CHEM 1422 - Homework # 2 **Name: _____**

Thermodynamics **Signature: _____**

Due January 29, 2009 **Group Name: _____**

Check the box to the right if you want your graded homework to be placed out in the public rack outside Prof. Stanley's office. Otherwise you will have to pick up your homework from Prof. Stanley in person: ☐

1. (12 pts) From the thermodynamic data given at the end of your lecture notes calculate ΔH^o_{rxn}, ΔS^o_{rxn} and ΔG^o_{rxn} for the following reactions. For ΔG^o_{rxn} please use the $\mathbf{\Delta G^o_{rxn} = \Delta H^o_{rxn} - T\Delta S^o_{rxn}}$ formula with T = 298K. Indicate whether the reactions are <u>*spontaneous*</u> or <u>*non-spontaneous*</u>. Show your work.

a) $Cl_2(g) + H_2(g) \longrightarrow 2HCl(g)$

b) $Fe(s) + 5CO(g) \longrightarrow Fe(CO)_5(l)$

c) $SiO_2(s) + 6HF(g) \longrightarrow H_2SiF_6(aq) + 2H_2O(l)$ [glass is mainly SiO_2]

d) $CaCO_3(s) \longrightarrow CaO(s) + CO_2(g)$

2. (8 pts) Is the entropy ***increasing***, ***decreasing*** or staying ***about the same***? Use the qualitative entropy rules discussed in lecture to determine the answer. Write the answer to the right of each process.

a) $Fe_2O_3(s) + Al(s) \longrightarrow Fe(s) + Al_2O_3(s)$

b) raw egg $\longrightarrow$ hard boiled egg

c) $CaCl_2(s) + 6H_2O(l) \longrightarrow [Ca(H_2O)_6]Cl_2(s)$

d) $C_6H_{12}(l) + 9O_2(g) \longrightarrow 6CO_2(g) + 6H_2O(g)$

e) $H_2CO(aq) + H_2O(l) \longrightarrow 2H_2(g) + CO_2(g)$

f) mowing the lawn

g) $AgCl(s) + I^-(aq) \longrightarrow AgI(s) + Cl^-(aq)$

h) $Sr(s) + 2H_2O(l) \longrightarrow Sr^{2+}(aq) + 2OH^-(aq) + H_2(g)$

3. (2 pts) Circle the compound that has the highest entropy. Give a brief reason explaining your answer.

a) $Hg(l)$ b) $H_2O(l)$ c) $Pb(s)$ d) $C_2H_5OH(l)$ e) $CCl_4(l)$

4. (4 pts) Why does $Al_2O_3(s)$ have a lower entropy than $Fe_2O_3(s)$? There are two primary qualitative reasons for this. You may have to use the chemistry library to get more information (i.e., properties) on these two common compounds to answer the question.

5. (4 pts) a) Small amounts of $Fe(CO)_5(l)$ usually form in steel tanks containing pressurized $CO(g)$. You worked out the thermodynamics of this in question 1b. At what temperature (ºC) will the formation of $Fe(CO)_4$ become non-spontaneous? Show your work. **b)** A similar reaction occurs to make $Ni(CO)_4(l)$ with $\Delta G^o_{rxn} = -38$ kJ/mol, $\Delta H^o_{rxn} = -230$ kJ/mol, and $\Delta S^o_{rxn} = -480$ J/Kmol. High pressure reactors use a thin disk of metal as a safety mechanism that will rupture and release gasses if the pressure in the reactor gets too high. If one was using CO gas, which disk (Fe or Ni) would be more likely to prematurely fail due to the metal being dissolved away by CO? Briefly explain why.