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9 Chemical Names and Formulas

Big ideas
- ELECTRONS AND THE STRUCTURE OF ATOMS
- BONDING AND INTERACTIONS

9.1 Naming Ions

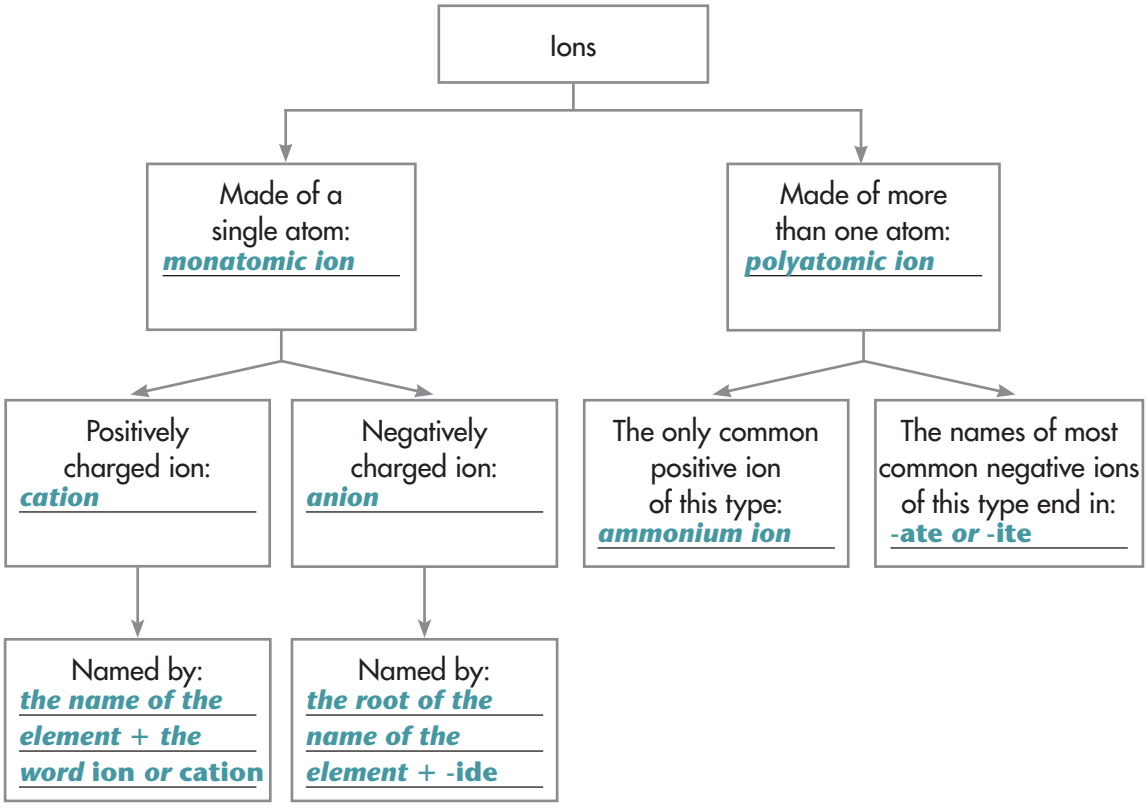
For students using the Foundation edition, assign problems 4, 8–15.

Essential Understanding Ions are named by determining their charges and applying certain rules.

Reading Strategy

Concept Map A concept map helps you organize concepts, using visual relationships and linking words. Mapping out these connections helps you think about how information fits together.

As you read Lesson 9.1, use the concept map below. Fill in this concept map to show how to identify and name different types of ions.



EXTENSION **Extend the concept map by providing an example of each of the four types of ions.**

Sample answers: cation: sodium ion; anion: chloride ion; positive polyatomic ion: ammonium ion; negative polyatomic ion: sulfate ion

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Lesson Summary

Monatomic Ions A one-atom ion is called a monatomic ion.

- A monatomic ion's charge depends on its place in the periodic table.
- Atoms that lose electrons become positively charged ions, or cations.
- Atoms that gain electrons become negatively charged ions, or anions.

Polyatomic Ions Polyatomic ions contain more than one atom and behave as a unit.

- Negatively charged polyatomic ions are named using a root word and an *-ate* or *-ite* suffix.

After reading Lesson 9.1, answer the following questions.

Monatomic Ions

1. What are monatomic ions?

Monatomic ions are ions consisting of only one atom.

2. How is the ionic charge of a Group 1A, 2A, or 3A ion determined?

The ionic charge is numerically equal to the group number.

3. How is the ionic charge of a Group 5A, 6A, or 7A ion determined?

The charge of an ion in Group 5A, 6A, or 7A is determined by subtracting 8 from the group number.

4. Circle the letter of the type of element that often has more than one common ionic charge.

a. alkali metal

b. alkaline earth metal

c. transition metal

d. nonmetal

5. The *Stock system* of naming transition metal cations uses a Roman numeral in parentheses to indicate the numeric value of the ionic charge.

6. An older naming system uses the suffix *-ous* to name the cation with the *lower ionic* charge, and the suffix *-ic* to name the cation with the *higher ionic* charge.

7. What is a major advantage of the Stock system over the old naming system?

The Stock system gives the actual charge of the ion.

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8. Use the periodic table to write the name and formula (including charge) for the ion formed from each element in the table below.

Element	Name	Formula
Fluorine	*fluoride ion*	F^-
Calcium	*calcium ion*	Ca^{2+}
Oxygen	*oxide ion*	O^{2-}

Polyatomic Ions

9. What is a polyatomic ion?

A polyatomic ion is a tightly bound group of atoms that behaves as a unit and carries a charge.

10. Is the following sentence true or false? The names of polyatomic anions always end in *-ide*. *false*

11. What is the difference between the sulfite and sulfate anions?

The sulfite ion has one less oxygen atom than the sulfate ion.

12. Look at Table 9.3. Circle the letter of a polyatomic ion that is a cation.

a. ammonium

b. acetate

c. oxalate

d. phosphate

13. How many atoms make up the oxalate ion and what is its charge?

It is made up of 6 atoms (2 carbon atoms and 4 oxygen atoms) and it has a charge of 2−.

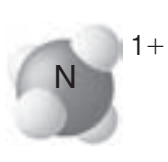
14. What three hydrogen-containing polyatomic anions are essential components of living systems?

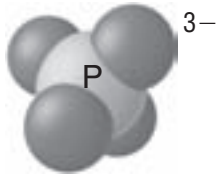
a. *hydrogen carbonate, HCO_3^-*

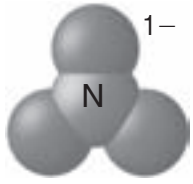
b. *hydrogen phosphate, HPO_4^{2-}*

c. *dihydrogen phosphate, $H_2PO_4^-$*

15. Look at Figure 9.5. Identify each of the ions shown below.







a. *ammonium ion* **b.** *phosphate ion* **c.** *nitrate ion*

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9.2 Naming and Writing Formulas for Ionic Compounds

For students using the Foundation edition, assign problems 2–7, 9, 10, 12, 13.

Essential Understanding In writing names and formulas for ionic compounds, the cation is listed first, followed by the anion.

Lesson Summary

Binary Ionic Compounds Binary ionic compounds are composed of two elements, one with a positive charge and one with a negative charge.

- The chemical formula of a binary ionic compound includes the cation's symbol, followed by the anion's symbol, with subscripts that balance positive and negative charges.

Compounds With Polyatomic Ions Ionic compounds are named by joining the cation and anion names.

- To indicate more than one polyatomic ion in a chemical formula, place parentheses around the polyatomic ion and use a subscript.
- Roman numerals indicate the oxidation number of cations having multiple possible oxidation states.

After reading Lesson 9.2, answer the following questions.

Binary Ionic Compounds

1. Traditionally, common names were based on some ***property*** of a compound or its ***source***.
2. What is the general name for compounds composed of two elements? They are ***binary compounds***.
3. When writing the formula for any ionic compound, the charges of the ions must ***balance***.
4. What are two methods for writing a balanced formula?
   a. ***finding the least common multiple of the charges***
   b. ***using the crisscross method***
5. What are the formulas for the compounds formed by the following pairs of ions?
   a. Fe^{2+}, Cl^- ***$FeCl_2$***
   b. Cr^{3+}, O^{2-} ***Cr_2O_3***
   c. Na^+, S^{2-} ***Na_2S***
6. What are the formulas for these compounds?
   a. lithium bromide ***LiBr***
   b. cupric nitride ***Cu_3N_2***
   c. magnesium chloride ***$MgCl_2$***

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7. The name of a binary ionic compound is written with the name of the ***cation*** first, followed by the name of the ***anion***.

8. How can you tell that cobalt(II) iodide is a binary ionic compound formed by a transition metal with more than one ionic charge?

The name includes a Roman numeral representing the ionic charge of the transition metal cation.

9. Write the names for these binary ionic compounds.

   a. PbS ***lead(II) sulfide***

   b. $MgCl_2$ ***magnesium chloride***

   c. Al_2Se_3 ***aluminum selenide***

Compounds With Polyatomic Ions

10. What is a polyatomic ion?

A polyatomic ion contains more than one element.

11. How do you write the formula for a compound containing a polyatomic ion?

Write the symbol or formula for the cation followed by the symbol or formula for the anion, and use subscripts to balance the charges.

12. Why are parentheses used to write the formula $Al(OH)_3$?

The parentheses indicate that more than one polyatomic ion is needed in the formula.

13. Complete the table for these ionic compounds containing polyatomic ions.

Cation	Anion	Name	Formula
NH_4^+	S^{2-}	***ammonium sulfide***	$(NH_4)_2S$
Fe^{3+}	CO_3^{2-}	iron(III) carbonate	$Fe_2(CO_3)_3$
Ag^+	NO_3^-	***silver nitrate***	$AgNO_3$
K^+	CN^-	potassium cyanide	KCN

Name _____ Class _____ Date _____

9.3 Naming and Writing Formulas for Molecular Compounds

For students using the Foundation edition, assign problems 1–9.

Essential Understanding Molecular compounds consist of nonmetal atoms, none of which is an ion, bonded together.

Lesson Summary

Binary Molecular Compounds Binary molecular compounds consist of two nonmetals.

- The prefixes in the name of a binary molecular compound show the number of atoms of each element in a molecule of the compound.
- The numbers related to the prefixes are used as subscripts when writing formulas of binary molecular compounds.
- When naming binary molecular compounds from their formulas, the subscripts in the formulas show what prefixes to use for each nonmetal in the compound.

After reading Lesson 9.3, answer the following questions.

Binary Molecular Compounds

1. Circle the letter of the type(s) of elements that form binary molecular compounds.

a. two nonmetallic elements

b. a metal and a nonmetal

c. two metals

2. Is the following sentence true or false? Two nonmetallic elements can combine in only one way. ***false***

3. What method is used to distinguish between different molecular compounds that contain the same elements? ***Prefixes are used.***

Match the prefix with the number it indicates.

c	**4.** *octa-*	**a.** 4
a	**5.** *tetra-*	**b.** 7
b	**6.** *hepta-*	**c.** 8
d	**7.** *nona-*	**d.** 9

8. What are the names of the following compounds?

a. BF_3 ***boron trifluoride***

b. N_2O_4 ***dinitrogen tetroxide***

c. P_4S_7 ***tetraphosphorus heptasulfide***

Name _____ Class _____ Date _____

9. What are the formulas for the following compounds?

a. carbon tetrabromide CBr_4

b. nitrogen triiodide NI_3

c. iodine monochloride ICl

d. tetraiodine nonaoxide I_4O_9

9.4 Naming and Writing Formulas for Acids and Bases

For students using the Foundation edition, assign problems 1–7.

Essential Understanding Acids and bases are ionic compounds. Their names and formulas reflect the number of hydrogen ions or hydroxide ions they contain.

Lesson Summary

Names and Formulas of Acids Names and formulas of acids are based on an acid's consisting of an anion and enough hydrogen ions to make the acid electrically neutral.

- The general formula for an acid is H_nX, where X is an anion, H is a hydrogen ion, and *n* is the number of hydrogen ions needed to make the acid neutral.
- Binary acids are named by using the prefix *hydro-*, the root name of the anion, and the suffix *-ic*, plus the word *acid*.
- Acids containing polyatomic ions are named according to the name of the anion.

Names and Formulas of Bases Bases are named like other ionic compounds.

- The name of a base is the name of the cation followed by the name of the anion (hydroxide).
- The formula of a base is written by showing the number of hydroxide ions needed to balance the positive charge on the cation.

After reading Lesson 9.4, answer the following questions.

Names and Formulas of Acids

1. Acids produce ***hydrogen*** ions when dissolved in water.

2. When naming acids, you can consider them to be combinations of ***anions*** connected to as many ***hydrogen*** ions as are necessary to create an electrically neutral compound.

3. What is the formula for hydrobromic acid? ***HBr***

4. What are the components of phosphorous acid? What is its formula?
hydrogen ion and phosphite ion; H_3PO_3

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5. Use Table 9.5 to help you complete the table about acids.

Acid Name	Formula	Anion Name
acetic acid	$HC_2H_3O_2$	*acetate*
carbonic acid	H_2CO_3	*carbonate*
hydrochloric acid	HCl	*chloride*
nitric acid	HNO_3	*nitrate*
phosphoric acid	H_3PO_4	*phosphate*
sulfuric acid	H_2SO_4	*sulfate*

Names and Formulas of Bases

6. A base is a compound that produces *hydroxide ions* when dissolved in water.

7. How are bases named?

Name the cation first followed by the name of the anion (hydroxide ion).

9.5 The Laws Governing How Compounds Form

For students using the Foundation edition, assign problems 1–7, 9, 10, 12–15.

Essential Understanding Rules for naming and writing compound formulas are possible because laws govern how compounds are formed.

Lesson Summary

The Laws of Definite and Multiple Proportions

The laws of definite and multiple proportions describe the ratios in which elements combine to form compounds.

- The law of definite proportions states that in any sample of a compound, the masses of the elements in the compound are always in the same proportion.
- The law of multiple proportions applies when the same two elements form more than one compound.
- When two elements form more than one compound, the law of multiple proportions says that the masses of one element combine with the same mass of the other element in simple, whole-number ratios.

Practicing Skills: Chemical Names and Formulas

To name or write the formula of a compound, you must first decide what type of compound it is.

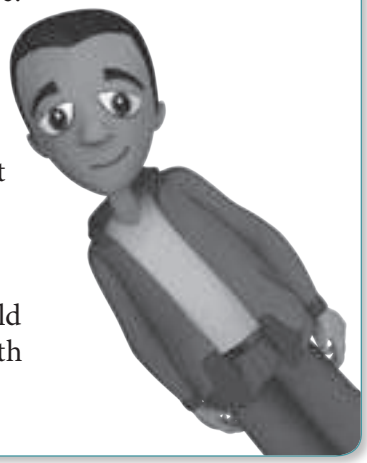
- Types of compounds include acids, binary compounds, compounds with polyatomic ions, and compounds containing metallic cations with different ionic charges.

Name _____ Class _____ Date _____

BUILD Math Skills

Finding a Mass Ratio A mass ratio is a way of showing a proportion of two different masses or compounds. It tells you how much you have of one substance for every gram—or other measurement—you have of another substance.

If you had twice as much mass of compound A than you had of compound B, the ratio would be written as 2:1; which is read as "two to one."



Typically in mass ratio problems, the amount of the element you are trying to find will be based upon the amount of another element. For example, for compound A, you may have 3.28 g of C for every 2.63 g of O; and for compound B, you may have 6.32 g of C for every 1.68 g of O.

So, if you were trying to find the ratio of carbon, you would need to find how much carbon exists for 1 g of oxygen for both compounds. You would do this by simply dividing the grams of carbon by the grams of oxygen.

To find a mass ratio, follow a few simple steps:

- Write down the known masses of both elements in both compounds.
- Identify the element for which you are trying to find the ratio.
- Divide the element for which you're finding the mass ratio by the other known element to get both compounds in equal proportions.
- To compare compound A to compound B, divide the mass of A by the mass of B. To compare compound B to compound A, divide B by A to obtain the mass ratio.
- If the nearest whole number is requested for the ratio, the answer will need to be rounded to the nearest whole number.

Sample Problem Carbon reacts with oxygen to create two compounds. Compound A contains 4.78 g of carbon for each 5.24 g of oxygen. Compound B contains 3.63 g of carbon for each 12.6 g of oxygen. What is the mass ratio of carbon rounded to the nearest whole number?

Write down the known masses of each element for both compounds.

Compound A: 4.78 g C, 5.24 g O
Compound B: 3.63 g C, 12.6 g O

Identify the element for which you are trying to find the ratio.

The question asks for the "mass ratio of carbon" so *carbon* is the element we want to compare.

Name _____ Class _____ Date _____

Next, get the two compounds in equal proportions by dividing the element for which you are trying to find the ratio—in this case, carbon—by the other element present, oxygen.

Compound A: $\frac{4.78\ g\ C}{5.24\ g\ O} = \frac{0.912\ g\ C}{1.00\ g\ O}$

Compound B: $\frac{3.63\ g\ C}{12.6\ g\ O} = \frac{0.288\ g\ C}{1.00\ g\ O}$

Both compounds are now in g C/1.00 g O, so they are in equal proportions.

Now divide the equal proportioned amounts to get the ratio of carbon. Since it is not specified if you want to compare A to B or B to A, either proportion can be used.

$$\text{Mass ratio of carbon} = \frac{\text{Compound A}}{\text{Compound B}}$$

$$= \frac{0.912\ g\ C\ (\text{compound A})}{0.288\ g\ C\ (\text{compound B})} = \frac{3.166}{1}$$

Finally, round the answer to the nearest whole number.

Since .166 is less than .5 the answer rounds down to 3.00, so the mass ratio is $\frac{3}{1}$ or 3:1.

Hint: Remember when rounding to the nearest whole number anything equal to or greater than .5 rounds up to the next whole number, while anything less than .5 will round down.

Now it's your turn to practice finding mass ratios. Remember to get the two compounds in equal proportions before finding the mass ratio.

1. Magnesium reacts with oxygen to form two compounds. Compound A contains 7.88 g of magnesium for every 15.68 g of oxygen. Compound B contains 2.12 g of magnesium for every 6.91 g of oxygen. What is the mass ratio of magnesium rounded to the nearest whole number?

   2:1

2. Chlorine reacts with oxygen to form two compounds. Compound A contains 8.43 g of chlorine for every 13.67 g of oxygen. Compound B contains 5.87 g of chlorine for every 17.33 g of oxygen. What is the mass ratio of chlorine rounded to the nearest whole number?

   2:1

Name _____ Class _____ Date _____

3. Lead forms two compounds when it reacts with oxygen. Compound A contains 8.45 g of lead for every 4.79 g of oxygen. Compound B contains 4.55 g of lead for every 0.77 g of oxygen. What is the mass ratio of oxygen rounded to the nearest whole number?
3:1

4. Sulfur reacts with oxygen and creates two compounds. Compound A contains 1.34 g of sulfur for every 0.86 g of oxygen. Compound B contains 11.63 g of sulfur for every 10.49 g of oxygen. What is the mass ratio of oxygen rounded to the nearest whole number?
1:1

After reading Lesson 9.5, answer the following questions.

The Laws of Definite and Multiple Proportions

5. What is the law of definite proportions?

In different samples of the same chemical compound, the masses of the elements are always present in the same proportions.

6. Circle the whole-number mass ratio of Li to Cl in LiCl. The atomic mass of Li is 6.9; the atomic mass of Cl is 35.5.

a. 42:1

b. 5:1

c. 1:5

7. Circle the whole-number mass ratio of carbon to hydrogen in C_2H_4. The atomic mass of C is 12.0; the atomic mass of H is 1.0.

a. 1:6

b. 6:1

c. 1:12

d. 12:1

8. In the compound sulfur dioxide, a food preservative, the mass ratio of sulfur to oxygen is 1:1. An 80-g sample of a compound composed of sulfur and oxygen contains 48 g of oxygen. Is the sample sulfur dioxide? Explain.

No; If the sample contains 48 g of oxygen, it contains 32 g of sulfur. The ratio 32:48 is equivalent to 2:3, not 1:1.

Name _____ Class _____ Date _____

9. What is the law of multiple proportions?

When two elements form more than one compound, the different masses of one element that combine with the same mass of the other element are in a ratio of small whole numbers.

10. Complete the table using the law of multiple proportions.

	Mass of Cu	Mass of Cl	Mass Ratio Cl:Cu	Whole-number Ratio of Cl
Compound A	8.3 g	4.6 g	*0.55*	*1*
Compound B	3.3 g	3.6 g	*1.1*	*2*

Practicing Skills: Chemical Names and Formulas

11. How can a flowchart help you to name chemical compounds?

It gives step-by-step directions for naming a compound.

12. Use the flowchart in Figure 9.18 to write the names of the following compounds:

a. CsCl ***cesium chloride***

b. $SnSe_2$ ***tin(IV) selenide***

c. NH_4OH ***ammonium hydroxide***

d. HF ***hydrofluoric acid***

e. Si_3N_4 ***trisilicon tetranitride***

13. Complete the following five rules for writing a chemical formula from a chemical name.

a. In an ionic compound, the net ionic charge is ***zero***.

b. An *-ide* ending generally indicates a(n) ***binary*** compound.

c. An *-ite* or *-ate* ending means that the formula contains a(n) ***polyatomic*** ion that includes oxygen.

d. ***Prefixes*** in a name generally indicate that the compound is molecular and show the number of each kind of atom in the molecule.

e. A(n) ***Roman numeral*** after the name of a cation shows the ionic charge of the cation.

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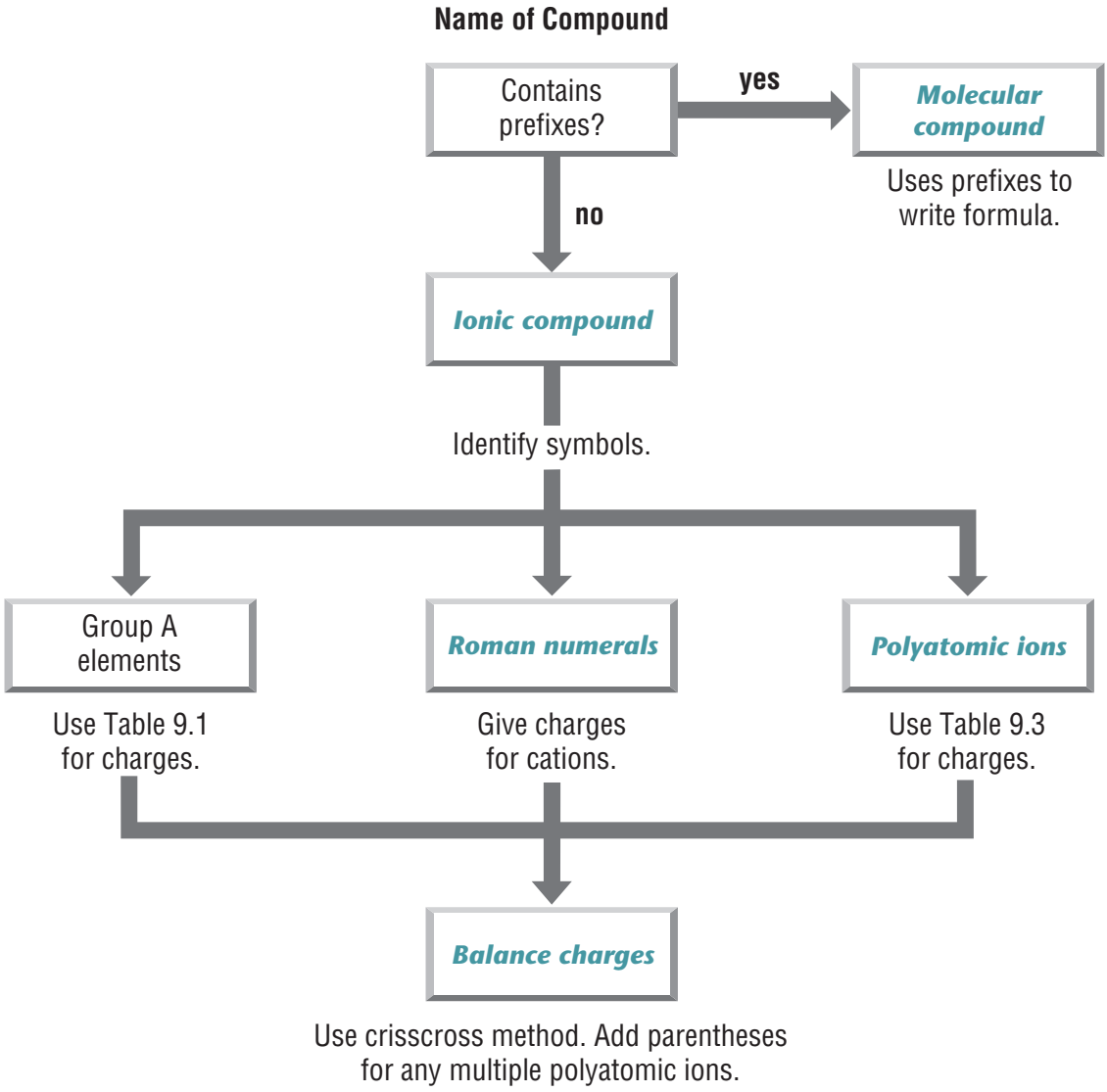
14. Fill in the missing labels from Figure 9.19.



15. Use the flowchart in Figure 9.19 to write the formulas of the following compounds:

a. potassium silicate K_2SiO_3

b. phosphorus pentachloride PCl_5

c. manganese(II) chromate $MnCrO_4$

d. lithium hydride LiH

e. diiodine pentoxide I_2O_5

Name _____ Class _____ Date _____

Guided Practice Problems

Answer the following questions about Practice Problem 2.

How many electrons were lost or gained to form these ions?

a. Fe^{3+} **b.** O^{2-} **c.** Cu^{+} **d.** Sr^{2+}

Step 1. Determine the number of electrons based on the size of the charge.

Step 2. Determine whether the electrons were lost or gained based on the sign of the charge.

a. *Fe^{3+} lost 3 electrons.*

b. *O^{2-} gained 2 electrons.*

c. *Cu^{+} lost 1 electron.*

d. *Sr^{2+} lost 2 electrons.*

Answer the following questions about Practice Problems 10b and 10c.

Write formulas for compounds formed from these pairs of ions.

b. Li^{+}, O^{2-} **c.** Ca^{2+}, N^{3-}

Li^{+}, O^{2-}

Analyze

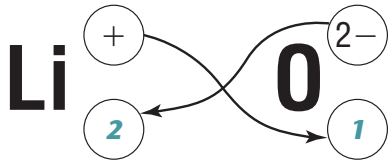
Step 1. Do the ions combine in a 1:1 ratio?

No, the charges on the ions are not equal.

Solve

Step 2. Use the crisscross method to balance the formula.

Write the formula. *Li_2O*



Ca^{2+}, N^{3-}

Analyze

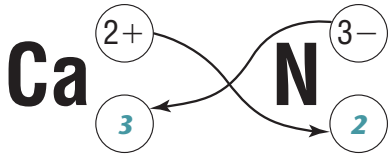
Step 1. Will the calcium (Ca^{2+}) and nitride (N^{3-}) ions combine in a 1:1 ratio? How do you know?

No, because then the total charge would be negative, instead of neutral.

Solve

Step 2. Use the crisscross method to balance the formula.

Write the formula. *Ca_3N_2*



Name _____ Class _____ Date _____

Answer the following questions about Practice Problem 15b.

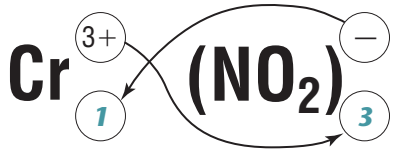
Write the formula for chromium(III) nitrite.

Step 1. Is the compound ionic or molecular? Explain.

It is ionic because it has no prefixes and it contains a metal.

Step 2. Use Table 9.3 to write the formula for the nitrite ion. NO_2^-

Step 3. Use the crisscross method to balance the formula. Write the formula. $Cr(NO_2)_3$



Answer the following questions about Practice Problem 48.

Lead forms two compounds with oxygen. One compound contains 2.98 g of lead and 0.461 g of oxygen. The other contains 9.89 g of lead and 0.763 g of oxygen. For a given mass of oxygen, what is the lowest whole-number mass ratio of lead in the two compounds?

Complete the following steps to solve the problem.

	First compound	Second compound
Step 1. Write the ratio of lead to oxygen for each compound.	$\frac{\boxed{2.98}\text{ g lead}}{0.461\text{ g oxygen}}$	$\frac{9.89\text{ g lead}}{\boxed{0.763}\text{ g oxygen}}$
Step 2. Divide the numerator by the denominator in each ratio.	$\frac{6.46\ \boxed{\text{g lead}}}{\boxed{\text{g oxygen}}}$	$\frac{\boxed{13.0}\text{ g lead}}{\text{g oxygen}}$
Step 3. Write a ratio comparing the first compound to the second.	$\frac{\boxed{6.46}\ \text{g lead/g oxygen}}{13.0\ \text{g lead/g oxygen}}$	
Step 4. Simplify. Note that this ratio has no units.	$\frac{0.497}{1} = \text{roughly } \frac{1}{\boxed{2}}$	

The mass ratio of lead per gram of oxygen in the two compounds is *1:2*.

Name _____ Class _____ Date _____

Apply the Big ideas

Copper and chlorine form copper(I) chloride, CuCl, and copper(II) chloride, $CuCl_2$.

a. How do these compounds relate to the number of electrons gained or lost by copper?

In both compounds, Cl gains one electron and has a charge of −1. Because the ratio of Cu and Cl in CuCl is 1:1, Cu must have lost one electron and obtained a charge of +1. In $CuCl_2$, Cu lost two electrons and has a charge of +2.

b. How does this information support the law of multiple proportions?

Comparing the mass of Cu that reacts with one Cl in the two compounds, the ratio of Cu in CuCl to Cu in $CuCl_2$ is 1:2, which is a small, whole-number ratio.

Name _____ Class _____ Date _____

9 Self-Check Activity

For Questions 1–11, complete each statement by writing the correct word or words. If you need help, you can go online.

9.1 Naming Ions

1. When metals lose electrons, they form ***cations*** _____.

2. A(n) ***polyatomic*** _____ ion contains more than one atom and acts as a unit.

9.2 Naming and Writing Formulas for Ionic Compounds

3. To write the formula for an ionic compound, write the formulas for the cation and the anion, then use subscripts to ***balance*** _____ charges.

4. To name an ionic compound, name the ***cation*** _____, then name the ***anion*** _____.

9.3 Naming and Writing Formulas for Molecular Compounds

5. To name a molecular compound, name the first element, add the root of the second element plus *-ide,* then add ***prefixes*** _____ given by the formula's subscripts.

6. To write the formula of a molecular compound, write the symbol of each element, then write ***subscripts*** _____ given by prefixes in the name of the compound.

9.4 Naming and Writing Formulas for Acids and Bases

7. Acids are named based on the ***anion*** _____ present in the compound.

8. Bases are named like other ***ionic*** _____ compounds.

9.5 The Laws Governing How Compounds Form

9. If the ratio of the number of each type of atom is fixed, their ***mass*** _____ ratio is also fixed.

10. When naming a compound of a metal that can have more than one charge, use a(n) ***Roman numeral*** _____ to show the charge of the metal ion.

11. If the name of a compound ends in *-ide*, the compound is usually ***binary*** _____.

If You Have Trouble With…											
Question	1	2	3	4	5	6	7	8	9	10	11
See Page	264	268	272	274	281	282	286	287	289	292	293

Name _____ Class _____ Date _____

Review Vocabulary

Fill in each of the blanks with a word or words that relate to each vocabulary term.

1. monatomic ion

A monatomic ion contains only one ***atom*** and has either a positive or a negative ***charge***. It differs from a(n) ***polyatomic*** ion, which contains more than one atom. Ions with a positive charge are known as ***cations***, and those with a negative charge are ***anions***. The name of a positive monatomic ion is the ***name of the element***. The name of a negative monatomic ion is the ***root of the name of the element*** plus the suffix ***-ide***.

2. binary compound

A binary compound might contain many atoms, but it contains only ***two*** different types of atoms. The name of a binary ***ionic*** compound consists of the names of the cation plus the name of the anion in the compound. ***Molecular*** binary compounds are named by using ***prefixes*** that show the number of each type of atom in the compound.

3. acid

Acids contain ***hydrogen*** atoms and release ***hydrogen*** ions in solution. They differ from bases, which release ***hydroxide*** ions in solution. Acids are named according to the ***anion*** present in the compound. The name of a binary acid includes the prefix ***hydro-***, the root of the name of the other element present, the suffix ***-ic***, and the word ***acid***. Other acids are named according to the name of the ***polyatomic*** ion they contain.

4. law of definite proportions

5. law of multiple proportions

These two laws help show how elements combine to form compounds. The law of definite proportions states that the ***masses*** of elements in a specific compound are always in the same ***proportion***. The law of multiple proportions is used when ***more than one*** compound forms from two elements. It states that the amount of one element that combines with a specific amount of the other element in the compounds is in the ratio of ***small, whole numbers***.