

Experiment 5 – Thermochemistry

Report Sheet

1. Academic honesty statement.

Part I: Determining the Heat Capacity of a Calorimeter

2. Prepare a plot of temperature versus time for the calorimetry reaction between NaOH to HCl using the Excel data provided. Include the lines used to extrapolate the final temperature.
3. Complete the table below using the data provided in the assigned Excel sheet for the reaction of HCl and NaOH.

T_i of HCl and Calorimeter ($^{\circ}\text{C}$)	
T_i of NaOH ($^{\circ}\text{C}$)	
T_f of HCl, Calorimeter and NaOH ($^{\circ}\text{C}$)	

4. What is the limiting reagent of the reaction between NaOH and HCl described in this section and how many moles are present?
5. Use the value for $\Delta H^{\circ}_{\text{H}_3\text{O}^+ + \text{OH}^-}$ from Part B and the moles of limiting reagent in question 3 to find the heat (q_{reaction}) released by the NaOH and HCl neutralization reaction. Be sure to include units.
6. Calculate the heat capacity of the calorimeter in $\text{J}/^{\circ}\text{C}$. Assume $C_{\text{ACID}} = C_{\text{BASE}} = C_{\text{WATER}} = 4.184 \text{ J } ^{\circ}\text{C}^{-1} \text{ mL}^{-1}$. Note, we expect a value between 10 – 200 $\text{J}/^{\circ}\text{C}$. If you get a negative value, or a number *significantly* outside this range, check over your calculations or your line of best fit. This value will be used in later calculations. Be sure to include units.

Part II: Determining the Enthalpy of the Reaction of $\text{Mg(s)} + \text{HCl(aq)}$

7. Prepare a plot of temperature versus time for the addition of magnesium (Mg) to hydrochloric acid (HCl) using the Excel data provided. Include the lines used to extrapolate the final temperature.
8. Complete the table below using the data provide in the Excel sheet for the reaction between Mg and HCl.

T_i of HCl and Calorimeter ($^{\circ}\text{C}$)	
T_f of HCl and Calorimeter ($^{\circ}\text{C}$)	
Mass of Mg (g)	

9. Calculate q_{reaction} for the reaction between magnesium and hydrochloric acid. Remember that the acid solution was diluted with 75 mL of water, so the total volume of solution is 150 mL. Be sure to include units.

- What is the limiting reagent for the reaction between Mg and HCl and how many moles of limiting reagent are present?
- Calculate the enthalpy of the reaction between magnesium and hydrochloric acid ($\Delta H^\circ_{\text{Mg}+2\text{HCl}}$). Be sure to include units.

Part III: Determining the Enthalpy of formation of MgO

- Prepare a plot of temperature versus time for the addition of magnesium oxide (MgO) to hydrochloric acid (HCl). Include the lines used to extrapolate the final temperature.
- Complete the table below using the data provided in the Excel sheet for the reaction between MgO and HCl.

T_i of HCl and Calorimeter ($^\circ\text{C}$)	
T_f of HCl and Calorimeter ($^\circ\text{C}$)	
Mass of MgO (g)	

- Calculate q_{reaction} for the reaction between magnesium oxide and hydrochloric acid. Be sure to include units.
- What is the limiting reagent for the reaction between MgO and HCl and how many moles of limiting reagent are present?
- Calculate the enthalpy of the reaction between magnesium oxide and hydrochloric acid ($\Delta H^\circ_{\text{MgO}+2\text{HCl}}$). Be sure to include units.
- Summarize the relevant ΔH° values in the table below. Note that the ΔH° values for the first two reactions in the table come from the experimental data in your Excel spreadsheet and the ΔH° value for the last reaction comes from the literature.

Reaction	ΔH° (kJ/mol)
$\text{Mg(s)} + 2\text{HCl(aq)} \rightarrow \text{MgCl}_2\text{(aq)} + \text{H}_2\text{(g)}$	
$\text{MgO(s)} + 2\text{HCl(aq)} \rightarrow \text{MgCl}_2\text{(aq)} + \text{H}_2\text{O(l)}$	
$\text{H}_2\text{(g)} + \frac{1}{2} \text{O}_2\text{(g)} \rightarrow \text{H}_2\text{O(l)}$	

- Heat of formation (ΔH_f°) is defined as the heat released when 1 mol of a compound forms from elements in their standard states. What is the chemical equation for the heat of formation of MgO?
- Use Hess's Law to calculate the heat of formation of MgO from $\Delta H^\circ_{\text{Mg} + 2\text{HCl}}$, $\Delta H^\circ_{\text{MgO} + 2\text{HCl}}$, and the heat of formation of water. Be sure to include units.
- What is the literature value of ΔH_f° of MgO? Provide one reference for this value.
- Calculate the % error for your experimental ΔH_f° for MgO.