Chem notes 9.30.08
Lecture 9 (mo)

Complicated Explanations
Dispersion forces of HCl > HF
Dipole-dipole forces of HF > HCl
Boiling point HF > HCl because hydrogen bond of HF is strongest

*Dipole – Dipole moment matters most in small molecules
*Dispersion Forces matter most in large molecules

Solid to Liquid = Molecules must overcome forces just a little bit
Liquid to Gas = Molecules must completely overcome forces of attraction and escape

In Diagram:
CH_4 through SnH_4 line – As molecule gets bigger, dispersion forces get greater, it takes more energy to break the forces

Mixed Intermolecular Forces

<u>3 kinds of attractions when an ion is dissolved in water</u>
1. Water – water
   Dipoles will align
2. Ion - ion
   Ions will attract cation to anion and vice versa
3. Ion - dipole
   A specific orientation of dipoles will form around the ion (depending on whether it's a + or - ion
4. Dipole – induced dipole
   Dipole causes momentary dipole in non-polar molecule
   This is why it is possible for non-polar molecules to dissolve in polar molecules

What is a solution?

*Solution = mixture
*Dispersion and uniformity involve entropy
*Substance – Chemical that can't be broken down without a chemical reaction

Which is which? And how can you tell the difference between them?
**Refer to slide for statement
1. melt
2. dissolve
3. dissolve
4. dissolve and react

Sugar (number 2)
- Sugar is a molecule that breaks apart in tea
- The tea tastes sweet in every part of the cup because it is uniformly dispersed
- Sugar in this instance is not being melted; to melt it must be heated in its pure form (sugar in a pan by itself)

Helium in balloon (number 3)
- Helium dissolves in the air when the balloon is popped
- Helium does not react because it is inert

Alka Seltzer (number 4)
- Chemicals do not react in solid form (when tablet is in foil wrapper)
- H_2O is the medium that allows the chemical reaction to occur
- When tablet is put into water, the different parts (acetaminophen, flavor, $NaHCO_3$) dissolve in the water
- Sodium bicarbonate reacts with water and creates bubbles (CO_2)

*Melting is the change from a solid to liquid of a pure substance
*Dissolving is always a mixture of two substances (solvent and solute)

Recognizing solutions

*Dissolving = mixing
*Solution = one substance is completely mixed into the other

The solutions we usually study are aqueous
*Aqueous solution = water and something that can be dissolved in water
- All aqueous solutions are liquid, even though before the water and solute were mixed, one may have been a solid or a gas (seltzer water, alka seltzer)

Solvent vs. Solute
In helium balloon example:
- Helium = solute
- Air = solvent

*Helium (solute) is dissolved in air (solvent)

Solubility, saturation, and supersaturation

3 conditions of solution
1. Saturation
2. Below saturation
3. Supersaturation

Solubility = point of saturation
- most commonly a solute mixed into 100 mL of water

*In picture of NaCl dissolving in water
- Crystal of NaCl at bottom of beaker
- Hydration shells form around Na^+ and Cl^- ions
- Hydrations shells cover ions and make them look like water

Solubility = Maximum amount that can dissolve (at a given temperature)

<u>Positive slopes</u>
Solubility increases
Temperature increases
Endothermic change

<u>Negative slopes</u>
Solubility decreases
Temperature decreases
Exothermic change

KNO_3 is most endothermic on graph
- Little energy input = drastic increase in solubility

*For a crystal to form at supersolubility, additional input of energy is needed

How to read a solubility curve
**see slide for questions
1. 43g KCl
2. KNO_3
3. 40g NaCl in 100g water
4. Supersaturated
   - Dissolve $KClO_3$ at higher temperature to make sure it dissolves, and then cool to 60^o and the solution becomes supersaturated

Energetics of dissolving process (at dilution) or Enthalpy of solution

*Break bonds = endothermic
*Make bonds = exothermic

1. Separation of solute molecules = most completely overcome forces of attraction
   - Energy put into system
   - Endothermic

2. Separation of solvent molecules = intermolecular forces must be overcome to make space for the solute molecules
   - Energy put into system
   - Endothermic

3. Formation of solute-solvent interactions
    - Separated states come together
    - Energy is given off when bonds are created
    - Exothermic

*When potential energy is lower = more stable

*Review Hess' Law
    - No matter which path is taken, the sum of all segments will equal the end result.

Is a particular solution process endothermic or exothermic?

*A process is endothermic if the energy to break bonds > energy given off by bonds Created
*A process is exothermic when the energy given off by bonds created > energy required to break bonds

Remember the solubility rules?

Contradictions of solubility rules
*Every compound has limited solubility based on temperature
*There is no such thing as completely insoluble