



## DPP-3 [Raoult's Law]

### Chapter: Solution

*“The difference between average and confident students is assignment completion”*

## TYPE-1 : Basic Raoult's Law & Total Vapour Pressure

- If Raoult's law is obeyed, the vapour pressure of the solvent in a solution is directly proportional to:**
  - Mole fraction of the solvent
  - Mole fraction of the solute
  - Mole fraction of the solvent and solute
  - The volume of the solution
- The vapour pressure of a pure liquid 'A' is 70 torr at 27°C. It forms an ideal solution with another liquid B. The mole fraction of B is 0.2 and total vapour pressure of the solution is 84 torr at 27°C. The vapour pressure of pure liquid B at 27°C is:**
  - 14
  - 56
  - 140
  - 70
- 1 mol of heptane (V.P. = 92 mm of Hg) is mixed with 4 mol of octane (V.P. = 31 mm of Hg). The vapour pressure of the resulting ideal solution is:**
  - 46.2 mm of Hg
  - 40.0 mm of Hg
  - 43.2 mm of Hg
  - 38.4 mm of Hg
- At 88°C benzene has a vapour pressure of 900 torr and toluene has a vapour pressure of 360 torr. What is the mole fraction of benzene in the mixture with toluene that will boil at 88°C at 1 atm pressure, benzene–toluene form an ideal solution:**
  - 0.416
  - 0.588
  - 0.688
  - 0.740
- A gaseous mixture was prepared by taking equal mole of CO and N<sub>2</sub>. If the total pressure of the mixture was found 1 atmosphere, the partial pressure of the nitrogen (N<sub>2</sub>) in the mixture is:**
  - 0.5 atm
  - 0.8 atm
  - 0.9 atm
  - 1 atm

6. The vapour pressure of two liquids 'P' and 'Q' are 80 and 60 torr, respectively. The total vapour pressure of solution obtained by mixing 3 mole of P and 2 mol of Q would be:
- (1) 68 torr
  - (2) 140 torr
  - (3) 72 torr
  - (4) 20 torr
7.  $p_A$  and  $p_B$  are the vapour pressure of pure liquid components, A and B, respectively of an ideal binary solution. If  $x_A$  represents the mole fraction of component A, the total pressure of the solution will be:
- (1)  $p_B + x_A(p_B - p_A)$
  - (2)  $p_B + x_A(p_A - p_B)$
  - (3)  $p_A + x_A(p_B - p_A)$
  - (4)  $p_A + x_A(p_A - p_B)$
8. Vapour pressure of chloroform ( $\text{CHCl}_3$ ) and dichloromethane ( $\text{CH}_2\text{Cl}_2$ ) at  $25^\circ\text{C}$  are 200 mmHg and 415 mmHg respectively. Vapour pressure of the solution obtained by mixing 25.5 g of  $\text{CHCl}_3$  and 40 g of  $\text{CH}_2\text{Cl}_2$  at the same temperature will be: (Molecular mass of  $\text{CHCl}_3 = 119.5$  u and molecular mass of  $\text{CH}_2\text{Cl}_2 = 85$  u)
- (1) 347.9 mmHg
  - (2) 280.5 mmHg
  - (3) 173.9 mmHg
  - (4) 615 mmHg
9. The vapour pressure of two liquids P and Q are 80 and 60 torr, respectively. The total vapour pressure of solution obtained by mixing 3 moles of P and 2 moles of Q would be [AIPMT (Prelims)-2005]
- (1) 140 torr
  - (2) 20 torr
  - (3) 68 torr
  - (4) 72 torr
10. For a binary ideal liquid solution, the total vapour pressure of solution is given as
- (1)  $P_T = (P_A^\circ + P_B^\circ)X_B$
  - (2)  $P_T = P_A^\circ \times P_B^\circ$
  - (3)  $P_T = P_A^\circ/P_B^\circ$
  - (4)  $P_T = P_B^\circ + (P_A^\circ - P_B^\circ)X_A$
11. Which of the following plots does not represent the behaviour of an ideal binary liquid solution:
- (1) Plot of  $P_A$  versus  $X_A$  (mole fraction of A in liquid phase) is linear
  - (2) Plot of  $P_B$  versus  $X_B$  is linear
  - (3) Plot of  $p_{\text{total}}$  versus  $X_A$  (or  $X_B$ ) is linear
  - (4) Plot of  $p_{\text{total}}$  versus  $X_A$  is non linear
12. The vapour pressure of two pure liquids (A) and (B) are 100 and 80 torr respectively. The total pressure of the solution obtained by mixing 2 mol of (A) and 3 mol of (B) would be
- (1) 20 torr

- (2) 36 torr  
 (3) 88 torr  
 (4) 180 torr
13. **For a solution of two liquids A and B, it was proved that  $P = X_A(P_A^0 - P_B^0) + P_B^0$ . The solution is:**
- (1) Ideal  
 (2) Non ideal  
 (3) Both (1) and (2)  
 (4) None of the above

## TYPE-2 : Mole Fraction in Vapour Phase

1. **If  $P_A^0$  and  $P_B^0$  are 108 and 36 torr respectively. What will be the mole fraction of A in vapour phase if B has mole fraction in solution 0.5.**
- (1) 0.25  
 (2) 0.75  
 (3) 0.60  
 (4) 0.35
2. **What is correct relation between mole fraction in vapour phase ( $Y_A$ ) of A in terms of  $X_A$ . If mole fraction in solution of A is ( $X_A$ ) (If  $P_A^0$  is vapour pressure of A in pure state)**
- (1)  $(1 - X_A)P_A^0$   
 (2)  $\frac{X_A}{1 - X_A}P_A^0$   
 (3)  $\frac{1 - X_A}{X_A}P_A^0$   
 (4)  $\frac{P_A^0 X_A}{P_S}$
3. **Mole fraction of A vapours above solution in mixture of A and B ( $X_A = 0.4$ ) will be:**  
 ( $P_A^0 = 100$  mm,  $P_B^0 = 200$  mm)
- (1) 0.4  
 (2) 0.8  
 (3) 0.25  
 (4) None
4. **The vapour pressure of pure benzene and toluene are 160 and 60 torr respectively. The mole fraction of toluene in vapour phase in contact with equimolar solution of benzene and toluene is:**
- (1) 0.50  
 (2) 0.6  
 (3) 0.27  
 (4) 0.73
5. **At 25°C, the vapour pressure of pure liquid A (mol. wt. = 40) is 100 torr, while that of pure liquid B is 40 torr, (mol. wt. = 80). The vapour pressure at 25°C of a solution containing 20 g of each A and B is**
- (1) 80 torr

- (2) 59.8 torr  
(3) 68 torr  
(4) 48 torr
6. **The vapour pressures of two liquids A and B are 100 and 160 torr respectively. The total vapour pressure obtained by mixing 4 mole of A and 5 mole of B would be**  
(1) 126.66 torr  
(2) 140.44 torr  
(3) 150.00 torr  
(4) 133.33 torr
7. **The vapour pressure of ethanol and methanol are 42.0 mm and 88.5 mm Hg respectively. An ideal solution is formed at the same temperature by mixing 46.0 g of ethanol with 16.0 g of methanol. The mole fraction of methanol in the vapour is:**  
(1) 0.467  
(2) 0.502  
(3) 0.513  
(4) 0.556
8. **A solution has a 1 : 4 mole ratio of pentane to hexane. The vapour pressures of the pure hydrocarbons at 20°C are 440 mm Hg for pentane and 120 mm Hg for hexane. The mole fraction of pentane in the vapour phase would be:**  
(1) 0.200  
(2) 0.478  
(3) 0.549  
(4) 0.786
9. **A mixture of ethyl alcohol and propyl alcohol has a vapour pressure of 290 mm at 300 K. The vapour pressure of propyl alcohol is 200 mm. If the mole fraction of ethyl alcohol is 0.6, its vapour pressure (in mm) at the same temperature will be**  
(1) 300  
(2) 700  
(3) 360  
(4) 350
10. **An ideal solution was obtained by mixing methanol and ethanol. If the partial vapour pressure of methanol and ethanol are 2.619 kPa and 4.556 kPa respectively, the composition of vapour (in terms of mole fraction) will be:**  
(1) 0.635 MeOH, 0.365 EtOH  
(2) 0.365 MeOH, 0.635 EtOH  
(3) 0.574 MeOH, 0.326 EtOH  
(4) 0.173 MeOH, 0.827 EtOH
11. **Calculate the mole fraction of toluene in the vapour phase which is in equilibrium with a solution of benzene and toluene having a mole fraction of toluene 0.5. (The vapour pressure of pure Benzene is 119 torr and that of toluene is 37 torr at the same temperature)**  
(1) 0.5  
(2) 0.75  
(3) 0.625

- (4) 0.237
12. A solution of A and B with 30 mole percent of A is in equilibrium with its vapour which contains 60 mole percent of A. Assuming ideality of the solution and the vapour, the vapour pressure of pure A to that of pure B is
- (1) 3 : 2
  - (2) 4 : 5
  - (3) 2 : 1
  - (4) 7 : 2

### TYPE-3 : Equation Based Problems

1. The total vapour pressure,  $P_{\text{total}}$  (in torr) for a mixture of two volatile components, A and B is given by:

$$P_{\text{total}} = 220 - 110 X_B$$

where,  $X_B$  is mole fraction of component B in mixture.

Hence, pressure (in torr) of pure components, A and B are respectively [NCERT Pg. 43]

- (1) 110, 220
  - (2) 220, 110
  - (3) 220, 330
  - (4) 220, 150
2. At 40°C the vapour pressure (in torr) of mixture of methyl alcohol and ethyl alcohol is represented by

$$P = 199x + 135$$

(where  $x$  is the mole fraction of methyl alcohol.) What are the vapour pressures of pure methyl alcohol and pure ethyl alcohol at 40°C?

- (1) 135 and 254 torr
- (2) 119 and 135 torr
- (3) 119 and 254 torr
- (4) 334 and 135 torr

### TYPE-4 : JEE Main PYQs

1. Benzene and toluene form nearly ideal solutions. At 20°C, the vapour pressure of benzene is 75 torr and that of toluene is 22 torr. The partial vapour pressure of benzene at 20°C for a solution containing 78 g of benzene and 46 g of toluene in torr is: [AIEEE-2005, 3/225]
- (1) 50
  - (2) 25
  - (3) 37.5
  - (4) 53.5
2. A mixture of ethyl alcohol and propyl alcohol has a vapour pressure of 290 mm at 300 K. The vapour pressure of propyl alcohol is 200 mm. If the mole fraction of ethyl alcohol is 0.6, its vapour pressure (in mm) at the same temperature will be: [AIEEE-2007, 3/120]

- (1) 700  
 (2) 360  
 (3) 350  
 (4) 300
3. **At 80°C, the vapour pressure of pure liquid 'A' is 520 mm Hg and that of pure liquid 'B' is 1000 mm Hg. If a mixture solution of 'A' and 'B' boils at 80°C and 1 atm pressure, the amount of 'A' in the mixture is (1 atm = 760 mm Hg)** [AIEEE-2008, 3/105]  
 (1) 34 mol percent  
 (2) 48 mol percent  
 (3) 50 mol percent  
 (4) 52 mol percent
4. **Two liquids X and Y form an ideal solution. At 300K, vapour pressure of the solution containing 1 mol of X and 3 mol of Y is 550 mmHg. At the same temperature, if 1 mol of Y is further added to this solution, vapour pressure of the solution increases by 10 mmHg. Vapour pressure (in mmHg) of X and Y in their pure states will be, respectively:** [AIEEE-2009, 8/144]  
 (1) 300 and 400  
 (2) 400 and 600  
 (3) 500 and 600  
 (4) 200 and 300
5. **On mixing, heptane and octane form an ideal solution. At 373 K, the vapour pressures of the two liquid components (heptane and octane) are 105 kPa and 45 kPa respectively. Vapour pressure of the solution obtained by mixing 25.0 g of heptane and 35 g of octane will be (molar mass of heptane = 100 g mol<sup>-1</sup> and of octane = 114 g mol<sup>-1</sup>)** [AIEEE-2010, 4/144]  
 (1) 72.0 kPa  
 (2) 36.1 kPa  
 (3) 96.2 kPa  
 (4) 144.5 kPa
6. **A solution at 20°C is composed of 1.5 mol of benzene and 3.5 mol of toluene. If the vapour pressure of pure benzene and pure toluene at this temperature are 74.7 torr and 22.3 torr, respectively, then the total vapour pressure of the solution and the benzene mole fraction in equilibrium with it will be, respectively:** [JEE(Main) 2015 Online (10-04-15), 4/120]  
 (1) 35.0 torr and 0.480  
 (2) 30.5 torr and 0.389  
 (3) 38.0 torr and 0.589  
 (4) 35.8 torr and 0.280
7. **A solution is prepared by mixing 8.5 g of CH<sub>2</sub>Cl<sub>2</sub> and 11.95 g of CHCl<sub>3</sub>. If vapour pressure of CH<sub>2</sub>Cl<sub>2</sub> and CHCl<sub>3</sub> at 298 K are 415 and 200 mmHg respectively, the mole fraction of CHCl<sub>3</sub> in vapour form is:** [JEE(Main) 2017 Online (09-04-17), 4/120]  
 (Molar mass of Cl = 35.5 g mol<sup>-1</sup>)  
 (1) 0.675  
 (2) 0.162

- (3) 0.486  
(4) 0.325
8. **Liquids A and B form an ideal solution in the entire composition range. At 350 K, the vapor pressures of pure A and pure B are  $7 \times 10^3$  Pa and  $12 \times 10^3$  Pa, respectively. The composition of the vapor in equilibrium with a solution containing 40 mole percent of A at this temperature is:** [JEE(Main) 2019 Online (10-01-19), 4/120]
- (1)  $x_A = 0.28$  ;  $x_B = 0.72$   
 (2)  $x_A = 0.76$  ;  $x_B = 0.24$   
 (3)  $x_A = 0.37$  ;  $x_B = 0.63$   
 (4)  $x_A = 0.4$  ;  $x_B = 0.6$
9. **The vapour pressures of pure liquids A and B are 400 and 600 mmHg, respectively at 298 K. On mixing the two liquids, the sum of their initial volumes is equal to the volume of the final mixture. The mole fraction of liquid B is 0.5 in the mixture. The vapour pressure of the final solution, the mole fractions of components A and B in vapour phase, respectively are:** [JEE(Main) 2019 Online (08-04-19)S1, 4/120]
- (1) 500 mm Hg, 0.4, 0.6  
 (2) 450 mmHg, 0.4, 0.6  
 (3) 500 mmHg, 0.5, 0.5  
 (4) 450 mmHg, 0.5, 0.5
10. **Liquid 'M' and liquid 'N' form an ideal solution. The vapour pressures of pure liquids 'M' and 'N' are 450 and 700 mmHg, respectively, at the same temperature. Then correct statement is:**
- ( $x_M$  = Mole fraction of 'M' in solution;  $x_N$  = Mole fraction of 'N' in solution;  
 $y_M$  = Mole fraction of 'M' in vapour phase;  $y_N$  = Mole fraction of 'N' in vapour phase)
- [JEE(Main) 2019 Online (09-04-19)S1, 4/120]
- (1)  $\frac{x_M}{x_N} < \frac{y_M}{y_N}$   
 (2)  $(x_M - y_M) < (x_N - y_N)$   
 (3)  $\frac{x_M}{x_N} > \frac{y_M}{y_N}$   
 (4)  $\frac{x_M}{x_N} = \frac{y_M}{y_N}$

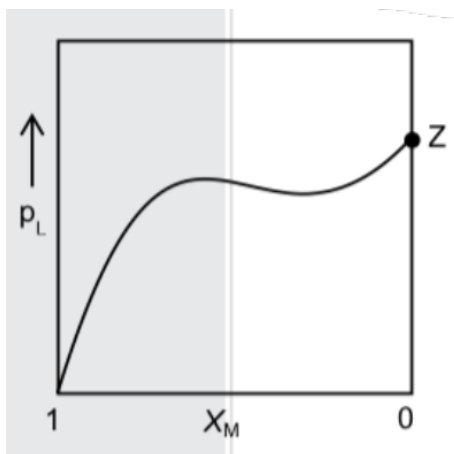
## TYPE-5 : Additional Practice Problems

1. **The vapour pressure of a pure liquid A is 40 mmHg at 310 K. The vapour pressure of this liquid in a solution with liquid B is 32 mmHg. Mole fraction of A in the solution, if it obeys Raoult's law is:**
- (1) 0.8  
 (2) 0.5  
 (3) 0.2  
 (4) 0.4
2. **Mole fraction of the toluene in the vapour phase which is in equilibrium with a solution of benzene ( $p^\circ = 120$  Torr) and toluene ( $p^\circ = 80$  Torr) having 2.0 mol of each is**
- (1) 0.50  
 (2) 0.25

- (3) 0.60  
 (4) 0.40
3. The vapor pressure of two pure isomeric liquids X and Y are 200 torr and 100 torr respectively at a given temperature. Assuming a solution of these components to obey Raoult's law, the mole fraction of component X in vapor phase in equilibrium with the solution containing equal amounts of X and Y, at the same temperature, is [NSEC-2015]
- (A) 0.33  
 (B) 0.50  
 (C) 0.66  
 (D) 0.80
4. The vapour pressure of two pure liquids A and B, that form an ideal solution are 100 and 900 torr respectively at temperature T. This liquid solution of A and B is composed of 1 mole of A and 1 mole of B. What will be the pressure, when 1 mole of mixture has been vapourized?
- (A) 800 torr  
 (B) 500 torr  
 (C) 300 torr  
 (D) None of these

## TYPE-6 : JEE Advanced PYQs

1. Liquids A and B form ideal solution over the entire range of composition. At temperature T, equimolar binary solution of liquids A and B has vapour pressure 45 Torr. At the same temperature, a new solution of A and B having mole fractions  $x_A$  and  $x_B$ , respectively, has vapour pressure of 22.5 Torr. The value of  $x_A/x_B$  in the new solution is \_\_\_\_\_. [JEE(Advanced) 2018, 3/120]  
 (given that the vapour pressure of pure liquid A is 20 Torr at temperature T)
2. For a solution formed by mixing liquids L and M, the vapour pressure of L plotted against the mole fraction of M in solution is shown in the following figure. Here  $x_L$  and  $x_M$  represent mole fractions of L and M, respectively, in the solution. The correct statement(s) applicable to this system is (are) [JEE(Advanced) 2017, 4/122]



- (A) The point Z represents vapour pressure of pure liquid M and Raoult's law is obeyed from  $x_L = 0$  to  $x_L = 1$ .

- (B) Attractive intermolecular interactions between **L-L** in pure liquid **L** and **M-M** in pure liquid **M** are stronger than those between **L-M** when mixed in solution
- (C) The point **Z** represents vapour pressure of pure liquid **M** and Raoult's law is obeyed when  $x_L \rightarrow 0$
- (D) The point **Z** represents vapour pressure of pure liquid **L** and Raoult's law is obeyed when  $x_L \rightarrow 1$