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

a) $\text{Cl}_2(g) + \text{H}_2(g) \rightarrow 2\text{HCl}(g)$

b) $\text{Fe}(s) + 5\text{CO}(g) \rightarrow \text{Fe}(	ext{CO})_5(l)$

c) $\text{SiO}_2(s) + 6\text{HF}(g) \rightarrow \text{H}_2\text{SiF}_6(aq) + 2\text{H}_2\text{O}(l)$ [glass is mainly SiO2]

d) $\text{CaCO}_3(s) \rightarrow \text{CaO}(s) + \text{CO}_2(g)$
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) Fe₂O₃(s) + Al(s) → Fe(s) + Al₂O₃(s)
   b) raw egg → hard boiled egg
   c) CaCl₂(s) + 6H₂O(l) → [Ca(H₂O)₆]Cl₂(s)
   d) C₆H₁₂(l) + 9O₂(g) → 6CO₂(g) + 6H₂O(g)
   e) H₂CO(aq) + H₂O(l) → 2H₂(g) + CO₂(g)
   f) mowing the lawn
   g) AgCl(s) + I⁻(aq) → AgI(s) + Cl⁻(aq)
   h) Sr(s) + 2H₂O(l) → Sr²⁺(aq) + 2OH⁻(aq) + H₂(g)

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

   a) Hg(l)   b) H₂O(l)   c) Pb(s)   d) C₂H₅OH(l)   e) CCl₄(l)

4. (4 pts) Why does Al₂O₃(s) have a lower entropy than Fe₂O₃(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 (°C) 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 ΔG°_rxn = −38 kJ/mol, ΔH°_rxn = −230 kJ/mol, and ΔS°_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.