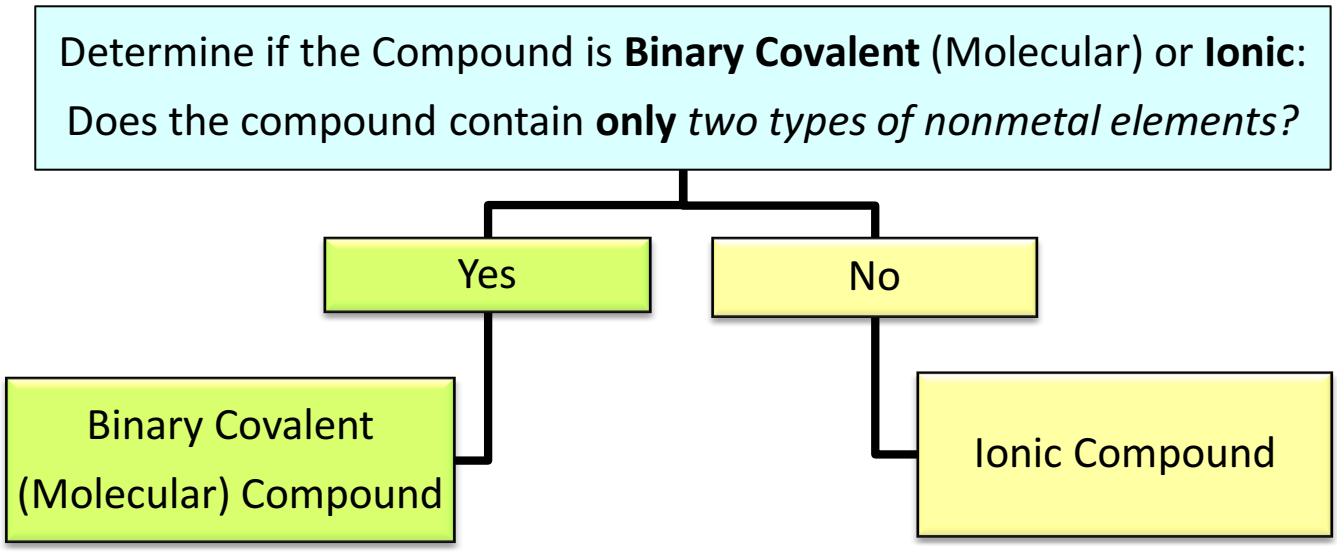
Naming Compounds Tutorial and Worksheet

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 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 $C_6H_{12}O_6$, 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.

   Ca Br

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:

     $Ca_{\square}Br_{\square}$
   - 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.

     2+ 1-

     $Ca_{\square}Br_{\square}$

   - 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.

     2+ 1-

     $Ca_{\boxed{1}}Br_{\boxed{2}} = CaBr_2$

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

     2+ 1-

     $Ca_{\boxed{1}}Br_{\boxed{2}} = CaBr_2$

   - 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.

$$Mg\ \ NO_3$$

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:

$$Mg_{\square}NO_{3\square}$$

- 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.

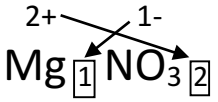
- First, temporarily write the charge of each ion above the ion's symbol.

$$\overset{2+}{Mg}_{\square}\overset{1-}{NO_{3\square}}$$

- 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.

$$\overset{2+}{Mg}_{\boxed{1}}\overset{1-}{NO_{3\,\boxed{2}}}$$

- 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*

$$Mg_{\boxed{1}}NO_{3\,\boxed{2}} = Mg(NO_3)_2$$

In compound where there is just **one formula unit** of a polyatomic ion, no parenthesis are needed. An example of this is **sodium nitrate: $NaNO_3$**

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.

$$Fe\ \ PO_4$$

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:

$$Fe_{\square}\ PO_{4\square}$$

- 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.

$$\overset{2+}{Fe}_{\square}\ \overset{3-}{PO_4}_{\square}$$

- 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 Fe^{2+} ions to balance the charge:
    - 2(-3) + 3(-2) = 0 zero total charge.

$$\overset{2+}{Fe}_{\boxed{3}}\ \overset{3-}{PO_4}_{\boxed{2}}$$

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

$$\overset{2+}{Fe}_{\boxed{3}}\ \overset{3-}{PO_4}_{\boxed{2}}$$

*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.*

$$Fe_{\boxed{3}}PO_4{}_{\boxed{2}} = Fe_3(PO_4)_2$$

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.

   Ba S

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:

     $Ba_{\square}S_{\square}$
   - 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.

     2+ 2-

     $Ba_{\square}S_{\square}$

   - 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.

     2+ 2-

     $Ba_{\boxed{1}}S_{\boxed{1}} = BaS$

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

     2+ 2-

     $Ba_{\boxed{2}}S_{\boxed{2}} = BaS$

   - 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

     ~~Ba_2S_2~~ = BaS

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 $NaHCO_3$

sodium fluoride NaF

iron (III) chloride $FeCl_3$

sodium carbonate Na_2CO_3

copper (II) sulfate $CuSO_4$

magnesium hydroxide $Mg(OH)_2$

barium nitrate $Ba(NO_3)_2$

lithium sulfate Li_2SO_4

magnesium chloride $MgCl_2$

silver nitrate $AgNO_3$

aluminum sulfate $Al_2(SO_4)_3$

calcium hydroxide $Ca(OH)_2$

calcium sulfate $CaSO_4$

mercury (II) nitrate $Hg(NO_3)_2$

lead (IV) nitrate $Pb(NO_3)_4$

magnesium iodide MgI_2

sodium nitride Na_3N

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.

$N_{\square}F_{\square}$

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

N_2F_4

- **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_4

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.

$C_{\square}S_{\square}$

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

$C_1S_2 \quad = CS_2$

- **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 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 **$CaBr_2$**

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 **$Mg(NO_3)_2$**

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 **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

$NaCl$ _____

$Fe_2(CO_3)_3$ _____

$Cu(OH)_2$ _____

$(NH_4)_2SO_4$ _____

$LiNO_3$ _____

$BaSO_4$ _____

$Mg(NO_3)_2$ _____

$AgCl$ _____

$Al(OH)_3$ _____

$CaSO_4$ _____

FeS _____

$FeCl_3$ _____

NaI _____

$MgCO_3$ _____

KEY

NaCl sodium chloride

$Fe_2(CO_3)_3$ iron(III) carbonate

$Cu(OH)_2$ copper(II) hydroxide

$(NH_4)_2SO_4$ ammonium sulfate

$LiNO_3$ lithium nitrate

$BaSO_4$ barium sulfate

$Mg(NO_3)_2$ magnesium nitrate

AgCl silver chloride

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

$Al(OH)_3$ aluminum hydroxide

$CaSO_4$ calcium sulfate

FeS Iron(II) sulfide

$FeCl_3$ iron(III) chloride

NaI sodium iodide

$MgCO_3$ 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 **N_2S_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 **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 **mono**sulfur 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 **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 **mono**sulfur 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 **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 **mono<u>oo</u>xide** because of this rule!

Write the names of the following compounds:

See next page for key

a. Br_2I_4 _____

b. P_5F_8 _____

c. 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. NBr_3 _____

e. N_2O_5 _____

f. $BrCl_3$ _____

g. H_2S _____

h. N_2O _____

KEY

a. Br_2I_4 dibromine tetriodide

b. P_5F_8 pentaphosphorus octafluoride

c. 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. NBr_3 nitrogen tribromide

e. N_2O_5 dinitrogen pentoxide

f. $BrCl_3$ bromine trichloride

g. H_2S dihydrogen monosulfide

h. N_2O dinitrogen monoxide