

Common Polyatomic Ions and the Corresponding Acids

There is a pattern associated with many of the polyatomic ions in chemistry that can aid you when learning names and the relationships with the corresponding acids. Some combinations of a central atom with oxygen are found more often in nature, and they are designated the “common” form of the polyatomic... yet due to oxygen’s “social nature”, several other combinations of the central atom with oxygen can exist. A pattern exists which relates the number of oxygen atoms relative to the “common” form... and this pattern can be extended to a host of oxygen-containing acids.

First, remember this phrase:

“Nick the Camel Brat ate Icky Clam for Supper in Phoenix”

This phrase helps you remember the **central atom**, the **number of oxygen atoms in the “common” form** of the polyatomic, and the **charge** on the polyatomic ion. *All of the common form polyatomic ions get an “ate” suffix.*

- The **number of consonants** = the **number of oxygen atoms** in the common form of the polyatomic ion
- The **number of vowels** = the **negative charge** on the polyatomic ion

Nick = **nitrate**, NO_3^{-1}

Camel = **carbonate**, CO_3^{-2}

Brat = **bromate**, BrO_3^{-1}

Icky = **iodate**, IO_3^{-1} (*note that y is a consonant and not a vowel in this context!*)

Clam = **chlorate**, ClO_3^{-1}

Supper = **sulfate**, SO_4^{-2}

Phoenix = **phosphate**, PO_4^{-3}

- Polyatomic ions in the **common** form have an “**ate**” suffix (i.e. chlorate, ClO_3^{-1})
- Polyatomic ions with **one more oxygen** than the common form get a “**per**” prefix and an “**ate**” suffix (i.e. perchlorate, ClO_4^{-1})
- Polyatomic ions with **one less oxygen** than the common form get an “**ite**” ending (i.e. chlorite, ClO_2^{-1})
- Polyatomic ions with **two less oxygen atoms** than the common form get a “**hypo**” prefix and the “**ite**” suffix (i.e. hypochlorite, ClO^{-1})

The following table shows the various polyatomic ions and all of their known variations:

	<i>nitrogen</i>	<i>carbon</i>	<i>bromine</i>	<i>iodine</i>	<i>chlorine</i>	<i>sulfur</i>	<i>phosphorus</i>
<i>-2 oxygen</i>	-	-	hypobromite , BrO^{-1}	hypoiodite , IO^{-1}	hypochlorite , ClO^{-1}	-	-
<i>-1 oxygen</i>	nitrite , NO_2^{-1}	-	bromite , BrO_2^{-1}	iodite , IO_2^{-1}	chlorite , ClO_2^{-1}	sulfite , SO_3^{-2}	phosphite , PO_3^{-1}
<i>common</i>	nitrate , NO_3^{-1}	carbonate , CO_3^{-2}	bromate , BrO_3^{-1}	iodate , IO_3^{-1}	chlorate , ClO_3^{-1}	sulfate , SO_4^{-2}	phosphate , PO_4^{-3}
<i>+1 oxygen</i>	-	-	perbromate , BrO_4^{-1}	periodate , IO_4^{-1}	perchlorate , ClO_4^{-1}	-	-

Entries with a “-” are not known to exist and can be ignored.

Polyatomic ions readily make acids. An acid is a compound with a hydrogen atom that reacts readily with other substances. In chemistry, we list the acidic hydrogen first to designate its reactivity.

As before, a naming pattern exists for acids containing an oxygenated polyatomic ion:

- Acidic polyatomic ions in the **common** form have an “**ic acid**” suffix (i.e. **chloric acid**, HClO₃)
- Acidic polyatomic ions with **one more oxygen** than the common form get a “**per**” prefix and an “**ic acid**” suffix (i.e. **perchloric acid**, HClO₄)
- Acidic polyatomic ions with **one less oxygen** than the common form get an “**ous acid**” ending (i.e. **chlorous acid**, HClO₂)
- Acidic polyatomic ions with **two less oxygen atoms** than the common form get a “**hypo**” prefix and the “**ous acid**” suffix (i.e. **hypochlorous acid**, HClO)
- Acidic polyatomic ions with **no oxygen atoms** get a “**hydro**” prefix and the “**ic acid**” suffix (i.e. **hydrochloric acid**, HCl)

The following table shows the acidic form of the polyatomic ions with all of their known variations:

	<i>nitrogen</i>	<i>carbon</i>	<i>bromine</i>	<i>iodine</i>	<i>chlorine</i>	<i>sulfur</i>	<i>phosphorus</i>
<i>no oxygen</i>	-	-	hydrobromic acid , HBr	hydroiodic acid , HI	hydrochloric acid , HCl	hydrosulfuric acid , H ₂ S	-
<i>-2 oxygen</i>	-	-	hypobromous acid , HBrO	hypoiodous acid , HIO	hypochlorous acid , HClO	-	-
<i>-1 oxygen</i>	nitrous acid , HNO ₂	-	bromous acid , HBrO ₂	iodous acid , HIO ₂	chlorous acid , HClO ₂	sulfurous acid , H ₂ SO ₃	phosphorous acid , H ₃ PO ₃
<i>common</i>	nitric acid , HNO ₃	carbonic acid , H ₂ CO ₃	bromic acid , HBrO ₃	iodic acid , HIO ₃	chloric acid , HClO ₃	sulfuric acid , H ₂ SO ₄	phosphoric acid , H ₃ PO ₄
<i>+1 oxygen</i>	-	-	perbromic acid , HBrO ₄	periodic acid , HIO ₄	perchloric acid , HClO ₄	-	-

Finally, please note that this list is not 100% inclusive... but similar patterns can be applied to polyatomic ions not on this list. For example,

- H₂SeO₄ = selenic acid *and* H₂SeO₃ = selenous acid
- AsO₄⁻³ = arsenate ion *and* AsO₃⁻³ = arsenite ion