# Nomenclature for ionic compounds

## Worksheet

Name _____ Date _____

**Nomenclature** is a system of naming. This worksheet presents a widely used system of nomenclature for ionic compounds.

**The big picture:** How this worksheet is organized:

There are two types of metal cations with different naming conventions discussed separately.

Use a Roman numeral

- **Part A:** Fixed charge (single charge) cations → Never
- **Part B:** Variable charge (multiple charge) cations → Always

## Cations with a single, fixed charge

**Cations** have a positive charge. They are formed from metals, which lie on the left side of the periodic table. The main group (Groups 1-8) metals form cations with a single, fixed charge. The charge is the same as the Group (column) number on the periodic table. The cation name is formed by adding the word "ion" after the element name. For example, the element sodium (Na) is found in Group 1. It ionizes to form the "sodium ion" represented as $Na^+$. The charge is +1 because it is in Group 1.

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**Anions** have a negative charge. They are formed from nonmetals, which lie on the right side of the periodic table. The negative charge is found using the **Octet Rule** as eight (8) minus the Group number. Anions always have a single, fixed charge. The anion name is formed by changing the element name suffix to "-ide" and adding the word "ion" after the element name. For example, the element chlorine (Cl) is found in Group 7. It ionizes to form the "chloride ion" represented as $Cl^-$. The charge is -1 because it is in Group 7, and 8 - 7 = 1.

**Ionic compounds** are formed by cation-anion pairs in electrically neutral ratios. They are named using the cation name first, followed by the anion name, excluding the word "ion." For example, sodium ion ($Na^+$) and chloride ion ($Cl^-$) form the compound sodium chloride. Its formula is NaCl, which is electrically neutral because sodium ion is +1 and chloride ion is -1. As a second example, magnesium chloride has the formula $MgCl_2$. The subscript indicates 2 chloride ions ($Cl^-$) per 1 magnesium ion ($Mg^{2+}$). The subscript "1" is always implied and never written.

***Note: There is <u>never</u> any charge indicated in the name of a compound having a cation with a single, fixed charge. The single, fixed charge is obvious to a chemist.***

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**Exercise 1.** Provide the name or formula for each ion:

| | | | |
|---|---|---|---|
| ___ | chloride ion | $Li^+$ | _____ |
| ___ | bromide ion | $Na^+$ | _____ |
| $F^-$ | _____ | $K^+$ | _____ |
| $S^{2-}$ | _____ | $Mg^{2+}$ | _____ |
| $O^{2-}$ | _____ | $Ca^{2+}$ | _____ |
| $N^{3-}$ | _____ | $Al^{3+}$ | _____ |
| $P^{3-}$ | _____ | ___ | barium ion |
| $I^-$ | _____ | ___ | boron ion |

**Exercise 2.** Complete the table of neutral ionic compounds with the formulas and names for each cation-anion pair.

| | **$Cl^-$** | **$I^-$** | **$S^{2-}$** | **$O^{2-}$** | **$Br^-$** | **$N^{3-}$** |
|---|---|---|---|---|---|---|
| **$Na^+$** | | | | | | |
| **$K^+$** | | | | | | |
| **$Mg^{2+}$** | | | | | | |
| **$Al^{3+}$** | | | | | | |

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### Cations with a variable/multiple charges

Some transition metals have multiple possible cation charges. A roman numeral (I, II, III, IV, V, …) must be used in the cation and ionic compound naming system to distinguish between the charges. For example, iron (Fe) can form the iron (II) ion and also the iron (III) ion, denoted $Fe^{2+}$ and $Fe^{3+}$, respectively. Iron (II) oxide and iron (III) oxide are distinct compounds, with electrically neutral formulas FeO and $Fe_2O_3$, respectively.

**Exercise 3.** Provide the formula for each compound.

iron (II) oxide _____

iron (III) oxide _____

lead (II) chloride _____

lead (IV) iodide _____

cobalt (II) chloride _____

cobalt (III) chloride _____

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### Mixed cation types

The first step in naming an ionic compound is to determine whether or not the cation can exhibit multiple charges. This requires memorization. Learn the following procedure.

1. The main group (Groups 1-8) elements always have a single charge, determined by the column on the periodic table.
2. Silver and zinc are the only transition metals with a single charge. Memorize the ionic charges for $Ag^{+}$ and $Zn^{2+}$.
3. All other transition metals have multiple charges. Use a roman numeral to indicate the cation charge, which can be figured out from the given information.

Exercise 4. Provide the name for each compound.

| | | | |
|---|---|---|---|
| FeO | _____ | CaS | _____ |
| NaCl | _____ | $Ag_2S$ | _____ |
| $CuBr_2$ | _____ | $CoI_3$ | _____ |
| ZnO | _____ | $Be_3N_2$ | _____ |
| $K_3P$ | _____ | NaCl | _____ |