

Introduction

In the previous note pack, we discussed molecular and ionic compounds. In this note pack, we will narrow our focus to the ionic compounds and discuss how they are named. The naming system for ionic compounds is fairly straightforward., but you'll want to practice with examples in your textbook and on the web to make sure you get it right.

The steps of naming an ionic compound: Step 1

First, you must **make sure the compound is ionic in the first place**. We've already discussed this in more detail, but **in general** you're looking for metallic elements combined with nonmetallic elements. An exception to this rule are certain compounds involving **polyatomic ions**. Polyatomic ions are combinations of several elements that **together** act as a single ion. Most of these are anions, but at least one common polyatomic ion is a cation. A few common polyatomic ions are listed below in the table. See your textbook or the course web site for a more complete list.

<i>Name of ion</i>	<i>Chemical formula</i>
nitrate ion	NO_3^-
ammonium ion	NH_4^+
carbonate ion	CO_3^{2-}
sulfate ion	SO_4^{2-}
sulfite ion	SO_3^{2-}

Step 2: Name the ions

Second, you must **name the ions**. How you name an ion depends on what kind of ion you're talking about in the first place – a cations or an anion. By convention, ionic compounds are written with their cation (usually a metal) first, followed by the anion.

Here's how you name a cation. Single-element cations are named using the name of the element forming the ion, plus “ion”. For **transition metal cations**, the charge must be indicated. You need to indicate the charge of a transition metal cation because most transition metals can form several different cations - each with a different charge. Iron (Fe), for example, regularly forms cations with +2 and +3 charges: Fe^{2+} and Fe^{3+} . The transition metal cations are named like other cations, except that you use a Roman numeral in parenthesis after the element name to indicate the **charge** of the cation. Here are a few examples.

<i>Chemical formula</i>	<i>Name of cation</i>
Fe^{2+}	iron(II) ion
Mg^{2+}	magnesium ion
Fe^{3+}	iron(III) ion
Na^+	sodium ion
Ti^{4+}	titanium(IV) ion

You will sometimes see a few of the transition metal cations named using only the element name – ions like Ag^+ (silver ion) and Zn^{2+} (zinc ion). Chemists sometimes leave off the Roman numerals on these ions because silver always forms a +1 ion and zinc always forms a +2 ion.

Most anions are simple to name. To name a single-element anion, take the **stem name** of the element and add “-ide ion”. Here are a few examples (with stem names in bold).

<i>Chemical formula</i>	<i>Name of anion</i>
O^{2-}	oxide ion
F^-	fluoride ion
N^{3-}	nitride ion
Cl^-	chloride ion
S^{2-}	sulfide ion

Some cations and anions contain more than one element – the polyatomic ions we mentioned above. You'll eventually memorize the names of these ions, but start off referring to an ion chart for the names.

Step 3: Name the compound

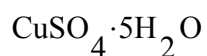
Finally, you **name the compound**. You name the ionic compound by simply combining the names of the cation and anion, removing the word “ion” from each. So, a compound made from copper(II) ion and chloride ion would be called “copper(II) chloride”. Here are some example ionic compounds and their names. See if you can write the names of the compounds from their formulas, or the formulas of the compounds from their names.

<i>Chemical formula</i>	<i>Name of compound</i>
Na ₂ SO ₄	sodium sulfate
MgF ₂	magnesium fluoride
Ca ₃ N ₂	calcium nitride
Fe ₂ O ₃	iron(III) oxide
CuF ₂	copper(II) fluoride
Ti(NO ₃) ₄	titanium(IV) nitrate

A special case: Hydrates

Ionic compounds are often collected by crystallizing them from water. In the crystallization process, water molecules may actually become part of the crystals of some ionic compounds. Ionic compounds that have water molecules bound up in their crystals are called **hydrates**, and the water molecules are called **water of hydration**. Since ionic crystals have very definite structures, hydrate crystals contain a definite amount of water.

We write the water of hydration as part of the chemical formula of the hydrate. The water of hydration, though, is only **weakly** bound to the crystals, and can be driven off by heating. We use a special notation to indicate that the water is weakly bound. Here is an example of the notation:



This notation indicates that, in the crystal, there are five units of water per unit of CuSO₄. The water of hydration is indicated by a dot. This indicates that the water is weakly associated with the CuSO₄.

We would name this compound like we would any other ionic compound – but we also need to indicate the presence of the water. We indicate the presence of the water by using the word "hydrate" along with a **prefix** indicating the number of water molecules associated with the ionic compound. The first ten prefixes are listed in the chart. Most of them will sound familiar.

<i>Number</i>	<i>Prefix</i>
1	mono-
2	di-
3	tri-
4	tetra-
5	penta-
6	hexa-
7	hepta-
8	octa-
9	nona-
10	deca-

The hydrate above is named “copper(II) sulfate **pentahydrate**”. Some other examples are below.

<i>Chemical formula</i>	<i>Name of hydrate</i>
$\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$	barium chloride di hydrate
$\text{CrCl}_3 \cdot 6\text{H}_2\text{O}$	chromium(III) chloride hexa hydrate
$\text{Ba}(\text{OH})_2 \cdot 8\text{H}_2\text{O}$	barium hydroxide octa hydrate

Naming an ionic compound - in brief

Here's a brief run-down of the steps you'd take to name an ionic compound:

1. First, either write or **obtain the chemical formula**. You may have the formula already given to you (e.g. on the side of a bottle of a chemical in the lab), or you might have to write the formula based on the elements present in the compound. Ionic formulas are always written cation first, anion second.
2. Second, **name the ions**. If your cation is a transition metal, don't forget the Roman numeral to specify the charge (e.g. Fe^{3+} is "iron(III) ion").
3. Third, **name the compound**. Strip the word "ion" off the names of the cation and anion and put the names together. If your compound is a hydrate, indicate this by following the name of the compound with the word "hydrate" - with the appropriate Greek prefix.

Summary

In this note pack, we have discussed the naming of ionic compounds. After reading this note pack, you should understand how to write the name of an ionic compound given the formula, or how to write the formula of an ionic compound given the name. You should also be able to deal with the names of a special class of ionic compounds called hydrates - ionic compounds which have definite amounts of water bound in their crystals.