Hess's Law and Calorimetry Problems

1. Given ▲ H^o_f = -394 kJ for $CO_{2(g)}$, ▲ H^o_f = -286 kJ for $H_2O_{(l)}$ and ▲ H^o_{comb} = -891 kJ for $CH_{4(g)}$, determine ▲ H^o_f for $CH_{4(g)}$.

2. Determine ▲ H^o for the following reaction

$$C_{(s)} + H_20_{(l)} \rightarrow CO_{(g)} + H_{2(g)}$$

Given the following equations:

1) $C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}$ ▲ H^o_1 = -395 kJ
2) $CO_{(g)} + ½\ O_{2(g)} \rightarrow CO_{2(g)}$ ▲ H^o_2 = -281 kJ
3) $H_{2(g)} + ½\ O_{2(g)} \rightarrow H_2O_{(l)}$ ▲ H^o_3 = -242 kJ

3. Given ▲ H^o_{comb} = -1301 kJ for $C_2H_{2(g)}$, $CO_{2(g)}$, ▲ H^o_f = -394 kJ for $CO_{2(g)}$ and ▲ H^o_f = -286 kJ for $H_2O_{(l)}$, calculate the ▲ H^o_f for $C_2H_{2(g)}$.

4. Exactly 3.0g of $C_{(s)}$ was burned to $CO_{2(g)}$ in a copper calorimeter. The mass of the calorimeter was 1.500 kg and the mass of the water in which the calorimeter was immersed was 1.500 kg. The initial temperature of the system was 20°C and the final temperature was 31.0°C. Calculate the heat formation of $CO_{2(g)}$, under the conditions present in the calorimeter. The specific heat of copper is 0.39 J/g °C.

5. Given ▲ H^o_f = -85 kJ for $C_2H_{6(g)}$, ▲ H^o_f = -394 kJ for $CO_{2(g)}$ and ▲ H^o_f = -286 kJ for $H_2O_{(l)}$, calculate ▲ H^o_{comb} for $C_2H_{6(g)}$.

6. One step in the manufacturing of $CCl_{4(l)}$ includes the reaction

$$3\ Cl_{2(g)} + CS_{2(l)} \rightarrow CCl_{4(l)} + S_2Cl_{2(l)}$$

where ▲ H^o_f = -88 kJ for $CS_{2(l)}$, ▲ H^o_f = -139 kJ for $CCl_{4(l)}$, ▲ H^o_f = -60 kJ for $S_2Cl_{2(l)}$. If the reaction takes place inside a reactor which is cooled by water at 25°C must pass through the cooling coils of the reactor for each kilogram of $Cl_{2(g)}$ reacting in order to keep the temperature at 25°C?

7. We can generate hydrogen chloride by heating a mixture of sulfuric acid and potassium chloride according to the reaction

$$2\ KCl_{(s)} + H_2SO_{4(l)} \rightarrow 2\ HCl_{(g)} + K_2SO_{4(s)}$$

Calculate ▲ H^o for this reaction from the following thermochemical equations. Give your answer in kilojoules.

$$HCl_{(g)} + KOH_{(s)} \rightarrow KCl_{(s)} + H_2O_{(l)} \qquad ▲ H^o = -203.6\ kJ$$

$$H_2SO_{4(l)} + 2\ KOH_{(s)} \rightarrow K_2SO_{4(s)} + 2\ H_2O_{(l)} \qquad ▲ H^o = -342.4\ kJ$$