#### Name:

# BCI SCIENCE SCH 3U

## 1. BONDING CAPACITY (VALENCE)

The number of bonds an atom can make. For a **Cation**, the bonding capacity is the number of electrons lost to become stable. For an **Anion**, the bonding capacity is the number of electrons gained to fill the outer energy level to eight.

Date: \_\_\_\_\_

Nomenclature

Ex. For sodium the bonding capacity is **ONE**. For oxygen the bonding capacity is **TWO**.

#### 2. OXIDATION NUMBERS

The charge of the ion of an atom.

Ex. For sodium the oxidation number is +1. For oxygen the oxidation number is -2.

#### 3. NAMING ELEMENTS

<u>All elements</u> (substances composed of only one type of atom) are named as on the periodic table.

Ex. Mg  $\rightarrow$  Magnesium Fe  $\rightarrow$  Iron

#### 4. NAMING DIATOMIC GASES

The following gases exist in nature in a diatomic form having the general chemical formula " $X_2$ ". The names of these binary compounds are found by just using the element's name from the Periodic Table.

Name of diatomic gas	Formula for diatomic gas
hydrogen	
oxygen	
fluorine	
bromine	
iodine	
nitrogen	
chlorine	

#### REMEMBER: H<sub>2</sub>, O<sub>2</sub>, F<sub>2</sub>, Br<sub>2</sub>, I<sub>2</sub>, N<sub>2</sub>, Cl<sub>2</sub>

5. NAMING MONATOMIC GASES

The elements of Group 8A (Noble gases) exist in nature as monatomic gases. These gases are considered "inert" or non-reactive under most conditions. Some may react under extreme pressures or temperatures. These elements are **NOT** binary chemical compounds, but you should know the names and formulas of these elements. Use your Periodic Table to determine the noble gas that is at the end of each period.

period	name of gas	formula or symbol
period 1		
period 2		
period 3		
period 4		
period 5		
period 6		

#### 6. NAMING BINARY IONIC COMPOUNDS

Binary ionic compounds are compounds containing only two elements (a metal and a non-metal)

#### RULES:

Ex.

1. Write the cation (metal) first, using the name of the element as on the periodic table.

2. Write the anion second, dropping the usual ending (-ine, -ium, -ogen etc.).and replace it with -ide.

NaCl sodium chlor<u>ide</u> KBr potassium brom<u>ide</u> K<sub>2</sub>O potassium ox<u>ide</u>

chemical formula	chemical name
NaI	
BeF2	
MgO	
Na <sub>2</sub> O	
Li₂S	
BCl <sub>3</sub>	
Al <sub>2</sub> O <sub>3</sub>	
K₂S	

#### 7. WRITING FORMULA FOR BINARY IONIC COMPOUNDS

#### RULES:

- 1. Write the symbol for the cation (metal) then write the symbol for the anion (nonmetal) beside.
- 2. Write the charge of the ion (oxidation number) for each element above the element.
- 3. Cross over the charges for each ion and leave out the charge sign.
- 4. Write the crossed over charges as subscripts behind the ion to which it refers.
- 5. Reduce the whole number ratio to lowest terms

Ex. # 1 potassium oxide	Ex # 2 calcium nitride
1. K O	1. Ca N
+1 -2 2. K O	+2 -3 2. Ca N
3. K <sub>2</sub> O	3. Ca3 N 2

chemical name	chemical formula
sodium fluoride	
lithium chloride	
beryllium bromide	
magnesium oxide	
boron iodide	
aluminum sulfide	
potassium oxide	
calcium fluoride	

## 8. WRITING NAMES AND FORMULA FOR MULTI-VALENT CATIONS

A "**multi-valent cation**" is an element that can form more than one stable <u>POSITIVE</u> ion. The term "multi-valent" means the same as "multi-oxidation state". Different positive ions of the same element are formed when reacting under different conditions. Use your "Oxidation States" sheet and your Periodic Table to identify the "multi-valent cations".

#### A) "Ous-ic" Method

# RULES:

1. Find the latin name of the cation in the chemical formula. Usually, the latin name for Hg and Sb are

# not used. If the cation does not have a latin name, ignore this step.

2. Remove the last syllable (usually "um" for the latin name) and add the suffix ("ous" or "ic") in its

place. Arsenic's name remains unchanged when the higher oxidation state is used. For some

elements, the last syllable is not removed (i.e., Co, Ni).

# The suffix "ous" indicates the lower oxidation state was used for the cation.

# The suffix "ic" indicates the higher oxidation state was used for the cation.

3. The anion name is written as you have done previously (ending with "ide").

chemical name	chemical formula	chemical name	chemical formula
ferrous oxide			Fe <sub>2</sub> O <sub>3</sub>
stannous chloride			SnCl₄
plumbous sulfide			PbS2
cuprous bromide			CuBr <sub>2</sub>
aurous iodide			AuI₃
mercurous fluoride			HgF₂

# B) Roman Numeral Method

The "Roman Numeral" or "Stock System" method is the <u>most widely used</u> and the **preferred** method for naming chemical compounds containing a <u>multi-valent metal cation</u>. This method is <u>NOT</u> used if the cation has only a single valence or oxidation state.

## RULES:

## i) Naming:

- 1. The English name of the multi-valent metal cation is written first.
- A Roman numeral indicating the positive charge on the cation is written in brackets after the cation's name. No space is left between the cation name and the Roman numeral in brackets.
- 3. The anion name is written as you have done previously (ending with "ide").

chemical formula	chemical name
CuF2	
MnO <sub>2</sub>	
NiCl <sub>3</sub>	
SnS₂	
HgI₂	

#### ii) Writing Formula

1. Follow the same rules used when writing the formula of regular binary compounds; however use the oxidation number indicated in brackets after the cation.

chemical name	chemical formula
copper(I) fluoride	
manganese(II) oxide	
nickel(II) chloride	
tin(II) sulfide	
mercury(I) iodide	

# 9. NAMING BINARY MOLECULAR (COVALENT) COMPOUNDS

<u>Binary molecular (covalent) compounds</u> are compounds containing only two elements (a non-metal and a non-metal)

## RULES:

 Attach a prefix that indicates the number of atoms in the chemical formula to the front the name of element that is more to the left on the periodic table. <u>The prefix "mono-" is omitted from the</u> <u>name of the first element if it is the prefix required.</u> The Greek prefixes are as follows:

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

- A second prefix indicating the number of atoms in the chemical formula is attached to the second name of the element. This element is usually found on the right of the periodic table. The name of the second element ends in -<u>ide</u>.
- 3. The "o" or "a" ending of the prefix is omitted if the cation or anion name starts with an "o" or "a".

Ex.	P <sub>2</sub> O <sub>3</sub> is called diphosphorous trioxide	N2O5 is called dinitrogen pentoxide		
	CO2 is called carbon dioxide	H2O is called dihydrogen monoxide		

chemical formula	chemical name
CO2	
As <sub>2</sub> O <sub>3</sub>	
NO2	
P <sub>2</sub> O <sub>5</sub>	
CBr <sub>4</sub>	

## 10. WRITING FORMULA FOR MOLECULAR (COVALENT) COMPOUNDS

#### RULES:

1. Write the elemental symbol for each of the elements named.

2. Use the prefixes to determine the number of elements in each molecule.

E×.	dinitrogen tetroxide	N204	
	diphosphorous trisulf	ide	P253

carbon tetrachloride*CC*I4 sulfur hexafluoride SF<sub>6</sub>

chemical name	chemical formula	
nitrogen monoxide		
silicon dioxide		
carbon monoxide		
sulfur trioxide		
phosphorus pentabromide		

#### 11. WRITING NAMES AND FORMULA FOR BINARY ACIDS

A binary acid is a binary chemical compound containing hydrogen and a nonmetal from Group 6 or 7. These compounds can be named using the regular naming system for binary molecular compounds if they are gases. But, binary acids are usually found as clear, viscous liquids at room temperature and a different naming system is used when they are in this state. If the binary acid is in aqueous state, the prefix "hydro" and ending "ic" is added to the first syllable of the nonmetal and this becomes the first part of the name. The word "acid" is included as the second part of the name.

Use the above instructions and examples included in the below to name the binary acids in their liquid and gas form.

binary acid formula	name of binary acid (liquid form)	name of gas (vapour form)
HF		
HCI	hydrochloric acid	
HBr		
ні		hydrogen iodide
H₂S		
H₂Se		

#### 12. WRITING NAMES FOR POLYATOMIC IONS

Polyatomic ions are groups of atoms which act as a unit. They consist of two or more different non-metal atoms joined by a covalent bond. The bonding capacity of the polyatomic ion is the same as the charge.

PO4 <sup>-3</sup>	phosphate	ClO3 <sup>-1</sup>	chlorate	CO3 <sup>-2</sup>	carbonate
504 <sup>-2</sup>	sulfate	NO3-1	nitrate	OH-1	hydroxide
NH4 <sup>+1</sup>	ammonium	HCO3 <sup>-1</sup>	hydrogen carbonate		

#### RULES:

1. Write the cation first, using the name of the element as on the periodic table.

2. Write the name of the polyatomic ion with the -ate ending.

Ex. Na2(504)	sodium sulf <u>ate</u>	K3(PO4)	potassium phosph <u>ate</u>
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chemical formula	chemical name
H <sub>3</sub> PO <sub>4</sub>	
K <sub>2</sub> CO <sub>3</sub>	
H <sub>2</sub> SO <sub>4</sub>	
(NH₄)₂S	

## 13. WRITING FORMULA FOR POLYATOMIC IONS

#### RULES:

- Write the symbol for the cation or polyatomic ion named first then write the symbol for the polyatomic ion or anion named second.
- 2. Write the charge of the ion (oxidation number) for each element or polyatomic ion above each element or polyatomic ion.
- 3. Cross over the charges for each ion and leave out the charge sign.
- 4. Write the crossed over charges as subscripts behind the ion to which it refers.
- 5. Reduce the whole number ratio to lowest terms.

Ex.	#1M	agnesium sulfate	Ex # 2 ammonium chloride
1.	Mg	5O <sub>4</sub>	1. NH4 CI
	+2	-2	+1 -1
2.	Mg	5O <sub>4</sub>	2. NH₄ CI

3. Mg SO<sub>4</sub>

3. NH₄ CI

chemical name	chemical formula
ammonium sulfate	
sodium hydroxide	
magnesium sulfate	
hydrogen carbonate	

## 14. NAMING AND WRITING FORMULAS FOR POLYATOMIC ION DERIVATIVES (SALTS):

A **derivative** may be formed during a chemical reaction when atom(s) or ions are added to or removed from a polyatomic ion. Information in the box below shows how the name and formula are changed when adding or removing atoms or ions from the original formula.

<ul> <li>if ONE OXYGEN ATOM IS ADDED, add prefix "per" to the name.</li> <li>e.g. ClO<sub>4</sub><sup>-1</sup> = <u>perate</u></li> </ul>
• if ONE OXYGEN ATOM IS REMOVED, remove "ate" and add "ite" to name. e.g. $SO_3^{-2}$ =ite
<ul> <li>if TWO OXYGEN ATOMS ARE REMOVED, add prefix "hypo" and "ite" to name.</li> <li>e.g. NO<sup>-1</sup> = <u>hypo</u>ite</li> </ul>
• if <b>REPLACING AN OXYGEN ATOM WITH AN S</b> , add the prefix "thio" to name. e.g. $SO_4^{-2}$ to $S_2O_3^{-2}$ = thio ate
• if <b>ADDING A HYDROGEN ION</b> , add prefix "hydrogen" or "bi" to name. e.g. $CO_3^{-2}$ to $HCO_3^{-1} = \underline{bi}$ ate
• if ADDING <b>TWO HYDROGEN IONS</b> , add prefix "dihydrogen" to name. e.g. $CO_3^{-2}$ to $H_2CO_3 = \underline{dihydrogen}$ ate

#### 15. WRITING FORMULA FOR OXY ACIDS

An **oxy acid** is a polyatomic compound containing hydrogen, oxygen and an electronegative element (i.e., Cl, N. S, P, etc.). These acids are sometimes referred to as "mother acids" because many names and formulae of other oxy acids and polyatomic ions are derived from these. The top 5 oxy acids are the main oxy acids used in industry. Use the names already given to help fill in the chart below.

oxy acid chemical name	oxy acid chemical formula
phosphoric acid	H₃PO₄
	H₂SO₄
carbonic acid	H <sub>2</sub> CO <sub>3</sub>
	HNO <sub>3</sub>
chloric acid	HClO <sub>3</sub>
	HFO <sub>3</sub>
	HBrO₃
	HIO <sub>3</sub>

#### 16. NAMING AND WRITING FORMULAS for OXY ACID DERIVATIVES:

An **oxy acid derivative** may be formed during a chemical reaction when oxygen atom(s) are added to or removed from an **oxy acid**. (Note: Although you can write the chemical formulas and names of all oxy acid derivatives using the system described below, some may not be able to be produced naturally or synthetically.) Information in the box below shows how the name and formula of an oxy acid are changed when adding or removing oxygen atoms from the original **oxy acid** formula.

- if ONE OXYGEN ATOM IS ADDED, add prefix "per" to the "ic" acid name
   <u>per\_\_\_\_\_\_acid</u> (called "per-ic" acid)
- OXY ACID = sulfuric acid (called "ic" acid or AKA "mother acid")
- if ONE OXYGEN ATOM IS REMOVED, remove "ic" and add "ous" to acid name
- = \_\_\_\_\_ous acid (called "ous" acid)
- if TWO OXYGEN ATOMS ARE REMOVED, add prefix "hypo" to "ous" acid name = hypo ous acid (called "hypo-ous" acid)

Complete the following table to show how you would name and write the formulas for the oxy acid derivatives of sulfuric acid (use information from the box above).

change in oxy acid formula	oxy acid name	oxy acid formula
add one oxygen atom(*) ("per-ic" acid)		
no change ("ic" acid)	sulfuric acid	H₂SO₄
remove one oxygen atom(*) ("ous" acid)		
remove two oxygen atoms(*) ("hypo-ous" acid)		