# Common Ions and Their Charges

A mastery of the common ions, their formulas and their charges, is essential to success in AP Chemistry. You are expected to know all of these ions on the first day of class, when I will give you a quiz on them. You will always be allowed a periodic table, which makes indentifying the ions on the left "automatic." For tips on learning these ions, see the opposite side of this page.

| **From the table:** | |
|---|---|
| **Cations** | **Name** |
| $H^+$ | Hydrogen |
| $Li^+$ | Lithium |
| $Na^+$ | Sodium |
| $K^+$ | Potassium |
| $Rb^+$ | Rubidium |
| $Cs^+$ | Cesium |
| $Be^{2+}$ | Beryllium |
| $Mg^{2+}$ | Magnesium |
| $Ca^{2+}$ | Calcium |
| $Ba^{2+}$ | Barium |
| $Sr^{2+}$ | Strontium |
| $Al^{3+}$ | Aluminum |
| | |
| **Anions** | **Name** |
| $H^-$ | Hydride |
| $F^-$ | Fluoride |
| $Cl^-$ | Chloride |
| $Br^-$ | Bromide |
| $I^-$ | Iodide |
| $O^{2-}$ | Oxide |
| $S^{2-}$ | Sulfide |
| $Se^{2-}$ | Selenide |
| $N^{3-}$ | Nitride |
| $P^{3-}$ | Phosphide |
| $As^{3-}$ | Arsenide |
| **Type II Cations** | **Name** |
| $Fe^{3+}$ | Iron(III) |
| $Fe^{2+}$ | Iron(II) |
| $Cu^{2+}$ | Copper(II) |
| $Cu^+$ | Copper(I) |
| $Co^{3+}$ | Cobalt(III) |
| $Co^{2+}$ | Cobalt(II) |
| $Sn^{4+}$ | Tin(IV) |
| $Sn^{2+}$ | Tin(II) |
| $Pb^{4+}$ | Lead(IV) |
| $Pb^{2+}$ | Lead(II) |
| $Hg^{2+}$ | Mercury(II) |
| | |
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| **Ions to Memorize** | |
|---|---|
| **Cations** | **Name** |
| $Ag^+$ | Silver |
| $Zn^{2+}$ | Zinc |
| $Hg_2^{2+}$ | Mercury(I) |
| $NH_4^+$ | Ammonium |
| | |
| | |
| **Anions** | **Name** |
| $NO_2^-$ | Nitrite |
| $NO_3^-$ | Nitrate |
| $SO_3^{2-}$ | Sulfite |
| $SO_4^{2-}$ | Sulfate |
| $HSO_4^-$ | Hydrogen sulfate (bisulfate) |
| $OH^-$ | Hydroxide |
| $CN^-$ | Cyanide |
| $PO_4^{3-}$ | Phosphate |
| $HPO_4^{2-}$ | Hydrogen phosphate |
| $H_2PO_4^-$ | Dihydrogen phosphate |
| $NCS^-$ | Thiocyanate |
| $CO_3^{2-}$ | Carbonate |
| $HCO_3^-$ | Hydrogen carbonate (bicarbonate) |
| $ClO^-$ | Hypochlorite |
| $ClO_2^-$ | Chlorite |
| $ClO_3^-$ | Chlorate |
| $ClO_4^-$ | Perchlorate |
| $BrO^-$ | Hypobromite |
| $BrO_2^-$ | Bromite |
| $BrO_3^-$ | Bromate |
| $BrO_4^-$ | Perbromate |
| $IO^-$ | Hypoiodite |
| $IO_2^-$ | iodite |
| $IO_3^-$ | iodate |
| $IO_4^-$ | Periodate |
| $C_2H_3O_2^-$ | Acetate |
| $MnO_4^-$ | Permanganate |
| $Cr_2O_7^{2-}$ | Dichromate |
| $CrO_4^{2-}$ | Chromate |
| $O_2^{2-}$ | Peroxide |
| $C_2O_4^{2-}$ | Oxalate |
| $NH_2^-$ | Amide |
| $BO_3^{3-}$ | Borate |
| $S_2O_3^{2-}$ | Thiosulfate |

# Tips for Learning the Ions

**"From the Table"**

These are ions can be organized into two groups.

1. Their place on the table suggests the charge on the ion, since the neutral atom gains or loses a predictable number of electrons in order to obtain a noble gas configuration. This was a focus in first year chemistry, so if you are unsure what this means, get help BEFORE the start of the year.
    a. All Group 1 Elements (alkali metals) lose one electron to form an ion with a 1+ charge
    b. All Group 2 Elements (alkaline earth metals) lose two electrons to form an ion with a 2+ charge
    c. Group 13 metals like aluminum lose three electrons to form an ion with a 3+ charge
    d. All Group 17 Elements (halogens) gain one electron to form an ion with a 1- charge
    e. All Group 16 nonmetals gain two electrons to form an ion with a 2- charge
    f. All Group 15 nonmetals gain three electrons to form an ion with a 3- charge

    Notice that cations keep their name (sodium ion, calcium ion) while anions get an "-ide" ending (chloride ion, oxide ion).

2. Metals that can form more than one ion will have their positive charge denoted by a roman numeral in parenthesis immediately next to the name of the

**Polyatomic Anions**

Most of the work on memorization occurs with these ions, but there are a number of patterns that can greatly reduce the amount of memorizing that one must do.

1. "ate" anions have one more oxygen then the "ite" ion, but the same charge. If you memorize the "ate" ions, then you should be able to derive the formula for the "ite" ion and vice-versa.
    a. sulfate is $SO_4^{2-}$, so sulfite has the same charge but one less oxygen ($SO_3^{2-}$)
    b. nitrate is $NO_3^-$, so nitrite has the same charge but one less oxygen ($NO_2^-$)

2. If you know that a sufate ion is $SO_4^{2-}$ then to get the formula for hydrogen sulfate ion, you add a hydrogen ion to the front of the formula. Since a hydrogen ion has a 1+ charge, the net charge on the new ion is less negative by one.
    a. Example:

| | | | | |
|---|---|---|---|---|
| $PO_4^{3-}$ | → | $HPO_4^{2-}$ | → | $H_2PO_4^-$ |
| phosphate | | hydrogen phosphate | | dihydrogen phosphate |

3. Learn the hypochlorite → chlorite → chlorate → perchlorate series, and you also know the series containing iodite/iodate as well as bromite/bromate.
    a. The relationship between the "ite" and "ate" ion is predictable, as always. Learn one and you know the other.
    b. The prefix "hypo" means "under" or "too little" (think "hypodermic", "hypothermic" or "hypoglycemia")
        i. Hypochlorite is "under" chlorite, meaning it has one less oxygen
    c. The prefix "hyper" means "above" or "too much" (think "hyperkinetic")
        i. the prefix "per" is derived from "hyper" so perchlorate (hyperchlorate) has one more oxygen than chlorate.
    d. Notice how this sequence increases in oxygen while retaining the same charge:

| | | | | | | |
|---|---|---|---|---|---|---|
| $ClO^-$ | → | $ClO_2^-$ | → | $ClO_3^-$ | → | $ClO_4^-$ |
| hypochlorite | | chlorite | | chlorate | | perchlorate |