Exercise 6.1
Enthalpy and Hess' Law

1.

(a) What does enthalpy change tell us about a reaction? Your answer should address both the sign of the enthalpy change and the magnitude of the enthalpy change.

(b) Under what sorts of experimental conditions would you expect it to be meaningful to discuss the enthalpy change of a reaction?

2. Calculate the standard enthalpy change for the following reaction:

$$Na_2CO_{3(s)} + 2\,H^+_{(aq)} \rightarrow 2Na^+_{(aq)} + H_2O_{(l)} + CO_{2(g)}$$

$$\Delta H_f^o\left(CO_{2(g)}\right) = -393.5\ \frac{kJ}{mol}$$
$$\Delta H_f^o\left(H_2O_{(l)}\right) = -285.8\ \frac{kJ}{mol}$$
$$\Delta H_f^o\left(Na^+_{(aq)}\right) = -240.1\ \frac{kJ}{mol}$$
$$\Delta H_f^o\left(Na_2CO_{3(s)}\right) = -1130.7\ \frac{kJ}{mol}$$

3. The standard heat of combustion of octane is 5470 kJ/mol. This is the heat released when octane is fully combusted under standard conditions. As such, the standard enthalpy change for the complete combustion of octane is -5470 kJ/mol.

(a) Write a balanced chemical equation for combustion of octane (C_8H_{18}) under standard conditions.

(b) Calculate the standard enthalpy of formation of octane.

4. Sodium hydride can be prepared from molten sodium metal and hydrogen gas.

The heat of fusion of sodium is 2.6 kJ/mol (measured at 98℃, the melting point of sodium).

$$Na_{(s)} \rightarrow Na_{(l)} \qquad \Delta H = +2.6\,\frac{kJ}{mol}$$

If it is reasonable to assume that the enthalpy change for the reaction above is approximately the same at 298.15 K, what is the standard enthalpy change for the following reaction?

$$2\,Na_{(l)} + H_{2(g)} \rightarrow 2\,NaH_{(s)}$$

$$\Delta H_f^o\left(CO_{2(g)}\right) = -393.5\,\frac{kJ}{mol}$$
$$\Delta H_f^o\left(H_2O_{(l)}\right) = -285.8\,\frac{kJ}{mol}$$
$$\Delta H_f^o\left(NaH_{(s)}\right) = -56.28\,\frac{kJ}{mol}$$