CH1020 Exercises (Worksheet 14)
(Enthalpy, Thermochemical equations)

1. Under what condition will the enthalpy change of a process equal the amount of heat transferred into or out of the system?

2. Does the enthalpy of a system in a particular state depend on how the system reached that state? Explain.

3. During a constant-pressure process the system absorbs heat from the surroundings. Does the enthalpy of the system increase or decrease in the process?

4. Why is the change in enthalpy a meaningful for many chemical processes?

5. H is a state function but q is not a state function. Explain.

6. For a given process at constant pressure, ΔH is negative. Is the process endothermic or exothermic?

7. The complete combustion of $CH_3OH(l)$ to form $H_2O(l)$ and $CO_2(g)$ at constant pressure produces 726.7 kJ of heat per mole of CH_3OH. Write a balanced thermochemical equation for this reaction.

8. The decomposition reaction of $NH_3(g)$ to form $N_2(g)$ and $H_2(g)$ at constant pressure requires 46.19 kJ of heat per mole of $NH_3(g)$. Write a balanced thermochemical equation for the reaction.

9. You are given ΔH for a process that occurs at constant pressure. What additional information is needed to determine ΔE for the process?

10. What is the advantage of using enthalpy rather than internal energy to describe energy changes in reactions?

11. The reaction: $SO_3(g) + H_2O(l) \rightarrow H_2SO_4(aq)$
is the last step in the commercial production of sulfuric acid. The enthalpy change for this reaction is –227 kJ. In designing a sulfuric acid plant, is it necessary to provide for heating or cooling of the reaction mixture? Explain.

12. Are the following processes exothermic or endothermic?
    a. when solid KBr is dissolved in water, the solution gets colder.
    b. Natural gas (CH_4) is burned in a furnace
    c. When concentrated H_2SO_4 is added to water, the solution gets very hot
    d. Water is boiled in a teakettle
    e. the combustion of gasoline in a car engine
    f. water condensing on a cold pipe
    g. CO_2 (s) $\rightarrow$ CO_2 (g)
    h. F_2 (g) $\rightarrow$ 2F (g)

13. Which of the following has the highest enthalpy at a given temperature and pressure: H_2O(s); H_2O(l); or H_2O(g)? Which has the lowest enthalpy?

14. Consider the following reaction:
    $$3O_2(g) \rightarrow 2O_3(g) \quad \Delta H = +284.6\ kJ$$
    Under the conditions of this reaction, does O_2(g) or O_3(g) have the higher enthalpy?

15. The overall reaction in commercial heat packs can be represented as
    $$4Fe(s) + 3O_2(g) \rightarrow 2Fe_2O_3(s) \qquad \Delta H = -1652\ kJ$$

    a. How much heat is released when 1.00 mol Fe_2O_3 is produced?

    b. How much heat is released when 1.00 g of iron is reacted with excess O_2?

    c. How much heat is released when 4.00 moles of Fe and 4.00 moles of O_2 are reacted?

    d. How much heat is released when 0.540 moles of Fe and 15.0 g of O_2 react?

    e. How many grams of Fe is required to react to release 1200. kJ of heat?

16. Consider the following reaction:
    $$2H_2(g) + O_2(g) \rightarrow 2H_2O(l)\ \Delta H = -572\ kJ$$

    a. How much heat is evolved for the production of 1.00 mol of H_2O(l)?

    b. How many grams of hydrogen is required to react, so that it produces 1400. kJ of heat?
    c. How much heat is evolved when 4.03 g of hydrogen is reacted with excess oxygen?

17. Consider the combustion reaction of ethane gas, C_2H_6(g):

$$C_2H_6(g) + 7/2O_2(g) \rightarrow 2CO_2(g) + 3H_2O(g) \qquad \Delta H = -1430\ kJ$$

a. What is the enthalpy change for the reverse reaction?

b. Balance the forward reaction with whole-number coefficients. What is the ΔH for the reaction represented by this equation?

c. Which is more likely to be thermodynamically favored, the forward reaction or the reverse reaction?

d. If the reaction were written to produce $H_2O(l)$ instead of $H_2O(g)$, would you expect the magnitude of ΔH to increase, decrease, or stay the same? Explain.

18. Consider the decomposition of liquid benzene, $C_6H_6(l)$ to gaseous acetylene, $C_2H_2(g)$:

$$1/3C_6H_6(l) \rightarrow C_2H_2(g) \qquad \Delta H = +210\ kJ$$

a. What is the enthalpy change for the reverse reaction?

b. What is ΔH for decomposition of 78.1 g of benzene to acetylene?

c. Which is more likely to be thermodynamically favored, the forward reaction or the reverse reaction?

d. If $C_6H_6(g)$ were consumed instead of $C_6H_6(l)$, would you expect the magnitude of ΔH to increase, decrease, or stay the same? Explain.