Chem 102 Conference: Week of 3/3/08

1. Identify non-chemical processes that fit the following definitions:

a. Entropically and enthalpically favorable.

Milk spilling out of an upturned glass.

b. Entropically favorable, but enthalpically unfavorable.

Melting ice cream

c. Entropically unfavorable, but enthalpically favorable.

Rain collecting in a gutter and headed down the downspout.

d. Entropically and enthalpically unfavorable.

Pennies leaving a piggy bank and scattering across the ceiling.

2. Rank the following in order of increasing entropy.

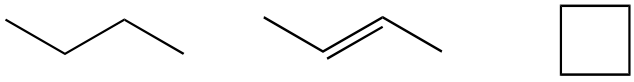
a. $Cl_{2(g)}$, $Br_{2(l)}$, $I_{2(s)}$

Cl_2 (gas) > Br_2 (liquid) > I_2 (solid)

b. $CaCO_{3(s)}$, $C_{graphite}$, $NaCl_{(s)}$

$CaCO_{3(s)}$ > NaCl > $C_{graphite}$ based on # of atoms/molecule

c. The following gases at 300 K.



Most Least

Based on conformational flexibility (remember double bond doesn't rotate)

3. For each of the following reactions, **predict** whether the thermodynamic parameters listed here are positive, negative or about zero at 25°C.

	ΔH°	ΔS°
$3\ O_{2(g)} \rightarrow 2\ O_{3(g)}$	+	-
$2\ C_8H_{18(g)} + 25\ O_{2(g)} \Leftrightarrow 16\ CO_{2(g)} + 18\ H_2O_{(g)}$	-	+
$2\ Fe_{(s)} + 3\ O_{2(g)} \Leftrightarrow Fe_2O_{3(s)}$ (rust formation)	-	-
$Fe_2O_{3(s)} + 2\ Al_{(s)} \Leftrightarrow Al_2O_{3(s)} + 2\ Fe_{(s)}$	-	0

4. Consider the following reactions. For each reaction, (i) Calculate ΔH°, ΔS° and ΔG° at 25°C. (ii) Predict whether the reaction is spontaneous under standard state conditions. (iii) Determine whether it would change in spontaneity at other temperatures.

a. $2\ HI_{(g)} \Leftrightarrow H_{2(g)} + I_{2(g)}$

(i) $\Delta H^\circ = 0 + 62\ kJ/mol - 2(27\ kJ/mol) = +8\ kJ/mol$
$\Delta S^\circ = 260\ J/molK + 130\ J/molK - 2(207\ J/molK) = -24\ J/molK$
$\Delta G^\circ = 8\ kJ/mol - (298\ K)(-0.024\ kJ/molK) = 15\ kJ/mol$

(ii) $\Delta G^\circ > 0$, not spontaneous

(iii) Enthalpically and entropically unfavorable, it will never be spontaneous.

b. $N_{2(g)} + 3\ H_{2(g)} \Leftrightarrow 2\ NH_{3(g)}$

(i) $\Delta H^\circ = 2(-46\ kJ/mol) = -92\ kJ/mol$
$\Delta S^\circ = 2(193\ J/molK) - 3(130\ J/molK) - 192\ J/molK = -389\ J/molK$
$\Delta G^\circ = -92\ kJ/mol - (298\ K)(-0.389\ kJ/molK) = 24\ kJ/mol$

(ii) $\Delta G^\circ > 0$, not spontaneous

(iii) Enthalpicallyfavorable, entropically unfavorable – spontaneous at lower temps

	ΔH_f° (kJ/mol)	S° (J/molK)
$H_{2(g)}$	0	130
$I_{2(g)}$	62	260
$HI_{(g)}$	27	207
$N_{2(g)}$	0	192
$NH_{3(g)}$	-46	193

5. Consider the following reactions that are under equilibrium. For each reaction, (i) write the equilibrium expression and determine the value of the equilibrium constant at 298 K given the provided concentrations of all species and (ii) determine if the reaction is product- or reactant-favored.

a. $\underset{5\ M}{2\ NO_{2\,(g)}} \Leftrightarrow \underset{0.0001\ M}{2\ NO_{(g)}} + \underset{0.001\ M}{O_{2\,(g)}}$

$$K = \frac{[O_2][NO]^2}{[NO_2]^2} = \frac{(.001)(.0001)^2}{(5)^2} = 4 \times 10^{-13}$$

b. $Sn_{(s)} + \underset{1\ M}{2\ Cl_{2\,(g)}} \Leftrightarrow \underset{1.2\ M}{SnCl_{4\,(g)}}$

$$K = \frac{[SnCl_4]}{[Cl_2]^2} = \frac{1.2}{1} = 1.2$$