2 \longrightarrow 2CO_2 + H_2O(\ell)$

x mL 2.5x mL 2x ml

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

y mL $\frac{y}{2}$ mL y mL

$x + y = 20$ .....(i) $2x + y = 26$ .....(ii)

$\frac{5x}{2} + \frac{y}{2} = 22 \Rightarrow 5x + y = 44$ .....(iii)

$x = 6$ $y = 14$

Volume of $C_2H_2 = 6$ mL , Volume of CO = 14 mL

EXERCISE (O-II)

1. $SO_3 + H_2O \rightarrow H_2SO_4$

80g 18g 98g

4g $\left(\frac{18}{80}\times 4\right)$g $\left(\frac{98}{80}\times 4\right)$g $\simeq 4.9$ g

$$\% \frac{w}{w} = \left(\frac{(100\times 1.96\times 0.8)+4.9}{100\times 1.96+4}\right)$$

$\simeq 80.8\%$

correct option is (A)

2. Let volume of 0.2 M NaCl be V_1

& volume of 0.1 M $CaCl_2$ be V_2

$$\Rightarrow \quad [Cl^-] = \frac{0.2v_1+0.1\times 2\times v_2}{v_1+v_2} \quad \Rightarrow \quad [\text{cation}] = \frac{0.2v_1+0.1v_2}{v_1+v_2} = 0.6 \times \frac{0.2v_1+0.2v_2}{v_1+v_2}$$

$$\Rightarrow \quad \frac{v_1}{v_2} = 0.25$$

$\Rightarrow$ the correct option is (D)

3.

	Ag_2SO_4	+ $2NaCl$	$\rightarrow$ $2AgCl(\downarrow)$	+ Na_2SO_4
moles	(2×2)	(4×1)	0	0
	2	0	4	2

$\Rightarrow$ molar concentration of all ions = $\frac{4+2+4+2}{6} \simeq 2M$

$\Rightarrow$ correct option is (B)

4. $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

x $(1-x)(0.2)$

Now, $.2(1-x) = 2x$

$$\Rightarrow x = \frac{1}{11}$$

correct option is (A)

5. $[H^+] = \left(\frac{14\times 2}{98\times 100}\right) \simeq \frac{2}{700}$ $\Rightarrow$ correct option is (A)

6. $P_4O_{10} + 6H_2O \rightarrow 4H_3PO_4$

$284g \quad 6 \times 18g$

$xg \quad \left(\frac{18\times6}{284}\right)\times xg$

$\Rightarrow \quad 127 = 100 + \left(\frac{18\times6}{284}\right)\times x \quad \Rightarrow \quad x = 71 \text{ gm} \quad \Rightarrow \quad$ correct option is (A)

ONE OR MORE THAN ONE MAY BE CORRECT

7. (A) Wt. of NaOH = $50\times\frac{80}{100}=40g$ (B) Wt. of NaOH = $\frac{50}{1.2}\times\frac{80}{100}=33.33g$

(C) Wt. of NaOH = $\frac{50}{1000}\times20\times40=40g$ (D) Wt. of NaOH = $\frac{50}{1000}\times5\times40=10g$

8. NaOH solution is 7 molal i.e. 7 moles of NaOH are present per kg of solvent.

Mass of NaOH = 7 × 40 = 280 gm

Mass of solution = Mass of NaOH + Mass of solvent

= 280 + 1000 = 1280 gm.

(A) $\frac{w}{w}\% = \frac{\text{Mass of NaOH}}{\text{Mass of solution (in gm)}}\times100$

$=\frac{280}{1280}\times100=21.7$

(C) Moles fraction of H_2O = $X_{H_2O} = \frac{\text{Moles of } H_2O}{(\text{Moles of } H_2O + \text{Moles of NaOH})}\times1$

$X_{H_2O} = \frac{1000/18}{\left(\frac{1000}{18}+7\right)}\times1=\frac{55.55}{62.55}\times1$

= 0.88

$X_{NaOH} = \frac{\text{Moles of NaOH}}{(\text{Moles of NaOH + moles of } H_2O)}\times1$

$=\frac{7}{(7+55.55)}=\frac{7}{62.55}$

At. mass of Na = 23

9. 2 moles of solute in 1L of solution.
Mass of solution = 1090 g; mass of solvent = 900 g

Molality of Cl^- = $\frac{2\times2\times1000}{900}=4.44$; Mole fraction $MgCl_2$ = $\frac{2}{52}=0.038$

%w/V = $\frac{190\times100}{1000}=19\%$ PPM of $MgCl_2$ = $\frac{190\times10^6}{1090}=17.43\times10^4$

10. M = $\frac{56}{11.2}=5$ %w/V = $\frac{170}{1000}\times100=17\%$

Mole fraction = $\frac{5}{5+\left[\frac{530-170}{18}\right]}=0.2$ m_{H2O2} = $\frac{5}{0.360}=\frac{1000}{72}$

11. $Ca(NO_3)_2 + Na_2C_2O_4 \rightarrow CaC_2O_4 + 2NaNO_3$

6 mmoles	3 mmoles	0	0
3 mmoles	0	3	6

$[Ca^{2+}]_f$ = $\frac{3}{150}=0.02\,M$ $[C_2O_4^{2-}]_f$ = $\frac{3}{150}=0.02\,M$

13. M = $\frac{9.8}{98}\times10\times1.5=1.5$
Moles of $H_2SO_4 = 1.5\times2=3$

14. moles of H^+ $= 3\times2=6$
moles of OH^- $= 3\times1=3$

$\left[H^+\right]_f = \frac{6-3}{5} = \frac{3}{5}M$

15. $n_{SO_3} = \frac{20}{80} = \frac{1}{4}$

$n_{H_2SO_4} = \frac{30}{98}$

$$X_{SO_3} = \frac{0.25}{0.25 + \frac{30}{98}} = 0.45$$

16. $SO_3 + H_2O \longrightarrow H_2SO_4$

$\frac{1}{4}$ mol $\quad\quad$ $\frac{1}{4}$ mol

Mass of H_2O vacts with 50g sample = 4.5g

% labeling of oleum = 100 + 2 × 4.5 = 109%

17. Moles of AgBr = moles of Br

Moles of Br = $\frac{0.12}{188}$

Mass of Br = $\frac{0.12}{188} \times 80$ = 0.051g

Mass % = $\frac{0.051}{0.15}$ × 100 = 34 %

18. Moles of S = moles of $BaSO_4$ = $\frac{0.35}{233}$

Mass of S = $\frac{0.35}{233}$ × 32 = 0.048g

Mass % of S = $\frac{0.048}{0.2595} \times 100$ = 18.25 %

19. 1 × moles of P = 2 × moles of $Mg_2P_2O_7$ = 2 × $\frac{0.22}{222}$

Mass of P = $\frac{0.44}{222} \times 31$ = 0.0614g

Mass % of P = $\frac{0.0614}{0.12} \times 100$ = 51.20 %

20. 1 × moles of P = 2 × moles of $Mg_2P_2O_7$

Moles of $Mg_2P_2O_7$ = $\frac{1}{2} \times \frac{10 \times 6.2}{100} \times \frac{1}{31} = \frac{1}{100}$

Mass of $Mg_2P_2O_7 = \frac{1}{100} \times 222 = 2.22g$

21. $P_{N_2} = 715 - 15 = 700$ mm

$$n_{N_2} = \frac{\frac{700}{760} \times 50 \times 10^{-3}}{0.0821 \times 300} = 0.00187$$

Mass of N – atom = 0.00187 × 28 = 0.05236g

$$\text{Mass \% of N} = \frac{0.05236}{0.3} \times 100 = 17.46\ \%$$

22. $2NH_3 + H_2SO_4 \longrightarrow$ wt. of N $= \frac{14 \times 20}{1000}$

20 m mol 10 mmol $= 0.28g$

$2NaOH + H_2SO_4 \longrightarrow$ % wt. of N $= \frac{0.28}{0.5} \times 100$

30 m mol 15 m mol $= 56\ \%$

23. $2\ NH_3 + H_3PO_3 \longrightarrow$ wt. of N $= \frac{14 \times 20}{1000}$

20 m mol 10 m mol $= 0.28$ g

$Ca(OH)_2 + H_3PO_3$ % wt. of N $= \frac{0.28}{0.4} \times 100$

15 m mol 15 m mol $= 70\ \%$

24. $2NH_3 + H_2SO_4 \longrightarrow$ wt. of N $= 14 \times 0.4 \times 10^{-4}$

0.4×10^{-4} 0.2×10^{-4} $= 5.6 \times 10^{-4}$

$$\text{\% wt. of N} = \frac{5.6 \times 10^{-4}}{2 \times 10^{-3}} \times 100 = 28\%$$

25. (A) 10 moles MgO $\longrightarrow$ 1 lit solution

400 gm MgO $\longrightarrow$ 1200 gm solution

400 gm MgO $\longrightarrow$ 800 gm solvent

OR 800 gm solvent $\longrightarrow$ 1200 gm solution

OR 100 gm solvent $\longrightarrow$ 150 gm solution

Option (Q) is correct

(B) 40 gm solute $\longrightarrow$ 100 ml solution

40 gm solute $\longrightarrow$ 160 gm solution

40 gm solute $\longrightarrow$ 120 gm solvent

Option (P) is matching

(C) 8 m $CaCO_3$

8 mole $CaCO_3$ $\longrightarrow$ 1000 gm solvent

800 gm $CaCO_3$ $\longrightarrow$ 1000 gm solvent

100 gm $CaCO_3$ $\longrightarrow$ 125 gm solvent

Option (S) is matching

(D) 0.6 moles of X $\longrightarrow$ 0.4 moles of Y

12 gm X $\longrightarrow$ 10 gm of Y

120 gm solute $\longrightarrow$ 100 gm of solvent

(R) is correct option

26. (A) $M = \frac{20}{11.35} = 1.76$

(B) $M = \frac{24.5 \times 10}{98} = 2.5$

(C) $M = \frac{1000}{18} = 55.5$

(D) $M = \frac{5}{40} \times 10 \times 1.2 = 1.5$

27. (A) $M = \frac{2}{1} = 2$

$\%\ w/w = \frac{120}{1200} \times 100 = 10\ \%$

$$\% \text{ w/v} = \frac{120}{1000} \times 100 = 12\%$$

$$m = \frac{2 \times 1000}{1200 - 120} = 1.85$$

(B) $$M = \frac{120}{180} = \frac{2}{3}$$

$$\% \text{ w/w} = \frac{120}{1200} \times 100 = 10\%$$

$$\% \text{ w/v} = \frac{120}{1000} \times 100 = 12\%$$

$$m = \frac{2/3}{1080} \times 1000 = 0.617$$

(C) $$\% \text{ w/w} = \frac{1 \times 60}{60 + 540} \times 100 = \frac{60}{600} \times 100 = 10\ \%$$

$$m = \frac{1}{540} \times 1000 = 1.85$$

(D) $$M = \frac{19.6}{98} \times 10 = 2 \qquad \% \text{ w/w} = \frac{19.6}{120} \times 100 = 16.33\%$$

$$m = \frac{2}{1200 - 196} \times 1000 = 1.99$$

EXERCISE (S-II)

1. 120 g, 40% (w/w) NaCl + 200g, 15% (w/w) NaCl

$W_{NaCl} = 120 \times \frac{40}{100} = 48g$ $W_{NaCl} = 200 \times \frac{15}{100} = 30g$

$W_{solvent} = 72$ g $W_{solvent} = 170$g

$W_{solution} = 320$ g

(a) mass % = $\frac{78}{320} \times 100 = 24.375$

(b) m = $\frac{78/58.5}{242} \times 1000 = 5.5$

(c) $X_{solute} = \frac{78/58.5}{78/58.8 + \frac{242}{18}} = \frac{1.33}{1.33+13.44} = 0.09$

(d) M = $\frac{78/58.5}{320} \times 1.6 \times 1000 = 6.6$

(e) % (w/w) = $\frac{78}{320} \times 1.6 \times 100 = 39$ %

2. $\frac{n_{urea}}{n_{H_2O}} = \frac{1}{4}$

$\Rightarrow \frac{W_{urea}}{W_{H_2O}} = \frac{60}{72}$

$\Rightarrow$ weight of solution= 132 gm

In 132 gm mole of urea = 1

$\Rightarrow$ In 500 gm mole of urea = $\frac{1}{132} \times 500$

Also, In 132 gm, mole of H_2O = 4

In 500gm, mole of H_2O = $\frac{4}{132} \times 500$

Now, on dilution

$$x_{solute} = \frac{\frac{500}{132}}{\frac{500}{132}+\left(\frac{4}{132}\times 500+\frac{1000}{18}\right)} = 0.05$$

3. $H_3PO_4 + 3NaOH \longrightarrow Na_3PO_4 + 3H_2O$

m moles of NaOH = 3 × m moles if H_3PO_4

= 3 × 20 × 2 = 120

$M_{NaOH} \times 300 = 120$

$M_{NaOH} = 0.4$

$$0.4 = \frac{0.2\times V+500\times 0.5}{V+500}$$

V = 250 mL

4. $Al_2(SO_4)_3 + 3Ca(NO_3)_2 \longrightarrow 2Al(NO_3)_3 + 3CaSO_4$

$\frac{1}{3}\times\frac{1}{136}$ mol $\qquad\qquad \frac{1}{136}$ mol

$$0.1 \times V(L) = \frac{1}{3\times 136}$$

V(mL) = 24.51 mL

5. Mass of fat = 100 × 0.875 = 87.5 g

Mass of fat free milk = 1035 – 87.5 = 947.5 g

Vol. of fat free milk = 900 mL

Density of fat free milk = $\frac{947.5}{900}$ = 1.052 g/mL

6. $[B^-] = \frac{100\times 0.1+100\times 0.2\times 2}{150+250}\times 4$ = 0.5 M

7. $60 \times \frac{x}{100}\times 0.6 = \frac{12}{100} \times 0.9 \times 200$

X = 60 mL

8. $m = \frac{2+8}{3} = \frac{10}{3}$

9. $2Al + 2\,NaOH + 2H_2O \longrightarrow 2NaAlO_2 + 3H_2$

2 moles 3 moles

Total mass of NaOH = 5 × 0.1 × 40 + 200 × 1.5 × 0.2 = 80 g

V_{H_2} = at STP = 3 × 22.7 = 68.1 L

10. $M = \frac{2 \times 0.5 + \frac{72}{60}}{1.1} = 2$

13. $CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$

x mL 2x mL x mL

$C_2H_4 + 3O_2 \longrightarrow 2CO_2 + 2H_2O$

y mL 3y mL 2y mL

$CO_2 + O_2 \longrightarrow$ X (no reaction)

z mL

x + y + z = 10 .....(i) y = 4

$\Delta v = 10 + v - [10 + y + v - 2x - 3y] = 17$

$2x + 2y = 17 \Rightarrow x = 4.5$

Volume of CH_4 = 4.5 mL

Volume of C_2H_2 = 4 mL z = 1.5

Volume of CO_2 = 1.5 mL

EXERCISE (JEE – MAINS)

1. $C_xH_yO_z + \left(x+\frac{y}{4}-\frac{z}{2}\right)O_2 \longrightarrow xCO_2 + \frac{y}{2}H_2O$

0.3g 0.2g 0.1g

$$\frac{n_{CO_2}}{n_{H_2O}} = \frac{x}{y/2} = \frac{0.2/44}{0.1/18}$$

$$\frac{2x}{y} = \frac{36}{44} = \frac{9}{11}$$

$$x = \frac{9y}{22}$$

$$\frac{n_{C_xH_yO_z}}{n_{CO_2}} = \frac{1}{x}$$

$$\frac{0.3}{12x+y+16z} \times \frac{44}{0.2} = \frac{1}{x}$$

66x = 12 x + y + 16 z

54x = y + 16 z

$$\frac{54\times 9y}{22} - y = 16z$$

$$\frac{464y}{22} = 16z$$

$$z = \frac{29y}{22}$$

$C_xH_yO_z = C_xH_yO_z$

$$C_{\frac{9y}{22}}H_yO_{\frac{29y}{22}}$$

$C_9H_{22}O_{29}$

$$\% \text{ of C} = \frac{12\times 9}{(12\times 9+22+29\times 16)} \times 100 = \frac{108}{594} \times 100$$

2. $\text{ppm} = \frac{W_{Mg}}{V_{soln.}} \times 10^6 = 48$

$\Rightarrow W_{Mg} = \frac{48 \times 2 \times 1000}{10^6}$

$= 48 \times 2 \times 10^{-3}\text{g}$

$n_{Mg} = \frac{W_{Mg}}{24} = \frac{48 \times 2 \times 10^{-3}}{24}$

$= 4 \times 10^{-3}$

Number of Mg atoms $= 4 \times 10^{-3} \times 6.02 \times 10^{23}$

$= 4 \times 6.02 \times 10^{20}$

$= 24.08 \times 10^{20}$

$\therefore x = 24.08$

3. m_{eq} of NaOH used $= 30 \times 0.25$

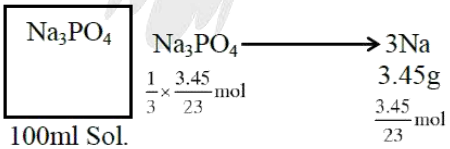
m_{eq} of H_2SO_4 taken $= 50 \times 0.5$

$\therefore$ m_{eq} of H_2SO_4 used

$= 50 \times 0.25 \times 30 \times 0.25 = 17.5$ m mol of NH_3

$\therefore \%\ N = \frac{17.5 \times 10^{-3} \times 14}{0.166} \times 100 = 147.59\%$ (Not Possible)

4.



therefore molarity of Na_3PO_4 Solution $= \frac{n_{Na_3PO_4}}{\text{Volume of solution in L}}$

$= \frac{\frac{1}{3} \times \frac{3.45}{23}\text{mol}}{0.1\text{L}}$

$= 0.5 = 50 \times 10^{-2}$

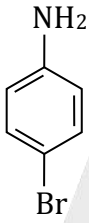
6. Moles of N in N,N – dimethylaminopentane

$$=\left(\frac{57.5}{115}\right)=0.5\,\text{mol}$$

$$\Rightarrow C_7H_{17}N+\frac{45}{2}CuO\longrightarrow 7CO_2+\frac{17}{2}H_2O+\frac{1}{2}N_2+\frac{45}{2}Cu$$

$$\frac{n_{CuO}\text{reacted}}{\left(\frac{45}{2}\right)}=\frac{n_{C_7H_{17}NB}\ \text{reacted}}{1}$$

$$\Rightarrow n_{CuO}\text{ reacted}=\left(\frac{45}{2}\right)\times 0.5=11.25$$

7. So compound is 

9. Molecular mass of $BaSO_4$ = 233 g

$\because$ 233 $BaSO_4$ contain $\longrightarrow$ 32 g sulphur

$\therefore$ 1.44 g $BaSO_4$ contain $\rightarrow \frac{32}{233}\times\times$ 1.44 g sulphur given : 0.471 g of organic compound

$$\%\text{ of S}=\frac{32\times 1.44}{233\times 0.471}\times 100=41.98\%\approx 42\%$$

11. $C_xH_y+\left(x+\frac{y}{4}\right)O_2\longrightarrow xCO_2+\frac{y}{2}H_2O$

Vol. of CO_2 = x × vol. of C_xH_y

4.0 = x × 10

x = 4

Vol. of $O_2=\left(x+\frac{y}{4}\right)$ × vol. of C_xH_y

$$55 = \left(x + \frac{y}{4}\right) \times 10$$

$y = 6$

Hence hydrocarbon is C_4H_6

12. $$X_{NaOH} = \frac{\frac{8}{40}}{\frac{8}{40} + \frac{18}{18}} = 0.167$$

$$\text{Molality} = \frac{\frac{8}{40} \times 1000}{18} = 11.11$$

13. Volume strength = M × 11.35

= 1 × 11.35

= 11.35

14. Moles of $CoCl_3 . 6H_2O = 10^{-2}$

moles of AgCl precipitated $= \frac{1.2 \times 10^{22}}{6 \times 10^{23}} = 2 \times 10^{-2}$

moles of Cl^- precipitated $= 10^{-2}$

15. Initial mmoles of $CH_3COOH = 0.06 \times 50$

Final mmoles of $CH_3COOH = 0.042 \times 50$

Hence, mass of CH_3COOH adsorbed per gram of charcoal

$= \frac{(0.06 - 0.042) \times 50 \times 10^{-3} \times 60 \times 10^3}{3}$ = 18 mg

16. Mass of organic compound = 1.4 g

let it contain x mmole of N atom.

organic compound $\longrightarrow$ NH_3

x m mole

$2NH_3 + H_2SO_4 \longrightarrow (NH_4)_2 SO_4$. (1st)

6 mmole

initially taken.

$H_2SO_4 + 2NaOH \longrightarrow Na_2SO_4 + 2H_2O$ (2nd)

2 mmole

reacted

Hence m moles of H_2SO_4 reacted in 2nd equation = 1

$\Rightarrow$ m moles of H_2SO_4 reacted from 1st equation = 6 – 1 = 5 m moles

$\Rightarrow$ m moles of NH_3 in 1st equation = 2 × 5 = 10 m moles

$\Rightarrow$ m moles of N atom in the organic compound = 10 m moles

$\Rightarrow$ mass of N = $10 \times 10^{-3} \times 14 = 0.14$ g

$\Rightarrow$ % of N = $\frac{0.14}{1.4} \times 100 = 10\ \%$

17. $BaCl_2 + H_2SO_4 \rightarrow BaSO_4 + 2\ HCl$

$\frac{20.8}{208} = 0.1 \qquad \frac{4.9}{98} = 0.05$

Mole of $BaSO_4$ formed = 0.05

Wt. of $BaSO_4$ formed = 0.1×233 = 11.65 gram

18. 3M = 3 moles of solute present in 1L of solution

Wt. of solute = 3 ×58.5 = 175.5 g

Wt. of solution = 1000 mL ×1.252 = 1252 g

Wt. of solvent =1252 – 175.5 = 1076.5

$m = \frac{3 \times 1000}{1076.5} = 2.786$

19. $M_1V_1 + M_2V_2 = M_3V_3$

$2 \times 10 + 0.5 \times 200 = M_3 \times 210$

$M_3 = 0.57$ M

20. Molarity $= \frac{\text{mols of solute}}{\text{volume of sol. } (\ell)} = \frac{120 \times 1.15}{60 \times 1120} = 2.05$ M

21. Molarity $= \frac{\text{mols of solute} \times 1000}{\text{volume of sol. (mL)}} = \frac{95 \times 1.834 \times 1000}{98 \times 100} = 17.778$

22. $X_{\text{ethyl alcohol}} = \frac{5.2}{5.2 + \frac{1000}{18}} = 0.086$

23. $\text{Molarity} = \frac{\text{mols of solute}}{\text{volume of sol. } (\ell)} = \frac{6.02 \times 10^{21} \times 1000}{6.02 \times 10^{23} \times 100} = 0.1 \text{ M}$

JEE ADVANCED

1. $H_2C_2O_4 + 2NaOH \rightarrow Na_2C_2O_4 + 2H_2O$

5mlM

0.1M

By law of equivalence

Number of eq. of NaOH = Number of eq. of oxalic acid

$$M = [NaOH] = \frac{[H_2C_2O_2]\ Xvol.X2}{vol.of\ 2aOH}$$

$$[NaOH]_1 = \frac{5 \times 0.1 \times 2}{12.5} = \frac{1}{12.5}$$

$$[NaOH]_3 = \frac{5 \times 0.1 \times 2}{9} = \frac{1}{9} = [NaOH]_4 = [NaOH]_5$$

$$[NaOH]\ FinalResult\ = \frac{\frac{1}{12.5} + \frac{1}{10.5} + \frac{1}{9} \times 3}{5}$$

$$[NaOH]\ FinalResult\ = \frac{\frac{2}{25} + \frac{2}{21} + \frac{1}{3}}{5}$$

$$[NaOH]\ FinalResult\ = \frac{0.08 + 0.095 + 0.333}{5}$$

$= 0.102 \simeq 0.11$ Ans.

2. Let, mole of urea = x

According to the question,

$$\frac{x}{x + \frac{900}{18}} = 0.05$$

$$\Rightarrow x = \frac{50}{19}$$

We know,
Mass of solution = mass of solute + mass of solvent

$$= \frac{50}{19} \times 60 + 900 = \frac{20100}{19}$$

Again, density = mass / volume
So,

$$\text{Volume of solution} = \frac{20100}{19 \times 1.2} \text{ mL}$$

$$= \frac{20.1}{19 \times 1.2} \text{ L}$$

$$\text{Therefore, Molarity} = \frac{\text{moles}}{\text{volume(L)}} = \frac{\frac{50}{19}}{\frac{20.1}{19\times1.2}}$$

$$= \frac{60}{20.1} = 2.98\text{M}$$

3. $\frac{X_{solute}}{X_{solvent}} = \frac{0.1}{0.9} = \frac{1}{9}$

$\frac{W_{solute}}{W_{solvent}} \times \frac{M_{solvent}}{M_{solute}} = \frac{1}{9}$ ..... (Eq. 1)

$W_{solute} + W_{solvent}$ = Density × Volume

$W_{solute} + W_{solvent} = 2 \times V$

Molarity = Molality..... (Given)

$$\frac{n_{solute}}{V_{solution}} = \frac{n_{solute}}{W_{solvent}}$$

$$W_{solvent} = V_{solution} = \frac{W_{solute} + W_{solvent}}{2}$$

$2W_{solvent} = W_{solute} + W_{solvent}$

$W_{solute} = W_{solvent}$ ..... (Eq. 2)

From (1) and (2),

$$\frac{M_{solute}}{M_{solvent}} = 9$$

4. Given 3.2 M solution
∴ moles of solute = 3.2 mol

Consider 1 L Solution.

$\therefore$ volume of solvent = 1 L

$P_{solvent}$ = 0.4 g.mL^{-1} $\therefore$ $m_{solvent}$ = P × V = 400 g

$\therefore$ molality = $\frac{3.2 \text{ mol}}{0.4 \text{ kg}}$ = 8 molal

5. Mole = $\frac{120}{60}$ = 2

mass of solution = 1120 g

V = $\frac{1120}{1.15\times1000}$ = L

M = $\frac{2\times115}{112}$ = 2.05 mol/litre

6. Moles of CH_3COOH absorbed = Initial moles – Final moles

= 0.5 × 100 × 10^{-3} – 0.049 × 100 × 10^{-3}

= 0.05 – 0.049 = 0.001

No. of molecules of CH_3COOH absorbed

= 0.001 × 6.02 × 10^{23}

= 6.02 × 10^{20}

Surface area = 3.01 × 10^2 m^2 (given)

Surface area of charcoal absorbed by in each

Molecule of charcoal absorbed by in each

Molecule of CH_3COOH = $\frac{3.01\times10^2}{6.02\times10^{20}}$ = 5 × 10^{-19} m^2

7. Density of the Water = 1000 kg/m^3

We know,

1 liter of water = 1 kg.

(Since, Density is 1000 kg/m^3

Thus, 1000ml of water = 1 kg.

(Since, 1 liter = 1000ml)

Now, Mass of Water = 1 kg. = 1000 g.

The molecular mass of the water molecules = 18 grams.

Using the formula,

$$\text{No.of moles} = \frac{\text{mass}}{\text{molar mass}}$$

$$= \frac{1000}{18}$$

$= 55.56$ moles

For the Molarity,

Using the Formula,

$$\text{Molarity} = \frac{\text{Number of moles}}{\text{volume in ml}} \times 1000$$

$$= \frac{55.56}{1000} \times 1000$$

$= 55.56M$