Compounds Involving a Polyatomic Ion

Given Formula, Write the Name

These compounds to follow ARE NOT binary compounds. They contain three or more elements, as opposed to only two in a binary compound.

Consequently, a warning: it is important that you learn to recognize the presence of a polyatomic ion in a formula. Many ChemTeam students have made it their first priority to make a set of flashcards with the name on one side and the ion and its charge on the other. Then, carry them everywhere and use them.

The cations used will be a mix of fixed charges AND variable charges. You must know which are which.

Another warning: you must also know the charges associated with each polyatomic ion. For example, NO_3^- is called nitrate and it has a minus one charge. Once again, many unaware ChemTeam students have thought this means nitrate has a minus three charge. IT DOES NOT.

Use of Parenthesis

When more than one polyatomic ion is required, parenthesis are used to enclose the ion with the subscript going outside the parenthesis. For example, the very first formula used is $Fe(NO_3)_2$. This means that two NO_3^- are involved in the compound. Without the parenthesis, the formula would be $FeNO_{32}$, a far cry from the correct formula.

When you say a formula involving parenthesis out loud, you use the word "taken" as in the formula for ammonium sulfide, which is $(NH_4)_2S$. Out loud, you say "N H four taken twice S." OR with the formula for copper(II) chlorate, which is $Cu(ClO_3)_2$. You say " Cu Cl O three taken twice."

Example #1 - write the name for **$Fe(NO_3)_2$**

Step #1 - decide if the cation is one showing variable charge. If so, a Roman numeral will be needed. In this case, iron does show variable charge.

If a variable charge cation is involved, you must determine the Roman numeral involved. You do this by computing the total charge contributed by the polyatomic ion. In this case, NO_3^- has a minus one charge and there are two of them, making a total of minus 2.

Therefore, the iron must be a positive two, in order to keep the total charge of the formula at zero.

Step #2 - determine the name of the polyatomic ion. Nitrate is the name of NO_3^-.

The correct name is iron(II) nitrate. The common name would be ferrous nitrate.

Example #2 - write the name for **NaOH**

Step #1 - the cation, Na^+, does not show a variable charge, so no Roman numeral is needed. The name is sodium.

Step#2 - OH^- is recognized as the hydroxide ion.

The name of this compound is sodium hydroxide.

Usually, at this point, a cry is heard in the ChemTeam's classroom. "But how do you know that OH^- is hydroxide?" is the plaintive wail. The stock ChemTeam answer is "Well, how do you know anything? How do you know your phone number? How do you know your best friend's name? In fact, how do you know your name?" There are three things you must memorize: the name (hydroxide), the symbol (OH) and the charge (minus one). You must put in the time to learn this nomenclature stuff. It does not come easy and the ChemTeam realizes you'd rather be spending the time doing more important things: going cool places with friends, spending time with members of the opposite sex, spending your parents' money, sleeping, etc. Maybe some other time. Right now, let's move on.

Example #3 - write the name for **$KMnO_4$**

Step #1 - the cation, K^+, does not show a variable charge, so no Roman numeral is needed. The name is potassium.

Step#2 - MnO_4^- is recognized as the permanganate ion.

The name of this compound is potassium permanganate.

Example #4 - write the name for **Cu_2SO_4**

Step #1 - decide if the cation is one showing variable charge. If so, a Roman numeral will be needed. In this case, copper does show variable charge.

If a variable charge cation is involved, you must determine the Roman numeral involved. You do this by computing the total charge contributed by the polyatomic ion. In this case, SO_4^{2-} has a minus two charge and there is only one, making a total of minus 2.

Therefore, the copper must be a positive one. Why? Well, there must be a positive two to go with the negative two in order to make zero. Since the formula shows two copper atoms involved, each must be a plus one charge.

Step #2 - determine the name of the polyatomic ion. Sulfate is the name of SO_4^{2-}.

The correct name is copper(I) sulfate. The common name would be cuprous sulfate.

Example #5 - write the name for **$Ca(ClO_3)_2$**

The first part of the name comes from the first element's name: calcium. You also determine that it is not a cation of variable charge.

The second part of the name comes from the name of the polyatomic ion: chlorate.

This compound is named calcium chlorate.

Example #6 - write the name for **$Fe(OH)_3$**

Iron is an element with two possible oxidation states. The iron is a +3 charge because (1) there are three hydroxides, (2) hydroxide is a minus one charge, (3) this gives a total charge of negative three and (40 there is only one iron, so it must be a +3.

Therefore the first part of the name is iron(III).

The second part of the name is hydroxide, the name of the polyatomic ion.

The name of this compound is iron(III) hydroxide (or ferric hydroxide when using the common method).

Practice Problems

The cations in this first set are all of fixed oxidation state, so no Roman numerals are needed.

Write the correct name for:

1) $AlPO_4$

2) KNO_2

3) $NaHCO_3$

4) $CaCO_3$

5) $Mg(OH)_2$

6) Na_2CrO_4

7) $Ba(CN)_2$

8) K_2SO_4

9) NaH_2PO_4

10) NH_4NO_3

These formulas involve the use of a polyatomic ion. The cations are all of variable oxidation state, so Roman numerals are needed.

Write the correct name for:

11) $Sn(NO_3)_2$

12) $FePO_4$

13) Cu_2SO_4

14) $Ni(C_2H_3O_2)_2$

15) $HgCO_3$

16) $Pb(OH)_4$

17) $Cu_2Cr_2O_7$

18) $Cu(ClO_3)_2$

19) $FeSO_4$

20) $Hg_2(ClO_4)_2$

These formulas mix the use of the two types of cations.

Write the correct name for:

21) $KClO_3$

22) $SnSO_4$

23) $Al(MnO_4)_3$

24) $Pb(NO_3)_2$

25) $Mg_3(PO_4)_2$

26) CuH_2PO_4

27) $CaHPO_4$

28) $Fe(HCO_3)_3$

29) Na_2CO_3

30) $MnSO_4$