Finding the Ratio of Moles of Reactants in a Chemical Reaction Lab Exercise

Chemistry II

10 points

Name: _____

Partner: _____

USE BLUE/BLACK INK!!!! Date: _____ Hour: _____

Goal:

The goal of this lab is to determine the mole ratios in a reaction where one of the chemicals is an unknown.

Introduction/Background:

A balanced chemical equation gives the mole ratios of reactants and products for a chemical reaction. If the formulas of all reactants and products are known, it is relatively easy to balance the equation to find out what these mole ratios are. When the formulas of the products are not known, experimental measurements must be made to determine the ratios.

This experiment uses the method of continuous variations to determine the mole ratio of two reactants in a chemical reaction. Several steps are involved. First, solutions of the 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 or on the amount of reactant that remains is measured. This property may be the color intensity due to a reactant or product, the mass of a precipitate that forms, the volume of a gas evolved, or the temperature.

In the method of continuous variations, the total number of moles of reactants is kept constant for the series of measurements. Each measurement is made with a different mole ratio of reactants. The optimum ratio, which is the stoichiometric ratio for the reactants in the balanced chemical equation, should consume the greatest amount of reactants, form the greatest amount of product, or generate the most heat and produce the maximum temperature change.

Research questions: (If more room is needed to answer a question, additional pages may be attached.)

1) What would the double displacement reaction equation be between silver nitrate and potassium chromate?

2) The following values were obtained in a continuous variations experiment (like the one we will be doing) designed to find the mole ratio for the reaction between 0.5 M solutions of silver nitrate and potassium chromate. One of the products is a precipitate.

Trial	mL silver nitrate	mL potassium chromate	grams of 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

a) Plot the data on a piece of graph paper. The x-axis should be volume of silver nitrate solution. The y-axis should be mass of precipitate.

b) Use a ruler to draw the two best-fitting straight lines through the data points.

c) What volumes of reactants would cause the most precipitate to be produced? (This is where the two lines cross.)

silver nitrate: _____ mL potassium chromate: _____ mL

d) What would the ***ratio*** of silver nitrate to potassium chromate be based on the data? How does this compare to the reaction equation you came up with in question #1?

Materials:

175 mL 0.5 M NaClO
1 Styrofoam cup
2 400 mL beakers
1 permanent marker
1 stirring rod
1 test tube clamp

175 mL 0.5 M unknown solution
2 10 mL graduated cylinders
2 50 mL graduated cylinders
1 digital thermometer
1 ringstand
1 test tube brush

_____ _____

_____ _____

Hazards:

The student safety contract applies. The unknown solution is slightly toxic by ingestion and a body tissue irritant. _____

_____

_____

_____

_____

Procedure:

1. Prepare equipment
    a. physically and chemically clean glassware
    b. label one 400 mL beaker NaClO solution
    c. label the other 400 mL beaker unknown solution
2. Obtain solutions
    a. obtain approximately 175 mL of NaClO solution in the 400 mL beaker
    b. obtain approximately 175 mL of unknown solution in the other 400 mL beaker
3. Take the temperatures of the two solutions
4. Set up
    a. clamp test tube clamp to ring stand
    b. attach digital thermometer to test tube clamp
    c. put Styrofoam cup below thermometer
5. React the solutions together
    a. use a 10 mL graduated cylinder to measure 5.0 mL of NaClO solution
    b. use a 50 mL graduated cylinder to measure 45.0 mL of unknown solution
    c. pour the two solutions into the Styrofoam cup
    d. use the stirring rod to stir the two solutions together
    e. record the highest temperature reached
6. Prepare for another trial
    a. dispose of mixture in the waste container
    b. physically and chemically rinse the Styrofoam cup, stirring rod, and thermometer
7. Repeat steps 5 and 6 with various amounts of the two solutions (keeping the total volume at 50.0 mL) until there are at least three temperatures on each side of the mixture that gave the highest temperature
8. Clean up

Data:

Initial temperature of NaClO solution: _____ Unknown solution: _____

mL NaClO	mL unknown	T_{final} (°C)	ΔT (°C)

mL NaClO	mL unknown	T_{final} (°C)	ΔT (°C)

Observations:

After lab, **graph the data** and **determine the ratio of reactants**. Also answer the following questions:

1) Which measurement, temperature or volume, limits the precision of the data in this experiment? Explain your answer.
2) Which reactant is the limiting reactant along the upward sloping line of the graph? Which is the limiting reactant along the downward sloping line?
3) Why is it more accurate to use the point of intersection of the two lines to find the mole ration rather than the ratio associated with the greatest temperature change?

Lab handout based on the experiment "Finding the Ratio of Moles of Reactants in a Chemical Reaction" in Laboratory Experiments for Advanced Placement Chemistry (Second Edition) by S.A. Vonderbrink (Flinn Scientific, 2006)