Question

What role does the molecular interaction play in a solution of alcohol and water?

Answer:

Intermolecular attraction between water - alcohol is weaker than intermolecular attraction between water-water and alcohol-alcohol molecule. Thus vapour pressure of solution is more than predicted value by Raoult's law. This is positive deviation. These form minimum boiling azeotrope.

Question

What is meant by positive and negative deviation from Raoult's law and how is the sign of $\Delta_{sol}H$ related to positive and negative deviations from Raoult's law?

Answer

Positive deviation solution:

i) $P > P_A^{\circ} x_A + P_B^{\circ} x_B$

ii) i.e vapour pressure is more than that predicted by Raoult's law.

iii) A - B interactions are weaker than A-A and B-B interact-ions.

iv) $\Delta_{sol}H > 0$.

Negative deviation solution:

i) $P < P_A^{\circ} x_A + P_B^{\circ} x_B$

ii) i.e vapour pressure is less than that predicted by Raoult's law.

iii) A-B interactions are stronger than A-A and B-B interactions.

iv) $\Delta_{sol} H < 0$

Question

Suggest the most important type of intermolecular interaction in the following pairs.

i) n-hexane and n-octane

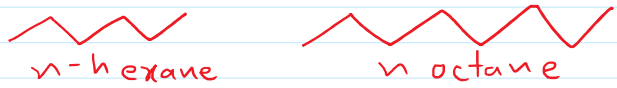
ii) I_2 and CCl_4

iii) $NaClO_4$ and water.

iv) methanol and acetone

v) acetonitrile and acetone.

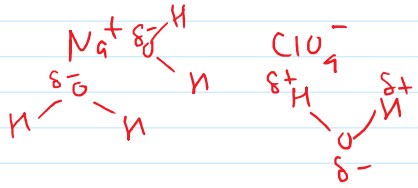
Answer:

i)  → Both non polar

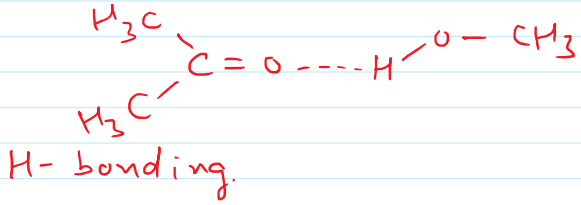
Van der Waals force of attraction.

ii) I_2 + CCl_4 → Both non polar.

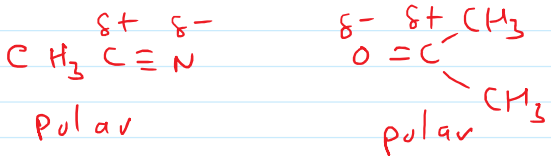
Van der Waals force of attraction.

iii) 

Ion-dipole interactions.

iv) 

H-bonding.

v) 

Dipole-dipole attraction.

Question

Based on solute-solvent interactions, arrange the following

in order of increasing solubility in n-octane and give reason.

Cyclohexane, KCl, CH_3OH, CH_3CN.

Answer

Like dissolves like.

n-octane is non-polar solvent, thus non polar solute is more soluble in it

Order of polarity of given solutes is:

KCl (ionic) > CH_3OH > CH_3CN (polar covalent) >  (non polar covalent)

thus order of solubility in n-octane is:

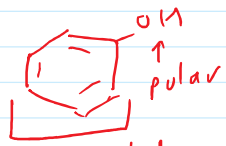
KCl < CH_3OH < CH_3CN < 

Question

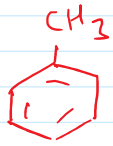
Among the following compounds, identify which are insoluble, partially soluble and highly soluble in water?

i) phenol ii) Toluene iii) Formic acid iv) Ethylene glycol v) Chloroform vi) Pentanol.

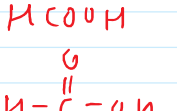
Answer

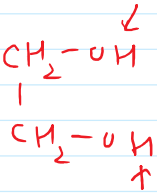


phenol



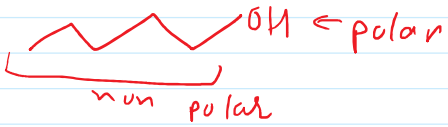
Toluene





$CHCl_3$

chloroform



a) Toluene and chloroform do not contain polar groups, hence are insoluble in water.

b) Phenol and pentanol contain polar -OH group that forms H bonding with water, but they also contain bulky

non-polar group which is water insoluble. Hence both are partially soluble in water.

c) Formic acid has $\diagup C=O$ group and -OH group which forms H-bonds with water. Glycol has two -OH groups to form H-bonds with water. Hence both are highly soluble in water.

Question

Which of the following mixtures can be separated into pure components by fractional distillation.

a) Benzene - Toluene b) water - alcohol c) water - HNO_3

d) Water - HCl.

Answer:

- Non ideal solutions form azeotropic mixtures and cannot be separated into pure components by fractional distillation.
- Ideal solutions can be separated.
- Benzene - Toluene → Ideal solution (can be separated)

water - alcohol → (+ve deviation)

- water - HNO_3, water - HCl (-ve deviation)

Question

A non-ideal solution was prepared by mixing 30ml chloroform and 50ml acetone. The volume of mixture will be

a) > 80ml b) < 80ml c) = 80ml d) cannot be predicted.

Answer:

Chloroform and acetone form negative deviation solution. So $\Delta V_{mix} < 0$. Thus volume of mixture is < 80ml.

Question

The vapour pressure of the solution of two liquids A ($P_A^\circ = 80$ mm Hg) and B ($P_B^\circ = 120$ mm Hg) is found to be 100 mm Hg when $x_A = 0.4$. Is solution ideal, shows positive deviation or shows negative deviation.

Answer:

By Raoult's law

$P = P_A^\circ x_A + P_B^\circ x_B = 80 \times 0.4 + 120\,(1-0.4) = 104$ mm Hg

as $P_{actual} < P_{ideal}$

solution shows negative deviation.