Problem Set 4 – Due by 5 p.m. Tues., Oct. 29, 2019

1. Suppose that you want to know the enthalpy change for the following reaction to form methanol, CH_3OH:

   $$CO\ (g)\ +\ 2\ H_2\ (g)\ \rightarrow\ CH_3OH\ (g) \quad \Delta H_{rxn}^\circ = ???$$

   You have enthalpy data for the following reactions:

   $2\ C\ (s)\ +\ O_2\ (g)\ \rightarrow\ 2\ CO\ (g)$ $\Delta H_{rxn}^\circ = -221.0$ kJ

   $2\ C\ (s)\ +\ O_2\ (g)\ +\ 4\ H_2\ (g)\ \rightarrow\ 2\ CH_3OH\ (g)$ $\Delta H_{rxn}^\circ = -402.4$ kJ

   Use these data to calculate the enthalpy change for the formation of 100.0 g of CH_3OH (*g*).

2. Ethanol, CH_3CH_2OH, is currently blended with gasoline as an automobile fuel.

   a. Write a balanced equation for the complete combustion of liquid ethanol, assuming that all products are gaseous.
   b. Calculate ΔH_{rxn}° using data in Appendix 4. Is the reaction endothermic or exothermic?

3. Suppose that you drink 3.50×10^2 mL of diet soda that is at a temperature of 5.0 °C. To determine the net energy change in your body, you must consider both (a) the energy cost of raising the temperature of the soda to body temperature (something we don't usually think about) and (b) the energy input from the nutritional content of the soda.

   a. How much energy will your body expend to raise the temperature of this liquid to body temperature (37.0 °C)? Assume that the density and specific heat capacity of diet soda are the same as those of water.
   b. The nutritional information on the soda can indicates that it has an energy content of 1 Calorie. Calculate the **net energy change** in your body (the system) as a result of drinking this beverage. [Is there a net energy input, or does this process end up costing your body energy? **Overall, how much energy in Calories is gained or lost?**]

4. Suppose that you have one mole of each of the following substances, all at the same initial temperature: Al (*s*), Pb (*s*), air (*g*), and H_2O (*l*). If an equal amount of heat is absorbed by each substance, which one will have the highest final temperature? Explain briefly. [**Hint:** You will need to refer to a table in Chapter 9 of your textbook.]

5. A 192-g piece of copper is heated to 100.0 °C in a boiling water bath and then dropped into a beaker containing 751 g of water at 4.0 °C. What is the final temperature of the copper and water after thermal equilibrium is reached? [Note: The specific heat capacity of copper is 0.385 J/g °C; that of water is 4.184 J/g °C.]

6. When a 6.50-g sample of solid sodium hydroxide dissolves in 100.0 g of water in a coffee-cup calorimeter, the temperature rises from 21.6 to 37.8 °C. (Assume that the specific heat capacity of solution is the same as that of water, 4.184 J/g °C.)

   a. Calculate the heat of the reaction, q_{rxn}. Is heat absorbed or released?
   b. Using your answer from (a), calculate ΔH_{rxn} in kJ per mole of NaOH.