EXPERIMENT 13:
STOICHIOMETRY - SYNTHESIZING CHALK

Introduction: In this experiment you will study a precipitation reaction between calcium chloride and sodium carbonate. You will collect, dry, and weigh the precipitate and compare this experimental yield to the theoretical yield you will calculate from the balanced equation.

Background: A double displacement or metathesis reaction occurs when two soluble ionic compounds are mixed and form an insoluble ionic compound or a gas or a slightly ionized compound. We will study a reaction in which a precipitate is formed. The general scheme for such a reaction is AB + CD → CB + AD, where A and C are cations and B and D are anions.
For this experiment we will precipitate calcium carbonate from the reaction between sodium carbonate and calcium chloride. The reaction is:

$$Na_2CO_3\,(aq) + CaCl_2(aq) \rightarrow CaCO_3\,(s) + 2\,NaCl\,(aq)$$

We will use approximately 0.02 mole of each reactant and expect to obtain approximately 0.02 mole of solid product, since the stoichiometric coefficients are all 1 in the balanced equation. You will need to calculate the limiting reactant, and the theoretical yield, from your measured amount of each reactant.

For example, if we use 2.00 g $CaCl_2$ x $\frac{1\text{ mole}}{111\text{ g }CaCl_2}$ = 0.0180 mole $CaCl_2$

and mix it with 2.00 g Na_2CO_3 x $\frac{1\text{ mole}}{106\text{ g}}$ = 0.0189 mole Na_2CO_3

The maximum amount of $CaCO_3$ we can expect is 0.0180 mole x 100 g/mole = 1.80 g
The 1.80 g is the theoretical (calculated) yield of $CaCO_3$ in this example. Your values may differ. We will compare the actual yield (experimental value) with the theoretical yield to find the % yield. .

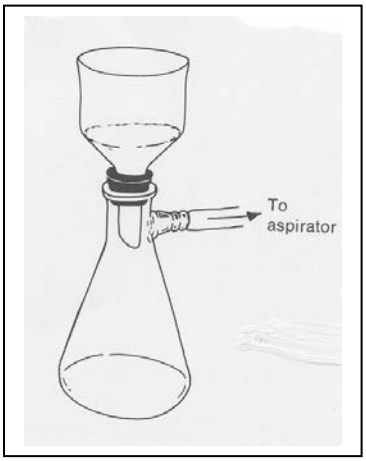
$$\%\text{ yield} = \frac{\text{actual yield of precipitate}}{\text{theoretical yield}} \times 100$$

Materials Needed

Equipment	Chemicals
Clean dry beakers (2), Stirring rod Vacuum filtration apparatus & Buchner funnel Wash bottle Watch glasses (2) spatula	Sodium carbonate (Na_2CO_3 Calcium chloride ($CaCl_2$) #442 filter paper

Procedure

1. Into two clean, weighed beakers weigh out separately, about 2 g of sodium carbonate and about 2 g of calcium chloride. Use the larger of the two beakers for the Na_2CO_3 (Weigh the samples to two decimal places; 3 sig figs) on a pan balance.
2. Add about 10 mL of distilled water to the $CaCl_2$, and 20 mL to the Na_2CO_3 and stir each sample until dissolved.
3. Slowly, with stirring, add small portions of the Na_2CO_3 solution to the $CaCl_2$. The mixture will begin to look frothy. Stir until the mixture vigorously until it is no longer frothy, and it settles to the bottom (about 5 minutes).
4. Weigh a piece of filter paper that fits the Buchner funnel (#42, 9cm diameter). Also weigh a watch glass.
1. We will use a vacuum filtration apparatus to obtain the precipitate. Your instructor will demonstrate its use.



On each bench there is an apparatus for your use.
Obtain a Buchner funnel from the stockroom. Place the funnel securely in the side-arm flask. Place the weighed filter paper into the funnel. Turn on the water attached to the vacuum system. Direct a stream of water from a wash bottle onto the filter paper. Make sure the filter paper is tightly held in the funnel and that suction exists. (Check by covering the funnel with your hand).

Pour the contents of your beaker into the funnel. You must do this slowly or some of the precipitate will go through the filter paper. Try to get most of the precipitate out of the beaker by washing several times with small quantities of water and using a wash bottle filled with DI water to rinse the beaker. Don't use more than 100 mL for the rinsings.

6. Shut off the water, remove the funnel, and remove the filter paper and sample. Use a spatula to pry the filter paper loose from the funnel. Place the filter paper and sample on a labeled, weighed watch glass. Let it dry in an oven for about ½ hour at 110°C. Weigh the sample with the filter paper and watch glass after cooling.

Safety and Waste Disposal

Safety: You must wear safety goggles at all times.
Waste Disposal: After using the vacuum filtration apparatus, dispose of the liquid in the side-arm flask in the sink. Place the filter paper and your product in the waste containers in the hood after showing it to the instructor.

Name _____

EXPERIMENT 13: REPORT
STOICHIOMETRY Section _____

Show all data and calculations in your lab notebook and attach the carbon copies to this cover sheet.

DATA AND CALCULATIONS:

The reactants:

Weight of beaker with sodium carbonate _____

Weight of empty beaker _____

Weight of sodium carbonate _____

Calculation of moles of Na_2CO_3
Show your calculations in your notebook _____

Weight of beaker with calcium chloride _____

Weight of empty beaker _____

Weight calcium chloride _____

Calculation of moles of $CaCl_2$
Show your calculations in your notebook _____

Use these calculations of moles of each reactant to determine the limiting reactant.

The limiting reactant is_____

The product

Weight of filter paper with calcium carbonate _____

Weight of filter paper _____

Weight of calcium carbonate _____
(This is the "actual" or experimental yield of product)

Calculate the **theoretical yield** (in grams) of calcium carbonate from the moles of limiting reactant. **Show your calculations in your notebook.**

_____g $CaCO_3$

Calculate the **%** yield. **Show your work in yur lab notebook.**

_____% yield

QUESTIONS

1. If you had used 1.30 grams of barium chloride instead of calcium chloride, and 1.20 grams of the Na_2CO_3, what would be the theoretical yield of barium carbonate? (Write and balance the equation, determine the limiting reactant, and maximum yield.)

2 a) Would there be any effect on the amount of precipitate in the experiment if tap water containing calcium ions is used instead of deionized water, to dissolve the reactants Assume that Na_2CO_3 is present in excess. Explain your answer.

b) What would happen if Na_2CO_3 were not in excess but rather was the limiting reactant? Would there be any effect on the amount of precipitate of $CaCO_3$ if tap water containing Ca^{2+} were used? Explain your answer.