

### Lab 4: Solution stoichiometry

#### Objective:

Apply stoichiometry and the idea of a limiting reactant to a reaction in solution

#### Skills:

- Write a recipe for making a given volume, given concentration solution
- Make a given volume, given concentration solution from such a recipe
- Use a Buchner funnel and vacuum filtration to isolate a precipitate from solution

#### Background:

The study of mass relationships in chemical reactions is called stoichiometry. All problems in stoichiometry involve mole-mole conversions. Such calculations are needed to determine both the quantities of reactants that are required for a chemical reaction, and the theoretical yield of the reaction.

The reaction you will carry out in lab is a double replacement reaction between sodium carbonate and calcium chloride, in which a precipitate will form. You will isolate the precipitate by a process called **vacuum filtration**.

In reactions, one reactant is often used **in excess** in comparison to the other. The excess reactant will not react completely. The reactant that is not used in excess (it gets completely used up in the reaction) is referred to as the **limiting reactant**. The amount of product formed is dependent upon the amount of limiting reactant present.

#### Pre-lab (due Thursday at the beginning of class):

*Please show the details of each calculation, as required.*

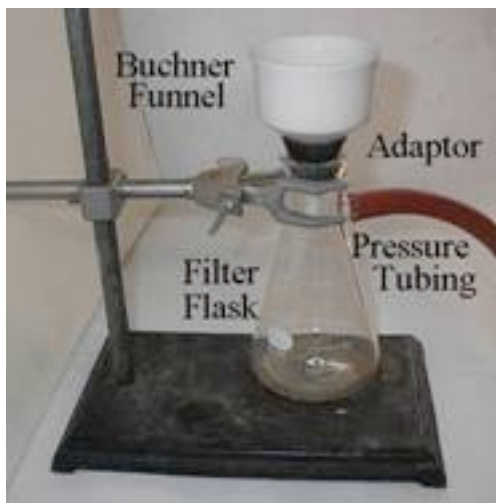
1. Write the **balanced chemical equation** for this reaction, including the state symbols (such as (s) or (aq)).
2. Calculate the mass of  $\text{Na}_2\text{CO}_3$  needed to prepare 50.0 mL of a 0.700M (0.700 moles per liter of solution) aqueous solution, then fill in the following recipe:

“To make 50.0 mL of a 0.700 M solution of sodium carbonate: In a 50 mL volumetric flask, add \_\_\_\_\_ g of sodium carbonate powder. Add distilled water nearly to the graduation on the flask, then mix thoroughly, such that the powder completely dissolves. Add distilled water exactly to the graduation, then stir again.”

3. Calculate the **theoretical yield** of the precipitate in this reaction (the number of grams you expect to isolate).

### Procedure:

1. Using a 50 mL volumetric flask, prepare 50.0 mL of 0.700 M  $\text{Na}_2\text{CO}_3$  solution by following your recipe.
2. In an appropriate-sized beaker, mix the above solution with 60.0 mL of 0.500 M  $\text{CaCl}_2$  solution. **Please do not use more than 60.0 mL of the calcium chloride solution.**
3. Stir and then let the solid that has formed settle. Collect the solid product via vacuum filtration; the setup is shown in the photo below.



Inside the Buchner funnel should be a filter paper circle of the appropriate size. Make sure you wet the filter paper first and are running the vacuum before pouring the product into the funnel. Also, **be careful how you disconnect the vacuum** when you are finished; *always* disconnect the vacuum line from the filter flask first, *then* turn off the water.

4. Dry and weigh the product. Record the mass.

**Lab 4: Solution stoichiometry data and calculations** (supply appropriate units!):

Moles of sodium carbonate used	
Moles of calcium chloride used	
Moles of precipitate expected	
Theoretical yield of precipitate	
Actual yield of precipitate	
<b>Percent yield</b>	

Show details of the above calculations here:

**Questions** (you may answer the questions here or on another sheet of paper):

1. Which reactant was limiting, if any? Show a calculation that proves this point.

2. Why was important to wet the filter paper prior to filtering your precipitate?

3. Percent yields for this reaction typically run above 80%. Was your percent yield high or low? List at least two factors that could have affected your percent yield (increased or decreased it, as the case may be). Note that there may be factors that work against each other.