Due: Friday, 8-October-2004 at the beginning of class. Show all work clearly. Remember that this is to be your own work.

1) The bombardier beetle uses an explosive discharge as a defensive measure. The chemical reaction involved is the oxidation of hydroquinone by hydrogen peroxide to quinone and water:

\[
C_6H_4(OH)_2(aq) + H_2O_2(aq) \rightarrow C_6H_4O_2(aq) + 2H_2O(l)
\]

Calculate \(\Delta H\) for this reaction from the following data:

\[
\begin{align*}
C_6H_4(OH)_2(aq) \rightarrow C_6H_4O_2(aq) + H_2(g) & \quad \Delta H = +177.4\ \text{kJ} \\
H_2(g) + O_2(g) \rightarrow H_2O_2(aq) & \quad \Delta H = -191.2\ \text{kJ} \\
H_2(g) + 1/2\ O_2(g) \rightarrow H_2O(g) & \quad \Delta H = -241.8\ \text{kJ} \\
H_2O(g) \rightarrow H_2O(l) & \quad \Delta H = -43.8\ \text{kJ}
\end{align*}
\]

2) The composition of a particular natural gas sample, expressed on a mole fraction basis, is: \(\text{CH}_4, 0.820; \ C_2\text{H}_6, 0.102, \ C_3\text{H}_8, 0.078\). A 215-L sample of this natural gas, measured at 24.5 °C, and 744 mm Hg, is burned in an excess of oxygen. How much heat is evolved in the combustion? (The \(\Delta H^\circ\)\(_\text{f}\)(\(\text{C}_3\text{H}_8\)) = -103.85 kJ/mol.)

3) Calculate \(\Delta H^\circ\) for the reaction

\[
2K(s) + 2H_2O(l) \rightarrow 2KOH(aq) + H_2(g)
\]

A 5.00 g chunk of potassium is dropped into 1.00 kg water at 24.0°C. What is the final temperature of the water after the preceding reaction occurs? Assume that all the heat is used to raise the temperature of the water. (NEVER run this reaction! It is very dangerous; it bursts into flames!!)

4) A rebreathing mask contains potassium superoxide, \(\text{KO}_2\), which reacts with moisture in the breath to give oxygen:

\[
4\text{KO}_2(s) + 2H_2O(l) \rightarrow 4\text{KOH}(s) + 3\ O_2(g)
\]

Estimate the grams of potassium superoxide required to supply a person's oxygen needs for one hour. Assume a person requires \(1.50 \times 10^2\ \text{kcal}\) of energy for this time period. Further assume that this energy can be equated to the heat of combustion of a quantity of glucose, \(\text{C}_6\text{H}_12\text{O}_6\), to \(\text{CO}_2(g)\) and \(\text{H}_2\text{O}(l)\). From the amount of glucose required to give \(1.50 \times 10^2\ \text{kcal}\) of heat, calculate the amount of oxygen consumed and hence the amount of \(\text{KO}_2(s)\) required. The \(\Delta H^\circ\)\(_f\) for glucose\(_s\) is -1273 kJ/mol.
5) Does a negative $\Delta H_{\text{rxn}}$ mean that the heat can be thought of as a reactant or as a product? Explain your choice.