Experiment 16

Heat of Neutralization

Pre-Lab Assignment

Before coming to lab:

- Read the lab thoroughly.
- Answer the pre-lab questions that appear at the end of this lab exercise.
- Review Introduction 2: Writing Scientific Lab Reports

Purpose

An experiment will be designed to determine the heat of neutralization (ΔH_{rxn}) in kJ/mol for the reaction between hydrochloric acid (HCl) and sodium hydroxide (NaOH).

Background

An acid-base neutralization reaction follows the general form seen in Eqn. 1.

$$\text{acid} + \text{base} \rightarrow H_2O(l) + \text{salt} \qquad \text{Eqn. 1}$$

Typically these reactions are exothermic. Their enthalpies of reactions, specifically known as heats of neutralization, can be measured via calorimetry.

You will need to develop an experimental procedure to measure the heat of neutralization for the reaction between hydrochloric acid and sodium hydroxide. Your final answer should be in units of kJ/mol. You will be provided with solutions of HCl(aq) and NaOH(aq) as well as any equipment needed, including Styrofoam cups, lids, and thermometers.

A good experiment will be both accurate and precise. You will need to include some way to measure and report your accuracy and precision

Use your knowledge of prior experiments, theory and examples learned in lecture, and outside research for ideas. It may take many trials and much tweaking and adjustment to develop a solid procedure and procure your data. Stay flexible and open-minded, as even inconclusive results can often point you in the right direction. Record everything you do in lab so that you know what worked and what did not. You will be preparing a full lab report detailing your successful procedure, data, and results that needs to be written clearly enough that another ChemV01AL student could follow the instructions and understand the explanations.

Procedure

Design your own procedure to determine the heat of neutralization for the reaction between 1.0 M HCl and 1.0 M NaOH. This procedure must be approved by your instructor before you can begin experimentation. It will most likely change as you work in lab. You will also need to decide what data to record. Include the finalized procedure, your data, and conclusions in your formal lab report.

Your completed lab report will be turned in as your data sheet and post-lab assignment.

Consider:

- Think carefully about what data you will need to collect. As always, show all your work clearly and fully for one trial in a way that a fellow ChemV01AL student could follow.
- 1.0 M NaOH(aq), 1.0 M HCl(aq), coffee-cup calorimeters, and thermometers will be provided. Any additional chemicals and equipment required will be provided upon request and instructor approval. You may use any laboratory technique learned thus far in this course.
- Make sure that one of the reagents is the limiting reactant (hint: how will you design this?). Think carefully about what data you will need to research to determine the stoichiometry of the reaction.
- Assume the specific heat capacity of the solution is 4.184 J/g °C.
- Precise experiments should always include multiple, matching trials.
- Your final answer should also report a measure of its accuracy. Use the following heat of formation data to determine your theoretical value.

Compound	NaOH(aq)	HCl(aq)	NaCl(aq)	$H_2O(l)$
$\Delta H_f°$ (kJ/mol)	–470.11	–167.16	–407.27	–285.85

Experiment 16—Pre-Lab Assignment

Name: _____

1. Design a preliminary procedure including sample calculations to determine the heat of neutralization for the reaction between 1.0 M HCl and 1.0 M NaOH in kJ/mol. Use your knowledge of the chemicals, their properties, and the laboratory techniques learned thus far in this course. Any chemicals and equipment that you require will be provided in the lab. This procedure must be approved by your instructor before you can begin experimentation.

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