

Experiment: Aqueous Chemical Reactions

Objectives:

- To write out the chemical formulas and molecular masses for a number of ionic compounds
- Observe a large number of chemical reactions by mixing solutions of ionic compounds
- To predict the precipitate product in these reactions using Solubility Rules
- For each chemical reaction observed, determine:
 1. the unbalanced chemical equation
 2. the balanced chemical equation

Before we get started, let's observe some important ions (worth remembering):

Ammonium **NH₄⁺** (cation)

Sulfate **SO₄²⁻** (anion)

Sulfite **SO₃²⁻** (anion)

Hydroxide **OH⁻** (anion)

Nitrite **NO₂⁻** (anion)

Nitrate **NO₃⁻** (anion)

Carbonate **CO₃²⁻** (anion)

Phosphate **PO₄³⁻** (anion)

Hypochlorite **OCl⁻** (anion) {this ion is an active ingredient in household bleach}

**** NOTE:** When these polyatomic ions combine with ionic elements to form ionic compounds, the total charge of the compound is zero. You can treat them just like ionic compounds

Examples:

1) Na₂SO₄ is called sodium sulfate and contains two Na⁺ ions and one SO₄²⁻ ion

2) KNO₃ is called potassium nitrate and contains one K⁺ ions and one NO₃⁻ ion

3) (NH₄)₂SO₄ is called ammonium sulfate and contains two NH₄⁺ ions and one SO₄²⁻ ion

Part 1. Naming Ionic Compounds in Solution

Obtain a tray of 14 microburets from the instructor. Each microburet is labeled and contains a different solution. Let's see how many chemical names you know. Complete the table below, matching the formula on the label on the microburet to the name in the table. Use the Periodic Table as a guide

Name	Chemical Formula of Solute	Concentration	Molecular Mass	Mass (in grams) in 10.0 mL
Sulfuric acid		1.0 M		
Sodium hydroxide		1.0 M		
Sodium phosphate		0.20 M		
Sodium carbonate		0.20 M		
Silver nitrate		0.10 M		
Potassium iodide		0.20 M		
Nitric acid		1.0 M		
Lead (II) nitrate		0.20 M		
Hydrochloric acid		1.0 M		
Iron (III) chloride		0.10 M		
Copper (II) sulfate		0.20 M		
Barium chloride		0.10 M		
Ammonium hydroxide		1.0 M		
Aluminum chloride		0.30 M		

Part 2. Identifying Solids Formed in Reactions in Aqueous Solutions**Procedure:**

1. Place the plastic covered grid (with inserted grid matrix) in front of you. This grid will serve as your reaction surface during the activities in this worksheet.
2. Obtain the microburet containing 0.20 M copper(II) sulfate and carefully place a drop of solution in each grid location along the row labeled **CuSO₄**.
3. Place a drop of 1.0 M **NH₄OH** into the first grid square on the left containing **CuSO₄**. Notice that the column label at the top of the grid sheet for this location is labeled **NH₄OH**.
4. Using the plastic stirrer provided, gently mix the two solutions.
 - a. Describe what occurred when the two solutions were mixed together.
 - b. Write down the chemical equation for the chemical reactants and predict the products.
 - c. Using the solubility rules, predict which of the products might be expected to precipitate in water.
 - d. Write down the complete chemical equation for the reaction (reactants and products).
 - e. Balance the chemical reaction above.

5. Now let's try another reaction. Repeat steps 3 & 4 by placing a drop of **BaCl₂** into the second square on the left containing **CuSO₄**. Again notice the column label at the top of the grid sheet for this location (it should be labeled **BaCl₂**). Gently mix the two solutions using the plastic stirrer.
- Describe what occurred when the two solutions were mixed together.
 - Write down the chemical equation for the chemical reactants and predict the products.
 - Using the solubility rules, predict which of the products might be expected to precipitate in water.
 - Write down the complete chemical equation for the reaction (reactants and products).
 - Balance the chemical reaction above.
6. Select two different reactants and observe a new reaction. **Reactants:**
- Describe what occurred when the two solutions were mixed together.
 - Write down the chemical equation for the chemical reactants and predict the products.
 - Using the solubility rules, predict which of the products might be expected to precipitate in water.
 - Write down the complete chemical equation for the reaction (reactants and products).
 - Balance the chemical reaction above.

7. Select two different reactants and observe a new reaction. **Reactants:**
- Describe what occurred when the two solutions were mixed together.
 - Write down the chemical equation for the chemical reactants and predict the products.
 - Using the solubility rules, predict which of the products might be expected to precipitate in water.
 - Write down the complete chemical equation for the reaction (reactants and products).
 - Balance the chemical reaction above.
8. Select two different reactants and observe a new reaction. **Reactants:**
- Describe what occurred when the two solutions were mixed together.
 - Write down the chemical equation for the chemical reactants and predict the products.
 - Using the solubility rules, predict which of the products might be expected to precipitate in water.
 - Write down the complete chemical equation for the reaction (reactants and products).
 - Balance the chemical reaction above.

Solubility of Ionic Compounds in Water			
Negative Ions (anions)	+	Positive Ions (cations)	form Compounds which are:
All		Group 1 ions (Li^+ , Na^+ , K^+ , Rb^+ , etc.)	Soluble
All		Ammonium ion, NH_4^+	Soluble
Nitrate, NO_3^-		All	Soluble
Acetate, $\text{C}_2\text{H}_3\text{O}_2^-$		All	Soluble
Chloride, Cl^- Bromide, Br^- Iodide, I^-		Ag^+ , Pb^{2+} , Hg_2^{2+} , Cu^+ All Others	Not Soluble Soluble
Sulfate, SO_4^{2-}		Ca^{2+} , Ba^{2+} , Sr^{2+} , Pb^{2+} All Others	Not Soluble Soluble
Sulfide, S^{2-}		Group 1 ions, NH_4^+ , Group 2 ions (Be^{2+} , Mg^{2+} , etc.) All Others	Soluble Soluble Insoluble
Hydroxide, OH^-		Group 1 ions, NH_4^+ , Ba^{2+} , Sr^{2+} All others	Soluble Not Soluble
Phosphate, PO_4^{3-} Carbonate, CO_3^{2-} Sulfite, SO_3^{2-}		Group 1 ions, NH_4^+ All others	Soluble Not Soluble
<u>Note:</u> Soluble means more than 0.1 mole will dissolve per liter			