

# Names and Formulas of Compounds

Textbook pages 184–201

## Before You Read

In this section, you will learn how to write the names and formulas of ionic and covalent compounds. Write what you already know about these compounds in the lines below.

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## How do you represent an ionic compound?

**Ionic compounds** are composed of positive and negative ions. They can be represented with both a name and a chemical formula.

1. Name: In an **ionic compound**, the first part of the name indicates the positive ion (a metal) and the second part indicates the negative ion (a non-metal). The non-metal's name always ends with the suffix “-ide.” For example, lead sulphide.
2. Chemical formula: Follow the steps in the table below to write the chemical formula for an ionic compound.

Steps	Example Ionic Compound: Lead Sulphide
Identify the chemical symbol for each ion and its charge.	lead: $\text{Pb}^{4+}$ sulphide: $\text{S}^{2-}$
Determine the total charges needed to balance the positive and negative charges of each ion.	$\text{Pb}^{4+}$ : $+4 = +4$ $\text{S}^{2-}$ : $-2 -2 = -4$
Note the ratio of positive to negative ions.	1 $\text{Pb}^{4+}$ : 2 $\text{S}^{2-}$
Use these subscripts to write the chemical formula. Make sure the subscripts represent the smallest whole number formula. A “1” is not shown as a subscript.	$\text{PbS}_2$

There are also two special cases you must consider when naming and writing the chemical formulas of ionic compounds. These are compounds containing multivalent metals and polyatomic ions.



**Mark the Text**

### Check for Understanding

As you read this section, be sure to reread any parts you do not understand. Highlight any sentences that help make concepts clearer for you.

continued

 **Reading Check**

What is a multivalent metal?

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

1. **Multivalent metals:** Multivalent metals can form two or more positive ions with different ionic charges. To distinguish between two ions formed from multivalent metals, the name must contain the ion's charge. The Roman numerals I, II, III, IV, V, VI, and VII, corresponding to ion charges 1+ to 7+, are used for this purpose. The Roman numerals are included in the name of the compound. For example, nickel (II) chloride has the formula  $\text{NiCl}_2$ . Thus, nickel (II) has an ion charge of 2+. Nickel (III) has the formula  $\text{NiCl}_3$ . The ion charge of nickel (III) is 3+. ✓
2. **Polyatomic ions:** A **polyatomic ion** is an ion composed of more than one type of atom joined by covalent bonds. For example, carbonate ( $\text{CO}_3^{2-}$ ) is a polyatomic atom. All polyatomic atoms have special names assigned to them. You will need to look these up in the following table when naming a compound that includes a polyatomic ion.

**Table 4.11 Names, Formulas, and Charges of Some Polyatomic Ions**

Positive Ions		Negative Ions	
$\text{NH}_4^+$ ammonium	$\text{CH}_3\text{COO}^-$ acetate	$\text{HCO}_3^-$ hydrogen carbonate, bicarbonate	$\text{NO}_2^-$ nitrite
	$\text{CO}_3^{2-}$ carbonate	$\text{HSO}_4^-$ hydrogen sulfate, bisulfate	$\text{ClO}_4^-$ perchlorate
	$\text{ClO}_3^-$ chlorate	$\text{HS}^-$ hydrogen sulfide, bisulfide	$\text{MnO}_4^-$ permanganate
	$\text{ClO}_2^-$ chlorite	$\text{HSO}_3^-$ hydrogen sulfite, bisulfite	$\text{PO}_4^{3-}$ phosphate
	$\text{CrO}_4^{2-}$ chromate	$\text{OH}^-$ hydroxide	$\text{PO}_3^{3-}$ phosphite
	$\text{CN}^-$ cyanide	$\text{ClO}^-$ hypochlorite	$\text{SO}_4^{2-}$ sulfate
	$\text{Cr}_2\text{O}_7^{2-}$ dichromate	$\text{NO}_3^-$ nitrate	$\text{SO}_3^{2-}$ sulfite

## How do you represent a binary covalent compound?

A **binary covalent compound** contains two non-metal elements joined together by one or more covalent bonds. Like ionic compounds, binary covalent compounds can be represented with both a name and a chemical formula.

1. **Name:** When naming a binary covalent compound, prefixes are used to indicate how many atoms of each element are present. The second element's name ends with the suffix "-ide." For example, dinitrogen trioxide has two atoms of nitrogen and three atoms of oxygen. No prefix is used if there is just one atom of the first element. For example, carbon dioxide. The table below provides the first ten prefixes used to name binary covalent compounds. ✓

Prefix	Number of atoms
mono-	1
di-	2
tri-	3
tetra-	4
penta-	5
hexa-	6
hepta-	7
octa-	8
nona-	9
deca-	10

2. **Chemical formula:** When writing the chemical formula, subscripts are used to indicate the number of atoms present. For example, dinitrogen trioxide has the chemical formula  $N_2O_3$ . The exact number of atoms is always shown in the formula. For example, hydrogen peroxide is written as  $H_2O_2$ , not HO. Unlike the formula for an ionic compound, the subscripts do not always represent the smallest whole number formula.

### ✓ Reading Check

A certain element has 5 atoms in a binary covalent compound. Which prefix is used to name this element?

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Use with textbook pages 189–193.

## Multivalent metals and polyatomic ions

1. Define the following terms:

(a) ionic compound

\_\_\_\_\_

(b) multivalent metal

\_\_\_\_\_

(c) polyatomic ion

\_\_\_\_\_

2. Write the formulae and names of the compounds with the following combination of ions. The first row is completed to help guide you.

	Positive ion	Negative ion	Formula	Compound name
(a)	Pb <sup>2+</sup>	O <sup>2-</sup>	PbO	lead(II) oxide
(b)	Sb <sup>4+</sup>	S <sup>2-</sup>		
(c)			TlCl	
(d)				tin(II) fluoride
(e)			Mo <sub>2</sub> S <sub>3</sub>	
(f)	Rh <sup>4+</sup>	Br <sup>-</sup>		
(g)				copper(I) telluride
(h)			NbI <sub>5</sub>	
(i)	Pd <sup>2+</sup>	Cl <sup>-</sup>		

3. Write the chemical formula for each of the following compounds.

(a) manganese(II) chloride _____	(f) vanadium(V) oxide _____
(b) chromium(III) sulphide _____	(g) rhenium(VII) arsenide _____
(c) titanium(IV) oxide _____	(h) platinum(IV) nitride _____
(d) uranium(VI) fluoride _____	(i) nickel(II) cyanide _____
(e) nickel(II) sulphide _____	(j) bismuth(V) phosphide _____

4. Write the formulae for the compounds formed from the following ions. Then name the compounds.

	Ions	Formula	Compound name
(a)	$K^+$ $NO_3^-$	$KNO_3$	potassium nitrate
(b)	$Ca^{2+}$ $CO_3^{2-}$		
(c)	$Li^+$ $HSO_4^-$		
(d)	$Mg^{2+}$ $SO_3^{2-}$		
(e)	$Sr^{2+}$ $CH_3COO^-$		
(f)	$NH_4^+$ $Cr_2O_7^{2-}$		
(g)	$Na^+$ $MnO_4^-$		
(h)	$Ag^+$ $ClO_3^-$		
(i)	$Cs^+$ $OH^-$		
(j)	$Ba^{2+}$ $CrO_4^{2-}$		

5. Write the chemical formula for each of the following compounds.

(a) barium bisulphate _____	(f) calcium phosphate _____
(b) sodium chlorate _____	(g) aluminum sulphate _____
(c) potassium chromate _____	(h) cadmium carbonate _____
(d) calcium cyanide _____	(i) silver nitrite _____
(e) potassium hydroxide _____	(j) ammonium hydrogen carbonate _____

Use with textbook pages 186–196.

## Chemical names and formulas of ionic compounds

1. Write the name for each of the following compounds.

(a) BeS

\_\_\_\_\_

(b) Hg<sub>3</sub>N<sub>2</sub>

\_\_\_\_\_

(c) Cu(NO<sub>3</sub>)<sub>2</sub>

\_\_\_\_\_

(d) Ag<sub>2</sub>O

\_\_\_\_\_

(e) CoBr<sub>2</sub>

\_\_\_\_\_

(f) Bi<sub>3</sub>(PO<sub>4</sub>)<sub>5</sub>

\_\_\_\_\_

(g) CaF<sub>2</sub>

\_\_\_\_\_

(h) Mn<sub>2</sub>O<sub>3</sub>

\_\_\_\_\_

(i) Cr<sub>2</sub>(SO<sub>4</sub>)<sub>3</sub>

\_\_\_\_\_

(j) ZnCl<sub>2</sub>

\_\_\_\_\_

(k) Ni(OH)<sub>2</sub>

\_\_\_\_\_

(l) K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub>

\_\_\_\_\_

(m) ScF<sub>3</sub>

\_\_\_\_\_

(n) NaI

\_\_\_\_\_

(o) Pb(CO<sub>3</sub>)<sub>2</sub>

\_\_\_\_\_

(p) RbClO<sub>2</sub>

\_\_\_\_\_

(q) K<sub>3</sub>P

\_\_\_\_\_

(r) Mg(CN)<sub>2</sub>

\_\_\_\_\_

(s) SnS

\_\_\_\_\_

(t) NaHCO<sub>3</sub>

\_\_\_\_\_

2. Write the chemical formula for each of the following compounds.

(a) aluminum bromide \_\_\_\_\_

(b) platinum(II) sulphide \_\_\_\_\_

(c) strontium sulfite \_\_\_\_\_

(d) scandium oxide \_\_\_\_\_

(e) titanium(IV) nitrite \_\_\_\_\_

(f) ammonium sulphate \_\_\_\_\_

(g) lithium selenide \_\_\_\_\_

(h) lead(II) hydrogen sulphate \_\_\_\_\_

(i) sodium acetate \_\_\_\_\_

(j) cesium chloride \_\_\_\_\_

(k) cadmium(II) hydroxide \_\_\_\_\_

(l) zinc phosphate \_\_\_\_\_

(m) barium chloride \_\_\_\_\_

(n) tin(II) permanganate \_\_\_\_\_

(o) lithium hypochlorite \_\_\_\_\_

(p) gold(III) sulphate \_\_\_\_\_

(q) sodium nitrate \_\_\_\_\_

(r) chromium(III) chloride \_\_\_\_\_

(s) potassium carbonate \_\_\_\_\_

(t) iron(III) bisulphate \_\_\_\_\_

Use with textbook pages 193–197.

## Chemical names and formulas of covalent compounds

1. What is a covalent compound?

\_\_\_\_\_

2. What type of bond is formed in a covalent compound?

\_\_\_\_\_

3. What is used in naming covalent compounds?

\_\_\_\_\_

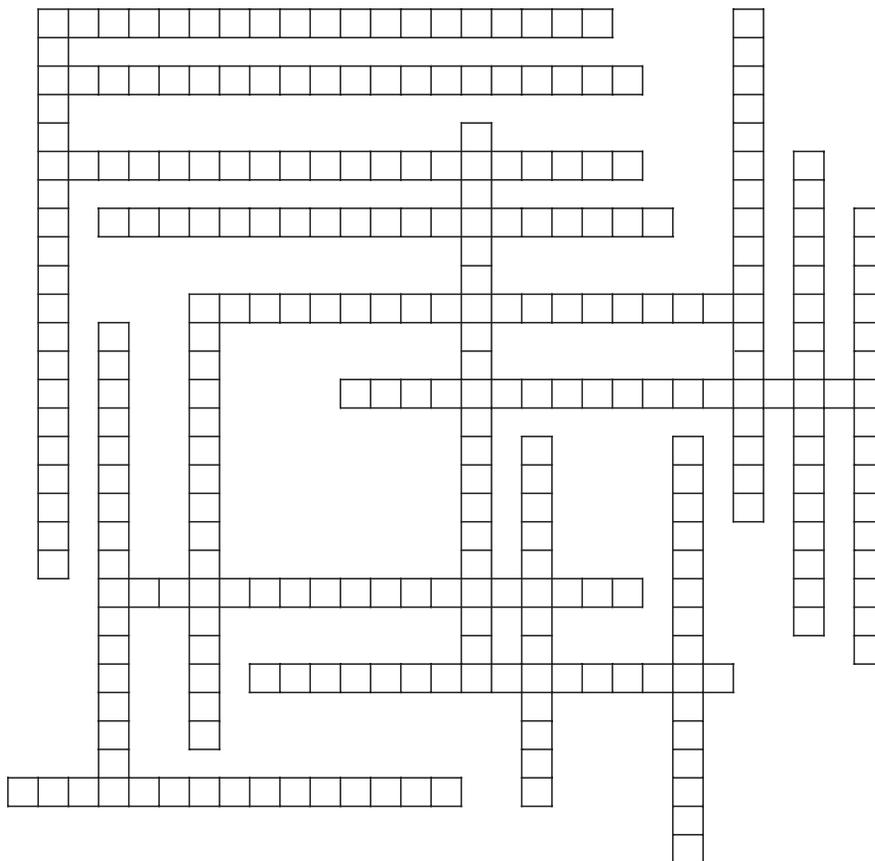
4. Write the chemical formula for each of the following compounds.

(a) silicon dioxide _____	(i) dinitrogen pentoxide _____
(b) chlorine dioxide _____	(j) dinitrogen monoxide _____
(c) tellurium dioxide _____	(k) arsenic tetrabromide _____
(d) selenium trioxide _____	(l) arsenic pentachloride _____
(e) carbon disulphide _____	(m) disulphide pentoxide _____
(f) arsenic trichloride _____	(n) sulphur monochloride _____
(g) chlorine heptoxide _____	(o) phosphorus trichloride _____
(h) selenium difluoride _____	(p) diphosphorus pentoxide _____

5. Complete the following crossword puzzle. Given the chemical formula, what is the name for the covalent compound?

**COVALENT COMPOUNDS****Word List**

Arsoenic trioxide  
 Boron monoxide  
 Carbon disulphide  
 Chlorine monoxide  
 Diarsenic pentoxide  
 Dichlorine heptoxide  
 Dinitrogen trioxide  
 Disulphur dichloride  
 Iodine trichloride  
 Nitrogen dioxide  
 Nitrogen monoxide  
 Phosphorus tribromide  
 Silicon tetrafluoride  
 Sulphur tetrachloride  
 Tellurium dibromide  
 Tellurium trioxide

**ACROSS**

1.  $S_2Cl_2$
3.  $PBr_3$
5.  $SiF_4$
7.  $Cl_2O_7$
9.  $ClF_3$
11.  $N_2O_3$
14.  $TeBr_2$
15.  $ClO$
16.  $AsO_3$

**DOWN**

1.  $P_2O_3$
2.  $As_2O_5$
4.  $SCl_4$
6.  $ICl_3$
8.  $NO$
9.  $CS_2$
10.  $TeO_3$
12.  $BO$
13.  $NO_2$

Use with textbook pages 184–197.

## Names and formulas of compounds

Match each Chemical Name on the left with the correct Chemical Formula on the right.

Chemical Name	Chemical Formula
1. _____ tin(II) chlorate	<b>A.</b> SCl
2. _____ sulphur dichloride	<b>B.</b> S <sub>2</sub> Cl
3. _____ strontium perchlorate	<b>C.</b> SCl <sub>2</sub>
	<b>D.</b> SnClO
	<b>E.</b> Sn(ClO <sub>2</sub> ) <sub>2</sub>
	<b>F.</b> Sn(ClO <sub>3</sub> ) <sub>2</sub>
	<b>G.</b> Sn(ClO <sub>4</sub> ) <sub>2</sub>
	<b>H.</b> Sr(ClO <sub>3</sub> ) <sub>2</sub>
	<b>I.</b> Sr(ClO <sub>4</sub> ) <sub>2</sub>

4. Which of the following is a covalent compound?
- A.** SrO                      **C.** SnO<sub>2</sub>  
**B.** SeO<sub>2</sub>                    **D.** Sc<sub>2</sub>O<sub>3</sub>
5. In which of the following do covalent bonds hold the atoms together?
- A.** silver  
**B.** calcium carbonate  
**C.** silicon tetrafluoride  
**D.** magnesium bromide
6. What is the total number of atoms that make up iodine pentachloride?
- A.** 2                          **C.** 5  
**B.** 4                          **D.** 6
7. Which of the following occurs when carbon forms a compound with oxygen?
- A.** oxygen and carbon share electrons  
**B.** both oxygen and carbon lose electrons  
**C.** oxygen gains electrons, while carbon loses electrons  
**D.** carbon gains electrons, while oxygen loses electrons

8. In the chemical reaction  $\text{CuO} + \text{CO}_2 \rightarrow \text{CuCO}_3$ , which of the following are ionic compounds?

I.	CO <sub>2</sub>
II.	CuO
III.	CuCO <sub>3</sub>

- A.** I and II only              **C.** II and III only  
**B.** I and III only            **D.** I, II, and III
9. Which of the following is the formula for the compound formed by ammonium and dichromate?
- A.** NH<sub>4</sub>Cr<sub>2</sub>O<sub>7</sub>  
**B.** (NH<sub>4</sub>)<sub>2</sub>CrO<sub>4</sub>  
**C.** NH<sub>4</sub>(Cr<sub>2</sub>O<sub>7</sub>)<sub>2</sub>  
**D.** (NH<sub>4</sub>)<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub>
10. In which of the following compounds does manganese have the highest ion charge?
- A.** MnO<sub>3</sub>                      **C.** MnSO<sub>3</sub>  
**B.** MnBr<sub>2</sub>                    **D.** Mn(OH)<sub>4</sub>
11. In which of the following compounds is the ion charge on copper the same?

I.	Cu <sub>2</sub> O
II.	CuCl <sub>2</sub>
III.	CuCO <sub>3</sub>

- A.** I and II only              **C.** II and III only  
**B.** I and III only            **D.** I, II, and III
12. In the name arsenic(III) chloride, what does the Roman numeral reveal about arsenic?
- A.** it has an ion charge of 3–  
**B.** it has an ion charge of 3+  
**C.** it has gained three electrons  
**D.** it can form three positive ions