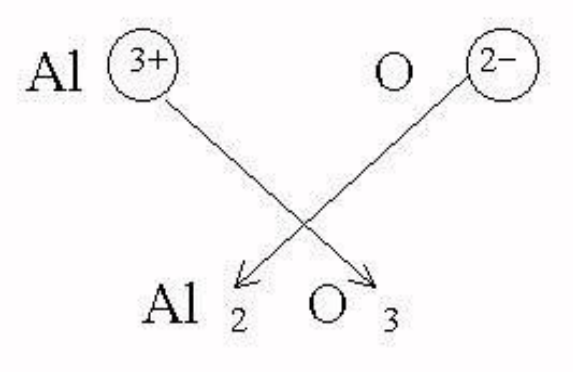
Nomenclature of Ionic Compounds of Monatomic Ions

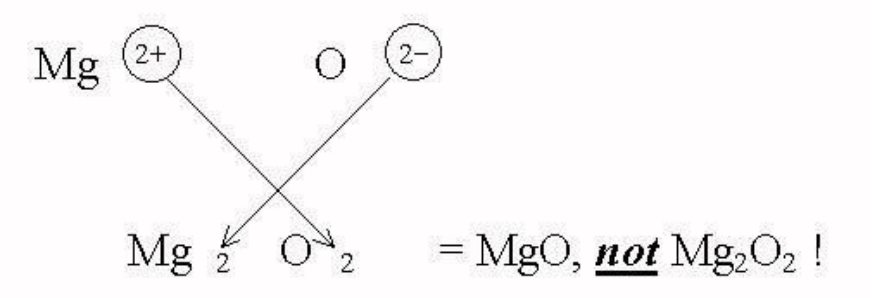
An ionic compound is generally made of one type of cation combined with one type of anion. The formula has no *net* charge even though the ions themselves are charged. Thus, the number of cations and the number of anions present must reflect a net charge of zero. These numbers appear as subscripts, immediately following each element.

For example, Na^+ combines with Cl^- to form NaCl (net charge of zero, so no charges are shown). When Na^+ combines with O^{2-}, however, you will need two Na^+ to neutralize the charge of 2– on the oxygen, to give Na_2O. When Mg^{2+} combines with Cl^-, you will similarly need two Cl^- to neutralize the charge of 2+ on the magnesium, to give $MgCl_2$. Note that the subscript 2 refers only to the number of Cl, and not the number of Mg. When no subscript shows, it is assumed to be one. Thus, the formula $MgCl_2$ tells us that there is one Mg ion for every two Cl ions. The subscripts show us the *simplest ratio* of cation to anion. (It would be wrong to write Mg_2Cl_4 because 2:4 can be reduced to 1:2.)

When you combine Al^{3+} with O^{2-}, in order to come up with a net charge of zero, you would need two Al^{3+} and three O^{2-}, to give Al_2O_3. You can arrive at this answer by simply thinking about how the charges must work out, or use the *Cross Over Method*.



The *Cross Over Method* is merely a fast way to figure out how to make the net charge come out zero. It does ***not*** mean that Al now becomes 2– and oxygen now becomes 3+. Note also that in the *Cross Over Method*, the signs (charges) do not cross over (i.e. charges do not appear in the subscript.) Remember that in this method, you must always check that the subscripts are always reduced to the ***simplest ratio***.



Even though there are ions (and charges) present in the compound, we do not show the charges in these formulas. It would be improper to write $Al^{3+}{}_2O^{2-}{}_3$ or $Mg^{2+}O^{2-}$, unless you needed to stress the charges for a special reason.

Writing Formulas from a Given Name

First figure out the charges of the cation and the anion by examining the name. Then combine the ions in a ratio that gives you a net charge of zero as described above. If you have trouble deciding what the charges are on the ions, *you need to review Unit III !* You should be able to do the drill without using anything but a periodic table.

For example, given the name, tin(II) oxide, you know that the ions are Sn^{2+} and O^{2-}. (If you don't know how I came up with these ions, you need to review Nomenclature Unit III.)
To write the formula for the compound with Sn^{2+} and O^{2-}, you examine the charges and can see that it will take one Sn^{2+} and one O^{2-} to form a neutral compound.

Let's look at another example. Given the name, tin(IV) oxide, you know that the ions are Sn^{4+} and O^{2-}. In order to form a neutral compound, we must have one Sn^{4+} and two O^{2-}. The formula must therefore be SnO_2.

Now try out the Drill D.

Drill D: Formulas of Ionic Compounds of Monatomic ions

NAME	FORMULA
magnesium fluoride	
lithium sulfide	
calcium selenide	
nickel(II) fluoride	
copper(II) bromide	
chromium(III) sulfide	
tin(II) phosphide	

Answers to Drill D: Formulas of Ionic Compounds of Monatomic Ions

NAME	FORMULA
magnesium fluoride	MgF_2
lithium sulfide	Li_2S
calcium selenide	$CaSe$
nickel(II) fluoride	NiF_2
copper(II) bromide	$CuBr_2$
chromium(III) sulfide	Cr_2S_3
tin(II) phosphide	Sn_3P_2

Writing Names from a Given Formula

Examine the formula. If the cation belongs in the group that has *fixed charges*, then you just name the cation, followed by the name of the anion, but drop the word "ion" that comes in between. For example NaCl is sodium chloride, and not sodium ion chloride. $MgCl_2$ is magnesium chloride.

Drill E: Writing Names of Compounds with Cations of Fixed Charges

KBr	
Li_2O	
Mg_3As_2	
Na_3P	

Answers to **Drill E: Writing Names of Compounds with Cations of Fixed Charges**

KBr	*potassium bromide*
Li_2O	*lithium oxide*
Mg_3As_2	*magnesium arsenide*
Na_3P	*sodium phosphide*

Writing Names from a Given Formula with Variable Charges

If the cation belongs in the group that has variable charges, you must figure out what that charge is from the charge of the anion (which is always fixed). Do ***not*** use the *Cross Over Method* as it may lead to the wrong answer. For example, the formula SnO tells us that Sn must have a charge of 2+ since the oxygen ion is always 2– . If you used the *Cross Over Method*, you would have erroneously come up with Sn having 1+ charge. The *Cross Over Method* may seem to work, but it works only in some and not *all* cases. So, it would be wiser not to use it at all for going backwards (from formula to name).

Remember that the charge is per ion. Thus, Cu_2S tells us that Cu had a charge of 1+, not 2+. Since the S ion is always 2– (Group VIA), the two Cu must have a total charge of 2+. Thus *each Cu must have 1+*.

Drill F: Determining the Charge and Name of the Cation First, Then Name of Compound

Formula	Charge of Cation	Name of Cation	Name of Compound
MnO_2			
PbS			
Cr_2O_3			

Rb_2Se			
$CuCl_2$			
CuO			
Cu_2O			

Check your answers to the above drill before going on. If you have made any mistakes be sure you find out why before you continue to the next drill. If necessary you should review all the previous Units.

Answers to Drill F: Determining the Charge and Name of the Cation First, Then Name of Compound

Formula	Charge of Cation	Name of Cation	Name of Compound
MnO_2	*4+*	*manganese(IV) ion*	*manganese(IV) oxide*
PbS	*2+*	*lead(II) ion*	*lead(II) sulfide*
Cr_2O_3	*3+*	*chromium(III) ion*	*chromium(III) oxide*
Rb_2Se	*1+*	*rubidium ion*	*rubidium selenide*
$CuCl_2$	*2+*	*copper(II) ion*	*copper(II) chloride*
CuO	*2+*	*copper(II) ion*	*copper(II) oxide*
Cu_2O	*1+*	*copper(I) ion*	*copper(I) oxide*

Drill G: Nomenclature of Ionic Compounds of Monatomic Ions (Both Fixed & Variable Charges)

FORMULA	NAME		FORMULA	NAME
	sodium oxide		RbBr	
	magnesium		$FeBr_2$	
	copper(I) sulfide		PbS	
	manganese(II)		Ba0	
	iron(III)		K_20	
	copper(II) oxide		$SbBr_3$	
	tin(II) nitride		Fe_3P_2	
	strontium oxide		Li_2Se	
	tin(IV) oxide		$CuCl_2$	

Check your answers to the above drill before going on. If you have made any mistakes be sure you find out why before you continue to the next drill. If necessary you should review all the previous Units.

Answers to Drill G: Nomenclature of Ionic Compounds of Monatomic Ions (Both Fixed & Variable Charges)

FORMULA	NAME		FORMULA	NAME
Na_2O	sodium oxide		RbBr	*rubidium bromide*
Mg_3N_2	magnesium nitride		$FeBr_2$	*iron(II) bromide*
Cu_2S	copper(I) sulfide		PbS	*lead(II) sulfide*
MnI_2	manganese(II) iodide		Ba0	*barium oxide*
FeP	iron(III) phosphide		K_20	*potassium oxide*
CuO	copper(II) oxide		$SbBr_3$	*antimony(III) bromide*
Sn_3N_2	tin(II) nitride		Fe_3P_2	*iron(II) phosphide*
SrO	strontium oxide		Li_2Se	*lithium selenide*
SnO_2	tin(IV) oxide		$CuCl_2$	*copper(II) chloride*

Extra Drill H: Nomenclature of Ionic Compounds of Monatomic Ions (Both Fixed & Variable Charges)

FORMULA	NAME
$RaCl_2$	
$BiCl_3$	
Fe_20_3	
$CdBr_2$	
Mn0	
$Mn0_2$	

Extra Drill H: Nomenclature of Ionic Compounds of Monatomic Ions (Both Fixed & Variable Charges)

FORMULA	NAME
$RaCl_2$	*radium chloride*
$BiCl_3$	*bismuth(III) chloride*
Fe_20_3	*iron(III) oxide or ferric oxide*
$CdBr_2$	*cadmium(II) bromide*
Mn0	*manganese(II) oxide*
$Mn0_2$	*manganese(IV) oxide*