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:

$$Mg^{+2}\ \ N^{-3}$$

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

$$Mg^{+2}\ \ N^{-3}$$

$$Mg_3N_2$$

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

$$Ca^{+2}\ \ O^{-2}$$

$$Ca^{+2}\ \ O^{-2}$$

$$Ca_2O_2$$

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

$$Ca_{2/2}O_{2/2}$$

This yields:

$$Ca_1O_1$$

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

$$CaO$$

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 Mg_3N_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. Be_3N_2
   c. $SrBr_2$
   d. $AlCl_3$
   e. Ra_3P_2
   f. CaI_2
   g. Rb_2O
   h. Ba_3P_2

5. Some of the formulas and names below are written incorrectly. Identify those that are incorrect and write them properly.
   a. NaI_2
   b. Potassium sulfur
   c. CsCl
   d. In_2O_3
   e. Rubidiumide fluoride
   f. Fr_3P
   g. Ra_2O_2
   h. Ge_4N_3

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Supplemental Exercises
Binary Naming and Formula Writing

Write the correct name for the following compounds.

1. $BaCl_2$
2. NaBr
3. MgF_2
4. Na_2O
5. SrS
6. BN
7. NaI
8. SrF_2
9. CaF_2
10. Li_2S
11. $RaCl_2$
12. CaO
13. RbI
14. $CaBr_2$
15. LiI
16. MgS
17. KBr
18. Ba_3N_2
19. Sr_3P_2
20. $BeBr_2$
21. AlP
22. K_2S
23. LiBr
24. AlN
25. K_2O
26. SrI_2
27. Al_2S_3

Write the correct formula for the following compounds.

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