

**Binary Ionic Compounds**

An **ionic compound** is a compound that is formed between a **metal** and a **non-metal**. (Metalloids can also be used in ionic compounds, sometimes as cations and sometimes as anions, depending on the properties of the specific element.) In ionic compounds the **metal will always be a cation** and the **non-metal will always be an anion**. Please note, **the negative oxidation numbers we wrote on top of Groups IVA, VA, VIA & VIIA on our periodic tables refer only to the non-metals and the metalloids**. The metals in these columns have different oxidation numbers. (I will go more into this in a later class.)

When forming ionic compounds the goal is to balance the number of positive charges with the number of negative charges. More specifically, you want to ensure that the number of electrons that the cations are giving up is equal to the number of electrons the anions need so that both have full outer energy level.

Today we will be working with binary ionic compounds. Binary ionic compounds contain only two elements, one is the cation and the other is the anion. It is important to remember that when writing binary ionic compounds **THE CATION MUST ALWAYS BE WRITTEN FIRST**. The rest of the rules will be outlined in the following example.

**Part I. How to Write a Binary Ionic Compound Formula**

In this first example we will use **barium** and **sulfur**.

Description of Action	Action
1. Write the symbol of the <b>cation</b> with its charge.	1. Ba <sup>2+</sup>
2. To the right of the cation, write the <b>anion</b> and its charge.	2. Ba <sup>2+</sup> S <sup>2-</sup>
3. <b>Cross</b> each element's oxidation number to the <b>lower right side</b> of the other element's symbol.	3. Ba <sup>2+</sup> S <sup>2-</sup> <b>Result:</b> Ba <sub>2</sub> S <sub>2+</sub>
4. Remove all (+) signs, (-) signs and ones.	4. Ba <sub>2</sub> S <sub>2</sub>
5. Reduce, if necessary. You can only reduce when the subscripts of all the symbols have a common denominator.	5. Since Ba and S both have a 2 for a subscript, it can be reduced to 1. And, since ones are not written, the answer is: <b>BaS</b>

**Important:** When writing an element with its oxidation number, the oxidation number should be written as a superscript (higher than the symbol). Upon crossing oxidation numbers you must write the number as a subscript (lower than the symbol). In both cases the number is always written to the right of the element symbol to which it applies.

Try the next one on your own. Write in the descriptions of the actions and the actions. It will help you to remember how to write binary ionic formulas.

In this one use **aluminum** and **oxygen**.

Description of Action	Action
1.	1.
2.	2.
3.	3.
4.	4.
5.	5.

After doing a few examples, you will not need to go through all of the above steps. You will be able to do some of it in your head. All I am concerned with is your answer (the result you get in step 5). So you do not need to show me all of your steps. Of, course, if you are more comfortable going step by step, continue to do so. Try the six practice problems below.

**More Practice:**

1. potassium and fluorine
2. bromine and magnesium
3. strontium and phosphorus
4. cesium and sulfur
5. selenium and calcium
6. rubidium and nitrogen

**Part II. Naming Binary Ionic Compounds**

**IMPORTANT:** On your periodic table, cross out the suffixes for the non-metals and metalloids that form anions. For each of the halogens, cross out **-ine**; for selenium and tellurium, cross out **-ium**; for carbon, arsenic, and sulfur, cross out the last two letters of each name; and for oxygen, nitrogen and phosphorus, cross out the last four letters of each element's name. What remains will be referred to as the anion's root name. We will use this root name and the new suffix **-ide** when naming ionic compounds.

For our first example, we will name the compound we made earlier using barium and sulfur, **BaS**.

Description of Action	Action
1. Write the name of the cation.	1. barium
2. To the right of the cation name, write anion's root name.	2. barium sulf
3. Add the suffix <b>-ide</b> to the end of the anion.	3. barium sulfide

**Important:** Lower case lettering should be used when naming an ionic compound. Also note that our answer is two separate words. The first is the cation and the second is the root of the anion and the suffix **-ide**.

Try the next one on your own. Again, write in the descriptions of the actions and the actions. It will help you to remember how to name binary ionic compounds.

Name the second compound we made above using aluminum and oxygen, **Al<sub>2</sub>O<sub>3</sub>**.

Description of Action	Action
1.	1.
2.	2.
3.	3.

## Homework

**Part I:** Name each of the following below.

1.  $\text{CaCl}_2$
2.  $\text{Mg}_2\text{C}$
3.  $\text{RbAt}$
4.  $\text{RaI}_2$
5.  $\text{LiF}$
6.  $\text{K}_2\text{Se}$
7.  $\text{NaBr}$
8.  $\text{Be}_3\text{As}_2$
9.  $\text{H}_3\text{N}$
10.  $\text{In}_2\text{S}_3$
11.  $\text{Fr}_3\text{P}$
12.  $\text{SrTe}$
13.  $\text{AlF}_3$
14.  $\text{HI}$
15.  $\text{CsI}$

**Part II:** Write the formula of each binary ionic compound named below.

16. strontium fluoride
17. sodium phosphide
18. beryllium iodide
19. calcium bromide
20. aluminum astatide
21. lithium telluride
22. magnesium arsenide
23. potassium nitride
24. rubidium carbide
25. hydrogen chloride
26. cesium sulfide
27. calcium selenide
28. gallium oxide
29. strontium selenide
30. francium nitride
31. When writing the formula or name of a binary ionic compound, which is written first? CATION or ANION

**•SYMBOLS OF COMMON POLYATOMIC IONS•**

$(\text{AsO}_3)^{3-}$	arsenite	$(\text{C}_2\text{O}_4)^{2-}$	oxalate	$(\text{N}_3)^{1-}$	azide
$(\text{AsO}_4)^{3-}$	arsenate	$(\text{CrO}_4)^{2-}$	chromate	$(\text{NH}_2)^{1-}$	amide
$(\text{BO}_3)^{3-}$	borate	$(\text{Cr}_2\text{O}_7)^{2-}$	dichromate	$(\text{NH}_4)^{1+}$	<b>AMMONIUM</b>
$(\text{B}_4\text{O}_7)^{2-}$	tetraborate	$(\text{HCO}_3)^{1-}$	bicarbonate	$(\text{NO}_2)^{1-}$	nitrite
$(\text{BrO})^{1-}$	hypobromite	$(\text{HC}_2\text{O}_4)^{1-}$	bioxalate	$(\text{NO}_3)^{1-}$	nitrate
$(\text{BrO}_3)^{1-}$	bromate	$(\text{H}_3\text{O})^{1+}$	<b>HYDRONIUM</b>	$(\text{O}_2)^{2-}$	peroxide
$(\text{CHO}_2)^{1-}$	formate	$(\text{HPO}_4)^{2-}$	biphosphate	$(\text{OH})^{1-}$	hydroxide
$(\text{C}_2\text{H}_3\text{O}_2)^{1-}$	acetate	$(\text{H}_2\text{PO}_4)^{1-}$	dihydrogen phosphate	$(\text{PO}_3)^{3-}$	phosphite
$(\text{C}_4\text{H}_4\text{O}_6)^{1-}$	tartrate	$(\text{HS})^{1-}$	bisulfide	$(\text{PO}_4)^{3-}$	phosphate
$(\text{C}_6\text{H}_5\text{O}_7)^{1-}$	citrate	$(\text{HSO}_3)^{1-}$	bisulfite	$(\text{SCN})^{1-}$	thiocyanate
$(\text{ClO})^{1-}$	hypochlorite	$(\text{HSO}_4)^{1-}$	bisulfate	$(\text{SO}_3)^{2-}$	sulfite
$(\text{ClO}_2)^{1-}$	chlorite	$(\text{IO})^{1-}$	hypoiodite	$(\text{SO}_4)^{2-}$	sulfate
$(\text{ClO}_3)^{1-}$	chlorate	$(\text{IO}_2)^{1-}$	iodite	$(\text{S}_2\text{O}_3)^{2-}$	thiosulfate
$(\text{ClO}_4)^{1-}$	perchlorate	$(\text{IO}_3)^{1-}$	iodate	$(\text{SeO}_4)^{2-}$	selenate
$(\text{CN})^{1-}$	cyanide	$(\text{IO}_4)^{1-}$	periodate	$(\text{SiF}_6)^{2-}$	hexafluorosilicate
$(\text{CO}_3)^{2-}$	carbonate	$(\text{MnO}_4)^{1-}$	permanganate	$(\text{SiO}_3)^{2-}$	silicate
The word hydrogen can be substituted for the prefix bi-. (i.e. hydrogen sulfide = bisulfide)					

The chart above lists the polyatomic ions we will use this year. It is also listed on the back of your periodic table. Polyatomic ions are groups of two or more atoms with an overall ionic charge. The polyatomic ions that are highlighted must be memorized. It would be wise to make flash cards for these ions.

**A few items of note:**

- Most polyatomic ions end in -ite or -ate. To keep these straight think:  
 -ite is lite  
 -ate is great(er)

Since the ions that end in -ite have fewer atoms than the ones that end in -ate.

- Even though most polyatomic ions end in -ite or -ate, there are a few that end in -ide. They are cyanide, bisulfide, azide, amide, hydroxide and peroxide. You will only have to memorize hydroxide, but it is helpful to know of the others as it will help you to locate their formulas quicker.
- Most polyatomic ions have a negative charge. There are a couple that we will use that have a positive charge. They are hydronium and ammonium. To make these stick out, I listed these in all caps.
- The word hydrogen can be substituted for the prefix bi-. (i.e. hydrogen sulfide = bisulfide)