CHEMISTRY

NCERT - NCERT CHEMISTRY(TELUGU)

SOLUTIONS

Example

1. Calculate the mole fraction of ethylene glycol $(C_2H_6O_2)$ in a solution containing $20\,\%$ of $C_2H_6O_2$ by mass.

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2. Calculate the molarity of a solution containing 5g of Sodium Hydroxide (NaOH) in 450 ml solution.

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3. Calculate molality of 2.5 of ethanoic acid (CH_3COOH) in 75g of benzene.

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4. If N_2 gas is bubbled through water at 293 K, how many millimoles of N_2 gas would dissolve in 1 litre of water ? Assume that N_2 exerts a partial pressure of 0.987 bar. Given that Henry's law constant for N_2 at 293 K is 76.48 k bar.

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5. Vapour pressure of chloroform $(CHCl_3)$ and dichloromethane (CH_2Cl_2) at 298 K are

200 mm Hg and 415 mm Hg respectively. (i) Calculate the vapour pressure of the solution prepared by mixing 25.5 g of $CHCl_3$ and 40 g of CH_2Cl_2 at 298 K and (ii) mole fractions of each component in vapour phase.

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6. The vapour pressure of pure benzene at a certain temperature is 0.850 bar. A non-volatile, non-electrolyte solid weighing 0.5g when added to 39.0 g of benzene (molar mass

78 g mol^{-1}), vapour pressure of the solution, then, is 0.845 bar. What is the molar mass of the solid substance ?

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7. 18g of glucose, $C_6H_{12}O_6$, is dissolved in 1 kg of water in a saucepan. At what temperature will water boil at 1.013 bar ? K_b for water is 0.52 kg mol^{-1}.

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8. The boiling point of benzene is 353.23 K. When 1.80 g of a non-volatile solute was dissolved in 90 g of benzene, the boiling point is raised to 354.11 K. Calculate the molar mass of the solute. K_b for benzene is $2.53 \ \mathrm{K\ kg\ mol^{-1}}$.

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9. 45 g of ethylene glycol $(C_2H_6O_2)$ is mixed with 600 g of water. Calculate (a) the freezing

point depression and (b) the freezing point of the solution.

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10. 1.00 g of a non-electrolyte solute dissolved in 50g of benzene lowered the freezing point of benzene by 0.40 K. The freezing point depression constant of benzene is 5.12 K kg mol^{-1}. Find the molar mass of the solute.

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11. $200\ \mathrm{cm}^2$ of an aqueous solution of a protein contains 1.26 g of the protein. The oxmotic pressure of such a solution at 300 K is found to be 2.57×10^{-3} bar. Calculate the molar mass of the protein.

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12. 2 g of benzoic acid (C_6H_5COOH) dissolved in 25g of benzene shows a depression in freezing point equal to 1.62 K. Molal depression constant for benzene is 4.9 K

kg mol^{-1}. What is the precentage association of acid if it forms dimer in solution ?

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13. 0.6 mL of acetic acid (CH_3COOH), having density $1.06\ \mathrm{g\,mL}^{-1}$, is dissolved in 1 litre of water. The depression in freezing point observed for this strength of acid was $0.0205^{\circ}C$. Calculate the van't Hoff factor and the dissociation constant of acid.

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Intext Questions

1. Calculate the mass percentage of benzene (C_6H_6) and carbon tetrachloride (CCl_4) if 22g of benzene is dissolved in 122g of carbon tetrachloride.

Then, calculate the mass percentage from the formula

$$\text{Mass } \% = \frac{\text{Mass of one component}}{\text{Mass of solution}} \times 100$$

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2. Calculate the mole fraction of benzene is solution containing $30\,\%$ by mass in carbon tetrachloride.

Then calculate the mole fraction by using the formula

Mole fraction of a component $= \dfrac{\text{Number of moles of the component}}{\text{Total number of moles of all components}}$

$$x_A = \frac{n_A}{n_A + n_B}$$

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3. Calculate the molarity of each of the following solution :

(a) 30g of $CO(NH_3)_2.6H_2O$ in 4.3 L of solution.

(b) 30 mL of $0.5 \ \mathrm{MH_2SO_4}$ diluted to 500 mL.

(a) Molarity $= \dfrac{\text{moles of solute}}{\text{Volume of solution litre}}$

and moles of solute $= \dfrac{\text{mass of solute}}{\text{molar solution of solute}}$

So, first find molar mass by adding atomic masses of different elements, then find moles of solute and then molarity.

(b) Use molarity equation for dilution.

$M_1V_1 = M_2V_2$

(Before dilution) (After dilution)

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4. Calculate the mass of urea (NH_2CONH_2) required in making 2.5 kg of 0.25 molar aqueous solution.

We know that molarity (m) $= \frac{\text{Moles of solute}}{\text{Mass of solvent in kg}}$

and moles of soute $= \frac{\text{Mass of solute}}{\text{Molar mass of solute}}$

So, find the molar mass of solute by adding

atomic masses of different element present in it and mass by using the formula,

Molality

$$= \frac{\text{Mass of solute/molar mass of solute}}{\text{Mass of solvent in kg}}$$

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5. Calculate a) molality b) molarity and c) mole fraction of KI if the density of $20\,\%$ (mass / mass) aqueous KI is $1.202 \ \ \mathrm{g\,mL^{-1}}$.

As density and % by mass is given, so find the mass of solute and solvent (as x % solution

contains x g solute in (100 - x) g solvent).

Find volume of the solution, by using„

$$\text{Volume} = \frac{\text{Mass}}{\text{Density}}$$

Recall the formulae of molality, molarity and mole fraction, to calculate them.

Molality

$$= \frac{\text{Mass of solute/ molar mass of solute}}{\text{Mass of solventin kg}}$$

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6. H_2S, a toxic gas with rotten egg like smell, is used for the qualitative analysis. If the

solubility of H_2S in water at STP is 0.195m, calculate Henry's law constant.

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7. Henry's law constant for CO_2 in water is 1.67×10^8 Pa at 298 K. Calculate the quantity of CO_2 in 500 mL of soda water when packed under 2.5 atm CO_2 pressure at 298 K.

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8. The vapour pressure of pure liquids A and B are 450 and 700 mm Hg respectively, at 350 K. Find out the composition of the liquid mixture if total vapour pressure is 600 mm Hg. Also find the composition of the vapour phase.

Apply Raoult's law $P_T = P_A^0 x_A + P_B^0 x_B = P_B^0 x_A + P_B^0(1 - x_A)$ to calculate mole fraction of $A(x_A)$ and $B(x_B)$.

In vapour phase, partial pressure are used insted of number of moles.

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9. Vapour pressure of pure water at 298 K is 23.8 mm Hg. 50g urea (NH_2CONH_2) is dissolved in 850 g of water. Calculate the vapour pressure of water for this solution and its relative lowering.

Consider Raoult's law and formula for relative lowering in vapour pressure,

$$\frac{P_A^0 - P_s}{P_A^0} = \frac{n_B}{n_A} = \frac{W_B}{M_B} \times \frac{M_A}{W_A}$$

Where, $\frac{P_A^0 - P_s}{P_A^0}$ is called relative lowering in vapour pressure.

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10. Boiling point of water 750 mm Hg is $99.63^{\circ}C$. How much sucrose is to be added to 500 g of water such that it boils at $100^{\circ}C$.

$\left[K_b \text{ for water is } 0.52 \ \ \mathrm{K\ kg\ mol^{-1}}\right]$

i) Since boiling point is changing, apply the formula for elevation in boiling point,

$\Delta \mathrm{T}_b = K_b m$

ii) $m = \dfrac{W_B}{M_B . W_A}$

So, $\Delta T_b = \dfrac{K_b . W_B}{M_B \times W_A}$

Or $W_B = \dfrac{\Delta T_b \times M_B \times W_A}{K_b}$

iii) Find ΔT_b as $\Delta T_b = T_b = T_b - T_b^0$

T_b= Boiling point of solution

T_b^0 = Boiling point of pure solvent

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11. Calculate the mass of ascorbic acid (Vitamin C, $C_6H_8O_6$) to be dissolved in 75 g of acetic acid to lower its melting point by $1.5^\circ C$. $K_f = 3.9 \text{ K kg mol}^{-1}$

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12. Calculate the osmotic pressure in pascals exerted by a solution prepared by dissolving 1.0 g of polymer of molar mass 185,000 in 450 mL of water at $37^{\circ} C$

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Exrecises

1. How many types of solutions are formed ? Givee an example for each type of solution.

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2. Suppose a solid solution is formed between two substances, one whose particles are very large and the other whose particles are very small. What kind of solid solution is this likely to be?

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3. Define the following terms:

(i) Mole fraction (ii) Molality (iii) Molarity (iv)

Mass percentage.

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4. Concentrated nitric acid used in the laboratory work is 68% nitric acid by mass in aqueous solution. What should be the molarity of such a sample of the acid if the denisty of the solution is $1.504 \ \mathrm{mL}^{-1}$?

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5. A solution of glucose in water is labelled as $10\,\%$ w/w. What would be the molarity of the solution ?

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6. How many ml of 0.1 HCl is required to react completely with 1.0g mixture of Na_2CO_3 and $NaHCO_3$ containing equi-molar amounts of both ?

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7. A solution is obtained by mixing 300g of $25\,\%$ solution and 400g of $40\,\%$ solution by mass. Calculate the mass percentage of the resulting solution.

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8. An antifreeze solution is prepared from 222.6g of ethylene glycol $[(C_2H_6O_2)]$ and 200g of water (solvent). Calculate the molality of the solution.

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9. A sample of drinking water was found to be severely contaminated with chloroform $(CHCl_3)$ supposed to be a carcinogen. The level of contamination was 15 ppm (by mass):

(i) express this in percent by mass

(ii) determine the molality of chloroform in the water sample.

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10. What role do the molecular interactions play in a solution of alcohol and water ?

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11. Why do gases always tend to be less soluble in liquids as the temperature is raised ?

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12. State Henry's law and mention some important applications?

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13. The partial pressure of ethane over a solution containing 6.50×10^{-3} g of ethane is 1 bar. If the solution contains $5.00 \times 10^{-2} g$ of ethane, then what shall be the partial pressure of the gas?

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14. What is meant by positive deviations from Raoult's law and how is the sign of $\Delta_{\text{mix}}H$ related to positive deviation from Raoult's law ?

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15. An aqueous solution of 2% non volatile solute exerts a pressure of 1.004 bar at the normal boiling point of the solvent. What is the molecular mass of the solute ?

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16. Heptane and Octane form an ideal solution. At 373 K the vapour pressure of the two liquid components are $105.2\ \mathrm{kP}_a$ and $46.8\ \mathrm{kP}_a$ respectively. What will be the vapour pressure of a mixture of 26.0 g heptane and 35g of octane ?

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17. The vapour pressure of water is 12.3 k P_a at 300 K. Calculate the vapour pressure of 1 molal solution of a non-volatile solute in it.

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18. Calculate the mass of a non-volatile solute (molar mass $40\mathrm{g\,mol^{-1}}$) which should be dissolved in 114g Octane to reduce its vapour pressure to $80\,\%$.

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19. A solution containing 30g of non-volatile solute exactly in 90g of water has a vapour pressure of $2.8\ \mathrm{kP}_a$ at 298 K. Further 18g of water is then added to the solution and the new vapur pressure becomes $2.9\ \mathrm{kP}_a$ at 298 K. Calculate (i) The moar mass of the solute and (ii) Vapour pressure of water at 298 K.

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20. A 5% solution (by mass) of cane suger in water has freezing point of 271K. Calculate the freezing point of 5% glucose in water if freezing point of water is 273.15 K.

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21. Two elements A and B from compounds having formula AB_2 and AB_4. When dissolved in 20g of Benzene (C_6H_6), 1g of AB_2 lowers the freezing point by 2.3 K whereas 1.0g of

AB_4 lowers it by 1.3 K. The molar depression constant for benzene is 5.1 K kg mol^{-1}. Calculate atomic masses of A and B.

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22. At 300 K, 36 g of glucose present in a litre of its solution has an osmotic pressure of 4.98 bar. If the osmotic pressure of the solution is 1.52 bars at the same temperature, what would be its concentration?

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23. Suggest the most important type of intermolecular attractive interaction in the following pairs.

(i) n-hexane and n-octane

(ii) I_2 and CCl_4

(iii) $NaClO_4$ and water

(iv) methanol and acetone

(v) acetonitrile (CH_3CN) and acetone (C_3H_6O)

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24. Based on solute-solvent interactions, arrange the following in order of increasing solubility in n-octane and explain. Cyclohexane, KCl , CH_3OH, CH_3CN

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25. Amongst the following compounds, identify which are insoluble, partially soluble and highly soluble in water. (i) phenol (ii) toluene (iii) formic acid (iv) ethylene glycol (v) chloroform (vi) pentanol.

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26. If the density of some lake water is 1.25 $\mathrm{g\,mL^{-1}}$ and contains 92 $\mathrm{g\ of}$ Na^+ ions per kg of water, calculate the molality of Na^+ ions in the lake.

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27. If the solubility product of CuS is 6×10^{-16}, calculate the maximum molarity of

CuS in aqueous solution.

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28. Calculate the mass precentage of aspirin $(C_9H_8O_4)$ in acetonitrile (CH_3CN) when 6.5 gm of $C_9H_8O_4$ is dissolved in 450g of CH_3CN.

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29. Nalorphene$(C_{19}H_{21}NO_3)$, similar to morphine, is used to combat withdrawal symptoms in narcotic users. Dose of nalorphene generally given is 1.5 mg. Calculate the mass of 1.5 - 10^3 m aqueous solution required for the above dose

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30. Calculate the amount of benzoic acid (C_6H_5COOH) required for preparing 250 ml

of 0.15 M solution in methanol.

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31. The depression in freezing point of water observed for the same amount of acetic acid, dichloro-acetic acid and trichloro acetic acid increases in the order given above. Explain briefly.

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32. Calculate the depression in the freezing point of water when 10g of $CH_3CH_2CHClCOOH$ is added to 250g water. $K_a = 1.4 \times 10^{-3}$, $K_f = 1.86 \text{ K kg mol}^{-1}$.

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33. 19.5g of CH_2FCOOH is dissolved in 500g of water. The depression in freezing point of water observed is $1.0^\circ C$. Calculate the Van't

Hoff factor and dissociation constant of fluoroacetic acid.

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34. Vapour pressure of of water at 293K is 17.535 mm Hg. Calculate the vapour pressure of the solution at 293K when 25g of glucose is dissolved in 450g of water ?

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35. Henry's law constant for the molality of methane in benzene at 298 K is 4.27×10^5 mm Hg . Calculate the solubility of methane in benzene at 298 K under 760 mm Hg.

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36. 100g of liquid A(molar mass $140 \mathrm{g\,mol^{-1}}$) was dissolved in 1000g of liquid B(molar mass $180 \mathrm{g\,mol^{-1}}$). The vapour pressure of pure liquid B was found to be 500 torr. Calculate

the vapour pressure of pure liquid A and its vapour pressure in the solution if the total vapour pressure of the solution is 475 torr.

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37. Benzene and Toluene form ideal solution over the entire range of composition. The vapour pressure of pure benzene and toluene at 300 K are 50.71 mm of Hg and 32.06 mm of Hg respectively. Calculate the mole fraction of

benzene in vapour phase if 80g of benzene is mixed with 100g of toluene.

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38. The air is a mixture of a number of gases. The major components are oxygen and nitrogen with approximate proportion of 20% is to 79% by volume at 298 K. The water is in equilibrium with air at a pressure of 10 atm. At 298 K if the Henry's law constants for oxygen and nitrogen at 298 K are 3.30×10^7 mm and

6.51×10^7 mm respectively, calculate the composition of these gases in water .

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39. Determine the amount of $CaCl_2$ (i=2.47) dissolved in 2.5 litre of water such that its osmotic pressure is 0.75 atm at $27^\circ C$.

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40. Determine the osmotic pressure of a solution prepared by dissolving 25 mg of K_2SO_4 in two litre of water at $25^\circ C$ assuming that it is completely dissociated.

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