

5.10: Naming Polyatomic and Ternary Ionic Compounds

Learning Objectives

- Recognize polyatomic ions in chemical formulas.
- Write the correct formula for ionic compounds with polyatomic ions.
- Use the rules for naming ionic compounds with polyatomic ions.

Polyatomic Ions

Some ions consist of groups of atoms bonded together and have an overall electric charge. Because these ions contain more than one atom, they are called polyatomic ions. Polyatomic ions have characteristic formulas, names, and charges. For example, NO_3^- is the nitrate ion; it has one nitrogen atom and three oxygen atoms and an overall 1- charge. Table 5.10.1 lists the most common polyatomic ions.

Table 5.10.1 Some Polyatomic Ions

Name	Formula
ammonium ion	NH_4^+
acetate ion	$\text{C}_2\text{H}_3\text{O}_2^-$ (also written CH_3CO_2^-)
carbonate ion	CO_3^{2-}
chromate ion	CrO_4^{2-}
dichromate ion	$\text{Cr}_2\text{O}_7^{2-}$
hydrogen carbonate ion (bicarbonate ion)	HCO_3^-
cyanide ion	CN^-
hydroxide ion	OH^-
nitrate ion	NO_3^-
nitrite ion	NO_2^-
permanganate ion	MnO_4^-
phosphate ion	PO_4^{3-}
hydrogen phosphate ion	HPO_4^{2-}
dihydrogen phosphate ion	H_2PO_4^-
sulfate ion	SO_4^{2-}
hydrogen sulfate ion (bisulfate ion)	HSO_4^-
sulfite ion	SO_3^{2-}

The rule for constructing formulas for ionic compounds containing polyatomic ions is the same as for formulas containing monatomic (single-atom) ions: the positive and negative charges must balance. If more than one of a particular polyatomic ion is needed to balance the charge, the *entire formula* for the polyatomic ion must be enclosed in parentheses, and the numerical subscript is placed *outside* the parentheses. This is to show that the subscript applies to the entire polyatomic ion. An example is $\text{Ba}(\text{NO}_3)_2$.

Writing Formulas for Ionic Compounds Containing Polyatomic Ions

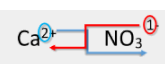
Writing a formula for ionic compounds containing polyatomic ions also involves the same steps as for a binary ionic compound. Write the symbol and charge of the cation followed by the symbol and charge of the anion.

✓ Example 5.10.1: Calcium Nitrate

Write the formula for calcium nitrate.

Solution

Example 5.10.1: Steps For Problem Solving, Write the formula for calcium nitrate

Criss Cross Method	Write the formula for calcium nitrate
1. Write the symbol and charge of the cation (metal) first and the anion (nonmetal) second.	$\text{Ca}^{2+} \quad \text{NO}_3^-$
2. Transpose only the number of the positive charge to become the subscript of the anion and the number only of the negative charge to become the subscript of the cation.	 <p>The 2+ charge on Ca becomes the subscript of NO₃ and the 1- charge on NO₃ becomes the subscript of Ca.</p>
3. Reduce to the lowest ratio.	$\text{Ca}_1(\text{NO}_3)_2$
4. Write the final formula. Leave out all subscripts that are 1. If there is only 1 of the polyatomic ion, leave off parentheses.	$\text{Ca}(\text{NO}_3)_2$

✓ Example 5.10.2

Write the chemical formula for an ionic compound composed of the potassium ion and the sulfate ion

Solution

Example 5.10.2: Explanation for Writing the Chemical Formula for an Ionic Compound Composed of the Potassium Ion and the Sulfate Ion

Explanation	Answer
Potassium ions have a charge of 1+, while sulfate ions have a charge of 2-. We will need two potassium ions to balance the charge on the sulfate ion, so the proper chemical formula is K_2SO_4 .	K_2SO_4

? Exercise 5.10.1

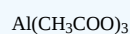
Write the chemical formula for an ionic compound composed of each pair of ions.

- the magnesium ion and the carbonate ion
- the aluminum ion and the acetate ion

Answer a:



Answer b:



Naming Ionic Compounds with Polyatomic Ions

The process of naming ionic compounds with polyatomic ions is the same as naming binary ionic compounds. The cation is named first, followed by the anion. One example is the ammonium sulfate compound in Figure 5.10.6

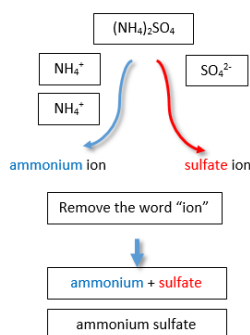
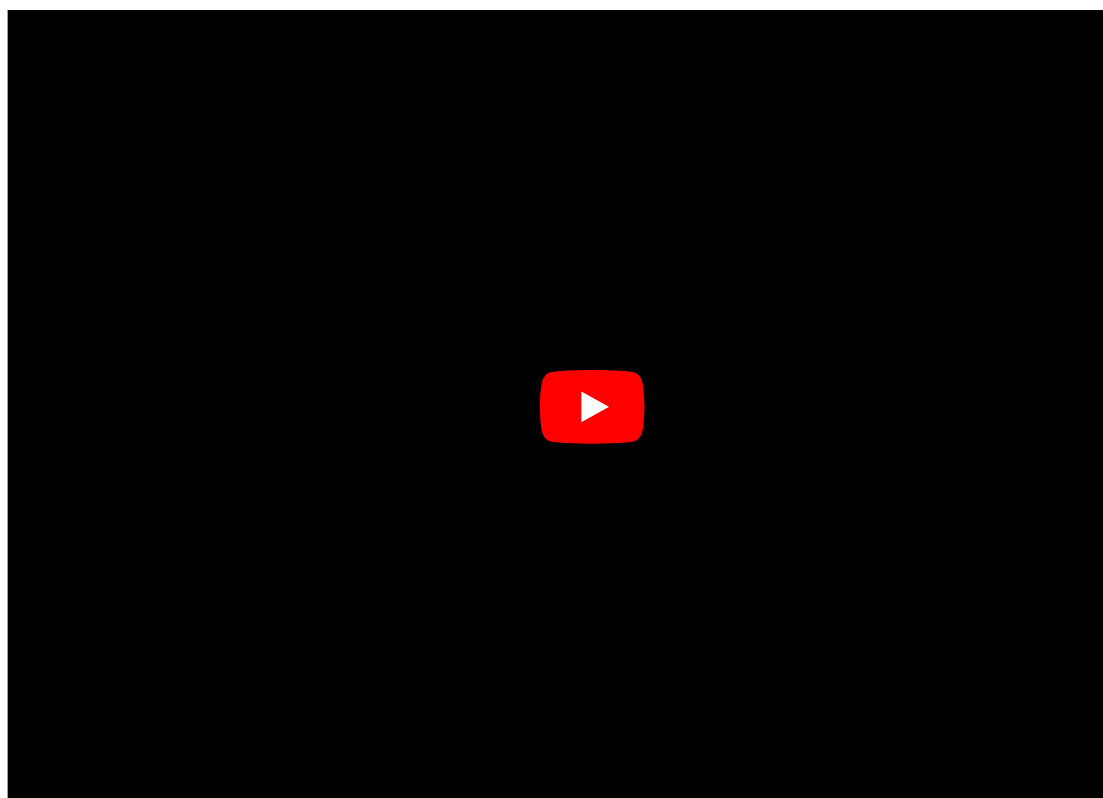


Figure 5.10.2 Naming Ionic Compounds with Polyatomic Ions



Naming Compounds with Polyatomic Ions



1. Name the metal (the cation) using
the Periodic Table.

2. Write the name of the polyatomic ion
using the Common Ion Table.

✓ Example 5.10.3: Naming Ionic Compounds

Write the proper name for each ionic compound.

- $(\text{NH}_4)_2\text{S}$
- AlPO_4
- $\text{Fe}_3(\text{PO}_4)_2$

Solution

Example 5.10.3: Explanation for Naming Ionic Compounds

Ionic Compound	Explanation	Answer

Ionic Compound	Explanation	Answer
a. $(\text{NH}_4)_2\text{S}$	a. The ammonium ion has a 1+ charge and the sulfide ion has a 2- charge. Two ammonium ions need to balance the charge on a single sulfide ion. The compound's name is ammonium sulfide.	ammonium sulfide
b. AlPO_4	b. The ions have the same magnitude of charge, one of each (ion) is needed to balance the charges. The name of the compound is aluminum phosphate.	aluminum phosphate
c. $\text{Fe}_3(\text{PO}_4)_2$	c. Neither charge is an exact multiple of the other, so we have to go to the least common multiple of 6. To get 6+, three iron(II) ions are needed, and to get 6-, two phosphate ions are needed. The compound's name is iron(II) phosphate.	iron(II) phosphate

? Exercise 5.10.2

Write the proper name for each ionic compound.

- a. $(\text{NH}_4)_3\text{PO}_4$
- b. $\text{Co}(\text{NO}_2)_3$

Answer a:

ammonium phosphate

Answer b:

cobalt(III) nitrite

Contributors and Attributions

-
- [Marisa Alviar-Agnew \(Sacramento City College\)](#)
- [Henry Agnew \(UC Davis\)](#)

This page titled [5.10: Naming Polyatomic and Ternary Ionic Compounds](#) is shared under a [CC BY-NC 4.0](#) license and was authored, remixed, and/or curated by [Alaka Pradhan](#).

- [4.9: Polyatomic Ions](#) is licensed [CC BY-NC-SA 4.0](#).