CHAPTER 5-PROBLEM SET

1. Calculate ΔE and determine whether the process is endothermic or exothermic for the following cases: (**a**) $q = 0.763$ kJ and $w = -840$ J. (**b**) A system releases 66.1 kJ of heat to its surroundings while the surroundings do 44.0 kJ of work on the system.

2. A gas is confined to a cylinder under constant atmospheric pressure, as illustrated in Figure 5.4. When 0.49 kJ of heat is added to the gas, it expands and does 214 J of work on the surroundings. What are the values of ΔH and ΔE for this process?

3. At one time, a common means of forming small quantities of oxygen gas in the laboratory was to heat $KClO_3$: $2\ KClO_3(s) \rightarrow 2\ KCl(s) + 3\ O_2(g)$ $\Delta H = -89.4$ kJ
   For this reaction, calculate ΔH for the formation of (**a**) 1.36 mol of O_2 and (**b**) 10.4 g of KCl. **(c)** The decomposition of $KClO_3$ proceeds spontaneously when it is heated. Do you think that the reverse reaction, the formation of $KClO_3$ from KCl and O_2, is likely to be feasible under ordinary conditions? Explain your answer.

4. A 1.800-g sample of phenol (C_6H_5OH) was burned in a bomb calorimeter whose total heat capacity is 11.66 kJ/°C. The temperature of the calorimeter plus contents increased from 21.36 to 26.37 °C. (**a**) Write a balanced chemical equation for the bomb calorimeter reaction. (**b**) What is the heat of combustion per gram of phenol? Per mole of phenol?

5. Under constant-volume conditions, the heat of combustion of glucose ($C_6H_{12}O_6$) is 15.57 kJ/g. A 3.500-g sample of glucose is burned in a bomb calorimeter. The temperature of the calorimeter increases from 20.94 to 24.72 °C. (**a**) What is the total heat capacity of the calorimeter? (**b**) If the size of the glucose sample had been exactly twice as large, what would the temperature change of the calorimeter have been?

6. From the enthalpies of reaction

$$H_2(g) + F_2(g) \rightarrow 2\ HF(g) \quad \Delta H = -537 \text{ kJ}$$
$$C(s) + 2\ F_2(g) \rightarrow CF_4(g) \quad \Delta H = -680 \text{ kJ}$$
$$2\ C(s) + 2\ H_2(g) \rightarrow C_2H_4(g) \quad \Delta H = +52.3 \text{ kJ}$$

   calculate ΔH for the reaction of ethylene with F_2:

$$C_2H_4(g) + 6\ F_2(g) \rightarrow 2\ CF_4(g) + 4\ HF(g)$$

7. Using values from Appendix C, calculate the standard enthalpy change for each of the following reactions:
   (a) $2\ SO_2(g) + O_2(g) \rightarrow 2\ SO_3(g)$
   (b) $Mg(OH)_2(s) \rightarrow MgO(s) + H_2O(l)$
   (c) $N_2O_4(g) + 4\ H_2(g) \rightarrow N_2(g) + 4\ H_2O(g)$
   (d) $SiCl_4(l) + 2\ H_2O(l) \rightarrow SiO_2(s) + 4\ HCl(g)$

8. Complete combustion of 1 mol of acetone 1C3H6O2 liberates 1790 kJ:
   C3H6O1*l*2 + 4 O21*g*2 ¡ 3 CO21*g*2 + 3 H2O1*l*2 _*H*° = -1790 kJ
   Using this information together with the standard enthalpies of formation of O21*g*2, CO21*g*2, and H2O1*l*2 from Appendix C, calculate the standard enthalpy of formation of acetone.

9. A coffee-cup calorimeter of the type shown in Figure 5.17 contains 150.0 g of water at 25.1 °C. A 121.0-g block of copper metal is heated to 100.4 °C by putting it in a beaker of boiling water. The specific heat of Cu(*s*) is 0.385 J/g.K. The Cu is added to the calorimeter, and after a time the contents of the cup reach a constant temperature of 30.1 °C. (**a**) Determine the amount of heat, in J, lost by the copper block. (**b**) Determine the amount of heat gained by the water. The specific heat of water is 4.18 J/g.K. (**c**) The difference between your answers for (a) and (b) is due to heat loss through the Styrofoam® cups and the heat necessary to raise the temperature of the inner wall of the apparatus. The heat capacity of the calorimeter is the amount of heat necessary to raise the temperature of the apparatus (the cups and the stopper) by 1 K. Calculate the heat capacity of the calorimeter in J/K. **(d)** What would be the final temperature of the system if all the heat lost by the copper block were absorbed by the water in the calorimeter?