Activity 8 – Chemical Names and Formulas[1]

Goals

- Write chemical names and formulas of common chemical compounds.
- Describe the colors and textures of common ionic compounds.
- Synthesize chemical compounds and write their names and formulas.

Pre-Lab Lecture Questions. *Answer these questions on a separate sheet using complete sentences.*

1. What is an ion? What is an ionic compound? How can we recognize ionic compounds? What is a salt?
2. Compare cations, anions and polyatomic ions. What do they all have in common? How are they different?
3. How can the periodic table help to remember the charges on the simple ions of the representative (main group) elements?
4. What is the chemical name of baking soda? Is there more than one name that can be used?
5. Why do some cation names include Roman numerals in parentheses?
6. Why do some chemical formulas include parentheses and others do not?
7. What is the precipitate formed when iron (III) chloride reacts with silver nitrate?

Concepts to Review

Names of Elements
Periodic Table
Atomic Structure
Transition Elements, Representative Elements

Introduction

Chemistry is the central science, a study of all that has mass and volume. An effort of this magnitude requires a clear language that communicates in a broad but consistent way. At first appearance, chemistry may appear difficult because there are common words that take on new meaning. For example, "salt" is a term widely used to describe table salt (also known as sodium chloride). In chemistry, a **salt** is simply **any compound composed of ions other than hydrogen ion, oxide ion, or hydroxide ion**. Sodium chloride is an example of a salt, as is potassium chloride, calcium carbonate and stannous fluoride. In chemistry, there is an effort to move away from using common names to identify the majority of compounds because this would require memorization of every single name. Considering the vast number of ionic compounds (over a million), a systematic method of nomenclature has been developed to designate these.

As a student of chemistry you will learn how to translate a chemical formula into the systematic name and vice versa. The observations and experiments in today's lab only involve compounds containing charged species—cations, anions and polyatomic ions. The various combinations of oppositely charged ions are called **ionic compounds.** Their chemical formulas represent the proportion of positive ion to negative ion that results in electrical neutrality, i.e., no net charge. The correct chemical formula for sodium chloride is NaCl. The 1:1 ratio of sodium to chloride ions tells us that sodium ions and chloride ions must have the same charge magnitude. (Note that when there is only one of an ion per formula, we do not use the number one as subscript to indicate this; i.e., we don't write Na_1Cl_1.) After looking at the table on the following page, we see that sodium is a cation with a 1+ charge and chloride is an anion with a 1- charge. Knowing both the magnitude and the sign of the charge is necessary for writing the correct formulas and the correct chemical names. Sodium oxide has a formula of Na_2O. Without looking at the table of ions, what must the charge of oxide be? If you recognized that there are two sodium 1+ ions for each oxide ion and deduced that oxide must have a 2- charge you are well on your way to describing ionic compounds!

[1] Adapted from: Waterman, E. L. *Chemistry: Small-Scale Chemistry Laboratory Manual;* Addison-Wesley/Prentice-Hall, Inc.: Upper Saddle River, New Jersey, 2002; pp 51-58.

It is common to see **precipitates** in the chemical reactions of ionic compounds in solution, i.e. insoluble solids coming out of solution. *A general rule is that precipitates usually do not contain sodium, potassium, acetate, nitrate or sulfate ions.*

Table 1. A Collection of Common Ions.

Name	**Formula**	**Name**	**Formula**	**Name**	**Formula**
Sodium	Na^+	Magnesium	Mg^{2+}		
Potassium	K^+	Calcium	Ca^{2+}		
Copper (I)	Cu^+	Copper (II)	Cu^{2+}		
Silver	Ag^+	Iron (II)	Fe^{2+}	Iron (III)	Fe^{3+}
Ammonium	NH_4^+	Lead (II)	Pb^{2+}	Lead (IV)	Pb^{4+}
		Tin (II)	Sn^{2+}	Tin (IV)	Sn^{4+}
Fluoride	F^-	Oxide	O^{2-}	Nitride	N^{3-}
Chloride	Cl^-	Sulfide	S^{2-}		
Bromide	Br^-	Sulfate	SO_4^{2-}		
Iodide	I^-				
Acetate	$C_2H_3O_2^-$				
Hydroxide	OH^-				
Nitrate	NO_3^-				
Nitrite	NO_2^-				
Hydrogen carbonate (**bicarbonate**)	HCO_3^-	Carbonate	CO_3^{2-}		
Dihydrogen phosphate	$H_2PO_4^-$	Hydrogen phosphate	HPO_4^{2-}	Phosphate	PO_4^{3-}

Safety

Wear safety glasses at all times!
Act in accordance with the laboratory safety rules of Cabrillo College.
Avoid contact with all chemical reagents and dispose of reactions using appropriate waste containers.

Contact with silver nitrate ($AgNO_3$) will stain the skin.

Materials

Reagent Central chemicals include a variety of pure ionic compounds and aqueous solutions of ionic compounds as identified on your experimental pages.

Equipment: Empty pipet for stirring Lab top reaction surface

Experimental Procedure

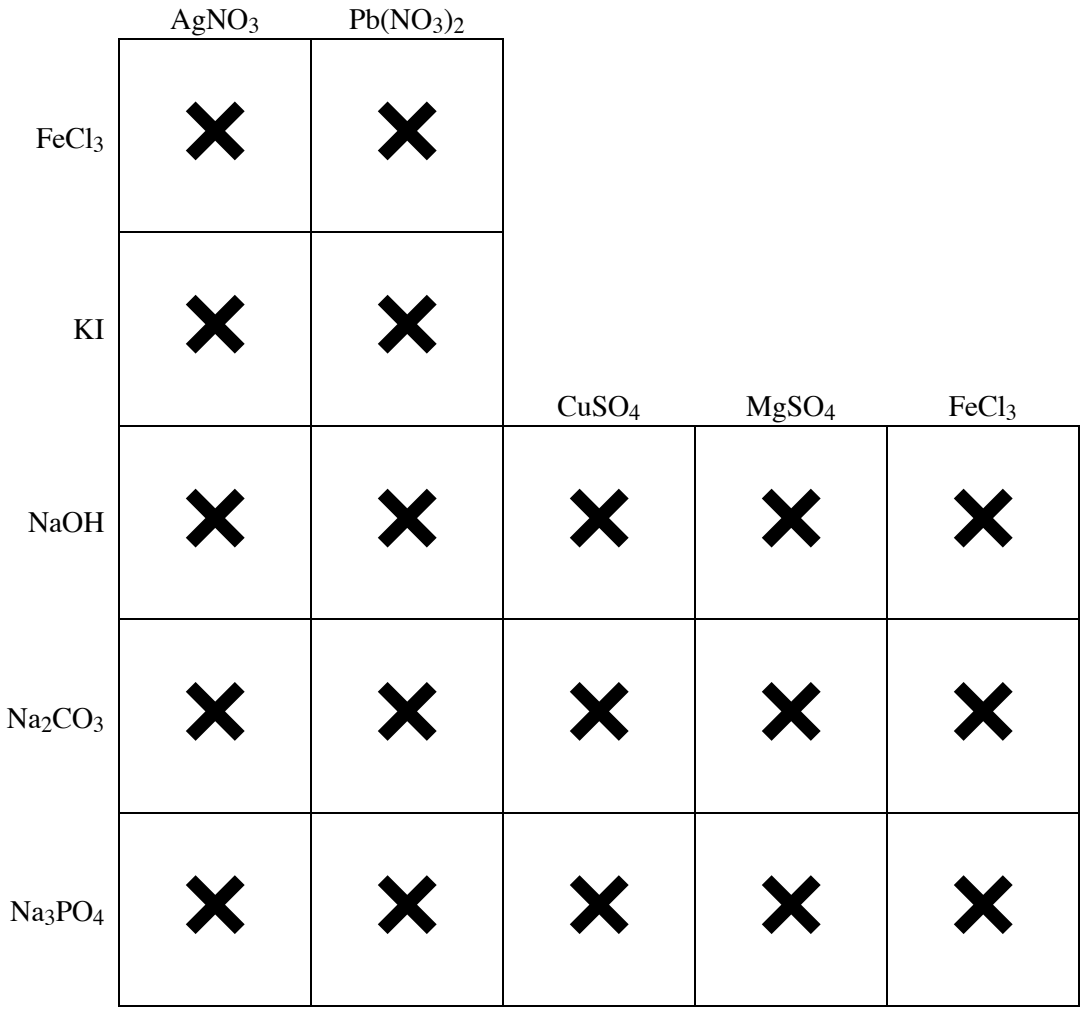
A. Compound Observations

1. View the samples of solid compounds available at Reagent Central. Write a description of the color and any other adjectives that might distinguish one compound from another. If the formula is given on the data sheet, provide the correct name. If the name is given, write the correct formula. Record observations and answers in your laboratory notebook and/or the data page provided.

B. Precipitation Reactions

1. Insert your experimental page inside of your reaction surface.
2. Place one drop of each solution in the indicated spaces below, taking care not to contaminate the microburets. Stir by blowing air from a dry pipet. Record any observable changes, describing what happened when the two solutions were mixed.
3. Any precipitates represent new compounds formed from swapping ion partners. Write the correct formulas for the two possible products. The precipitate will be the product that doesn't contain sodium, potassium, or nitrate ions. Write the name and formula of the precipitate on your worksheet.

Reaction Template: Insert this page into the labtop. Mix one drop of each solution, using a long stem pipet to blow air past the droplet to complete the mixing.



Activity 8 - Chemical Names and Formulas Worksheet

Name_____

Section_____ **Date**_____

Exercise A. Compound Observations

1. Write observations in boxes and provide missing formula or name.

Compound Name	Formula	Description of Solid	Compound Name	Formula	Description of Solid
Potassium iodide			Sodium carbonate		
Sodium chloride			Lead (II) nitrate		
Magnesium sulfate			Sodium acetate		
Copper (II) sulfate			Ammonium chloride		
$NaHCO_3$			$CaCl_2$		
$AgNO_3$			$FeCl_3$		
KF			NaH_2PO_4		

Exercise B. Precipitation Reactions

1. Write initial observations of the solutions as observed prior to mixing in the precipitation reactions. Review the material on page 49 regarding the description of liquids if you need assistance.

Solution	Formula	Description of Aqueous Solution
Silver nitrate	$AgNO_3$ (aq)	
Iron (III) chloride		
Sodium hydroxide		
Sodium carbonate		
Sodium phosphate		
Lead (II) nitrate		
Copper (II) sulfate		
Magnesium sulfate		
Potassium Iodide		

2. Write your observations on the products of these precipitation reactions. Review the material on page 49 regarding the description of precipitates if you need assistance.

Reaction	**Description of Precipitate**
$AgNO_3(aq) + FeCl_3(aq)$	
$AgNO_3(aq) + KI(aq)$	
$AgNO_3(aq) + NaOH(aq)$	
$AgNO_3(aq) + Na_2CO_3(aq)$	
$AgNO_3(aq) + Na_3PO_4(aq)$	
$Pb(NO_3)_2(aq) + FeCl_3(aq)$	
$Pb(NO_3)_2(aq) + KI(aq)$	
$Pb(NO_3)_2(aq) + NaOH(aq)$	
$Pb(NO_3)_2(aq) + Na_2CO_3(aq)$	
$Pb(NO_3)_2(aq) + Na_3PO_4(aq)$	
$CuSO_4(aq) + NaOH(aq)$	
$CuSO_4(aq) + Na_2CO_3(aq)$	
$CuSO_4(aq) + Na_3PO_4(aq)$	
$MgSO_4(aq) + NaOH(aq)$	
$MgSO_4(aq) + Na_2CO_3(aq)$	
$MgSO_4(aq) + Na_3PO_4(aq)$	
$FeCl_3(aq) + NaOH(aq)$	
$FeCl_3(aq) + Na_2CO_3(aq)$	
$FeCl_3(aq) + Na_3PO_4(aq)$	

Questions and Problems

What did you learn? Give complete and legible answers for the following:

1. Write the formulas (including charges) and names of all the **cations** represented in this experiment.

2. Write the formulas (including charges) and names of all the **anions** represented in this experiment.

3. Write a simple rule for naming ionic compounds.

4. Write a simple rule for writing chemical formulas of ionic compounds.

5. When are Roman numerals used in naming compounds?

6. What does a numerical subscript following an element in a chemical formula mean?

7. When is it correct to use parentheses in chemical formulas?

8. Do this on a separate sheet of paper. Complete each of the 19 reactions by writing the correct formulas of the two possible products formed. Use subscripts on cations and anions to appropriately balance the charges in each product. One product will be a solid (designated by (s)) and the other will remain in solution (designated as aqueous by (aq)). Determine the phases of each product and indicate them using the proper abbreviation in parenthesis. The precipitate (solid) will not contain sodium or nitrate ions. The reaction equation does not need to be balanced with coefficients. For example:

$$AgNO_3(aq) + FeCl_3(aq) \rightarrow Fe(NO_3)_3(aq) + AgCl(s)$$