

5.5: Binary Ionic Compounds

Learning Objectives

- Write the correct names and formulas for binary ionic compounds.

Ionic compounds do not exist as molecules. In the solid state, ionic compounds are in a crystal lattice containing many ions each of the cation and anion. An ionic formula, like NaCl, is an empirical formula. This formula merely indicates that sodium chloride is made of an equal number of sodium and chloride ions. Sodium sulfide, another ionic compound, has the formula Na_2S . This formula indicates that this compound is made up of twice as many sodium ions as sulfide ions. This section will teach you how to write the names of binary ionic compounds, as well as to determine the correct ratio of ions, so that you may correctly write a formula.

Writing Chemical Names

As we recall, a binary ionic compound is one that contains two elements, one of which is a metal and the other of which is a nonmetal. The metal is always written first in the name and formula followed by the nonmetal. The convention for naming binary ionic compounds is

- Metals retain their name.
- Nonmetals retain their root name followed by a suffix of *-ide*.

The root name represents the first one or two syllables of an element's name:

Table 5.5.1: Root Names for the Common Nonmetals

Symbol	Name	Root Name	Symbol	Name	Root Name
H	hydrogen	<i>hydr-</i>	P	phosphorus	<i>phosph-</i>
C	carbon	<i>carb-</i>	S	sulfur	<i>sulf-</i>
N	nitrogen	<i>nitr-</i>	Cl	chlorine	<i>chlor-</i>
O	oxygen	<i>ox-</i>	Br	bromine	<i>brom-</i>
F	fluorine	<i>fluor-</i>	I	iodine	<i>iod-</i>

Example 5.5.1: Writing Chemical Names

Write the name for each compound.

- Al_2S_3
- BaBr_2
- K_3N

Solution

A. Al = aluminum. S = sulfur. The root name of sulfur is *sulf-*. The nonmetal has a suffix of *-ide*. Al_2S_3 is aluminum sulfide.

B. Ba = barium. Br = bromine. The root name of bromine is *brom-*. The nonmetal has a suffix of *-ide*. BaBr_2 is barium bromide.

C. K = potassium. N = nitrogen. The root name of nitrogen is *nitr-*. The nonmetal has a suffix of *-ide*. K_3N is potassium nitride.

Writing Chemical Formulas

If you know the name of a binary ionic compound, you can write its **chemical formula**. Start by writing the metal ion with its charge, followed by the nonmetal ion with its charge. Because the overall compound must be electrically neutral, decide how many of each ion is needed in order for the positive and negative charges to balance each other. If the charges of the ions are $2+$ and $2-$, nothing needs to be done – the charges are already balanced. If the charges of the ions are $3+$ and $1-$, three of the ions with the $1-$ charge are needed to balance one of the ions with the $3+$ charge.

When balancing charges, many find it easiest to think of the least common multiple between the magnitude of charge. For example, if the charges of the ions are $2+$ and $3-$, the least common multiple between 2 and 3 is 6. Therefore, the charge will be balanced when the positive charges sum to 6 and the negative charges sum to 6.

The ions shown in [Figure 5.5.1](#) have fixed charges related to their position on the periodic table, as previously discussed in [Section 4.8](#). Note that most main-group elements (groups labeled with Roman numerals followed by the letter *A*) have fixed charges, while most transition metals (groups labeled with Roman numerals followed by the letter *B*) have charges that are variable. Metals that have variable charges are discussed in the next section.

1 IA	2 IIA	11 IB	12 IIB	13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 VIIIA
H ⁺									
Li ⁺	Be ²⁺					N ³⁻	O ²⁻	F ⁻	
Na ⁺	Mg ²⁺			Al ³⁺		P ³⁻	S ²⁻	Cl ⁻	
K ⁺	Ca ²⁺		Zn ²⁺				Se ²⁻	Br ⁻	
Rb ⁺	Sr ²⁺	Ag ⁺	Cd ²⁺					I ⁻	
Cs ⁺	Ba ²⁺								

Figure 5.5.1: Ions with fixed charges related to position on the periodic table.

✓ Example 5.5.2: Writing Chemical Formulas

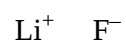
Write the chemical formulas for:

- lithium fluoride
- sodium oxide
- strontium iodide

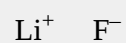
Solution

lithium fluoride

1. Write the symbol and charge of the cation and the anion.



2. Balance the charge of the cations and anions.



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o
d
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u
m
m
i
d
e
d
e

S
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2
+

O
f
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N
E
O
t
N
a
+

3. Explanation.

1⁺ balances 1⁻

4. Write the final formula. Charges are left off.
Subscripts of 1 are implied.

LiF

2
+
b
a
l
a
n
c
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S
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✓ Example 5.5.3: Writing Chemical Formulas

Write the chemical formulas for:

- magnesium sulfide
- aluminum oxide

Solution

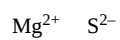
magnesium sulfide

aluminum oxide

magnesium sulfide

aluminum oxide

1. Write the formula for the ionic compound formed by the ions.



	magnesium sulfide	aluminum oxide
2. Balance the charge of the cations and anions.	Mg^{2+} S^{2-}	Al^{3+} O^{2-} Al^{3+} O^{2-} Al^{3+} O^{2-}
3. Explain what ion.	2+ balances 2-	6+ balances 6-
4. Write	MgS	Al ₂ O ₃

magnesium sulfide

aluminum oxide

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magnesium sulfide

aluminum oxide

d

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Exercise 5.5.1

If the chemical formula is provided, write the name. If the name is provided, write the formula.

- A. Li_2S
- B. Ca_3N_2
- C. potassium phosphide
- D. barium oxide

Answer A

lithium sulfide

Answer B

calcium nitride

Answer C

K_3P

Answer D

BaO

Summary

- Formulas for ionic compounds contain the symbols and number of each atom present in a compound in the lowest whole number ratio.
- Ionic compounds must be neutral overall.

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