

**MATH SKILLS**● **Writing Ionic Formulas**

The following table lists most of the ionic formulas you will need for the Your Turn to Think section. The charge on other positive ions will be indicated by a Roman numeral.

**Table of Some Common Ions**

Name	Formula	Name	Formula	Name	Formula
Aluminum ion	$\text{Al}^{3+}$	Bromide ion	$\text{Br}^-$	Carbonate ion	$\text{CO}_3^{2-}$
Ammonium ion	$\text{NH}_4^+$	Chloride ion	$\text{Cl}^-$	Cyanide ion	$\text{CN}^-$
Calcium ion	$\text{Ca}^{2+}$	Fluoride ion	$\text{F}^-$	Hydrogen carbonate ion	$\text{HCO}_3^-$
Lithium ion	$\text{Li}^+$	Iodide ion	$\text{I}^-$	Hydroxide ion	$\text{OH}^-$
Potassium ion	$\text{K}^+$	Nitride ion	$\text{N}^{3-}$	Nitrate ion	$\text{NO}_3^-$
Sodium ion	$\text{Na}^+$	Oxide ion	$\text{O}^{2-}$	Phosphate ion	$\text{PO}_4^{3-}$
Strontium ion	$\text{Sr}^{2+}$	Sulfide ion	$\text{S}^{2-}$	Sulfate ion	$\text{SO}_4^{2-}$

**Sample Problem**

Tungsten has the highest melting point of any element. It appears in nature in the mineral, *wolframite*, as the compound tungsten(VI) oxide. Write the ionic formula for this compound.

- List the symbols for each ion.

Symbol for tungsten(VI) ion:  $\text{W}^{6+}$  (VI indicates a charge of 6+)

Symbol for oxide ion:  $\text{O}^{2-}$

- Write the symbols for the ions, side by side, with the cation first.

$\text{W}^{6+}\text{O}^{2-}$

- Find the least common multiple of the ion's charges.

The least common multiple of 6 and 2 is 6. To get a neutral compound, you need a total of six positive charges and six negative charges.

To get six positive charges, you need one  $\text{W}^{6+}$  ion, because  $1 \times 6+ = 6+$ .

To get six negative charges, you need three  $\text{O}^{2-}$  ions, because  $3 \times 2- = 6-$ .

- Write the chemical formula, using subscripts to indicate how many of each ion are needed to make a neutral compound.

$\text{WO}_3$

**MATH SKILLS**● **Writing Ionic Formulas** *continued***Your Turn to Think**

- Write the formulas for the following ionic compounds:
  - potassium chloride
  - tin(II) bromide
  - calcium nitride
  - sodium fluoride
- Write the ionic formula for the compound lithium chloride.
- Copper is found in a number of different ores, among them *cuprite* (copper(I) oxide), *nantokite* (copper(I) chloride), and *chalcocite* (copper( I) sulfide). Write the formulas for these three compounds.
- Titanium is a metal commonly used in building airplanes and rockets, because it is light and is stronger than either steel or aluminum. Titanium is most commonly found in the form of the mineral *rutile* as titanium(IV) oxide. Write the ionic formula for this compound.
- Mercury is obtained by heating the ore *cinnabar*, or mercury(II) sulfide. Write the ionic formula for mercury(II) sulfide.
- Iridium is named after the Latin word for *rainbow* because the ionic salts it forms are of many different colors. An example of this is the two kinds of iodine compounds formed with iridium: one, iridium(III) iodide, is a green crystalline compound, while the other, iridium(IV) iodide, consists of black crystals. Write the ionic formula for each of these iridium compounds.
- The mineral *molybdenite* is the main source of the element molybdenum, which is added to steel and other alloys to strengthen them. Molybdenite consists of the compound molybdenum(IV) sulfide. Write the ionic formula for this compound.
- The human body needs small quantities of iodine in order for the thyroid gland to function normally. Potassium iodide is used in table salt as a dietary source of iodine. Write the ionic formula for potassium iodide.
- Iron(III) bromide and iron(II) bromide, also known as ferric bromide and ferrous bromide, respectively, are both used in organic chemistry as catalysts. Write the ionic formula for each of these compounds.
- Calcium chloride is commonly used as a drying agent. Write the ionic formula for this compound.

**MATH SKILLS****● Writing Ionic Formulas** *continued*

11. Tin(II) fluoride, also known as stannous fluoride, has been used in toothpaste to help prevent tooth decay. The presence of fluoride ions helps tooth enamel to resist attack by acids. Write the ionic formula for tin(II) fluoride.
12. Write the ionic formula for the compound strontium bromide.

**Sample Problem**

Write the ionic formula for the compound lithium phosphate.

1. List the symbols for each ion.

Symbol for lithium ion:  $\text{Li}^+$

Symbol for phosphate ion:  $(\text{PO}_4)^{3-}$

2. Write the symbols for the ions side by side, with the cation first.

$\text{Li}^+(\text{PO}_4)^{3-}$

3. Find the least common multiple of the ions' charges.

The least common multiple of 1 and 3 is 3. To get a neutral compound, you need a total of three positive charges and one negative charge.

To get three positive charges, you need three  $\text{Li}^+$  ions, because  $3 \times 1+ = 3+$ .

To get three negative charges, you need one  $(\text{PO}_4)^{3-}$  ion, because  $1 \times 3- = 3-$ .

4. Write the chemical formula, using subscripts to indicate how many of each ion are needed to make a neutral compound.

$\text{Li}_3(\text{PO}_4)$

**Your Turn to Think**

13. Many ionic compounds that contain calcium have been in use for so long that they are often identified by their mineral or common names, which were given to them before their chemical composition was determined. Write the ionic formulas for the following calcium compounds, whose common or mineral names are in parentheses:
  - a. calcium oxide (quicklime)
  - b. calcium fluoride (fluorite or fluorspar)
  - c. calcium carbonate (calcite)
14. One of the features that has made gold attractive for centuries is that it does not lose its luster. This is because gold, unlike many metals, does not react with air or water. In fact, gold is not highly reactive at all. Nevertheless, there are a few gold compounds. Among the more common of these are gold(III) chloride and gold(I) cyanide. Write the ionic formulas for these two compounds.

**MATH SKILLS**● **Writing Ionic Formulas** *continued*

15. The element manganese is used in the production of types of steel, serves as a catalyst, and is the primary source of color in amethyst. The two forms of ore from which manganese is extracted are *pyrolusite*, or manganese(IV) oxide, and *rhodochrosite*, or manganese(II) carbonate. Determine the ionic formulas for these two compounds.
16. Certain compounds change colors when water is incorporated into their crystal structure. One example of these compounds is cobalt(II) chloride, which is naturally lavender in color and turns a pinkish red when water is added. Another example is copper(II) sulfate, which turns from white to deep blue when water is added. Write the ionic formulas for these two compounds.
17. The word *chromium* is derived from the Greek word for color, and the element chromium is so named because of the bright colors that many of its compounds have. Listed below are several chromium compounds and, in parentheses, their colors. Write the ionic formulas for these compounds.
- chromium(VI) oxide (red)
  - chromium(II) hydroxide (yellow-brown)
  - chromium(III) oxide (green)
  - chromium(III) chloride (violet)
18. A common compound added to fireworks to produce a red glare is strontium nitrate. Strontium nitrate is also used in signal flares and matches. Write the ionic formula for this compound.
19. Sodium bicarbonate, which is also known as baking soda, is used in various applications where carbon dioxide must be produced (such as baking) or where a mild base is needed. The bicarbonate ion is also called the hydrogen carbonate ion, because it consists of a carbonate ion bonded with a hydrogen ion. Write the ionic formula for sodium bicarbonate.
20. The ammonium ion is a polyatomic cation that is widely used. Below are listed several ammonium compounds along with a description of their uses. Write the ionic formula for each of these compounds.
- ammonium chloride (used in batteries)
  - ammonium hydroxide (used in a solution as a cleanser, liquid ammonia)
  - ammonium nitrate (used in fertilizers)
  - ammonium sulfate (used in fertilizers and as a buffer in baking)

**MATH SKILLS**● **Writing Ionic Formulas** *continued*

21. Aluminum sulfate has been widely used for the last 150 years as a “size,” which is a substance used to make paper smooth and easy to write or print on. Unfortunately, the mixture using aluminum sulfate becomes acidic from the formation of sulfuric acid, and so causes paper to become brown and brittle. Write the ionic formula for aluminum sulfate.
22. Cobalt(II) phosphate is a compound used in a number of paint pigments, giving them a rich purple color. Write the ionic formula for this compound.
23. Manganese can combine with oxygen to form several compounds and anions.
  - a. The compound potassium permanganate is used as an indicator of when a solution has reached a certain level of acidity. It consists of potassium and the permanganate ion, which is made from manganese(VII) and four oxygen atoms. Write the ionic formula for potassium permanganate.
  - b. The compound manganese(VII) oxide is a neutral ionic compound. Write its formula.