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## CHEMISTRY

# NCERT - NCERT CHEMISTRY(ENGLISH)

# SOLUTION

Solved Examples

**1.** Calculate the mole fraction of ethylene glycol  $(C_2H_6O_2)$ 

in a solution containing  $20\,\%\,$  of  $C_2 H_6 O_2\,$  by

mass.



**3.** Calculate molality of 2.5g of ethanoic acid

 $(CH_3COOH)$  in 75g of benzene.



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



5. The vapour pressure of chloroform  $(CHCl)_3$  and dichlorocethene  $(CH_2Cl_2)$  at 298K is 200mmHg and 415mmHg, respectively. Calculate a. The vapour pressure of the solution prepared by mixing 25.5g of  $CHCl_3$  and 40gof  $CH_2 \ \_ Cl(2)$  at 298K.

b. Mole fractions of each components 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 weighting 0.5g when added to 39.0g of benzene (molar mass  $78gmol^{-1}$ ). The vapour pressure of the solution then is 0.845 bar. What is the molar mass of the solid substance?



7. 18g of glucose  $(C_6H_{12}O_6)$  is dissolved in 1kg of water in a saucepan. At what

temperature will the water boil (at 1 atm) ?  $K_b$ 

for water is  $0.52 K k g mol^{-1}$ .



8. The boiling a point of benzene is 353.23K. 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 K kg  $mol^{-1}$ . **9.** 45g of ethylene glycol  $C_2H_6O_2$  is mixed with 600g of water. Calculate (a) the freezing point depression and (b) the freezing point of solution.

Given  $K_f = 1.86 K k g mol^{-1}$ .

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**10.** 1.0g of non-electrolyte solute dissolved in 50.0g of benzene lowered the freezing point of benzene by 0.40K. The freezing point

depression constant of benzene is  $5.12 kgmol^{-1}$ . Find the molecular mass of the solute.

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**11.**  $200cm^3$  of an aqueous solution of a protein contains 1.26g of the protein. The osmotic pressure of such a solution at 300K is found to be  $2.57 \times 10^{-3}$  bar. Calculate the molar mass of the protein. 12. Two grams of benzoic acid  $(C_6H_5COOH)$ dissolved in 25.0*g* of benzene shows a depression in freezing point equal to 1.62*K*. Molal depression constant for benzene is  $4.9Kkg^{-1}mol^{-1}$ . What is the percentage association of acid if it forms dimer in solution?

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**13.** 0.6mL of acetic acid  $(CH_3COOH)$  having density  $1.06 qm L^{-1}$  is dissolved in 1L 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 dissociation constant of the acid.  $K_f$  for  $H_2O = 1.86Kkg^{-1} \mathrm{mol}^{-1}$ 

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



**2.** Calculate the mole fraction of benzene in solution containing 30% by mass in carbon tetrachloride.



**3.** Calculate the molarity of each of the following solutions :

a. 30g of  $Co(NO_3)_2.6H_2O$  in 4.3L of solution

b. 30mL of  $0.5MH_2SO_4$  diluted to 500mL.



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

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

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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.



7. Henry's law constant for  $CO_2$  in water is  $1.67 \times 10^8 Pa$  at 298K. Calculate the quantity of  $CO_2$  in 500mL of soda water when packed under  $2.5atmCO_2$  pressure at 298K.



**8.** The vapour pressure of pure liquids A and B is 450 and 700mmHg, respectively, at

350K. Find out the composition of the liquid mixture if the total vapour pressure is 600mmHg. Also find the composition of the vapour phase.

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



10. The boiling point of water at 750mmHg is

 $99.63\,^\circ C$ . How much sucrose is to be added to

500g of water such that it boils at  $100^{\circ}C$ .

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11. Calculate the mass of ascorbic acid ( Vitamin  $C, C_6 H_8 O_6$ ) to be dissolved in 75g of acetic acid to lower its melting point by  $1.5^{\circ}C. K_f = 3.9 K k g mol^{-1}$ 



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



**13.** Define the term solution. How many types of solutions are formed ? Write briefly about

each type with an example.



14. Give an example of a solid solution in which

the solute is a gas.

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**15.** Define the following terms :

- a. Mole fraction b. Molality
- c. Molarity 'd. Mass percentage.



**16.** 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 density of solution is  $1.504 gm L^{-1}$ ?



17. A solution of glucose in water is labelled as 10 percent w / w, what would be the molality and mole fraction of each component in the solution? If the density of the solution is  $1.2gmL^{-1}$ , then what shall be the molarity of the solution?

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**18.** Volume of 0.1MHCl required to react completely with 1g equimolar mixture of

### $Na_2CO_3$ and $NaHCO_3$ is



**19.** Calculate the percentage composition in terms of mass of solution obtained by mixing 300g of a 25% and 400g of a 40% solution by mass.



**20.** An antifreeze solution is prepared from 222.6g of ethylene glycol  $[C_2H_4(OH)_2]$  and 200g of water. Calculate the molality of the solution. If the density of the solution is  $1.072gmL^{-1}$  then what shall be the molarity of the solution?

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**21.** A sample of drinking water was found to be severely contaminated with chloroform,

CHCl<sub>3</sub>, supposed to be carcinogen. The level

of contamination was 15 ppm (by mass).

(i) Express this in per cent by mass.

(ii) Determine the molality of chloroform in

the water sample.

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22. What role does the molecular interaction

play in a solution of alcohol and water ?

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24. State Henry's law and mention some

important applications ?

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**25.** The partial pressure of ethane over a saturated solution containing  $6.56 \times 10^{-2}g$  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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**26.** What is meant by positive and negative deviations from Raoult's law and how is the

sign of  $\Delta_{mix}H$  related to positive and

negative deviations from Raoult's law?



**27.** An aqueous solution of 2 per cent (wt. / wt) non-volatile solute exerts a pressure of 1.004 bar at the boiling point of the solvent. What is the molecular mass of the solute?



**28.** Heptane and octane form ideal solution. At 373K, the vapour pressure of the two liquids are 105.2kPa and 46.8kPa respectively. What will be the vapour pressure, in bar, of a mixture of 25g of heptane and 35g of octane?

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**29.** The vapour pressure of water is 12.3kPa at 300K. Calculate vapour pressure of 1 molal solution of a solute in it.

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**30.** Calculate the mass of a non-volatile solute ( molecular mass 40) which should be dissolved in 114g octane to reduce its vapour pressure to 80%.

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**31.** A solution containing 30g of a non-volatile solute exactly in 90g water has a vapour pressure of 2.8kPa at 298K. Further 18g of

water is then added to solution, the new vapour pressure becomes 2.9kPa at 298K. Calculate:

(i) molecular mass of the solute,

(ii) vapour pressure of water at 298K.

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**32.** A 5% solution (by mass) of cane sugar in water has freezing point of 271 K. Calculate the freezing point of a 5% glucose (by mass) in

water. The freezing point of pure water is 273.15 K.

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**33.** Two elements A and B form compounds having molecular formula  $AB_2$  and  $AB_4$ . When dissolved in 20g of benzene, 1g of  $AB_2$ lowers the freezing point by 2.3K, whereas 1.0g of  $AB_4$  lowers it by 1.3K. The molal depression constant for benzene is  $5.1 K k g m o l^{-1}$ . Calculate the atomic mass of

A and B.

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**34.** At 300K, 36g of glucose present per litre in its solution had an osmotic pressure 4.98 bar. If the osmotic pressure of solution is 1.52 bar at the same temperature, what would be its concentration.



**35.** Suggest the most important type of intermolecular attractive interaction in the following pairs : a. n – Hexane and n – octane b.  $I_2$  and  $CCl_4$ c.  $NaClO_4$  and water d. Methanol and acetone e. Acetonitrile  $(CH_3CN)$  and acetone  $(C_{3}H_{6}O)$ 

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**36.** Based on solute – solvent interactions, arrange the following in order of increasing solubility in n – octane and explain the result. Cyclohexane, KCl,  $CH_3OH$ ,  $CH_3CN$ .

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**37.** Among the following compounds, identify which are insoluble, partially soluble, and highly soluble in water ?

a. Phenol b. Toluene

- c. Formic acid d. Ethylene glycol
- e. Chloroform f. Pentanol



**38.** If the density of some lake water is  $1.25gmL^{-1}$  and contains 92g of  $Na^{\oplus}$  ions per kg of water, calculate the molality of  $Na^{\oplus}$  ions in the lake.

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**39.** If the solubility product of CuS is  $6 imes 10^{-16}$ , calculate the maximum molarity of CuS in aqueous solution.



**40.** Calculate the mass percentage of aspirin  $(C_9H_8O_4)$  in acetonitrile  $(CH_3CN)$  when 6.5g of  $C_9H_8O_4$  is dissolved in 450g of  $CH_3CN$ . **41.** Nalorphene  $(C_{19}H_{22}NO_3)$ , similar to morphine, is used to combat withdrawal symptoms in narcotic users. The dose of nalorphene generally given is 1.5mg. Calculate the mass of solution of  $1.5 \times 10^{-3}m$  aqueous solution required for the above dose.

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**42.** Calculate the amount of benzoic acid  $(C_6H_5COOH)$  required for preparing 250mL

of 0.15M solution in methanol.



**43.** The depression in freezing point of water observed for the same amount of acetic acid, trichloroacetic acid, and trifluoroacetic acid increases in the order given above. Explain briefly.

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**44.** Calculate the depression in the freezing point of water when 10g of  $CH_3CH_2CHClCOOH$  is added to 250gwater.

 $K_a = 1.4 imes 10^{-3}, K_f = 1.86 K kg mol^{-1}.$ 

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**45.** 19.5g of  $CH_2FCOOH$  is dissolved in 500g of water . The depression in the freezing point of water observed is  $1.0^{\circ}C$ . Calculate the Van't

Hoff factor and dissociation constant of

fluoroacetic acid.



**46.** The vapour pressure of water at 293K is 17.535mmHg. Calculate the vapour pressure of water at 293K when 25g of glucose is dissolved in 450g of water.

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**47.** Henry's law constant for the molality of methane in benzene at 298K is  $4.27 \times 10^5 mmHg$ . Calculate the solubility of methane in benzene at 298K under 760mmHg.

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**48.** 100g of liquid A( molar mass  $140gmol^{-1})$  was dissolved in 1000g of liquid B( molar mass  $180gmol^{-1})$ . The vapour pressure of

pure liquid B was found to be 500 torr. Calculate the vapour pressure of pure liquid Aand its vapour pressure in the solution if the total vapour pressure of the solution is 475 Torr

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Vapour pressures of pure acetone and chloroform at 328K are 741.8 mm Hg and 632.8 mm Hg respectively. Assuming that they form ideal solution over the entire range of composition. Plot  $p_{\rm total}, p_{\rm chloroform}, {
m and} p_{\rm acetone}$  as a function of  $x_{\rm acetone}$ . the experimental data observed for

different compositions of mixture is: Plot this

data also on the same graph paper. indicate

whether it has positive deviation or negative

deviation from the ideal solution.



50. Benzene and toluene form ideal solution over the entire range of composition. The vapour pressure of pure benzene and naphthalene at 300K are 50.71mmHg and 32.06mmHg, respectively. Calculate the mole fraction of benzene in vapour phase if 80g of benzene is mixed with 100q of naphthalene.

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**51.** The air is a mixture of a number of gases. The major components are oxygen and nitrogen with approximate proportion of 20%:79% by volume at 298K. The water is in equilibrium with air at a pressure of 10atmAt 298K if Henry's law constants for oxygen and nitrogen at 298K are  $3.30 imes 10^7 mm$  and  $6.51 imes 10^7 mm$ , respectively, calculate the composition of these gases in water.

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

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**53.** Determine the osmotic pressure of a solution prepared by dissolving 25mg of  $K_2SO_4$  in 2L of water at  $25^{\circ}C$ , assuming that it is completely dissociated.

