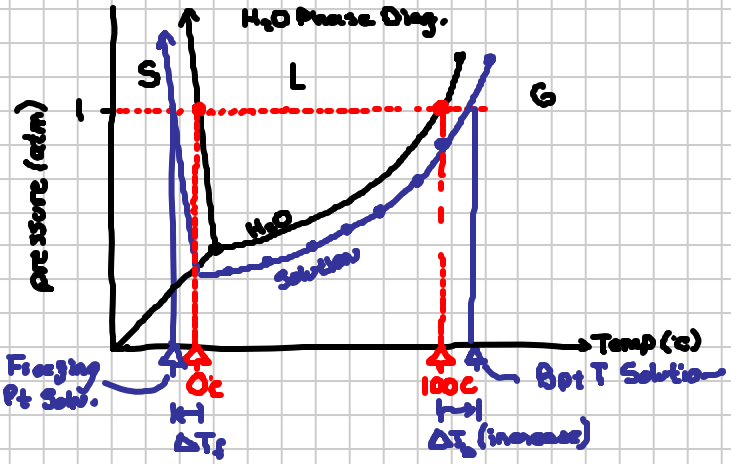
Lecture 3.4 Colligative Properties: Bpt Elevation & Fpt Depression

Note Title

Raoult's Law: $P_{solution} < P_{solvent}$ $\quad \Delta P = i\, X_{solute}\, P_{solvent}$

Boiling occurs $P_{soln} = P_{atm}$ $\quad \uparrow P_{solution} = P_{atm}$ .. incr. Boiling Temp.
Boiling Pt Elevation

Phase Diagrams: Pressure - temperature roadmap



- pure H_2O boils @ 100°C
- pure H_2O freezes @ 0°C

Boiling Point Elevation: .. incr. in Bpt Temp

$\Delta T_b = i \cdot m \cdot K_b$

i = Van't Hoff factor; m = molal conc; K_b = Boiling Pt elevation const: $K_b{}_{H_2O} = 0.512\ ^\circ C/m$

Freezing Point Depression: ... decr. in Fpt. Temp

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

K_f = Freezing Pt Depr. Const: $K_f{}_{H_2O} = 1.86\ ^\circ C/m$

Example: 8.75 g of solid NaCl is dissolved in 250. mL of distilled H_2O.

Calculate the boiling point temp. and the freezing point temp. for the solution.

$8.75\ g_{NaCl} = 0.149719\ mol$, $250\ mL = 0.250\ kg$, $m = \frac{mol\ NaCl}{kg\ H_2O} = \frac{0.149719\ m}{0.250\ kg} = 0.598876\ m$

$\Delta T_b = i\, m\, K_b$

$\Delta T_b = (1.9)(0.598876\ m)(0.512\ ^\circ C/m)$

$\Delta T_b = 0.58_{288}\ ^\circ C$

$T_b{}_{Solution} = T_b{}_{Solvent} + \Delta T_b = 100C + 0.58_{288}$

$= 100.58\ ^\circ C$

"slight increase"

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

$\Delta T_f = (1.9)(0.598876\ m)(1.86\ ^\circ C/m)$

$\Delta T_f = 2.1\ ^\circ C$

$T_f{}_{Solution} = T_f{}_{Solvent} - \Delta T_f = 0^\circ C - 2.1^\circ C$

$T_f{}_{Solution} = -2.1^\circ C$