Chemistry Lecture 4 – Solutions

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Definitions/Formulas

- *Solution*: homogeneous mixture of compounds in single phase
- *Solvent*: what there's more of
- *Solute*: what there's less of
- *Ideal solution*: solute particles can't interact with each other
- *Colloid*: a solution with larger particles, usually opaque instead of clear
- *Solvation*: when an ionic compound dissolves in a solution (ionic bonds broken)
  - Polar/charged molecules can dissolve in polar solutions, etc.
- *Hydration*: when water molecules surround an ion
  - Creates an aqueous phase for ionic compounds
- *Electrolyte*: something that forms ions in aqueous solution, conducts electricity
  - Usually ionic compounds or acids/bases

Concentration

- *Molarity*: M = moles of solute (before dissociation) / volume of solution
- *Molality*: m = moles of solute / kilograms of solvent
- *Mole fraction*: x = moles of solute / (moles of all solutes + moles of solvent)
- *Mass* %: 100% * mass of solute / total mass of solution
- *Parts per million*: 1000000 * mass of solute / total mass of solution

Heat of solution

- Three step process:
  (1) Solute-solute bonds broken (endothermic)
  (2) Solvent-solvent bonds broken (endothermic)
  (3) Solvent-solute bonds formed (exothermic)
- Heat of solution = sum of all changes in enthalpy
  - (-): new bonds stronger, (+): new bonds weaker
- Solution formation always has positive entropy

Vapor pressure

- Equilibrium between molecules leaving liquid & molecules coming back into liquid, directly prop to temperature
- *Boiling*: when vapor pressure reaches atmospheric pressure
- *Raoult's law*: addition of a nonvolatile solute decreases vapor pressure, $P_{actual} = \chi_{liquid} P_{liquid}$
  - Addition of volatile solute: $P_{actual} = \chi_{liquid} P_{liquid} + \chi_{volatile\ solute} P_{volatile\ solute}$
  - (-) heat of solution: negative deviation, (+) heat of solution: positive deviation
- *Solubility*: how likely a solute is to dissolve in a solvent
- *Precipitation*: opposite of dissolution
- *Saturated solution*: when rate of dissolution = rate of precipitation
- *Solubility product* K_{sp}: equilibrium constant
  - if $AB_2(s) \rightarrow A\ (aq) + 2B\ (aq), K_{sp} = [A][B]^2$
- *Solubility*: max # of moles per liter that can dissolve in solution, can solve using K_{sp}
- *Spectator ions*: ions that aren't part of a compound you're adding, don't change solubility
- *Common ion effect*: ions that are part of compound you're adding, does change solubility

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Solubility guidelines

- Things containing NO_3^-, NH_4^+, alkali metal ions are soluble
- Things containing halogens are soluble EXCEPT when they contain Ag^+, Hg_2^{2+}, Pb^{2+}
- Things containing SO_4^{2-} are soluble EXCEPT when they contain $Hg_2^{2+}, Pb^{2+}, Ca^{2+}, Sr^{2+}, Ba^{2+}$
- Things containing Ca^{2+}, Sr^{2+}, Ba^{2+} are soluble ONLY when they contain S^{2-} or OH^-
- Things containing CO_3^{2-}, PO_4^{3-}, S^{2-}, OH^- are soluble ONLY when they're attached to #1

Things that affect solubility

- Increasing pressure on a gas increases solubility (Henry's law)
- Increasing temperature usually increases solubility of solutes (b/c increase in entropy)
- Increasing temperature usually decreases solubility of gases