Polyatomic Ions: # of Oxygen, Names, & Charges

Determining the name of a polyatomic ion when given the formula, or the chemical formula and charge when given the name can be simplified with a few simple rules for most cases. Recognize that the table below is from the upper right corner of the periodic table (the non-metals). Then get to know the two rows of numbers I’ve added across the top. Explained below is how to use those numbers.

<table>
<thead>
<tr>
<th>Standard oxygen # (for –ate ion)</th>
<th>3</th>
<th>4</th>
<th>4</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Charge</td>
<td>-2</td>
<td>-3</td>
<td>-2</td>
<td>-1</td>
</tr>
<tr>
<td>C</td>
<td>N</td>
<td>O</td>
<td>F</td>
<td></td>
</tr>
<tr>
<td>Si</td>
<td>P</td>
<td>S</td>
<td>Cl</td>
<td></td>
</tr>
<tr>
<td>As</td>
<td>Se</td>
<td>Br</td>
<td>I</td>
<td></td>
</tr>
</tbody>
</table>

1) Identify the non-oxygen element
2) Determine the suffix
3) Determine any prefix
4) Identify the charge

Name or give formulas for the following polyatomic ions:

\[ \text{NO}_3^- \quad \text{SO}_4^{2-} \quad \text{carbonate} \quad \text{hypochlorite} \quad \text{HSO}_3^- \]

0) Nitrogen is a weirdo!

Before we get started, if you have nitrogen in your ion, throw these rules out! You’ve just got to commit to memory that nitrate is \( \text{NO}_3^- \). We can still adjust things from there, but the number of oxygens and charge do not follow the pattern of the rest. Sorry!

1) Identify the non-oxygen element

Assuming a non-nitrogen polyatomic ion, the first step is to identify the non-metal present. These will closely parallel the names of the elements. For the list above, that means you determine (skipping nitrate):

sulfur, carbon, chlorine, sulfur
2) Determine the suffix

**ATE** - If the ion has at least as many oxygen present as indicated in the table the suffix will be ‘-ate.’

**ITE** - If the ion has fewer oxygen present than indicated in the table, the suffix will be ‘-ite.’

The ending of your polyatomic ion name is an indicator of how many oxygen atoms are paired with the non-metal. There are two endings. “-ate” is the standard ending, and it will always have the at least the number of oxygens as indicated in the table above – 3, 4, 4, or 3 depending on the group. It is possible to increase the number of oxygen present by 1, or to decrease it by 1 or 2. **Only with fewer oxygen does the suffix change.**

3) Determine the prefix

**PER** – Add ‘per-’ if the number of oxygen is higher than the standard number from the table. (4, 5, 5, 4)

**HYPO** – Add ‘hypo-’ if the number of oxygen is two lower than the standard number. (1, 2, 2, 1)

The beginning of your polyatomic ion name also indicated how many oxygen atoms are paired with the non-metal. If extra oxygen are present then ‘per-’ is added, short for hyper. Remember, hyper means above. Recall that it’s possible for ions to have either one or two fewer oxygen than standard (see step 2). If there are two fewer, then not only does the suffix change from ‘-ate’ to ‘-ite,’ but the prefix ‘hypo-’ is also added. Remember, hypo means below.

So let’s look at the examples one more time. Skipping the nitrate ion:

<table>
<thead>
<tr>
<th>Sulfate</th>
<th>CO₃</th>
<th>ClO</th>
<th>Sulfite (but there is that H)</th>
</tr>
</thead>
</table>

4) Identify the Charge

The charges for polyatomic anions are related to the non-metal present and **do not change** based on the number of oxygen present. So to determine charge you only need to refer to the table and the row labeled charge. Do note that the charges mirror the charges for the lone elemental anions. Just as chloride is -1 (as in NaCl), chlorate polyatomic anions are also -1 (NaOCl, sodium hypochlorite).

<table>
<thead>
<tr>
<th>Sulfate (2-)</th>
<th>CO₃²⁻</th>
<th>ClO⁻</th>
<th>Sulfite (2-) (but there’s still that H)</th>
</tr>
</thead>
</table>

**What about those added hydrogens?** If the ion has an extra hydrogen, that will affect the name and the charge. To name the ion you have the option of adding “hydrogen-” or “bi-” to the beginning.

Unfortunately it’s not super clear cut. Adding “hydrogen-“ or “dihydrogen-“ indicates exactly how many hydrogen are present. Adding “bi-“ is the old way of indicating the presence of a hydrogen.

Note that hydrogen also brings with it a +1 charge! This is just as you would find in balancing chemical formulas. So if a hydrogen is present, the charge of the ion will become less negative by 1. See the example with HSO₃⁻. Sulfur polyatomic ions usually have a -2 charge, but with the H, the ion becomes -1. You’ll also see this with carbonate ions.

Following these rules you can name almost any polyatomic oxygen-containing ion.