14. DEPRESSION IN FREEZING POINT (Cryoscopy)

SOLUTIONS

TEACHING TASK

JEE MAINS LEVEL QUESTIONS

1. Freezing point of pure water is 0 °C. If 0.5 mol urea is dissolved in 1 kg water (Kf = 1.86 K·kg·mol^{-1}), the freezing point of solution is:
   A) 0 °C B) –0.93 °C C) –1.86 °C D) –2.0 °C

Answer:B

Solution: $\Delta T_f = K_f \times m = 1.86 \times 0.5 = 0.93^\circ C$

Freezing point $= 0 - 0.93 = -0.93^\circ C$

2. Which of the following is a colligative property?
   A) Surface tension B) Viscosity
   C) Freezing point depression D) Refractive index

Answer:C

Solution:Freezing point depression is colligative.

3. 18 g of glucose (M = 180 g·mol^{-1}) is dissolved in 100 g water. ΔT_f = ? (Kf = 1.86)
   A) 0.10 K B) 1.86 K C) 0.50 K D) 1.0 K

Answer:B

Solution:Mass of solvent = 100 g = 0.1 kg

Moles of glucose = 18/180 = 0.1 mol

Molality = 0.1 / 0.1 = 1 m

$\Delta T_f = 1.86 \times 1 = 1.86 \approx 1.86K$

4. Which solute will produce the maximum depression in freezing point, if 1 mol is dissolved in 1 kg water? **(FA & SA- 2 Marks)**
   A) Glucose B) Urea C) NaCl D) K_2SO_4

Answer:D

Solution:or 1 mol solute in 1 kg water, depression $\rightarrow$ i.

i values: glucose/urea =1, NaCl˜2, K_2SO_4˜3

K_2SO_4 gives maximum.

5. Depression in freezing point is directly proportional to:
   A) Vapour pressure B) Molality
   C) Osmotic pressure D) Temperature

Answer:B

Solution: $\Delta Tf \propto$ molality.

6. If 0.2 mol NaCl is dissolved in 1 kg water (i = 2, K_f = 1.86), ΔT_f is:

(FA & SA- 5 Marks / 8 Marks)

A) 0.186 K B) 0.372 K C) 0.744 K D) 1.86 K

Answer:C

Solution: $\Delta Tf = i \times Kf \times m = 2 \times 1.86 \times 0.2 = 0.744\,K$

7. For dilute solutions, depression in freezing point depends on:

A) Nature of solute B) Molality of solution only

C) Vapour pressure of solute D) Density of solvent

Answer:B

Solution:Colligative property $\rightarrow$ depends on molality only.

8. Which one of the following aqueous solutions has the lowest freezing point?

A) 1 m urea B) 1 m NaCl C) 1 m glucose D) 1 m sucrose

Answer:B

Solution:1 m urea i=1, NaCl i~2, glucose i=1, sucrose i=1 $\rightarrow$ NaCl lowest F.P.

9. If ΔT_f = 0.372 K and K_f = 1.86, molality of solution = ?

(FA & SA- 3 Marks / 4 Marks)

A) 0.1 B) 0.2 C) 0.3 D) 0.5

Answer:B

Solution: $m = \Delta Tf / Kf = 0.372 / 1.86 = 0.2$

10. Which statement is correct about depression in freezing point?

A) It increases with increase in vapour pressure of solvent

B) It decreases with molality

C) It depends on number of solute particles

D) It depends on colour of solute

Answer:C

Solution: ΔT_f depends on number of solute particles.

JEE ADVANCED LEVEL QUESTIONS

Multi correct answer type:

11. In the depression of freezing point experiment, it is found that

A) The vapour pressure of the solution is less than that of the pure solvent

B) The vapour pressure of the solution is more than that of the pure solvent

C) Only solute molecules solidify at the freezing point

D) only solvent molecules solidify at the freezing point

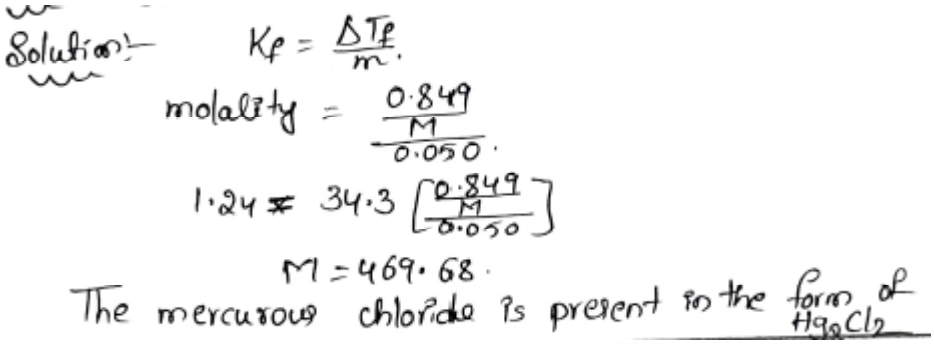
Answer:A,D

Solution:In freezing point depression of a solution (colligative property):

A) True — Adding solute lowers the vapor pressure (Raoult's law).
B) False — The vapor pressure decreases, not increases.
C) False — At freezing point, pure solvent solidifies out; solute typically does not solidify at that temperature (unless eutectic).
D) True — Only solvent molecules solidify at the freezing point of the solution.

12. For a solution of 0.849 g of mercurous chloride in 50 g of $HgCl_2$(l) the freezing point depression is 1.24°C. K_f for $HgCl_2$ is 34.3. What is the state of mercurous chloride in $HgCl_2$ is incorrect? (Hg – 200, Cl – 35.5)
A) as Hg_2Cl_2 molecules B) as HgCl molecules
C) as Hg^+ and Cl^- ions D) as Hg_2^{2+} and Cl^- ions

Answer:B,C,D



Assertion and Reason Type:

A) Both Assertion and Reason are true, and Reason is the correct explanation for Assertion.
B) Both Assertion and Reason are true, but Reason is NOT the correct explanation for Assertion.
C) Assertion is true, but Reason is false.
D) Assertion is false, but Reason is true.

13. **Assertion :** Depression of freezing point is a colligative property
Reason : The depression of freezing point for a solution is directly proportional to the molality of the solution.

Answer:A

Solution:Freezing point depression is colligative because it depends only on the number of solute particles → expressed through molality

Comprehension Type:

The freezing point is the temperature at which the solid and liquid forms of a substance are in equilibrium , i.e., their vapour pressures are equal.
Example: Ice and water at 0°C.
Adding a non-volatile solute lowers the freezing point of the solvent.
This lowering is called depression in freezing point (ΔT_f).
Reason: The vapour pressure of the solution is lower than that of the pure solvent. Since freezing occurs when vapour pressures are equal, the solution freezes at a lower temperature.

The decrease in the freezing point of a solvent when a non-volatile solute is dissolved in it is called the depression in freezing point.

Pure solvent: Freezing point = T_f^0

Solution: Freezing point = $T_f < T_f^0$

Depression in freezing point: $\Delta T_f = T_f^0 - T_f$

14. The freezing point of a substance is the temperature at which:
A) Its vapour pressure becomes zero
B) Its liquid and vapour phases are in equilibrium
C) Its solid and liquid phases are in equilibrium
D) Its solid and vapour phases are in equilibrium

Answer:C

Solution:Freezing point = temperature at which solid and liquid phases coexist in equilibrium.

15. When a non-volatile solute is added to a solvent, its freezing point:
A) Increases B) Decreases
C) Remains the same D) First decreases then increases

Answer:B

Solution:Adding non-volatile solute $\rightarrow$ freezing point decreases

16. Depression in freezing point is caused because:
A) Solute particles increase vapour pressure of the solvent
B) Solute particles decrease vapour pressure of the solvent
C) Solute particles evaporate rapidly
D) Solvent becomes more volatile

Answer:B

Solution: Depression in freezing point occurs because solute particles decrease vapour pressure of the solvent, shifting solid–liquid equilibrium to lower temperature

17. If T_f^0 is the freezing point of pure solvent and T_f is the freezing point of the solution, then depression in freezing point is:
A) $T_f - T_f^0$ B) $T_f^0 + T_f$ C)$T_f^0 - T_f$ D) $T_{f/}\ T_f^0$

Answer:C

Solution: Depression in freezing point = $T_f^0 - T_f$

Integer type:

18. Calculate the mass (in g) of glucose (molar mass = 180 $g \cdot mol^{-1}$) to be dissolved in 74 g of water so that the freezing point is lowered by 1.50°C. (K_f for water = 1.86 $°C \cdot kg \cdot mol^{-1}$)

Answer:11

Solution:Given: ΔT_f = 1.50°C

K_f = 1.86,Mass of water = 74 g = 0.074 kg,Molar mass of glucose = 180 g/mol

$$\Delta T_f = K_f \times m$$

Formula: $m = \frac{\Delta T_f}{K_f} = \frac{1.50}{1.86} = 0.806\, mol/kg$

Moles of glucose needed:
n=m×mass of solvent (kg)
n=0.806×0.074=0.0596~0.060 mol
Mass:mass=n×180=0.060×180=10.8 g~11g

19. The amount of urea (molar mass = 60 g·mol^{-1}) to be dissolved in 500 cm^3 of water to produce a depression of 2.00°C in the freezing point is _____ g. (Take density of water = 1 g·cm^{-3} so 500 cm^3 = 0.500 kg; K_f = 1.86 °C·kg·mol^{-1})

Answer:32

Solution:Given: ΔT_f = 2.00°C

K_f = 1.86
Mass of water = 500 cm^3 = 0.500 kg
Molar mass = 60 g/mol

$$m = \frac{\Delta T_f}{K_f} = \frac{2.00}{1.86} = 1.075\, mol/kg$$

Moles required:n=m×0.500=1.075×0.5=0.5375 mol
Mass:mass=0.5375×60=32.25

Matrix Matching Type:

20.

Column I	Column II
A) Definition of freezing point	(i) $\Delta T_f = K_f \times m$
B) Addition of non-volatile solute	(ii) $T_f^0 - T_f$
C) Depression in freezing point (ΔT_f)	(iii) Lowers freezing point of solvent
D) Formula for depression in freezing point	(iv)Temperature where solid and liquid phases are in equilibrium

Answer:A-iv,B-iii,C-ii,D-i

Solution:

A) Definition of freezing point	(iv)Temperature where solid and liquid phases are in equilibrium
B) Addition of non-volatile solute	(iii) Lowers freezing point of solvent
C) Depression in freezing point (ΔT_f)	(ii) $T_f^0 - T_f$
D) Formula for depression in freezing point	(i) $\Delta T_f = K_f \times m$

LEARNERS TASK

CONCEPTUAL UNDERSTANDING QUESTIONS (CUQ'S)

1. In cold countries, ethylene glycol is added to water in the radiations of cars during winter. This results in
   A) Lowering of F.P.
   B) Reducing the viscosity
   C) Reducing the specific heat
   D) Making water a better conductor of electricity

Ans:- A
Solution:- Addition of glycol lowers the freezing point of water in the radiators, so that the cold winter temperatures wouldn't burst the lines and thus glycol-water mixture is used as antifreeze in radiators of cars.

2. Which of the following has lowest freezing point
   A) 0.1M aqueous solution of glucose
   B) 0.1M aqueous solution of NaCl
   C) 0.1M aqueous solution of $ZnSO_4$
   D) 0.1M aqueous solution of urea

Answer:B

Solution:Lower FP $\rightarrow$ highest number of particles (van't Hoff factor i)
Glucose $\rightarrow$ i = 1
Urea $\rightarrow$ i = 1
NaCl $\rightarrow$ i = 2
$ZnSO_4$ $\rightarrow$ i = 2
But $ZnSO_4$ partially dissociates (i ˜ 2) similar to NaCl.
Both give more particles than glucose/urea.
NaCl or $ZnSO_4$ $\rightarrow$more ions $\rightarrow$ lowest FP.
Between NaCl (2 ions) and $ZnSO_4$ (2 ions), both same approx.
But $ZnSO_4$ may undergo slight ion pairing$\rightarrow$effective i < 2.
So NaCl gives maximum depression

3. Which of the following will have the highest F.P at one atmosphere
   A)0.1M NaCl solution
   B) 0.1Msugar solution
   C) *0.1M* $BaCl_2$ solution
   D) *0.1M* $FeCl_3$ solution

Ans:- B
Solution:- Greater the no. of particles, lower freezing point.
lower no. of particles higher freezing point.
→ NaCl ⟶ i = 2
→ sugar ⟶ i = 1.
→ $BaCl_2$ ⟶ i = 3
→ $FeCl_3$ ⟶ i = 4
∴ Sugar has lower particles. So it has higher freezing point.

4. The freezing point of 1 percent solution of lead nitrate in water will be
A) Below 0°C B) 0°C C) 1°C D) 2°C

Ans:- a.
Solution:- Aqueous solution of any substance if it is non volatile freezes below 0°c because the vapour pressure of the solution becomes lower than that of pure solvent.

5. If K_f value of H_2O is 1.86. The value of ΔT_f for 0.1 m solution of non-volatile solute is
A) 18.6 B) 0.186 C) 1.86 D) 0.0186

Ans:- b.
Solution:- $K_f = 1.86$, $m = 0.1$.

$$\Delta T_f = K_f m$$
$$= 1.86 \times 0.1 = 0.186.$$

6. When mercuric iodide is added to the aqueous solution of potassium iodide, the
A) Freezing point is raised B)Freezing point is lowered
C) Freezing point does not change D) Boiling point does not change

Answer:A

Solution:- HgI reacts with KI, to form $K_2[HgI_4]$.
Due to this, the no. of ions decreases thus decreasing the van't Hoff factor.

$\Delta T_f = i \times K_f \times m$.

Since 'i' has decreased, it result in less depression in the freezing point causing the freezing point to rise.

7. The molal depression constant depends upon

A) Nature of solute B) Nature of solvent

C) $\Delta H_{solution}$ D) Vapour pressure of solution

Ans:- B

Solution:- $\Delta T_f \propto m$, $\Delta T_f \propto k_f \rightarrow \Delta T_f = K_f m$.

K_f is constant.

ΔK_f depends on molality. Molal depression constant does not depend on the nature of the solute. It is depends the nature of solvent.

8. The freezing point of a solution containing 4.8 *g* of a compound in 60 *g* of benzene is 4.48. What is the molar mass of the compound

($K_f = 5.1 K\,m^{-1}$, freezing point benzene $= 5.5^{\circ}C$)

A) 100 B) 200 C) 300 D) 400

Ans:- D.

Solution:- $m = \frac{K_f \times 1000 \times w}{W \times \Delta T_f}$

$\Delta T_f = 5.5 - 4.48$
$= 1.02$

$= \frac{5.1 \times 1000 \times 4.8}{60 \times 1.02}$

$= \frac{24480}{61.2} = 400$

9. During depression of freezing point in a solution the following are in

equilibrium

A) Liquid solvent, solid solvent B) Liquid solvent, solid solute
C) Liquid solute, solid solute D)Liquid solute, solid solvernt

Ans:- A.

Solution:- During the depression of freezing point in a solution, liquid solvent & solid solvent are in equilibrium. During freezing of a solution, only the solvent freezes out and the equilibrium exists blw solid and liquid form of solvent.

10. The freezing point order of the solution of glucose is

A) 10% > 3% > 2% > 1% B) 1% > 2% > 3% > 10%
C) 1% > 3% > 10% > 2% D) 10% > 1% > 3% > 2%

Ans:- B.

Solution:- Freezing point is inversly proportional to mass percentage of the non-volatile electrolyte (Glucose)

1% > 2% > 3% > 10%.

JEE MAINS LEVEL QUESTIONS

1. The freezing point of pure water is 0°C. A solution of 10 g NaOH (M = 40) in 500 g water will freeze at: (K_f for water = 1.86 K kg mol^{-1})

(FA & SA- 3 Marks / 4 Marks)

A) –0.93°C B) –0.465°C C) –1.86°C D) –3.72°C

Answer:C

Solution:Given:moles NaOH = 10/40 = 0.25 mol
Mass of water = 0.5 kg
Molality = 0.25 / 0.5 = 0.5 m
NaOH is strong electrolyte $\rightarrow$ $Na^+ + OH^-$
van't Hoff factor i ˜ 2
ΔT_f = i Kf m = 2 × 1.86 × 0.5 = 1.86°C
Freezing point = 0 – 1.86 = –1.86°

2. A 0.1 m urea solution in water has ΔT_f = 0.186 K. For the same concentration, a 0.1 m Na_2SO_4 solution will show ΔT_f = ? (K_f = 1.86 K kg mol^{-1})

(FA & SA- 5 Marks / 8 Marks)

A) 0.186 K B) 0.372 K C) 0.558 K D) 0.744 K

Answer:C

Solution:For urea: ΔTf = 0.186 K (i = 1)

$Na_2SO_4 \rightarrow Na^+ + Na^+ + SO_4^{2-} \rightarrow$ 3 ions $\rightarrow$ i ˜ 3

So, ΔTf = i × 0.186 = 3 × 0.186 = 0.558 K

3. Which solution will have the maximum depression in freezing point?

A) 0.05 m glucose B) 0.05 m urea C) 0.05 m KCl D) 0.05 m Na_2SO_4

Answer:D

Solution:Compare i × m:

Glucose $\rightarrow$ i = 1

Urea $\rightarrow$ i = 1

KCl $\rightarrow$ i ˜ 2

$Na_2SO_4 \rightarrow$ i ˜ 3

Largest = Na_2SO_4

4. In which case will the freezing point of water decrease the most?

(FA & SA- 2 Marks)

A) Adding NaCl B) Adding sugar C) Adding urea D) Adding ethanol

Answer:A

Solution:Electrolytes cause more particles $\rightarrow$ more depression.

Among given: NaCl is strongest electrolyte

5. A solution contains 18 g glucose (M = 180) dissolved in 90 g water. Depression in freezing point is: (K_f water = 1.86 K kg mol?¹)

A) 0.2 K B) 0.186 K C) 0.372 K D) 2.07 K

Answer:D

Solution:Moles glucose = 18/180 = 0.1 mol

Mass water = 0.09 kg

Molality = 0.1 / 0.09 = 1.11 m

ΔT_f = 1 × 1.86 × 1.11 ˜ 2.07 K

6. A solution of NaCl freezes at –0.372°C. If Kf = 1.86 K kg mol^{-1}, the molality of NaCl solution is approximately:

A) 0.1 m B) 0.2 m C) 0.05 m D) 0.25 m

Answer:A

Solution: $NaCl \rightarrow i \approx 2.$

$\Delta T_f = 0.372\ K$

$0.372 = 2 \times 1.86 \times m$

$m = 3.72/0.372 = 0.1$

7. If 0.2 mol of NaCl and 0.1 mol of urea are dissolved in 1000 g of water, the total depression in freezing point is: (K_f = 1.86 K kg mol^{-1})

A) 0.186 K B) 0.372 K C) 0.744 K D) 0.93 K

Answer:D

Solution:Total effective particles:

NaCl i = 2 $\rightarrow$ contributes 0.2 × 2 = 0.4

Urea i = 1 → contributes 0.1 × 1 = 0.1
Total molality = 0.4 + 0.1 = 0.5 m
ΔT_f = 1.86 × 0.5 = 0.93 K

8. For a solution of 1 molal NaCl in water, the van't Hoff factor i is nearly:
A) 1 B) 2 C) 3 D) 0

Answer:B

Solution: 1 molal NaCl → i ~ 2 (strong electrolyte)

9. A non-electrolyte solute lowers the freezing point of 100 g of benzene by 1.86°C. If Kf for benzene is 5.12 K kg mol^{-1}, the moles of solute present are:
A) 0.1 B) 0.05 C) 0.2 D) 0.036

Answer:D

Solution: ΔT_f = 1.86
Kf = 5.12
Molality = ΔT_f/ Kf = 1.86 / 5.12 ˜ 0.363
Mass benzene = 0.1 kg
Moles solute = 0.363 × 0.1 = 0.036

10. Which solution will freeze at the highest temperature (least depression)?
A) 0.1 m NaCl B) 0.1 m glucose C) 0.1 m Na_2SO_4 D) 0.1 m KNO_3

Answer:B

Solution:Highest freezing point = smallest ΔT_f → smallest i×m. m=0.1 same.
NaCl i=2, glucose i=1, Na_2SO_4 i=3, KNO_3 i=2.
Smallest i = glucose (i=1) → B.

JEE ADVANCED LEVEL QUESTIONS

Multi correct answer type:

11. Which of the following are correct regarding depression in freezing point?
A) It is a colligative property
B) It depends on the nature of solute
C) It depends only on the number of solute particles present
D) It is directly proportional to molality

Answer:A,C,D

Solution:Regarding depression in freezing point:
A → True (colligative property).
B → False (colligative means independent of nature of solute, depends only on particle concentration).
C →True (depends on number of solute particles).
D → True ($\Delta T_f = i \cdot K_f \cdot m$, for given solute i constant → proportional to molality; even generally, $\Delta T_f \alpha$ (i·m), so proportional to molality for fixed i).

12. For an aqueous solution of NaCl:
A) The van't Hoff factor (i) is nearly 2
B) The depression in freezing point is about twice that of a non-electrolyte

solution of same molality

C) The freezing point of the solution is higher than pure water

D) NaCl dissociates to give more particles in solution

Answer:A,B,D

Solution:A $\rightarrow$ True (NaCl $\rightarrow$ Na^+ + Cl^-, i ˜ 2 for dilute).

B $\rightarrow$ True (Δ T_f is twice that of non-electrolyte of same molality, since i=2).

C $\rightarrow$ False (freezing point is lower, not higher).

D $\rightarrow$ True (dissociates into Na^+ and Cl^-, so more particles).

Assertion and Reason Type:

A) Both Assertion and Reason are true, and Reason is the correct explanation for Assertion.

B) Both Assertion and Reason are true, but Reason is NOT the correct explanation for Assertion.

C) Assertion is true, but Reason is false.

D) Assertion is false, but Reason is true.

13. **Assertion :** Depression of freezing point is directly proportional to the molality of the solution.

Reason : Molality depends on the mass of solute and the volume of the solution.

Answer:C

Solution:Assertion: Depression of freezing point is directly proportional to the molality of the solution.

This is true for nonelectrolytes ($\Delta T_f = K_f \times m$) and for electrolytes if we consider effective molality (i × m). For a given solute with constant i, $\Delta T_f \alpha$ m. So assertion is true.

Reason: Molality depends on the mass of solute and the volume of the solution.

Molality = moles of solute / mass of solvent in kg — not volume of solution. So the reason is false.

Comprehension Type:

When a non-volatile solute is dissolved in a solvent, the freezing point of the solution is found to be lower than that of the pure solvent. This decrease is called **depression in freezing point**.

Mathematically, $\Delta T_f = k_f . m . i$

where K_f is the molal depression constant, m is the molality of the solution, and i is the van't Hoff factor.

* For non-electrolytes, i = 1.
* For strong electrolytes, i > 1 due to dissociation into ions.
* For association of molecules (like acetic acid in benzene), i < 1.

Freezing point is defined as the temperature at which the solid and liquid phases of the solvent are in equilibrium.

14. Which of the following statements is Incorrect?

A) ΔT_f depends on the number of solute particles, not their nature

B) ΔT_f is proportional to molality of solution

C) ΔT_f is zero for pure solvent

D) Freezing point of a solution is always higher than that of solvent

Answer:D

Solution:A) True — colligative property.

B) True — $\Delta T_f \ \alpha$ m (with i constant).

C) True — $\Delta T_f = 0$ for pure solvent (no solute).

D) False — Freezing point of solution is lower, not higher, than that of pure solvent.

15. The van't Hoff factor i is equal to 1 for:

A) NaCl in water B) Glucose in water

C) K_2SO_4 in water D) NH_4Cl in water

Answer:B

Solution:i = 1 for non-electrolytes.

Glucose in water $\rightarrow$ non-electrolyte $\rightarrow$ i=1

16. A solution of 0.1 m NaCl in water has nearly the same ΔT_f as which of the following solutions?

A) 0.1 m glucose B) 0.2 m glucose

C) 0.05 m glucose D) 0.4 m glucose

Answer:B

Solution:Effective particles =0.1×2=0.2

Which glucose solution gives effective molality = 0.2

Glucose is non-electrolyte $\rightarrow$ i = 1.

So 0.2 m glucose $\rightarrow$ effective = 0.2

17. If acetic acid dimerizes in benzene, the value of van't Hoff factor i will be:

A) 1 B) Less than 1 C) Greater than 1 D) Equal to zero

Answer:B

Solution:

Acetic acid dimerizes in benzene :

$CH_3\ COOH \rightleftharpoons (CH_3\ COOH)_2$

Number of particles decreases $\rightarrow$ i < 1 $\rightarrow$B.

Integer type:

18. A 0.002 m aqueous solution of an ionic compound freezes at –0.00744°C. (Kf for water = 1.86 K·kg·mol^{-1}).Find the number of ions produced by 1 mole of the compound on dissolving in water._____

Answer:2

$$\Delta T_f = i \cdot K_f \cdot m$$

$$i = \frac{\Delta T_f}{K_f \cdot m}$$

$$\Delta T_f = 0.00744^\circ \text{C}$$

Solution: $K_f = 1.86 \text{K} \cdot \text{kg} \cdot \text{mol}^{-1}$

$$m = 0.002 \text{m}$$

$$i = \frac{0.00744}{1.86 \times 0.002} = 2$$

19. x g of urea is dissolved in 500 g of water and the solution is cooled to –2°C, whereby 128 g of ice separates out from the solution. (K_f for water = 1.86 K·kg·mol^{-1}).Calculate the value of x._____

Answer:24

Solution:Total water = 500 g

Ice separated = 128 g

remaining solvent:500-128=372g=0.372kg

Freezing point depression: $\Delta T_f = 2^\circ C$

$$\Delta T_f = K_f m$$

Molality: $2 = 1.86 m$

$$m = 2 / 1.86 = 1.075$$

Now, molality formula:

$$m = \frac{n}{kg\ of\ solvent}$$

$$1.075 = n / 0.372$$

$$n = 0.399 mol$$

Mass of urea :

$$x = n \times M = 0.399 \times 60 = 23.94 \approx 24 \text{g}$$

20. Equimolal solutions of NaCl and $CaCl_2$ are prepared in water. The freezing point depression of NaCl solution is found to be 0.372°C.
What is the freezing point depression of the $CaCl_2$ solution (assuming complete dissociation)?_____

Answer:0.558°C

Solution:Given:For NaCl, $\Delta T_f = 0.372^\circ C, i = 2$,

For $CaCl_2$, complete dissociation: $CaCl_2 \rightarrow Ca^{2+} + 2Cl^- \Rightarrow i = 3$

Since both are equimolal solutions:

$$\frac{\Delta T_{f(CaCl_2)}}{\Delta T_{f(NaCl)}} = \frac{i_{CaCl_2}}{i_{NaCl}}$$

$$\Delta T_{f(CaCl_2)} = 0.372 \times \frac{3}{2} = 0.558^{\circ}C$$

Matrix Matching Type:

21. **Column - I** **Column- II**

P) molal cryoscopic constant for benzene 1) 5.26 K molality^{-1}

Q) The factor $\Delta T_f / K_f$ represents 2) $1.86\ \text{deg} - kg\ mol^{-1}$

R) K_f for water is 3) proportional to osmotic pressure

S) depression in freezing point 4) molality

A) P-2 Q-4 R-2 S-3 B) P-1 Q-4 R-2 S-3

C) P-2 Q-4 R-1 S-3 D) P-2 Q-3 R-2 S-4

Answer:B

Solution:

P) molal cryoscopic constant for benzene 1) 5.26 K molality^{-1}

Q) The factor $\Delta T_f / K_f$ represents 4) molality

R) K_f for water is 2) $1.86\ \text{deg} - kg\ mol^{-1}$

S) depression in freezing point 3) proportional to osmotic pressure

A) P-2 Q-4 R-2 S-3 B) P-1 Q-4 R-2 S-3

C) P-2 Q-4 R-1 S-3 D) P-2 Q-3 R-2 S-4

KEY

				TEACHING TASK					
			JEE MAINS LEVEL QUESTIONS						
1	2	3	4	5	6	7	8	9	10
B	C	B	D	B	C	B	B	B	C
			JEE ADVANCED LEVEL QUESTIONS						
11	12	13	14	15	16	17	18	19	
A,D	B,C,D	A	C	B	B	C	11	32	
20-A-iv,B-iii,C-ii,D-i									
				LEARNERS TASK					
			CONCEPTUAL UNDERSTANDING QUESTIONS (CUQ's)						
1	2	3	4	5	6	7	8	9	10
A	B	B	A	B	A	B	D	A	B
			JEE MAINS LEVEL QUESTIONS						
1	2	3	4	5	6	7	8	9	10
C	C	D	A	D	A	D	B	D	B
			JEE ADVANCED LEVEL QUESTIONS						
11	12	13	14	15	16	17	18	19	20
A,C,D	A,B,D	C	D	B	B	B	2	24	0.558
21									
B									