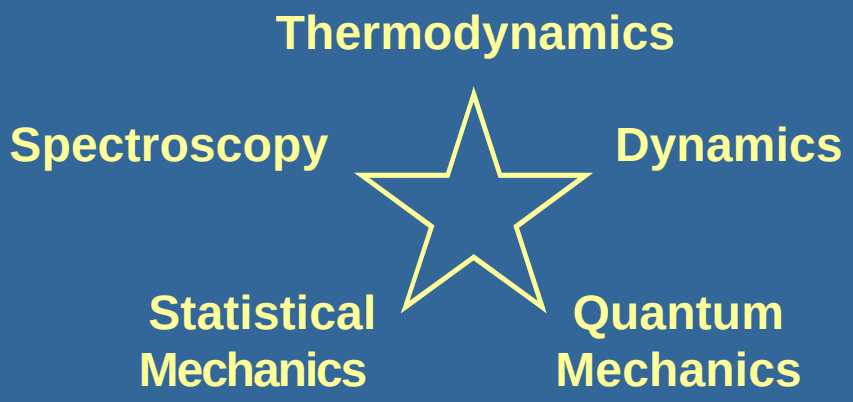
Physical Chemistry



Mixtures

Colligative Properties

Jeffrey J. Weimer
Chemistry / Chemical & Materials Engineering
University of Alabama in Huntsville

January 30, 2002

Outline

- Principle and Definition
- Applications
- Assumptions
- Colligative Properties
  - Boiling Point
  - Freezing Point
  - (Solubility)
  - Osmotic Pressure

Principle and Definition

- Molecular interactions in a solvent are disturbed by any type of solute molecule in a similar fashion regardless of the type of solute molecule.

- Solution properties that depend only on the number of solute particles (molecules) present are colligative properties.

Applications

Applies primarily to dilute solutions.

Colligative Properties

Boiling Point

Freezing Point

(Solubility)

Osmotic Pressure

Colligative Properties

Assumptions

- Binary solutions
  (A-solvent, B-solute)
- Solute is not volatile
  (no solute vapor)
- Solute does not dissolve in solid solvent
  (phase separation occurs)
- Ideal solutions
  (Raoults law in vapor phase)

Colligative Properties

Boiling Point

Freezing Point

(Solubility)

Osmotic Pressure

Colligative Properties

Boiling Point

- Boiling Point Increase

$$\ln(1-x_B) = \frac{\Delta_{vap}H}{R}\left(\frac{1}{T} - \frac{1}{T^*}\right)$$

Simplified Forms

$$\Delta T = Kx_B \qquad K = RT^{*2}/\Delta_{vap}H$$

$$\Delta T = K_b b$$

Colligative Properties

Freezing Point

- Freezing Point Decreases

$$\ln(1-x_B) = \frac{-\Delta_{fus}H}{R}\left(\frac{1}{T} - \frac{1}{T^*}\right)$$

Simplified Forms

$$\Delta T = Kx_B \qquad K = RT^{*2}/\Delta_{fus}H$$

$$\Delta T = K_f b$$

Colligative Properties

Solubility

- Solubility Depends on Temperature

$$\ln(x_B) = \frac{-\Delta_{fus}H}{R}\left(\frac{1}{T} - \frac{1}{T^*}\right)$$

(strictly speaking, not a colligative property)

Osmotic Pressure

The osmotic pressure Π is the additional pressure that is needed to bring a solvent in a solution to the same chemical potential as it would have if it was a pure solvent.