Chemical Formulas and Nomenclature

Chemical formulas show what elements, and in what proportions each element is present in a compound

Important Terminology

Binary Compounds are compounds that contain *two* elements.

Tertiary Compounds are compounds that contain *three* elements.

Molecules are discrete particles of *covalent compounds* whose formula represents the *number* of each atom present in the compound.

Crystals are particles of *ionic compounds* whose formula represents the lowest whole number *ratio* of each element in the compound.

Bonding Capacity refers to the *number* of bonds an atom can form.

Polyatomic ions are *charged molecules*. These ions should be treated as a single ion. These molecules are often identifiable by their *suffixes* which usually contain *-ite* or *-ate.*

E.g. sulfate SO_4^{2-}, chlorate ClO_3^{1-}

Determining Chemical Formulas

When writing chemical formulas, the *less electronegative element* or ion is listed *first.*

Zero sum rule - the *sum* of the positive charges and negative charges must equal zero for neutral chemical compounds.

The Criss-Cross Method - Metal with a Nonmetal

1. List the symbols of the elements
2. Place the charge of each element above its symbol
3. Using arrows, crisscross the numbers and bring them down to the subscript positions (drop the signs)
4. Check the subscripts. Reduce if possible. Subscripts of "1" should not be included.

The Prefix Method - Two Nonmetals

Prefixes are used to indicate the number of each atom in the compound.

For the *first* element a prefix only used if there is *more than one* atom, but it is *always* used for the *second* element.

Prefix	Number
mono	1
di	2
tri	3
tetr(a)	4
pent(a)	5
hex(a)	6
hept(a)	7
oct(a)	8
non(a)	9
dec(a)	10

E.g. CO_2 → carbon dioxide

H_2O → dihydrogen monoxide

Nomenclature – Naming Compounds

A. Monovalent metals with a non-metal.

1. place metal first, non-metal second
2. drop the ending of the non-metal and add "-ide".

E.g. NaCl → sodium chloride

B. i) Multivalent metals with a non-metal (IUPAC System).

If a metal has more than one possible valence (charge) the valence of the metal is indicated using a roman numeral.

E.g. $FeCl_2$ → iron *(II)* chloride

$FeCl_3$ → iron *(III)* chloride

ii) Multivalent metals with a non-metal (classical system)

When naming multivalent ions, the ending of the metal is changed to "–ic" to indicate the *larger* valence, or "–ous" to indicate the *smaller* valence.

E.g. Cu^{+1} → cuprous

Cu^{+2} → cupric

***The limitation with this system is that it only accommodates two different charges AND is based on the Latin names of elements.*

C. Ionic Compounds containing polyatomic ions.

Place the name of the metal and the polyatomic ion together, without adding or dropping anything.

E.g. calcium sulphate

D. Two Non-metals

Use prefixes in the name to determine the number of each atom in the compound.

E.g. carbon dioxide → CO_2

dihydrogen monoxide → H_2O

E. Binary Acids – *contain* hydrogen *and one other* non-metallic *element and are aqueous.*

E.g. $HF_{(aq)}$ → hydrofluoric acid

$HCl_{(aq)}$ → hydrochloric acid

$HI_{(aq)}$ → hydroiodic acid

These acids have the prefix *"hydro-"* and suffix *"-ic acid"*

F. Oxyacids – contain *hydrogen*, *oxygen*, and one other *non-metallic* element, and are *aqueous*.

Two different suffixes are possible:

i. "-ous" acids come from polyatomic ions with "-ite" endings

ii. "-ic" acids come from polyatomic ions with "-ate" endings

E.g. $HClO_{3(aq)}$ → chloric acid

$HClO_{2(aq)}$ → chlorous acid

$HClO_{(aq)}$ → hypochlorous acid

$HClO_{4(aq)}$ → perchloric acid

G. Acid Salts – form when at least one (but not all) *hydrogen atoms* are replaced by a *metal* in an acid.

Use prefixes to show the number of hydrogen atoms in compound (*if there's more than one*)

E.g. $NaHCO_3$ → sodium hydrogen carbonate

$Fe(H_2PO_4)_3$ → iron (III) *di*hydrogen phosphate

H. Hydrates - chemicals with *water* molecules loosely bonded to a *formula unit*.

E.g. $CuSO_4 \cdot 5\ H_2O$ → copper (II) sulphate pentahydrate