NAME: HONORS CHEMISTRY

SECTION: Lab: Calculations with a Chemical Reaction

The "recipe" for a chemical reaction is the balanced chemical equation. In the simplest example of $2\ H_2 + O_2 \rightarrow 2\ H_2O$, the recipe states that 2 moles of hydrogen molecules plus one mole of oxygen molecules will produce 2 moles of water molecules. Moles are the common language of chemical equations. However, there are no balances that measure amounts in moles. Balances measure amounts in grams. In the above example, we can use the gfm's of hydrogen, oxygen, and water to change the equation to say that 4.0 g of hydrogen will combine with 32.0 g of oxygen to form 36.0 g of water.

Often in chemical reactions, the amounts of substances are known or can be easily measured with a balance. Sometimes, the substances are dissolved in water, forming a solution. Solution concentrations are very often expressed in "molarity," abbreviated M. A 1.00 M solution contains exactly 1.00 mole of a substance per liter of solution. If you need to know the number of moles of the substance in a certain volume, you can multiply the volume in liters by the molarity. For example, if you wanted to know how many moles of sodium chloride were present in 0.500 L of a .250 M solution, you would multiply as follows:

L x M = moles
0.500 L x .250 mol/L = 0.125 mol

In this experiment, you will be observing the reaction between calcium chloride and sodium carbonate. Both substances are soluble in water, so the reaction will be carried out by combining solutions of the two substances. The products of the reaction are calcium carbonate and sodium chloride. The sodium chloride is soluble, so it will remain in solution. The calcium carbonate is insoluble, so it will form a precipitate, which can then be collected and dried to determine the mass of the product formed.

Objectives

- To observe the reaction between solutions of calcium chloride and sodium carbonate, forming an insoluble precipitate
- To calculate the number of moles of each of the starting materials present in the solutions
- To determine the reactant that is in excess
- To determine the theoretical amount of calcium carbonate that could be produced
- To compare the theoretical amount to the actual amount of calcium carbonate and calculate the percent yield

Materials

balance	100 mL graduated cylinders
funnel	filter paper
wash bottle	2 beakers
stirring rod with rubber policeman	ring stand and ring
0.60 M sodium carbonate solution, Na_2CO_3	0.40 M calcium chloride solution, $CaCl_2$

Safety

Wash spills and splashes off your skin and clothing with plenty of water. Wear your safety goggles to keep spills and splashes out of your eyes.

Roles

Project Manager _____
Quality Control Manager _____
Materials Manager _____

Procedure

1. Put on your laboratory apron and safety goggles.
2. Copy the data table into your lab notebook—do not record information on this lab sheet!
3. Obtain a clean 250 mL beaker. Rinse the inside of the beaker with a small amount of water. Pour out the water.
4. Pour between 25-75 mL of the sodium carbonate solution into the designated graduated cylinder. Record the volume to the nearest 0.1 mL in your data table. Pour the sodium carbonate solution into the beaker.
5. Using the designated graduated cylinder, pour between 15-50 mL of the calcium chloride solution into the graduated cylinder. Again, record the volume used in your data table to an appropriate degree of precision. Pour the calcium chloride into the beaker. Describe the resulting reaction in your lab notebook. Stir the contents of the beaker for about 1 minute, then allow the solid to settle.
6. While waiting for the solid to settle, label a piece of filter paper along the edge with your initials in pencil. Determine the mass of the filter paper to the appropriate degree of precision and record the amount in your data table.
7. Set up a funnel and the filter paper of known mass using a ring stand and ring. Use a 250 mL beaker under the ring.
8. Wet the filter paper with a small amount of water. Now pour the contents of the beaker slowly into the funnel. Be careful as you pour, so that none of the solid flows out of the filter paper or funnel. Use the rubber policeman to remove as much of the solid from the beaker as possible. Rinse the inside of the beaker with some water to remove any more solid. Rinse the beaker 2 or 3 times.
9. Once all of the solid is on the filter paper and the liquid has all drained through into the beaker, carefully remove the filter paper from the funnel and unfold it onto a paper towel. Allow the filter paper to dry overnight.
10. Begin the calculations for the lab report. Before you leave the lab, clean up all the materials and wash your hands thoroughly with soap and water.
11. After it is completely dried, find the mass of the filter paper and precipitate and record it.

Data and Observations

Record your data in your lab notebook, NOT on this page! Remember that your data must be presented in your lab report. It is NOT acceptable to simply attach this page to your report.

		Observations
Volume of sodium carbonate solution		
volume of calcium chloride solution		
Mass of dry filter paper		
mass of filter paper + dry solid		

Calculate the following values in your lab report, and show all work.

a) moles of sodium carbonate used
b) moles of calcium chloride used
c) mass of calcium carbonate produced
d) moles of calcium carbonate produced

Post-Lab Discussion

In a chemical reaction, theoretical yield is the term used to describe the expected or ideal amount of product based on a stoichiometric calculation. The actual yield is the experimentally determined amount of product. Percent yield tells you the percent of product obtained compared to the theoretical yield. You can calculate the theoretical yield by using the formula:

$$\%\ \ yield = \frac{actual\ \ yield(g)}{theoretical\ \ yield(g)}\ \ x\ \ 100$$

Analyze and Apply Questions

1. What class of reaction occurred in this experiment?
2. Determine which of the reactants was the limiting reagent in this experiment. Support your answer with calculations.
3. Calculate the theoretical yield and percent yield of calcium carbonate in this reaction.
4. What steps would you perform to recover the sodium chloride from the filtrate in your experiment? Provide your answer as a series of illustrations (i.e., no text)—show all the steps. Be sure to include all the lab equipment you would need!
5. 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
    c) you mixed up the volumes of the two solutions
6. One day in lab, 60.0 mL of 0.45 M barium chloride solution was mixed with 80.0 mL of .70 M sodium carbonate solution.
    a) Which reactant is in excess?
    b) Calculate the theoretical yields of both barium carbonate and sodium chloride.
    c) Suppose the percent yield of barium carbonate for this reaction is 87%. How many grams of barium carbonate were actually produced?

Remember to write an appropriate conclusion for this experiment: restate your findings, and discuss possible sources of error (not human error or calculation mistakes!).

Introduction for *Calculations with a Chemical Reaction* Lab Report

- Define the term *limiting reactant* in your own words. (2 pts)
- When a limiting reactant is present, in what way is the reaction "limited"? What happens to a reaction when the limiting reactant is used up? (3 pts)
- For a reaction of your choice, use *picture models* to illustrate a limiting reactant situation, including initial and final conditions. Identify the limiting reactant, determine the amount of excess reagent left over, and determine the amount of product formed. (5 pts)
- Write a balanced (complete molecular) chemical equation and a net ionic equation for the reaction that you observed in this experiment. (5 pts)