



DPP-8 [Depression in Freezing Point]

Chapter: Solution

“Jab result haath mein aata hai, sabse pehle parents yaad aate hain — aur aankhen bhar jaati hain. Yeh aansu haar ke nahi, koshish ke hote hain. Bas chalte raho. Tum sochte ho usse zyada strong ho. Yeh sirf journey ka ek phase hai.”

TYPE-1 : Basic ΔT_f Calculation

- Molal depression constant of water is $1.86 \text{ K Kg mol}^{-1}$. 0.02 mol of urea dissolved in 100 g of water will produce a depression in freezing point of :**
(1) 0.186°C (2) 0.372°C
(3) 1.86°C (4) 3.72°C
- What would be the freezing point of aqueous solution containing 18 g of $\text{C}_4\text{H}_{10}\text{O}_4$ in 1000 g of water? ($K_f = 1.86 \text{ K molality}^{-1}$)**
(1) -0.186°C (2) -0.372°C
(3) -0.54°C (4) -0.72°C
- A solution of sucrose (molar mass = 342 g mol^{-1}) has been prepared by dissolving 68.5 g of sucrose in 1000 g of water. The freezing point of the solution obtained will be :- (K_f for water = $1.86 \text{ K kg mol}^{-1}$)**
(1) -0.570°C (2) -0.372°C
(3) -0.520°C (4) $+0.372^\circ\text{C}$
- 1.00 g of a non-electrolyte solute (molar mass 250 g mol^{-1}) was dissolved in 51.2 g of benzene. If the freezing point depression constant, K_f of benzene is $5.12 \text{ K kg mol}^{-1}$, the freezing point of benzene will be lowered by :**
(1) 0.4 K (2) 0.3 K
(3) 0.5 K (4) 0.2 K
- Mole fraction of a non-electrolyte in aqueous solution is 0.07 . If K_f is $1.86^\circ \text{ mol}^{-1} \text{ kg}$, depression in f.p., ΔT_f is :**
(1) 0.26° (2) 1.86° (3) 0.13° (4) 7.78°
- Density of 1M solution of a non-electrolyte $\text{C}_6\text{H}_{12}\text{O}_6$ is 1.18 g/mL . If K_f (H_2O) is $1.86^\circ \text{ mol}^{-1} \text{ kg}$, solution freezes at :**
(1) -1.58°C (2) -1.86°C (3) -3.16°C (4) 1.86°C

TYPE-2 : Finding Molar Mass from ΔT_f

- A solution of 1.25 g of a non-electrolyte in 20 g of water freezes at 271.94 K . If $K_f = 1.86 \text{ K molality}^{-1}$ then the molecular wt. of the solute is :**
(1) 207.8 g mol^{-1} (2) $179.79 \text{ g mol}^{-1}$
(3) 209.6 g mol^{-1} (4) 96.01 g mol^{-1}

8. 1 g solute is dissolved in 50 g benzene shows depression in freezing point by 0.4 K. Then calculate molar mass of solute if $K_f = 5.12 \text{ K kg mol}^{-1}$
- (1) 512 (2) 256 (3) 728 (4) 738
9. 45 g non volatile solute A is dissolved in 600 g of water if depression in freezing point is 2.2 K. Then what will be mass of solute :-
- (1) 126.8 (2) 31.7 (3) 63.4 (4) 158.5

TYPE-3 : K_f Determination / Molality from ΔT_f

10. Pure benzene freezes at 5.45°C at a certain place but a 0.374 m solution of tetrachloroethane in benzene freezes at 3.55°C . The K_f for benzene is –
- (1) 5.08 K Kg mol⁻¹ (2) 508 K Kg mol⁻¹
 (3) 0.508 K Kg mol⁻¹ (4) 50.8°C Kg mol⁻¹
11. What is the molality of $\text{C}_2\text{H}_5\text{OH}$ in water solution which will freeze at -10°C ? [Mol. wt. of $\text{C}_2\text{H}_5\text{OH} = 46$, K_f for water = 1.86]
- (1) 6.315 m (2) 63.15 m
 (3) 3.540 m (4) 5.3 m
12. Glucose is added to 1 litre water to such an extent that $\frac{\Delta T_f}{K_f}$ becomes equal to $\frac{1}{1000}$, the wt. of glucose added is :-
- (1) 180 g (2) 18 g
 (3) 1.8 g (4) 0.18 g

TYPE-4 : Antifreeze / Ethylene Glycol Problems

13. The depression in freezing point of water containing ethylene glycol is 7.4°C . Calculate the mass of ethylene glycol added in 500 g water. ($K_f = 1.86 \text{ K kg mol}^{-1}$).
- (1) 23.3 g (2) 233.3 g
 (3) 123.3 g (4) 12.33 g
14. K_f for water is $1.86 \text{ K kg mol}^{-1}$. If your automobile radiator holds 1.0 kg of water, how many grams of ethylene glycol ($\text{C}_2\text{H}_6\text{O}_2$) must you add to get the freezing point of the solution lowered to -2.8°C ?
- [AIEEE 2012, 4/120]
- (1) 72 g (2) 93 g (3) 39 g (4) 27 g
15. Ethylene glycol $\left(\begin{array}{c} \text{CH}_2\text{OH} \\ | \\ \text{CH}_2\text{OH} \end{array} \right)$ is used as an antifreezing agent. Mass of ethylene glycol which should be added to 2 litre of water to prevent it from freezing at -24°C will be (K_f for water = $1.86 \text{ K kg mol}^{-1}$)
- (1) 1600 g (2) 1200 g
 (3) 800 g (4) 400 g
16. Ethylene glycol is used as an antifreeze in a cold climate. Mass of ethylene glycol which should be added to 4 kg of water to prevent it from freezing at -6°C will be : (K_f for water = $1.86 \text{ K kg mol}^{-1}$, and molar mass of ethylene glycol = 62 g mol^{-1})
- (1) 400.00 g (2) 304.60 g
 (3) 800.00 g (4) 204.30 g

17. In cold climate, the water in a radiator of car gets frozen causing damage to the radiator. Ethylene glycol is used as an antifreezing agent. The amount of ethylene glycol that should be added to 5 kg of water to prevent it from freezing at -7°C is : [NSEC-2016]
- (Given : K_f for water = $1.86 \text{ K mol}^{-1} \text{ kg}$; Molar mass of ethylene glycol = 62 g mol^{-1})
- (A) 1165 g (B) 46.7 g (C) 116.7 g (D) 93.4 g
18. Which of the following compounds can be used as antifreeze in automobile radiators ?
- (1) Nitrophenol (2) Ethyl alcohol
(3) Methyl alcohol (4) Glycol

TYPE-5 : Relation between K_b and K_f / Boiling & Freezing Point

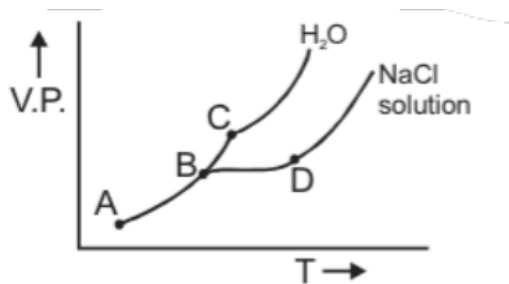
19. An aqueous solution freezes at -0.186°C ($K_f = 1.86 \text{ K kg mol}^{-1}$; $K_b = 0.512 \text{ K kg mol}^{-1}$). What is the elevation in boiling point ?
- (1) 0.186 (2) 0.512
(3) $\frac{0.512}{1.86}$ (4) 0.0512
20. An aqueous solution freezes at -0.36°C . K_f and K_b for water are 1.8 and $0.52^{\circ}\text{C}\cdot\text{kg mol}^{-1}$ respectively then value of boiling point of solution at 1 atm pressure is
- (1) 101.04°C (2) 100.1°C
(3) 0.104°C (4) 100°C
21. A solution of urea (mol. mass 60 g mol^{-1}) boils at 100.18°C at the atmospheric pressure. If K_f and K_b for water are 1.86 and $0.512 \text{ K kg mol}^{-1}$ respectively, the above solution will freeze at [AIPMT (Prelims)-2005]
- (1) -6.54°C (2) 6.54°C
(3) 0.654°C (4) -0.654°C
22. Addition of 1 kg of non volatile solute in volatile solvent increases the boiling point from 350 K to 355 K and decreases the freezing point from 250 K to 220 K. If K_b is 15.5 K Kg m^{-1} , then K_f will be
- (1) $2.1 \text{ K kg mol}^{-1}$ (2) $93.0 \text{ K kg mol}^{-1}$
(3) 76 K kg mol^{-1} (4) 10 K kg mol^{-1}
23. Elevation in the boiling point for 1 molal solution of glucose is 2 K. The depression in the freezing point for 2 molal solution of glucose in the same solvent is 2 K. The relation between K_b and K_f is : [JEE(Main) 2019 Online 10-01-19, 4/120]
- (1) $K_b = 0.5K_f$ (2) $K_b = K_f$ (3) $K_b = 1.5K_f$ (4) $K_b = 2K_f$
24. A 5% solution (by mass) of cane sugar in water has freezing point of 271 K and freezing point of pure water is 273.15 K. The freezing point of a 5% solution (by mass) of glucose in water is –
- (1) 271 K (2) 273.15 K
(3) 269.07 K (4) 277.23 K

TYPE-6 : Conceptual / Theory Questions

25. **If molality of a dilute solution is doubled, the value of molal depression constant (K_f) will be :-**
(1) halved (2) tripled
(3) unchanged (4) doubled
26. **In the depression of freezing point experiment, it is found that :-**
(1) The vapour pressure of solution is more than of pure H_2O .
(2) The vapour pressure of solution is less than that of pure solute
(3) Only solute molecules solidify at the freezing point
(4) Only solvent molecules solidify at the freezing point
27. **In the depression of freezing point experiment, it is found that :**
I. The vapour pressure of the solution is less than that of pure solvent.
II. The vapour pressure of the solution is more than that of pure solvent.
III. Only solute molecules solidify at the freezing point.
IV. Only solvent molecules solidify at the freezing point.
- [JEE 1999, 3/80]
- (A) I, II (B) II, III (C) I, IV (D) I, II, III
28. **Equimolar solutions in the same solvent have :**
- [AIEEE-2005, 3/225]
- (1) same boiling point but different freezing point
(2) same freezing point but different boiling point
(3) same boiling and same freezing points
(4) different boiling and freezing points
29. **The freezing point order of the solution of glucose is**
(1) $2\% > 3\% > 1\%$ (2) $1\% > 2\% > 3\% > 10\%$
(3) $1\% > 3\% > 10\% > 2\%$ (4) $10\% > 1\% > 3\% > 2\%$
30. **During depression of freezing point in a solution, the following are in equilibrium :**
- [JEE 2003, 3/84]
- (A) Liquid solvent–solid solvent (B) Liquid solvent–solid solute
(C) Liquid solute–solid solute (D) Liquid solute–solid solvent
31. **The melting points of most of the solid substances increases with an increase of pressure acting on them. However, ice melts at a temperature lower than its usual melting point, when the pressure increases. This is because :**
(A) Ice is less dense than water (B) Pressure generates heat
(C) The bonds break under pressure (D) Ice is not a true solid

TYPE-7 : JEE Advanced / Graph-Based / Application Problems

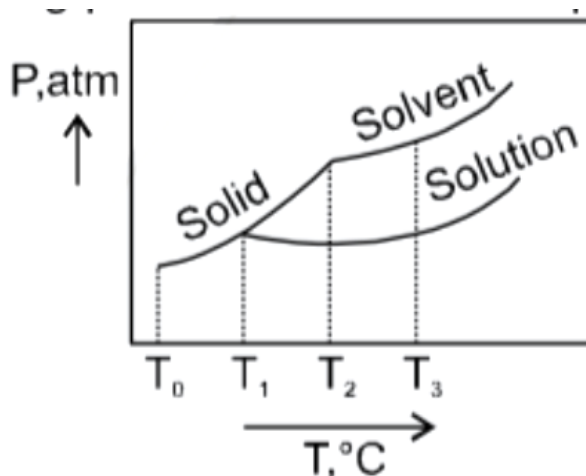
32. [Refer to the figure below]



Freezing point of solution is marked as

- (1) A (2) B (3) C (4) D

33. What is the normal freezing point of the solution represented by the phase diagram ?

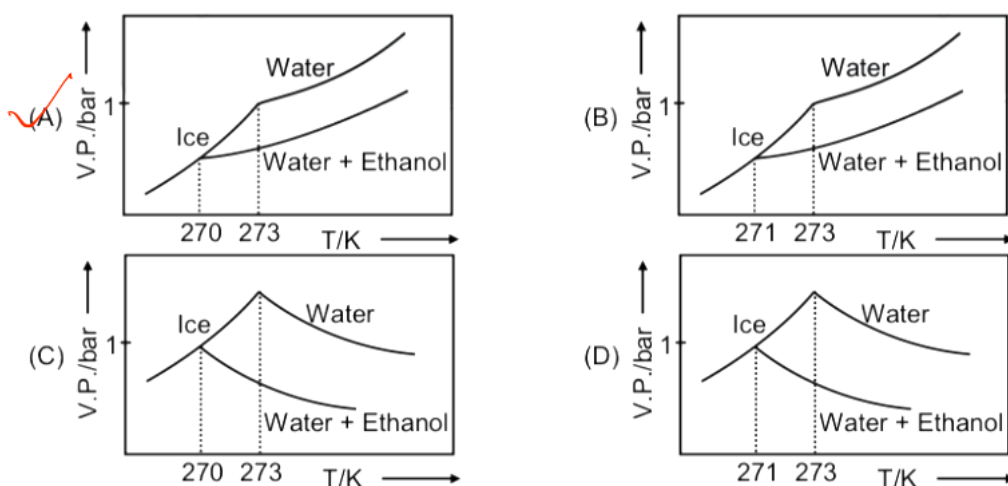


- (1) T_1 (2) T_2 (3) T_3 (4) T_0

34. Pure water freezes at 273 K and 1 bar. The addition of 34.5 g of ethanol to 500 g of water changes the freezing point of the solution. Use the freezing point depression constant of water as 2 K kg mol^{-1} . The figures shown below represent plots of vapour pressure (V.P.) versus temperature (T). [molecular weight of ethanol is 46 g mol^{-1}]

[JEE(Advanced) 2017, 3/122]

Among the following, the option representing change in the freezing point is



- (A) A (B) B (C) C (D) D

35. On dissolving 0.5 g of a non-volatile non-ionic solute to 39 g of benzene, its vapor pressure decreases from 650 mm Hg to 640 mm Hg. The depression of freezing point

of benzene (in K) upon addition of the solute is (1.04) (Given: Molar mass and the molal freezing point depression constant of benzene are 78 g mol^{-1} and $5.12 \text{ K kg mol}^{-1}$, respectively)

[JEE(Advanced) 2019, 3/124]

36. A solution containing 62 g ethylene glycol in 250 g water is cooled to -10°C . If K_f for water is $1.86 \text{ K kg mol}^{-1}$, the amount of water (in g) separated as ice is :

[JEE(Main) 2019 Online 09-01-19, 4/120]

- (1) 16 (2) 32 (3) 48 (4) 64

37. The freezing point of a diluted milk sample is found to be -0.2°C , while it should have been -0.5°C for pure milk. How much water has been added to pure milk to make the diluted sample?

[JEE(Main) 2019 Online 11-01-19, 4/120]

- (1) 1 cup of water to 3 cups of pure milk (2) 1 cup of water to 2 cups of pure milk
(3) 2 cups of water to 3 cups of pure milk (4) 3 cups of water to 2 cups of pure milk