1. Indicate the principal types of solute-solvent interaction in each of the following solutions, and rank the solutions from weakest to strongest solute-solvent interaction: a) KCl in water, b) CH₂Cl₂ in benzene (C₆H₅), c) methanol (CH₃OH) in water.

- KCl in water = Ionic interaction (Polar)
- Methanol in water = Hydrogen bonding (Polar)
- CH₂Cl₂ in benzene = London Dispersion Forces

2. A solution is made containing 25.5 g of phenol (C₆H₅OH) in 495 g of ethanol (CH₃CH₂OH).
   Calculate a) the mole fraction of phenol, b) the mass percent of phenol, c) the molality of phenol.

\[
\text{Moles of Phenol} = \frac{25.5 \text{ g}}{94 \text{ g mol}^{-1}} = 0.27 \text{ mole}
\]
\[
\text{Moles of Ethanol} = \frac{495 \text{ g}}{49.8 \text{ g mol}^{-1}} = 10.8 \text{ mol}
\]

a) Mole fraction of phenol = \[
\frac{0.27 \text{ mol}}{0.27 + 10.8} = 0.024
\]

b) Mass percent of phenol = \[
\frac{25.5 \text{ g}}{(25.5 + 495) \text{ g}} \times 100 = 4.90\%
\]

\[
\text{Molality of Phenol} = \frac{\text{No. of moles of phenol}}{\text{No. of kg of EtOH}} = \frac{0.27 \text{ mol}}{0.495 \text{ kg}} = 0.55 \text{ mol kg}^{-1}
\]

3. A dilute aqueous solution of an organic compound soluble in water is formed by dissolving 2.35 g of the compound in water to form a 0.250 L solution. The resulting solution has an osmotic pressure of 0.605 atm at 25 °C. Assuming that the organic compound is a nonelectrolyte, what is its molar mass?

\[
\Pi = MRT \Rightarrow \Pi = \left(\frac{n}{V}\right)RT
\]

So \(\Pi = 0.605 \text{ atm; } T = 25^\circ \text{C} = 298 \text{ K; } V = 0.250 \text{ L}\)

\[
\text{So number of moles} = n = \frac{\Pi \cdot V}{RT} = \frac{0.605 \text{ atm} \times 0.250 \text{ L}}{0.0821 \frac{\text{L atm}}{\text{mol K}} \times 298 \text{ K}} = 0.00618 \text{ mol}
\]

\[
\text{Molality} = \frac{\text{Mass of Solute}}{\text{Molal Mass}} = \frac{2.35 \text{ g}}{0.00618 \text{ mol}} = 380.9 \text{ moles}
\]

4. Using Table 13.4 in the book, calculate the boiling point of 20.0 g of decane (C₁₀H₂₂) in 45.5 g CHCl₃.

So, Solute: Decane

Moles of Solute = \[
\frac{20.0 \text{ g}}{142 \text{ g mol}^{-1}} = 0.141 \text{ mol}
\]

Kg of Solvent = 45.5 g = 0.0455 kg

\[
\Delta T_b = K_b \cdot m
\]

\[
\Delta T_b = 3.63 \frac{^\circ \text{C}}{\text{m}} \times 3.10 \text{ m}
\]

= 11.3 °C

Final boiling pt of solution = (61.2 + 11.3) - 72.5 °C

\[
molality (m) = \frac{\text{Molal mass of solution}}{\text{Kg of solvent}} = \frac{0.141 \text{ mol}}{0.0455 \text{ kg}} = 3.10 \text{ mol kg}^{-1}(or \text{m})
\]