

## Nomenclature & Formula Writing 3

# Writing Formulas & Names for Binary Compounds

### INFORMATION

A **compound** is a combination of atoms of two or more different elements. When ions come together to form **ionic compounds**, *the compound must always include at least one cation and at least one anion.*

Ionic compounds must always include at least one cation and at least one anion.

The convention is to write or name the cation first, on the left, followed by the anion on the right.

Ionic compounds are classified by the fact that ions *exchange* electrons with each other to form bonds. For example, lithium (valence +1) loses an electron to form its ion. That electron can then be acquired by a chlorine (valence -1) atom to form a chloride anion.

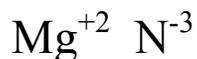
The subsequent ions are attracted to each other by strong electromagnetic forces. The positive-negative attraction can be likened to bringing the north and south poles of two different magnets to each other.

The formation of any ionic compound requires the **balancing of charges**; that is, the positive charges of the cations must be exactly balanced (cancelled) by the negative charges of the anions.

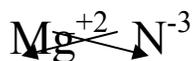
### Writing Formulas for Ionic Compounds

The technique for writing the formula for an ionic compound is very simple:

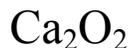
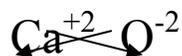
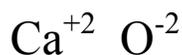
1. Write the cation (on the left) and the anion (on the right). In the **superscript** (above and to the right) position, write the charge of the ions, which are determined from the periodic table:



2. Move the **absolute value** (no sign) of each charge to become the *subscript* of the opposite atom. This is known as the “crossover” or “criss-cross” method:



3. If the subscripts have a common factor, they must be simplified by that common factor. For example:



In this case, the subscripts have a common factor of 2. To simplify, divide both subscripts by the common factor:



This yields:



4. If any subscript is a “1”, it is not written (it is an assumed 1, like  $x$  is assumed to be  $1x$  in algebra). So:



This type of compound is called a **binary** compound. The formulas above represent single units of this compound. Single units of ionic compounds are referred to as **formula units** (as opposed to *molecules*, which is a term reserved for covalent compounds). In the same way that a molecule is the smallest unit of a covalent compound, a formula unit is the smallest unit of an ionic compound.

Single units of ionic compounds are called **formula units**.

### Charge Balance

It is important to understand that the *ratios* in which ions combine is a result of the ions' attempts to neutralize their overall charge. In the calcium oxide (CaO) example above, the calcium ion begins the process with a charge of  $2+$ , and the oxygen begins with a charge of  $2-$ . Combining one of each type of ion – which pairs a  $2+$  charge with a  $2-$  charge – results in the charges cancelling each other out and resulting in a neutral charge for the formula unit.

This will be the case for any neutral ionic compound – *the charges of all of the ions involved in forming the compound will cancel each other out*. This is a simplified explanation of this phenomenon, and is covered in more detail in the series of activities on **Bonding**.

### Naming Binary Compounds

Determining the name of a binary compound is straightforward. It is comprised of two parts – one to identify the cation (metal), and one to identify the (anion) nonmetal.

1. The cation (metal) keeps its complete name. Continuing with the example from above, the first part of  $\text{Mg}_3\text{N}_2$  is called *magnesium*.
2. The anion is named slightly differently. The nonmetal name is truncated to include only the root, and the ending *-ide* is added. This holds for all nonmetals in binary compounds. The nonmetal in the above example is nitrogen. The root is *nitr-*, so the second component of the name is *nitride*.
3. The complete name of the compound is *magnesium nitride*.

## Nonmetal Roots

Arsenic	arsen-	Fluorine	fluor-	Phosphorus	phosph-
Bromine	brom-	Iodine	iod-	Selenium	selen-
Carbon	carb-	Nitrogen	nitr-	Sulfur	sulf-
Chlorine	chlor-	Oxygen	ox-		



### Key Questions:

1. In grammatically correct English, explain why noble gases do not form ionic compounds. Use what you have learned about valence, ions, and compounds to support your explanation.
2. In grammatically correct English, write detailed procedures for a) writing formulas and b) naming binary compounds. Assume that the procedures will be used by someone who has no prior knowledge of this material.

### Exercises

3. Write the formulas for the following compounds:
  - a. Sodium chloride
  - b. Strontium phosphide
  - c. Lithium bromide
  - d. Aluminum sulfide
  - e. Beryllium iodide
  - f. Indium oxide
  - g. Rubidium arsenide
  - h. Cesium nitride
4. Write the names for the following compounds:
  - a. KBr
  - b.  $\text{Be}_3\text{N}_2$
  - c.  $\text{SrBr}_2$
  - d.  $\text{AlCl}_3$
  - e.  $\text{Ra}_3\text{P}_2$
  - f.  $\text{CaI}_2$
  - g.  $\text{Rb}_2\text{O}$
  - h.  $\text{Ba}_3\text{P}_2$
5. Some of the formulas and names below are written incorrectly. Identify those that are incorrect and write them properly.
  - a.  $\text{NaI}_2$
  - b. Potassium sulfur
  - c.  $\text{CsCl}$
  - d.  $\text{In}_2\text{O}_3$
  - e. Rubidiumide fluoride
  - f.  $\text{Fr}_3\text{P}$
  - g.  $\text{Ra}_2\text{O}_2$
  - h.  $\text{Ge}_4\text{N}_3$

Student Name: \_\_\_\_\_ Pd. \_\_\_\_\_ Date: \_\_\_\_\_

**Supplemental Exercises**  
**Binary Naming and Formula Writing**

Write the correct name for the following compounds.

- |                          |                             |                             |
|--------------------------|-----------------------------|-----------------------------|
| 1. $\text{BaCl}_2$       | 10. $\text{Li}_2\text{S}$   | 19. $\text{Sr}_3\text{P}_2$ |
| 2. $\text{NaBr}$         | 11. $\text{RaCl}_2$         | 20. $\text{BeBr}_2$         |
| 3. $\text{MgF}_2$        | 12. $\text{CaO}$            | 21. $\text{AlP}$            |
| 4. $\text{Na}_2\text{O}$ | 13. $\text{RbI}$            | 22. $\text{K}_2\text{S}$    |
| 5. $\text{SrS}$          | 14. $\text{CaBr}_2$         | 23. $\text{LiBr}$           |
| 6. $\text{BN}$           | 15. $\text{LiI}$            | 24. $\text{AlN}$            |
| 7. $\text{NaI}$          | 16. $\text{MgS}$            | 25. $\text{K}_2\text{O}$    |
| 8. $\text{SrF}_2$        | 17. $\text{KBr}$            | 26. $\text{SrI}_2$          |
| 9. $\text{CaF}_2$        | 18. $\text{Ba}_3\text{N}_2$ | 27. $\text{Al}_2\text{S}_3$ |

Write the correct formula for the following compounds.

- |                       |                        |                         |
|-----------------------|------------------------|-------------------------|
| 28. sodium oxide      | 37. magnesium oxide    | 46. cesium sulfide      |
| 29. magnesium iodide  | 38. lithium bromide    | 47. potassium chloride  |
| 30. lithium chloride  | 39. calcium nitride    | 48. strontium phosphide |
| 31. beryllium bromide | 40. calcium fluoride   | 49. barium iodide       |
| 32. aluminum sulfide  | 41. potassium iodide   | 50. rubidium oxide      |
| 33. calcium bromide   | 42. strontium chloride | 51. calcium iodide      |
| 34. beryllium oxide   | 43. sodium sulfide     | 52. cesium oxide        |
| 35. strontium sulfide | 44. radium bromide     | 53. calcium fluoride    |
| 36. calcium fluoride  | 45. magnesium sulfide  | 54. aluminum oxide      |