Chem 309 Name _____

Chapter 2 Supplemental Homework
Nomenclature and Formula Writing

Objective

The purpose of this assignment is to gain practice in using chemical nomenclature for naming compounds and writing chemical formulas.

Discussion

Chemical nomenclature is the system of names used to distinguish compounds from each other and the rules needed to devise these names. In the early history of chemistry there was no system for naming compounds. Early names included quicksilver, blue vitriol, Glauber's salt, gypsum, sal ammoniac and laughing gas. As chemistry grew, it became clear that the "anything goes" system was not acceptable. Without a system for naming compounds, coping with the multitude of known substances would be a hopeless task.

A systematic set of rules for naming compounds is available for use by scientists. These rules, known as IUPAC rules, have been formulated by the nomenclature committees of the International Union of Pure and Applied Chemistry (IUPAC). The committees of the international scientific organization meet periodically to revise and update the nomenclature rules to accommodate any newly discovered types of compounds. The flow chart on the next page provides a summary of the nomenclature rules for inorganic compounds.

A chemical formula gives a great deal of information about a particular compound. By reading a chemical formula, one can tell what elements are present in the substance and the number of atoms of each element in a formula unit of a particular compound. A formula unit is the smallest uncharged particle formed by the bonding of two or more ions or atoms.

There are a few simple rules to follow when writing formulas:

1. The formula contains the symbols of all elements in a compound.
2. Each symbol represents one atom of an element.
3. Subscripts are used to indicate more than one atom of an element in a molecule or formula unit.
4. Parentheses enclose polyatomic ions occurring more than once in a formula unit and subscripts following parentheses indicate the quantity of the group in the formula unit. Parentheses do NOT enclose polyatomic ions unless they occur at least twice in the unit.
5. Formulas do NOT show how atoms are arranged in a molecule.
6. In a neutral compound, the sum of the positive and negative charges equals zero. The charges of the ions are NOT included in the formula.

Every compound has its own CHEMICAL FORMULA and its own NAME. The nomenclature (naming systems) for IONIC and COVALENT compounds are different.

IONIC COMPOUNDS

These consist of any positive ion (except H^+) combined with any negative ion. If H^+ is the positive ion, the compound is an ACID (once again, hydrogen plays by its own rules.)

- The positive ion (cation) may be a metal (such as Na^+) or a polyatomic ion (such as NH_4^+).
- The negative ion (anion) may be a non-metal ion (such as Cl^-) or a polyatomic ion (such as SO_4^{2-} or NO_3^-).

All names follow the same general format: cation is cited first & anion is cited second.

Case 1 – Ionic Compounds: Fixed Charge Metal + Non-metal

Name format:	Metal Name + Anion Name

- Metal is always named first (name unchanged)
- Anion named second

Examples:		
	KBr	potassium bromide
	$AlCl_3$	aluminum chloride
	Li_3N	lithium nitride

Note: The name does NOT indicate how many of each atom. Everyone has memorized their ions, so they know how many are needed to create a compound with zero net charge.

1. Write formulas for the following cations:

barium ion _____ aluminum ion _____ potassium ion _____

2. Write formulas for the following anions:

bromide _____ nitride _____ iodide _____ oxide _____ sulfide _____

3. Name the following compounds:

SrI_2 _____ Ca_3N_2 _____

K_2O _____ Al_2O_3 _____

Ba_3N_2 _____ Na_3P _____

4. Give formulas for the following compounds – refer to the periodic table only.

potassium phosphide _____ calcium iodide _____

strontium chloride _____ magnesium nitride _____

zinc bromide _____ lithium sulfide _____

Case 2 – Ionic Compounds: Transition Metal + Non-metal

Name format:	Metal Name + Roman Numeral + Anion Name

In general, it is NOT possible to use the periodic table to predict what ions are formed by transition metals. You need to know the charge of the anions to determine the charge of most transition metals.

For transition metals that form two ions, the naming system is as follows:

Modern System:

- Metal is always first (name unchanged)
- A Roman numeral in parentheses indicating the charge on the metal ion
  There are 3 transition metals that do NOT require a Roman Numeral: Ag^{+}, Zn^{2+} & Cd^{2+}.
- Non-metal with the ending changed to –IDE

Examples		
	FeF_2	iron(II) flouride
	SnO_2	tin(IV) oxide
	Cu_3P	copper(I) phosphide

Old System:

- -ous ending refers to the ion with lower charge
- -ic ending refers to the ion with higher charge

Examples

Fe^{2+}	ferrous	Fe^{3+}	ferric	Cr^{2+}	chromous	Cr^{3+}	chromic
Cu^{+}	cuprous	Cu^{2+}	cupric	Sn^{2+}	stannous	Sn^{4+}	stannic
Pb^{2+}	plumbous	Pb^{4+}	plumbic				

FeF_2	ferrous flouride
SnO_2	stannic oxide
Cu_3P	cuprous phosphide

5. Name the following compounds using Modern and Old Names if applicable.

	Modern Name (use Roman Numerals)	Old Name (use '-ic' or "-ous")
$SnCl_2$	_____	_____
$FeBr_3$	_____	_____
Cu_3N	_____	_____

6. Give formulas for the following compounds.

chromium(III) oxide	_____	stannous fluoride	_____
ferrous iodide	_____	zinc nitride	_____
cupric bromide	_____	cobalt(II) oxide	_____

Case 3 – Ionic Compounds: Polyatomic Ions as the Cation or Anion

Name format: Cation Name + Anion Name

Now we will introduce the polytatomic cations and anions. Notice that the format for each name remains the same. We still list the cation name first and the anion name second. If the cation is a varioable charge metal, then we must continue indicating the charge with a Roman numeral.

Examples

$(NH_4)_2SO_4$	ammonium sulfate
FeO	iron(II) oxide
Fe_2O_3	iron(III) oxide
$AgNO_3$	silver nitrate

7. Give the names for the following ionic compounds.

NH_4Cl _____

$NaHCO_3$ _____

$Ca(OH)_2$ _____

$AlPO_4$ _____

$AgNO_3$ _____

$Sn(CO_3)_2$ _____

8. Give the chemical formula for the following ionic compounds.

Copper(II) cyanide _____

Chromium(III) carbonate _____

Tin(IV) bisulfate _____

Ammonium hydroxide _____

Zinc bromide _____

COVALENT COMPOUNDS – two or more non-metals

When non-metal atoms **share** electrons with other non-metal atoms, they form **covalent (molecular) compounds.** We shall learn the nomenclature for binary covalent compounds. A binary covalent compound is a compound formed by only two elements.

Case 4 – Binary Covalent Compounds

Name format: Greek prefix + 1st Non-metal + Greek Prefix + 2nd Non-metal prefix + "ide"

- The less electronegative atom is first and assumes the position of the 'cation.'
- The more electronegative atom is last and gets an –IDE ending.
- The number of each atom is specified with a Greek prefix.

The Greek prefixes you need to know are:

1 is mono-	2 is di-	3 is tri-	4 is tetra-	5 is penta-
6 is hexa-	7 is hepta-	8 is octa-	9 is nona-	10 is deca-

Note: 1. When there is only one atom of the first element, the mono prefix is omitted.
2. When oxygen requires a prefix, the last vowel of the prefix is omitted if it is an 'a'

Examples		
	NF_3	nitrogen trifluoride
	I_2S	diiodine monosulfide
	P_4O_{10}	tetraphosphorus decoxide

You must memorize these very important common names.

H_2O (water) NH_3 (ammonia) CH_4 (methane) H_2O_2 (hydrogen peroxide)

9. Name the following compounds.

N_2O_4 _____ PCl_5 _____

SO_2 _____ SO_3 _____

CS_2 _____ Br_2O_7 _____

CO _____ P_2O_5 _____

10. Give formulas for the following compounds.

iodine pentabromide _____ chlorine dibromide _____

oxygen difluoride _____ carbon tetrachloride _____

sulfur hexafluoride _____ iodine heptafluoride _____

Case 5 – Diatomic Molecules

Several common non-metal elements exist as diatomic molecules. The element name refers to the diatomic molecule. For example, hydrogen refers to H_2 and oxygen refers to O_2. If we mean the atom, we say atomic hydrogen or atomic oxygen.

11. List the 7 elements that exist as diatomic molecules: _____

12. Write the chemical formula for the underlined names of the gases.

Dry air contains about 79% nitrogen and 21% oxygen, with small amounts of carbon dioxide, neon, and argon. Polluted air may contain small amounts of sulfur dioxide, sulfur trioxide, nitrogen dioxide, dinitrogen monoxide, chlorine, ammonia, methane and carbon monoxide.

13. Write the chemical name for the chemical formulas in the following paragraph.

Probably the most important element found uncombined in nature is O_2. O_2 is quite reactive, forming compounds with the halogens F_2, Cl_2, Br_2, and I_2. O_2 forms two compounds with H_2. Following the usual rules of nomenclature, the most common oxide of hydrogen (H_2O) would be name dihydrogen monoxide. O_2 forms a series of compounds with N_2, many of which are atmospheric pollutants, including NO, N_2O, NO_2, N_2O_4, and N_2O_5.

Now Put it All Together

14. Write the chemical name for each formula.

$BaCl_2$ _____

F_2 _____

N_2 _____

$LiNO_3$ _____

N_2O_5 _____

OF_2 _____

$NiCl_4$ _____

P_4S_3 _____

Fe_2O_3 _____

AuF_3 _____

$PbBr_2$ _____

$Cr(CN)_3$ _____

Cu_2O _____

$Sn(SO_4)_2$ _____

$CuSO_4$ _____

SO_2 _____

$Cr(CH_3CO_2)_3$_____

$Sr_3(PO_4)_2$ _____

$ZnCO_3$ _____

Cl_2 _____

$KClO_3$ _____

CO_2 _____

15. Write the formula for the following compounds.

iron(II) nitrate _____

lithium sulfide _____

zinc phosphide _____

silver bicarbonate _____

sulfur hexafluoride _____

chromium(III) sulfate _____

ammonium acetate _____

copper(II) phosphate _____

chromium(III) hydroxide _____

tetranitrogen hexoxide _____

iodine _____

nitrogen trichloride _____

magnesium carbonate _____

oxygen _____

gold(III) nitrite _____

ammonium nitrate _____

tin(IV) sulfite _____

aluminum phosphate _____