Name _____ **Honors Chemistry** __/__/__

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 14, 15, 16 & 17 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 **cation** with its charge.	**1.** Ba^{2+}
2. To the right of the cation, write the **anion** and its charge.	**2.** $Ba^{2+}\ S^{2-}$
3. Cross each element's oxidation number to the **lower right side** of the other element's symbol.	**3.** $Ba^{2+}\ S^{2-}$ **Result:** $Ba_{2-}\ S_{2+}$
4. Remove all (+) signs, (-) signs and ones.	**4.** Ba_2S_2
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: **BaS**

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.**

Practice (More problems like these appear in Part II of the homework.)**:**

1. potassium and fluorine
2. selenium and calcium
3. strontium and phosphorus

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 **–ide** 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, $\mathbf{Al_2O_3}$.

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

At the completion of this assignment you will be prepared to take the following Chapter 4 on-line quizzes:

• binary compound formula quiz 1	• binary compound names quiz 1
• binary compound formula quiz 2	• binary compound names quiz 2
• binary compound formula quiz 3	• binary compound names quiz 3
• binary ionic compound true false quiz	•

Homework

Part I: Name each of the following below.

1. $CaCl_2$
2. Mg_2C
3. RbAt
4. RaI_2
5. LiF
6. K_2Se
7. NaBr
8. Be_3As_2
9. H_3N
10. In_2S_3
11. Fr_3P
12. SrTe
13. AlF_3
14. HI
15. 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

Ionic Compounds Using Polyatomic Ions

Next we will study ionic compounds that use polyatomic ions. **Polyatomic ions are a group of two or more elements that have an overall ionic charge**. Most times the polyatomic ion will function as an anion, but there are a few polyatomic ions that are cations. All of the polyatomic ions that we will use are listed on the back of your periodic table.

Please note: All of the polyatomic ions are written with parenthesis. **You CANNOT change any of the information inside the parenthesis**. Think of anything inside parenthesis as being protected. When you cross oxidation numbers you must write it outside the parenthesis. Writing ionic compounds that have polyatomic ions is, for the most part, a lot like writing binary ionic compounds. The only difference is one extra step.

Part III: How to Write a Formula for an Ionic Compound that has a Polyatomic Ion

For the first example I'll use **aluminum** and **phosphite**.

Description of Action	Action
1. Write the symbol of the cation with its charge.	**1.** Al^{3+}
2. To the right of the cation, write the polyatomic anion and its charge.	**2.** $Al^{3+}\ (PO_3)^{3-}$
3. Cross each element's oxidation number to the lower right side of the other element's symbol.	**3.** $Al^{3+}\ (PO_3)^{3-}$ **Result:** $Al_{3-}\ (PO_3)_{3+}$
4. Remove all (+) signs, (-) signs and ones.	**4.** $Al_3\ (PO_3)_3$
5. Reduce, if necessary. Remember, **do not touch anything inside the parenthesis**.	**5.** $Al\ (PO_3)$
6. If there is no subscript outside the anion's parenthesis, remove the parenthesis.	**6. Answer:** $Al\ PO_3$

Now you try this one using **calcium** and **chlorate**.

Description of Action	Action
1.	**1.**
2.	**2.**
3.	**3.**
4.	**4.**
5.	**5.**
6.	**6.**

Note: When you say out loud a formula involving parenthesis, you use the word "taken" as in the formula above for calcium chlorate, which is $Ca(ClO_3)_2$. You say "Ca Cl O three taken twice."

More Practice:

1. **ammonium** and **nitrate**
2. magnesium and oxalate
3. strontium and phosphate

Part IV: Naming Ionic Compounds that have Polyatomic Ions

For the first example we will use our answer from the first example on the other side, **$Al PO_3$**

Description of Action	Action
1. Write the name of the cation.	**1.** aluminum
2. To the right of the cation name, write anion's name.	**2.** aluminum phosphite

That's it! Just two steps. Don't get confused by the lack of parenthesis or any number that may appear outside of it. All that matters is the formula inside the parenthesis or what is left over. Try to name the answer from our second example in the first part, **$Ca(ClO_3)_2$**

Description of Action	Action
1.	**1.**
2.	**2.**

At the completion of this assignment you will be prepared to take the following Chapter 4 on-line quizzes:

• ternary compound formula quiz 1	• ternary compound names quiz 1
• ternary compound formula quiz 2	• ternary compound names quiz 2
• ternary compound formula quiz 3	• ternary compound names quiz 3

Homework

Part III: Write the formula of each ionic compound named below.

1. sodium sulfate
2. cesium nitrate
3. calcium hydroxide

4. strontium hexafluorosilicate
5. gallium permanganate
6. beryllium citrate

7. hydrogen cyanide
8. aluminum hydrogen sulfate
9. lithium perchlorate

10. magnesium thiocyanate
11. potassium tartrate
12. rubidium borate

13. ammonium hypobromite
14. radium hydrogen oxalate
15. francium tetraborate

Part IV: Name each of the following ionic compounds.

16. $NaHCO_3$
17. $Be(CHO_2)_2$
18. H_2O_2

19. $In(HSO_4)_3$
20. Fr_3PO_4
21. $Sr(N_3)_2$

22. $Ga_2(SiO_3)_3$
23. $AlAsO_4$
24. $(NH_4)_3PO_4$

25. $Na_2Cr_2O_7$
26. $KMnO_4$
27. $K_3C_6H_5O_7$

28. $Li_2C_2O_4$
29. CsN_3
30. $Ca_3(AsO_3)_2$

•SYMBOLS OF COMMON POLYATOMIC IONS•

$(AsO_3)^{3-}$	arsenite	$(C_2O_4)^{2-}$	oxalate	$(N_3)^{1-}$	azide
$(AsO_4)^{3-}$	arsenate	$(CrO_4)^{2-}$	chromate	$(NH_2)^{1-}$	amide
$(BO_3)^{3-}$	borate	$(Cr_2O_7)^{2-}$	dichromate	$(NH_4)^{1+}$	AMMONIUM
$(B_4O_7)^{2-}$	tetraborate	$(HCO_3)^{1-}$	bicarbonate	$(NO_2)^{1-}$	nitrite
$(BrO)^{1-}$	hypobromite	$(HC_2O_4)^{1-}$	bioxalate	$(NO_3)^{1-}$	nitrate
$(BrO_3)^{1-}$	bromate	$(H_3O)^{1+}$	HYDRONIUM	$(O_2)^{2-}$	peroxide
$(CHO_2)^{1-}$	formate	$(HPO_4)^{2-}$	biphosphate	$(OH)^{1-}$	hydroxide
$(C_2H_3O_2)^{1-}$	acetate	$(H_2PO_4)^{1-}$	dihydrogen phosphate	$(PO_3)^{3-}$	phosphite
$(C_4H_4O_6)^{1-}$	tartrate	$(HS)^{1-}$	bisulfide	$(PO_4)^{3-}$	phosphate
$(C_6H_5O_7)^{3-}$	citrate	$(HSO_3)^{1-}$	bisulfite	$(SCN)^{1-}$	thiocyanate
$(ClO)^{1-}$	hypochlorite	$(HSO_4)^{1-}$	bisulfate	$(SO_3)^{2-}$	sulfite
$(ClO_2)^{1-}$	chlorite	$(IO)^{1-}$	hypoiodite	$(SO_4)^{2-}$	sulfate
$(ClO_3)^{1-}$	chlorate	$(IO_2)^{1-}$	iodite	$(S_2O_3)^{2-}$	thiosulfate
$(ClO_4)^{1-}$	perchlorate	$(IO_3)^{1-}$	iodate	$(SeO_4)^{2-}$	selenate
$(CN)^{1-}$	cyanide	$(IO_4)^{1-}$	periodate	$(SiF_6)^{2-}$	hexafluorosilicate
$(CO_3)^{2-}$	carbonate	$(MnO_4)^{1-}$	permanganate	$(SiO_3)^{2-}$	silicate

The word hydrogen can be substituted for the prefix bi-. (i.e. hydrogen sulfide = bisulfide)