Name: 5A (Key) Period: Date:

Lab Activity- Calculations with a Chemical Reaction

Introduction: Every balanced chemical equation tells you the relative number of ***moles*** of the substances in the reaction. The familiar reaction: $2H_2 + O_2 \rightarrow 2H_2O$, tells you that when 2 moles of hydrogen molecules react with 1 mole of oxygen molecules, 2 moles of water are produced. Equations deal with moles, but tools used in the laboratory- balances, graduated cylinders, pipettes- do not measure moles directly. It is necessary to convert mass to moles by using the molar mass or a substance or to convert volume to moles by using the molarity of a solution. In this experiment, the reactants are dissolved in water and the concentrations of the solutions are expressed in molarity- moles per liter of solution (M).

The reaction takes place between solutions of calcium chloride and sodium carbonate. The products are calcium carbonate and sodium chloride. Because sodium chloride is soluble in water, it will remain in solution. However, calcium carbonate is insoluble in water. It will form a precipitate. You will collect the calcium carbonate by filtration, dry it, and determine the mass of this product of the reaction.

Objectives:

1. Observe the reaction between solutions of calcium chloride and sodium carbonate.
2. Calculate the number of moles of each reactant and determine the reactant that is in excess.
3. Determine the theoretical yield of calcium carbonate and compare it to the actual amount produced.
4. Calculate the percent yield.

Pre-Lab Questions

1. What is the number of moles present in 24.0 mL of 0.500 M solution of sodium chloride, NaCl? $.5 \frac{mol}{L}$

$$24\,\cancel{mL}\left(\frac{1\,L}{1000\,\cancel{mL}}\right) = .024\,\cancel{L} \times \frac{.5\,mol}{\cancel{L}} = \boxed{.012 \text{ moles NaCl}}$$

2. How many moles are there in 456 g of calcium fluoride, CaF_2?

$$456g \div 78\,g/mole = \boxed{5.85 \text{ moles}}$$

$$(1\times 40)+(2\times 19) = 78$$

3. What is the formula for:
   a. sodium carbonate Na^{+1} CO_3^{-2} Na_2CO_3
   b. calcium chloride Ca^{+2} Cl^{-1} $CaCl_2$
   c. calcium carbonate Ca^{+2} CO_3^{-2} $CaCO_3$
   d. sodium chloride Na^{+1} Cl^{-1} $NaCl$

4. What is the purpose of removing all the precipitate from inside the beaker?

To collect all of the chalk.

5. In the procedure, there are several washings of the solid with water. What is the purpose of these washings?

To collect as much chalk as possible.

6. Why is it important that the solid be dry before the final mass measurement?

To get the most accurate results. Wet chalk weighs more.

Procedure

1. Clean and dry a 250-mL beaker.
2. From your teacher, obtain 65 mL of 0.6 M sodium carbonate and add it to the beaker.
3. Measure out 50 mL of 0.4 M calcium chloride and add it to the beaker. Use some distilled water and rinse your graduated cylinder and add it to the beaker.
4. Observe reaction, record observations in your data table and stir the mixture.
5. Obtain a piece of dry filter paper, put it on a balance and record the mass in your data table.
6. Put filter paper in your funnel system with a funnel and an Erlenmeyer flask.
7. Decant solution into the filter setup and let the sodium chloride solution filter through, leaving behind the calcium carbonate in the filter paper.
8. Once entire solution is filtered, use "rubber policeman" to get the entire solid out of the beaker.
9. Rinse the beaker with distilled water and filter it through. Repeat this process 2 more times.
10. Let remaining product sit in your filter paper and let dry overnight.

Data and Observations

Volume of sodium carbonate solution .6M 65 mL

Volume of calcium chloride solution .4M 50 mL

Observations when calcium chloride is added to sodium carbonate

Milky white solution formed

Mass of dry filter paper 1.01 g

Mass of filter paper and dry solid 3.00 g

Calculations & Conclusions

1. Calculate the following values. Show your work.
   a. moles of sodium carbonate used .039 mol

   $.065 \cancel{L} \times .6 \frac{mol}{\cancel{L}} =$

   b. moles of calcium chloride used .02 mol

   $.05 \cancel{L} \times .4 \frac{mol}{\cancel{L}} =$

   c. mass of calcium carbonate produced 1.99 g

   $3.00 - 1.01 =$

   d. moles of calcium carbonate produced .0199 mol

$1.99 \div 100 =$

$CaCO_3$

$(1 \times 40) + (1 \times 12) + (3 \times 16) = 100$ g/mole

2. Write a balanced chemical equation for the reaction that you observed in this experiment.

$$Na_2CO_3 + CaCl_2 \longrightarrow CaCO_3 + 2NaCl$$

3. Determine which of the reactants was in excess in this reaction. Which of the reactants is the "limiting reactant?" Show your work.

$$.039 \text{ mol } Na_2CO_3 \left(\frac{1 \text{ mol } CaCO_3}{1 \text{ mole } \cancel{Na_2CO_3}}\right) = .039 \text{ mol } CaCO_3$$

excess

$$.02 \text{ mol } \cancel{CaCl_2} \left(\frac{1 \text{ mole } CaCO_3}{1 \text{ mole } \cancel{CaCl_2}}\right) = .02 \text{ mol } CaCO_3 \leftarrow \text{Limiting Reactant}$$

4. Calculate the amount of calcium carbonate that should theoretically form from the amount of the limiting reactant. Show your work.

$$.02 \text{ mol } CaCO_3 \times 100 \text{ g/mole}$$

Theoretical amount of calcium carbonate ____2____ g

5. Calculate the percent yield in your reaction.

% Yield = $\frac{\text{actual amount}}{\text{Theoretical amount}}$ x 100

% Yield $\frac{1.99}{2} \times 100$ ____99.5____ %

6. Predict what would happen to the percent yield (greater than, less than, or no change) if the following occurred:
   a. the solid was not completely dry ____↑____
   b. the balance measured all values over by 0.12 g ____No change____
   c. you mixed up the volumes of the two liquids ____↑____

Source of Error

- lost chalk by touching
- lost chalk during Filtering
- Not giving exact amounts of Liquids

- Not dried enough
- Chalk left behind in beaker.