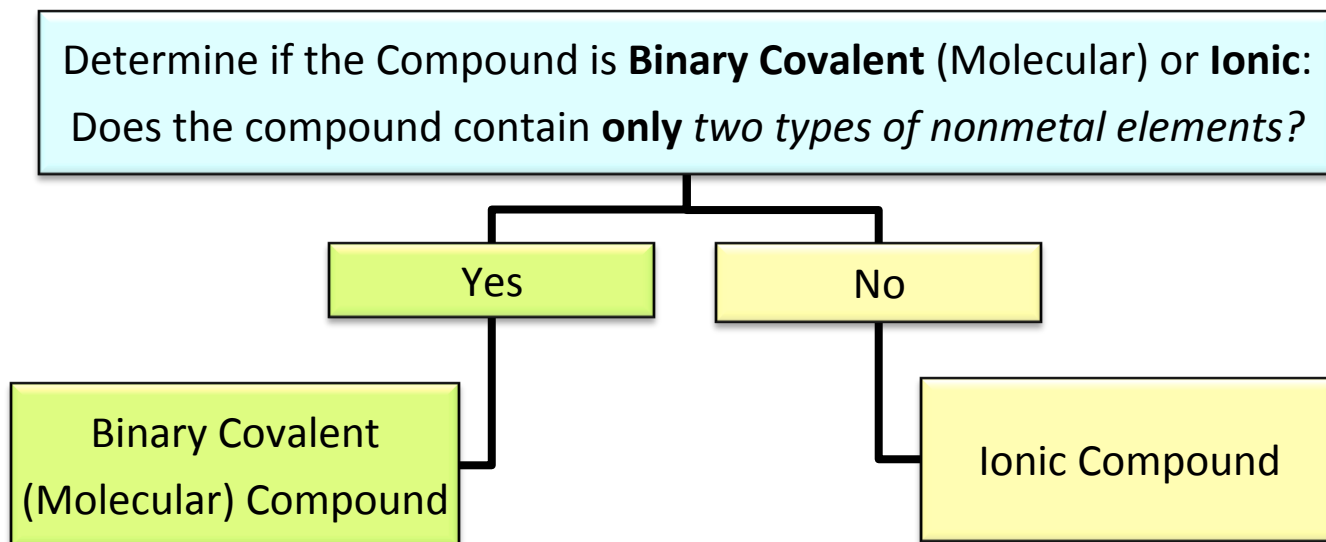


## Naming Compounds Tutorial and Worksheet

Since we use different methods in naming binary covalent (molecular) compounds and ionic compounds, the **first step** in naming or writing the formula of a compound is to **determine which of the 2 compound classes it belongs**. This can be done as follows:



Binary covalent compounds will contain **only two types of non-metal elements**. There may be more than one of each element. For example  $\text{CO}_2$  contains just two types of elements, carbon and oxygen. We will discuss naming covalent compounds that contain more than two types of elements, like glucose  $\text{C}_6\text{H}_{12}\text{O}_6$ , in later chapters.

Once it is determined that the compound is **ionic** or **covalent**, the student can be asked to do either of the following:

1) Given the **name** of the compound, write the **formula**.

**Or**

2) Given the **formula** of the compound, write the **name**.

In this tutorial we will review the process for achieving these 2 objectives and practice with some worksheet problems. First, we will review and practice how to write formulas for compounds when given the compound's name. Second, we will review and practice how to write the name of a compound when given the compound's formula.

## Given the Name of the Compound, Writing Formulas for Compounds

Determine if the Compound is **Binary Covalent (Molecular)** or **Ionic**:

Does the compound contain **only two** types of *nonmetal elements*?

Yes

No

### Binary Covalent (Molecular) Compound:

- 1) Write the symbol of the first element in the compound's name, then the symbol of the second element in the compound's name.
- 2) Indicate how many atoms of each element the molecule contains using subscripts after the atomic symbol.
  - The numbers of atoms are given in the molecule's name in Greek prefixes
    - NOTE: If there is no Greek prefix in front of the first element in the name that implies the number is 1.

### Ionic Compound:

- 1) Write the symbol/formula of the first ion in the compound's name, then the symbol/formula of the second ion in the compound's name.
- 2) Indicate the ratio of the ions in the compound using subscripts after each ion.
  - The ratio of the ions is deduced by balancing the charges of the ions.
  - **IMPORTANT:** When there is more than one of a polyatomic ion in the formula unit we use parenthesis. Example  $Mg(NO_3)_2$

# Writing the Formulas of Ionic Compounds

**Example:** Write the formula for **calcium bromide**.

- 1) Write the symbol/formula of the first ion in the compound's name, then the symbol/formula of the second ion in the compound's name.



- 2) Indicate the ratio of the ions in the compound using subscripts after each ion.

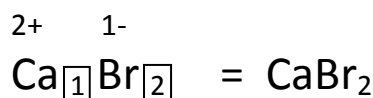
- This step involves filling in the subscripts boxes as we did in the lecture:



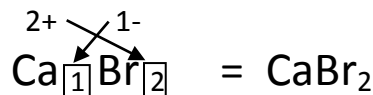
- The ratio of the ions is deduced by **balancing the charges** of the ions.
  - This is done so that the **total charge** in the crystal, when large numbers of cations and anions combine, is **equal to zero**.
  - We find the ion's charge from its position on the periodic table or we look it up in a table in the case of polyatomic ions.
  - Transition metal with varying charges will be written in the compound name in Roman numerals.
- First, temporarily write the charge of each ion above the ion's symbol.



- Next, place numbers in the subscripts such that the total charge of the compound is zero. Note that in this example, we need **two** bromide ions, each has a charge of (1-) to cancel the (2+) charge of the calcium ion:
  - $2(-1) + (+2) = 0$  zero total charge.



- We saw a shortcut way to do this called the Criss-Cross Method (see your chapter 3 notes)



- Note, we do not leave the charges written above the symbols in the completed formula.

*IMPORTANT: When there is more than one of a polyatomic ion in the formula, we use parenthesis.*

- Not applicable in this example since there are no polyatomic ions in calcium bromide.

## Examples: Writing the Formulas of Ionic Compounds

Write the formula for **magnesium nitrate**.

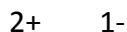
- 1) Write the symbol/formula of the first ion in the compound's name, then the symbol/formula of the second ion in the compound's name.
  - When you see a polyatomic ion (nitrate), look up the formula and charge in the table of polyatomic ions.



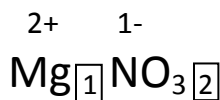
- 2) Indicate the ratio of the ions in the compound using subscripts after each ion.
  - a. This step involves filling in the subscripts boxes as we did in the lecture:



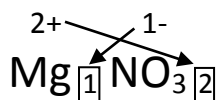
- The ratio of the ions is deduced by **balancing the charges** of the ions.
  - This is done so that the **total charge** in the crystal, when large numbers of cations and anions combine, is **equal to zero**.
  - We find the ion's charge from its position on the periodic table or we look it up in a table in the case of polyatomic ions.
  - Transition metal with varying charges will be written in the compound name in Roman numerals.
- First, temporarily write the charge of each ion above the ion's symbol.



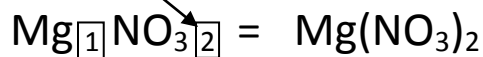
- Next, place numbers in the subscripts such that the total charge of the compound is zero. Note that in this example, we need **two** nitrate ions, each has a charge of (1-) to cancel the (2+) charge of the magnesium ion:
  - $2(-1) + (+2) = 0$  zero total charge.



- We saw a shortcut way to do this called the Criss-Cross Method (see your chapter 3 notes)



*IMPORTANT: When there is more than one of a polyatomic ion in the formula unit we use parenthesis. There are **2 ions** of nitrate in magnesium nitrate*



In compound where there is just **one formula unit** of a polyatomic ion, no parenthesis are needed. An example of this is **sodium nitrate:  $\text{NaNO}_3$**

## Examples: Writing the Formulas of Ionic Compounds

Write the formula for **iron(II) phosphate**.

- 1) Write the symbol/formula of the first ion in the compound's name, then the symbol/formula of the second ion in the compound's name.
  - When you see a polyatomic ion (phosphate in this case), look up the formula and charge in the table of polyatomic ions.



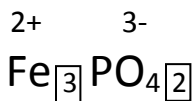
- 2) Indicate the ratio of the ions in the compound using subscripts after each ion.
  - b. This step involves filling in the subscripts boxes as we did in the lecture:



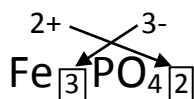
- The ratio of the ions is deduced by **balancing the charges** of the ions.
  - This is done so that the **total charge** in the crystal, when large numbers of cations and anions combine, is **equal to zero**.
  - We find the ion's charge from its position on the periodic table or we look it up in a table in the case of polyatomic ions.
  - **Transition metal with varying charges will be written in the compound name in Roman numerals.**
    - In this example, now we know the charge on **the Fe ion is 2+**
- First, temporarily write the charge of each ion above the ion's symbol.



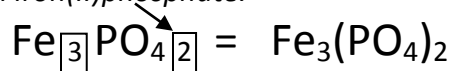
- Next, place numbers in the subscripts such that the total charge of the compound is zero. Note that in this example, we need **two** phosphate ions, each has a charge of (3-) and three  $\text{Fe}^{2+}$  ions to balance the charge:
  - $2(-3) + 3(-2) = 0$  zero total charge.



- We saw a shortcut way to do this called the Criss-Cross Method (see your chapter 3 notes)



**IMPORTANT:** When there is more than one of a polyatomic ion in the formula unit we use parenthesis. There are **2 ions** of phosphate in iron(II)phosphate.



## Examples: Writing the Formulas of Ionic Compounds

Write the formula for **barium sulfide**.

- 1) Write the symbol/formula of the first ion in the compound's name, then the symbol/formula of the second ion in the compound's name.



- 2) Indicate the ratio of the ions in the compound using subscripts after each ion.

- This step involves filling in the subscripts boxes as we did in the lecture:

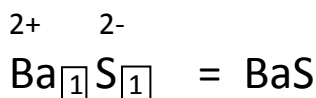


- The ratio of the ions is deduced by **balancing the charges** of the ions.
  - This is done so that the **total charge** in the crystal, when large numbers of cations and anions combine, is **equal to zero**.
  - We find the ion's charge from its position on the periodic table or we look it up in a table in the case of polyatomic ions.
  - Transition metal with varying charges will be written in the compound name in Roman numerals.

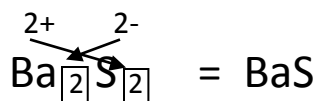
- First, temporarily write the charge of each ion above the ion's symbol.



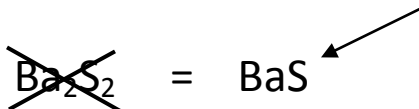
- Next, place numbers in the subscripts such that the total charge of the compound is zero. Note that in this example, we need **one** sulfide ion, with a charge of (2-) to cancel the (2+) charge of the barium ion:
  - $(-2) + (+2) = 0$  zero total charge.



- We saw a shortcut way to do this called the Criss-Cross Method (see your chapter 3 notes)



- Note, the subscripts in ionic compound represent the ratio in which large numbers of anions and cations combine to form the ionic compounds. Since we want the **lowest ratio**: we use 1:1, since  $2:2 = 1:1$



**Write the formula for the following ionic compounds: (see next page for key)**

sodium bicarbonate \_\_\_\_\_

sodium fluoride \_\_\_\_\_

iron (III) chloride \_\_\_\_\_

sodium carbonate \_\_\_\_\_

copper (II) sulfate \_\_\_\_\_

magnesium hydroxide \_\_\_\_\_

barium nitrate \_\_\_\_\_

lithium sulfate \_\_\_\_\_

magnesium chloride \_\_\_\_\_

silver nitrate \_\_\_\_\_

aluminum sulfate \_\_\_\_\_

calcium hydroxide \_\_\_\_\_

calcium sulfate \_\_\_\_\_

mercury (II) nitrate \_\_\_\_\_

lead (IV) nitrate \_\_\_\_\_

magnesium iodide \_\_\_\_\_

sodium nitride \_\_\_\_\_

## Practice Problems KEY

sodium bicarbonate  $\text{NaHCO}_3$

sodium fluoride  $\text{NaF}$

iron (III) chloride  $\text{FeCl}_3$

sodium carbonate  $\text{Na}_2\text{CO}_3$

copper (II) sulfate  $\text{CuSO}_4$

magnesium hydroxide  $\text{Mg(OH)}_2$

barium nitrate  $\text{Ba(NO}_3)_2$

lithium sulfate  $\text{Li}_2\text{SO}_4$

magnesium chloride  $\text{MgCl}_2$

silver nitrate  $\text{AgNO}_3$

aluminum sulfate  $\text{Al}_2(\text{SO}_4)_3$

calcium hydroxide  $\text{Ca(OH)}_2$

calcium sulfate  $\text{CaSO}_4$

mercury (II) nitrate  $\text{Hg(NO}_3)_2$

lead (IV) nitrate  $\text{Pb(NO}_3)_4$

magnesium iodide  $\text{MgI}_2$

sodium nitride  $\text{Na}_3\text{N}$



## Writing the Formulas of Covalent Compounds

- 1) Write the symbol/formula of the first element in the compound's name, then the symbol/formula of the second element in the compound's name.
- 2) Indicate how many atoms of each element the molecule contains using subscripts after the atomic symbol.
  - The numbers of atoms are given in the molecule's name in Greek prefixes
  - NOTE: If there is no Greek prefix in front of the first element in the name, that means the number is 1.

**Example:** Write the formula of **dinitrogen tetrafluoride**.

- 1) Write the symbol/formula of the first element in the compound's name, then the symbol/formula of the second element in the compound's name.

N F

- 2) Indicate how many atoms of each element the molecule contains using subscripts after the atomic symbol.

N  F

- The numbers of atoms are given in the molecule's name in Greek prefixes.
  - **dinitrogen tetrafluoride**
  - see your chapter 3 notes for a list of the Greek prefixes

**N<sub>2</sub>F<sub>4</sub>**

- **NOTE:** If there is no Greek prefix in front of the first element in the name, then the number is 1.
  - Example carbon tetrachloride = CCl<sub>4</sub>

**Example:** Write the formula of **carbon disulfide**.

- 1) Write the symbol/formula of the first element in the compound's name, then the symbol/formula of the second element in the compound's name.

C S

- 2) Indicate how many atoms of each element the molecule contains using subscripts after the atomic symbol.

C  S

- The numbers of atoms are given in the molecule's name in Greek prefixes.
  - carbon **disulfide**
  - see your chapter 3 notes for a list of the Greek prefixes

**C<sub>1</sub>S<sub>2</sub> = CS<sub>2</sub>**

- **NOTE:** If there is no Greek prefix in front of the first element in the name, then the number is 1.

Write the formulas for the following covalent compounds:

See next page for KEY

a. disulfur tetrafluoride \_\_\_\_\_

b. carbon trioxide \_\_\_\_\_

c. nitrogen pentoxide \_\_\_\_\_

d. nitrogen tribromide \_\_\_\_\_

e. dinitrogen heptachloride \_\_\_\_\_

f. carbon tetrachloride \_\_\_\_\_

g. hydrogen monochloride \_\_\_\_\_

h. trihydrogen monophosphide \_\_\_\_\_

i. dihydrogen monoxide \_\_\_\_\_

## KEY

- a. disulfur tetrafluoride  $S_2F_4$
- b. carbon trioxide  $CO_3$
- c. nitrogen pentoxide  $NO_5$
- d. nitrogen tribromide  $NBr_3$
- e. dinitrogen heptachloride  $N_2Cl_7$
- f. carbon tetrachloride  $CCl_4$
- g. hydrogen monochloride  $HCl$
- h. trihydrogen monophosphide  $H_3P$
- i. dihydrogen monoxide  $H_2O$

## Given the Formulas for Compounds, Write the Name

Determine if the Compound is **Binary Covalent (Molecular)** or **Ionic**:  
Does the compound contain **only two types of nonmetal elements**?

Yes

No

### Binary Covalent (Molecular) Compound:

- 1) List the name of the first element in the formula.
- 2) List the second element and add the "ide" suffix.
- 3) Use Greek prefixes to indicate the number of each atom in the formula.
  - Exception: **Do not use** mono- for the first element in the name.
  - The *o* or *a* at the end of the Greek prefix is dropped when the element name begins with a vowel.

### Ionic Compound:

- 1) Write the cation name first, then name the anion.
  - Monoatomic anions use the "ide" suffix
- 2) If the cation is one of the transition metals with various charges, write the charge using parenthesis and Roman numerals after the metal name.

# Writing the Names of Ionic Compounds

**Example:** Write the name for  $\text{CaBr}_2$

- 1) Write the cation name first, then name the anion.
  - monoatomic anions use the “ide” suffix

**calcium bromide**

- 2) If the cation is one of the transition metals with various charges, write the charge using parenthesis and Roman numerals after the metal name.
  - Not necessary here, there is not a transition metal present

**Example:** Write the name for  $\text{Mg}(\text{NO}_3)_2$

- 1) Write the cation name first, then name the anion.
  - monoatomic anions use the “ide” suffix
    - Here we notice that the anion is a **polyatomic ion**. Get the name from the polyatomic ion table (in your notes or textbook). *You will be given a copy of the polyatomic ion table on your exams.*
    - **Do not** change the suffix to “ide” with polyatomic ions:

**magnesium nitrate**

- 2) If the cation is one of the transition metals with various charges, write the charge using parenthesis and Roman numerals after the metal name.
  - Not necessary here, there is not a transition metal present

# Writing the Names of Ionic Compounds

**Example:** Write the name for  $\text{CuF}_2$

- 1) Write the cation name first, then name the anion.
  - monoatomic anions use the “ide” suffix

**copper fluoride**

- 2) If the cation is one of the *transition metals* with various charges, write the **charge using parenthesis and Roman numerals** after the metal name.

**copper(?) fluoride**

- We must figure out what the charge is on the copper, we can deduce the charge on the transition metal cations from the charge on the anions
  - Recall that the total charge for any compound must equal zero.
  - Since there are two fluorides, each with a charge of (1-) and there is only one copper, we can conclude that the charge on the copper must be (2+).
    - You can think of this as the reverse criss-cross! See chapter 3 notes for more details.

**copper(II) fluoride**



write the **charge in parenthesis in Roman numerals** after the cation name

**Write the names of the following compounds:**

See next page for key

NaCl \_\_\_\_\_

$\text{Fe}_2(\text{CO}_3)_3$  \_\_\_\_\_

$\text{Cu}(\text{OH})_2$  \_\_\_\_\_

$(\text{NH}_4)_2\text{SO}_4$  \_\_\_\_\_

$\text{LiNO}_3$  \_\_\_\_\_

$\text{BaSO}_4$  \_\_\_\_\_

$\text{Mg}(\text{NO}_3)_2$  \_\_\_\_\_

AgCl \_\_\_\_\_

$\text{Al}(\text{OH})_3$  \_\_\_\_\_

$\text{CaSO}_4$  \_\_\_\_\_

FeS \_\_\_\_\_

$\text{PbCl}_2$  \_\_\_\_\_

NaI \_\_\_\_\_

$\text{MgCO}_3$  \_\_\_\_\_

## KEY

NaCl sodium chloride

$\text{Fe}_2(\text{CO}_3)_3$  iron(III) carbonate

$\text{Cu}(\text{OH})_2$  copper(II) hydroxide

$(\text{NH}_4)_2\text{SO}_4$  ammonium sulfate

$\text{LiNO}_3$  lithium nitrate

$\text{BaSO}_4$  barium sulfate

$\text{Mg}(\text{NO}_3)_2$  magnesium nitrate

AgCl silver chloride

- (note: silver is one of the transition metals that only occurs as a (1+) ion)

$\text{Al}(\text{OH})_3$  aluminum hydroxide

$\text{CaSO}_4$  calcium sulfate

FeS Iron(II) sulfide

$\text{PbCl}_2$  lead(II) chloride

NaI sodium iodide

$\text{MgCO}_3$  magnesium carbonate



## Writing the Names of Covalent Compounds

- 1) List the name of the first element in the formula.
- 2) List the second element and add the –ide suffix.
- 3) Use Greek prefixes to indicate the number of each atom in the formula.
  - Exception: do not use mono- for the first element in the name.
  - The *o* or *a* at the end of the Greek pre-fix is usually dropped when the element name begins with a vowel

**Example:** Write the name for  $\text{N}_2\text{S}_4$

- 1) List the name of the first element in the formula.

**nitrogen**

- 2) List the second element and add the –ide suffix.

**nitrogen sulfide**

- 3) Use Greek prefixes to indicate the number of each atom in the formula.

- See your textbook or lecture notes for a table of the Greek prefixes.

\_\_\_\_ **nitrogen** \_\_\_\_ **sulfide**

**dinitrogen tetrasulfide**

- Exception: do not use mono- for the first element in the name.
  - Not applicable in this example
- The *o* or *a* at the end of the Greek pre-fix is usually dropped when the element name begins with a vowel
  - Not applicable in this example

**Example:** Write the name for  $\text{SO}_3$

- 1) List the name of the first element in the formula.

**sulfur**

- 2) List the second element and add the –ide suffix.

**sulfur oxide**

- 3) Use Greek prefixes to indicate the number of each atom in the formula.

\_\_\_\_ **sulfur** \_\_\_\_ **oxide**

**sulfur trioxide**

- Exception: do not use **mono-** for the *first* element in the name.
  - NOTE, we did not write **monosulfur** because of this rule!
- The *o* or *a* at the end of the Greek pre-fix is usually dropped when the element name begins with a vowel
  - Not applicable in this example

**Example:** Write the name for  $\text{SO}_2$

1) List the name of the first element in the formula.

**sulfur**

2) List the second element and add the -ide suffix.

**sulfur oxide**

3) Use Greek prefixes to indicate the number of each atom in the formula.

\_\_\_\_\_ **sulfur** \_\_\_\_\_ **oxide**

**sulfur dioxide**

- Exception: do not use **mono-** for the *first* element in the name.
  - NOTE, we did not write **monosulfur** because of this rule!
- The *o* or *a* at the end of the Greek pre-fix is usually dropped when the element name begins with a vowel
  - Not applicable in this example

**Example:** Write the name for  $\text{CO}$

1) List the name of the first element in the formula.

**carbon**

2) List the second element and add the -ide suffix.

**carbon oxide**

3) Use Greek prefixes to indicate the number of each atom in the formula.

\_\_\_\_\_ **carbon** \_\_\_\_\_ **oxide**

**carbon monoxide**

- Exception: do not use **mono-** for the *first* element in the name.
  - NOTE, we did not write **monocarbon** because of this rule!
- The *o* or *a* at the end of the Greek pre-fix is usually dropped when the element name begins with a vowel
  - NOTE, we did not write **monooxide** because of this rule!

Write the names of the following compounds:

See next page for key

a.  $\text{Br}_2\text{I}_4$  \_\_\_\_\_

b.  $\text{P}_5\text{F}_8$  \_\_\_\_\_

c.  $\text{NO}_5$  \_\_\_\_\_

- Remember: The *o* or *a* at the end of the Greek pre-fix is usually dropped when the element name begins with a vowel

d.  $\text{NBr}_3$  \_\_\_\_\_

e.  $\text{N}_2\text{O}_5$  \_\_\_\_\_

f.  $\text{BrCl}_3$  \_\_\_\_\_

g.  $\text{H}_2\text{S}$  \_\_\_\_\_

h.  $\text{N}_2\text{O}$  \_\_\_\_\_

## KEY

- a.  $\text{Br}_2\text{I}_4$  dibromine tetriodide
- b.  $\text{P}_5\text{F}_8$  pentaphosphorus octafluoride
- c.  $\text{NO}_5$  nitrogen pentoxide
  - The *o* or *a* at the end of the Greek pre-fix is usually dropped when the element name begins with a vowel
    - NOTE, we did not write **pentaoxygen** because of this rule!
- d.  $\text{NBr}_3$  nitrogen tribromide
- e.  $\text{N}_2\text{O}_5$  dinitrogen pentoxide
- f.  $\text{BrCl}_3$  bromine trichloride
- g.  $\text{H}_2\text{S}$  dihydrogen monosulfide
- h.  $\text{N}_2\text{O}$  dinitrogen monoxide

