Chemistry 2000B Spring 2002 Assignment 5

Due: Thursday, April 4, noon

As in the last assignment, you will need to look up several pieces of data in your textbook.

1. (a) How much heat is liberated when 1.0043 g of benzoic acid (C_6H_5COOH) burns in an excess of oxygen at constant pressure? The enthalpy of formation of benzoic acid is $-384.8\,\mathrm{kJ/mol}$. Assume that the water produced is in the liquid state. [7 marks]

   (b) Suppose that you measured the heat of combustion in a bomb calorimeter. Would you get the same value as above? Why or why not? [2 marks]

2. After arriving at home on a hot summer day, you realize that none of your ginger ale is in the refrigerator. The temperature in your apartment is 30°C. You pour 300 mL of ginger ale into a glass with a heat capacity of 94 J/K.[1] You decide to add exactly the right amount of ice to bring the temperature of your drink down to 4°C which, as we all know, is the perfect temperature for a cold drink on a hot day. The ice in your refrigerator is at a temperature of −5°C.

   (a) Neglecting heat exchange with the room and given that ginger ale is mostly water, what mass of ice should you add to your drink? [8 marks]

   (b) Supposing that your ice cubes are geometrically perfect cubes with 2.7 cm sides, how many ice cubes (rounded to the nearest cube) would you need? [5 marks]

   (c) Since there will be some heat exchange between the room and your drink, how will this affect the amount of ice you have to add? Will it be more or less than the amount calculated in part a of this question? [2 marks]

3. (a) Calculate the equilibrium constant for the reaction

$$CO_{(g)} + Cl_{2(g)} \rightleftharpoons COCl_{2(g)}$$

   at 298.15 K. [4 marks]

   (b) Suppose that a flask is filled with 0.40 atm of carbon monoxide and 0.25 atm of chlorine gas at 298.15 K. What are the equilibrium pressures of the three gases? [4 marks]

4. What is the minimum pressure of carbon monoxide required to make the production of ferrocene ($Fe(CO)_{5(l)}$) spontaneous in the presence of solid iron at 298.15 K? [10 marks]

5. Using data available in your textbook for barium sulfate, calculate the standard free energy of formation of the aqueous Ba^{2+} ion. The standard free energy of formation of the aqueous sulfate ion is $-744.00\,\mathrm{kJ/mol}$. [8 marks]

[1] What, you mean you haven't measured the heat capacities of your glasses and cups?