Procedures for Naming Ionic Compounds

Always write the name of the metal first and then the nonmetal when you name an ionic compound. A good example is the reaction between lithium and sulfur. First write the name of the metal, lithium, and then write the name of the nonmetal, adding an -ide ending so that sulfur becomes sulfide.

Li_2S: Lithium sulfide

If you are naming Ionic compounds involving polyatomic ions, it follows the same pattern. Write the name of the metal first, and then add the name of the nonmetal. With polyatomic anions, do not add the -ide ending. Here are two examples:

$(NH_4)_2CO_3$: Ammonium carbonate

K_3PO_4: Potassium phosphate

The only real time students get confused by these rules is if you are studying a transition metal that has more than one oxidation state. When the metal involved is a transition metal with more than one oxidation state. In that case, there can be more than one way to correctly name the compound. For example, suppose that you want to name the compound formed between the cation:

Fe^{3+}

and the cyanide ion:

Cn^-

The most common method is to use the metal name followed in parentheses by the ionic charge written as a Roman numeral: Iron(III). But an older naming method, which is still in use, is to use -ous and -ic endings. The ion with the lower oxidation state given an -ous ending, and the ion with the higher oxidation state (higher numerical charge) is given an -ic ending.
So the compound can be named:

$Fe(CN)_3$: Iron (III) cyanide or ferric cyanide

Sometimes figuring out the charge on an ion can be a little challenging (and fun), so try to name the following ionic compound:

$FeNH_4(SO_4)_2$

The sulfate SO_4 ion has a 2- charge, and from the formula you can see that there are two of them. Therefore, you have a total of four negative charges. The ammonium ion has a 1+ charge, so you can figure out the charge on the iron cation. Because you have a 4- for the sulfates and a 1+ for the ammonium, the iron must be a 3+ to make the compound neutral. So the iron is in the Iron(III), or ferric, oxidation state. You can name the compound two ways:

$FeNH_4(SO_4)_2$: Iron (III) ammonium sulfate or ferric ammonium sulfate

And, finally, if you have the name, you can derive the formula and the charge on the ions. For example, suppose that you're given the name cuprous oxide. You know that the cuprous ion has 1+ charge:

Cu^+

The oxide ion has a 2- charge:

O^{2-}

Put them together and you get the following formula:

Cuprous oxide: Cu_2O

Procedures for Naming Covalent Compounds

Why are rules for naming covalent compounds a little different?
In naming ionic compounds, there is no need to indicate the number of atoms of each element in a formula since there is only one possible compound that can form from the ions present. For example, when aluminum combines with sulfur, the only possible compound is aluminum sulfide, Al_2S_3. The only exception to this is a few variable oxidation number metals. Those metals are named with Roman numerals for the oxidation number of the metal, as in iron (II) chloride, $FeCl_2$.

With covalent compounds, however, we have a very different situation. There are six different covalent compounds that can form between nitrogen and oxygen and in two of these nitrogen compounds, nitrogen has the same oxidation number. Therefore, the Roman numeral system will not work. Chemists devised a nomenclature system for covalent compounds that indicate how many atoms of each element are present in a molecule of the compound.

Rules are presented here for naming binary covalent compounds, those composed of two different elements. In naming binary covalent compounds, four rules apply:

1. **The first element in the formula is named first using the normal name of the element with no changes.**
2. **The second element is named as if it were an anion. Note: There are no ions in these compounds but we use the "-ide" ending on the second element as if it were an anion.**
3. **Greek prefixes are used for each element to indicate the number of atoms of that element present in the compound.**

Greek Prefixes:	
Prefix	Number Indicated
Mono-	1
Di-	2
Tri-	3
Tetra-	4
Penta-	5
Hexa-	6
Hepta-	7
Octa-	8
Nona-	9
Deca-	10

4. The prefix "mono-" is never used for naming the first element. For example, CO is called carbon monoxide, not monocarbon monoxide.

Examples:

N_2O	dinitrogen monoxide
NO	nitrogen monoxide
NO_2	nitrogen dioxide
N_2O_3	dinitrogen trioxide
N_2O_4	dinitrogen tetraoxide
N_2O_5	dinitrogen pentaoxide
SF_6	sulfur hexafluoride
CO_2	carbon dioxide
P_4O_{10}	tetraphosphorus decaoxide
P_2S_5	diphosphorus pentasulfide

Presented here are the names and charges of common anions and cations.

Common Cations		
Charge	Formula	Name
+1	H^+	Hydrogen ion
	Li^+	Lithium ion
	Na^+	Sodium ion
	K^+	Potassium ion
	Ag^+	Silver ion
	NH_{4+}	Ammonium ion
	Cu^+	Copper (I) or cuprous ion
+2	Mg^{2+}	Magnesium ion
	Ca^{2+}	Calcium ion
	Sr^{2+}	Strontium ion
	Zn^{2+}	Zinc ion
	Cu^{2+}	Copper (II) or cupric ion
	Fe^{2+}	Iron(II) or ferrous ion
	Pb^{2+}	Lead (II) ion
	Sn^{2+}	Tin ion
+3	Al^{3+}	Aluminum ion
	Cr^{3+}	Chromium (III) ion

Presented here are the names and charges of common anions and cations.

Common Anions		
Charge	Formula	Name
1-	H^-	Hydride ion
	F^-	Fluoride ion
	Cl^-	Chloride ion
	Br^-	Bromide ion
	I^-	Iodide ion
	CN^-	Cyanide ion
	OH^-	Hydroxide ion
	NO_3^-	Nitrate ion
2-	O^{2-}	Oxide ion
	O_2^{2-}	Peroxide ion
	S^{2-}	Sulfide ion
	SO_4^{2-}	Sulfate ion
3-	N^{3-}	Nitride ion
	PO_4^{3-}	Phosphate ion

Try naming or providing a formula for these ionic compounds:

NaCl

Chromium(III) phosphate

Calcium sulfate

Ammonium nitrate

PbI

Magnesium oxide

Try naming these covalent compounds:

SO_2

N_2O

CCl_4

OF_2

IBr_3