**CHEM 100**
*Chemistry I*
Problem Set V
Chapter 6

Due: **Monday**, 23-October-2006 at the beginning of class. Show all work clearly. Remember that this is to be your own work.

1) Oxidation of ClF by $F_2$ yields $ClF_3$, an important fluorinating agent formerly used to produce the uranium compounds in nuclear fuels:

$$ClF_{(g)} + F_{2(g)} \text{---->} ClF_{3(l)}$$

Use the following thermochemical equations to calculate DH° for the production of $ClF_3$:

$2ClF_{(g)} + O_{2(g)}$ -----> $Cl_2O_{(g)} + OF_{2(g)}$ $\Delta H° = 167.5kJ$
$2F_{2(g)} + O_{2(g)}$ -----> $2OF_{2(g)}$ $\Delta H° = -43.5$ kJ
$2ClF_{3(l)} + 2O_{2(g)}$ -----> $Cl_2O_{(g)} + 3OF_{2(g)}$ $\Delta H° = 394.1$ kJ

2) The heat of combustion of benzoic acid, $HC_7H_5O_2$, is 3221.6 kJ/mole. A 1.200 g sample of benzoic acid is burned in an apparatus called a *bomb calorimeter*. (This is used for very accurate determinations.) The temperature of the calorimeter, with its water and other stuff present, increased from 22.45°C to 26.10°C.

a) Calculate the total heat capacity of the calorimeter.

b) If the calorimeter contained 1.500 kg of water, what is the heat capacity of the calorimeter when it contains no water?

3) An industrial process for manufacturing sulfuric acid, $H_2SO_4$, uses hydrogen sulfide, $H_2S$, from the purification of natural gas. In the first step of this process, the hydrogen sulfide is burned to obtain sulfur dioxide, $SO_2$:

$$2H_2S_{(g)} + 3O_{2(g)} \rightarrow 2H_2O_{(l)} + 2SO_{2(g)} \qquad \Delta H° = -1125 \text{ kJ}$$

The density of sulfur dioxide at 25°C and 1.00 atm is 2.62 g/L, and the molar heat capacity is 30.2 J/(mol•°C). **(a)** How much heat would be evolved in producing 1.00 L of $SO_2$ at 25°C and 1 atm? **(b)** Suppose heat from this reaction is used to heat 1.00 L of $SO_2$ from 25°C and 1.00 atm to 500°C for its use in the next step of the process. What percentage of the heat evolved is required for this?

4) A rebreathing mask contains potassium superoxide, $KO_2$, which reacts with moisture in the breath to give oxygen:

$$4KO_{2(s)} + 2H_2O_{(l)} \rightarrow 4KOH_{(s)} + 3\,O_{2(g)}$$

Estimate the grams of potassium superoxide required to supply a person's oxygen needs for one hour. Assume a person requires $1.75 \times 10^2$ kcal of energy for this time period. Further assume that this energy can be equated to the heat of combustion of a quantity of glucose, $C_6H_{12}O_6$, to $CO_{2(g)}$ and $H_2O_{(l)}$. From the amount of glucose required to give $1.75 \times 10^2$ kcal of heat, calculate the amount of oxygen consumed and hence the amount of $KO_{2(s)}$ required. The $\Delta H°_f$ for $glucose_{(s)}$ is -1273 kJ/mol.

5) Does a negative $\Delta H_{rxn}$ mean that the heat can be thought of as a reactant or as a product? Explain your choice.