

# Naming Covalent and Ionic Molecules

**Due:** Friday November 21, 2014

Name: \_\_\_\_\_

## Monatomic Ions

**Ions** are atoms that have either lost or gained electrons. While atoms are neutral, ions are **charged particles**.

- A *loss* of electrons results in a positive ion or **cation** (pronounced “cat-eye-on”).
- A *gain* of electrons results in a negative ion or **anion** (pronounced “an-eye-on”).

Although ions and elements have similar chemical symbols, they are entirely different substances with different physical properties.

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### A. Monatomic Ions

In order to determine the charge of *monatomic* ions, you can use the periodic table as a guide:

Group # (Column)	Ion Charge	Examples
1	These elements <u>lose one</u> electron to form <b>+1</b> ions.	Na <sup>+</sup> , Li <sup>+</sup> , K <sup>+</sup>
2	These elements <u>lose two</u> electrons to form <b>+2</b> ions.	Mg <sup>2+</sup> , Ca <sup>2+</sup> , Ba <sup>2+</sup>
Groups 3-12	The elements in groups 3-12 are called transition metals. These elements always lose electrons to form <b>positive</b> ions (cations) but their charges vary. For example, iron can form a +2 or a +3 ion. <i>In cases like these, you must be told which ion to use.</i>	Fe <sup>2+</sup> , Fe <sup>3+</sup>
13	These elements <u>lose three</u> electrons to form <b>+3</b> ion.	Al <sup>3+</sup>
14	The charges on these ions vary. Carbon and silicon do not form ions. For the rest of the group, you must be given the charge.	Sn <sup>2+</sup> , Pb <sup>2+</sup>
15	These elements <u>gain three</u> electrons and form <b>-3</b> ions.	N <sup>3-</sup> , P <sup>3-</sup>
16	These elements <u>gain two</u> electrons to form <b>-2</b> ions.	O <sup>2-</sup> , S <sup>2-</sup>
17	These elements <u>gain one</u> electron to form <b>-1</b> ions.	F <sup>-</sup> , Cl <sup>-</sup> , Br <sup>-</sup> , I <sup>-</sup>
18	These atoms do NOT form ions. Their charge is always <b>zero</b> .	He, Ne, Ar, Kr

*Naming Ions (Nomenclature):*

Simple **cations** are named by saying the element and adding the word “ion.”

Na<sup>+</sup> is called “sodium ion”

Mg<sup>2+</sup> is called “magnesium ion”

Simple **anions** are named by dropping the ending off the element name and adding “ide.”

F<sup>-</sup> is called “fluoride”

O<sup>2-</sup> is called “oxide”

N<sup>3-</sup> is called “nitride”

Note: the charge of a monatomic **anion** is equal to the group number minus 18.

## Nomenclature Worksheet 1: Monatomic Ions

*Use a periodic table to complete the table below:*

<b>Element Name</b>	<b>Element Symbol</b>	<b>Ion Name</b>	<b><u>Ion Formula</u></b>
1. sodium			
2. bromine			
3. magnesium			
4. chlorine			
5. oxygen			
6. boron			
7. lithium			
8. neon			
9. phosphorus			
10. aluminum			
11. calcium			
12. iodine			
13. nitrogen			
14. cesium			
15. sulfur			
16. fluorine			
17. potassium			
18. barium			
19. hydrogen			
20. helium			

## Simple Binary Ionic Compounds

Ionic compounds are compounds formed by the combination of a **cation** and a **anion**. (**Think: "metal plus nonmetal"**). Ionic compounds are more commonly known as "salts." Binary ionic compounds are compounds containing only two elements, as demonstrated in the examples below.

When writing formulas for ionic compounds, we use **subscripts** to indicate how many of each atom is contained in the compound. Remember that even though ions have charges, ionic compounds must be **neutral**. Therefore, the charges on the cation and the anion must cancel each other out. In other words, the **net charge** of an ionic compound equals zero.

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### **Example 1:**

For a salt containing sodium ion,  $\text{Na}^+$ , and chloride,  $\text{Cl}^-$ , the ratio is one to one. The positive charge on the sodium ion cancels out the negative charge on the chloride.

$$(+1) + (-1) = 0$$

Therefore, the formula for the salt is **NaCl**. (The actual formula is  $\text{Na}_1\text{Cl}_1$ , but chemists omit subscripts of 1).

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### **Example 2:**

For a salt containing calcium ion,  $\text{Ca}^{2+}$ , and chloride,  $\text{Cl}^-$ , the ratio can't be one to one.

$$(+2) + (-1) = +1$$

Remember that ionic compounds must be neutral. In order to yield a neutral compound, **two** chlorides must bond to the calcium ion:

$$(+2) + 2(-1) = 0$$

So, the formula for this salt is **CaCl<sub>2</sub>**.

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### **Nomenclature:**

When naming ionic compounds, simply write the *element name* of the metal followed by the *ion name* of the nonmetal. (**Remember: the metal ion (cation) is always written first!**)

NaCl is called "**sodium chloride**," and  $\text{CaCl}_2$  is called "**calcium chloride**."



## Nomenclature Worksheet 2: Simple Binary Ionic Compounds

*Please complete the following table:*

Name of Ionic Compound	Formula of Ionic Compound
1. Sodium bromide	
2. Calcium chloride	
3. Magnesium sulfide	
4. Aluminum oxide	
5. Lithium phosphide	
6. Cesium nitride	
7. Potassium iodide	
8. Barium fluoride	
9. Rubidium nitride	
10. Barium oxide	
11.	$K_2O$
12.	$Mg_2$
13.	$AlCl_3$
14.	$CaBr_2$
15.	$Na_3N$
16.	$LiF$
17.	$Ba_3P_2$
18.	$Cs_2S$
19.	$SrF_2$
20.	$NaCl$

## Naming Binary Covalent Compounds

Binary covalent compounds come from the combination of two nonmetals (or a nonmetal and a metalloid). These compounds do not involve ions; as a result, they have a slightly different naming system. Chemists use *prefixes* to indicate the number of atoms in each compound. The prefixes are listed in the table below:

# of Atoms	Prefix
1	Mono
2	Di
3	Tri
4	Tetra
5	Penta
6	Hexa
7	Hepta
8	Octa
9	Nona
10	Deca

When naming binary covalent compounds, the first element name is given followed by the second element with an "ide" ending. The first element gets a prefix when there is more than one atom in the compound.\* The second element ALWAYS gets a prefix. Here are some examples:

Compound	Name
NO*	Nitrogen Monoxide
N <sub>2</sub> O	Dinitrogen Monoxide
NO <sub>2</sub> *	Nitrogen Dioxide
N <sub>2</sub> O <sub>3</sub>	Dinitrogen Trioxide
N <sub>2</sub> O <sub>4</sub>	Dinitrogen Tetraoxide
N <sub>2</sub> O <sub>5</sub>	Dinitrogen Pentaoxide

\* Notice that the prefix "mono" is omitted in these cases

Prefixes are necessary when naming covalent compounds because the atoms can combine in any whole number ratio. N<sub>2</sub>O, for example, cannot simply be called "nitrogen oxide," because there are several other compounds that contain nitrogen and oxygen. We must specify that there are two nitrogen atoms bonded to a single oxygen atom.

When dealing with ionic compounds, there is only one way for a cation and anion to combine to form a neutral compound. As a result, there is no need to use prefixes. This is why CaCl<sub>2</sub> is called "calcium chloride," rather than "calcium dichloride."

## Nomenclature Worksheet 6: Binary Covalent Compounds

Please complete the following table:

Name of <i>Covalent</i> Compound	Formula of <i>Covalent</i> Compound
1. carbon dioxide	
2. phosphorus triiodide	
3. sulfur dichloride	
4. nitrogen trifluoride	
5. dioxygen difluoride	
	6. N <sub>2</sub> F <sub>4</sub>
	7. SCl <sub>4</sub>
	8. ClF <sub>3</sub>
	9. SiO <sub>2</sub>
	10. P <sub>4</sub> O <sub>10</sub>

Determine whether the following compounds are **covalent** or **ionic** and give them their proper names.

1. ~~Ba(NO<sub>3</sub>)<sub>2</sub>~~ NaBr
2. CO
3. PCl<sub>3</sub>
4. KI
5. CF<sub>4</sub>
6. MgO
7. Cu<sub>2</sub>S
8. SO<sub>2</sub>
9. NCl<sub>3</sub>
10. XeF<sub>6</sub>

### Shortcut for Formula Determination:

Use the following method when asked to determine the formula of an ionic compound:

1. Write the two ions with their charges (metal first).
2. Ignoring the + or – charges, “crisscross” the numbers and make them subscripts.
3. Then, rewrite the formula, dropping the charges.

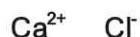
(See Examples Below)

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#### **Example 1:**

Write the formula for **calcium chloride**:

1. Write the two ions with their charges (metal first).



2. Ignoring the + or – charges, “crisscross” the numbers and make them subscripts:

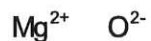


3. Then, rewrite the formula, dropping the charges. In this case, the formula is: **CaCl<sub>2</sub>**
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#### **Example 2:**

Write the formula for **magnesium oxide**:

1. Write the two ions with their charges (metal first).



2. Ignoring the + or – charges, “crisscross” the numbers and make them subscripts:



3. Then, rewrite the formula, dropping the charges. The rewritten formula is: Mg<sub>2</sub>O<sub>2</sub>.  
**Note:** Since the subscripts for the anion and cation are the same, the formula reduces to Mg<sub>1</sub>O<sub>1</sub>.

Therefore, the correct formula is written as: **MgO**.



## Naming Covalent Compounds Worksheet

Write the formulas for the following covalent compounds:

- 1) antimony tribromide \_\_\_\_\_
- 2) hexaboron silicide \_\_\_\_\_
- 3) chlorine dioxide \_\_\_\_\_
- 4) hydrogen iodide \_\_\_\_\_
- 5) iodine pentafluoride \_\_\_\_\_
- 6) dinitrogen trioxide \_\_\_\_\_
- 7) ammonia \_\_\_\_\_
- 8) phosphorus triiodide \_\_\_\_\_

Write the names for the following covalent compounds:

- 9)  $P_4S_5$  \_\_\_\_\_
- 10)  $O_2$  \_\_\_\_\_
- 11)  $SeF_6$  \_\_\_\_\_
- 12)  $Si_2Br_6$  \_\_\_\_\_
- 13)  $SCl_4$  \_\_\_\_\_
- 14)  $CH_4$  \_\_\_\_\_
- 15)  $B_2Si$  \_\_\_\_\_
- 16)  $NF_3$  \_\_\_\_\_