# Lab: Precipitation Reaction & Vacuum Filtration

Background:

One example of a double replacement (metathesis) reaction is the mixing of two solutions resulting in the formation of a precipitate. In solution chemistry, the term precipitate is used to describe a solid that forms when a positive ion (cation) and a negative ion (anion) are strongly attracted to one another. In this experiment, a precipitation reaction will be studied. Stoichiometry will then be used to investigate the amounts of reactants and products that are involved. The word stoichiometry is derived from two Greek words: *stoicheion* (meaning "element") and *metron* (meaning "measure"). Stoichiometry is an important field of chemistry that uses calculations to determine the quantities (masses, volumes) of reactants and products involved in chemical reactions. It is a very mathematical part of chemistry.

In this experiment, you will react a known amount of sodium carbonate solution with a known amount of calcium chloride solution. The skeletal (unbalanced) equation for the resulting double replacement reaction is:

$$Na_2CO_{3(aq)} + CaCl_{2(aq)} \rightarrow NaCl_{(aq)} + CaCO_{3(s)}$$
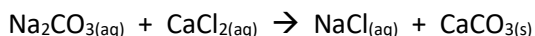
Note that three of the chemicals have their states or phases designated as *(aq)* and one is designated as *(s)*. The *(aq)* represents the term aqueous which means that the substance is soluble and dissolved in water. The *(s)* means that the substance is a solid (in this case, it is a precipitate). Precipitate formation is easily observed as the mixed solutions turn cloudy and, if desired, the precipitate can be easily separated from the solution by filtering. Since your precipitate will be separated and weighed, you will need to dry the precipitate in a drying oven before measuring its mass. Stoichiometry will then be used to determine the amount of precipitate that should be formed in the reaction.

It is often difficult as well as impractical to combine just the right amount of each reactant that is required for a particular reactant that is required for a particular reaction to occur. Given this fact, this experiment is designed so that only one of the reactants will be completely used up. This is called the *limiting* reactant because it limits the amount of products formed. Since the other reactant will have a quantity remaining, it is called the *excess reactant*. One of your tasks will be to determine which of your reactants is limiting and which is in excess.

The two chemical reactants in this experiment have common uses in our lives. In one solid form, sodium carbonate is known as "washing soda" and is used to enhance the effectiveness of laundry soap. Calcium chloride solid can act as a desiccant (drying agent) and is used by recreational vehicle owners to remove moisture from the air in the vehicle during winter storage.

Purpose:
1. To observe the reaction between solutions of sodium carbonate and calcium chloride.
2. To determine which of the reactants is the limiting reactant and which is the excess reactant.
3. To determine the theoretical mass of precipitate that should form.
4. To compare the actual mass with the theoretical mass of precipitate and calculate the percent yield.

Safety:
Safety goggles and lab apron should be worn at all times. Use caution when handling hot glassware and equipment.

Materials:

Balance	Wash bottle with distilled water	Scoopula
Hot plate		Stirring rod
	1 Buchner funnel	
2 graduated cylinders – 25 mL	Aspirator	Drying oven
2 beakers – 250 mL (1) and 400 mL (1)	1 side arm flask – 500 mL	Aqueous solution of sodium carbonate, Na_2CO_3(aq)
	Filter paper	Aqueous solution of calcium chloride, $CaCl_2$(aq)

Procedure:
1. Obtain and wear goggles and lab apron.
2. Obtain 25 mL of Na_2CO_3 in one graduated cylinder and 25 mL of $CaCl_2$ in another graduated cylinder. Record the concentrations of Na_2CO_3 and $CaCl_2$.
3. Pour the contents of both graduated cylinders into a clean, dry 250 mL beaker.
4. Stir the mixture. Record qualitative observations of the mixture. Allow the contents to sit undisturbed for 5 min.
5. While the mixture settles, obtain a piece of filter paper.
6. Record the mass of the filter paper.
7. Set up a filtering apparatus. See provided instructions on how to use a Buchner funnel and aspirator.
8. After the mixture has settled for 5 mins, use the wash bottle to lightly wet the filter paper in the funnel to keep the filter paper in place. Swirl the beaker and its contents to suspend the precipitate in the solution, then pour it carefully and slowly into the filter funnel. It takes time to compete the filtering process so plan to do it in stages. Use the wash bottle to rinse the remaining precipitate from the beaker.
9. Use the wash bottle to rinse the precipitate in the filter paper. This will remove any residual NaCl(aq) that remains with the precipitate.
10. After the filtering is complete, remove the wet filter paper containing the precipitate. Place the filter paper onto a piece of paper towel labeled with your initials and block.
11. Place the paper towel with filter paper onto the designated tray for the drying oven.
12. Obtain a 400 mL beaker.
13. Record the mass of the beaker.
14. Transfer the contents of the side-arm flask into a 400 mL beaker. Heat the beaker on a hot plate until the water is driven off. **To prevent spattering, do not heat the solution too fast.**
15. Measure and record the mass of the dry 400 mL beaker.
16. Measure and record the mass of the dry filter paper with precipitate.
17. Wash all glassware and return equipment.
18. Wash your hands with soap and water.
19. Return safety goggles and lab apron.

Data Table:

Molarity of Na_2CO_3	
Volume of Na_2CO_3 used (mL)	
Molarity of $CaCl_2$	
Volume of $CaCl_2$ used (mL)	

Observations of resulting mixture of Na_2CO_3 and $CaCl_2$	
Mass of filter paper (g)	
Mass of filter paper with dry precipitate (g)	
Mass of empty 400 mL filtrate beaker (g)	
Mass of 400 mL filtrate beaker with solids after water has been driven off (g)	

Pre-lab:
1. Write the balanced **net ionic equation** of the reaction that will take place in this lab.

2. Write the chemical formula of the precipitate that will form.

3. The filtrate is the solution that passes through the filter paper. What ions should be present in the filtrate?

4. A student mixes 35. mL of 1.45 M Na_2CO_3 with 40. mL of 1.03 M $CaCl_2$. Calculate the theoretical yield, in grams, of precipitate that should be made.

Post-lab and Data Analysis:
1. How many moles of Na_2CO_3 were added to the reaction beaker?

2. How many moles of $CaCl_2$ were added to the reaction beaker?

3. Which reactant is the limiting reactant? Justify your answer with a calculation.

4. Determine the theoretical yield, in grams, of precipitate.

5. How many grams of precipitate were actually formed in lab?

6. Determine the percent yield of precipitate.

7. Determine the mass of solids in the filtrate beaker.

8. Identify the names and chemical formulas of the ions in the filtrate.

9. Suppose a drying oven was not available and the precipitate was not dried sufficiently. Would the percent yield be too high or too low? Explain your reasoning.

10. Suppose a student's filtrate is really cloudy and he does not run the cloudy filtrate through the filter paper again. Would his percent yield be too high or too low? Explain your reasoning.