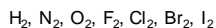


A molecule is an assembly of two or more atoms tightly bound together.

Common elements that are diatomic molecules:



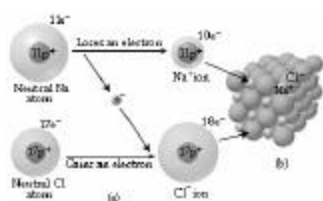
Chemical formulas that indicate the actual numbers and types of atoms in a molecule are called molecular formulas.

Chemical formulas that give only the relative number of atoms of each type in molecule are called empirical formulas. The subscripts in an empirical formula are always the smallest whole-number ratios.

The nucleus of an atom is unchanged by chemical processes, but atoms can readily gain or lose electrons.

If electrons are removed or added to a neutral atom a charged particle called an ion is formed.

An ion with a positive charge is called a cation; a negatively charged ion is called an anion.

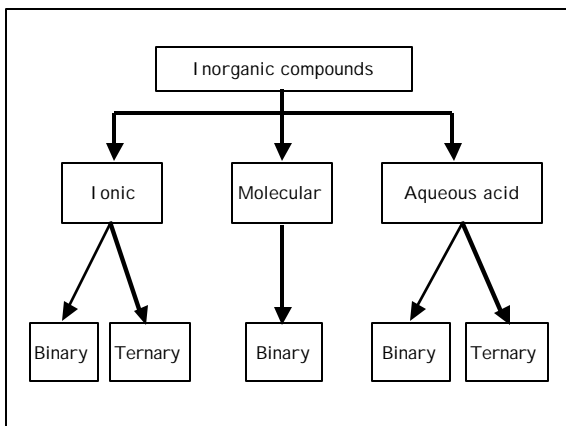


A molecule is an assembly of two or more atoms tightly bound together. Because there is no discrete molecule of NaCl, we are able to write only an empirical formula

Classification of Compounds (nomenclature)

International Union of Pure and Applied Chemistry IUPAC

Inorganic compounds can be placed into five common classes; binary ionic, ternary ionic, binary molecular, binary acid, and ternary oxyacid.



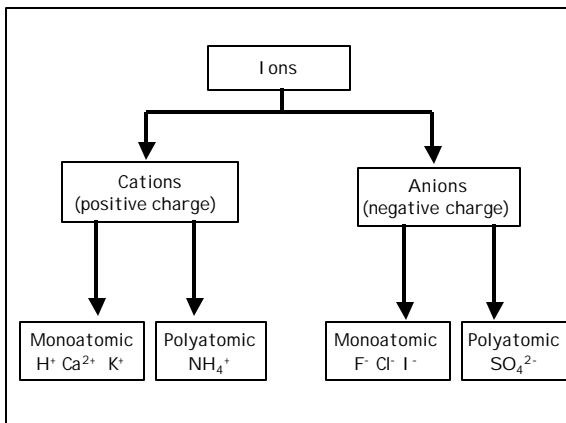
Binary Ionic: two elements, a metal and non-metal. NaCl, KI, $AlCl_3$, CaF_2

Ternary ionic: three elements, at least one metal and a nonmetal. KNO_3 , $Al(NO_3)_3$, $MgSO_4$

Binary molecular: two elements that are both nonmetals. H_2O , NH_3 , CO_2

Binary Acids: compounds containing hydrogen and one other nonmetal. HCl, HI, H_2S

Ternary oxyacids: compounds containing hydrogen a nonmetal and oxygen. HNO_3 , H_2SO_4 , H_3PO_4



Nomenclature of Monoatomic Cations

Main-group metals usually form one cation. Cations are named for the parent metal followed by the word ion. Na^+ (sodium ion) Al^{3+} (aluminum ion)

Transition metals often form more than one cation.

Ex. Fe^{2+} and Fe^{3+}

It is necessary to specify the charge. Iron(II) and iron(III) ion. Cu^+ is named copper(I) ion and Cu^{2+} is named copper(II) ion. This is called the Stock system.

Note that Ag^+ , Zn^{2+} , and Cd^{2+} are exceptions (have fixed ionic charge) and do not require Roman numerals.

Latin System or Suffix System

This system takes the Latin name of the metal and adds an -ous or -ic suffix. The lower of the two ionic charges receives the -ous suffix, and the higher charge receives the -ic suffix.

The Latin name for iron is ferrum. Fe^{2+} is ferrous while Fe^{3+} is ferric.

The Latin name for copper is cuprum. Add -ous or -ic to the cupr- stem.

Cu^+ cuprous ion. Cu^{2+} cupric ion.

IUPAC convention for nonmetal ions use using the *nonmetal stem + ide* suffix.

<u>Anion</u>	<u>IUPAC Name</u>
Br^-	bromide ion
Cl^-	chloride ion
F^-	fluoride ion
I^-	iodide ion
N^{3-}	nitride ion
O^{2-}	oxide ion
P^{3-}	phosphide ion

Most polyatomic anions end in an -ate or -ite suffix. The -ite suffix has one less oxygen than that for the -ate ending.

There are three exceptions to memorize, OH^- , CN^- (*ide*) and the ammonium cation (NH_4^+).

Polyatomic ions

NH_4^+	ammonium ion
$\text{C}_2\text{H}_3\text{O}_2^-$	acetate ion
CO_3^{2-}	carbonate ion
ClO_3^-	chlorate ion
ClO_2^-	chlorite ion
OH^-	hydroxide ion*
CN^-	cyanide ion*
SO_4^{2-}	sulfate ion
SO_3^{2-}	sulfite ion
NO_3^-	nitrate ion
NO_2^-	nitrite ion

Hypo means under and *per* means over.

ClO^-	hypochlorite ion
ClO_2^-	chlorite ion
ClO_3^-	chlorate ion
ClO_4^-	perchlorate ion

Writing Chemical Formulas

A formula unit is the simplest representative particle in an ionic compound. The total positive charge must equal the total negative charge for the unit to be neutral.

NaCl contains one Na^+ and one Cl^-

CaCl_2 contains one Ca^{2+} and two Cl^-

Binary compounds

Name the most metallic (less electronegative) element first and the more electronegative element second.

The less metallic (more electronegative) element is named by adding an "-ide" suffix to the element's *unambiguous* stem.

B bor	C carb	N nitr	O ox	H hydr
Si silic	P phosph	S sulf	F fluor	
		Se selen	Cl chlor	
		Te tellur	Br brom	
			I iod	

Compounds composed of nonmetals only

Nearly all binary molecular compounds involve two nonmetals bonded together. Although many nonmetals can exhibit different ionic charges (oxidation numbers), their oxidation numbers properly are not indicated by Roman numerals or suffixes. Instead, elemental proportions are indicated by using a prefix system for both elements.

Greek prefixes are used to indicate the number of each atom

Atoms	Prefix	Atoms	Prefix
1	mono	6	hexa
2	di	7	hepta
3	tri	8	acta
4	tetra	9	nona
5	penta	10	deca

Formula	Name
SO ₂	sulfur dioxide
SO ₃	sulfur trioxide
N ₂ O ₄	dinitrogen tetroxide
Cl ₂ O ₇	dichlorine heptoxide
CS ₂	carbon disulfide
As ₄ O ₆	tetraarsenic hexoxide

Compounds formed between metals and nonmetals.

Binary ionic compounds contain metal cations and nonmetal anions. The cation is named first and the anion second according to the rule described previously.

Formula	Name
KBr	potassium bromide
CaCl ₂	calcium chloride
NaH	sodium hydride
RbS	rubidium sulfide
Al ₂ Se ₃	aluminum selenide
SrO	strontium oxide

Metals with multiple ionic charges (oxidation states)

The preceding method is sufficient for naming binary ionic compounds containing metals that exhibit only one oxidation number other than zero. Most transition elements, and few of the more electronegative representative metals exhibit more than one oxidation number. To distinguish among all possibilities, the oxidation number of the metal is indicated by a Roman numeral in parentheses following its name.

Formula	Charge	
	on metal	Name
Cu ₂ O	+1	copper(I) oxide
CuF ₂	+2	copper(II) fluoride
FeS	+2	iron(II) sulfide
Fe ₂ O ₃	+3	iron(III) oxide

Compounds containing 3 or more atoms

Formula	Name
NH_4I	ammonium iodide
$\text{Ca}(\text{CN})_2$	calcium cyanide
NaOH	sodium hydroxide
NH_4CN	ammonium cyanide
$\text{Cu}(\text{ClO}_3)_2$	copper(I I) chlorate or cupric chlorate
$\text{Fe}_2(\text{SO}_4)_3$	iron(I I I) sulfate or ferric sulfate

Aqueous solutions

Binary acids are compounds in which H is bonded to the more electronegative nonmetals. These compounds act as acids when dissolved in water. The compounds are named as typical binary compounds. Their aqueous solutions are named by modifying the characteristic stem of the nonmetal with the prefix "hydro-" and the suffix "-ic" followed by the word "acid."

Formula	Name of Compound	Name of Aqueous solution
HCl	hydrogen chloride	hydrochloric acid
HF	hydrogen fluoride	hydrofluoric acid
H_2S	hydrogen sulfide	hydrosulfuric acid
HCN	hydrogen cyanide	hydrocyanic acid

For ternary and higher compounds, the word "hydrogen" is dropped, and the name of the polyatomic ion is used. "-ate" is replaced with "-ic" and "-ite" is replaced with "-ous"

Formula	Name of Compound	Aqueous solution
HNO_2	hydrogen nitrite	nitrous acid
HNO_3	hydrogen nitrate	nitric acid
H_2SO_4	hydrogen sulfate	sulfuric acid
H_3PO_3	hydrogen phosphite	phosphorous acid
H_3PO_4	hydrogen phosphate	phosphoric acid