



Name: _____ Per: _____

Naming and Writing Formulas of Ionic Compounds when a Metal Cation has multiple possible oxidation states.

Read This!

When the metal in an ionic compound always forms an ion with the same charge, you need not indicate that charge as part of the compound name. However, some atoms have the ability to form more than one type of ion. This can make naming confusing. You can't simply refer to a compound of copper and oxygen as "copper oxide." People won't know which compound you are referring to— Cu_2O or Cu_2O_2 .

Model 1 - Ionic Compound Names (Metals that form multiple ions)

Cu_2O	Copper(I) oxide	PbO	Lead(II) oxide
CuO	Copper(II) oxide	PbO_2	Lead(IV) oxide
SnF_2	Tin(II) fluoride	$FeCl_2$	Iron(II) chloride
SnF_4	Tin(IV) fluoride	$FeCl_3$	Iron(III) chloride

- Model 1 is labeled "Metals that form multiple ions." What other metals could be included in this model? (Look on the periodic table)
- Describe the most obvious difference between the names of the ionic compounds in Model 1 and the names of simple binary ionic compounds we have named so far.

- Keeping in mind that the sum of the charges in an ionic compound must equal zero, use the chemical formulas in Model 1 to answer the following questions:
 - Identify the charge on the copper cations in copper(I) oxide and copper(II) oxide, respectively.
 - Identify the charge on the iron cations in iron(II) chloride and iron(III) chloride, respectively.
 - What do the Roman numerals in the compounds described in questions a and b indicate?

Practice Questions

- In the table below, state the charge of the metal cation and name the compound using the proper Roman numeral to indicate the charge of the metal.

Compound	Charge on Cation	Name of the Compound
$PbCl_4$	Pb^{4+}	Lead(IV) chloride
Fe_2O_3		
SnO		
$CuBr_2$		

- Now, let's practice distinguishing when Roman numerals are necessary from when they are not.

For each of the compounds in the table below, determine the type of metal in the compound and then name the compound using the correct naming method.

Compound	Metal forms only one ion	Metal forms multiple ions	Name
$CuBr_2$			
MgO			
Ag_3N			
$SnCl_2$			
CuF_2			
K_2P			
Zn_3N_2			
HgO			

- Write the formula for the following compounds.
 - chromium (III) chloride
 - lead (IV) oxide

Naming and Writing Formulas of Ionic Compounds Containing Polyatomic Ions.

Polyatomic Ions

Can a group of atoms have a charge?

Why?

Do you know you eat a lot of "salt"? Next time you look at a food label, read the ingredients and you will likely find a number of ingredients that end with "ate," such as sodium phosphate or calcium carbonate. Did you ever wonder what the chemical formulas of these ingredients look like? In this activity we will explore polyatomic ions, which are groups of atoms that carry a charge. These ions are found in our food ingredients, natural sweeteners, and many other chemical compounds you encounter every day.

Model 2 - Types of Ions

Monatomic Ions	Nitride N^{-3}	Sulfide S^{-2}	Chloride Cl^{-1}
Polyatomic Ions	Nitrate 	Sulfate 	Ammonium
	Nitrite 	Sulfite 	Hydride

1. Use Model 2 to complete the table below.

Name of Ion	Nitride	Nitrate	Sulfate	Sulfite	Ammonium
Charge on Ion		-1			
Type and Number of Atoms			1 sulfur 4 oxygen		
Chemical Formula				SO_3^-	

2. Consider the terms "monatomic" and "polyatomic" as they are used in Model 2. Write a definition for each of these terms.

Monatomic ion-

Polyatomic ion-

3. What types of elements (metals or nonmetals) are shown in the polyatomic ions in Model 2?

4. What types of bonds (ionic or covalent) hold the atoms together in polyatomic ions? Explain your reasoning.

5. Find Table E on your Reference Tables and write the formula and charge of 3 polyatomic ions not present in Model 2.

Model 3 - Ionic Compounds containing polyatomic ions

Compound Name	Ion Symbol and Charge	Chemical Formula
Ammonium phosphate	NH_4^+	$(\text{NH}_4)_3\text{PO}_4$
Barium nitrate	Ba^{+2}	$\text{Ba}(\text{NO}_3)_2$
Ammonium sulfate	NH_4^+	$(\text{NH}_4)_2\text{SO}_4$
Aluminum carbonate	Al^{+3}	$\text{Al}_2(\text{CO}_3)_3$
Iron(III) hydroxide	Fe^{+3}	$\text{Fe}(\text{OH})_3$
Potassium nitrate	K^+	KNO_3

6. How are the names of polyatomic ions represented in the names of the ionic compounds in Model 3?

7. A student writes the chemical formula for the ionic compound calcium hydroxide as CaOH_2 .
 a. Write the chemical formula for each ion in the compound.
 Calcium hydroxide

b. Why is the student's chemical formula for the compound calcium hydroxide wrong?

8. Write the name or formula for each of the following ionic compounds containing a polyatomic ion.

- a. calcium sulfate
- b. K_2CO_3
- c. aluminum carbonate
- d. $\text{Fe}(\text{NO}_3)_3$

9. When asked to classify sodium acetate ($\text{NaC}_2\text{H}_3\text{O}_2$) as either an ionic or covalent compound, a student correctly responded with, "Sodium acetate is both ionic and covalent." Explain why the student was correct.