

Naming Compounds

Before naming a compound, you have to figure out what kind of compound it is. We will review the three types and introduce new material on them.

1. **Covalent Compounds.** These are formed from non-metals that share electrons. Because there are many sharing possibilities between two non-metals, the formula cannot be guessed unless we have a naming system that reveals the number of atoms involved.

For this we use a set of prefixes:

The only time we drop a prefix is if the *mono* is to appear at the beginning of the name.

Examples: CO = carbon monoxide
(note we don't say *monocarbon monoxide*)
CO₂ = carbon dioxide

Prefix	Number of atoms
mono	1
di	2
tri	3
tetra	4
penta	5
hexa	6

dinitrogen pentoxide = N₂O₅.
phosphorus trichloride PCl₃.

Note that none of the above compounds contain a metal. Metals do not form covalent compounds, so we generally don't use prefixes for compounds containing metals.

2. **Ionic Compounds Without a Transition Metal.**

Ionic compounds are formed when a metal gives up its electrons to a non-metal. Basically if the compound contains a metal, it is ionic. But there are different sets of rules for transition metals. A transition metal is an element with an atomic number of 21 to 30, 39 to 48, or 57 to 80.

- a. So **for a compound with any other metal**, apply these rules:
- The metal ion's name does not change regardless of charge
 - The non-metal's name ends in *ide*.

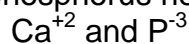
For example: AlCl₃ = aluminum chlor**ide**
Na₂S = sodium sulf**ide**
K₂O = potassium ox**ide**
MgH₂ = magnesium hydr**ide**

Notice how the little numbers (subscripts) do not affect the way we name them.

- b. In **going backwards** (from name to formula), we will have more fun. In such a case the total charge of the (+) and (-) ions in the compound has to be ZERO.

Example: What is the correct formula for calcium phosphide?

Here, we have to consider the common charges for calcium and phosphorus, which are +2 and -3, respectively. Calcium, if you recall, typically loses two electrons to get a noble gas electron arrangement, and phosphorus needs three more electrons.



One of each would create a sum of $2 + (-3) = -1$. To get a sum of zero, we need three Ca^{+2} ions and two P^{-3} for a total of $3(2) + 2(-3) = 0$.

So the answer is Ca_3P_2 .

Other examples: potassium oxide: K^{+1} and O^{-2} give K_2O
aluminum bromide Al^{+3} and Br^{-1} yield AlBr_3 .

c. Polyatomic Ions

When metals are bonded to polyatomic ions, *which consist of two or more atoms with one overall charge*, the same rules apply, but you have to learn the names and charges of common polyatomic ions.

Polyatomic Ion	Name
NH_4^{+1}	ammonium
OH^{-1}	hydroxide
ClO_3^{-1}	chlorate
ClO_2^{-1}	chlorite
NO_3^{-1}	nitrate
NO_2^{-1}	nitrite
$\text{C}_2\text{H}_3\text{O}_2^{-1}$	acetate (polish remover)
CO_3^{-2}	carbonate
HCO_3^{-1}	hydrogen carbonate or bicarbonate
SO_4^{-2}	sulfate
SO_3^{-2}	sulfite
PO_4^{-3}	phosphate

Na_2CO_3 = sodium carbonate. (This is a useful chemical in purifying others; it is sometimes called *washing soda*.)

KNO_3 = potassium nitrate (This is an ingredient of gunpowder and it is also found in fertilizer.)

To go backwards:

Aluminum sulfate

This has Al^{+3} and SO_4^{-2} . To get a sum charge of ZERO, we need two aluminum ions and three sulfates, so the formula becomes $\text{Al}_2(\text{SO}_4)_3$. Notice that when there is more than one polyatomic group, we make use of brackets.

A couple of other interesting facts concerning the naming of polyatomic ions follows:

- When **two** different "versions" of a polyatomic ion exists (highlighted in chart):
 - the ion with more atoms is named: "___ate"
 - the ion with fewer atoms is named: "___ite"

Therefore:

SO_4^{2-} is the sulfate ion and

SO_3^{2-} is the sulfite ion

This should help you keep the names straight.

3. Ionic Compounds With a Transition Metal.

The only difference here is that we have to specify the charge of the transition metal ion by using a Roman numeral, and keep in mind that a transition metal is an element with an atomic number of 21 to 30, 39 to 48, or 57 to 80.

Roman numeral	Charge
I	+1
II	+2
III	+3
IV	+4
V	+5
VI	+6

The reason we do this is not for the sake of nostalgia for bygone Roman numerals nor to imitate movie credits. Because transition metals can assume more than one charge, we have to specify which one is involved.

Example: manganese(II) oxide contains Mn^{+2} and O^{-2} . So we just need one of each and the formula becomes MnO .

Copper(I) oxide is Cu_2O .

To go backwards, we need to figure out the charge of the transition metal.

Example: What is the correct name of CrCl_3 ?

The charge of Cr is unknown = x . But chloride = (-1) . The sum of the charges has to be zero,
so: $x + 3(-1) = 0$.
 $x = 3$.

Answer: CrCl_3 = chromium (III) chloride.

There are some exceptions. When naming a compound with a transitional element, there are 3 transitional metals whose charge remains consistent between compounds, so that the Roman numeral system is not used.

They are: Zn^{2+} , Cd^{2+} , and Ag^+

In these cases, use the rules for naming of ionic compounds.

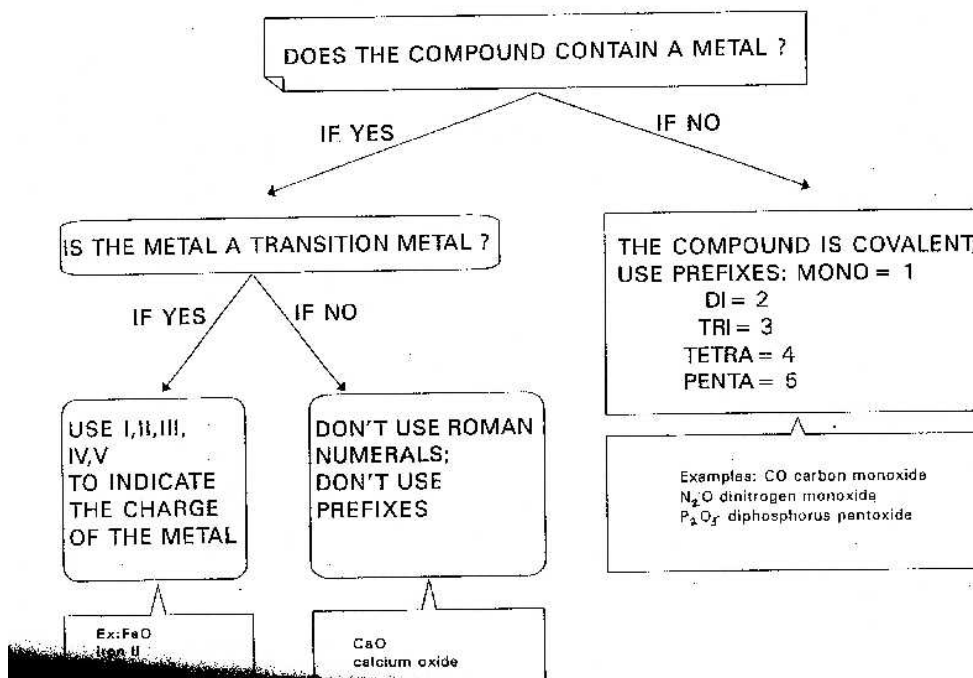
For example, Ag_2SO_4 is named silver sulfate, rather than silver (I) sulfate.

$\text{Zn}(\text{SO}_3)_2$ is named zinc sulfite, rather than zinc (II) sulfite.

Oddly enough, the metals in groups III A through VI A act like transitional metals. They have the ability to have different charges. The exception is Al^{+3} . Aluminum always has a +3 charge in its ion state. This means that when an ionic compound is formed with one of the metals in these groups, that the Roman numeral system must be used (except aluminum). For example, $\text{Pb}(\text{CO}_3)_2$ is lead (IV) carbonate, rather than lead carbonate.

There is more detail available regarding this that you may choose to research to better understand why. It has to do with orbitals and is quite interesting.

Summary:



More Practice With Naming

1. Name the following:

a. NaOH; b. Li₂S; c. FeCl₃; d. H₂O; e. K₃N; f. CaSO₄

2. Write formula for the following:

a. beryllium chloride; b. copper (I) oxide; c. diphosphorus pentoxide;
d. aluminum carbonate; e. ammonium phosphate; f. sulfur dioxide

Answers

1. a. sodium hydroxide b. lithium sulfide c. iron(III)chloride d. dihydrogen monoxide e. potassium nitride f. calcium sulphate
2. a. BeCl₂ b. Cu₂O c. P₂O₅ d. Al₂(CO₃)₃ e. (NH₄)₃PO₄ f. SO₂