

Tutorial 5: Writing Chemical Formulas for Ionic Compounds

Goals:

- ✓ Be able to write formulas and names for elements, ions and ionic compounds.
- ✓ Memorize the polyatomic ions that are required for your chemistry class.

Naming Cations

Cations: When a metal loses its valence electron(s) it becomes a cation, which is an ion with a positive charge.

- Loss of electrons is known as oxidation.
- A metal will usually lose all valence electrons when oxidized. Since the number of valence electrons is equal to the group number, it is easy to predict the number of electrons that will be lost from an atom by looking at the group number.
- The cation is named by using the element name followed by the word “ion”.

Examples:

- Sodium is in group 1, and it will lose 1 electron to form the cation Na^+ , known as a sodium ion.
- Calcium is in group 2, and it will lose 2 electrons to form the cation Ca^{2+} , known as a calcium ion.

NOTE: Metals in group 4A (Sn and Pb), and many transition metals have multiple oxidation states possible. This is a more advanced topic that will not be covered here.

Naming Anions

Anions: When a nonmetal gains electrons to its valence shell it becomes an anion, which is an ion with a negative charge.

- Gain of electrons is known as reduction.
- Nonmetals will gain enough electrons to complete octet. This is easily calculated by subtracting the group number from 8.
- The anion is named by using the stem of the element's name with an *-ide* ending.

Examples:

- Fluorine is in group 7, and it will gain 1 electron to form F^- , which is known as a fluoride ion.
- Oxygen is in group 6, and it will gain 2 electrons to form O^{2-} , which is known as an oxide ion.

Chemical Formulas for Ionic Compounds

Ionic compounds are formed when electrons are transferred between atoms in order to achieve a stable electron configuration (octet). Ions are formed, but the overall charge on the compound balances out to neutral. Ionic compounds are held together by electrostatic forces of attraction, and are typically formed when metals react with nonmetals.

Binary Ionic Compounds: contain only one type of metal and one type of nonmetal.

Formula to name:

- Write the name of the cation
- Write the name of the anion (use the -ide ending)

Example:

Na_2S is named as sodium sulfide

Chemical Formulas for Ionic Compounds Continued

Name to formula:

- Determine the charge on the cation
- Determine the charge on the anion
- Determine the ratio of cations to anions needed to make the compound neutral
- Always express the ratio of cations to anions in the simplest whole number ratio

Examples:

- Lithium fluoride is composed of Li^+ and F^- ; this forms the compound LiF
- Magnesium bromide is composed of Mg^{2+} and Br^- ; this forms the compound MgBr_2

Naming Ionic Compounds with Polyatomic Ions

Polyatomic Ions: Polyatomic ions are ions that contain two or more atoms (a group of atoms) with an overall charge. Polyatomic ions are held together by covalent bonds (to be discussed later), but they have an overall charge. The next page contains a list of some common polyatomic ions.

Formula to Name:

- Write the name of the cation
- Write the name of the anion

Example:

$\text{Ca}_3(\text{PO}_4)_2$ is named as calcium phosphate

Name to Formula:

- Determine the charge on the cation
- Determine the charge on the anion
- Determine the ratio of cations to anions needed to make the compound neutral
- Always express the ratio of cations to anions in the simplest whole number ratio
- If there is more than one polyatomic ion use parenthesis and write the subscript outside the last parenthesis

Example:

Magnesium nitrate has the formula $\text{Mg}(\text{NO}_3)_2$

Polyatomic Ion Chart

Name	Formula
Acetate	$\text{C}_2\text{H}_3\text{O}_2^-$ (CH_3COO^-)
Carbonate	CO_3^{2-}
Hydrogen carbonate (bicarbonate)	HCO_3^-
Hydroxide	OH^-
Hydronium	H_3O^+
Nitrate	NO_3^-
Nitrite	NO_2^-
Phosphate	PO_4^{3-}
Hydrogen phosphate	HPO_4^{2-}
Dihydrogen phosphate	H_2PO_4^-
Ammonium	NH_4^+
Sulfate	SO_4^{2-}
Sulfite	SO_3^{2-}
Cyanide	CN^-
