

## Chemical Names and Formulas

(The Language of Chemistry)

Systematic chemical names of inorganic compounds were developed by a group of scientists who were part of the International Union of Pure and Applied Chemistry (IUPAC), which first met in 1921. Elements are represented by symbols which are the first, first two, or first and third letters from the name of the element. Some element symbols are derived from early names for these elements. The table below illustrates some of these.

<u>Present Name</u>	<u>Symbol</u>	<u>Former Name</u>
Antimony	Sb	Stibium
Copper	Cu	Cuprum
Gold	Au	Aurum
Iron	Fe	Ferrum
Lead	Pb	Plumbum
Potassium	K	Kalium
Silver	Ag	Argentum
Sodium	Na	Natrium
Tin	Sn	Stannum
Tungsten	W	Wolfram

The names of inorganic compounds are constructed so that every compound can be named from its formula and each formula has a name unique to that formula. For the purpose of clarity, we will divide the formulas into the following categories:

- 1) Binary compounds of two nonmetals, such as  $\text{CCl}_4$  (covalent molecules).
- 2) Binary compounds of a metal and nonmetal, such as  $\text{Al}_2\text{O}_3$  (ionic compounds).
- 3) Ternary and higher compounds, such as  $\text{Al}_2(\text{SO}_4)_3$ .

### *I. Binary Compounds of nonmetals (Covalent Molecules):*

1. Name the first nonmetal. If there are two or more atoms of the element, use a Greek prefix.
2. Name the second nonmetal. Always use a Greek prefix. Change the ending to **-ide**.

<b>1 = mono-</b>	<b>2 = di-</b>	<b>3 = tri-</b>	<b>4 = tetra-</b>	<b>5 = penta-</b>
<b>6 = hexa-</b>	<b>7 = hepta-</b>	<b>8 = octa-</b>	<b>9 = nona-</b>	<b>10 = deca-</b>

<u>Examples:</u>	<u>Formula</u>	<u>Name</u>
	$\text{PCl}_3$	Phosphorous trichloride
	$\text{SO}_2$	Sulfur dioxide
	$\text{CO}$	Carbon monoxide

## II. Binary Compound of a Metal and a Nonmetal (ionic)

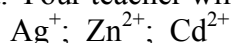
### A. Metal with only one charge

1. Name cation (metal) first.
2. Name the anion (nonmetal) second with the ending changed to **-ide**.

<u>Examples:</u>	<u>Formula</u>	<u>Name</u>
	KCl	Potassium chloride
	Na <sub>2</sub> S	Sodium sulfide
	Al <sub>2</sub> S <sub>3</sub>	Aluminum sulfide

**What metals have only one charge?** Group IA metals are always +1  
 Group IIA metals are always +2  
 Aluminum is always +3

There are a few metals that were considered to have only one charge in the past because they are almost always found with this charge. Some books now place them in the next category of variable charge while some books still consider them fixed. Your teacher will discuss with you how to treat these metals:



### B. Metals with variable charge.

1. Name the metal. In parentheses, write the charge of the metal with a Roman numeral. The charge is determined based on the fixed charge of the nonmetal. (For ionic compounds: VIA (-1), VIA (-2), VA (-3).)
2. Name the nonmetal with the ending **-ide**.

There is a second, older method for naming variable charge methods using the *-ous* or *-ic* suffix system. In the *ous/ic* system, the Latin stem for the metal is used with the proper suffix, the *-ous* representing the lower charge. The following examples use both methods.

<u>Examples:</u>	<u>Formula</u>	<u>Name</u>		
	CuCl	Copper (I) chloride	or	Cuprous chloride
	CuCl <sub>2</sub>	Copper (II) chloride	or	Cupric chloride
	FeO	Iron (II) oxide	or	Ferrous oxide
	Fe <sub>2</sub> O <sub>3</sub>	Iron (III) oxide	or	Ferric oxide

In naming binary compounds there are a few steps you must master first. Below is a checklist.

1. Is the compound ionic (metal and nonmetal) or molecular covalent (2 nonmetals)?
2. If the compound is ionic, is the metal a fixed or variable charge? In other words, do you need to use parentheses when writing the name of the metal?
3. If the compound is ionic, is the anion a monoatomic or polyatomic? If monatomic, the compound ends in "ide".

### C. Metals with polyatomic anions

When naming ionic compounds, you should go through several steps:

1. Identify that the compound is ionic (metal + nonmetal or polyatomic + polyatomic)
2. If ionic, identify if the metal is a fixed or variable charge cation:
  - a) **Fixed charge cations**, just name the cation. Alkali metals, alkaline earth metals, and  $\text{Al}^{+3}$  are always considered fixed charged. Usually  $\text{Ag}^+$ ,  $\text{Zn}^{+2}$ , and  $\text{Cd}^{+2}$  are considered fixed charged.
  - b) **Variable charge**, give name of the cation followed by (charge in Roman numerals). All other metals are considered variable charged.
3. Identify if the nonmetal is a monoatomic or polyatomic anion. Notice that the anion's suffix tells you if you are working with a mono- or polyatomic anion.
  - a) **Monoatomic anions**: determine charge from periodic table.  
Ending is **-IDE** (oxide, fluoride, etc)
  - b) **Polyatomic anions**: nonmetal + oxygen(s); ending is **-ATE** or **-ITE** (see below)

**Common polyatomics:** (These eight polyatomics will be given on quizzes and exams.)

$\text{CO}_3^{2-}$	carbonate	$\text{OH}^{1-}$	hydroxide
$\text{NO}_3^{1-}$	nitrate	$\text{ClO}_3^{1-}$	chlorate
$\text{PO}_4^{3-}$	phosphate	$\text{CH}_3\text{CO}_2^{1-}$	acetate
$\text{SO}_4^{2-}$	sulfate	$\text{NH}_4^{1+}$	ammonium

**Other polyatomics:** There are several other polyatomics whose formulas you are responsible for deriving from those polyatomics given above.

1. **Families:** Other nonmetals in the same family (same column) combine with oxygen atoms to form polyatomic ions. These polyatomics have the same number of oxygens and the same charge as the nonmetal in the polyatomics above.

For example, bromate is a polyatomic ion containing bromine and oxygen. Since bromine is in the same family as chlorine, its polyatomic ion will be similar to chlorate:  $\text{BrO}_3^{-1}$ .

2. **Changing the number of oxygen atoms:** In addition, other polyatomics exist with a different number of oxygens than the most common form given above. (These polyatomics are not given on exams, so you must learn how to derive them from the polyatomics above.)

<u>Oxygens</u>	<u>Anion</u>	<u>Example</u>	<u>Formula</u>
+1 Oxygen	per- -ate	perchlorate	$\text{ClO}_4^-$
Common	-ate	chlorate	$\text{ClO}_3^-$
-1 Oxygen	-ite	chlorite	$\text{ClO}_2^-$
-2 Oxygen	hypo- -ite	hypochlorite	$\text{ClO}^-$
No Oxygen	-ide	chloride	$\text{Cl}^-$

Notice that if you take away one oxygen from any of the above polyatomics, the ending changes from -ATE to -ITE and the charge does not change.

3. **Adding a hydrogen:** when one hydrogen ion ( $\text{H}^+$ ) is added to the polyatomics above that have a 2- or a 3- charge, the charge changes by one (3- becomes 2-) and the prefix hydrogen- is added.



**NOMENCLATURE OF BINARY COMPOUNDS****Name:****Part A: COVALENT COMPOUNDS (nonmetal + nonmetal)**1. SF<sub>6</sub> \_\_\_\_\_

2. IBr \_\_\_\_\_

3. \_\_\_\_\_ Carbon monoxide

4. \_\_\_\_\_ Dinitrogen pentoxide

**Part B: IONIC COMPOUNDS (metal + nonmetal)**

	FORMULA	CATION	ANION	NAME
Ex.	CaBr <sub>2</sub>	Ca <sup>2+</sup>	Br <sup>1-</sup>	Calcium Bromide
1				<b>Magnesium Nitride</b>
2		K <sup>+</sup>	S <sup>2-</sup>	
3	<b>ZnO</b>			
4		Sn <sup>4+</sup>	O <sup>2-</sup>	
5	<b>Cr<sub>2</sub>S<sub>3</sub></b>			
6				<b>Copper (I) phosphide</b>
7	<b>RbI</b>			
8				<b>Calcium nitride</b>
9				<b>Titanium (IV) chloride</b>
10	<b>SrS</b>			
11	<b>Au<sub>2</sub>O<sub>3</sub></b>			
12				<b>Cadmium(II) phosphide</b>

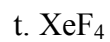
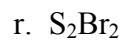
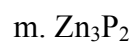
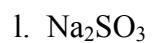
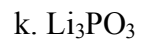
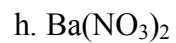
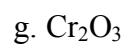
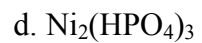
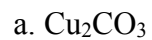
**C. IONIC COMPOUNDS (metal + polyatomic)**

	<b>FORMULA</b>	<b>CATION</b>	<b>ANION</b>	<b>NAME</b>
Ex.	$\text{Ca}(\text{BrO}_2)_2$	$\text{Ca}^{2+}$	$\text{BrO}_2^{1-}$	Calcium Bromite
1				<b>Lithium carbonate</b>
2		$\text{Mg}^{+2}$	$\text{ClO}_3^-$	
3				<b>Iron (III) phosphate</b>
4	$\text{Al}_2(\text{SO}_3)_3$			
5		$\text{Ti}^{2+}$	$\text{NO}_2^-$	
6	$\text{Sn}(\text{HPO}_4)_2$			
7		$\text{Cu}^{1+}$	$\text{SO}_3^{2-}$	
8	$\text{Ba}_3(\text{PO}_4)_2$			
9				<b>Manganese (III) periodate</b>
10	$\text{Ni}(\text{CH}_3\text{CO}_2)_2$			

**Chemical Formulas:**

Name \_\_\_\_\_

1. Name the following compounds:



**2. Write formulas for the following compounds:** (Hint: First determine charges of ions, for ionic compounds!)

- a. Iron (II) phosphate
- b. Silver(I) nitrite
- c. Magnesium hypoiodite
- d. Calcium carbonate
- e. Lithium fluoride
- f. Barium iodide
- g. Palladium (II) bromide
- h. Zinc(II) arsenide
- i. Sodium periodate
- j. Gold (III) oxide
- k. Calcium bromate
- l. Lead (IV) oxide
- m. Copper (I) sulfide
- n. Ammonium hydroxide
- o. Sulfur hexafluoride
- p. Potassium bicarbonate
- q. Nitrogen trichloride
- r. Sodium sulfite
- s. Chlorine dioxide
- t. Phosphorus pentachloride