Microscale Chemical Reactions – Solubility

Introduction:

Today we will perform twenty-eight chemical reactions! Not bad for one lab period. While exploring the reaction of several combinations of chemicals we will generate less than 20 milliliters of chemical waste per student.

We will practice writing balanced chemical equations for each reaction that we perform to represent double replacement (aka metathesis) reactions and we will use this information to devise a set of solubility rules.

Learning Objectives:

(a) Observe a reaction mixture and distinguish between soluble and insoluble compounds.
(b) Learn to classify compounds as soluble and insoluble.
(c) Learn to balance chemical reactions of salts.

Materials:

-0.1 M solutions of eleven different salts in dropper bottles or with droppers
-Sheet protector
-Reaction grid
-Safety goggles

Hazard Information:

Solution	Health Hazards	Physical Hazards	Environmental Hazards
0.1 M $AlCl_3$	Irritant	Mildly corrosive	Low hazard
0.1 M KCl	Irritant	Low hazard	Low hazard
0.1 M NH_4Cl	Low hazard	Low hazard	Low hazard
0.1 M $MgCl_2$	Irritant	Low hazard	Low hazard
0.1 M $CaCl_2$	Low hazard	Low hazard	Low hazard
0.1 M $FeCl_3$	Irritant	Mildly corrosive	Low hazard
0.1 M $SrCl_2$	Irritant	Low hazard	Low hazard
0.1 M NaBr	Low hazard	Low hazard	Low hazard
0.1 M Na_2CO_3	Irritant	Low hazard	Low hazard
0.1 M Na_2SO_4	Low hazard	Low hazard	Low hazard
0.1 M Na_3PO_4	Low hazard	Low hazard	Low hazard

Waste:

Description of Material	Quantity per group	Hazard	Disposal Method
0.1 M Salt solution mixture	3 mL	Low	Curl the reaction sheet and allow the drops to drain into a beaker.
Sheet Protector	1	Low	Trash

Procedure:

1. Obtain an 8 1/2" x 11" plastic pouch and a laminated paper grid. The grid will look like the Data Collection Table for this experiment. The plastic sheet will serve as the reaction vessel for all of your reactions simultaneously. Slip the grid sheet into the pocket of the plastic sheet protector. Wipe the plastic sheet carefully with a dry towel to remove any residue from previous experiments. Tape the plastic sheet down flat on the bench.

2. A box containing small dropper bottles of solutions will be provided for each pair of students. All the starting materials are soluble, so a precipitate in the reactant bottle indicates that the bottle is contaminated with some other substance. **If any of the bottles contains a precipitate or cloudiness, show it to your instructor and the bottle will be replaced.**

3. Place a drop of each cation on the grid. Start with the potassium chloride solution and working your way across with one drop in each box. Continue to the next row of boxes and put a drop of ammonium chloride solution in each of the boxes in the next row. Continue until there is a drop of cation in each box.

4. Add a drop of anion solution **next to, not on top of,** the drop of cation, starting with bromide ion. **Be careful not to touch the drop on the sheet with the tip of the dropper!** Add anions down each column until the there is a drop of anion and a drop of cation in each box.

5. Use a toothpick to nudge the pairs of drops together and then stir with the same end of the toothpick. Use the fresh toothpick for each reaction.

6. Record your observations for each reaction in the table below. What is the color of the starting solutions? What is the color of the reacted solution? Is there a precipitate? What color is the precipitate?

Cleanup:
Remove the tape. Carefully curl the plastic sheet, and empty as much as possible of the solutions and solids into a large beaker. Pour the contents of the beaker into the labeled waste container.

Student Name:_____ Date: _____

Observations

Data Summary

Fill in the following table with the data gathered from the experiment. Look for the formation of solid precipitate, color change and gas bubbles.

Na^+ → ↓ Cl^-	Br^-	CO_3^{2-}	SO_4^{2-}	PO_4^{3-}
Al^{3+}				
NH_4^+				
Ca^{2+}				
Fe^{3+}				
K^+				
Mg^{2+}				
Sr^{2+}				

Lab Questions

1) Which cations seemed to be soluble when mixed with any of the anions and which seemed to be insoluble?

Soluble

Insoluble

2) Which anions seemed to be soluble when mixed with any of the cations and which seemed to be insoluble?

Soluble

Insoluble

3) Green Question(s)

List three ways that running these reactions on microscale makes this lab greener.

References

Siena College Chemistry Department Lab book. Solubility Rules. Written in fall 2004.