Heat of Combustion Lab

Part I – Heat of Combustion of Magnesium Metal

Reaction	Reactants	Initial Temp.	Final Temp.
$Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$ $\Delta H^\circ = ?$	_____ g Mg (approx. 1.0 g) 100 mL HCl		
$MgO(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2O(l)$ $\Delta H^\circ = ?$	_____ g MgO (approx. 1.5 g) 100 mL HCl		
$H_2(g) + {}^1/_2\, O_2(g) \rightarrow H_2O(l)$ $\Delta H^\circ = -285.5$ kJ	USE THIS REACTION AS IS IN THE HESS' LAW CALCULATION IN #3 IN PART I CALCULATIONS		

Part II – Heat of Combustion of Calcuim Metal

Reaction	Reactants	Initial Temp.	Final Temp.
$Ca(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2(g)$ $\Delta H^\circ = ?$	_____ g Ca (approx. 1.5 g) 100 mL HCl		
$CaO(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l)$ $\Delta H^\circ = ?$	_____ g CaO (approx. 2.0 g) 100 mL HCl		
$H_2(g) + {}^1/_2\, O_2(g) \rightarrow H_2O(l)$ $\Delta H^\circ = -285.5$ kJ	USE THIS REACTION AS IS IN THE HESS' LAW CALCULATION IN #3 IN PART II CALCULATIONS		

CALCULATIONS:

Part #1 – Combustion of Magnesium Metal

1. For reaction first reaction between Mg and the HCl solution:
   a) Write the thermodynamic equation with ΔH° = ?
   b) Perform a Q = mcΔT calculation to determine the heat absorbed by the "water". Treat the HCl solution as if it were pure water with specific heat capacity of 4.184 J/g °C)
   c) Convert this answer to the amount of heat that would have been produced if you had used one mole of reactant (i.e. a ratio to ratio conversion factor)
   d) Change the heat produced per mole (kinetic energy) to a heat of reaction (i.e. $\Delta H^\circ = -Q$)
   e) Re-write the reaction between magnesium and hydrochloric acid as a thermodynamic equation (with the ΔH° = ??.??? that you have calculated).

2. Repeat all steps from question #1 for the reaction between MgO and the HCl solution.

3. Using your thermodynamic equations obtained from question #1 and #2 and the thermodynamic equation for the formation of water (see data sheet), perform a Hess' law calculation to determine the heat of combustion of Mg (i.e you are using Hess' law to find the combustion reaction for Mg). Please use FULL FORMAT for this Hess' law calculation as shown in class.

4. Note that the formation reaction for MgO just happens to be the same as the combustion reaction for Mg (this is true only when elements are combusted). Look up the accepted value for the heat of formation of MgO from page 799 in text and use this to perform a percentage error calculation using this formula. The actual value is the value from the text, the experimental value is your final answer from question #3.

$$\% \text{ error} = \left| \frac{\text{experimental value - actual value}}{\text{actual value}} \right| \text{ x } 100\%$$

Part #2 – Combustion of Calcium Metal

Repeat the above calculation for the second set of reactions using calcium and calcium oxide (i.e. find the heat of combustion for calcium).

CONCLUSIONS:

1. List as many **GOOD** sources of error that are inherent in the experimental procedure.