Changing Freezing and Boiling Points

Freezing Point Depression

- Freezing point depression occurs when the freezing point of a liquid is lowered by adding another compound to it
- The solution has a lower freezing point than that of the pure solvent
  - For example, the freezing point of seawater is lower than that of pure water
  - The freezing point of water to which antifreeze has been added is lower than that of pure water

- For a liquid to freeze, it must achieve an ordered state that results in the formation of a crystal
- If there are impurities in the liquid (solute), then the liquid is inherently less ordered
- Therefore, a solution is more difficult to freeze than the pure solvent, and a lower temperature is required to freeze the solution

- Another way to explain this is to say that, as a solution is cooled, solvent molecules lose average kinetic energy
- This enables them to settle into the crystal structure of the pure solvent
- As the crystal grows, solute molecules interfere with the growth of the solvent crystals
- To compensate, more kinetic energy must be taken from the solution, thus depressing the freezing point.

Boiling Point Elevation

- Boiling point elevation occurs when the boiling point of a solution becomes higher than the boiling point of a pure solvent
- The temperature at which the solvent boils is increased by adding any non-volatile solute
  - A common example of boiling point elevation can be observed by adding salt to water (The boiling point of the water is increased)

- If we add solute to a solvent, the vapor pressure of the solution is lowered
  - At the surface of the solution where evaporation occurs, there are fewer solvent particles due to the presence of solute particles
  - The solute particles absorb energy and, therefore, reduce the energy available to evaporate the solvent particles
  - Energy is required to overcome the intermolecular forces between the solute and the solvent particles

- Boiling point is the temperature at which the vapor pressure equals the pressure above the liquid
- If the vapor pressure is lowered, it will require additional energy to raise the temperature to where the vapor pressure equals that of the pressure above the solution
- Hence, the boiling-point elevation.