Naming Ionic Compounds – Rule Summary

Formula to Name:

1. Find the cation (comes first in the formula).
2. Find the anion (comes last in the formula).
3. Write the name of the cation, then the anion.
    a. If the cation is a metal that can have more than one charge (e.g. iron, copper, etc.), you must use Roman numerals in the name)
        i. Use the charge of the anion to figure out the charge of the cation
4. DO NOT add ANY prefixes to the names of the ions (if the ion's name already has a prefix, that's ok – just don't add your own).

Examples:

- $CaCl_2$ = calcium chloride
- $FeCl_3$ = iron (III) chloride (we know it is iron (III) because if there are 3 chlorides, each with a -1 charge, the iron needs to have a total +3 charge)
- $(NH_4)_2SO_4$ = ammonium sulfate

Name to Formula:

1. Write the correct formula and charge for the cation (it will be the first part of the name)
2. Write the correct formula and charge for the anion (it will come last in the name)
3. Add subscripts to the ions so that their total charge will add up to zero.
    - If the charges on the cation and anion are equal in magnitude (i.e. +1/-1, +2/-2, +3/-3), combine the cation and anion in a 1:1 ratio.
    - If the charges on the cation and anion are NOT equal in magnitude, use the charge on the cation as the subscript for the anion. Use the charge on the anion (omitting the negative sign) as the subscript for the cation.
    - *Place parentheses around a polyatomic ion if you need more than one of them in the final formula.*
    - Do not show the charges of the ions when you write the final formula for the compound (erase!).
4. Make sure that the subscripts for the cation and anion are the smallest whole number ratio.

Naming Covalent Compounds – Rule Summary

Rules for Naming Binary Covalent Compounds

A binary covalent compound is composed of two different elements (usually nonmetals). For example, a molecule of chlorine trifluoride, ClF_3 contains 1 atom of chlorine and 3 atoms of fluorine.

1. The element with the lower group number is written first in the name; the element with the higher group number is written second in the name.
2. If both elements are in the same group, the element with the higher period number is written first in the name.
3. Change the second element's suffix to *-ide* (e.g., fluorine = F, "fluoride" = F^-; sulfur = S, "sulfide" = S^{2-}).
4. Greek prefixes are used to indicate the number of atoms of each element in the chemical formula for the compound. *Exception: if the compound contains one atom of the element that is written first in the name, the prefix "mono-" is <u>not</u> used.*

Note: when the addition of the Greek prefix places two vowels adjacent to one another, the "a" (or the "o") at the end of the Greek prefix is usually dropped; for example, "nonaoxide" would be written as "nonoxide", and "monooxide" would be written as "monoxide". The "i" at the end of the prefixes "di-" and "tri-" are never dropped.

Detailed Rules for Naming and Writing Formulas

Modified from http://www.chem.purdue.edu/gchelp/ and
http://www.occc.edu/kmbailey/chem1115tutorials/formulas_ionic.htm

Rules for Naming Binary Ionic Compounds Containing a Metal Ion With a Fixed Charge

A binary ionic compound is composed of ions of two different elements - one of which is a metal, and the other a nonmetal. For example, sodium iodide, NaI, is composed of sodium ions, Na^+ (elemental sodium is a metal), and iodide ions, I^- (elemental iodine is a nonmetal).

Rule 1. The cation is written first in the name; the anion is written second in the name.
Rule 2. The name of the cation is the same as the (neutral) element from which it is derived (e.g., Na^+ = "sodium").
Rule 3. The anion is named by adding the suffix *-ide* to the root of the element name (e.g., I^- = "**iod***ide*").
Note: *Greek prefixes are **not** used to indicate the number of atoms of each element in the formula unit for the compound (e.g., Na_2O is named "sodium oxide" not "disodium oxide", or "disodium monoxide").*

Rules for Naming Binary Ionic Compounds Containing a Metal Ion with a Variable Charge

A binary ionic compound is composed of ions of two different elements - one of which is a metal, and the other a nonmetal. For example, iron(III) iodide, FeI_3, is composed of iron ions, Fe^{3+} (elemental iron is a metal), and iodide ions, I^- (elemental iodine is a nonmetal).

Rule 1. The positive ion (cation) is written first in the name; the negative ion (anion) is written second in the name.
Rule 2. The name of the cation is the same as the name of the (neutral metal) element from which it is derived. The charge on the cation is indicated using a Roman numeral, within parentheses, immediately following the name of the cation (e.g., Fe^{3+} = "iron(III)", Fe^{2+} = "iron(II)").
Rule 3. The anion is named by adding the suffix *-ide* to the root of the (nonmetal) element name (e.g., **iod**ine = I, "**iod**ide" = I^-; **sulf**ur = S, "**sulf**ide" = S^{2-}).
Note: *Greek prefixes are **not** used to indicate the number of atoms of each element in the formula unit for the compound (e.g., FeI_3 is named "iron(III) iodide" not "iron(III) triiodide").*

Rules for Naming Ionic Compounds Containing Polyatomic Ions

Polyatomic ions are ions which consist of more than one atom. For example, nitrate ion, NO_3^-, contains one nitrogen atom and three oxygen atoms. The atoms in a polyatomic ion are usually covalently bonded to one another, and therefore stay together as a single, charged unit.

Rule 1. The cation is written first in the name; the anion is written second in the name.
Rule 2. When the formula unit contains *two or more* of the *same* polyatomic ion, that ion is written in parentheses with the subscript written outside the parentheses.

> ***Note: parentheses and a subscript are <u>not</u> used unless more than one of a polyatomic ion is present in the formula unit (e.g., the formula unit for calcium sulfate is "$CaSO_4$" not "$Ca(SO_4)$").***

Rule 3. If the cation is a metal ion with a fixed charge, the name of the cation is the same as the (neutral) element from which it is derived (e.g., Na^+ = "sodium"). If the cation is a metal ion with a variable charge, the charge on the cation is indicated using a Roman numeral, in parentheses, immediately following the name of the cation (e.g., Fe^{3+} = "iron(III)").

Rule 4. If the anion is a monatomic ion, the anion is named by adding the suffix *-ide* to the root of the element name (e.g., I^- = "iodide").

*Note: Greek prefixes are **not** used to indicate the number of atoms, or polyatomic ions, in the formula unit for the compound (e.g., $Ca(NO_3)_2$ is named "calcium nitrate" not "calciuim dinitrate").*

Rules for Writing Formulas of Ionic Compounds if Given the Name

The total charge of an ionic compound must equal zero (neutral). Therefore, the total positive charge must equal the total negative charge. The correct formula for an ionic compound should contain the smallest whole number coefficients that will make the compound neutral.

To write the empirical (simplest) formula for an ionic compound:

5. Write the correct formula and charge for the cation (it will be the first part of the name)
6. Write the correct formula and charge for the anion (it will come last in the name)
7. Combine the cation and anion to produce an <u>electrically neutral compound</u>.
    - If the charges on the cation and anion are equal in magnitude (i.e. +1/-1, +2/-2, +3/-3), combine the cation and anion in a 1:1 ratio.
    - If the charges on the cation and anion are NOT equal in magnitude, use the charge on the cation as the subscript for the anion. Use the charge on the anion (omitting the negative sign) as the subscript for the cation.
    - Place parentheses around a polyatomic ion if you need more than one of them in the final formula.
    - Do not show the charges of the ions when you write the final formula for the compound (erase!).
8. Make sure that the subscripts for the cation and anion are the smallest whole number ratio.

Rules for Naming Binary Covalent Compounds

A binary covalent compound is composed of two different elements (usually nonmetals). For example, a molecule of chlorine trifluoride, ClF_3 contains 1 atom of chlorine and 3 atoms of fluorine.

Rule 1. The element with the lower group number is written first in the name; the element with the higher group number is written second in the name. ***Exception: when the compound contains oxygen and a halogen, the name of the halogen is the <u>first</u> word in the name.***

Rule 2. If both elements are in the same group, the element with the higher period number is written first in the name.

Rule 3. The second element in the name is named as if it were an anion, i.e., by adding the suffix *-ide* to the root of the element name (e.g., **fluor**ine = F, "**fluor**ide" = F^-; **sulf**ur = S, "**sulf**ide" = S^{2-}).

Rule 4. Greek prefixes are used to indicate the number of atoms of each element in the chemical formula for the compound. ***Exception: if the compound contains one atom of the element that is written first in the name, the prefix "mono-" is <u>not</u> used.***

*Note: when the addition of the Greek prefix places two vowels adjacent to one another, the "a" (or the "o") at the end of the Greek prefix is usually dropped; for example, "**nona**oxide" would be written as "**non**oxide", and "**mono**oxide" would be written as "**mon**oxide". The "i" at the end of the prefixes "di-" and "tri-" are never dropped.*

prefix	number indicated
mono-	1
di-	2
tri-	3
tetra-	4
penta-	5
hexa-	6
hepta-	7
octa-	8
nona-	9
deca-	10