CHEM 281 HW 6. Chapter 6.

1. For the formation of solid calcium oxide from solid calcium and gaseous oxygen, what is the probable sign of the entropy change? What, then, must be the sign of the enthalpy change if the formation of the product occurs spontaneously? Do not consult data tables.
2. At very high temperatures, water will decompose to hydrogen and oxygen gas. Explain why this is to be expected in terms of the formula relating free energy with the other two common thermodynamic functions. Do not consult data tables.
3. Using enthalpy of formation and absolute entropy values from the data tables in the Appendices, determine the enthalpy, entropy, and free energy of reaction for the following reaction. Use this information to identify whether the reaction is spontaneous at standard temperature and pressure.
   $H_2(g) + 1/2\ O_2(g) \rightarrow H_2O(l)$
4. Which one of the N-N or N=N bonds will be stronger? Do not look at data tables. Explain your reasoning.
5. The molecules of dinitrogen and carbon monoxide are isoelectronic. Yet the C≡ O bond energy (1072 kj-mol^{-1}) is stronger than that of the N≡ N bond (942 kj-mol^{-1}). Suggest an explanation.
6. Use bond energy data to calculate an approximate value for the enthalpy of reaction for:

   $CH_4(g) + 4\ F_2(g) \rightarrow CF_4(g) + 4\ HF(g)$

7. Place the following compounds in order of increasing lattice energy: magnesium oxide, lithium fluoride, and sodium chloride. Give the reasoning for this order.
8. Calculate the first two terms of the series for the Madelung constant for the cesium chloride lattice. How does this compare with the limiting value?
9. Using the Born-Lande equation, calculate the lattice energy of cesium chloride.
10. Construct a Born-Haber cycle for the formation of aluminum fluoride. Do not perform any calculation.

11. The lattice energy of sodium hydride is -782 kj-mol^{-1}. Using additional data from the Appendices, calculate a value for the electron affinity of atomic hydrogen.
12. Calculate the enthalpy of formation of calcium oxide using a Born-Haber cycle. Obtain all necessary information from the data tables in the Appendices. Compare the value that you obtain with the actual entropy measured value of $\Delta H_f(CaO(s))$. Then calculate a similar cycle assuming that calcium oxide is Ca^+O^- rather than $Ca^{2+}O^{2-}$. Take the lattice energy of Ca^+O^- to be 800 kJ-mol^{-1}. Discuss why the second scenario is less favored in enthalpy terms.
13. Use lattice energy and enthalpy of hydration values from data tables to determine the enthalpy of solution of (a) lithium chloride; (b) magnesium chloride. Explain the major difference in the two values in terms of the theoretical steps.
14. Construct an energy diagram, similar to a Born-Haber cycle, for the formation of carbon tetrafluoride. Then calculate the enthalpy of formation from the steps, using numerical values from the data tables in the Appendices. Finally, compare your value with the tabulated value of $\Delta H_f(CF_4)(g))$.
15. Although the hydration energy of the calcium ion, Ca^{2+}, is much greater than that of the potassium ion, K^+, the molar solubility of calcium chloride is much less than that of potassium chloride. Suggest an explanation.