Enthalpy of Neutralization

**Question:** What is the enthalpy of a neutralization reaction? Does it depend on the specific acids and bases used?

Pre-lab reading

Atkins & Jones (5th ed.): Sections 7.4 - 7.5, 7.8; Fundamentals J “Acids and Bases”, M.2 “The Limits of a Reaction”

Safety and Waste Disposal

- Eye protection should be worn at all times.
- Waste solutions produced in this investigation can be washed down the drain.

Background

Calorimetry is used to determine the amount of heat released or taken up during a chemical reaction. In this lab we will use simple solution calorimeters to determine the heat of reaction for two different acid-base reactions. We will use simple styrofoam coffee cups for a calorimeter. These cups have (to a very close approximation) a zero heat capacity. Thus no heat is transferred to the cups. However, the heat released by the reacting acid and base IS released to the surrounding aqueous solution. The aqueous solutions have a heat capacity of \( c_{\text{sol}} = 4.184 \, \text{J/g°C} \) and a density of 1.00g/mL. We can measure the increase in temperature of the solution (\( \Delta T \)) and calculate the amount of heat gained by the solution (\( q_{\text{sol}} \)) using our model for heat transfer:

\[
q_{\text{sol}} = m_{\text{sol}} \cdot c_{\text{sol}} \cdot \Delta T
\]

Since the heat gained by the solution equals the heat lost by the reaction we find that the heat of the solution is related to the enthalpy change for the reaction:

\[
q_{\text{rxn}} = -q_{\text{sol}} \quad \text{and} \quad \Delta H_{\text{rxn}} = \frac{q_{\text{rxn}}}{n}
\]

Procedure

Your instructor will provide you with an assignment card indicating the acid to be analyzed by your group and the set of acid and base volumes that you and your partner will use during each trial of the investigation. Wash and dry two beakers. Using these beakers, obtain approximately 200mL of base and 100 mL of your assigned acid. Also obtain: a thermometer; two graduated cylinders (one marked “acid” and the other “base”); and a “coffee-cup” calorimeter (consisting of two nested styrofoam cups, a lid, and stirrer).

Begin each trial by placing the volume of acid assigned for your first trial (measured with the “acid” graduated cylinder) into the calorimeter. Monitor the temperature of the acid. When the temperature of the acid has reached a constant value, record the temperature. Quickly add the assigned volume of base (measured with the “base” graduated cylinder) to the acid in the calorimeter and place the lid on the calorimeter. Stir the reaction mixture, recording the temperature at 30-second intervals until the temperature begins to fall. Record the maximum temperature reached by the solution.

Dispose of the reaction mixture, rinse and dry the calorimeter, and repeat the procedure for the remaining trials.
Calculate the heat of reaction for each trial and the moles of the acid used. Report these data to your instructor by adding your data to the data spreadsheet for the acid(s) you studied.

References