Enthalpy Stoichiometry Practice

1. Citric acid reacts with sodium bicarbonate according to the balanced equation below.

 $H_3C_6H_5O_7(aq) + 3 NaHCO_3(s) \rightarrow 3 NaC_6H_5O_7(aq) + 3 H_2O(I) + 3 CO_2(g)$

 $\Delta H = 70. \text{ kJ/mol}$

a. Calculate the quantity of heat, in joules, absorbed when 5.00 grams of sodium bicarbonate reacts with excess citric acid.

b. Calculate the grams of carbon dioxide produced when 300. kj of heat are absorbed.

2. The combustion of benzene, $C_6H_6(I)$, in oxygen liberates heat according to the balanced equation below.

$$2 C_6 H_6(I) + 15 O_2(g) \rightarrow 12 CO_2(g) + 6 H_2O(g) + 6.536 \times 10^3 \text{ kJ}$$

- a. Is the reaction endothermic or exothermic? Explain your reasoning.
- b. What is the value of ΔH ?
- c. Draw the potential energy diagram for this reaction.

d. Calculate the quantity of heat released when 10.00 g of benzene is burned in excess oxygen.

e. How many grams of benzene must be burned to evolve 1.00 kJ of heat?

Hess's Law

1. Calculate ΔH for the reaction: $N_2(g) + 2 O_2(g) \rightarrow 2 NO_2(g)$.

Given:
$$N_2(g) + O_2(g) \rightarrow 2 \text{ NO}(g)$$
 $\Delta H = 180 \text{ kJ/mol}_{rxn}$
 $2 \text{ NO}(g) + O_2(g) \rightarrow 2 \text{ NO}_2(g)$ $\Delta H = -112 \text{ kJ/mol}_{rxn}$

2. Calculate ΔH for the reaction: $C_{graphite}(s) \rightarrow C_{diamond}(s)$

Given:
$$C_{graphite}(s) + O_2(g) \rightarrow CO_2(g)$$
 $\Delta H = -394 \text{ kJ/mol}_{rxn}$
 $C_{diamond}(s) + O_2(g) \rightarrow CO_2(g)$ $\Delta H = -396 \text{ kJ/mol}_{rxn}$

3. Calculate ΔH for the reaction: 2 $H_3BO_3(aq) \rightarrow B_2O_3(s) + 3 H_2O(l)$

Given:
$$H_3BO_3(aq) \rightarrow HBO_2(aq) + H_2O(I)$$
 $\Delta H = -0.02 \text{ kJ/mol}_{rxn}$ $H_2B_4O_7(aq) + H_2O(I) \rightarrow 4 HBO_2(aq)$ $\Delta H = -11.3 \text{ kJ/mol}_{rxn}$ $H_2B_4O_7(aq) \rightarrow 2 B_2O_3(s) + H_2O(I)$ $\Delta H = 17.5 \text{ kJ/mol}_{rxn}$