

Name:

D ¹²³ <small>01110.com</small>	R ¹³⁰ <small>Rearden</small>	.	S ¹⁰ <small>Sulfur</small>	H ¹ <small>Hydrogen</small>	A ¹²⁴ <small>Aluminum</small>	N ⁷ <small>Nitrogen</small>	Z ¹³¹ <small>Zinc</small>	Er ⁶⁸ <small>Erkhan</small>
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Regents Chemistry: Dr. Shanzer

Practice Packet

Chapter 7: Formulas Writing and Naming



Naming Ionic Compounds

What are the structural units that make up ionic compounds and how are they named?

Why?

When working in chemistry, it is often convenient to write a chemical in symbols. For example we might write down the substance table salt as NaCl. In talking about chemistry however, it is a bit tacky to say “en-ay see-ell” when we want to refer to a substance. Also, in formal writing we should use the name of the compound rather than its symbols. Therefore we need to learn how to say the proper names of ionic substances.

Model 1 – Ion Charges for Selected Elements

1	H ⁺										
2	Li ⁺	Be ²⁺						N ³⁻	O ²⁻	F ¹⁻	
3	Na ⁺	Mg ²⁺	Transition elements			Al ³⁺		P ³⁻	S ²⁻	Cl ¹⁻	
4	K ⁺	Ca ²⁺	Fe ²⁺ Fe ³⁺	Ni ²⁺ Ni ³⁺	Cu ⁺ Cu ²⁺	Zn ²⁺				Br ¹⁻	
5	Rb ⁺	Sr ²⁺			Ag ¹⁺		Sn ²⁺ Sn ⁴⁺			I ¹⁻	
6		Ba ²⁺				Hg ₂ ²⁺ Hg ²⁺	Pb ²⁺ Pb ⁴⁺				

←———— Cations —————→ ←———— Anions —————→

- Based on the information in Model 1:
 - Identify three elements that form only one cation.
 - Identify three elements that form only one anion.
 - Identify three elements that form more than one cation.
 - In what region of the periodic table are these “multiple ion” elements usually located?
- Consider the ions of potassium (K) and sulfur (S). Write chemical formulas for all possible ionic compounds involving these ions, using the simplest ratio(s) of potassium (K) and sulfur (S). Keep in mind that the sum of the charges in an ionic compound must equal zero.
- Consider the ions of iron (Fe) and sulfur (S). Write chemical formulas for all possible ionic compounds involving these ions, using the simplest ratio(s) of iron (Fe) and sulfur (S). Keep in mind that the sum of the charges in an ionic compound must equal zero.



Model 2 – Ionic Compound Names (Metals that form one ion)

NaCl	Sodium chloride	Zn ₃ P ₂	Zinc phosphide
CaS	Calcium sulfide	Al ₂ O ₃	Aluminum oxide
Ag ₂ S	Silver sulfide	SrCl ₃	Strontium chloride

- Circle the symbol for the metal in each of the compounds in Model 2.
- Which element comes first in the name and formula of the compounds in Model 2—the metal or the nonmetal?
- Use the table of ions in Model 1 to answer the following questions:
 - In the compound zinc phosphide, what is the charge on the zinc ion?
 - In the compound zinc phosphide, what is the charge on the phosphide ion?
- Explain why a 3 to 2 ratio of ions is necessary for the compound zinc phosphide.
- The compound carbon dioxide has a name that gives you a hint as to how many oxygen atoms are in the compound. Is there anything in the name “zinc phosphide” that indicates there are three zinc and two phosphorus ions in the formula unit?
- Is there any other ratio of zinc and phosphorus ions that could exist? For instance, could you have Zn₂P or ZnP₂? Explain your answer.



- Explain why you don't need to specify the number of ions in the compound when you are naming ionic substances like those in Model 2.
- Model 2 is labeled “Metals that form one ion.” What other metals that also form only one ion could be included in the Model 2 list? Model 1 may be helpful in this regard.
- Describe how the names of the nonmetal elements in Model 2 are changed when they are in their anion forms.
- Name the following ionic compounds using what you learned from Model 2.



14. Provide the chemical formula for each of the following ionic compounds.

Barium chloride

Magnesium oxide

15. Consider the two chemical formulas you wrote in Question 3 for compounds of iron and sulfur. Would the name “iron sulfide” be sufficient to uniquely identify either of those compounds? Explain.

Read This!

When the metal in an ionic compound always forms an ion with the same charge, you need not indicate that charge as part of the compound name. However, some atoms have the ability to form more than one type of ion. This can make naming confusing. You can't simply refer to a compound of copper and oxygen as “copper oxide.” People won't know which compound you are referring to— CuO or Cu_2O .

Model 3 – Ionic Compound Names (Metals that form multiple ions)

Cu_2O Copper(I) oxide

PbO Lead(II) oxide

CuO Copper(II) oxide

PbO_2 Lead(IV) oxide

SnF_2 Tin(II) fluoride

FeCl_2 Iron(II) chloride

SnF_4 Tin(IV) fluoride

FeCl_3 Iron(III) chloride

16. Model 3 is labeled “Metals that form multiple ions.” What other metals that form multiple ions could be included in Model 3? Model 1 may be helpful in this regard.

17. Describe the most obvious difference between the names in Model 3 and those in Model 2.

18. Do the Roman numerals in the names in Model 3 relate to the number of cations or number of anions in the formula unit? Support your answer by citing two specific examples.

19. Keeping in mind that the sum of the charges in an ionic compound must equal zero, use the chemical formulas in Model 3 to answer the following questions:

a. Identify the charge on the copper cations in copper(I) oxide and copper(II) oxide, respectively.

b. Identify the charge on the iron cations in iron(II) chloride and iron(III) chloride, respectively.



20. What do the Roman numerals in the compounds described in Question 19 indicate?

21. Fill in the table below using what you've learned from Model 3.

Compound	Charge on Cation	Name of the Compound
PbCl_4	Pb^{4+}	Lead(IV) chloride
Fe_2O_3		
SnO		
CuBr_2		



22. For each of the compounds in the table below, determine the type of metal in the compound and then name the compound using the correct naming method.

	Metal forms only one ion	Metal forms multiple ions	Name
CaBr_2			
MgO			
Ag_3N			
SnCl_2			
CuF_2			
K_3P			
Zn_3N_2			
HgO			

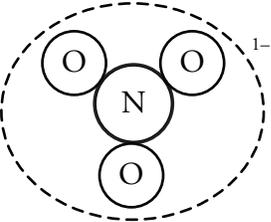
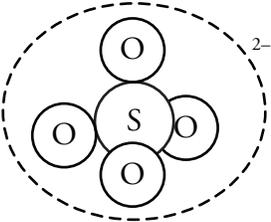
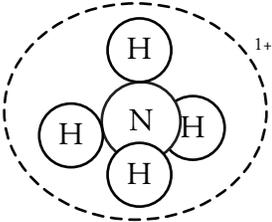
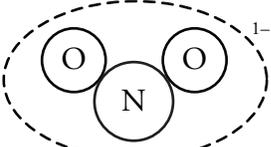
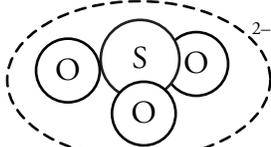
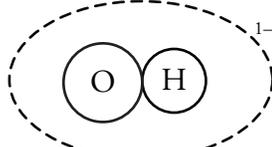
Polyatomic Ions

Can a group of atoms have a charge?

Why?

Do you know you eat a lot of “-ates”? Next time you look at a food label, read the ingredients and you will likely find a number of ingredients that end with “-ate,” such as sodium phosphate or calcium carbonate. Did you ever wonder what the chemical formulas of these ingredients look like? In this activity we will explore polyatomic ions, which are groups of atoms that carry a charge. These ions are found in our food ingredients, natural waterways, and many other chemical compounds you encounter every day.

Model 1 – Types of Ions

Monatomic Ions	Nitride 	Sulfide 	Chloride 
Polyatomic Ions	Nitrate 	Sulfate 	Ammonium 
	Nitrite 	Sulfite 	Hydroxide 

1. Use Model 1 to complete the table below.

Name of Ion	Nitride	Nitrate	Sulfate	Sulfite	Ammonium
Charge on Ion		-1			
Type and Number of Atoms			1 sulfur 4 oxygen		
Chemical Formula				SO_3^{2-}	

2. Consider the terms “monatomic” and “polyatomic” as they are used in Model 1. Write a definition for each of these terms. It may be helpful to break the words apart (*i.e.*, poly – atomic). Make sure your group comes to consensus.

Monatomic—

Polyatomic—

3. What types of elements (metals or nonmetals) are shown in the polyatomic ions in Model 1?

4. The net charge on a sulfide ion (S^{2-}) is -2 . Explain how this ion obtains its charge. Your answer should include a discussion of subatomic particles.



5. The dotted line around each polyatomic ion in Model 1 shows that the group of atoms has a charge. The charge is not on any one atom, but rather on the group of atoms as a whole. Based on your knowledge of monatomic ions, propose an explanation for the net charge on a polyatomic ion. Your answer should include a discussion of subatomic particles.

6. What are the similarities and differences between the nitrate and nitrite ions in Model 1?

7. What are the similarities and differences between the sulfate and sulfite ions in Model 1?

8. The “chlorate” polyatomic ion has a charge of -1 and is composed of one chlorine atom (the central atom) and three oxygen atoms.

a. Draw a model of a chlorate ion.

b. Write the chemical formula for the chlorate ion, including its charge.



9. In your group discuss what “chlorite” would look like.

a. Draw a model of a chlorite ion.

b. Write the chemical formula for the chlorite ion, including its charge.



Model 2 – Common Polyatomic Ions

1+		1-		2-		3-	
ammonium	NH_4^{1+}	acetate	$\text{CH}_3\text{COO}^{1-}$	sulfate	SO_4^{2-}	phosphate	PO_4^{3-}
		hydroxide	OH^{1-}	sulfite	SO_3^{2-}		
		nitrate	NO_3^{1-}	carbonate	CO_3^{2-}		
		nitrite	NO_2^{1-}	chromate	CrO_4^{2-}		
		bicarbonate	HCO_3^{1-}	dichromate	$\text{Cr}_2\text{O}_7^{2-}$		
		permanganate	MnO_4^{1-}				
		perchlorate	ClO_4^{1-}				
		chlorate	ClO_3^{1-}				
		chlorite	ClO_2^{1-}				
		hypochlorite	ClO^{1-}				

10. What is the only polyatomic ion that is a cation?

11. How are bicarbonate and carbonate related?

12. Predict the chemical formula and charge for the bisulfate ion.

13. How are chromate and dichromate related?

14. Bromine forms polyatomic ions with structures similar to those of chlorine. Using the chlorine family of polyatomic ions as a model, predict the name of the BrO_4^{1-} ion.
15. Identify the polyatomic ion in each of these ionic compounds. Write out the name and formula of the ions including their charges.
- a. CaCO_3 b. $\text{Mg}(\text{OH})_2$ c. NH_4Cl



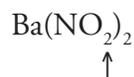
Model 3 – Ternary Ionic Compounds

Compound Name	Ion Symbols and Charges		Chemical Formula
Ammonium phosphate	NH_4^{1+}	PO_4^{3-}	$(\text{NH}_4)_3\text{PO}_4$
Barium nitrite	Ba^{2+}	NO_2^{1-}	$\text{Ba}(\text{NO}_2)_2$
Ammonium sulfate	NH_4^{1+}	SO_4^{2-}	$(\text{NH}_4)_2\text{SO}_4$
Aluminum carbonate	Al^{3+}	CO_3^{2-}	$\text{Al}_2(\text{CO}_3)_3$
Iron(III) hydroxide	Fe^{3+}	OH^{1-}	$\text{Fe}(\text{OH})_3$
Potassium nitrate	K^{1+}	NO_3^{1-}	KNO_3

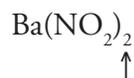
16. How are ternary ionic compounds in Model 3 different from binary ionic compounds (NaCl , MgO , CaBr_2 , etc.) that you've seen previously? *Hint:* Consider the meaning of the word “**binary**.”



17. Consider the compound iron(III) hydroxide in Model 3.
- a. How many hydroxide ions (OH^{1-}) are combined with an iron(III) ion (Fe^{3+})?
- b. Is your answer to part a the only combination of iron(III) and hydroxide that should exist in nature? Explain.
18. Consider the compound barium nitrite in Model 3.
- a. What does the subscripted “2” *inside* the parentheses of the chemical formula tell you about the compound?



- b. What does the subscripted “2” *outside* the parentheses of the chemical formula tell you about the compound?



19. How many atoms of each element are in one formula unit of ammonium phosphate, $(\text{NH}_4)_3\text{PO}_4$?
- | | | | |
|----------|----------|------------|--------|
| nitrogen | hydrogen | phosphorus | oxygen |
|----------|----------|------------|--------|

20. A student writes the chemical formula for the ionic compound calcium hydroxide as CaOH_2 .

- a. Write the chemical formula for each ion in the compound.

Calcium:

Hydroxide:

- b. Why is the student’s chemical formula for the compound calcium hydroxide wrong?

21. Many of the chemical formulas in Model 3 include parentheses. Which one of the following rules summarizes the appropriate use of parentheses in ternary ionic compounds? For the three rules that do not apply in all cases, show at least one counter example from the chemical formulas in Model 3.

*Parentheses are used around any ion that is used more than once in a formula unit.

*Parentheses are used around any polyatomic ion.

*Parentheses are used around any polyatomic ion used more than once in a formula unit.

*Parentheses are only used around polyatomic anions used more than once in a formula unit.



22. Write chemical formulas for the following ternary ionic compounds.

a. Calcium sulfate

b. Copper(II) nitrate

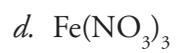
c. Lithium phosphate

d. Potassium permanganate

e. Aluminum sulfite

f. Magnesium bicarbonate

23. Name the following ternary ionic compounds.



Naming Molecular Compounds

How are the chemical formula and name of a molecular compound related?

Why?

When you began chemistry class this year, you probably already knew that the chemical formula for carbon dioxide was CO_2 . Today you will find out why CO_2 is named that way. Naming chemical compounds correctly is of paramount importance. The slight difference between the names carbon monoxide (CO , a poisonous, deadly gas) and carbon dioxide (CO_2 , a greenhouse gas that we exhale when we breathe out) can be the difference between life and death! In this activity you will learn the naming system for molecular compounds.

Model 1 – Molecular Compounds

Molecular Formula	Number of Atoms of First Element	Number of Atoms of Second Element	Name of Compound
ClF			Chlorine monofluoride
ClF_5	1	5	Chlorine pentafluoride
CO			Carbon monoxide
CO_2			Carbon dioxide
Cl_2O			Dichlorine monoxide
PCl_5			Phosphorus pentachloride
N_2O_5			Dinitrogen pentoxide

1. Fill in the table to indicate the number of atoms of each type in the molecular formula.
2. Examine the molecular formulas given in Model 1 for various molecular compounds.
 - a. How many different *elements* are present in each compound shown?
 - b. Do the compounds combine metals with metals, metals with nonmetals, or nonmetals with nonmetals?
3. Find all of the compounds in Model 1 that have chlorine and fluorine in them. Explain why the name “chlorine fluoride” is not sufficient to identify a specific compound.
4. Assuming that the name of the compound gives a clue to its molecular formula, predict how many atoms each of these prefixes indicates, and provide two examples.

mono-

di-

penta-

Model 2 – Prefixes and Suffixes

Prefix	Numerical Value
mono-	
di-	
tri-	
tetra-	
penta-	
hexa-	
hepta-	
octa-	
nona-	
deca-	

Molecular Formula	Name of Compound
BCl_3	Boron trichloride
SF_6	Sulfur hexafluoride
IF_7	Iodine heptafluoride
NI_3	Nitrogen triiodide
N_2O_4	Dinitrogen tetroxide
Cl_2O	Dichlorine monoxide
P_4O_{10}	Tetraphosphorus decoxide
B_5H_9	Pentaboron nonahydride
Br_3O_8	Tribromine octoxide
ClF	Chlorine monofluoride

- Examine the prefixes in Model 2. Fill in the numerical value that corresponds to each prefix.
- What suffix (ending) do all the compound names in Model 2 have in common?



- Carefully examine the names of the compounds in Model 2. When is a prefix NOT used in front of the name of an element?
- Consider the compound NO.
 - Which element, nitrogen or oxygen, would require a prefix in the molecule name? Explain your answer.

b. Name the molecule NO.



- Find two compounds in Model 2 that contain a subscript of “4” in their molecular formula.
 - List the formulas and names for the two compounds.
 - What is different about the spelling of the prefix meaning “four” in these two names?

10. Find two compounds in Model 2 that contain the prefix “mono-” in their names.
 - a. List the formulas and names for the two compounds.
 - b. What is different about the spelling of the prefix meaning “one” in these two names?
11. Identify any remaining names of compounds in Model 2 where the prefixes that do not exactly match the spelling shown in the prefix table.
12. Use your answers to Questions 9–11 to write a guideline for how and when to modify a prefix name for a molecular compound. Come to a consensus within your group.
13. Would the guideline you wrote for Question 12 give you the correct name for NI_3 as it is given in Model 2? If not, modify your guideline to include this example.
14. All of the compounds listed in Model 2 are binary molecular compounds. Compounds such as CH_3OH or PF_2Cl_3 are not binary, and compounds such as NaCl or CaCl_2 are not molecular. Propose a definition for “binary molecular compounds.”
-  15. Collaborate with your group members to write a list of rules for recognizing and naming binary molecular compounds from their chemical formulas.



16. For each of the following compounds, indicate whether or not your naming rules from Question 15 will apply. If not, explain why the naming rules do not apply.



17. Using the rules your group developed in Question 15, name each of the following molecular compounds.

Molecular Formula	Molecule Name
PBr_3	
SCl_4	
N_2F_2	
SO_3	
BrF	

18. Write molecular formulas for the following compounds.

Molecular Formula	Molecule Name
	Disulfur decafluoride
	Carbon tetrachloride
	Oxygen difluoride
	Dinitrogen trioxide
	Tetraphosphorus heptasulfide



Compounds: Putting it all Together

Name: _____

The compounds below are of several different types. Use the flow chart to determine the naming system to use and name each compound show below.

Formula	IUPAC Name
1. $\text{Fe}(\text{NO}_2)_3$	
2. $\text{Na}_2\text{S}_2\text{O}_3$	
3. P_2O_5	
4. BaBr_2	
5. $\text{Mn}_2(\text{Cr}_2\text{O}_7)_7$	
6. CaCl_2	
7. $(\text{NH}_4)_2\text{S}$	
8. CuF	
9. Br_2O	
10. HgSO_4	
11. Al_2O_3	
12. SCl_6	
13. IF_7	
14. $\text{Cr}(\text{CO}_3)_3$	
15. KNO_2	

Write the correct name for the chemical formulas below. Use the flow chart to help!

IUPAC Name	Formula
1. antimony tribromide	
2. chlorine dioxide	
3. sodium sulfate	
4. iron (II) oxide	
5. calcium chloride	
6. ammonia	
7. zinc hydroxide	
8. diphosphorus pentoxide	
9. zinc nitrate	
10. iron (III) oxide	
11. potassium nitride	
12. tin (IV) oxide	
13. ammonium phosphate	
14. magnesium hydroxide	
15. carbon monoxide	

Formula Writing & Naming Review

1. In the formula $X_2(SO_4)_3$, the X represents a metal. This metal could be located on the Periodic Table in
- 1) Group 1 3) Group 13
2) Group 2 4) Group 14
2. Every water molecule has two hydrogen atoms bonded to one oxygen atom. This fact supports the concept that elements in a compound are
- 1) chemically combined in a fixed proportion
2) chemically combined in proportions that vary
3) physically mixed in a fixed proportion
4) physically mixed in proportions that vary
3. Which element forms a compound with chlorine with the general formula MCl
- 1) Rb 2) Ra 3) Re 4) Rn
4. Which formula represents strontium phosphate?
- 1) $SrPO_4$ 3) $Sr_2(PO_4)_3$
2) Sr_3PO_8 4) $Sr_3(PO_4)_2$
5. The compound XCl is classified as ionic if X represents the element
- 1) H 2) I 3) Rb 4) Br
6. What is the chemical formula for iron(III) oxide?
- 1) FeO 3) Fe_3O
2) Fe_2O_3 4) Fe_3O_2
7. In which compound is the ratio of metal ions to nonmetal ions 1 to 2?
- 1) calcium bromide 3) calcium phosphide
2) calcium oxide 4) calcium sulfide
8. Element X reacts with iron to form two different compounds with the formulas FeX and Fe_2X_3 . To which group on the Periodic Table does element X belong?
- 1) Group 8 3) Group 13
2) Group 2 4) Group 16
9. What is the chemical formula for sodium sulfate?
- 1) Na_2SO_3 3) $NaSO_3$
2) Na_2SO_4 4) $NaSO_4$
10. What is the IUPAC name for the compound ZnO ?
- 1) zinc oxide 3) zinc peroxide
2) zinc oxalate 4) zinc hydroxide
11. What is the chemical formula of iron(III) sulfide?
- 1) FeS 3) $FeSO_3$
2) Fe_2S_3 4) $Fe_2(SO_3)_3$
12. Which formula represents copper(I) oxide?
- 1) CuO 3) Cu_2O
2) CuO_2 4) Cu_2O_2
13. Which formula represents lead(II) chromate?
- 1) $PbCrO_4$ 3) Pb_2CrO_4
2) $Pb(CrO_4)_2$ 4) $Pb_2(CrO_4)_3$
14. A compound is made up of iron and oxygen, only. The ratio of iron ions to oxide ions is 2:3 in this compound. The IUPAC name for this compound is
- 1) triiron dioxide 3) iron(III) oxide
2) iron(II) oxide 4) iron trioxide
15. What is the IUPAC name for the compound FeS ?
- 1) iron(II) sulfate 3) iron(II) sulfide
2) iron(III) sulfate 4) Iron(III) sulfide
16. What is the formula of titanium(II) oxide?
- 1) TiO 2) TiO_2 3) Ti_2O 4) Ti_2O_3
17. Which is a binary compound?
- 1) $CaCl_2$ 3) $NaNO_3$
2) KOH 4) $MgSO_4$
18. What is the correct formula for ammonium carbonate?
- 1) $NH_4(CO_3)_2$ 3) $(NH_4)_2(CO_3)_2$
2) NH_4CO_3 4) $(NH_4)_2CO_3$