

## AP LAB 06F: Enthalpy of Neutralization ( $\Delta H^\circ_{\text{neutralization}}$ )

**Aim** To calculate a value for the standard enthalpy of neutralization

**Apparatus** Insulated cups (the calorimeter), thermometer, graduated cylinder

**Chemicals** 2.00 M hydrochloric acid solution, 2.00 M sodium hydroxide solution

### Method

1. Using a graduated cylinder, place 50.0 mL of 2.00 M HCl solution into an insulated cup.
2. Allow a thermometer to sit in the acid solution for a few minutes and then record the initial temperature of the 2.00 M HCl solution.
3. Using a graduated cylinder, place 50.0 mL of 2.00 M NaOH solution into a second insulated cup.
4. Allow a thermometer to sit in the base solution for a few minutes and then record the initial temperature of the 2.00 M NaOH solution.
5. **Carefully** combine the contents of the two cups in a single cup.
6. Keep stirring the mixture for several minutes, and record the **highest** temperature reached.
7. Repeat the steps 1-6, this time using only 30.0 mL of each solution.

**Results**

**With 50.0 mL of each solution**

	HCl	NaOH
Initial temperature		
<i>Average</i> initial temp of the solutions <b>(before mixing)</b>		
Temp of solutions <b>(after mixing)</b>		
Change in temp		




**With 30.0 mL of each solution**

	HCl	NaOH
Initial temperature		
<i>Average</i> initial temp of the solutions <b>(before mixing)</b>		
Temp of solutions <b>(after mixing)</b>		
Change in temp		

### Conclusion/Calculation

1. The heat capacity of the calorimeter is known to be  $11.0 \text{ J/}^\circ\text{C}$ . Using that information, and your data, calculate the energy change in the surroundings ( $q_{\text{surroundings}}$ ), in each of your experiments.

*(Assume the density of all solutions to be  $1.00 \text{ g/mL}$  and their specific heat capacity to be  $4.18 \text{ J/gK}$ )*

With 50.0 mL of each solution	With 30.0 mL of each solution
	

2. What sign should be associated with  $q_{\text{surroundings}}$ ? Explain.
3. What does your answer to Q2 suggest about the chemical reaction ( $q_{\text{system}}$ )? Explain.

4. By using your answers in Q1, and given the definition below, calculate the **standard enthalpy of neutralization for each experiment.**

**“The standard enthalpy of neutralization is the enthalpy change per mole of water, formed in a reaction between an acid and a base”**

With 50.0 mL of each solution	With 30.0 mL of each solution
