Honors Chemistry

Chapter 17 – Hess's Law & Assorted Thermochemistry

1. Hess's law of heat summation: _____

2. When the reverse of a chemical reaction is written, what happens to the sign of ΔH? Why?

3. Calculate the enthalpy change, ΔH (in kJ) for the reaction:
   $BaO\ (s) + H_2SO_4\ (aq) \rightarrow BaSO_4\ (s) + H_2O\ (l)$

   Use the following data:
   $SO_3\ (g) + H_2O\ (l) \rightarrow H_2SO_4\ (aq)$ ΔH = -78.2 kJ
   $BaO\ (s) + SO_3\ (g) \rightarrow BaSO_4\ (s)$ ΔH = -213.4 kJ

4. The following equation shows the combustion of ethane.
   $2C_2H_6\ (g) + 7O_2\ (g) \rightarrow 4CO_2\ (g) + 6H_2O\ (l)$
   Use Hess's law and following data to calculate the enthalpy change.

   $C_2H_4\ (g) + 3O_2\ (g) \rightarrow 2CO_2\ (g) + 2H_2O\ (l)$ ΔH = -1323 kJ
   $C_2H_4\ (g) + H_2\ (g) \rightarrow C_2H_6\ (g)$ ΔH = -137 kJ
   $H_2\ (g) + ½\ O_2\ (g) \rightarrow H_2O\ (l)$ ΔH = -242 kJ

5. Calculate the enthalpy change, ΔH (in kJ) for the reaction:
   $C\ (s) + 2H_2\ (g) \rightarrow CH_4\ (g)$

   Use the following data:
   $C\ (s) + O_2\ (g) \rightarrow CO_2\ (g)$ ΔH = -393.5 kJ
   $H_2\ (g) + ½\ O_2\ (g) \rightarrow H_2O\ (l)$ ΔH = -285.8 kJ
   $CH_4\ (g) + 2O_2\ (g) \rightarrow CO_2\ (g) + 2H_2O\ (l)$ ΔH = -890.3 kJ

6. Calculate the standard molar enthalpy of formation, ΔH_f°, for the following using table 17.4 on page 580.
   a) $H_2\ (g) + ½\ O_2\ (g) \rightarrow H_2O\ (l)$

   b) $C\ (s) + 2H_2\ (g) \rightarrow CH_4\ (g)$

   c) $2Al\ (s) + 3/2\ O_2\ (g) \rightarrow Al_2O_3\ (s)$

   d) $½\ N_2\ (g) + 3/2\ H_2\ (g) \rightarrow NH_3\ (g)$

7. If 80.0 g of aluminum initially at 70˚C is dropped into 250.0 mL of water the temperature of the water rises to 22˚C. What was the initial temperature of the water. The specific heat of aluminum is 0.215 cal/g˚C.

8. A piece of unknown metal with a mass of 23.8 g is heated to 100.0˚C and dropped into 50 mL of water at 24.0˚C. The final temperature of the system is 32.5˚C. What is the specific heat of the metal in J/g˚C?

9. How much heat is released when 108 g of water at 0˚C freezes to ice.
   $\Delta H_{solid} = -6.02$ kJ/mol

10. You burn 1.5 g of benzoic acid, $C_7H_6O_2$ (aq), in a combustion calorimeter and find that the temperature of the calorimeter increases from 22.5˚C to 31.69˚C. The calorimeter contains 775 g of water. Calculate the molar heat of combustion, ΔH (in kJ/mol), of benzoic acid.
    $2C_7H_6O_2$ (aq) + $15O_2$ (g) → $14CO_2$ (g) + $6H_2O$ (g)

11. Calculate the heat energy required to raise the temperature of 4.5 g of water from -8˚C to 105.7˚C. Draw a diagram to show phase changes.
    $C_{ice} = 2.06$ J/g˚C
    $C_{liquid} = 4.18$ J/g˚C
    $C_{steam} = 2.02$ J/g˚C
    $\Delta H_{fus} = 6.02$ kJ/mol
    $\Delta H_{vap} = 40.7$ kJ/mol

12. How much heat energy is released when 80.0 g of oxygen gas reacts?
    $C_3H_8(g)$ + $5O_2(g)$ → $3CO_2(g)$ + $4H_2O(g)$ + 2220 kJ

13. The temperature of a 6.0-g sample of glass changed from 20˚C to 45˚C when it absorbed 550 J of heat. What is the specific heat of this glass sample?