Name: _____ Date: _____

BCI SCIENCE
SCH 4CI

Nomenclature

1. BONDING CAPACITY (VALENCE)

single e⁻

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.

Ex. For sodium the bonding capacity is **one**. For oxygen the bonding capacity is **two**.

2. OXIDATION NUMBERS

= charge

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

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

Ex. Mg → Magnesium Fe → 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	$H_2(g)$
oxygen	$O_2(g)$
nitrogen	$N_2(g)$
fluorine	F_2
chlorine	$Cl_2(g)$
bromine	$Br_2(l)$
iodine	$I_2(s)$

REMEMBER: HOFBrINCl

5. NAMING MONATOMIC GASES

The elements of Group 8A (Noble gases) exist in nature as monatomic gases. These gases are considered "**inert**" or unreactive 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	helium gas	$He(g)$
period 2	neon gas	$Ne(g)$
period 3	argon gas	$Ar(g)$
period 4	krypton	$Kr(g)$
period 5	xenon gas	Xe
period 6	radon gas	$Rn(g)$

6. NAMING BINARY MOLECULAR (COVALENT) COMPOUNDS

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

RULES:

1. 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. **The prefix "mono-" is omitted from the name of the first element if it is the prefix required.** 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

2. 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 **-ide**.
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_2O_3 is called diphosphorous trioxide — N_2O_5 is called dinitrogen pentoxide
CO_2 is called carbon dioxide — H_2O is called dihydrogen monoxide

chemical formula	chemical name
CO_2	carbon dioxide
As_2O_3	diarsenic trioxide
NO_2	nitrogen dioxide
P_2O_5	diphosphorous pentoxide
CBr_4	carbon tetrabromide

7. 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.

Ex. dinitrogen tetroxide N_2O_4 — carbon tetrachloride CCl_4
diphosphorous trisulfide P_2S_3 — sulfur hexafluoride SF_6

chemical name	chemical formula
nitrogen monoxide	NO
silicon dioxide	SiO_2
carbon monoxide	CO
sulfur trioxide	SO_3
phosphorus pentabromide	PBr_5

8. NAMING BINARY IONIC COMPOUNDS

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

RULES:

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**.

chemical formula	chemical name
NaI	sodium iodide
BeF_2	beryllium fluoride
MgO	magnesium oxide
Na_2O	sodium oxide
Li_2S	lithium sulphide
BCl_3	
Al_2O_3	
K_2S	

9. 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

chemical name	chemical formula
sodium fluoride	$Na^{+1}F^{-1}$
lithium chloride	
beryllium bromide	$Be^{+2}Br^{-1}_2$
magnesium oxide	$Mg^{+2}O^{-2}$
boron iodide	$B^{+3}I^{-1}_3$
aluminum sulfide	
potassium oxide	
calcium fluoride	

10. WRITING NAMES AND FORMULA FOR MULTI-VALENT CATIONS

A "**multi-valent cation**" is an element that can form more than one stable **POSITIVE** 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.**

Sb = antimony; Cu = cuprum; Au = aurum; Fe = ferrum; Pb = plumbum; Sn = stannum

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	$Fe^{+3}\ O^{-2}$		Fe_2O_3
stannous chloride	$Sn^{+4}\ Cl_2^{-1}$		$SnCl_4$
plumbous sulfide		plumbic sulphide	$Pb^{+2,+4}S_2^{-2}$
cuprous bromide			$CuBr_2$
aurous iodide		auric iodide	$Au^{+1,+3}I_3^{-1}$
mercurous fluoride			HgF_2

B) Roman Numeral Method

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

RULES:

I	II	III	IV	V	VI	VII
1	2	3	4	5	6	7

i) Naming:

1. The English name of the multi-valent metal cation is written first.
2. 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
$Cu^{+1,+2}F_2$	copper(II) fluoride
$Mn^{+2,+3,+4,+7}O_2^{-2}$	manganese(IV) oxide
$NiCl_3$	
SnS_2	
HgI_2	

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	$Cu^{+1}F^{-1}$
manganese(II) oxide	
nickel(II) chloride	
tin(II) sulfide	$Sn^{+2}S^{-2}$
mercury(I) iodide	

11. 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.

PO_4^{-3}	phosphate	ClO_3^{-1}	chlorate	CO_3^{-2}	carbonate
SO_4^{-2}	sulfate	NO_3^{-1}	nitrate	OH^{-1}	hydroxide
NH_4^{+1}	ammonium	HCO_3^{-1}	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. $Na_2(SO_4)$ sodium sulfate $K_3(PO_4)$ potassium phosphate

chemical formula	chemical name
H_3PO_4	hydrogen phosphate
K_2CO_3	potassium carbonate
H_2SO_4	hydrogen sulphate
$(NH_4)_2S$	ammonium sulphide

12. WRITING FORMULA FOR POLYATOMIC IONS

RULES:

1. 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.

chemical name	chemical formula
ammonium sulfate	$(NH_4)_2SO_4$
sodium hydroxide	$NaOH$
magnesium sulfate	$MgSO_4$
hydrogen carbonate	H_2CO_3

13. 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.

- if **ONE OXYGEN ATOM IS ADDED**, add prefix "per" to the name.

ClO_3 e.g. ClO_4^{-1} = per chlor ate

- if **ONE OXYGEN ATOM IS REMOVED**, remove "ate" and add "ite" to name.

SO_4 e.g. SO_3^{-2} = sulph ite

- if **TWO OXYGEN ATOMS ARE REMOVED**, add prefix "hypo" and "ite" to name.

NO_3 e.g. NO^{-1} = hypo nitr ite

- if **REPLACING AN OXYGEN ATOM WITH AN S**, add the prefix "thio" to name.

e.g. SO_4^{-2} **to** $S_2O_3^{-2}$ = thio sulf ate

- if **ADDING A HYDROGEN ION**, add prefix "hydrogen" or "bi" to name.

e.g. CO_3^{-2} **to** HCO_3^{-1} = bi carbon ate

- if ADDING **TWO HYDROGEN IONS**, add prefix "dihydrogen" to name.

e.g. CO_3^{-2} **to** H_2CO_3 = dihydrogen ate

14. 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.

"hydro" (aq) (g)

binary acid formula	name of binary acid (liquid form)	name of gas (vapour form)
HF	hydrofluoric acid	hydrogen fluoride
HCl	hydrochloric acid	hydrogen chloride
HBr	hydrobromic acid	hydrogen bromide
HI	hydroiodic acid	hydrogen iodide
H_2S	hydrosulphuric acid	hydrogen sulphide
H_2Se	hydroselenic acid	hydrogen selenide

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	H_3PO_4
sulphuric acid	H_2SO_4
carbonic acid	H_2CO_3
nitric acid	HNO_3
chloric acid	$HClO_3$