1. Using thermodynamic tables and a clearly well-organized approach, calculate the normal boiling point for hydrogen cyanide, HCN (l). You must show the appropriate reaction and all equations being used.

2. For hydrogen cyanide, HCN (l),

   a. Draw the Lewis Structure

   b. Clearly list and illustrate each type of intermolecular force present in HCN (l).

3. Hydrogen cyanide [HCN(l)] has a vapor pressure of 620 torr at 293K and a molar mass of 27.03 g/mole. Methyl formate has a vapor pressure of 476 mm at 293K and a molar mass of 60.05 g/mole. A solution of these two substances was prepared by mixing 100 grams of HCN(l) with 50 grams of methyl formate. For this solution at a temperature of 293K:

   a. Calculate the mole fractions of hydrogen cyanide and methyl formate in this solution.

   b. Calculate the vapor pressure of hydrogen cyanide present in the gas phase that is at equilibrium with this solution.

   c. Calculate the vapor pressure of methyl formate present in the gas phase that is at equilibrium with this solution.

   d. Calculate the mole fraction of HCN in the vapor phase above this solution.

4. A system under study had 100 J of heat added to it; the system also did 56 J of expansion work. Calculate the change in internal energy of the system.

5. The enthalpy of combustion for liquid methanol, CH_3OH, is -726 kJ / mole.

   a. Write a balanced chemical equation for the combustion of methanol.

   b. Calculate the amount of heat gained or released from the combustion of 22.0 grams of methanol.

   c. Clearly explain why this chemical reaction would actually gain heat or release heat. Fully explain just where in the world all this energy could be "going to" or "coming from" (needless to say, your explanation needs to clearly explain why and how the first Law of Thermodynamics applies).

6. For the very same methanol combustion reaction examined (and undoubtedly fully explained in your answer) in problem 5; under what conditions would the methanol combustion reaction be spontaneous? Clearly show all equations, all work, and your specific rationale for answering this question.

7. Calculate the heat required to increase the temperature of 10.0 grams of HCN (l) by 25 degrees Celsius. ***Hint***: the thermodynamic tables have heat capacity data for HCN (l).

8. This weekend, your chemistry professor purchased a book published in 2008, written by Thomas Hager, and entitled *The Alchemy of Air*. The book's central theme focuses on historical discoveries in chemistry that made possible the production of bread from air! The underlying challenge discussed in the book centers on the chemical inertness of nitrogen in air due to its strong bonds.

   a. Draw the Lewis structure for nitrogen in the form found in air (which is 78% nitrogen). Use the Lewis structure to clearly explain why nitrogen is inert in air.

   b. Write the chemical equation for the dissociation of nitrogen found in the air into atoms.

   c. Use bond energies to calculate the heat gained or lost when 10.2 grams of air nitrogen is dissociated into nitrogen atoms.

   d. Clearly explain why this process (the dissociation of air nitrogen into free atoms) does not spontaneously occur.