SAN JACINTO COLLEGE

STUDENT SUCCESS CENTER

Chemical Formulas Nomenclature

Binary Compounds

Binary compounds contain only two elements. The name of every binary compound ends with "**ide**." Binary Compounds can be divided into two basic types: ionic and covalent.

Ionic Compounds

Ionic compounds are comprised of positive and negative ions. An ion is an atom with an electric charge (positive or negative). The first part of the ionic compound name is simply the name of the cation. A simple cation (obtained from a single atom) takes its name from the name of the element. The second part of the name is the name of the anion. A simple anion (obtained from a single atom) is named by taking the first part of the element name (the root) with the ending changed to the suffix "ide" [1] [2]. Table 1 shows the common binary roots:

Table 1 Common roots of binary compounds

Element	Root	Element	Root
Arsenic	arsen	Nitrogen	nitr
Bromine	brom	Oxygen	ox
Carbon	carb	Phosphorus	phosph
Chlorine	chlor	Selenium	selen
Fluorine	fluor	Sulfur	sulf
Hydrogen	hydr	Tellurium	tellur
Iodine	iod		

Example: K_2S – Potassium Sulfide

The transition metals can have more than one charge, therefore, they can form more than one compound. These metals are called polyvalent. To distinguish different compounds from the same atom, a Roman numeral is used after the name of cation in parenthesis. Table 2 shows several common ionic compounds with polyvalent cations. The numbers 1 to 10 are expressed in Roman numerals as the following: I, II, III, IV, V, VI, VII, VIII, IX, X

Examples: $FeCl_2$ – Iron (II) Chloride, $FeCl_3$ – Iron (III) Chloride

Table 2 Ionic compound with polyvalent cations

Element	Common formed Ions	Systematic name	Trivial name
Chromium	Cr^{2+}	Chromium (II)	Chromous
	Cr^{3+}	Chromium (III)	Chromic
Cobalt	Co^{2+}	Cobalt (II)	-
	Co^{3+}	Cobalt (III)	-
Copper	Cu^{+}	Copper (I)	Cuprous
	Cu^{2+}	Copper (II)	Cupric
Iron	Fe^{2+}	Iron (II)	Ferrous
	Fe^{3+}	Iron (III)	Ferric
Lead	Pb^{2+}	Lead (II)	-
	Pb^{4+}	Lead (IV)	-
Tin	Sn^{2+}	Tin (II)	Stannous
	Sn^{4+}	Tin (IV)	Stannic
Mercury	Hg_2^{2+}	Mercury (I)	Mercurous
	Hg^{2+}	Mercury (II)	Mercuric

Covalent (Molecular) Compounds

Unlike an ionic compound, covalent compounds are named by using prefixes (Table 3) to denote the number of atoms present in the formula.

The first atom – the least electronegative atom – in the formula is named first, and the full element name is used. The second atom – the most electronegative atom – is named in the following form: "root + ide." Note that the prefix "mono-" is not normally used for naming the first element.

Table 3 Greek Prefixes

No. of atoms	Prefix
1	Mono
2	Di
3	Tri
4	Tetra
5	Penta
6	Hexa
7	Hepta
8	Octa
9	Nona
10	Deca

Examples: NO_2 – Nitrogen dioxide, N_2O_5 – Dinitrogen pentoxide

Polyatomic (Ternary) Compounds

A polyatomic ion is a group of atoms, unlike a single ion, with an electric charge. These ions consist of two or more nonmetal atoms covalently bonded together, and the entire group has a positive or negative charge. Although it is a group of atoms, it behaves like a single charged atom. The names of nearly all polyatomic ions end with the letters "**ate**" or "**it,**" with the following exceptions: cyanide, hydroxide, and peroxide. [3]

Example of exceptions: $CA(OH)_2$ – Calcium hydroxide, HCN – Hydrogen cyanide

Many nonmetal atoms form various polyatomic ions with oxygen. The naming system for these ions depends on the most common ion and the number of oxygen atoms compared to the most common ion. See Table 4.

Table 4 Naming criteria for polyatomic ions containing oxygen

No. Oxygen relative to most common ion	Name
+1	Per___ate
0	ate
-1	___ite
-2	Hypo___ite

Table 5 provides a list of common polyatomic ions:

Table 5 Common Polyatomic ions

Formula	Name	Formula	Name
NH_4^+	Ammonium	CN^-	Cyanide
$C_2H_3O_2^-$	Acetate	OH^-	Hydroxide
CO_3^{2-}	Carbonate	NO_2^-	Nitrite
HCO_3^-	Hydrogen carbonate	NO_3^-	Nitrate
ClO^-	Hypochlorite	MnO_4^-	Permanganate
ClO_2^-	Chlorite	PO_4^{3-}	Phosphate
ClO_3^-	Chlorate	HPO_4^{2-}	Hydrogen phosphate
ClO_4^-	Perchlorate	$H_2PO_4^-$	Dihydrogen phosphate
BrO^-	Hypobromite	IO^-	HypoIodate
BrO_2^-	Bromite	IO_2^-	Iodite
BrO_3^-	Bromate	IO_3^-	Iodate
BrO_4^-	Perbromate	IO_4^-	Periodate

CrO_4^{2-}	Chromate	PO_3^{3-}	Phosphite
$Cr_2O_7^{2-}$	Dichromate	HPO_4^{2-}	Hydrogen phosphite
$C_2O_4^{2-}$	Oxalate	$H_2PO_4^-$	Dihydrogen phosphite
O_2^{2-}	Peroxide	AsO_4^{3-}	Arsenate
SeO_4	Selenate	$HAsO_4^{2-}$	Hydrogen Arsenate
SeO_3	Selenite	$H_2AsO_4^{1-}$	Dihydrogen Arsenate
$HSeO_4^-$	Hydrogen selenate	AsO_3^{3-}	Arsenite
$HSeO_3^-$	Hydrogen selenite	$HAsO_3^{2-}$	Hydrogen Arsenite
SO_4^{2-}	Sulfate	$H_2AsO_3^{1-}$	Dihydrogen Arsenite
SO_3^{2-}	Sulfite	SCN^-	Thiocyanide
HSO_4^-	Hydrogen sulfate	HSO_3^-	Hydrogen sulfite

Examples: $Ni_3(PO_4)_2$ – Nickel (II) phosphate, $Ca(MnO_4)_2$ – Calcium permanganate

Acids

Binary Acids [3]

Binary Acids are composed of hydrogen and a nonmetal. The following format is used for naming binary acids: "Hydro" + base name of nonmetal + "ic" + "acid"

Example: HCl (aq) – Hydrochloric acid

Oxyacids (Polyatomic acids)

The oxyacid is the first name with "ate" and "it" changing to "ic" and "ous," respectively. Then the word acid is added to the end.

Example: H_2SO_4 (aq) – Sulfuric acid

References

[1] "Binary Compounds," [Online]. Available: http://limestone.k12.il.us/teachers/rhebron/Chem_HO/CO4_Naming_Writing.html

[2] D.A.E.F. Hal Bender, "Clackamas Community College," 2011. [Online]. Available: http://dl.clackamas.edu/ch104/lesson8naming_covalentcompounds.html

[3] N. J. Tro, Chemistry: A Molecular Approach, New York: Pearson, 2011.