

Name _____ Date _____ Hour _____

Finding the Ratio of Moles of Reactants in a Chemical Reaction

Purpose:

Determine the molar relationship between reactants in a chemical reaction based on the thermal change in the system.

Background:

This experiment uses the method of continuous variation to determine the mole ratio of two reactants in a chemical reaction. Several steps are involved. First, solutions of reactants are prepared in which the concentrations are known. Second, the solutions are mixed a number of times using different volume ratios of reactants. Third, some property of the reaction that depends on the amount of product formed, thermal energy, is measured. By comparing the extent of greatest quantity of product, we can determine the stoichiometric ratio of the reactants

Materials:

Chemicals

Sodium hypochlorite, NaClO, 0.5 M, 175mL

“Solution B”, 0.5 M, 175mL

Equipment

Beakers, 400-mL, 2

Graduated cylinders, 10-mL and 50-mL

Thermometer

Styrofoam cup

Safety:

Beach is a 5% solution of sodium hypochlorite and can cause skin burns. Keep solutions away from skin and clothing.

Wear safety goggles.

Procedure:

1. Obtain approximately 175mL of the NaClO solution in a clean 400-mL beaker and 175mL of “Solution B” to another clean 400-mL beaker. Label the beakers.
2. Measure the temperature of the NaClO solution and of “Solution B.” Record the data in the Data Table. Use the same thermometer or a pair of calibrated thermometers. The solution should be the same temperature.
3. Using a clean 10-mL graduated cylinder, measure 5.0mL of NaClO solution and pour the solution into a Styrofoam cup. Using a clean 50-mL graduated cylinder, measure 45.0mL of “Solution B” and add this to the Styrofoam cup.
4. Stir with a thermometer, and record the maximum temperature reached of the final solution in the Data Table.
5. Pour the solution out, rinse the cup and thermometer, and repeat steps 1-4 using a different ratio of the two substances, always keeping the total volume at 50.0mL.
6. Continue testing various ratios until you have *at least three measurements on each side of the one that gave the greatest temperature difference*.
7. Plot your data on a graph provided.
8. Draw two straight lines that best fit your data, and determine where they intersect. Be sure to include the points at the 0:50mL and 50:0mL ratios. If any points do not fall close to the lines, you should repeat these measurements. Find the stoichiometric mole ratio of reactants from the point of intersection on your graph.

Data Table

Initial Temperature _____

Data Table

Initial Temperature _____

[illegible]

Graph 1: Temperature Change vs. Volume Ratios

Temperature
Change, °C

Ratio of NaClO to “Solution B” _____

Post-Lab Questions

1. Explain how the method of continuous variations is used to determine the mole ratio of reactants in a chemical reaction.
2. Why was the total volume of solutions used kept constant in all trials?
3. Is it necessary that the concentrations of the two solutions be the same?
4. Which reactant is the limiting reagent along the upward sloping line of the graph? Which is the limiting reagent along the downward sloping line?

- Why is it more accurate to use the point of intersection of the two lines to find the mole ratio rather than the ratio associated with the greatest temperature change?
- If the two solutions used are not at the same initial temperature, a correction must be made to find the correct change in temperature. How could this be done?

Pre-Lab Questions

- The following values were obtained in a continuous variations experiments designed to find the mole ratio for the reaction between 0.5M solutions of AgNO_3 and K_2CrO_4 . One of the products is a precipitate.

Experiment	mL AgNO_3	mL K_2CrO_4	Grams Precipitate
1	5.0	45.0	1.7
2	15.0	35.0	5.0
3	25.0	25.0	8.3
4	30.0	20.0	10.0
5	35.0	15.0	9.9
6	40.0	10.0	6.6
7	45.0	5.0	3.3

Plot the data on the graph as outlined in the procedure. Label the axes and space the data so that the graph reflects the precision of the values given. Use a ruler to draw the best fitting straight lines through the data points and determine the coefficients for the reaction in the balanced chemical equation.

Mass of Precipitate vs. Reactant Volumes

_____ AgNO_3 + _____ K_2CrO_4 → Products

- Is there enough data to make a valid conclusion? Why or why not?