Announcements

- Turn on the Clicker (the red LED comes on).
- Push “Join” button followed by “20” followed by the “Send” button (switches to flashing green LED if successful).

- Kinetics lab handout will be available in the lab handout section of the class web site by Wednesday.

- Exam 1
  - Average: ~62%, similar to this classes scores last Spring
  - Almost done checking will send out e-mail when official scores posted (hopefully this morning).
- Quiz tomorrow
  - Nomenclature of alkenes and alkynes
  - Chang P. 95 and sections 18.1-18.4

Review

- Coal as fuel
  - older coal higher energy content less O primarily.
- Alkenes (hybridization, shape, naming, cis- vs. trans-).
- Alkynes (hybridization, shape, naming).

Entropy & Free Energy (Ch 13)

- Enthalpies of Solution (ΔH_{ionic}, $\Delta H_{H\text{-}bonds}$, $\Delta H_{ion\text{-}dipole}$, ΔH_{hyd})
- Entropy (S, ΔS, spontaneity)
- Free Energy (ΔG)
- Carbohydrates, Proteins and Lipids (peptide bond, stereoisomerism)
- ΔG in biochemical reactions.
- DNA and making proteins.

ΔH_{hyd} versus Ionic Radius and Charge

Chang
Fig. 8.8

Heats of Hydration for Ions

Ion	Radius (pm)	ΔH_{hyd}(kJ/mol)	Ion	Radius (pm)	ΔH_{hyd}(kJ/mol)
Li^+	76	-510	F^-	133	-431
Na^+	102	-410	Cl^-	181	-313
K^+	138	-336	Br^-	196	-284
Mg^{2+}	72	-1903	I^-	220	-247
Ca^{2+}	100	-1591			

Entropy versus Temperature and Phase

Chang Fig. 18.6

Second Law of Thermodynamics

- A process is spontaneous only if the entropy of the universe increases during the process.
- Entropy is times arrow, as time moves forward entropy increases.
- Spontaneous Process: $\Delta S_{univ} > 0$
- Non-spontaneous Process $\Delta S_{univ} < 0$
- $\Delta S_{univ} = \Delta S_{sys} + \Delta S_{surr}$.
- $\Delta S_{sys} \approx \Delta S^{o}_{rxn} = \Sigma S^{o}_{prod} - \Sigma s^{o}_{reac}$
  - S(perfect crystal at 0 K) = 0
  - S^{o} is relative to this perfect crystal

Possible combinations of ΔS_{sys} and ΔS_{surr}

- $\Delta S_{univ} = \Delta S_{sys} + \Delta S_{surr} = \Delta S_{sys} - \Delta H_{sys}/T$
  - $\Delta S_{surr} = - \Delta H_{sys}/T$, because $\Delta H < 0$ heats surroundings
  - 1/T factor because at high T same ΔH (q) causes less fractional change in entropy (disorder).
- $\Delta H < 0$, $\Delta S_{sys} > 0$ $\Delta S_{univ} > 0$ always spontaneous
- $\Delta H < 0$, $\Delta S_{sys} < 0$ $\Delta S_{univ} = ?$ spontaneous at low T
- $\Delta H > 0$, $\Delta S_{sys} < 0$ $\Delta S_{univ} < 0$ never spontaneous
- $\Delta H > 0$, $\Delta S_{sys} > 0$ $\Delta S_{univ} = ?$ spontaneous at high T

ΔG – Free Energy

- $\Delta G_{sys} = -T\Delta S_{univ} = \Delta H_{sys} - T\Delta S_{sys}$
- Usually drop "sys" subscripts: $\Delta G = \Delta H - T\Delta S$
- Interpretation of G:
  - $\Delta G < 0$ spontaneous
  - $\Delta G > 0$ nonspontaneous
  - $\Delta G = 0$ equilibrium