

Introduction

Qualitative analysis, or **QA**, is a system to determine the presence or absence of certain cations or anions in solution. The first step to being successful at identification is an understanding of the double replacement precipitation reactions that underlie this method of analysis. In this LAD you will practice these reactions and study qualitative chemistry by doing thoughtful comparison of a set of solutions with a list of their identities.

In precipitation reactions, two aqueous solutions will be combined and observations made to determine if a precipitate is formed. All aqueous solutions are transparent, though they may be colored. Any insoluble compound that forms will not be transparent, and will thus appear as a precipitate, which will of course show up as the appearance of a solid mass of material. Of course several different factors will contribute to the amount of solid material that forms. A sharp eye may be necessary to see a small amount of cloudiness, or a stringy material that may be indicating an insoluble product.

Precipitation Reactions and KISS Guidelines - (Keep It Simple Solubility)

The KISS Guidelines make a complicated topic approachable. This simplified five-step set of solubility guidelines is very user-friendly, allowing accurate prediction of precipitation in many (though not all) instances. It is important that you start writing precipitation reactions without depending on this chart. Try to work without it and then check it over with the chart.

The KISS Solubility Chart	
The Cation Guideline	
1. Na ⁺ , NH ₄ ⁺ , K ⁺	
The Anion Guidelines = soluble	
2. NO ₃ ⁻ , C ₂ H ₃ O ₂ ⁻ , ClO ₃ ⁻ , ClO ₄ ⁻	
3. Halides: Cl ⁻ , Br ⁻ , I ⁻ (EXCEPT when paired with: Ag ⁺ , Hg ₂ ²⁺ , Pb ²⁺)	
4. SO ₄ ²⁻ (EXCEPT when paired with Ag ⁺ , Hg ₂ ²⁺ , Pb ²⁺ or Ba ²⁺ , Sr ²⁺ , Ca ²⁺)	
The “Catch-All” Guideline = insoluble	
5. Everything else is assumed to be insoluble	

Colors of Ions

Certain ions in solution produce very particular colors. It is well worth committing the following ions and their colors to memory.

Cation	Color
Cu ²⁺	
Ni ²⁺	

Anion	Color
CrO ₄ ²⁻	

Pre-LAD Research and Preparation

A multi-solution mystery should be solved in two separate steps. The first requires some research. It will involve your knowledge of solubility and colors of ions in solutions. As you proceed through the lab, you will learn colors of precipitates as well.

1. First, use the “Table of Knowns” on the next page by listing the known formulas both across the top and down the left side of the table. In each cell of the table, you should note what (if anything) you expect to see if a solution of the compounds corresponding to that cell is mixed. If you predict that a precipitate forms, write the formula of that insoluble salt. If no reaction is predicted, write NAR for “no apparent reaction.”
2. On another piece of paper, for any combinations that you expect a precipitate, write both molecular (overall) and net ionic equations.

Procedure

- A. BE CAREFUL NOT TO CONTAMINATE THE DROPPING PIPETTES. If you suspect you have contaminated one, alert the teacher and we will replace it.
- B. Your research should be done the night before the LAD. Be sure you have left room on your chart of knowns to add any more info that you may learn when combining the known solutions. In the lab you will find a series of pipettes of the known chemicals marked with each identifying compound. Make each combination in the small wells on the plate with a couple of drops of each solution, checking the result with your research information and make any corrections necessary.
- C. Make the combinations of the unknowns in the small wells on the plate, noting the results on your table of unknowns.
- D. Once you have completed your experimental research and both tables have been filled in, a few minutes of careful comparison should enable you to identify each of the unknown solutions. If you are clever, you will realize that it is not necessary to mix every possible pair. Remember: the absence of any chemical change when two solutions are mixed is also valuable information.

Series B

This series of solutions that we will test are: ammonium carbonate, potassium hydroxide, sodium sulfite, potassium iodate, nickel(II) sulfate, barium chloride, lead(II) nitrate,. Write the formulas along the top and sides in preparation of making all the possible combinations in the lab

Table of Knowns

formulas							

Table of Unknowns

	A	B	C	D	E	F	G
A							
B							
C							
D							
E							
F							
G							