Introduction to Natural Science, Spring 2007
Chemistry Workshop – Week 1

1. A biology experiment requires the preparation of a water bath at 37 °C (body temperature). The temperature of the cold tap water is 22.0 °C and the temperature of the hot tap water is 55.0 °C . if a student starts with 90.0 g of cold water, what mass of hot water must be added to reach the desired temperature?

2. a 5.00 g sample of aluminum pellets (specific heat capacity 0.89 J $°C^{-1}$ g^{-1}) and a 10.00 g sample of iron pellets (specific heat capacity 0.45 J $°C^{-1}$ g^{-1}) are heated to 100 °C. The mixture of hot iron and aluminum is then dropped into 97.3 g of water at 22.0 °C. Calculate the final temperature of the metal and water mixture assuming no heat loss to the surroundings.

3. A 0.1964 g sample of quinone ($C_6H_4O_2$) is burned in a bomb calorimeter that has a heat capacity of 1.56 kJ $°C^{-1}$. The temperature of the calorimeter increases by 3.2 °C. Calculate the energy of combustion of quinone per gram and per mole.

4. Given the following data, calculate ΔH for the reaction: $ClF\,(g) + F_2\,(g) \rightarrow ClF_3\,(g)$

    $2\,ClF\,(g) + O_2\,(g) \rightarrow Cl_2O\,(g) + F_2O(g)$ ΔH = 167.4 kJ

    $2\,ClF_3\,(g) + 2\,O_2\,(g) \rightarrow Cl_2O\,(g) + 3\,F_2O(g)$ ΔH = 341.4 kJ

    $2\,F_2\,(g) + O_2\,(g) \rightarrow 2\,F_2O(g)$ ΔH = - 43.4 kJ

4. The bombardier beetle uses an explosive discharge as a defensive mechanism. The chemical reaction involved is the oxidation of hydroquinone by hydrogen peroxide to produce quinone and water as given below.

    $C_6H_4(OH)_2\,(aq) + H_2O_2\,(aq) \rightarrow C_6H_4O_2\,(aq) + 2\,H_2O(l)$

    Calculate ΔH for the above reaction using the following information.

    $C_6H_4(OH)_2\,(aq) \rightarrow C_6H_4O_2\,(aq) + H_2\,(g)$ ΔH = 177.4 kJ

    $H_2\,(g) + O_2\,(g) \rightarrow H_2O_2\,(aq)$ ΔH = - 191.2 kJ

    $H_2\,(g) + \frac{1}{2}\,O_2\,(g) \rightarrow H_2O\,(g)$ ΔH = - 241.8 kJ

    $H_2O\,(g) \rightarrow H_2O\,(l)$ ΔH = - 43.8 kJ

5. The Ostwald process for the commercial production of nitric acid from ammonia and oxygen involves the following steps. Calculate ΔH^0 for the following reactions using ΔH_f^0 data from standard tables.
    - $4\,NH_3\,(g) + 5\,O_2\,(g) \rightarrow 4\,NO\,(g) + 6\,H_2O\,(g)$
    - $2\,NO\,(g) + O_2\,(g) \rightarrow 2\,NO_2\,(g)$
    - $3\,NO_2\,(g) + H_2O\,(l) \rightarrow 4\,HNO_3\,(aq) + NO\,(g)$