*Use the class notes (and/or textbook) to complete this study guide.*

Chemical Symbols

* On the Periodic Table are a \_\_\_\_\_\_\_ for the elements — Symbols are either ONE or TWO letters. The \_\_\_\_\_\_\_ letter is ALWAYS capitalized, while the second letter is \_\_\_\_\_\_\_ case e.g. \_\_\_\_\_\_\_ (for sodium).

Give some examples for the following element symbols:

* Use the first letter of the Chemical Element:
* Use the first & second letter:
* Use the first & third letter:
* Symbols derived from the Latin:

Chemical Formulas

* Used to represent the composition of elements in a compound or molecule.
* \_\_\_\_\_\_\_ indicate the number of atoms within ONE compound or molecule. e.g.
* \_\_\_\_\_\_\_ indicate the number of compounds or molecules (“moles”) and are used to balance the chemical equation. E.g \_\_\_\_\_\_\_ oxygen molecules.

 Ca(ClO3)2 🡪 CaCl2 + 3 O2 (g)

 \_\_\_\_\_\_\_ 🡪 \_\_\_\_\_\_\_

Nomenclature: “rules” for “naming” compounds

* + Name the \_\_\_\_\_\_\_ (s) first, then \_\_\_\_\_\_\_ (s)
	+ Metal \_\_\_\_\_\_\_: name of metal (“as is”)
	+ Nonmetal anions: replace ending with \_\_\_\_\_\_\_
		- KBr K = \_\_\_\_\_\_\_, Br = \_\_\_\_\_\_\_, Name: \_\_\_\_\_\_\_ \_\_\_\_\_\_\_

\_\_\_\_\_\_\_ ions are covalently bonded atoms (composed of more than one atom), which behave as \_\_\_\_\_\_\_ unit and carries a charge. Name a polyatomic ion “as is” whether it is a cation or an anion. Polyatomic ions may be listed first (\_\_\_\_\_\_\_) or last (\_\_\_\_\_\_\_). The atoms are held together by polar \_\_\_\_\_\_\_ bonds, but the overall polyatomic ion bonds \_\_\_\_\_\_\_.

 e.g. (NH4+)(PO43–) \_\_\_\_\_\_\_ \_\_\_\_\_\_\_

Writing Chemical Formulas from the Name

Write the \_\_\_\_\_\_\_ “ion” (cation) first and the non-metallic “ion” (anion) \_\_\_\_\_\_\_

* Metals \_\_\_\_\_\_\_ electrons … therefore, become \_\_\_\_\_\_\_ charged
* Non-metals \_\_\_\_\_\_\_ electrons … become \_\_\_\_\_\_\_ charged

e.g. sodium chloride: \_\_\_\_\_\_\_ NOT Cl-1Na+1

Criss Cross Method

* The numerical value of the charge of each ion (\_\_\_\_\_\_\_ state) is crossed over and becomes the \_\_\_\_\_\_\_ for the other ion.
* Notice that the signs of the charges are dropped.
* The formula is correct because the overall charge of the formula is \_\_\_\_\_\_\_, and the subscripts are expressed in the \_\_\_\_\_\_\_ whole-number ratio. Example:

Naming Covalent Molecules

* Covalently bonded molecules usually involve \_\_\_\_\_\_\_ bonding with \_\_\_\_\_\_\_.
* Generally, one names the non-metals from left-to-right order as found on the periodic table, except that you would have to squeeze hydrogen in between nitrogen and oxygen.



* Name the \_\_\_\_\_\_\_ farthest to the left on the periodic table first. The most \_\_\_\_\_ element.
	+ - CO2 = \_\_\_\_\_\_\_ \_\_\_\_\_\_\_
* The second element is given an \_\_\_\_\_\_\_ ending.
* \_\_\_\_\_\_\_ are used to indicate how many atoms of each element are present in the compound.

\_\_\_\_\_\_\_ \* = one, ONLY used for the second element in compound;

e.g. CO is named: \_\_\_\_\_\_\_ \_\_\_\_\_\_\_

\_\_\_\_\_\_\_ = two; e.g.

\_\_\_\_\_\_\_ = three; e.g.

\_\_\_\_\_\_\_ = four; e.g.

Exceptions: Common Names & Hydrogen

* Some common compounds that contain hydrogen have non-IUPAC names that do not indicate the number of hydrogen atoms.

NH3 PCl3 \*

XeF6 \* SiO2 \*

N2O4 P4O6

\*If there is only ONE of the 1st element, do not use “\_\_\_\_\_”

Oxidation States

* The number representing the \_\_\_\_\_\_\_ of an atom when its \_\_\_\_\_\_\_ is complete in the formation of a compound or molecule (\_\_\_\_\_\_\_ rule).

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Group | IA | IIA | IIIA | IVA | VA | VIA | VIIA |
|  |
| Valence | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Expected Charge |   |  |  |  |  |  |  |
|  Lose or gain e- |  |  |  |  |  |  |  |

\_\_\_\_\_\_\_ Elements

* The oxidation number is \_\_\_\_\_\_\_ for all unbonded free elements 🡪 this includes all the elements on the Periodic Table EXCEPT:
* These \_\_\_\_\_\_\_ elements are considered free elements as well: “H O F Br I N Cl” 🡪 H2 O2 F2 Br2 I2 N2 Cl2

“Charged” Atoms or Ions

* Whenever a chemical reaction takes place, a free element must take on an “ionic” form as a \_\_\_\_\_\_\_ or an \_\_\_\_\_\_\_
* The oxidation number of the “ion” produced in a chemical reaction is determined the same way as the oxidation state of an atom filling its valence (octet rule)

\_\_\_\_\_\_\_ oxidation number = \_\_\_\_\_ exception: peroxides (e.g. H2O2) … -1

\_\_\_\_\_\_\_ oxidation number = \_\_\_\_\_ exception: hydrides (e.g. NaH, CaH2) … -1

Determining NON-expected Oxidation States of Atoms

* For a compound or molecule (electrically \_\_\_\_\_\_\_ overall), the sum of the oxidation numbers of all the elements must total \_\_\_\_\_\_\_.
* \_\_\_\_\_\_\_ metals (Groups 1B–8B) typically form more than one cation with different ionic charges.

Naming Molecules containing atoms with Multiple Oxidation States

\_\_\_\_\_\_\_ Molecules (2 elements bonded together)

Covalently bonded molecules usually have \_\_\_\_\_\_\_ oxidation states

* Commonly found with N, S, and P

OPTION 1 🡪 IUPAC naming system

* Use a \_\_\_\_\_\_\_ Numeral to indicate the \_\_\_\_\_\_\_ of the \_\_\_\_\_\_\_ element which has the multiple oxidation state (“Stock” system)
* \_\_\_\_\_\_\_ Elements usually exhibit multiple oxidation due to the filling of “d” and “f” sublevel orbitals

Binary Molecules

OPTION 2 🡪 Greek prefixes

* Add a prefix to EACH element, indicating the \_\_\_\_\_\_\_ of \_\_\_\_\_\_\_ of a particular element within the compound or molecule
* mono- \_\_\_ di- \_\_\_ tri- \_\_\_ tetra- \_\_\_ penta- \_\_\_ hexa- \_\_\_ hepta- \_\_\_ octa- \_\_\_

\_\_\_\_\_\_\_ Formulas

* For ionic compounds and many covalent molecules, formulas should be written with the \_\_\_\_\_\_\_ whole number ratio of atoms.

e.g. Calcium sulfide (Ca2+ and S2–) 🡪 \_\_\_\_\_\_\_

Naming Binary Acids

* The simplest acids contain \_\_\_\_\_\_\_ and we call these binary acids (example: HCl) which contains only \_\_\_ elements
	+ Acids donate an \_\_\_\_ ion in solution
* For Naming, use 🡪 “hydro \_\_\_\_\_ ic acid. Example:
	+ Start with hydro- to indicate H
	+ Add the root of the \_\_\_\_\_\_\_
	+ Add -ic

Naming Acids Containing Oxygen

* These molecules end in “-ate” or “-ite”
* Molecules are named based on the number of \_\_\_\_\_\_\_ in the molecule
* Naming “oxyacids” when placed in water
	+ The “-ate” is changed to “-\_\_\_\_” OR the “-ite” is changed to “-\_\_\_\_”

|  |  |  |  |
| --- | --- | --- | --- |
| Dry or Gaseous State | Name | Aqueous State | Name |
| H2SO5 |  | H2SO5 (aq) |  |
| H2SO4 |  | H2SO4 (aq) |  |
| H2SO3 |  | H2SO3 (aq) |  |
| H2SO2 |  | H2SO2 (aq) |  |

* + Use the “–ate” acid as the standard of comparison for the number of oxygen atoms. E.g. Hydrogen Sulfate becomes Sulfuric Acid.
	+ One more oxygen atom changes the name to “\_\_\_” (above)
	+ One less oxygen atom changes the name to “-\_\_\_\_”
	+ Two less oxygen atoms changes the name to “\_\_\_\_” (under) … “ite”

Naming Bases

* Simple bases are ionic compounds which produce \_\_\_\_\_\_\_ ions (OH)– when dissolved in water (aq).
* Bases are named in the same way as other ionic compounds – the name of the cation is followed by the name of the anion.
* Sodium hydroxide (\_\_\_\_\_\_\_) is composed of sodium cations (\_\_\_\_) and hydroxide anions (\_\_\_\_).

The Law of Definite Proportions

Proust’s discovery:

* + Samples of a compound have the same \_\_\_\_\_\_\_ of elements.
	+ CopperII carbonate Cu+2(CO3)-2 is composed of \_\_\_ part carbon (12/124), \_\_\_ parts oxygen (48/124), and \_\_\_ parts copper (64/124) by weight.
	+ Law of definite proportions: pure reactants always combine in the same \_\_\_\_\_\_\_ to produce a given substance

Example:

Magnesium sulfide (MgS) is composed of magnesium cations and sulfide anions.

Use the periodic table and “molar” masses of the elements

 Mg = S =

The Mg:S ratio of these masses is

Law of Multiple Proportions (Dalton)

* When one element combines with another to form more than one compound, the mass ratios of the elements in the compounds are simple whole numbers of each other.
* Give the basic formula for each series:

Sulfate series SO4-2 … 5:4:3:2 …

Phosphate series PO4-3 … 5:4:3:2 …

Chlorate series ClO3-1 … 4:3:2:1 …

Nitrate series NO3-1 … 4:3:2:1 …

Manganate series MnO-24 … 5:4:3:2 …

Consider the ratio of “Oxygen” \_\_\_\_\_\_\_ each compound.

Summary:

* Definite proportions compares the mass of the two elements \_\_\_\_\_\_\_ the same molecule
* Multiple proportions compares the mass of same element \_\_\_\_\_\_\_ different molecules