TABLE 3.8 Rules for Writing Formulas of Binary Ionic Compounds

Rules for Names	Examples	
	magnesium phosphide	aluminum bromide
1. Identify each ion and its charge.	magnesium: Mg^{+2} phosphide: P^{-3}	aluminum: Al^{+3} bromide: Br^{-1}
2. Determine the total charges needed to balance positive with negative.	Mg^{+2}: +2 +2 +2 = +6 P^{-3}: −3 −3 = −6	Al^{+3} : = +3 Br^{-1} : −1 −1 −1 = −3
3. Note the ratio of positive ions to negative ions.	3 Mg^{+2} ions for every 2 P^{-3} ions	1 Al^{+3}ion for every 3 Br^{-1} ions
4. Use subscripts to write the formula. Omit "1" where only one ion is needed.	Mg_3P_2	$AlBr_3$

Study Prep

1. Write the formulas of the ionic compounds containing the following ions:
   a) Na^{+1} with F^{-1} _____
   b) Mg^{+2} with Br^{-1} _____
   c) Cs^{+1} with S^{-2} _____
   d) Ba^{+2} with O^{-2} _____
   e) Ca^{+2} with P^{-3} _____

2. Write the formulas of the following binary ionic compounds:
   a) potassium chloride _____
   b) strontium nitride _____
   c) silver sulphide _____
   d) zinc selenide _____
   e) beryllium sulphide _____
   f) rubidium oxide _____
   g) lithium nitride _____
   h) radium iodide _____
   i) aluminum phosphide _____
   j) magnesium sulphide _____
   k) lithium fluoride _____
   l) beryllium iodide _____
   m) magnesium oxide _____
   n) radium nitride _____
   o) potassium sulphide _____

3. Write the names of the following binary ionic compounds:

a) CsI _____

b) Ba_3N_2 _____

c) $CdCl_2$ _____

d) AlF_3 _____

e) Li_2O _____

f) K_2O _____

g) Na_2O _____

h) CaI_2 _____

i) Sr_3P_2 _____

j) CaO _____

k) Cd_3N_2 _____

l) $RaBr_2$ _____

m) RbF _____

n) $AlCl_3$ _____

o) $NaBr$ _____

Metals with More Than One Combining Capacity

An element that can form more than one stable ion is called a **mulitvalent** element. Most metals in the middle of the periodic table are multivalent. Their combining capacities are listed in the periodic table, with the most common one listed first. For example, iron can have either a +2 or a +3 ion, but the +3 ion is the most common. The symbols and names of the iron ions are:

Fe^{+2}	iron(II)
Fe^{+3}	iron(III)

Notice that the Roman numeral in the ion's name corresponds to the charge on the ion. A list of Roman numerals is given in Table 3.9.

TABLE 3.9
Roman Numerals

Number	Roman Numeral
1	I
2	II
3	III
4	IV
5	V
6	VI
7	VII
8	VIII

Table 3.10 gives some examples of the names of binary ionic compounds containing a multivalent metal ion.

TABLE 3.10 Compounds with Multivalent Ions

Name	Formula
iron(III) iodide	FeI_3
iron(II) iodide	FeI_2
manganese(IV) sulphide	MnS_2
copper(I) nitride	Cu_3N

Table 3.11 shows examples of how the compound's name is used to write the formula.

Study Prep

1. Write the names and formulas of the ionic compounds containing the following ions:

   a) Cu^{+1} with S^{-2} _____

   b) Cu^{+2} with S^{-2} _____

   c) Cr^{+2} with F^{-1} _____

   d) Cr^{+3} with F^{-1} _____

   e) Fe^{+2} with N^{-3} _____

   f) iron(III) ion with bromide ion _____

   g) lead(IV) ion with iodide ion _____

   h) lead(II) ion with iodide ion _____

   i) cobalt(III) ion with phosphide ion _____

   j) platinum(IV) ion with selenide ion _____

2. Write the name of each ionic compound below. Remember to use a Roman numeral as part of the metal ion's name.

   a) $FeCl_2$ _____

   b) $FeCl_3$ _____

   c) Cu_2O _____

   d) CuO _____

   e) PbS _____

   f) PbS_2 _____

   g) $MnBr_2$ _____

   h) $MnBr_3$ _____

   i) Ti_3N_4 _____

   j) TiP _____

   k) SnF_2 _____

   l) TiS_2 _____

   m) Co_3N_2 _____

   n) PtI_2 _____

   o) Cu_3P _____

Continued

3. Write the formulas of the following ionic compounds:

a) iron(II) iodide _____

b) chromium(III) chloride _____

c) copper(II) bromide _____

d) mercury(II) oxide _____

e) tin(IV) nitride _____

f) tin(II) nitride _____

g) titanium(III) phosphide _____

h) gold(III) sulphide _____

i) manganese(IV) iodide _____

j) mercury(II) selenide _____

k) gold(I) iodide _____

l) titanium(IV) nitride _____

m) manganese(IV) oxide _____

n) cobalt(II) chloride _____

o) chromium(III) bromide _____

Polyatomic Ions

Some ions are made up of several atoms joined together by sharing electrons, just like a molecule. The difference is that this combination of atoms has an electric charge. It can have either a positive or a negative charge. A **polyatomic ion** is a group of atoms that are covalently bonded and have an overall electric charge ("poly" means *many*).

In the compound NaOH, for example, the sodium has a charge of +1. The oxygen and hydrogen together form the polyatomic ion hydroxide (OH^{-1}), which has a charge of −1. Another example of a polyatomic ion is the phosphate ion (PO_4^{-3}). It is made up of one phosphorus atom and four oxygen atoms joined together. They behave like a single unit with a charge of −3.

Table 3.13 gives some examples of common polyatomic ions. Page 1 of the *Data Booklet* lists the names and formulas of these and other common ions.

There are a few points worth noting about the ions in Table 3.13:

- There are many more negative ions than positive ions.
- The most common positive polyatomic ion is ammonium (NH_4^{+1}). Ammonium phosphate is the most common fertilizer ingredient in the world.