CHEMISTRY

JEE (MAIN AND ADVANCED)

CHEMISTRY

DILUTE SOLUTIONS

Examples

1. 3.15 Grams of oxalic acid crystals are present in a 500 mL aqueous solution. Calculate (a)

molarity and (b) normality.

2. What mass of solution chloride is present in 500 mL of 0.2 N solution?

3. Calculate the molality of 10 % (w/w) aqueous caustic sode. What is the mole fraction of water in the solution?

4. The specific gravity of 84% (w/w) H_2SO_4 is 1.752. Find (a) molarity and (b) normality of the solution.

5. Henry's law constant for nitrogen at $20°C$ is 76.48 k bar. Assuming the partial pressure as

0.987 bar, calculate mass of nitrogen dissovled in one litre water at $20°C$.

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6. Find the ratio of volumes of $2MHNO_3$ and $5MHNO_3$ required to mix in order to prepare one litre of $3MHNO_3$ solution.

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7. 20 ml of 10 M HCl and 10 ml of $18 M H_2 SO_4$ are mixed and sufficient water is added to make upto one litre. Calculate the molarity of proton in the mixture.

8. 50 mL of normal sulphuric acid neutralises 10 mL of potash solution. Calculate the strength of potash in mol L^- and gL^{-1}.

9. It is desired to prepare one litre of decimolar aqueous aluminium sulphate. Find the amount of solute to be weighed. Calculate the number of gram ions of sulphate in the solution.

10. Calculate the molality of one litre aqueous one molar NaOH solution, whose density is 0.01 g per mL.

11. The solubility of a substance X at $25°C$ and $50°C$ in water is respectively 35 and 50. If 300 grams of saturated solution at $50°C$ is cooled to $25°C$, calculate the maximum mass of 'X' separated out.

12. Raoult's law is a special case of Henry's law. Explain .

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13. At $70^\circ C$ vapour pressure of pure benezene and pure toluene are 500 torr and 200 torr, respectively. In a homogeneous mixture of toluene with benzene at $70^\circ C$, the mole fraction of benezene is 0.4. Calculate the vapour pressure of the mixture.

14. p° and p are vapour pressure of pure liquid and solution respectively. Among (a) p°, (b) p/p° and (c) $(p^\circ - p)/p^\circ$, which are temperature independent. Why ?

15. Drinking a hot beverage is easy and quick from a saucer than from a cup. Why ?

16. Vapour pressure of pure water at $23°C$ is 19.8 torr . Calculate the vapour of 3m aqueous solution.

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17. Vapour pressure of pure water at $27°C$ is 3000k Pa. By dissolving 5 g of a non volatile molecular solid in 100 g of water the vapour

pressure is decreased to 2985 k Pa. What si the molecular weight of solute?

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18. Calculate the vapour pressure of 10% (w/w) aqueous glucose solution at $30^\circ C$, if vapour pressure of pure water is 31.8 mm.

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19. Methanol and ethanol are liquids of similar nature, but a mixture of them is a non-ideal solution. Why?

20. Vapour pressure of pure liquids P and Q are 700 and 450 mm Hg respectively at 330K. What is the composition of the liquid mixture at 330 K, if the total vapour pressure is 600 mm Hg?

21. Molar masses of salutes are best measured from osmetic pressure. Why?

22. 2% of aqueous urea and 6% of aqueous 'X' are isotonic. If 'X' is a molecular solid, calculate its molar mass.

23. At $10°C$, the osmotic pressure of 1% (w/v) solution of 'X' is $7.87 \times 10^4 Nm^{-2}$. What is the molecular weight of solute X ?

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24. 7g of a solute are dissolved in 200 g of a solvent (mol. Wt. 78) to prepare a solution. At a certain temperature dry air is sent into a solution and solvent continuously. The loss is weights of containers containing solutions

and solvent are 0.975 g and 0.025 g. Calculate the molar mass of solute.

25. If extent of dissociation of both KCl and $BaCl_2$ of some concentrations with identical value of α as 0.9, what is the ratio of their van't Hoff factors?

1. Write the different types of solutions with suitable examples.

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2. Define (a) mole fraction, (b) molality (c) molarity and (d) normality. Write their units.

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3. What is solubility. Discuss the factos influencing solubility.

4. State the explain Henry's law .

5. How much water is to be added to prepare 0.12 M solutions from 100 mL of 0.3 M solution?

6. Calculate the mass of caustic soda present in 225 mL of 0.556 M solution.

7. 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 $= \dfrac{\text{Mass of solute}}{\text{Molar mass of solute}}$

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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8. Calculate the weights of solutes required to

prepre one litre each of (a) 0.45 M $KMnO_4$

solution and (b) $0.25 M CuSO_4$ solution.

9. A gaseous mixture has 7g of N_2, $8 g of He$ and $22 g of CO_2$. Calculate the molefractions of component gaese in the mixture.

10. Concentration hydrochloric acid has 38% of HCl by weight with a density of 1.1885 g per ml. Calculate the molarity of the acid. What volume of the acid on dilution to one litre gives finally decimolar solution?

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11. Calculate the weight of sodium oxalate present in 250 mL of seminormal solution.

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12. 1.032 kg of aqueous, one molal methanol is added with 500 mL water . Calculate the molality of dilute solution.

13. 0.5 g of $Ba(OH)_2$, $0.01mol Ba(OH)_2$ and 0.01 eq. $Ba(OH)_2$ were together diluted to one litre. Calculate the normality of basic solution.

14. Calculate the mass of urea (NH_2CONH_2) required in making 2.5 kg of 0.25 molal queous solution.

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

16. Calculate the volume of 0.1N potassium permanganate that can be decolourised by 22.5 mL of 0.25 N ferrous ammonium sulphate solution in acidic medium.

17. Mass percentage (w/w) of ethylene glycol. $(HOCH_2 - CH_2OH)$ in an aqueous solution is 20. Calculate (a) mole fraction of solute. (b) mole percentage of water and (c) molality of solution.

18. Calculate mole fraction of alcohol in 2 molal aqueous ethanol.

19. 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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1. What are vapourisation and condensation? On what factors rate of evaporisation depends upon?

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2. Define vapour pressure. How is it dependent on nature of solvent and temperature?

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3. Explain Raoult's law for a solution containing non-volatile solute.

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4. What are the applications and limitations of Raoult's law.

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5. Calculate the relative lowering of vapour pressure of a 10% aqeous caustic soda solution.

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6. The vapour pressure of 4% solution of a non-volatile solute in water at $100°C$ is 745 mm. What is the molecular weight of solute?

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7. At room temperature, write the ascending order of volatility and vapour pressres of (A) water, (B) hexane and (C) ethanol. Explain the reasons.

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8. 1.2 g of a non-volatile solute is added to 320 g of methyl alcohol at certain temperature. The vapour pressure is decreased from 400 mm to 399.2 mm Hg. Calculate the molecular weight of solute.

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9. 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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10. Relative lowering of a solution containing a non volatile solute (X) in a solvent (Y) is 3%. What is the mole percentage of component 'Y' in the solution.

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11. Calculate the vapour pressure , if 0.083 mole of a non-volatile solute is present in 80 g of ethanol at $25^\circ C$, Vapour pressure of ethanol is 22.45 mm.

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1. What are ideal solutions ? Give examples.

2. Write 2 differences between Ideal and non-ideal solutions.

3. Which mixtures show positive deviations from Raoult's law? Why?

4. Which mixtures show negative deviations from Raoult's law? Why ?

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5. What are azeotropic mixtures? Discuss with suitable examples.

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Exercise 1 1 4

1. What are colligative properties ? Give their names.

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2. Compare the lowering of vapour pressure of equimolar calcium bromide and glucose in aqueous solutions.

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3. Discuss the depression of freezing point of a solution.

4. Boiling point of a liquid increases upon dissolving a non - volatile solute. Discuss.

5. 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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6. 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, $\dfrac{P_A^0 - P_s}{P_A^0}$ is called relative lowering in vapour pressure.

7. 2.0 g of a non-electrolyte solute dissovled in 100 g of benezene lowered the freezing point of benzene by $0.4°C$. If the freezing point depression constant of benezene is $5.12 Kkgmol^{-1}$. Calculate the molar mass of solute.

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8. When 0.9 g of a non-volatile solute was dissovled in 45 g of benezene, the elevation of

boiling point is $0.88°C$. If K_b for benzene is $2.53 K kg mol^{-1}$, Calculate the molar mass of solute.

9. Cryoscopic constant for benezene is $4.9 K kg mol^{-1}$. Freezing point of benezene is 278.6 K. 4 grams of benzoic acid when dissolved in 50 g of benezene, the freezing point is 276.98K. Calculate the extent of association of benzoic acid in benezene .

10. At 750 torr water was a boiling point 372.63 K. How much sucrose is to be added to one kg of water such that water boils at 373K and 750 torr?

11. What are : (a) osmosis and (b) osmatic pressure ?

12. Disccuss on reverse osmasis and water purification.

13. Molar mass of polymer is $185000 gmol^{-1}$. Calculate the osmotic pressure exerted when 10 g of polymer is in 4.5 L of water at 310 K.

14. One liter aqueous solutions contains 2×10^{-2} kg glucose at $25°C$. Calculate the osmotic pressure of the solution.

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15. The osmatic pressure of a non-volatile solute 'X' in benezene at $25°C$ is $20.66 Nm^{-2}$. If the concentration of solution is $2gL^{-1}$, what molecular weight of X ?

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16. 200 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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17. Discuss the van't Hoff factor.

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18. What are abnormal molar masses? Why are the molar masses abnormal ?

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Exercise 1 2

1. What are the factor on-which solubility depends on ?

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2. Discuss on the vapour pressure of solutiosn of solids in liquids.

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3. Aerated water bottles are kept under cold water during summer. Why ?

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4. What is relative lowering of vapour pressure ?

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5. Write the units of cryoscopic constant and ebullioscopic constant?

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6. How is osmotic pressure useful in determining molar masses?

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7. How is the principle of reverse osmosis? Used for desalination?

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8. The molar concentration of proton obtained by mixing equal volumes of $1M HNO_3$ and $1M H_2SO_4$ is not equal to 1M. Explain.

9. Mixing n-pentane and n-hexane, an ideal solution is formed . Subtantiate.

10. A freash grape fruit dipped in brine solution shrinks. Why ?

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11. Vapour pressure of beneze and toluene are 160 are 60 torr. What will be the vapour pressure of a mixture of equal masses of benezene and toluene.

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12. How water can be made boiling without heating?

13. Write the reason of abnormality in molar masses.

14. Relate the colligative properties with van't Hoff factor.

15. Calculate the weight aof anhydrous sodium carbonate present in 200 mL of 0.2 M solution.

16. Calculate the normally of 10.6 % (w/v) Na_2CO_3 in aqueous solutions.

17. How many mL of 0.1 M ferrous oxalate can reduce 10 mL of 0.2 M potassium dichromate solution in acidic medium ?

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18. 250 mL of 0.2 M $NaOH$ and 100 mL of $0.25MBa(OH)_2$ are mixed. Calculate the molarity of hydroxyl ion in the mixture.

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19. The density of 8.653% (w/v) Na_2CO_3 solution is $1.018 gmL^{-1}$. Calculate (a) molality and (b) mole fraction.

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20. 100 mL of ethanol (density 0.8g/cc) is diluted to one litre using water. Calculate (a) molarity and (b) mole fraction.

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21. The density of 3M $Na_2S_2O_3$ is 1.25 g/cc. Calculate the mole fraction of $Na_2S_2O_3$ and molality of thiosulphate.

22. 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?

23. Vapour pressures of para xylene and methylbenezene at $90°C$ are respectivley 150 mm and 400 mm. Calculate the mole fraction of dimethyl benzene in the mixture that boils at $90°C$, when the pressure is 0.5 atm.

24. What weigth of a non-volatile solute (molar mass 40 g) should be dissolved in 114 g of

octance to reduce its vapour pressure by 20%.

25. Vapour pressure of pure water at 298 k is 23.8 mm Hg. Calculate the lowering of vapour pressure caused by adding 5g of sucrose in 50 g of water.

26. Non ideal solutions exhibit either possitive (or) -ve deviations from Raoult's law. What are these deviations and why are they caused. Explain with one example for each type.

27. Define the terms osmotic and osmatic pressure. What is the advantage of using osmatic pressure as compared to their

colligative properties for the determination of

mobr masses of solute in solutions?

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28. What is the effect of temperature of a

solutions on its molarity and molality.

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29. What is the vapour pressure of one molal

glucose solution at $100^\circ C$?

30. Vapour pressure of water at certain temperature is 155 mm Hg and that of the another solvent 'X' is 'p' mm Hg. Molecular weight of 'X' is 128. An aqueous solution of 'X' (64% by wt) has a vapour pressure of 145 mm Hg. What is 'p' ?

31. At $100°C$ vapour pressure of heptane and octane are respectively 105.2 and 46.8 kPa. Calculate the vapour pressure of 60 grams of the mixture of two liquids, in which the mass of octane is 35g.

32. Vapour pressure of aqueous glucose at 373 K is 750 mm Hg. Calculate the molality of solute present dissovled solution.

33. A mixture of two immiscible liquids water and nitrobeneze boiling at 372 K has partial vapour pressures of water 733 mm and nitrobenzene 27 mm. Calculate the weigth ratio of liqid components in distillate.

34. State the law co-relating the pressure of a gas and its solubility in a liquid . State one

application for this law.

35. State the condition resulting in reverse osmosis.

36. Define the following terms: (i) Ideal solution (ii) Azeotrope and (ii) Osmotic pressure

37. If 0.869 g of cholesterol is dissolved in 4.4 g of diethyl ether the vapour pressure of either lowers from 0.526 atm at $20°C$. Calculate the molecular weigth of cholesterol.

38. Boiling point of 100 g water containing 12 g of glucose dissolved in $100.34°C$. What is

K_b of water ?

39. Calculate the cryscopic constant of a solvent, If its latent heat of fusion is $180.75 kgmol^{-1}$ and freezing point $16.6°C$.

40. Freezing point depression of millimolal $K_nFe(CN)_6$ is $7.1 \times 10^{-3}K$. If

$K_f = 1.86 kKgmol^{-1}$. Calculate the value of

n.

41. A solution of urea has boiling point

$100.15° C$, K_f and K_b for water are 1.87 and

0.52 K kg mol^{-1}. Calculate (a) molality and (b)

freezing point of the solution.

42. Compare the weigths of methanol and glycerol, which would be required separately to lower the freezing point of one Kg water by $10°$.

43. At $0°C$, the vapour pressure of pure water is 4.63 mm and an aqueous solution of 8.49 g of $NaNO_3$ dissolved in 100g of water is 4.483

mm. What is the extent of ionisation of

$NaNO_3$ /

44. $75.2g$ of phenol is dissoved in one kg of solvent of K_f value $14KKgmol^{-1}$. If freezing point depression is 7K, what is the percentage dimerisation of phenol.

45. Latent heat of fusion and vaporisation of water are respectively 80 and $540 Calg^{-1}$. If the boiling point of a solution is $100.1°C$, what is its freezing point?

46. A storage battery contais a solution of sulphuric acid 38% by weight and at this concentration the Van't Hoff factor is 2.5 . If

K_f of water is $1.86 KKgmol^{-1}$, at what temperature the contents of battery freeze?

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47. 0.5% aqueous KCl has freezing point $-0.24°C$. Calcualte the degree of dissociation, If K_f for water is $1.86 Kkgmol^{-1}$.

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48. A 10% solution of sucrose is iso-osmotic with 1.754% solution of X. If X is non volatile and non - electrolyte solute, what is its molar mass?

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49. At $25°C$, a solution containing 0.1 g of polyisobutylene in 50 ml. of benzene developed a rise of 2.4 mm at osmotic

equilibrium . If density is $0.8cc^{-1}$, calculate the molecular weight of polyisobutylene .

50. 100 mL of an aqueous solution of protein contais 6.3 g of protein. Calculate the molar mass of protein if osmatic pressure of the solution at $27°C$ is 2.57×10^{-3} bar.

51. A 1% (w/v) aqueous solution of potassium chloride has extent of ionisation 0.82 in water it $18°C$. Calculate the osmatic pressure.

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52. Give one example each for non-ideal solution showing positive deviation and non-ideal solution showing negative deviation.

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53. Mention any two characteristics of an ideal solution.

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54. Why is the osmotic pressure of sodium chloroide solution higher than glucose solution?

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55. What happens to the vapour pressure of a liquid when a non-volatile solute is dissolved in it ?

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