Chemical Names and Formulas

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.

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 in chemistry. 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 has been developed.

As a student of chemistry you will learn how to translate a chemical formula into the systematic name and vice versa. The observations and experiment in today's lab only involve compounds containing charged species – cations, anions and polyatomic ions. These 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 (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 on 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 every one oxide and deduced that oxide must have a 2- charge you are well on your way to describing ionic compounds!

In the chemical reactions of ionic compounds in solution, it is common to see **precipitates**, insoluble solids coming out of solution. A general rule is that precipitates usually do not contain sodium, potassium, acetate, or nitrate ions. This could be important!!

Table I. 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-}	phosphate	PO_4^{3-}
bromide	Br^-	sulfate	SO_4^{2-}		
iodide	I^-	carbonate	CO_3^{2-}		
acetate	$C_2H_3O_2^-$	hydrogen phosphate	HPO_4^{2-}		
hydroxide	OH^-				
nitrate	NO_3^-				
nitrite	NO_2^-				
hydrogen carbonate (**bicarbonate**)	HCO_3^-				
dihydrogen phosphate	$H_2PO_4^-$				

Safety

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

*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

1. View the samples of solid compounds available at Reagent Central. Record the name and formula of each substance. Write a description of the color and any other adjectives that might distinguish one compound from another. Record observations and answers in your laboratory notebook.

2. a. Record initial observations on each of the aqueous solutions (Reactants).

3. a. Insert your experimental page inside of your reaction surface.

   b. 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 long stem pipet. Record any observable changes, describing what happened when the two solutions were mixed.

4. Answer all the questions.

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

	$AgNO_3$	$Pb(NO_3)_2$	$CuSO_4$	$MgSO_4$	$FeCl_3$
$FeCl_3$	X	X			
KI	X	X			
NaOH	X	X	X	X	X
Na_2CO_3	X	X	X	X	X
Na_3PO_4	X	X	X	X	X

Data Organization Suggestions

Part 1. Observation of common ionic compounds.

Construct a table with columns for "Compound Name," "Formula," and "Description." Leave space between each data entry row to make the information easier to read. Descriptions should be sufficient to help you identify the material within a series of unlabeled samples. Some examples follow:

Compound Name	Formula	Description
Silver Nitrate	$AgNO_3$	Brown semi-transparent flat crystals < $1mm^2$
Sodium Carbonate	Na_2CO_3	Small cylindrical rod like nodules. Not crystaline.
Calcium Chloride	$CaCl_2$	Opaque white spheres of varring sizes. Appears hygroscopic and bound in mass at bottom of tube.

Part 2. Initial observation of aqueous solutions.

Construct a table similar to that in part 1. Your descriptions should be appropriate for liquids and solutions. Review the information given on page 17 of this text regarding proper descriptive terms for liquids.

Part 3. Observation of precipitation reactions.

Construct a table with column headings for "Reaction," and "Description." Once again descriptions should be sufficient to help you identify the reaction result from a series of unknown samples. Review the information given on page 17 of this text regarding proper descriptive terms for precipitates. Some examples follow:

Reaction			Description
$KI_{(aq)}$	+	$Pb(NO_3)_{(aq)}$	Fast reaction yeilding a yellow opaque suspension. Upon stirring the particles clump slightly
$NaOH_{(aq)}$	+	$FeCl_{3(aq)}$	Fast reaction forming a cloudy red-brown percipitate. Upon stirring the precipitate finely divides and remains in suspension.
$Na_2CO_{3(aq)}$	+	$MgSO_{4(aq)}$	Slower reaction forming small amount of suspended white precipitate. Apperance unaffected by stirring.

Data Analysis

Answer the following questions in your laboratory notebook using complete sentences.

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

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

3. Write some simple rules for naming ionic compounds.

4. Write some simple rules 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. Any precipitates represent new compounds formed from swapping ion partners. Write the correct formulas for the two possible products. Indicate which of the two products is the precipitate by the addition of a subscripted "s" in parenthesis (ex. $PbCl_{2\,(s)}$). The precipitate will be the product that doesn't contain sodium, potassium, or nitrate ions.