Class-IX (Advanced)

7. Ideal and Non-Ideal Solutions

Teaching Task

Q1) Ans:- B.

Solution:- Some liquids on mixing, form azeotropes which are binary mixtures having the same composition in liquid and vapour phase and boil at a constant temperature.

→ May show positive or negative deviation from Roult's law.

Q2). Ans:- B.

Solution:- As the solution shows negative deviation A-B interactions are greater than A-A and B-B interactions.

Q3) Ans:- C.

Solution:- Acetone → Boiling Point = 329 K

CS_2 → Boiling Point = 320 K.

Boiling point of Solution = 312 k.

$(B.P)_A$, $(B.P)_{CS_2} > (B.P)_{solution}$.

↳ Minimum boiling point azeotrope.

Solutions which are having +ve deviation from roaults law are minimum boiling point azeotropes.

Q4) Ans:- B.

Solution:- Acetic acid (CH_3COOH) and pyridine (C_5H_5N) form hydrogen bonds (N---H−O), leading to stronger A-B interactions than A-A / A-B.

Stronger interactions → Lower vapourpressure → Negative deviation from Raoult's Law.

Q5) Ans:- C.

Solution:- Relation b/w vapour pressure & boiling point.

In the above graph represents minimum boiling point and maximum vapour pressure.

Q6) Ans:- B.

Solution:- Azeotropic mixtures are non-ideal solution because they form deviation from ideality in a solution.

→. Azeotropes have constant boiling point & their vapour phase has the same composition, making it impossible to separate them using fractional distillation.

Q7) Ans:- A.

Solution:-

→ Volume of mixing of ideal solution is zero because, there is no change in volume.

→ There is no heat absorbed or evolved during mixing, so there is no enthalpy change.

→ Negative deviation occurs when intermolecular forces blw the components are stronger than in the pure substances, resulting a less volatile mixture.

→ In an ideal solution, entropy of mixing is not zero, it increases because mixing leads to greater disorder.

Q8) Ans:- C.

Solution:- If the azeotropic solution has a lower boiling point than either of its two liquids then its shows positive deviation from roult's law.

Q9) Ans:- C.

Solution:- Liquids with similar chemical structure and polarity form an ideal solution.

Q10) Ans:- C.

Solution:- Solute - solute & solvent - solvent interactions are stronger than solute - solvent interactions show positive deviation.

→ In positive deviation, total vapour pressure is greater than the vapour pressure obtained from the Raoult's law.

Multiple Correct Answer Type

Q11) Ans:- B, D.

Solution:- $n_A = 4$ moles. | $n_B = 6$ moles.

$P_A^\circ = 80$ mm of Hg | $P_B^\circ = 100$ mm of Hg.

$$P_T = P_A^\circ X_A + P_B^\circ X_B$$

$$= 80 \times \frac{4}{10} + 100 \times \frac{6}{10} = 32 + 60 = 92 \text{ mm Hg} > 90 \text{ mm}$$

Observed vapour pressure less than expected.

So it is negative deviation from raoult's law.

Vapour pressure decrease boiling point increase.

→ The solution will boil at higher temperature than expected.

Q12) Ans:- A, B, C.

Solution:-

→ Acetone and Carbon disulphide, acetone & ethyl alcohol and acetone + benzene shows positive deviations because solute-solvent interactions are weaker than solute-solute & solvent-solvent interactions.

Q13) Ans:- C.

Solution:- The mixing of two completely miscible liquids A & B showing positive deviation from Raoult's law is followed by an absorption of heat

→ In positive deviation A-B interactions are weaker than A-A & B-B interactions.

Q14) Ans:- C.

Solution:- Ethanol-hexane interactions are weaker than Ethanol-Ethanol & hexane-hexane leads to positive deviation.

→ In ethanol, intermolecular hydrogen bonding is present

Q15) Ans:- D.

Solution:- → n-hexane + n-heptane, Methanol + Ethanol $CCl_4 + CS_2$ are either mixtures of non-polar or polar substances that have relatively similar intermolecular forces, so they obey Raoult's law.

→ Chloroform + acetone form strong hydrogen bonding blw them leading to negative deviation from Raoult's law.

Q16) Ans:- B.

Solution:-

i) $\Delta H_{mix} = 0$, $\Delta V_{mix} = 0$

For ideal solution there is no heat absorbed or released upon on mixing $\Delta H_{mix} = 0$,

The volume changing upon mixing is zero. $\Delta V_{mix} = 0$

ii) $\Delta S_{mix} > 0$, $\Delta V = 0$, For ideal solution, the entropy change upon mixing ΔS_{mix} is positive but $\Delta V = 0$.

iii) $\Delta H_{mix} = 0$, $\Delta S > 0$

→ The enthalpy of mixing $\Delta H_{mix} = 0$ but entropy of mixing $\Delta S_{mix} > 0$ (+ve)

iv) For an ideal solution, the observed vapour pressure equals the expected vapour pressure.

Integer Type

Q17) Ans:- 1

Solution:- $P_{total} = P_0^A + P_0^B$.

Given $P_0^B = 0$

$P_{total} = P_0^A$.

Q18) Ans:- 0

Solution:- For a solution to exhibit maximum boiling point azeotropes, the change in volume upon mixing (ΔV_{mix}) is always greater than the sum of the partial volumes of pure components.

$\Delta V_{mix} > 0$

Matrix Matching.

Q19) Ans:- A) q B) P C) r D) r.

Solution:-

A) Acetone + Aniline → q) Negative deviation

B) Water + CH_3OH → P) Positive deviation.

C) Benzene + toluene → r) Ideal solution.

D) n-hexane + n-heptane → r) Ideal solution

Learner's Task

Q1) Ans:- C.

Solution:- A solution that obeys Raoult's law is called ideal solution.

Q2) Ans:- B.

Solution:- Some liquids on mixing, having same composition in liquid, vapour phase & boil at a constant temperature. In such cases, it is not posibble to separate the components by fractional distillation. This mixture is known as Azeotropic mixture.

Q3) Ans:- D

Solution:- Liquid pair benzene (A) – toluene (B) shows practically no deviation from raoult's law as there is A–B ≈ A–A & B–B interactions.

Q4) Ans:- A.

Solution:- If liquids A & B form an ideal solution, the enthalpy of mixing is zero.

For ideal solution $\Delta V_{mixing} = 0$, $\Delta H_{mixing} = 0$.

The Gibbs free energy is always negative & becomes more negative as temperature is increased.

Q5) Ans:- D

Solution:- We know that a mixture shows negative deviation $\Delta V_{mix} < 0$.

$A-B > A-A$ & $B-B$.

Q6) Ans:- D.

Solution:- Benzene + methanol → Positive deviation.

Water + HCl, water + nitric acid, acetone + chloroform negative deviation.

Q7) Ans:- D.

Solution:-

→ A) $CH_3 + (CH_3)_2CO$ → -ve deviation.

B) $(CH_3)_2CO + C_6H_5NH_2$ → -ve deviation.

c) $CHCl_3 + C_6H_6$ → -ve deviation.

D) $(CH_3)_2CO + CS_2$ → shows +ve deviation.

Mixing of polar and non-polar liquids result a solution of weaker interactions

Q8) Ans:- D.

Solution:- Water and HCl form an azeotropic mixture. It is a constant boiling mixture in which the composition of mixture remains the same through out the boiling. That mixture neither pure HCl nor pure water.

Q9) Ans:- D.

Solution:- An azeotropic or a constant boiling mixture is a mixture of 2 or more liquids whose proportions cannot be altered by simple distillation. Azeotropic mixture of HCl contains 20.4% HCl.

Q10) Ans:- C

Solution:- Ethyl bromide + Ethyl iodide & Benzene + Toluene are ideal solutions.

→ Ethyl alcohol + water → Positive deviation.

→ Chloroform + Benzene → Negative deviation.

JEE Main Level Questions

Q1). Ans:- C

Solution:- Vapour pressure increases, positive deviations takes place.

A-B < A-A & B-B.

Q2) Ans:- B.

Solution:- Solution formed will be ideal if

Solution → Pure solute + Pure solvent.

$\Delta H = \Delta H_1 + \Delta H_2 + \Delta H_3$.

Q3) Ans:- B.

Solution:- When $15\,cm^3$ of X mixed with $20\,cm^3$ of 'y'.

Expected volume = $15+20 = 35\,cm^3$.

But the solution formed is $35.1\,cm^3$.

$\Delta V_{mix} = +ve$, It is positive deviation form Raoult's law hence $\Delta H_{mix} = +ve > 0$

Q4) Ans:- D.

Solution:- For non-Ideal solution, $\Delta V_{mix} < 0$.

Hence, total volume = $100+25 = 125\,mL$

$\Delta V_{mix} < 0$, so it is < 125 or nearly equals to 125mL

Q5) Ans:- D.

Solution:- Relation blw vapour pressure and boiling point

Graph represents maximum boiling point and minimum vapour pressure

Q6) Ans:- B.

Solution:- For a solution showing negative deviation,

→ Negative enthalpy change ($\Delta H < 0$).

→ Negative volume change ($\Delta V < 0$)

→ Vapour pressure lower than predicted.

$P_{total} < P_A^0 x_A + P_B^0 x_B$.

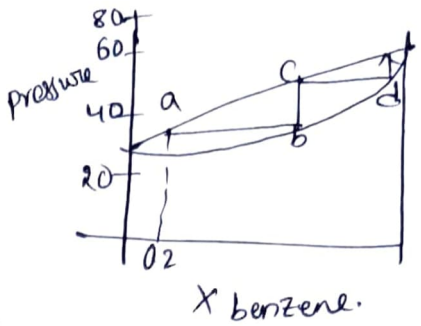
→ Leads to increase in entropy $\underline{\Delta S_{mix} > 0}$

Q7) Ans:- A.

Solution:-

Mole fraction of benzene at a = 0.2.

Mole fraction of toluene = 1 - 0.2
= 0.8.



b - C → No change in mole fraction, vapour pressure increase → So it is condensation.

C → d → Same vapour pressure change in mole fraction, vaporization.

Q8) Ans:- C

Solution:-

→ 68% HNO_3 & 32% H_2O by mass forms maximum boiling azeotrope with boiling point of 393.5 K.

→ Fermented sugar that contains about 95% ethanol by volume is an example of a minimum boiling azeotrope.

Q9) Ans:- D.

Solution:- Azeotropes boil at constant temperature like a pure liquid & possess same composition of components in liquid as well as in vapour phase because whole of the azeotropes changes into vapour state at constant temperature and their components can not be separated by fractional distillation.

Advanced Level Questions

Q10). Ans:- B, D.

Solution:- n-Heptane (A) is non-polar

Ethyl alcohol (B) is polar. The mixture formed by these two liquids is non-ideal.

$A-B < A-A \& B-B$.

This shows positive deviation & heat Absorbed.

Q11) Ans:- A, B, C.

Solutions:- For ideal solutions,

A) Plot of P_A versus x_A is linear.

B) Plot of P_B versus x_B is linear.

c) Plot of P_{total} versus x_A (&) x_B is linear.

Q12) Ans:- C.

Solution:- For ideal solutions,

$\Delta V_{mix} = 0$, $\Delta H_{mix} = 0$, $P_{total} = P_A^\circ x_A + P_B^\circ x_B$.

$\Delta S_{mix} \neq 0$.

Q13) Ans:- C

Solution:- $x_{Benzene} = 0.4$, $x_{Toluene} = 1 - 0.4 = 0.6$

$P_A^\circ = 40$ mm $\quad P_B^\circ = 30$ mm of Hg

$P_T = 40 \times 0.4 + 0.6 \times 30 = 16 + 18 = 34$

$$y_T = \frac{P_{Toluene}}{P_{Total}} = \frac{18}{34} \approx 0.53.$$

Q14) Ans:- B.

Solution:- Vapour pressure of 'B' > 'A' as the vapour pressure curve of component 'B' is higher than A.

Q15) Ans:- D.

Solution:- $P = P_A^\circ x_A + P_B^\circ . x_B$.

$x_A + x_B = 1$.

at $x_A = 1, x_B = 0$, $P = P_A^\circ < P_B^\circ$.

at $x_B = 1, x_A = 0$, $P = P_B^\circ > P_A^\circ$.

Integer Type

Q16) Ans:- 0.

Solution:- For positive deviation $\Delta V_{mix} > 0$.

For negative deviation $\Delta V_{mix} < 0$.

Q17) Ans:- Non-zero.

Solution:- If the solution doesnot form azeotrope then change in entalpy of that solution is $\Delta H \neq 0$

Matrix Matching.

Q18). Ans:- A) Q,R B) P,S C) P,S. D) Q,R.

A). 95.4% aqueous ethanol solution →

Q) Forms minimum boiling azeotrope.

R) ΔV_{mixing} is positive.

B) 68% aqueous HNO_3 →

P) Forms maximum boiling azeotrope.

S) ΔH_{mixing} is negative.

C) 20.3% aqueous HCL solution.

P) Forms maximum boiling azeotrope.

S) ΔH_{mixing} is negative.

D). 6.8% ethanol in chloroform.

Q) Forms minimum boiling azeotrope.

R) ΔV_{mixing} is positive.

7. Ideal and Non-Ideal Solution
KEY

TEACHING TASK

1	2	3	4	5	6	7	8	9	10
B	B	C	B	C	B	A	C	C	C

11	12	13	14	15	16	17	18	19
B,D	A,B,C	C	C	D	B	1	0	A-Q,B-P,C-R, D-R

LEARNERS TASK

CONCEPTUAL UNDERSTANDING QUESTIONS (CUQ's)

1	2	3	4	5	6	7	8	9	10
C	B	D	A	D	D	D	D	D	C

JEE MAIN LEVEL QUESTIONS

1	2	3	4	5	6	7	8	9
C	B	B	D	D	B	A	C	D

ADVANCED LEVEL QUESTIONS

10	11	12	13	14	15	16	17	18
B,D	A,B,C	C	C	B	D	0 NON ZERO		A-QR,B-PS,C-PS,D-QR