Regents Chemistry:

Unit 6: Supplemental

Naming

LESSON A: Writing Chemical Formulas for Ionic Compounds

Objective:

- ✓ ***Construct chemical formulas for ionic compounds***
- ✓ ***Construct chemical formulas for binary compounds containing multiple charges***
- ✓ ***Construct chemical formulas for tertiary compounds containing polyatomic ions***

Sub-Lesson A-1: Simple Binary ionic compounds (one metal and one non-metal atom)

Ionic Compounds require two types of ions: **cations** which are positive and **anions** which are negative. All **metals** (on the left side of the periodic table) form cations and **nonmetals** (on the right side of the periodic table) form anions primarily. In order to determine the formula of the compound they create you must make sure their ions sum to zero. For example, table salt is sodium chloride. Using the periodic table's first set of ions, sodium forms $^{+1}$ ions and chlorine forms $^{-1}$ ions. Therefore their ions cancel out and the formula is NaCl. It is not always that easy. Calcium chloride is the salt we put on roads to melt ice. Calcium forms $^{+2}$ ions and Chloride forms $^{-1}$ ions. We need two chloride ions to balance the charges. The formula is $CaCl_2$. **Notice the metal, or positive cation is always written first**! Try the following examples:

1. Cesium fluoride: _____
2. Potassium oxide: _____
3. Magnesium iodide: _____
4. Barium sulfide: _____
5. Aluminum chloride: _____
6. Calcium phosphide: _____

There is a short cut called the **criss cross and reduce rule**. Simply "drop" the sign of the charges then criss cross down to form subscripts (if you can reduce by a common factor you must do so). In example 6, calcium phosphide had charges $^{+2}$ and $^{-3}$ respectively. Drop the charges to form uncharged subscripts $_2$ and $_3$ and criss cross down to form Ca_3P_2. Try the criss cross and reduce rule to find the formula:

	Chloride	Sulfide	Fluoride	Phosphide
Lithium				
Aluminum	$Al^{+3}Cl^{-1}$ $AlCl_3$			
Magnesium				
Zinc				

Sub Lesson A-2: Formula Writing with Multiple Oxidation States

If the metal in an ionic compound has more than 1 oxidation state you must write the charge used (roman numerals in parenthesis).

Transition metals refer to the metals in groups 3-11 of the period table (elements Sc through Cu and down). These metals form various positive ions and therefore have more than one oxidation state (charge). Other metals, such as Lead (Pb) also have more than one oxidation state. It is important to identify which ion is used. When given the name, use that numeral as the CHARGE of that ion. Then apply the same rules as we did in lesson 4A to determine the formula.

One	**I**	**Five**	**V**
Two	**II**	**Six**	**VI**
Three	**III**	**Seven**	**VII**
Four	**IV**		

IF YOU ARE NOT FAMILIAR WITH ROMAN NUMERALS YOU NEED TO MEMORIZE THE LIST ABOVE.

You can still use the drop and swap (criss cross) rule, but recall that the final ratio must be the lowest common multiple (+2/-2 becomes 1:1). Remember the number in roman numerals refers to the charge of the metal ion (cation). Try to give the formula of the following compounds:

1. Chromium (VI) oxide _____
2. Manganese (VII) chloride _____
3. Lead (IV) iodide _____
4. Silver (I) sulfide _____
5. Nickel (II) fluoride _____
6. Zinc (II) oxide _____
7. Iron (II) oxide _____
8. Iron (III) oxide _____
9. Gold (III) phosphide _____
10. Titanium (IV) sulfide _____

Sub Lesson A-3: Polyatomic Ions

Binary compounds have only two elements in their formula, as we saw in exercises above. **Tertiary compounds** have three or more elements in their formula and have a new system of naming. These compounds have a **polyatomic ion**, which is an ion that has a few elements grouped together with only one charge between them. A common example is OH^- which shows two elements with an overall charge of -1. To find the formula and charge, look up the information on the polyatomic ion on **Table E**. Some notes:

- Names are similar – be sure you have the right one!
- Non-metal ions always end in "ide" however three polyatomic ions also end in ide – know them!
- Most polyatomic ions are anions, but ammonium (NH_4^+) is a cation and gets listed first in a formula
- Be sure to put parenthesis around a polyatomic ion BEFORE adding a subscript – they come as a unit!

To write the formula of a tertiary compound you can still use the drop and swap rule, however, you must be sure to only drop the superscripts and leave the subscripts alone. For example, aluminum carbonate:

Al^{+3} and CO_3^{-2} *Leave the $_3$ alone! Swap the ^{3} and ^{2}* *$Al_2(CO_3)_3$*

Remember, formulas don't show any charges. You can see that we use parenthesis around the polyatomic ion because the entire ion charge was -2 and must swap with aluminum so the entire ion gets aluminum's 3. Try to write the formula for the following compounds (write the formulas of the ions next to the name first):

	Hydroxide	**Nitrate**	**Carbonate**	**Phosphate**	**Acetate**
Sodium					
Calcium					
Ammonium					
Iron (II)					
Aluminum					

1. Zinc Hydroxide: _____
2. Calcium chlorate: _____
3. Hydrogen acetate: _____
4. Magnesium oxalate:_____
5. Lead (IV) chromate:_____
6. Strontium cyanide:_____

ADDITIONAL PRACTICE : LESSON A

Write the chemical formula for the following:

1. zinc oxide _____
2. potassium bromide _____
3. Aluminum nitride _____
4. copper (I) bromide _____
5. copper (II) bromide _____
6. Aluminum bromide _____
7. aluminum phosphate _____
8. strontium acetate _____
9. Aluminum sulfate _____

LESSON B: Naming Ionic Compounds

Objective:

- ✓ ***Name simple binary ionic compounds***
- ✓ ***Identify binary compounds containing multiple charges by name using roman numerals***
- ✓ ***Identify tertiary compounds containing polyatomic ions by name***

Sub Lesson B-1: Naming Simply Binary Ionic Compounds

Now we know how to write formulas from their names but we also need to know how to write names from formulas. The rule is: write the whole name of the first element and the second element drop the ending and replace with "ide." For example: Na_2S is sodium sulfide. In this case, the amount of each element doesn't affect the name of the compound. Use **table S** to help you find names. Try to name the following examples:

1. NaF _____
2. $MgCl_2$_____
3. Al_2O_3_____
4. MgI_2_____
5. CaH_2_____
6. NaH_____
7. K_3P _____
8. MgO_____
9. Li_2Te_____
10. $AlCl_3$_____

Sub Lesson B-2. Metals with Multiple Oxidation States

When a metal can have multiple oxidation states, we must indicate the appropriate charge with a roman numeral. To do this, we must work backwards to identify the charge of the metal, meaning, we will look at the charge for the negative (non-metal) ion in the formula to find that charge of the first. We will report the charge of the positive ion in roman numerals (the numerals you memorized in lesson 4, page 8) in parenthesis after that ion. For example:

CuO	*O is -2 so Cu needs to be +2*	*Copper (II) oxide*
Cu_2O	*O is -2 so each Cu must be +1*	*Copper (I) oxide*

These two compounds have different structures and properties and must have different names. Try to name the following compounds with metals with multiple oxidation states:

1. $FeBr_2$ _____
2. $FeBr_3$ _____
3. PbS _____
4. PbS_2 _____
5. NiO _____
6. NiF_3 _____
7. CuCl _____
8. $CuCl_2$ _____
9. CuS _____
10. Cu_2S _____

SubLesson B-3

As before, name the first element (cation) completely and then look up the rest of the compound on **table E** of the reference tables. Make sure you copy the right one, some are very similar! Also, beware of NH_4^+ which is the only polyatomic cation (that comes in front). Try naming the following examples:

1. $KHCO_3$_____
2. $CaSO_4$_____
3. $NaNO_3$_____
4. $LiNO_2$ _____
5. $Cu(ClO_4)_2$ _____
6. $Al_2(SO_3)_3$ _____

Additional Naming Practice: *Write the name of each of the following:*

1. $CaCl_2$ _____
2. NaBr _____
3. Na_2S _____
4. $FeCl_2$ _____
5. $FeCl_3$ _____
6. Ag_3N _____
7. KNO_3 _____
8. LiOH _____
9. $Ni(OH)_2$ _____

LESSON C: NAMING AND FORMULA WRITING: COVALENT (MOLECULAR) COMPOUNDS

Objective:

- ✓ ***Name simple binary covalent compounds***
- ✓ ***Given the name, write the formula for a simple binary covalent compound***

Sub-Lesson C-1: Simple Binary covalent compounds are composed of some ratio of two different non-metal atoms. Because elements can share electrons in varying structures, there are multiple possible combinations for any given pair of non-metals (for example CO and CO_2).

To name a binary covalent compound, we use a prefix (see below) to indicate the number of atoms, followed by the element name for the first element (exception, if only one, as in CO2, we don't say "monocarbon" we just say "carbon" and the one is assumed) The second element is named in the same way, but with the "ide" ending, just as in ionic naming.

So, going back to CO and CO_2, the first is carbon monoxide while the latter is carbon dioxide

Number of Atoms	Prefix
One	Mono
Two	Di
Three	Tri
Four	Tetra
Five	Penta
Six	Hexa
Seven	Hepta
Eight	Octa

REMEMBER IF IT IS AN ELEMENT, IT DOESN'T FOLLOW THESE RULES – IT IS SIMPLY THE ELEMENT, e.g., O_2 = oxygen

Try these:

XeF_6
SO_2
PCl_5
N_2O_4
OF_2
CCl_4
S_2O_3
NO
CS_2
H_2S

Some notes…

In the name and in the formula, the less electronegative (partial positive) is listed first, much like the cation in an ionic compound.

When combining prefixes and elements, reduce a double vowel to make it sound better, e.g., “pentoxide” for …O_5 sounds better then “pentaoxide.”

HCl, HF, HBr, and HI are named as if ionic (hydrogen chloride, etc) without the prefices (Hydrogen can only bond in one way so no ambiguity)

Organic compounds (Carbon compounds, usually with hydrogen) have a different set of rules we will cover in Unit 14.

Ammonia (TriHydrogen Nitride) has a historic name – ammonia and formula (NH_3)

Sublesson C-2. Writing formulas given the name.

Going in reverse to get the formula from the name simply requires "unpacking" the prefixes. So in the first example, *di*nitrogen = N_2 and *tri*oxide = O_3, for a formula of N_2O_3.

1. Write formulas for the following **molecular** substances.

Name	Formula		Name	Formula
dinitrogen trioxide			silicon tetrafluoride	
diphosphorus pentoxide			carbon tetrachloride	
sulfur dioxide			boron triiodide	
silicon dioxide			carbon disulfide	
xenon pentafluoride			phosphorus pentabromide	
dihydrogen monoxide			boron trihydride	

2. Write IUPAC Names for the following molecular (covalent) substances:

Name	Formula		Name	Formula
	N_2O_5			H_2S
	SF_5			BF_3
	PBr_3			PH_3
	SO_3			H_2O
	B_2H_4			Cl_2
	PCl_5			PCl_3
	P_2O_5			SCl_6
	CS_2			CO_2
	CO			NO
	BCl_3			NO_2