Mole Ratios
Vernier Data-Collection Activity

7192

INTRODUCTION

A balanced chemical reaction equation provides the mole ratios of the reactants and the products as coefficients. When some of the chemical formulas are not known, an experiment must be conducted to help determine the mole ratios.

This experiment uses two common substances as the reactants: hypochlorite ion (OCl^-) from household bleach and thiosulfate ion ($S_2O_3^{2-}$), the active ingredient in a photographic "fixer" solution used to develop film. In the reaction, hypochlorite ions oxidize the thiosulfate ions according to the unbalanced and incomplete reaction equation below.

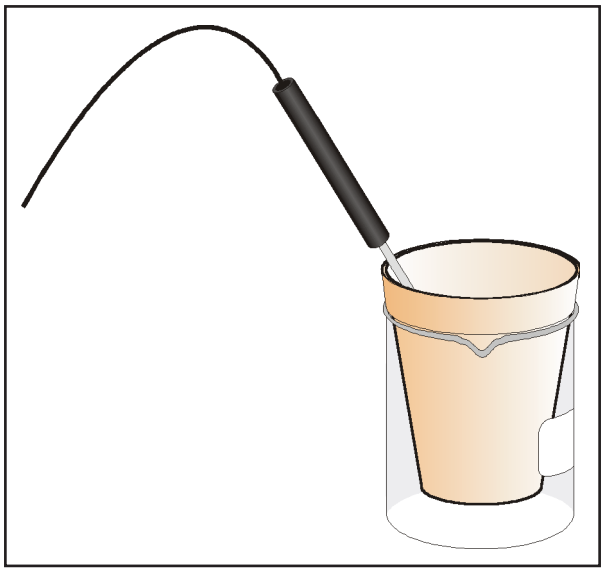
$$A\ OCl^- + B\ S_2O_3^{2-} \rightarrow \text{products}$$

It is possible to identify the coefficients, A and B, for the reactants, without knowing the products of the reaction. The process that you will use to determine the coefficients is called continuous variations. You will prepare a series of mixtures of the two reactants. Each mixture will have the same total volume and the same total number of moles of reactants. The reaction is exothermic, thus the mixture that generates the most heat energy will be the reaction that completely consumes both the hypochlorite and the thiosulfate ions. You will use this mixture to establish the coefficients, and therefore the mole ratio, for the reaction.

OBJECTIVES

In this experiment, you will

- Measure the enthalpy change of a series of reactions.
- Determine the stoichiometry of an oxidation-reduction reaction in which the reactants are known but the products are unknown.



MATERIALS

- TI-84 Plus graphing calculator
- EasyData application
- EasyTemp
- two 10 mL graduated cylinders
- two 25 mL graduated cylinders
- Styrofoam® Cups
- two 50 mL graduated cylinders
- three 250 mL beakers
- 0.50 M sodium hypochlorite, NaOCl, solution
- 0.50 M sodium thiosulfate, $Na_2S_2O_3$, solution in 0.2 M sodium hydroxide, NaOH

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PROCEDURE

1.

Obtain and wear goggles.

2.

Set up the data collection system.

a. Turn on the calculator.
b. Connect the EasyTemp to the calculator.
c. Select File from the Main screen, and then select **New** to reset the application.

3.

Obtain about 200 mL of each of the reactant solutions, NaOCl and $Na_2S_2O_3$.

4.

Measure out precisely 25.0 mL of the 0.50 M NaOCl solution. Pour this solution into a Styrofoam cup and nest the cup in a beaker to help stabilize the cup (see Figure 1).

5.

Immerse the tip of the Temperature Probe in the Styrofoam cup of NaOCl solution.

6.

Measure out precisely 25.0 mL of the 0.50 M $Na_2S_2O_3$ solution. **Note**: Do not mix the two solutions yet.

7.

Select Start to begin data collection. Let the program gather and graph a few initial temperature readings, and then add the $Na_2S_2O_3$ solution. Gently stir the reaction mixture with the Temperature Probe.

8.

Data collection will stop after 3 minutes. You may select Start to end data collection before three minutes have passed, if the temperature readings are no longer changing.

9.

Use the arrow keys to trace the graph. Calculate and record the maximum temperature change.

10.

Rinse out and dispose of the reaction mixture as directed.

11.

Repeat the necessary steps to continue testing various ratios of the two solutions, keeping the total volume at 50.0 mL, until you have three measurements on either side of the ratio that produced the greatest temperature change.

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DATA TABLE

Volume OCL (ml)	Volume $S_2O_3^{2-}$ (ml)	Temperature Change

DATA ANALYSIS

1. Determine the whole number mole ratio of the two reactants.

2. The molarities of the reactant solutions were equal in this experiment. Is this necessary, or even important, for the success of the experiment?

3. Which solution was the limiting reactant in each trial?

4. Find the actual balanced chemical equation for the reaction between OCl^- and $S_2O_3^{2-}$. Does the mole ratio that you determined in your experiment match the actual reaction equation's coefficients for the two reactants? Explain, especially if your mole ratios do not match the coefficients.