

Chemical Formulas - Nomenclature (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. There are some notable exceptions, where the symbols appear to have no connection to the name of the element. These 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 nonmetals (covalent molecules)
- 2) Binary compounds of a metal and nonmetal (ionic compounds)
- 3) Ternary and higher compounds (polyatomic ions and acids)

I. Binary Covalent Compounds: two nonmetals

1. Name first element, preceded by Greek prefix for number of atoms. If one, omit mono.
2. Name the second element, preceded by Greek prefix for number of atoms even if one.

The ending of the second element is -ide.

Greek Prefixes: 1 = mono 2 = di 3 = tri 4 = tetra 5 = penta
6 = hexa 7 = hepta 8 = octa 9 = nona 10 = deca

<u>Examples:</u>	<u>Formula</u>	<u>Name</u>
	PCl ₃	Phosphorous trichloride
	SO ₂	Sulfur dioxide
	CO	Carbon monoxide
	N ₂ O	Dinitrogen monoxide

II. Ionic Compounds: metal + nonmetal

A. Metal with a fixed charge (Groups IA, IIA, IIIA)

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

<u>Ex:</u>	<u>Formula</u>	<u>Name</u>	<u>Fixed Charge Cations</u>
	KCl	Potassium chloride	IA = +1
	Na ₂ S	Sodium sulfide	IIA = +2
	Al ₂ S ₃	Aluminum sulfide	IIIA = +3

In ionic compounds, the metal and nonmetal must combine in a ratio to give an overall neutral charge. To write formulas based on name, first write the symbol with the correct charge for the cation and anion. Then determine the lowest ratio for a neutral compound.

B. Metals with variable charge (transition metals, lanthanides, actinides, etc.)

1. Name metal. In parentheses write the charge of the metal in Roman numerals.
The charge is determined based on the fixed charge of the nonmetal.
[Fixed charges of nonmetal: VIIA = -1; VIA = -2; VA = -3]
2. Name nonmetal with the ending -ide.

<u>Examples:</u>	<u>Formula</u>	<u>Name</u>	<u>Old Method – do not use!</u>
	CuCl	Copper(I) chloride	<i>Cuprous chloride</i>
	CuCl ₂	Copper(II) chloride	<i>Cupric chloride</i>
	FeO	Iron(II) oxide	<i>Ferrous oxide</i>
	Fe ₂ O ₃	Iron(III) oxide	<i>Ferric oxide</i>

III. Polyatomic Anions and Acids

When writing names of ionic compounds composed of polyatomic anions or of acids, you must first learn the name, number of oxygens, and charge of the most common polyatomics (listed below). Then add the following rules for naming polyatomics and acids with differing number of oxygens. Notice that as oxygens are added/subtracted, the polyatomic charge remains the same.

Common polyatomic ions include:

CO ₃ ⁻²	carbonate	ClO ₃ ⁻¹	chlorate	OH ⁻¹	hydroxide
NO ₃ ⁻¹	nitrate	BrO ₃ ⁻¹	bromate	NH ₄ ⁺¹	ammonium
PO ₄ ⁻³	phosphate	IO ₃ ⁻¹	iodate	HCO ₃ ⁻¹	bicarbonate
SO ₄ ⁻²	sulfate	MnO ₄ ⁻¹	permanganate	Cr ₂ O ₇ ⁻²	dichromate
C ₂ H ₃ O ₂ ⁻¹	- acetate				

<u># Oxygens</u>	<u>Anion</u>	<u>Example</u>	<u>Acid</u>	<u>Example</u>
+1 Oxygen	per-ate	perchlorate, ClO ₄ ⁻	per-ic	perchloric acid, HClO ₄
common	-ate	chlorate, ClO ₃ ⁻	-ic	chloric acid, HClO ₃
-1 Oxygen	-ite	chlorite, ClO ₂ ⁻	-ous	chlorous acid, HClO ₂
-2 Oxygen	hypo-ite	hypochlorite, ClO ⁻	hypo-ous	hypochlorous acid, HClO
No Oxygen	-ide	chloride, Cl ⁻	hydro-ic	hydrochloric acid, HCl

For more polyatomic / acid help, see the “Common Polyatomic Ions and the Corresponding Acids” handout in your lab manual under “Learning Resources”

Chemical Formulas - Nomenclature
Name:
1a. Ionic Compounds (metal + nonmetal)

	FORMULA	CATION	ANION	NAME
Ex.	CaBr ₂	Ca ²⁺	Br ¹⁻	Calcium bromide
1				Magnesium nitride
2		K ⁺	S ²⁻	
3	ZnO			
4		Sn ⁴⁺	O ²⁻	
5	Cr₂S₃			
6				Copper(I) phosphide
7	RbI			
8				Calcium nitride
9				Titanium(IV) chloride
10	SrS			
11	Au₂O₃			
12				Cadmium phosphide

1b. Covalent Compounds (nonmetal + nonmetal)

- SF₆ _____
- IBr _____
- _____ Carbon monoxide
- _____ Dinitrogen pentoxide

2. Name the following: (Hint: First identify if the compound is ionic or covalent)

a. NaF

b. PbS

c. TiO₂

d. Cr₂O₃

e. Zn₃P₂

f. MnO₂

g. PI₃

h. S₂Br₂

i. IBr₅

j. XeF₄

3. Write formulas for the following compounds: (See hint above!)

a. Barium iodide

b. Palladium(II) bromide

c. Zinc arsenide

d. Gold(III) oxide

e. Lead(IV) oxide

f. Copper(I) sulfide

g. Sulfur hexafluoride

h. Nitrogen trichloride

i. Chlorine dioxide

Chemical Formulas - Nomenclature
Polyatomic Anions and Acids

Name:

4. Write the names for the following compounds. If the compound is an **acid**, name as an acid and not an ionic compound to receive full credit.

- a. Na_2SO_4
- b. $\text{Ca}(\text{ClO})_2$
- c. $\text{Ba}(\text{NO}_3)_2$
- d. $\text{Al}(\text{OH})_3$
- e. $\text{Fe}(\text{NO}_2)_3$
- f. CuSO_3
- g. Cu_2CO_3
- h. NH_4ClO
- i. $\text{Ni}_3(\text{PO}_4)_2$
- j. $\text{Pb}(\text{OH})_2$
- l. HBrO_3
- m. HBrO_2
- n. HBrO
- o. HBr
- p. HBrO_4
- q. H_2SO_4
- r. HNO_3
- s. H_3PO_3

5. Write the chemical formulas for the following compounds.

- a. sodium phosphate
- b. iron(II) sulfate
- c. calcium bromate
- d. aluminum nitrate
- e. zinc(II) sulfite
- f. copper(I) chlorite
- g. ammonium hydroxide
- h. silver nitrite
- i. lead(II) phosphate
- j. potassium bicarbonate
- k. iodic acid
- l. hypoiodous acid
- m. periodic acid
- n. iodous acid
- o. hydroiodic acid
- p. sulfurous acid
- q. nitric acid
- r. nitrous acid
- s. phosphoric acid
- t. acetic acid
- u. carbonic acid