Unit 11 – Chapter 6: Thermochemistry Name ______________

Assignment #2: ΔH Calculations & Hess's Law Period _____________

1) The enthalpy of combustion of solid carbon to form carbon dioxide is -393.7 kJ/mol carbon, and the enthalpy of combustion of carbon monoxide to form carbon dioxide is -283.3 kJ/mol CO. Use these data to calculate the Δ*H* for the reaction: $2\ C_{(s)} + O_{2(g)} \rightarrow 2\ CO_{(g)}$

2) Combustion reactions involve reacting a substance with oxygen. When compounds containing carbon and hydrogen are combusted, carbon dioxide and water are the products. Using the enthalpies of combustion for C_4H_4 (-2341 kJ/mol), C_4H_8 (-2755 kJ/mol), and H_2 (-286 kJ/mol), calculate Δ*H* for the reaction: $C_4H_{4(g)} + 2\ H_{2(g)} \rightarrow C_4H_{8(g)}$

3) Given the following data:

   $2\ ClF_{(g)} + O_{2(g)} \rightarrow Cl_2O_{(g)} + F_2O_{(g)}$ Δ*H* = +167.4 kJ

   $2\ ClF_{3(g)} + 2\ O_{2(g)} \rightarrow Cl_2O_{(g)} + 3\ F_2O_{(g)}$ Δ*H* = +341.4 kJ

   $2\ F_{2(g)} + O_{2(g)} \rightarrow 2\ F_2O_{(g)}$ Δ*H* = =43.4 kJ

   Calculate *ΔH* for the reaction: $ClF_{(g)} + F_{2(g)} \rightarrow ClF_{3(g)}$

4) The bombardier beetle uses an explosive discharge as a defensive measure. The chemical reaction involved is the oxidation of hydroquinone by hydrogen peroxide to produce quinone and water:

   $C_6H_4(OH)_{2(aq)} + H_2O_{2(aq)} \rightarrow C_6H_4O_{2(aq)} + 2\ H_2O_{(l)}$

   Calculate *ΔH* for this reaction from the following data:

   $C_6H_4(OH)_{2(aq)} \rightarrow C_6H_4O_{2(aq)} + H_{2(g)}$ Δ*H* = +177.4 kJ

   $H_{2(g)} + O_{2(g)} \rightarrow H_2O_{2(aq)}$ Δ*H* = -191.2 kJ

   $H_{2(g)} + \frac{1}{2}\ O_{2(g)} \rightarrow H_2O_{(g)}$ Δ*H* = -241.8 kJ

   $H_2O_{(g)} \rightarrow H_2O_{(l)}$ Δ*H* = -43.8 kJ

5) Given the following data:

   $P_{4(s)} + 6\ Cl_{2(g)} \rightarrow 4\ PCl_{3(g)}$ Δ*H* = -1225.6 kJ

   $P_{4(g)} + 5\ O_{2(g)} \rightarrow P_4O_{10(s)}$ Δ*H* = -2967.3 kJ

   $PCl_{3(g)} + Cl_{2(g)} \rightarrow PCl_{3(g)}$ Δ*H* = -84.2 kJ

   $PCl_{3(g)} + \frac{1}{2}\ O_{2(g)} \rightarrow Cl_2PO_{(g)}$ Δ*H* = -285.7 kJ

   Calculate the Δ*H* for the reaction: $P_4O_{10(s)} + 6\ PCl_{3(g)} \rightarrow 10\ Cl_3PO_{4(g)}$

6) Calculate ΔH^0 for each of the following reactions using the data in Appendix 4:

$4\ Na_{(s)} + O_{2(g)} \rightarrow 2\ Na_2O_{(s)}$

$2\ Na_{(s)} + 2\ H_2O_{(l)} \rightarrow 2\ NaOH_{(aq)} + H_{2(g)}$

$2\ Na_{(s)} + CO_{2(g)} \rightarrow Na_2O_{(s)} + CO_{(g)}$

Explain why a water or carbon dioxide fire extinguisher might not be effective in putting out a sodium fire.

7) The space shuttle orbiter utilizes the oxidation of methylhydrazine by dinitrogen tetroxide for propulsion:

$$4\ N_2H_3CH_{3(l)} + 5\ N_2O_{4(l)} \rightarrow 12\ H_2O_{(g)} + 9\ N_{2(g)} + 4\ CO_{2(g)}$$

Calculate ΔH^0 for this reaction.

8) Consider the reaction:

$$2\ ClF_{3(g)} + 2\ NH_{3(g)} \rightarrow N_{2(g)} + 6\ HF_{(g)} + Cl_{2(g)} \quad \Delta H^0 = -1196\ kJ$$

Calculate ΔH_f for $ClF_{3(g)}$.

9) The standard enthalpy of combustion of ethene gas, $C_2H_{4(g)}$, is -1411.1 kJ/mol at 298 K. Given the following enthalpies of formation, calculate ΔH^0_f for $C_2H_{4(g)}$.

$CO_{2(g)}$ = -393.5 kJ/mol

$H_2O_{(l)}$ = -285.8 kJ/mol