

Name: \_\_\_\_\_

Date: \_\_\_\_\_

## Lab Activity: Chemical Reaction Calorimetry

### Learning goals

After completing this activity, you will be able to ...

- Use a calorimeter to measure the temperature change caused by a chemical reaction.
- Use the specific heat equation to calculate the heat produced by an exothermic reaction.
- Determine the enthalpy change associated with a chemical reaction.

**Introduction:** Many chemical reactions are *exothermic*, they release heat. Other reactions are *endothermic*, meaning they absorb heat. In this experiment, you will use an insulated container called a *calorimeter* to measure how much heat is released or absorbed in a chemical reaction between sodium hydroxide (NaOH) and hydrochloric acid (HCl).

This lab activity requires a calorimeter. If you do not have access to a laboratory calorimeter, you can make a simple calorimeter by nesting two foam coffee cups. You can push the thermometer through the lid of the inner cup to measure the temperature of the liquid inside.



### Procedure

1. Put on lab coat or apron, goggles, and rubber gloves.  
**CAUTION:** Both NaOH and HCl are toxic and should be handled with care.
2. Measure 100.0 mL of 1.0-M HCl solution in the graduated cylinder. Add this solution to the calorimeter.
3. Record the temperature of the HCl in the calorimeter to the nearest 0.1 °C.
4. Place a sheet of weighing paper on the balance, and zero the balance.
5. Use the forceps or scoop to add approximately 2 grams of NaOH to the weighing paper. Measure the exact mass to the nearest 0.1 g, and record.
6. Add the NaOH pellets to the calorimeter and use the stirring rod to stir the mixture until the NaOH has dissolved. Place the lid on the calorimeter and record the maximum temperature.
7. Pour the solution into a container designated by your teacher. Clean all lab equipment and wipe your area clean.

### Materials

- NaOH pellets
- 1.0-M HCl solution
- 100-mL graduated cylinder
- Balance with weighing paper
- Glass stirring rod
- Forceps/laboratory scoop
- Calorimeter
- Thermometer
- Scientific calculator

### Safety Equipment

- Apron/lab coat
- Goggles
- Rubber gloves

**Results:**

Initial temperature: \_\_\_\_\_ Final temperature: \_\_\_\_\_ Temperature change: \_\_\_\_\_

Mass of NaOH: \_\_\_\_\_

Other observations: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**Analysis**

It requires 4.185 J of heat energy to heat 1 g of water by 1 °C. This value is known as the *specific heat* of water. To calculate the total amount of heat released in this reaction ( $q$ ), find the product of the specific heat ( $c$ ), water mass ( $m$ ), and the temperature change ( $\Delta T$ ):

$$q = cm \Delta T$$

As you record your answers, be sure to use the correct number of significant digits. (When you multiply or divide numbers, the number of significant digits in the answer should be the same as the number of significant digits in the measurement with the fewest significant digits.)

1. Assuming the density of the HCl solution is 1.00 g/mL, what was the approximate mass of water in this experiment? (Assume that the water mass is approximately equal to the mass of HCl solution.)

Water mass: \_\_\_\_\_

2. How much heat was released in this experiment? \_\_\_\_\_

Show your calculation here:

3. Look up the atomic masses of sodium (Na), oxygen (O), and hydrogen (H). What is the molar mass of NaOH?

Molar mass (NaOH): \_\_\_\_\_

4. Write a balanced equation for the reaction of NaOH and HCl:

→

5. How much heat would be released if 1 mole of NaOH reacted with excess HCl? \_\_\_\_\_

Show your calculation here:

The negative of this value is the enthalpy of reaction ( $\Delta H$ ) for the reaction of sodium hydroxide and HCl. (The enthalpy is negative because heat is released in the reaction.)

6. How close is your measured enthalpy to the theoretical value of -57.9 kJ/mol? \_\_\_\_\_

\_\_\_\_\_

7. Discuss possible reasons for differences between your experimental value and the actual value. How will each of these uncertainties affect your results?

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