

Experiment 7**Nomenclature**Skills/Concepts

- Nomenclature

Relevant Reading

Hein & Arena Chapter 6

Introduction

Since 1965, over ten million new substances have been discovered or synthesized. No one wants to memorize ten million names. So, chemists have agreed on a general system to name elements and compounds. This experiment introduces you to that system. Memorize only the few rules you need to use the system. Then, you can name any substance you'll see in class this semester or next. All compounds are composed of elements. So, before you can learn to name compounds, we must be able to write and name elements correctly. You need to know both the names and symbols.

There are two main classes of inorganic compounds: binary molecular compounds and ionic compounds. We'll start with the binary molecular compounds.

Binary Molecular Compounds

Binary molecular compounds consist of two elements, usually non-metals. A binary molecular compound always has a two-word name. The first word is the name of the first element of the compound. The second word is the name of the second element in the compound modified with the suffix *-ide*. Each word can be modified by prefixes that tell the number of each type of atom in one molecule. In general, the pattern is:

(number prefix+first element) (number prefix+second element+ide)

For example, N_2O_3 is dinitrogen trioxide. Note that CO is carbon monoxide. If there is only one of the first element in the compound, the prefix *mono-* is not included.

Prefixes Used in Naming Binary Molecular Compounds									
1	2	3	4	5	6	7	8	9	10
Mono-	Di-	Tri-	Tetra-	Penta-	Hexa-	Hepta-	Octa-	Nona-	Deca-

Ionic Compounds

Naming ionic compounds is easy. Name the cation, then name the anion. You will need to know the name and charges of all common monoatomic ions. Common monoatomic anions are listed in Table 6.2 in Hein and Arena.

All elements in the 1A(1) column in the periodic table always form +1 cations. All the elements in the 2A(2) column always form +2 cations. Aluminum in the 3A(3) column always forms +3

cations. The other elements in this column may form +3 cations, but may also form +1 cations. The simplified periodic table below shows the charges of common ions. A similar table is in Figure 6.2 of Hein & Arena.

1A		2A								3A		4A	5A	6A	7A		
+1	+2		+3		+2		+2			+1	+2	+1		+3	-2		
			+4		+3		+3			+2	+2			+3			
										+1	+2	+1		+5			
											+2	+3	+2				
										+1	+1						
										+2	+2						
										+2	+2						
										+2	+2						
										+2	+2						

To name a cation formed from a 1A(1) or a 2A(2) metal, just use the name of the element, followed by the word "ion." To name the monoatomic anion formed by a 6A(16) or 7A(17) non-metal, just use the name of the element, modified by an -ide suffix.

K^+ is a potassium ion and O^{2-} is an oxide ion. If potassium and oxide ions combine to form an ionic compound, how would we name it and what is the formula of the compound? The name would be potassium oxide. Note that we drop the word "ion" from each of the elements' names because the final stable compound is electrically neutral.

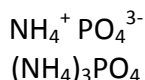
To write the correct formula for an ionic compound, we must balance the charges. The positive charge must equal the negative charge. We need to find the least common multiple of the charges. We can do this by cross-multiplying the charges. For example,



We need two potassium ions to balance one oxide ion. The formula becomes K_2O . The subscripts tell us how many of each ion are in the compound. Note that we do not write the subscript if it is 1. Also note that the charges are not shown in the final compound.

Polyatomic Ions

When either the cation or anion is polyatomic, you may need to use parentheses when writing the formula for these compounds. Write the formula for ammonium phosphate, given that the ammonium ion is NH_4^+ and the phosphate ion is PO_4^{3-} .



Parentheses work like those in math: they instruct us to take everything within them as a unit. Table 6.6 in Hein & Arena lists some common polyatomic ions.

Transition Metals

Many transition metals form more than one cation. We need a naming system to define cations of elements that can have more than one charge. This system adds the oxidation number to the name of the element. The oxidation number, written in Roman numerals and enclosed in parentheses, is placed directly to the right of the element's name. For example, Fe^{2+} is the iron(II) ion and Hg^{1+} is the mercury(I) ion. Table 6.4 in Hein & Arena lists common metal ions with more than one charge.

Oxyanions

Polyatomic anions have names that are usually derived from the names of oxyacids (acids that contain oxygen). You will eventually learn the names and formulas of all the anions in Table 6.9 of Hein & Arena.

If two oxyacids have the same non-metal element, but differing number of oxygen atoms, follow the pattern below:

Number of oxygens	Suffix on non-metal	Example
More	-ic	H_2SO_4 sulfuric acid
Fewer	-ous	H_2SO_3 sulfurous acid

The oxyanions also have names to differentiate themselves when they have the same non-metal element but differing numbers of oxygen atoms:

Number of oxygens	Suffix on anion	Example
More	-ate	SO_4^{2-} sulfate ion
Fewer	-ite	SO_3^{2-} sulfite ion

Halogens (elements in column (7A)(17)) form four different oxyacids. So, for these oxyacids, we need to expand our system for differentiating oxyanions and oxyacids.

Number of oxygens	Prefix on non-metal	Suffix on non-metal	Example
Even more	Per-	-ic	HClO_4 perchloric acid
More		-ic	HClO_3 chloric acid
Fewer		-ous	HClO_2 chlorous acid
Even fewer	Hypo-	-ous	HClO hypochlorous acid

Hydro acids

All hydro acids are made by dissolving a gas in water. All hydro acids do not have oxygen atoms. The gases form hydro acids are binary molecular compounds. For example, HCl(g) is hydrogen chloride and forms HCl(aq) , called hydrochloric acid, when dissolved in water.

You should know the six acids listed below. From these six, you can add some prefixes or suffixes to get all the names and formulas you need.

Acetic acid CH_3COOH	Phosphoric acid H_3PO_4	Nitric acid HNO_3
Chloric acid HClO_3	Carbonic acid H_2CO_3	Sulfuric acid H_2SO_4

Summary

For binary molecular compounds, name the first element, then name the second element with the *-ide* suffix. Use prefixes to denote the number of each atom in the compound. These compounds all have two words.

For ionic compounds, name the cation, then name the anion. Elements with only one charge are named by their element name followed by the word ion. Monatomic anions are named by the element with the *-ide* suffix.

If the cation is an element with more than one possible oxidation state, name it as the element followed by the charge in roman numerals in parentheses. If the anion is an oxyanion, use the suffix *-ous* to denote one fewer oxygen atom than the six central acids listed above. The prefix *per-* means one more oxygen than *-ic*. The prefix *hypo-* means one fewer oxygen than *-ous*.

Name: _____

Pre-Lab

Fill in the blanks in the chart below:

Element Symbol	Element Name
Na	
	Iron
	Calcium
Cl ₂	
	Nitrogen
Cu	
Mg	
Ni	
	Bromine
	Potassium

Name: _____

Lab Partner: _____

Procedure:

Where names are given, write the formulas. Where formulas are given, write the names.
Submit these sheets as your post-lab work.

<i>Binary Molecular Compounds</i>		<i>Acids</i>	
Name	Formula	Name	Formula
Carbon dioxide		Hydrobromic acid	
	CBr_4		HClO
	CO		HI
Dinitrogen tetroxide		Sulfuric acid	
	P_2O_3		HNO_3
Iodine chloride		Bromic acid	
Sulfur trioxide		Phosphoric acid	
Diphosphorus pentoxide		Nitrous acid	
	SiS_2		HIO_4
	S_2F_6		H_2SO_3

Name: _____

Lab Partner: _____

<i>Ionic Compounds</i>		<i>Ionic Compounds</i>	
Name	Formula	Name	Formula
Sodium nitrate		Aluminum sulfite	
	K ₂ SO ₄	Calcium chlorate	
	Na ₃ PO ₄	Sodium hypochlorite	
Calcium fluoride			K ₂ O
Potassium hydrogen sulfate			FeO
	Pb(NO ₃) ₂		NaHCO ₃
Sodium carbonate			Co(OH) ₂
Potassium bromide		Mercury(I) chloride	
	FeCl ₃	lithium hydrogen sulfite	
	KIO ₃	potassium periodate	
	Ca(OH) ₂		AgBrO ₃
Iron(III) sulfide			K ₃ PO ₄

Name: _____

Lab Partner: _____

The set of compounds with less common ions is a challenge problem. You can complete these! Refer to Table 6.6 in Hein & Arena and use your periodic table.

<i>Monatomic and Polyatomic Ions</i>		<i>Compounds with Less Common Ions</i>	
Name	Formula	Name	Formula
Calcium ion		strontium sulfate	
	Fe^{2+}	cesium iodide	
	Br^-	tellurium trioxide	
Sulfate ion		indium chloride	
Hydrogen phosphate ion		calcium hydride	
	ClO^-	sodium cyanide	
	CO_3^{2-}	Iron(II) thiocyanate	
	Cr^{3+}	Nickel chromate	
Iron(III) ion			
Iodite ion			
	SO_3^{2-}		
	HCO_3^-		