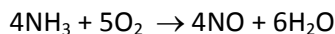


Experiment 4 - Limiting Reactant

A *limiting reactant* is the reagent that is completely consumed during a chemical reaction. Once this reagent is consumed the reaction stops. An *excess reagent* is the reactant that is left over once the limiting reagent is consumed. The maximum theoretical yield of a chemical reaction is dependent upon the limiting reagent thus the one that produces the least amount of product is the limiting reagent. For example, if a 2.00 g sample of ammonia is mixed with 4.00 g of oxygen in the following reaction, use stoichiometry to determine the limiting reagent.

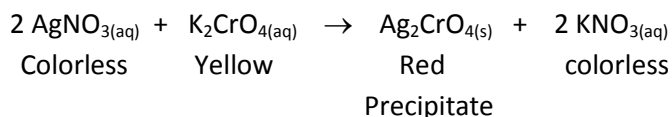


$$2.00 \text{ g NH}_3 \times \frac{\text{mol}}{17.0 \text{ g}} \times \frac{4 \text{ mol NO}}{4 \text{ mol NH}_3} \times \frac{30.0 \text{ g}}{\text{mol}} = 3.53 \text{ g NO}$$

$$4.00 \text{ g O}_2 \times \frac{\text{mol}}{32.0 \text{ g}} \times \frac{4 \text{ mol NO}}{5 \text{ mol O}_2} \times \frac{30.0 \text{ g}}{\text{mol}} = 3.00 \text{ g NO}$$

Since the 4.00 g of O₂ produced the least amount of product, O₂ is the limiting reagent.

In this experiment you will be given a mixture of two ionic solids, AgNO₃ and K₂CrO₄, that are both soluble in water. When the mixture is dissolved into water they will react to form an insoluble compound, Ag₂CrO₄, which can be collected and weighed. The reaction is the following:



Precipitate is the term used for an insoluble solid which is produced by mixing two solutions. Often the solid particles are so fine that they will pass right through the pores of a filter. Heating the solution for a while causes the particles to clump together, a process called *digesting*. The precipitate coagulates upon cooling and eventually settles to the bottom of a solution container. The clear liquid above the precipitate is called the *supernatant*. When the mixture is poured into a filter, solid is trapped by the filter and the clear liquid passes through as the *filtrate*. You will then test the filtrate to find out the limiting reagent and then weigh the precipitate collected to determine the mass of each reagent originally present in the solid mixture.

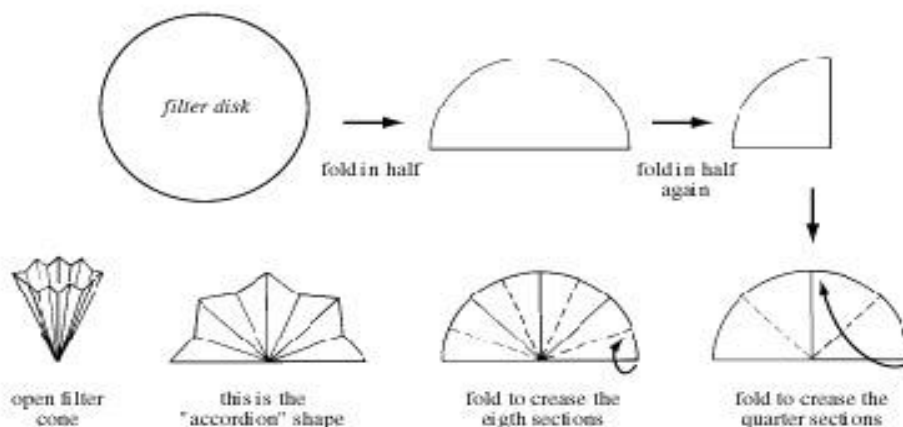
Equipment and Reagents

Unknown solid mixture	hot plate or burner	2 watch glasses	0.2 M K ₂ CrO ₄
2 Shell vials	beaker tongs	150 mL beaker	0.1 M AgNO ₃
Analytical balance	filter paper	wash bottle	
250 mL beaker	labeling tape	glass rod	
Distilled water	funnel	rubber policeman	

Procedure

Day 1- Precipitation and Isolation of Red Precipitate.

1. Obtain an unknown mixture in a shell vial from your instructor and record the sample ID number.
2. Weigh the vial containing the unknown mixture on the analytical balance. Transfer the solid mixture to a 250 mL beaker and reweigh the empty shell vial. Subtract the mass of the empty beaker from the mass of the beaker plus sample to obtain the mass of the mixture.
3. Add 100 mL of distilled water to the beaker containing the unknown mixture. Cover the beaker with a clean watch glass. Place the beaker over the burner or hot plate and heat almost to boiling. Turn the heat low to maintain the solution below boiling for 10 minutes. Notice the color change or lack of color change in the solution. Record your observation.
4. Use the tongs to move the beaker to a heat resistant surface and allow to cool slowly for 30 to 60 minutes.
5. While you are waiting, weigh a piece of filter paper on a clean dry watch glass on the analytical balance. Record this mass in your notebook. *Make sure not to mix this watch glass with the one used for the reaction.*
6. Prepare the filter paper for gravity filtration. Flute fold the filter paper to fit in the funnel (see diagram below). Support the funnel on an iron ring attached to a ring stand. Place the filter paper in the funnel and moisten with distilled water from a wash bottle. Place the 150 mL beaker under the funnel stem. The stem should touch the wall of the receiving vessel.



Flute Folding Diagram

7. Hold a glass stirring rod against the lip of the beaker to guide most of the supernatant liquid from the beaker into the filter. Stir the liquid and precipitate and carefully pour the liquid and solids from the beaker into the filter. Scrape the walls of the beaker with the rubber policeman to loosen the precipitate and rinse with small portions of DI water to transfer the remaining solid into the filter.
8. Wash the precipitate and filter paper with small portions of DI water from your wash bottle. There should be no yellow color left on the filter paper after rinsing. Allow to drip and proceed with the next step.

- Transfer some of the filtrate (liquid) from the 150 mL collection beaker into two shell vials marked A and B. The depth of the liquid in each shell vial should be about 2 cm. Transfer 10 drops of 0.2 M K_2CrO_4 to vial A and 10 drops of 0.1 $AgNO_3$ to vial B. Indicate if a red precipitate forms or not. Determine the limiting reagent from this observation. Discard the filtrate as instructed by the lab instructor.
- Place the filter paper and precipitate on the pre-weighed watch glass and allow to air dry in your locker until next period.

Day 2 – Analysis of product.

- Weight the watch glass with the filter paper and product on the analytical balance. Calculate the mass and moles of the Ag_2CrO_4 red precipitate.
- Determine the mass of the limiting reactant using stoichiometry. Calculate the mass % of the limiting reactant.
- Determine the mass of the excess reactant. This can easily be done by subtracting the mass of the limiting reactant from the original mass of the sample. Calculate the mass % of the limiting reactant.

Report

Show both the balanced molecular equation and the net ionic equation.

Tabulate results as follows:

Sample ID #	Reagent	Mass (g)	Mass %
Limiting			
Excess			