DATE: NAME: CLASS:

CHAPTER 9	Investigation 9.A: Determining the Enthalpy of a Neutralization Reaction	BLM 9.2.1
HANDOUT		

The neutralization of hydrochloric acid with sodium hydroxide solution is represented by the following equation:

$$HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(\ell)$$

Using a simple calorimeter, determine the enthalpy change for this reaction.

Question

What is the enthalpy of neutralization for a hydrochloric acid and sodium hydroxide solution?

Prediction

Will the neutralization reaction be endothermic or exothermic? Record your prediction, and give reasons.

Safety Precautions

• If you get any hydrochloric acid or sodium hydroxide solution on your skin, flush your skin with plenty of cold water.

Materials

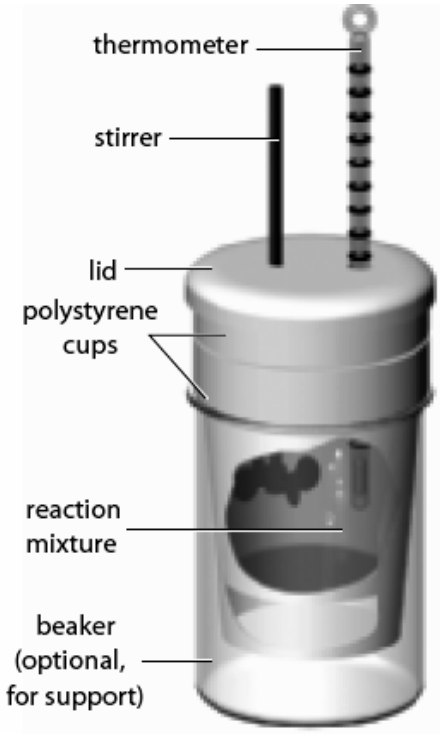
• 1.00 mol/L HCl(aq)
• 1.00 mol/L NaOH(aq)
• polystyrene cups that are the same size (2)
• plastic lid for cup
• 100 mL graduated cylinder
• 400 mL beaker
• thermometer (alcohol or digital)
• stirring rod

Procedure

1. Your teacher will allow the hydrochloric acid and sodium hydroxide solution to come to room temperature overnight.

2. Read the rest of this procedure carefully before you continue. Set up a graph to record your temperature observations.

3. Build a simple calorimeter, using the diagram to the right as a guide. You will need to make two holes in the lid—one for the thermometer and one for the stirring rod. The holes should be as small as possible to minimize thermal energy exchange with the surroundings.



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4. Rinse the graduated cylinder with a small quantity of 1.00 mol/L NaOH(aq). Use the cylinder to add 50.0 mL of 1.00 mol/L NaOH(aq) to the calorimeter. Record the initial temperature of the NaOH(aq). This will also represent the initial temperature of the HCl(aq).

5. Rinse the graduated cylinder with tap water. Then rinse it with a small quantity of 1.00 mol/L HCl(aq). Quickly and carefully, add 50.0 mL of 1.00 mol/L HCl(aq) to the NaOH(aq) in the calorimeter.

6. Cover the calorimeter. Record the temperature every 30 s, stirring gently and continuously.

7. When the temperature levels off, record the final temperature, t_f.

8. If time permits, repeat Procedure Steps 4 to 7.

Analysis

1. Determine the quantity of thermal energy absorbed by the solution in the calorimeter.

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2. Determine the quantity of thermal energy released by the reaction.

3. Determine the amounts (in mol) of HCl(aq) and NaOH(aq) that were involved in the reaction.

4. Use your knowledge of solutions to explain what happens during a neutralization reaction. Use equations in your answer. Was thermal energy absorbed or released during the neutralization reaction? Explain your answer.

Conclusion

5. Use your results to determine the enthalpy change of the neutralization reaction in kJ/mol of NaOH(aq). Write the thermochemical equation for the neutralization reaction.

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Applications

6. When an acid touches your skin, why must you flush the area with plenty of water rather than neutralizing the acid with a base?

7. Suppose that you had added solid sodium hydroxide pellets to hydrochloric acid, instead of adding hydrochloric acid to sodium hydroxide solution:

(a) Would you have obtained a different enthalpy change? Explain your answer.

(b) If so, would the enthalpy change have been higher or lower?

(c) How can you test your answer? Design an investigation, and carry it out with the permission of your teacher.

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(d) What change do you need to make to the thermochemical equation if you perform the investigation using solid sodium hydroxide?