

Unit 3 Packet Part 1: Naming

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CHEMICAL BONDING POGIL

Activity 1 – A compound by any other name...

Objective:

- Based on the elements present in a chemical formula, classify the compound as ionic or covalent (covalent molecules are also referred to as molecular compounds).

Getting Started:

Review the definitions for an element and a compound.

The Model:

Fe is the elemental form of iron.

C is the elemental form of carbon.

Cl₂ is the elemental form of chlorine.

FeCl₃ is a compound formed from the elements iron and chlorine

Reviewing the Model

1. What does the subscript 2 indicate in Cl₂?

2 chlorine atoms

2. What is implied when there is no subscript?

1 atom

3. Classify C, Fe and Cl as metals or nonmetals.

C → ~~metal~~ nonmetal Cl → nonmetal
Fe → metal

Exploring the Model

4. Evaluate the statement, "The formulas for elements never contain a subscript." Is this statement true?

this is false

5. From the two examples provided, would you expect the formula S₈ to represent a compound or an element?

element

6. Using examples from the Model, explain how you classified S₈.

since Cl₂ is considered an element, S₈ should be also

Exercising Your Knowledge

7. Classify each formula below as an element or a compound:

a. Co element

b. CaCl₂ compound

c. CsOH compound

d. Br₂ element

e. NaBr compound

f. SiO₂ compound

g. PF₅ compound

h. P₄ element

i. OF₂ compound

Summarizing Your Thoughts

8. What clues are given in chemical formulas that allow you to differentiate between an element and a compound?

An element only has one type of atom and a compound has more than one type of atom.

CHEMICAL BONDING POGIL

Activity 2 – Types of bonds...

Getting Started:

There are two major classes of compounds typically encountered as part of an introductory course: ionic and covalent compounds. The concepts describing how these compounds are held together can be developed as you progress through your studies. However, before you get to those concepts you must be able to quickly classify a compound into one class or the other. In other words, your ability to classify compounds will guide how you will think about bigger ideas.

The Model:

Table 1 – Compounds that are considered...

Ionic	Covalent
ZnCl ₂	CCl ₄
Na ₂ O	P ₂ O ₅
Fe ₂ O ₃	N ₂ O ₄
CuI	NI ₃

Reviewing the Model

1. The compound ZnCl₂ is considered to be a (an) ionic compound.
2. The compound that contains nitrogen and oxygen is a (an) covalent compound.

Chemical Bonding Worksheet

Ionic Bond	between a Metal and Non-Metal	(M + NM)
Covalent Bond	between a Non-Metal and Non-Metal	(NM + NM)
Metallic Bond	between a Metal and Metal	(M + M)

Determine if the elements in the following compounds are metals or non-metals. Describe the type of bonding that occurs in the compound.

Compound	Element 1 (metal or non-metal?)	Element 2 (metal or non-metal?)	Bond Type
NO ₂	N = non-metal	O = non-metal	covalent
NaCl	metal	nm	ionic
SO ₂	non-metal	nm	covalent
PO ₄ ³⁻	non-metal	nm	covalent
MgBr ₂	metal	nm	ionic
CaO	metal	nm	ionic
H ₂ O	non-metal	nm	covalent
K ₂ O	metal	nm	ionic
Cu-Zn alloy	metal	m	metallic
O ₂	non-metal	nm	covalent
CuCl ₂	metal	nm	ionic
NO ₂ ⁻	non-metal	nm	covalent
TiO ₂	metal	nm	ionic
HF	non-metal	nm	covalent
Rb ₂ S	metal	nm	ionic
Au-Ag mixture	metal	metal	metallic
Fe ₂ O ₃	metal	nm	ionic
C ₆ H ₁₂ O ₂₂	non-metal	nm nm	covalent

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 →

1. Based on the information in Model 1:

a. Identify three elements that form only one cation.

hydrogen, lithium, sodium (any that only have one charge)

b. Identify three elements that form only one anion.

fluorine, chlorine, bromine

c. Identify three elements that form more than one cation.

Iron, Nickel, Copper

d. In what region of the periodic table are these "multiple ion" elements usually located?

transition elements

2. 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.

K₂S

3. 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.

FeS and Fe₂S₃



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

NaCl Sodium chloride	Zn_3P_2 Zinc phosphide
CaS Calcium sulfide	Al_2O_3 Aluminum oxide
Ag_2S Silver sulfide	SrCl_2 Strontium chloride

4. Circle the symbol for the metal in each of the compounds in Model 2.
5. Which element comes first in the name and formula of the compounds in Model 2—the metal or the nonmetal?

metal

6. Use the table of ions in Model 1 to answer the following questions:

a. In the compound zinc phosphide, what is the charge on the zinc ion?

+2

b. In the compound zinc phosphide, what is the charge on the phosphide ion?

-3

7. Explain why a 3 to 2 ratio of ions is necessary for the compound zinc phosphide.

the sum of the charges have to equal zero

8. 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?

No

9. Is there any other ratio of zinc and phosphorus ions that could exist? For instance, could you have Zn_2P or ZnP_2 ? Explain your answer.

No because Zn always has a $+2$ charge and P always has -3 charge

10. 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.

always need to be neutral, so there is only possible combination

11. 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.

Lithium, potassium, rubidium, Beryllium, magnesium, Barium

12. Describe how the names of the nonmetal elements in Model 2 are changed when they are in their anion forms.

ending changes to -ide

13. Name the following ionic compounds using what you learned from Model 2.

Li_2O	MgF_2	Al_2S_3	K_3N
Lithium oxide	magnesium fluoride	aluminum sulfide	potassium nitride

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

Barium chloride $BaCl_2$

Magnesium oxide MgO

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.

No because we would not be able to tell the difference between the two

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.

$Ni, Hg,$

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

Roman numerals

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.

the # of anions

Cu_2O (copper(I) oxide)
~~example~~ SnF_4 Tin(IV) fluoride

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.

Cu^{+1} Cu^{+2}

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

Fe^{+2} Fe^{+3}

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

the charge of the cation

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 ₂ O ₃	Fe ³⁺	Iron(III) oxide
SnO	Sn ²⁺	Tin(II) oxide
CuBr ₂	Cu ²⁺	Copper(II) bromide



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	Ca	Ca	calcium bromide
MgO	Mg	Mg	magnesium oxide
Ag ₃ N	Ag	Ag	silver nitride
SnCl ₂		Sn	tin(II) chloride
CuF ₂		Cu	copper(II) fluoride
K ₃ P	K		potassium phosphide
Zn ₃ N ₂	Zn		zinc nitride
HgO		Hg	mercury(II) oxide

Ionic #1 WS – Formulas OnlyBinary Compounds – containing metal with nonmetal

Write formulas for the following:

- | | |
|----------------------|------------------------------------|
| 1. aluminum chloride | <u>AlCl₃</u> |
| 2. lithium sulfide | <u>Li₂S</u> |
| 3. calcium phosphide | <u>Ca₃P₂</u> |
| 4. barium fluoride | <u>BaF₂</u> |
| 5. potassium oxide | <u>K₂O</u> |
| 6. sodium bromide | <u>NaBr</u> |
| 7. barium nitride | <u>Ba₃N₂</u> |
| 8. lithium oxide | <u>Li₂O</u> |
| 9. aluminum oxide | <u>Al₂O₃</u> |
| 10. rubidium iodide | <u>RbI</u> |

Binary Compounds - containing transition metal with nonmetal

Write formulas for the following:

- | | |
|-------------------------|-------------------------|
| 1. mercury(II) sulfide | <u>HgS</u> |
| 2. copper(I) nitride | <u>Cu₃N</u> |
| 3. iron(III) bromide | <u>FeBr₃</u> |
| 4. mercury(I) oxide | <u>Hg₂O</u> |
| 5. silver fluoride | <u>AgF</u> |
| 6. copper(II) oxide | <u>CSO</u> |
| 7. chromium(III) iodide | <u>CrI₃</u> |
| 8. nickel(II) bromide | <u>NiBr₂</u> |
| 9. tin(IV) sulfide | <u>SnS₂</u> |
| 10. zinc oxide | <u>ZnO</u> |

Compounds containing polyatomic ions

Write formulas for the following:

- | | |
|-------------------------|--|
| 1. aluminum sulfate | <u>Al₂(SO₄)₃</u> |
| 2. zinc nitrite | <u>Zn(NO₂)₂</u> |
| 3. magnesium chlorate | <u>Mg(ClO₃)₂</u> |
| 4. sodium bicarbonate | <u>Na(HCO₃)</u> |
| 5. calcium hydroxide | <u>Ca(OH)₂</u> |
| 6. copper(II) carbonate | <u>CuCO₃</u> |
| 7. ammonium sulfide | <u>(NH₄)₂S</u> |
| 8. iron(III) acetate | <u>Fe(C₂H₃O₂)₃</u> |
| 9. lithium sulfite | <u>Li₂(SO₃)</u> |
| 10. strontium phosphate | <u>Sr₃(PO₄)₂</u> |

* bicarbonate = hydrogen carbonate

Ionic #1 WS - Part 2Binary Compounds - containing metal with nonmetal

Name the following:

1. NaF sodium fluoride
2. K₂O potassium oxide
3. LiBr lithium bromide
4. CaCl₂ calcium chloride
5. BaS barium sulfide
6. BaF₂ barium fluoride
7. Na₂S sodium sulfide
8. MgI₂ magnesium iodide
9. K₃N potassium nitride
10. BeSe beryllium selenide

Binary Compounds - containing transition metal with nonmetal

Name the following:

1. CuCl copper (I) chloride
2. CuCl₂ copper (II) chloride
3. FeO Iron (II) oxide
4. MnS manganese (II) sulfide
5. Cr₂O₃ chromium (III) oxide
6. NiF₂ Nickel (II) fluoride
7. SnCl₄ Tin (IV) chloride
8. Ag₃P silver phosphide
9. ZnS zinc sulfide
10. Hg₂Cl₂ _____

Compounds containing polyatomic ions

Name the following:

1. BaSO₄ barium sulfate
2. (NH₄)₂CO₃ ammonium carbonate
3. Li₂SO₃ lithium sulfite
4. CrPO₄ chromium (III) phosphate
5. NaC₂H₃O₂ sodium acetate
6. Ba(OH)₂ barium hydroxide
7. Fe(NO₃)₃ Iron (III) nitrate
8. KCN potassium cyanide
9. SrCrO₄ strontium chromate
10. CaCr₂O₇ calcium dichromate

Binary Molecular Compounds Practice



Name: _____

Date: _____

Write out the name for the following compounds.

1. P_4O_{10} tetraphosphorus decaoxide
2. $SeCl_2$ Selenium dichloride
3. NO nitrogen monoxide
4. N_2O dinitrogen monoxide
5. NO_2 nitrogen dioxide
6. SF_8 sulfur octafluoride
7. BCl_3 boron trichloride
8. As_2O_5 diarsenic pentoxide
9. P_4S_5 tetraphosphorus pentasulfide
10. Si_2Br_6 disilicon hexabromide
11. SeF_6 selenium hexafluoride
12. SCl_4 sulfur tetrachloride
13. CH_4 carbon tetrahydride
14. B_2S diboron monosulfide
15. NF_3 nitrogen trifluoride

Write the formulas for the following covalent compounds:

1. antimony tribromide SbBr₃
2. hexaboron monosilicide B₆Si
3. chlorine dioxide ClO₂
4. diphosphorus monosulfide P₂S
5. iodine pentafluoride IF₅
6. dinitrogen trioxide N₂O₃
7. phosphorus triiodide PI₃
8. phosphorus trichloride PCl₃
9. arsenic pentabromide AsBr₅
10. iodine trichloride ICl₃
11. carbon monoxide CO
12. diphosphorus pentoxide P₂O₅
13. boron trifluoride BF₃
14. dichlorine heptoxide Cl₂O₇
15. carbon tetrabromide CBr₄
16. nitrogen trihydride NH₃

Compound Practice

Name: _____

Date: _____

Part 1: Label each of the following as Covalent (C) or ionic (I), and fill in the formula for each compound.

1) sodium bicarbonate	<u>I</u>	<u>NaHCO₃</u>
2) magnesium sulfate	<u>I</u>	<u>MgSO₄</u>
3) lead (IV) sulfide	<u>I</u>	<u>PbS₂</u>
4) phosphorus trichloride	<u>C</u>	<u>PCl₃</u>
5) copper (I) carbonate	<u>I</u>	<u>Cu₂CO₃</u>
6) tetraphosphorus decoxide	<u>C</u>	<u>P₄O₁₀</u>
7) calcium chloride	<u>I</u>	<u>CaCl₂</u>
8) Zinc nitrate	<u>I</u>	<u>Zn(NO₃)₂</u>
9) tin (II) iodide	<u>I</u>	<u>SnI₂</u>
10) nitrogen monoxide	<u>C</u>	<u>NO</u>
11) sodium nitrate	<u>I</u>	<u>NaNO₃</u>
12) dinitrogen tetroxide	<u>C</u>	<u>N₂O₄</u>
13) titanium (IV) oxide	<u>I</u>	<u>TiO₂</u>
14) phosphorus pentabromide	<u>C</u>	<u>PBr₅</u>
15) iron (III) selenide	<u>I</u>	<u>Fe₂Se₃</u>
16) aluminum chloride	<u>I</u>	<u>AlCl₃</u>
17) nitrogen dioxide	<u>C</u>	<u>NO₂</u>
18) carbon tetrachloride	<u>C</u>	<u>CCl₄</u>
19) cobalt (II) iodide	<u>I</u>	<u>CoI₂</u>
20) Francium phosphate	<u>I</u>	<u>Fr₃PO₄</u>
21) Lead (IV) chromate	<u>I</u>	<u>Pb(CrO₄)₂</u>
22) magnesium acetate	<u>I</u>	<u>Mg(C₂H₃O₂)₂</u>
23) silver bromide	<u>I</u>	<u>AgBr</u>
24) chromium (III) nitride	<u>I</u>	<u>CrN</u>
25) potassium acetate	<u>I</u>	<u>KC₂H₃O₂</u>

covalent (C)

Part 2: Label each of the following as molecular (M) or ionic (I), and fill in the name for each compound.

26) $\text{Al}(\text{OH})_3$	<u>I</u>	<u>aluminum hydroxide</u>
27) SrCl_2	<u>I</u>	<u>strontium chloride</u>
28) NaBr	<u>I</u>	<u>sodium bromide</u>
29) S_2Cl_2	<u>C</u>	<u>disulfur dichloride</u>
30) Li_3PO_4	<u>I</u>	<u>lithium phosphate</u>
31) $\text{Fe}_2(\text{C}_2\text{O}_4)_3$	<u>I</u>	<u>iron(II) oxalate</u>
32) SiO_4	<u>C</u>	<u>silicon tetroxide</u>
33) HNO_2	<u>C</u>	<u>nitrous acid</u>
34) $\text{Cr}(\text{C}_2\text{H}_3\text{O}_2)_3$	<u>I</u>	<u>chromium(III) acetate</u>
35) $\text{Ni}(\text{HSO}_4)_2$	<u>I</u>	<u>Nickel(II) hydrogen sulfate</u>
36) Li_2CO_3	<u>I</u>	<u>lithium carbonate</u>
37) $\text{Cu}(\text{ClO}_4)_2$	<u>I</u>	<u>copper(II) perchlorate</u>
38) CsF	<u>I</u>	<u>cesium fluoride</u>
39) KOH	<u>I</u>	<u>potassium hydroxide</u>
40) $(\text{NH}_4)_2\text{SO}_3$	<u>I</u>	<u>ammonium sulfite</u>
41) MgSO_3	<u>I</u>	<u>magnesium sulfite</u>
42) IBr_3	<u>C</u>	<u>Iodine tribromide</u>
43) SO_3	<u>C</u>	<u>sulfur trioxide</u>
44) HgO	<u>I</u>	<u>mercury(II) oxide</u>
45) AgNO_3	<u>I</u>	<u>Silver nitrate</u>
46) FeCl_2	<u>I</u>	<u>Iron(II) chloride</u>
47) $\text{Cr}_3(\text{PO}_4)_2$	<u>I</u>	<u>Chromium(III) phosphate</u>
48) CuCl_2	<u>I</u>	barium <u>Copper(II) chloride</u>
49) NaNO_2	<u>I</u>	<u>sodium nitrite</u>
50) BaCO_3	<u>I</u>	<u>barium carbonate</u>