

Binary Ionic Compounds – Metals with Multiple Charges

Read from **Lesson 1: Ionic Compounds** in the **Chemistry Tutorial Section, Chapter 4** of **The Physics Classroom**:

Part b: [Combining Ions to form Ionic Compounds](#)

Part c: [Binary Ionic Compounds](#)

Some metals form one type of cation like Group 1 and 2 metals, silver, zinc, and aluminum. Other metals form cations with different charges. Chemists use Roman numerals to designate the specific type of charge on a cation.

If the metal can form ions with **different** charges, a **Roman numeral** in parentheses follows the name of the metal to specify its charge. CuCl is copper (I) chloride and CuCl₂ is copper (II) chloride. Other than using a Roman numeral in the name of the compound, naming compounds for binary ionic compounds with metals with multiple charges is the same process as naming compounds having metals with just one type of charge.

Complete the following table.

Metal/Cation	Nonmetal/Anion	Compound Name	Compound Formula
Iron (III) Fe ³⁺	Sulfide S ²⁻	Iron (III) sulfide	Fe ₂ S ₃
Tin (IV) Sn ⁴⁺	Sulfide S ²⁻	Tin (IV) sulfide	not Sn₂S₄ but SnS ₂
Tin (II) Sn ²⁺	Chloride Cl ⁻		
Lead (IV) Pb ⁴⁺	Phosphide P ³⁻		
Copper (I) Cu ⁺	Iodide I ⁻		
Chromium (III) Cr ³⁺	Oxide O ²⁻		
Manganese (VII) Mn ⁷⁺	Fluoride F ⁻		
Nickel (III) Ni ³⁺	Selenide Se ²⁻		
Vanadium (IV) V ⁴⁺	Oxide O ²⁻		
Cobalt (II) Co ²⁺	Nitride N ³⁻		

Names and Formulas

Determining the "Roman numeral" or charge for a metal in an ionic compound when naming the compound:

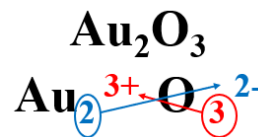
Example: What is the name of Au_2O_3 ?

The name of the compound is **NOT** gold oxide due to gold having more than one possible charge.

Method 1 of determining charge of each ion:

"Reverse" crisscross the subscripts to determine the charge of each ion. (Remember to make the metal a positive ion and the nonmetal a negative ion.)

The name of this compound is gold (III) oxide.



Method 2 of determining charge of each ion:

1. Determine the charge of the non-metal. The charge of oxide is 2-.

2. Set up an equation: charges added together must equal zero.

$$2\text{Au} + 3\text{O} = 0$$

3. Plug in the known charges and solve for the unknown charge.

$$2\text{Au} + 3\text{O} = 0$$

$$2\text{Au} + 3*(2-) = 0$$

$$2\text{Au} - 6 = 0$$

$$2\text{Au} = 6$$

$$\text{Au} = 3 \text{ (or } 3+) \rightarrow \text{Roman numeral (III)}$$

4. Name the metal with the Roman numeral, then the non-metal with an -ide ending. Au_2O_3 is **gold (III) oxide**

Practice: Name the following binary ionic compounds.

1. CrP

2. SnCl_4

3. CuS

4. Fe_3N_2

5. MnCl_7

6. CoN

7. Au_2S

8. Fe_2O_3

9. VBr₅

10. PbO_2 (this one is tricky)