Chemistry Resource NAME: ______________________________

Naming Chemical Compounds Block: _________

When naming or determining the name of a chemical compound, you must first decide what system to use. The system depends on the type of compound. In addition to the systematic names, some compounds are normally known by common or traditional names. The common names may not indicate anything about the formula but are used nevertheless. An example of a common name is water, for H_2O. (The systematic name is dihydrogen oxide, but no one calls it anything but water.) Ammonia, NH_3, and acetic acid, $HC_2H_3O_2$, are two other common names of very common compounds.

Since the systems are based on the elements, knowing the names and symbols of common elements is expected. The common elements are those through at least atomic number 20. Other common elements are atomic numbers 24-30, all but the last element in the halogens (group 17), the noble gases (group 18), alkali metals (group 1), and alkali earth metals (group 2), the first row transition metals (Sc, Ti, V, Cr, etc.) and the elements Ag, Au, Cd, Hg, Sn, Sb, Pt, Pb, and Bi.

Molecular compounds are normally a combination of nonmetals. Although they are molecular compounds, organic compounds are classified differently. Organic compounds are based on carbon. Typically, combinations consisting mostly of carbon and hydrogen are named with the organic naming system.

Ionic compounds are normally a combination of a metal, which forms the cation, and a nonmetal or combination of nonmetals, which form the anion. One common cation that is not a metal is NH_4^+, ammonium ion. Compounds containing the ammonium ion are still ionic, even though they do not contain a metal.

Making hydrogen the first element of the chemical formula indicates that it is an acid. This is standard for inorganic (not organic) acids. Organic acids are named with the organic naming system. An important type of organic acid has a formula that ends with COOH.

The names of chemical compounds are not capitalized. When you write a formula, the chemical symbols must be exact, including upper and lower case, for the formula to be correct. There are exceptions to most rules, but the following work for commonly encountered compounds.

Binary Molecular Compounds

Binary molecular compounds are composed of two types of nonmetals. The nonmetals are normally ordered with the element leftmost on the periodic table first. If both elements are in the same column, then the element lower on the periodic table is first. The order is the same for the formula and the name.

Because the nonmetals can combine in many ways, prefixes are used to express how many atoms of each element are in the atom. Memorize the following list of prefixes.

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

The prefix for one (mono) is starred because its use is optional for the second element. If there is only one atom of the first element, *no* prefix is used.

To name the compound, start with the name of the first element, adding the prefix if there is more than one atom of that element. After a space, use the appropriate prefix for the second element, the root of the element name and the ending *ide*.

Cations

Most cations are monatomic metals. Two important exceptions are ammonium ion, NH_4^+, and mercury(I) ion, Hg_2^{2+}. An uncharged metal can be differentiated from the ion in the formula because the ion will either be combined with an anion or have a superscripted (to the right) charge. Likewise, the metal is known to be an ion if its name is combined with the name of an anion or if its name is followed by the term *ion*. If it is uncharged, the name is commonly followed by term *metal*.

The name of metal ions with only one common charge is the same as the name of the metal. Two groups of metals with only one common charge are the alkali metals (group 1) and the alkali earth metals (group

2). Alkali metals always have a charge of +1, which is, not coincidentally, the group number and the number of electrons that, when lost, give the metal a noble gas electron configuration. When writing the formula of the ion, do not include the 1 as part of the charge. Alkali earth metals always have a +2 charge. In addition to these two groups, aluminum is always Al^{3+}, zinc is Zn^{2+}, and silver is Ag^{+}.

Other metals (most commonly transition metals) can form different ions with different charges, therefore the name must reflect charge. This is done by following the name of the metal with the charge, as a roman numeral, in parenthesis. (The "+" is assumed and not part of the Roman numeral.) An example is iron(II) to represent Fe^{2+}. An older way of designating charge is to use the Latin name and the suffix *ic* for the common ion of that metal with the *highest* charge and the suffix *ous* for the common ion with the *lowest* charge. Ions for which the older system is still commonly used are Fe^{3+}, ferric ion; Fe^{2+}, ferrous ion; Cu^{2+}, cupric ion; and Cu^{+}, cuprous ion. Less common but still in use are stannic ion and stannous ion for Sn^{4+} and Sn^{2+}, as well as plumbic ion and plumbous ion for Pb^{4+} and Pb^{2+}.

Anions

Monatomic anions are formed from nonmetals. These ions are named with the root element name and the suffix *ide*. The charge on these ions is the number of electrons needed for a noble gas configuration (or number of spaces needed to reach a noble gas). Therefore monatomic ions of the halogens (group 17) all have a –1 charge (don't write the 1 in the formula) and are collectively called halides.

Polyatomic anions are very common. These are normally combinations of nonmetals but can be combinations of metals and nonmetals. If there are two metals in a compound, the first is probably a cation and the next part of a polyatomic anion. Although there is some system to naming polyatomic ions, it is probably easier to memorize the common ones.

Sometimes a hydrogen is added to multiply charged anion. That changes its name by either adding the word *hydrogen* before the ion's name or by adding a *bi* prefix to the name. Each hydrogen adds +1 to the charge.

Binary Ionic Compounds

Binary ionic compounds may contain more that two elements but are binary because they contain two ions. The cation, a positively charged ion, is written first in both the formula and the name. The number of cations and anions (negatively charged ion) is not expressed in the name, since this value is always the simplest ratio that will make the entire compound neutral (uncharged). The compounds are named by naming the cation, then the anion.

Since the name of the compound does not express the ratio of cation and anion, *knowing the charge of the commonly used ions is essential* to determining the empirical formula. If the charge on one ion is known, it can be used to determine the charge on the other ion, since the entire compound must be neutral.

The names of monatomic (one-atom) ions can be determined systematically. Many polyatomic (many-atom) ions have a system for naming, but often, learning the system is more difficult than just memorizing the names of the ions.

Acids

Since acids are substances that release H^{+} in water, it is traditional to write the hydrogen atom first in the formula. There are two major categories of inorganic acids. Binary acids contain two elements. They are named as *hydro*{element root}*ic acid*. Oxoacids contain oxygen. The names of these acids are based on the anion the acid came from. (Hydrogen acts as a cation, H^{+}. Although acids are molecular compounds, they react with water to form ions.) If the anion has an *ate* ending, the *ate* is changed to *ic* and the word *acid* added. If the anion has an *ite* ending, the *ite* is changed to *ous* and is followed by *acid*.