13. ELEVATION IN BOILING POINT (Ebullioscopy)

SOLUTIONS

TEACHING TASK

JEE MAINS LEEL QUESTIONS

1. The elevation of boiling point is directly proportional to:
   A) Vapour pressure of solute
   B) Lowering of vapour pressure
   C) Number of solute particles
   D) Heat of vaporisation

Answer:C

Solution:Boiling point elevation is a colligative property $\rightarrow$depends on number of solute particles

2. A solution is prepared by dissolving 10 g of NaOH (M = 40 g/mol) in 250 g of water. If K_b of water = 0.512 K·kg·mol^{-1}, calculate the elevation in boiling point.

(FA & SA- 5Marks / 8 Marks)

   A) 0.128 K B) 0.512 K C) 0.640 K D) 1.024K

Answer:D

Solution:$NaOH \rightarrow Na^+ + OH^-$, i = 2 (complete dissociation).
Moles NaOH = 10/40 = 0.25 mol.
Mass solvent = 0.250 kg.
Molality m = 0.25 / 0.250 = 1.0 m.
$\Delta Tb = i \times Kb \times m = 2 \times 0.512 \times 1.0 = 1.024$ K.

3. Which of the following will show the maximum elevation in boiling point for equimolal aqueous solutions?
   A) NaCl B) K_2SO_4 C) Glucose D) $AlCl_3$

Answer:D

Solution:Depends on van't Hoff factor i:
NaCl $\rightarrow$ i=2, K_2SO_4 $\rightarrow$ i=3, Glucose $\rightarrow$ i=1, $AlCl_3$ $\rightarrow$ i=4 (if 100% dissociation).
$AlCl_3$ has highest i $\rightarrow$ maximum ΔTb.

4. For a solution, ΔTb = 0.25 K, molality = 0.5 m, then Kb is:

(FA & SA- 3 Marks / 4 Marks)

   A) 0.125 K·kg·mol^{-1} B) 0.25 K·kg·mol^{-1} C) 0.50 K·kg·mol^{-1} D) 1.0 K·kg·mol^{-1}

Answer:C

Solution: $\Delta Tb = i \times Kb \times m$ (assuming non-electrolyte) $\rightarrow$
$Kb = \Delta Tb / m = 0.25 / 0.5 = 0.50$ K·kg·mol^{-1}

5. Which of the following statements is correct?
   A) Elevation in boiling point depends on the nature of solute.

B) Elevation in boiling point is a colligative property.
C) Elevation in boiling point decreases with molality.
D) Pure solvent always boils at a higher temperature than solution.

Answer:B

Solution:A) False — independent of nature of solute (colligative property).
B) True.
C) False — increases with molality.
D) False — solution boils at higher temperature.

6. 0.5 molal solution of glucose in water has ΔTb = 0.256 K. What will be ΔTb for 0.5 molal solution of NaCl (assuming 100% dissociation)?
A) 0.128 K B) 0.256 K C) 0.512 K D) 1.024 K

Answer:C

Solution: ΔTb =i. Kb·m

0.5 molal glucose $\Delta T_b = 0.256\ K \Rightarrow K_b = 0.256 / (1\times 0.5) = 0.512\ K\cdot kg\cdot mol^{-1}$.

For 0.5 molal NaCl, $i = 2$, $\Delta T_b = 2 \times 0.512 \times 0.5 = 0.512\ K$.

7. Which of the following graphs correctly represents ΔTb vs molality (m)?
(FA & SA- 2 Marks)
A) Straight line through origin B) Parabola through origin
C) Hyperbola decreasing D) Constant straight line

Answer:A

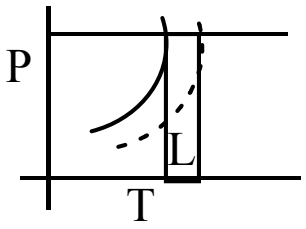
Solution: ΔTb = Kb·m $\rightarrow$ linear through origin.

8. Arrange the following w.r.t their B.P.
1) 0.2 m ethylene glycol 2) 0.12M K_2SO_4
3) 0.1m $MgCl_2$ 4) 0.12m KBr
A) I < IV < III < II B) III < II < IV < I C) II < IV < III < I D) II < III < IV < I

Answer:A

Solution:We need effective molality (i × m for electrolytes):
0.2 m ethylene glycol (i=1) $\rightarrow$ 0.2
0.12M K_2SO_4— need molality, but M ˜ m for dilute aq. soln; K_2SO_4 i=3 $\rightarrow$
0.12M K_2SO_4 effective = 0.36
0.1 m $MgCl_2$ i=3 $\rightarrow$ 0.3
0.12 m KBr i=2 $\rightarrow$0.24

9. The phase diagrams for the pure solvent (solid lines) and the solution (non-volatile solute, dashed line) are recorded below. The quantity indicated by 'L' in the figure is
A) Δp B) ΔT_f
C) K_b.m D) K_f.m



Answer:C

Solution:The solid line represents the pure solvent.

The dashed line represents the solution (with non-volatile solute).

The temperature difference 'L' between their boiling points (at constant pressure) is the elevation in boiling point

$L = \Delta T_b = K_b \times m$

JEE ADVANCED LEVEL QUESTIONS

Multi correct answer type:

10. Select the correct statement:

A) The melting of ice becomes fast if salt is spreaded on it

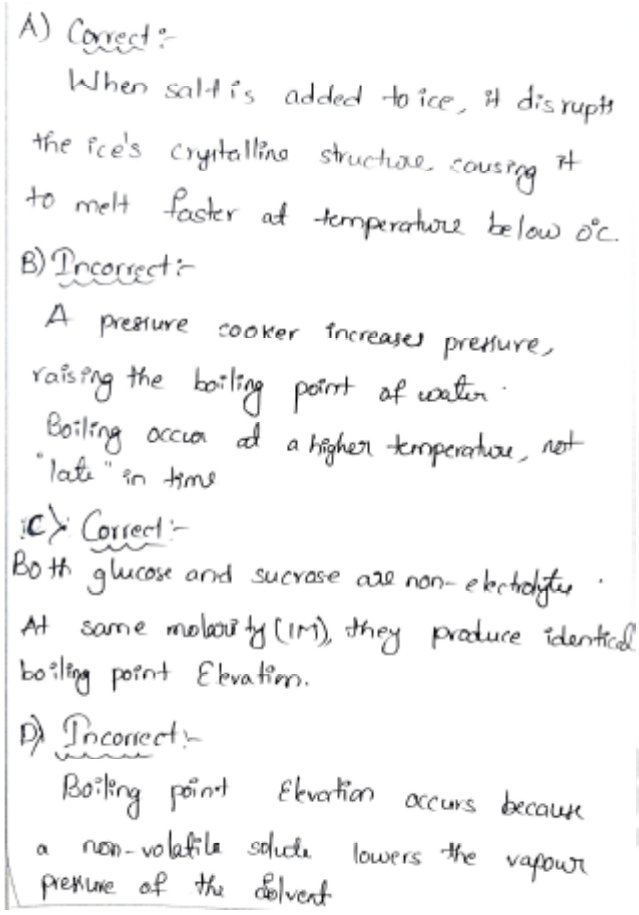
B) The boiling occurs late in pressure cooker

C) 1 M glucose solution has same boiling point as 1 M sucrose solution

D) Elevation in boiling point is due to increase in vapour pressure

Answer:A,C

Solution:


A) Correct:-
When salt is added to ice, it disrupts the ice's crystalline structure, causing it to melt faster at temperature below 0°C.
B) Incorrect:-
A pressure cooker increases pressure, raising the boiling point of water.
Boiling occurs at a higher temperature, not "late" in time
C) Correct:-
Both glucose and sucrose are non-electrolytes.
At same molarity (1M), they produce identical boiling point Elevation.
D) Incorrect:-
Boiling point Elevation occurs because a non-volatile solute lowers the vapour pressure of the solvent

11. Which of the following relations are correct

A) $m = \frac{100 \times K_b \times w}{\Delta T_b \times W}$; Where w and W are the weights of solute and solvent and m is the molecular weight of the solute

B) $K_b = \frac{0.002(T_0)^2}{l_V}$;where T_0 = Normal boiling point of the pure solvent; l_V = Latent heat of evaporation in cal/g of pure solvent

C) $K_b = \frac{RT_o^2}{\Delta H_{vap}}$, where ΔH_{vap} = molar heat of vapourisation of liquid , T_o = boiling point of pure solvent , R = gas constant.

Answer:B,C

Solution:

A) $m = \frac{1000 \times K_b \times w}{\Delta T_b \times W}$

B). $K_b = \frac{0.002 (T_0)^2}{L_v}$

c) $K_b = \frac{R T_0^2}{\Delta H_{ap}}$

Comprehension Type:

When some amount of non-volatile solute is dissolved in a solvent to prepare a dilute solution, the vapour pressure of the solvent is lowered and it is directly proportional to the mole fraction of solvent in the solution. Relative lowering in vapour pressure is equal to mole fraction of solute. Elevation in boiling point of solvent is a collgative property like lowering in vaour pressure of solvent in solution, K_b, i.e., molal elevation constant is calculated by the formula, $K_b = \Delta T_b$/ molality and also by the expression, $K_b = RT_b^2$ / **$1000 l_v$ where T_b is boliling point of solvent and lv is latent heat of vapourisation for 1 gm solvent.**

12. Lowering in vapour pressure in an experiment was found to be x mm of Hg. It is:
    A) Proportional to mole fraction of solvent in ideal solution
    B) Equal to mole fraction of solute in ideal solution
    C) Proportional to mole fraction of solute in ideal solution
    D) Equal to mole fraction of solvent in ideal solution

Answer:C

Solution:According to Raoult's Law: $\Delta P = P^0 - P = P^0 \cdot X_{solute}$

This means relative lowering of vapour pressure is directly proportional to mole fraction of solute.

13. Molal elevation constant (K_B)
    A) increasers on decreasing molality of solution
    B) decreases on decreasing molality of solution
    C) is independent of molality of the solution
    D) is a property of solute added to prepare the solution

Answer:C

Solution:K_b depends only on the solvent, not on concentration or solute.

It is a constant for a given solvent.

It does not change when molality changes.

Formula: $\Delta T_b = K_b \times m$

Integer type:

14. The boiling point of pure benzene is 353 K. When 2.5 g of a non-volatile solute (molar mass = 125 g mol^{-1}) is dissolved in 50 g of benzene, the solution shows an elevation in boiling point. (Given: K_b for benzene = 2.53 K·kg·mol^{-1})
    The elevation in boiling point, ΔTb, is _____ K

Answer:1.012

Solution:Moles of solute = 2.5/125=0.02 mol.

Solvent mass = 50 g=0.050 kg.

Molality =0.02/0.050=0.40 m.

$\Delta T_b = K_b \times m = 2.53 \times 0.40 = 1.012\,K$

15. The boiling point of a solution containing 10 g of urea (NH_2CONH_2,M=60) in 200 g of water is raised by ΔT_b. (Given K_b for water = 0.52 K kg mol^{-1}). Find ΔT_b ? (in K)_____

Answer:0.433

Solution: $\Delta T_b = K_b \times m$

Moles of solute = 10/60=0.166 mol.

Solvent mass = 200 g=0.2 kg.

Molality =0.166/0.2=0.83 m.

$\Delta T_b = K_b \times m = 0.52 \times 0.83 = 0.433K$

16. 0.5 mol of glucose ($C_6H_{12}O_6$) is dissolved in 250 g of water. If K_b for water = 0.52 K kg mol^{-1}, calculate the elevation in boiling point of the solution_____

Answer:1.04

Solution: $\Delta T_b = K_b \times m$

Moles of solute =0.5 mol.

Solvent mass = 250 g=0.25 kg.

Molality =0.5/0.25=2 m.

$\Delta T_b = K_b \times m = 0.52 \times 2 = 1.04K$

Matrix Matching Type:

17.

List I (Situation)	List II (Result/Concept)
A) Addition of non-volatile solute to solvent	1.Molality of solution
B) Magnitude of elevation of boiling point	2.Boiling point increases
C) Elevation of boiling point is directly proportional to	3.Landsberger's method / Cottrell's method
D) Method used for experimental determination	4.Value depends on K_b of solvent

Answer:A-2,B-4,C-1,D-3

Solution:

A) Addition of non-volatile solute to solvent	2.Boiling point increases
B) Magnitude of elevation of boiling point	4.Value depends on K_b of solvent
C) Elevation of boiling point is directly proportional to	1.Molality of solution
D) Method used for experimental determination	3.Landsberger's method / Cottrell's method

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LEARNERS TASK

CONCEPTUAL UNDERSTANDING QUESTIONS (CUQ'S)

1. The temperature at which the vapour pressure of a liquid becomes equal to the atmospheric pressure is known as
   A)Freezing point B) Boiling point
   C)Absolute temperature D) None of these

Answer:B

Solution:The temperature at which the vapour pressure of a liquid becomes equal to the atmospheric pressure is known as boiling point.

2. If the solution boils at temperature T_1 and the solvent at temperature T_2 the elevation of boiling point is given by
   A) $T_1 + T_2$ B) $T_1 - T_2$ C) $T_2 - T_1$ D) same as T_1 and T_2

Answer:B

Solution:Elevation = $T_1 - T_2$ (solution B.P. - pure solvent B.P.)

3. Which of the following statements is correct for the boiling point of solvent containing a dissolved solid substance
   A) Boiling point of the liquid is depressed
   B) Boiling point of the liquid is elevated
   C) There is no effect on the boiling point
   D)The change depends upon the polarity of liquid

Answer:B

Solution: Dissolved solute lowers vapour pressure, so a higher temperature is needed to boil.

4. A solution of 1 molal concentration of a solute will have maximum boiling point elevation when the solvent is
   A)Ethyl alcohol B)Acetone C) Benzene D) Chloroform

Answer:D

Solution: $\Delta T_b = K_b \times m$; Kb depends on solvent.
Among given: Ethanol (Kb=1.07), Acetone (1.71), Benzene (2.53), Chloroform (3.63) $\rightarrow$ Chloroform has highest K_b.

5. The elevation in boiling point for one molal solution of a solute in a solvent is called
   A)Boiling point constant B) Molal elevation constant
   C)Cryoscopic constant D)None of these

Answer:B

Solution:The elevation in boiling point for one molal solution is called Molal elevation constant. Also known as the ebullioscopic constant

6. The molal elevation constant is the ratio of the elevation in B.P. to
A)Molarity B) Molality
C) Mole fraction of solute D) Mole fraction of solvent

Answer:B

Solution:The molal elevation constant K_b is defined as the elevation in boiling point (ΔT_b) produced when 1 mole of solute is dissolved in 1 kg of solvent.

That means: $K_b = \frac{\Delta T_b}{m}$

where m is the molality.
So K_b is the ratio of the elevation in boiling point to molality.

7. Which solution will have the highest boiling point
A) 1% solution of glucose in water
B) 1% solution of sodium chloride inwater
C) 1% solution of zinc sulphate in water
D) 1% solution of urea in water

Answer:B

Solution:

Boiling point elevation α Number of particles (i × molality) (Colligative property).

Solute	Type	Van't Hoff factor
Glucose	Non-electrolyte	1
Urea	Non-electrolyte	1
NaCl	Strong electrolyte	2
$ZnSO_4$	Strong electrolyte (2 ions)	2

Both NaCl and $ZnSO_4$ dissociate into 2 ions, but $ZnSO_4$ forms some ion pairs in water, making effective i slightly less.

Therefore, NaCl gives the highest ΔT_b

8. The molecular mass of a solute in a solution can be calculated from the ebulliioscopic (elevation in B.P.) method using the expression

A) $m = \frac{100 \times K_{1000} \times \text{weight of solute}}{\Delta T \times \text{weight of solvent}}$

B) $m = \frac{1000 \times K_{1000} \times \text{weight of solute}}{\Delta T \times \text{weight of solvent}}$

C) $m = \frac{1000 \times K_{1000} \times \text{weight of solvent}}{\Delta T \times \text{weight of solvent}}$

D) $m = \frac{\Delta T \times \text{weight of solvent}}{1000 \times K_{1000} \times \text{weight of solute}}$

Answer:B

Solution: $\Delta T_b = K_b \times \frac{w_1}{M_1 \times w_2} \times 1000$.

$M_1 = \frac{K_b \times w_1 \times 1000}{\Delta T_b \times w_2}$

where M_1 = Molar mass of solute

w_1 = weight of solute, w_2 = weight of solvent

$M = \frac{K_b \times \text{weight of solute} \times 1000}{\Delta T \times \text{weight of solvent}}$.

9. The rise in the boiling point of a solution containing 1.8 gram of glucose in 100g of a solvent is $0.1^{\circ}C$ The molal elevation constant of the liquid is

A) 0.01K/m B) 0.1K/m C) 1K/m D) 10K/m

Answer:C

Solution: Given weight of solute = 1.8 g.

weight of solvent = 100 g.

$\Delta T_b = 0.1^{\circ}c$.

M_1: Glucose $C_6H_{12}O_6 = (6\times12) + (2\times1) + (6\times16) = 72+12+96 = 180$

$\Delta T_b = K_b \times \frac{w_1}{M_1 \times w_2} \times 1000$.

$0.1 = K_b \times \frac{1.8}{180 \times 100} \times 1000$

$0.1 = K_b \times \frac{18}{1800}$

$K_b = 0.1 \times 10 = 1 K/m$.

10. Elevation in boiling point was $0.52^{\circ}C$ when 6gm of a compound "X" was dissolved in 100gm of water. Molecular weight of is (K_b for water is 0.52 per of water)

A)120 B) 60 C)180 D) 600

Answer:B

Solution: Given data:

Elevation in boiling point, ΔT_b = 0.52°C

Mass of solute = 6 g
Mass of solvent = 100 g = 0.1 kg
K_b = 0.52 ,°C·kg·mol^{-1}
Formula: $\Delta T_b = K_b \times m$

$$m = \frac{\Delta T_b}{K_b} = \frac{0.52}{0.52} = 1 mol/kg$$

So the solution is 1 molal, meaning 1 mole of solute in 1 kg of solvent.
For 0.1 kg of solvent:

$$\text{moles of solute} = m \times \text{mass of solvent}(\text{in kg}) = 1 \times 0.1 = 0.1 \text{mol}$$

Now, molecular weight M = mass/moles = 6/0.1= 60

JEE MAINS LEVEL QUESTIONS

1. Which of the following is a colligative property? **(FA & SA- 2 Marks)**
   A) Viscosity B) Osmotic pressure
   C) Surface tension D) Refractive inde

Answer:B

Solution: Colligative properties depend on the number of solute particles in a solution, not on their identity.
Examples include:Osmotic pressure,Lowering of vapor pressure,Elevation of boiling point, Depression of freezing point
Viscosity, surface tension, and refractive index are not colligative properties.

2. If 1 mole of NaCl is dissolved in 1 kg of water and is completely dissociated, the elevation in boiling point is (K_b = 0.52 K kg mol^{-1}):
   A) 0.52 K B) 1.04 K C) 1.56 K D) 2.08 K

Answer:B

$$\text{NaCl}: i = 2 \left(\text{for 100\% dissociation into } Na^+ \text{ and } Cl^-\right).$$

Solution: $m = 1 \text{ mol} / 1 \text{ kg} = 1 \text{ m}$
$\Delta T_b = K_b \times m \text{ x } i = 0.52 \times 1 \text{x } 2 = 1.04 K$

3. The elevation in boiling point of 1 molal KCl solution (assuming 100% dissociation) is:
   A) equal to that of 1 molal urea solution
   B) less than that of 1 molal urea solution
   C) more than that of 1 molal urea solution
   D) zero

Answer:C

Solution:KCl i ˜ 2; urea i = 1. For same molality, KCl gives higher ΔT_b.

4. Which of the following solutions will have the highest boiling point ?
   A) 1 m urea B) 1 m NaCl C) 1 m K_2SO_4 D) 1 m glucose

Answer:C

Solution:Comparing same molality:
Urea i=1, NaCl i~2, K_2SO_4 i~3, glucose i=1.
Highest $\Delta T_b \rightarrow$ highest boiling point $\rightarrow K_2SO_4$.

5. A solution contains 0.5 mole of non-volatile solute dissolved in 500 g of benzene. If K_b = 2.53 K kg mol^{-1}, the elevation in boiling point is:
(FA & SA- 5 Marks / 8Marks)
A) 2.53 K B) 1.27 K C) 5.06 K D) 0.25 K

Answer:A

Solution:moles solute = 0.5 mol, mass solvent = 500 g = 0.5 kg.
Molality = 0.5 / 0.5 = 1 m (assuming non-electrolyte i=1).
$\Delta T_b = i \times K_b \times m = 1 \times 2.53 \times 1 = 2.53$ K.

6. The ebullioscopic constant (K_b) is directly proportional to:
A) Heat of vaporization B) 1 / (Heat of vaporization)
C) Molar mass of solute D) Vapour pressure of solvent

Answer:B

Solution:The ebullioscopic constant (K_b) is directly proportional to (1 / (Heat of vaporization)). The formula for the ebullioscopic constant is

$$K_b = \frac{RT_b^2 M}{\Delta H_{vap} \times 1000}$$

7. Which statement is correct?
A) Addition of a non-volatile solute increases vapour pressure of solvent
B) Addition of a non-volatile solute decreases vapour pressure of solvent
C) Addition of a volatile solute always increases vapour pressure
D) None of these

Answer:B

Solution:Addition of non-volatile solute decreases vapor pressure of solvent (Raoult's law).

8. If 1 mol of Na_2SO_4 is dissolved in 1 kg of water and is completely ionized, the van't Hoff factor (i) is:
A) 1 B) 2 C) 3 D) 4

Answer:C

Solution: $Na_2SO_4 \rightarrow 2Na^+ + SO_4^{2-}$, total ions per formula unit = 3. So i = 3 if 100% dissociated.

9. The boiling point of pure water is 373 K. The elevation in boiling point produced by dissolving a non-volatile solute in it is 0.52 K. The boiling point of the solution will be: **(FA & SA- 3 Marks / 4 Marks)**
A) 372.48 K B) 373.52 K C) 374.00 K D) 372.00 K

Answer:B

Solution:Boiling point = 373+0.52=373.52 K.

10. Which of the following has lowest vapour pressuren at the same temperature?

A) Pure water
B) 1 m urea solution
C) 1 m NaCl solution
D) 1 m K_2SO_4 solution

Answer:D

Solution:Lowest vapor pressure $\rightarrow$ largest number of solute particles in solution (greatest lowering of vapor pressure).
For same molality:
Pure water (highest vapor pressure)
1 m urea i=1 $\rightarrow$ moderate lowering
1 m NaCl i=2 $\rightarrow$ more lowering
1 m K_2SO_4 i=3 $\rightarrow$ most lowering $\rightarrow$ lowest vapor pressure.

JEE ADVANCED LEVEL QUESTIONS

Multi correct answer type:

11. Select the correct statements:
A) Addition of a non-volatile solute to a solvent raises its boiling point.
B) Boiling point elevation is directly proportional to the molality of the solution.
C) For an electrolyte, van't Hoff factor (i) is always less than 1.
D) For urea solution, van't Hoff factor (i) = 1.

Answer:A,B,D

Solution:A) True. Adding a non-volatile solute lowers vapour pressure $\rightarrow$raises boiling point.
B) True. $\Delta T_b = iK_b m$ — directly proportional to molality.
C) False. For electrolytes the ideal i>1 (number of ions). In practice ion-pairing can make the effective i<1 only in special cases, but it is not always <1.
D) True. Urea is a nonelectrolyte, so i=1

12. Which of the following is/are correct about elevation in boiling point?
A) It depends on the number of solute particles, not their nature.
B) It increases with increase in van't Hoff factor (i).
C) It decreases when heat of vaporization of solvent increases.
D) It is zero for ideal solutions.

Answer:A,B,C

Solution:A) True. Boiling point elevation is a colligative property — depends on number of solute particles, not their chemical identity.
B) True. Larger van't Hoff factor i $\rightarrow$ more particles $\rightarrow$ larger ΔT_b
C) True. $K_b = \frac{RT_0^2}{\Delta H_{vap}}$ so larger ΔH_{vap} $\rightarrow$ smaller $\rightarrow K_b \rightarrow$ smaller ΔT_b
D) False. For ideal solutions ΔT_b is generally not zero; ideal means obeying Raoult's law, but colligative effects still occur (non-volatile solute lowers vapour pressure)

Statement Type:

A) Both STATEMENT-I and STATEMENT-II are true and STATEMENT-II is the correct explanation of STATEMENT-I

B) Both STATEMENT-I and STATEMENT-II are true and STATEMENT-II is the not correct explanation of STATEMENT-I

C) STATEMENT-I is true but STATEMENT-II is false

D) STATEMENT-I is false but STATEMENT-II is true

13. **Statement I** : Sea water boils at higher temperature than distilled water
Statement II : Addition of non volatile solute to a solvent lowers the vapour pressure

Answer:A

Solution:Statement I: True – sea water contains salts (non-volatile solutes) ? boiling point elevation.
Statement II: True – Raoult's law.
Link: Boiling point elevation occurs because vapour pressure is lowered by solute addition. Lower vapour pressure means solvent needs higher temperature to reach atmospheric pressure ? higher boiling point.
So Statement II explains Statement I.

14. **Statement I** : The boiling point of a solution is directly proportional to the molality of solute in dilute solutions.
Statement I : $\Delta T_b = K_b m$

Answer:A

Solution:Statement I: True for non-electrolyte dilute solutions ($\Delta T_b = K_b m$), so boiling point $T_b = T_b^\circ + \Delta T_b$ is directly proportional to m for small m.
Statement II: True – formula for boiling point elevation for non-electrolyte.
Link: Statement II is the mathematical expression of the proportionality in Statement I, so Statement II explains Statement I.

Comprehension Type:

Elevation in Boiling Point (Ebullioscopy):**The boiling point of a liquid is the temperature at which its vapour pressure becomes equal to atmospheric pressure (760 mm Hg)**
When a non-volatile solute is dissolved in a liquid:
The vapour pressure of the solution decreases.
To reach atmospheric pressure, the solution must be heated more.
Hence, the solution boils at a higher temperature than the pure solvent.
Example: Sea water boils at a higher temperature than pure distilled water.

15. The boiling point of a liquid is defined as:

A) The temperature at which the vapour pressure of the liquid becomes equal to atmospheric pressure

B) The temperature at which the liquid evaporates completely

C) The temperature at which the vapour pressure of the liquid becomes zero

D) The temperature at which liquid freezes

Answer:A

Solution:Boiling point is the temperature at which the vapor pressure of a liquid

equals the atmospheric pressure.

16. When a non-volatile solute is dissolved in a solvent:
A) Vapour pressure of the solution increases
B) Vapour pressure of the solution decreases
C) Boiling point of the solution decreases
D) The solution and solvent boil at the same temperature

Answer:B

Solution:A non-volatile solute lowers the vapor pressure of the solvent (Raoult's law).

17. Sea water boils at a higher temperature than pure distilled water because:
A) The vapour pressure of sea water is greater than that of pure water
B) The vapour pressure of sea water is lower than that of pure water
C) Sea water contains only volatile solutes
D) Salt impurities increase the vapour pressure of water

Answer:B

Solution:Sea water contains dissolved salts (non-volatile solutes) $\rightarrow$ lowers vapor pressure $\rightarrow$ requires higher temperature to boil.

Integer type:

18. The rise in boiling point of a solution containing 1.8 g of glucose (M = 180 $g \cdot mol^{-1}$) dissolved in 100 g of solvent is 0.10 °C. The molal elevation constant K_b of the solvent is _____ $K \cdot kg \cdot mol^{-1}$.

Answer:1

Solution:- $\Delta T_b = 0.1°C$, $w_1 = 1.8g$, $w_2 = 100g$.

Molecular weight of glucose ($C_6H_{12}O_6$) = 180 gms.

$K_b = ?$

$$\Delta T_b = K_b \times \frac{w_1}{M_1 \times w_2} \times 1000.$$

$$0.1 = K_b \times \frac{1.8}{180 \times 100} \times 1000$$

$$0.1 = K_b \times \frac{18}{180}\ 10.$$

$$K_b = 10 \times 0.1$$

$$= 1$$

19. For water K_b = 0.512 $K \cdot kg \cdot mol^{-1}$. The boiling point elevation required is 0.512 K. The molality of the solution is _____m.

Answer:1

Solution: $m = \Delta T_b / K_b = 0.512 / 0.512 = 1.0$

Matrix Matching Type:

20. Column I (Quantity/Concept) — Column II (Description/Effect)

a) $\Delta T_b = i K_b m$	1. Accounts for dissociation/association of solutes
b) Van't Hoff factor (i)	2. Depends inversely on molar enthalpy of vaporization of solvent
c) K_b (ebullioscopic constant)	3. Formula for elevation in boiling point
d) Addition of NaCl to water	4. Raises boiling point of solvent

Answer:a-3,b-1,c-2,d-4

Solution:

a) $\Delta T_b = i K_b m$	3. Formula for elevation in boiling point
b) Van't Hoff factor (i)	1. Accounts for dissociation/association of solutes
c) K_b (ebullioscopic constant)	2. Depends inversely on molar enthalpy of vaporization of solvent
d) Addition of NaCl to water	4. Raises boiling point of solvent

KEY

				TEACHING TASK					
			JEE MAINS LEEL QUESTIONS						
1	2	3	4	5	6	7	8	9	
C	D	D	C	B	C	A	A	C	
			JEE ADVANCED LEVEL QUESTIONS						
10	11	12	13	14	15	16	17		
A,C	B,C	C	C	1.012	0.433	1.04	A-2,B-4,C-1,D-3		
				LEARNERS TASK					
			CONCEPTUAL UNDERSTANDING QUESTIONS (CUQ'S)						
1	2	3	4	5	6	7	8	9	10
B	B	B	D	B	B	B	B	C	B
			JEE MAINS LEVEL QUESTIONS						
1	2	3	4	5	6	7	8	9	10
B	B	C	C	A	B	B	C	B	D
			JEE ADVANCED LEVEL QUESTIONS						
11	12	13	14	15	16	17	18	19	
A,B,D	A,B,C	A	A	A	B	B	1	1	
20									
a-3,b-1,c-2,d-4									