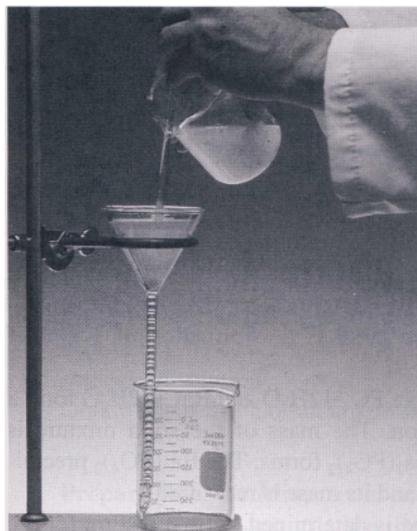


# Experiment 8

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## Limiting Reactant



Gravity filtration is used to filter finely divided precipitates.

### Introduction

Two factors affect the yield of products in a chemical reaction: 1. the amounts of starting materials (reactants) and 2. the percent yield of the reaction. Many experimental conditions, for example, temperature and pressure, can be adjusted to increase the yield of a desired product in a chemical reaction, but because chemicals react according to fixed mole ratios (stoichiometrically), only a limited amount of product can form from given amounts of starting materials. The reactant determining the amount of product generated in a chemical reaction is called the limiting reactant.

To better understand the concept of the limiting reactant, you will investigate the precipitation reaction that takes place between aqueous solutions of sodium phosphate dodecahydrate,  $\text{Na}_3\text{PO}_4 \cdot 12\text{H}_2\text{O}$ , and barium chloride dihydrate,  $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$ .

Write a balanced chemical equation for this reaction:

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**Procedure Overview:** A measure mass of a salt mixture of containing  $\text{Na}_3\text{PO}_4 \cdot 12\text{H}_2\text{O}$  and  $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$  is added to deionized water. The precipitate that forms is filtered, dried, and its mass measured. Observations from tests on the supernatant solution determines which salt in the mixture is the limiting reactant. An analysis of the data provides the determination of the percent composition of the salt mixture.

(over)

# Experimental Procedures

## A. Precipitation of $\text{Ba}_3\text{PO}_4$ from the Salt Mixture.

1. Obtain a vial containing an mixture of  $\text{Na}_3\text{PO}_4 \cdot 12\text{H}_2\text{O}$  and  $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$ . Record the number found on the vial lid.
2. Measure about 1-gram of the salt mixture into a 400 mL beaker and add approximately 200 mL of deionized water. Stir the mixture with a stirring rod, using a wash bottle to rinse off the stirring rod before removing it from the beaker, and allow the precipitate to settle for a few minutes.

## B. Digest the Precipitate.

3. Cover the beaker with a watch glass and warm the solution on a hot plate for 30 minutes at approximately  $80^\circ\text{C}$  (not to exceed  $90^\circ\text{C}$ ).
4. After 30 minutes, use beaker tongs to remove the beaker from the hot plate and allow the precipitate to settle; the solution does not need to cool to room temperature.

## C. Determination of the Limiting Reactant

5. While still warm and without disturbing the precipitate that has formed on the bottom of the beaker, carefully decant approximately 40 mL of the supernatant into two small 50-mL beakers.
6. Add a few drops of 0.5M  $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$  into one of the beakers and a few drops of 0.5M  $\text{Na}_3\text{PO}_4 \cdot 12\text{H}_2\text{O}$  into the other. An obvious formation of a white precipitate should appear in only one of the beakers. (Make sure you are looking very carefully with the drops are added.) If nothing is observed in either beaker, repeat using more drops until a precipitate is observed. The reagent that caused a precipitate to form is the limiting reactant from your mixture.

## D. Filtration of the Precipitate

7. Set up a gravity filtering apparatus (see photo on first page).
8. Place your initials (in pencil) on a piece of quantitative filter paper. Fold and tear off its corner, and record its mass.
9. Place the filter paper into the filter funnel, then dampen it with a small amount of deionized water to help seal it to the funnel.
10. Transfer the precipitate to the filter with the aid of a rubber policeman. Wash any remaining precipitate into the filter with warm deionized water. Allow any excess water to drain through the filter (this may take several minutes).

## E. Dry and Mass the Precipitate

11. Carefully remove the filter paper from the funnel and seal its contents using 2-3 folds (be careful not to hide your initials). Place the filter into a drying oven overnight.
12. On the next lab meeting, remove the filter paper from the drying oven and record its mass.