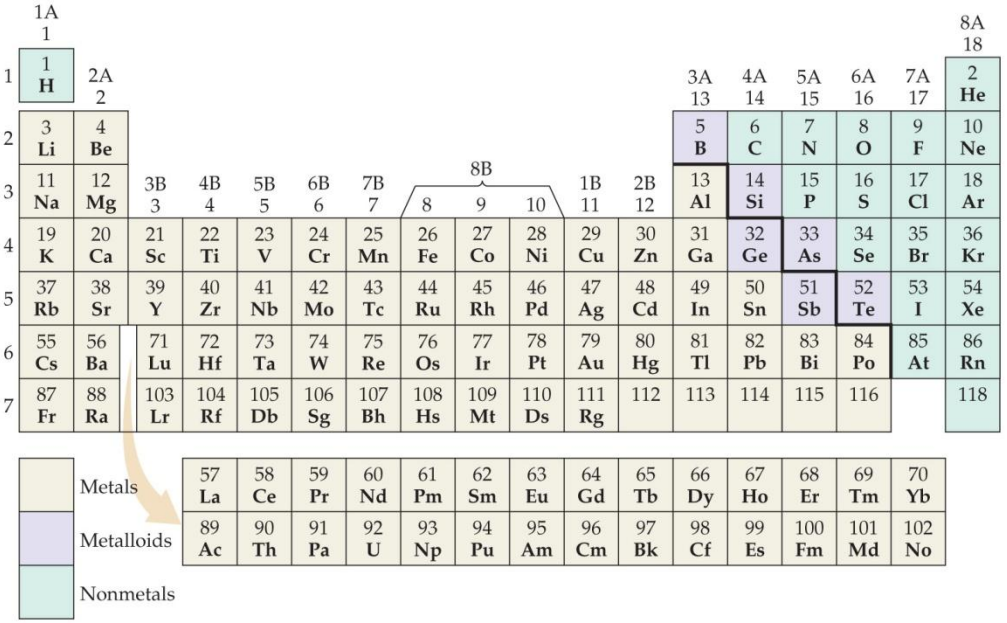
Periodic Table

- The rows on the periodic chart are periods.
- Columns are groups.
- Elements in the same group have similar chemical properties.



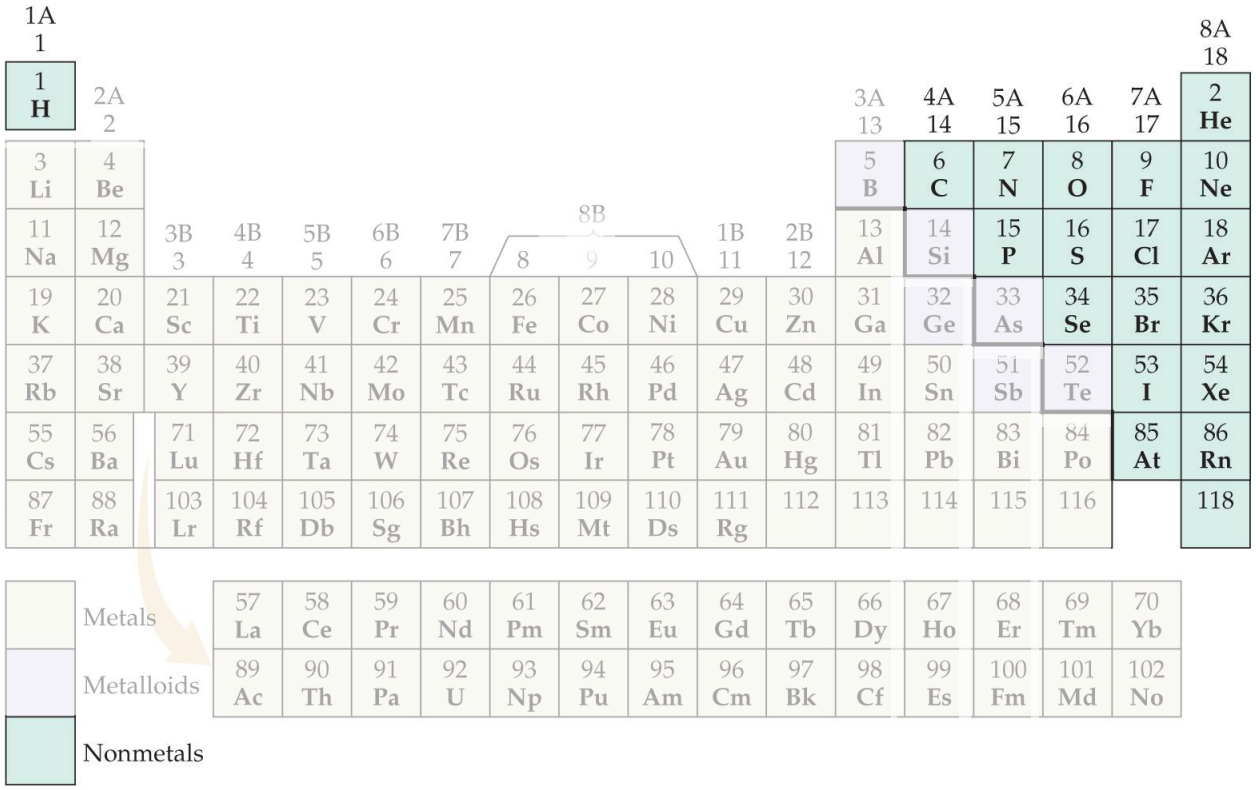
Atoms, Molecules, and Ions

Groups

Group	Name	Elements
1A	Alkali metals	Li, Na, K, Rb, Cs, Fr
2A	Alkaline earth metals	Be, Mg, Ca, Sr, Ba, Ra
6A	Chalcogens	O, S, Se, Te, Po
7A	Halogens	F, Cl, Br, I, At
8A	Noble gases (or rare gases)	He, Ne, Ar, Kr, Xe, Rn

These five groups are known by their names.

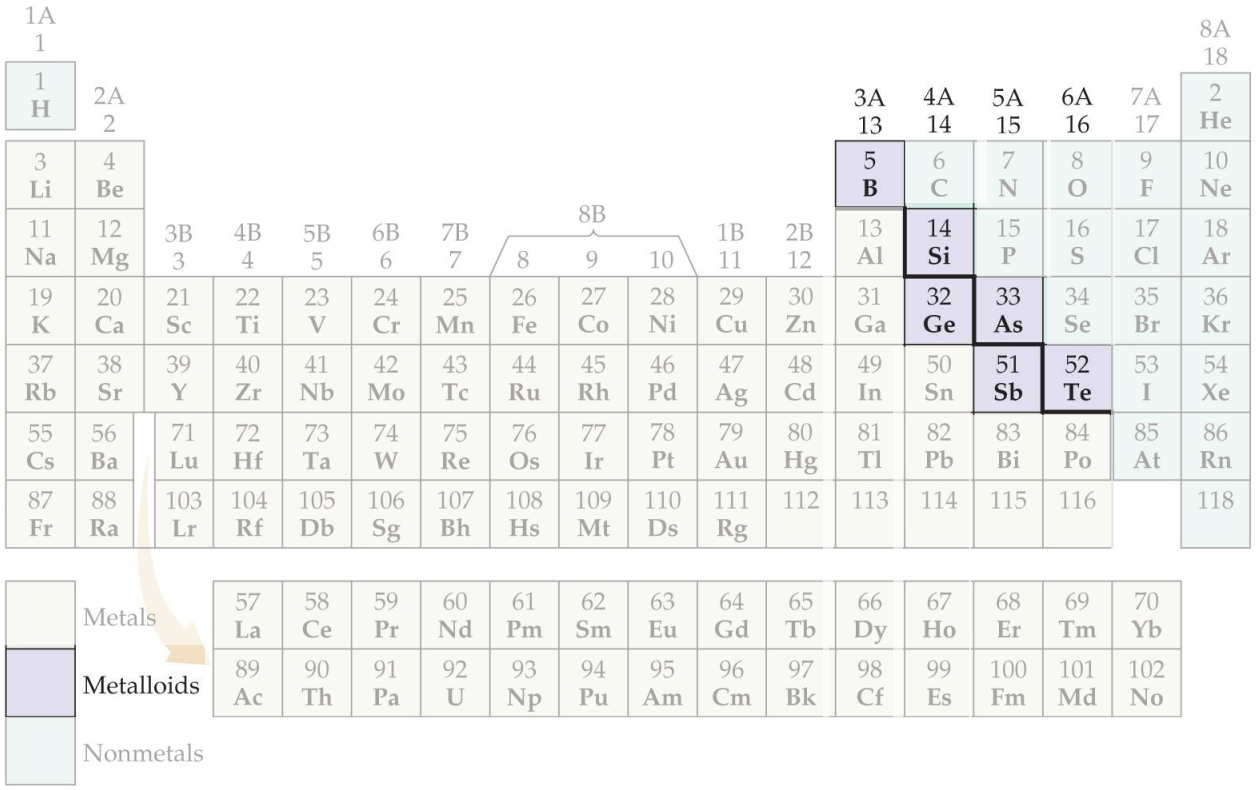
Periodic Table



Nonmetals are on the right side of the periodic table (with the exception of H).

Atoms, Molecules, and Ions

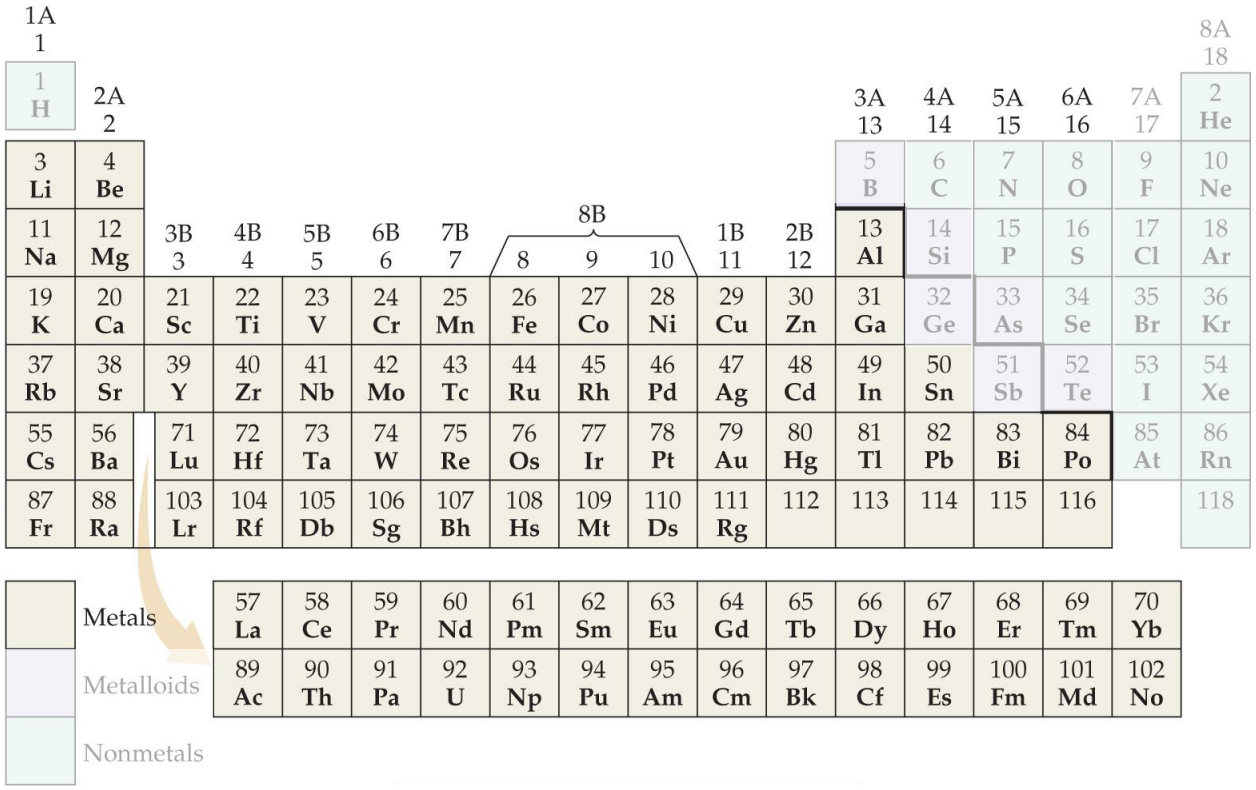
Periodic Table



Metalloids border the stair-step line (with the exception of Al, Po, and At).

Atoms, Molecules, and Ions

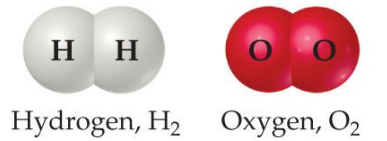
Periodic Table



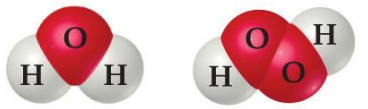
Metals are on the left side of the chart.

Atoms, Molecules, and Ions

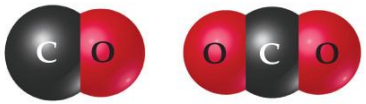
Chemical Formulas



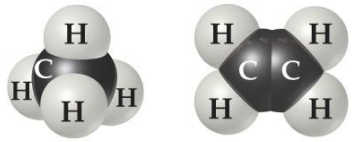
Hydrogen, H_2 Oxygen, O_2



Water, H_2O Hydrogen peroxide, H_2O_2



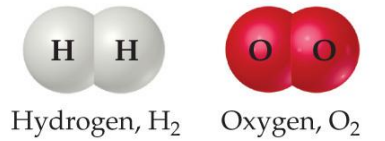
Carbon monoxide, CO Carbon dioxide, CO_2



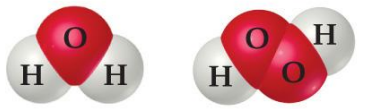
Methane, CH_4 C_2H_4

The subscript to the right of the symbol of an element tells the number of atoms of that element in one molecule of the compound.

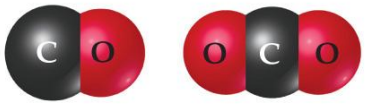
Chemical Formulas



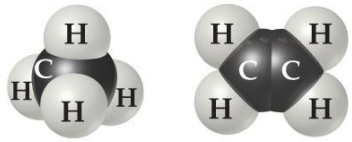
Hydrogen, H_2 Oxygen, O_2



Water, H_2O Hydrogen peroxide, H_2O_2



Carbon monoxide, CO Carbon dioxide, CO_2

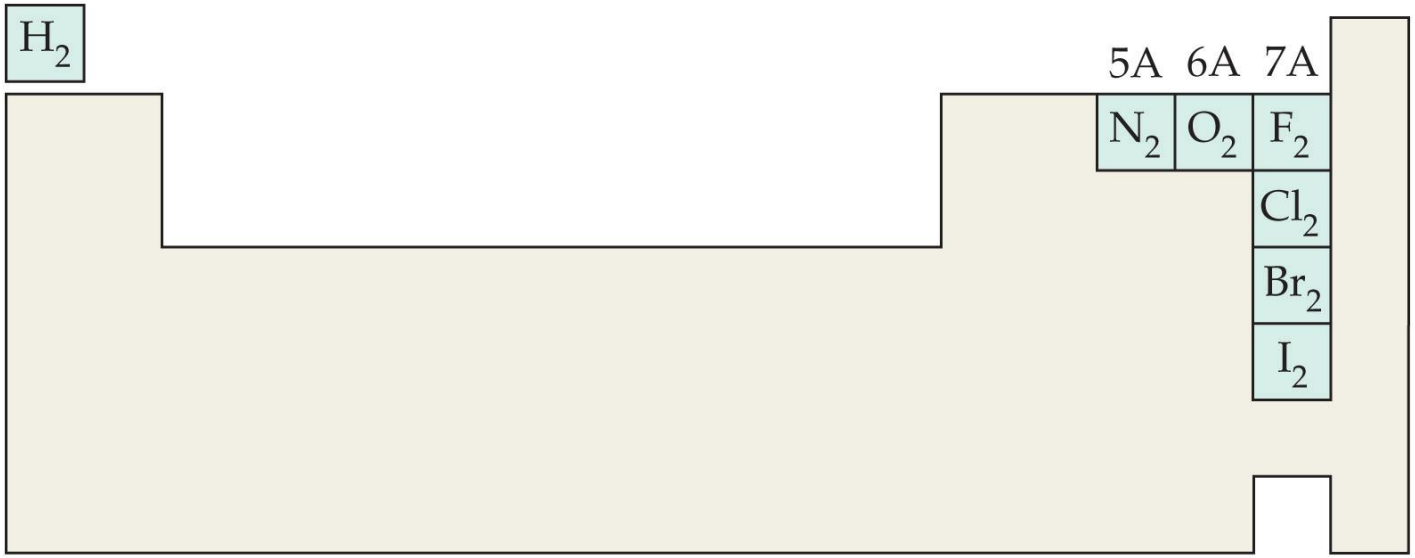


Methane, CH_4 C_2H_4

Molecular compounds are composed of molecules and almost always contain only nonmetals.

Atoms, Molecules, and Ions

Diatomic Molecules



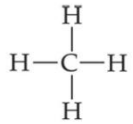
These seven elements occur naturally as molecules containing two atoms.

Atoms, Molecules, and Ions

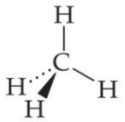
Types of Formulas

- Empirical formulas give the lowest whole-number ratio of atoms of each element in a compound.
- Molecular formulas give the exact number of atoms of each element in a compound.

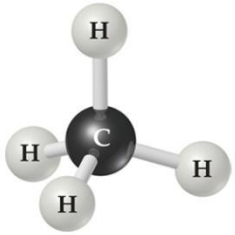
Types of Formulas



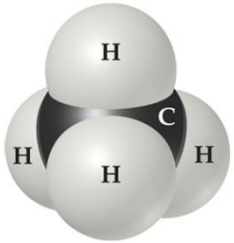
Structural formula



Perspective drawing



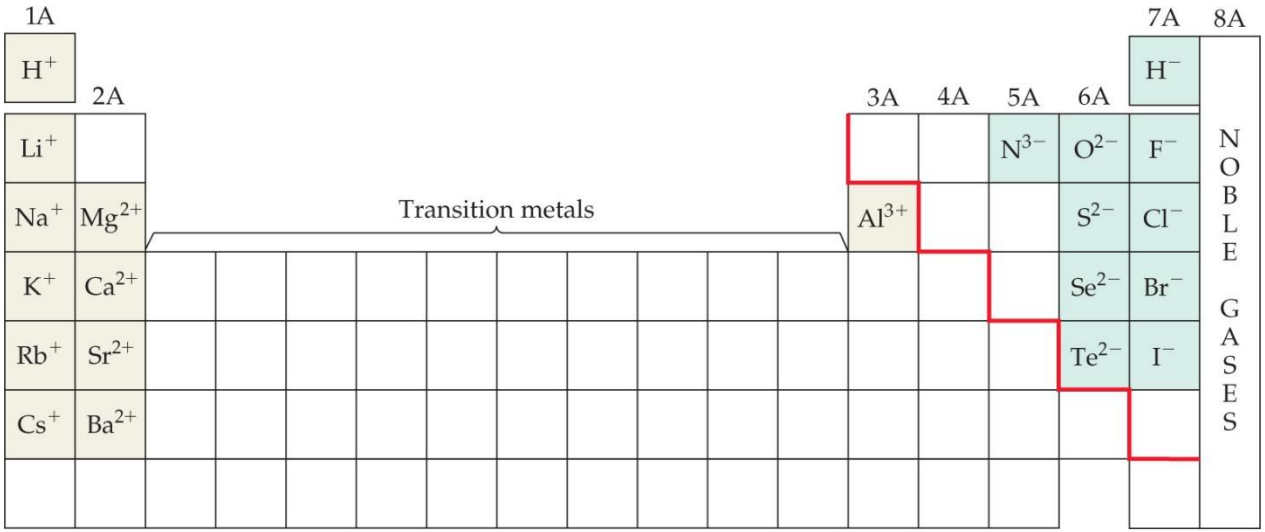
Ball-and-stick model



Space-filling model

- Structural formulas show the order in which atoms are bonded.
- Perspective drawings also show the three-dimensional array of atoms in a compound.

Ions

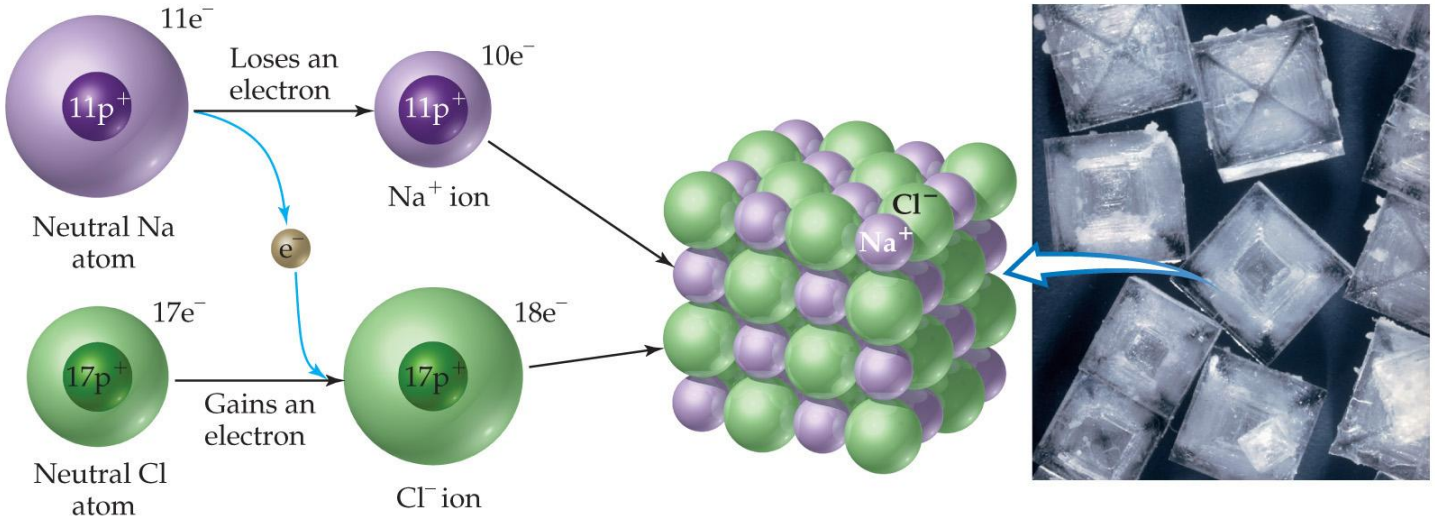


- When atoms lose or gain electrons, they become ions.
  - Cations are positive and are formed by elements on the left side of the periodic chart.
  - Anions are negative and are formed by elements on the right side of the periodic chart.

Atoms, Molecules, and Ions

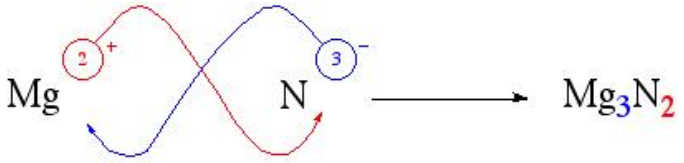
Ionic Bonds

Ionic compounds (such as NaCl) are generally formed between metals and nonmetals.



Atoms, Molecules, and Ions

Writing Formulas



- Because compounds are electrically neutral, one can determine the formula of a compound this way:
  - The charge on the cation becomes the subscript on the anion.
  - The charge on the anion becomes the subscript on the cation.
  - If these subscripts are not in the lowest whole-number ratio, divide them by the greatest common factor.

Common Cations

Charge	Formula	Name	Formula	Name
1+	**H^+**	**Hydrogen ion**	**NH_4^+**	**Ammonium ion**
	Li^+	Lithium ion	Cu^+	Copper(I) or cuprous ion
	Na^+	**Sodium ion**		
	K^+	**Potassium ion**		
	Cs^+	Cesium ion		
	Ag^+	**Silver ion**		
2+	**Mg^{2+}**	**Magnesium ion**	Co^{2+}	Cobalt(II) or cobaltous ion
	Ca^{2-}	**Calcium ion**	**Cu^{2+}**	**Copper(II)** or cupric ion
	Sr^{2+}	Strontium ion	**Fe^{2+}**	**Iron(II)** or ferrous ion
	Ba^{2+}	Barium ion	Mn^{2+}	Manganese(II) or manganous ion
	Zn^{2+}	**Zinc ion**	Hg_2^{2+}	Mercury(I) or mercurous ion
	Cd^{2+}	Cadmium ion	**Hg^{2+}**	**Mercury(II)** or mercuric ion
			Ni^{2+}	Nickel(II) or nickelous ion
			Pb^{2+}	**Lead(II)** or plumbous ion
			Sn^{2+}	Tin(II) or stannous ion
3+	**Al^{3+}**	**Aluminum ion**	Cr^{3+}	Chromium(III) or chromic ion
			Fe^{3+}	**Iron(III)** or ferric ion

*The most common ions are in boldface.

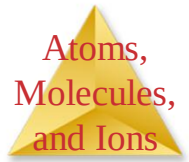
Common Anions

Charge	Formula	Name	Formula	Name
1−	H^-	Hydride ion	**CH_3COO^-** (or $C_2H_3O_2^-$)	**Acetate ion**
	F^-	**Fluoride ion**	ClO_3^-	Chlorate ion
	Cl^-	**Chloride ion**	**ClO_4^-**	**Perchlorate ion**
	Br^-	**Bromide ion**	**NO_3^-**	**Nitrate ion**
	I^-	**Iodide ion**	MnO_4^-	Permanganate ion
	CN^-	Cyanide ion		
	OH^-	**Hydroxide ion**		
2−	**O^{2-}**	**Oxide ion**	**CO_3^{2-}**	**Carbonate ion**
	O_2^{2-}	Peroxide ion	CrO_4^{2-}	Chromate ion
	S^{2-}	**Sulfide ion**	$Cr_2O_7^{2-}$	Dichromate ion
			SO_4^{2-}	**Sulfate ion**
3−	N^{3-}	Nitride ion	**PO_4^{3-}**	**Phosphate ion**

* The most common ions are in boldface.

Inorganic Nomenclature

- Write the name of the cation.
- If the anion is an element, change its ending to -*ide*; if the anion is a polyatomic ion, simply write the name of the polyatomic ion.
- If the cation can have more than one possible charge, write the charge as a Roman numeral in parentheses.

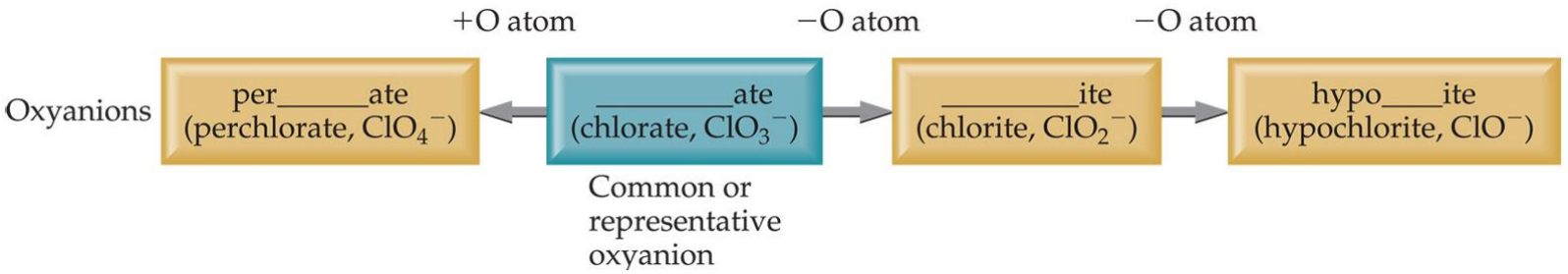


Patterns in Oxyanion Nomenclature

- When there are two oxyanions involving the same element:
  - The one with fewer oxygens ends in -*ite*.
    - NO_2^- : nitrite; SO_3^{2-} : sulfite
  - The one with more oxygens ends in -*ate*.
    - NO_3^- : nitrate; SO_4^{2-} : sulfate

Patterns in Oxyanion Nomenclature

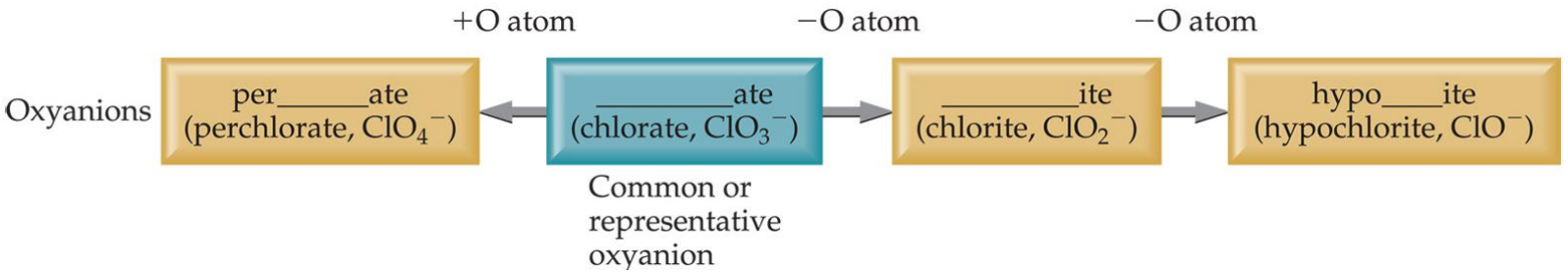
- The one with the second fewest oxygens ends in *-ite.*
  - ClO_2^- : chlorite
- The one with the second most oxygens ends in *-ate.*
  - ClO_3^- : chlorate



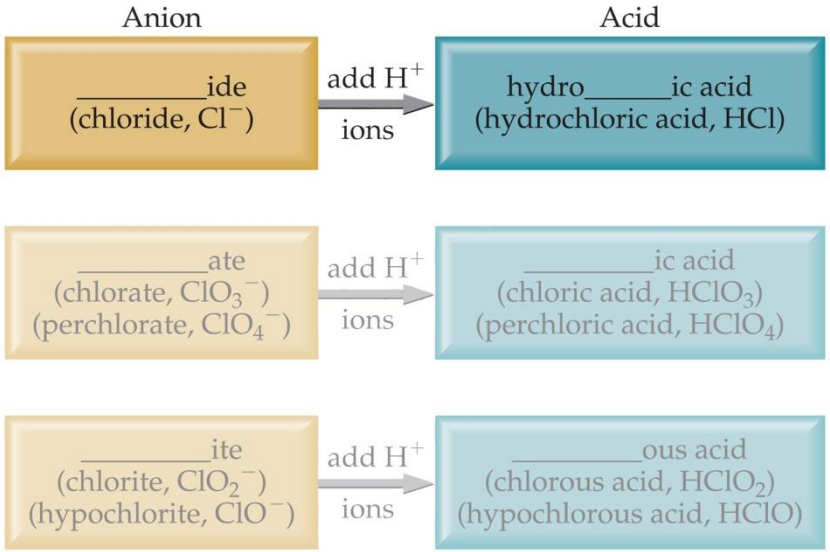
Atoms, Molecules, and Ions

Patterns in Oxyanion Nomenclature

- The one with the fewest oxygens has the prefix *hypo-* and ends in *-ite.*
  - ClO^- : hypochlorite
- The one with the most oxygens has the prefix *per-* and ends in *-ate.*
  - ClO_4^- : perchlorate

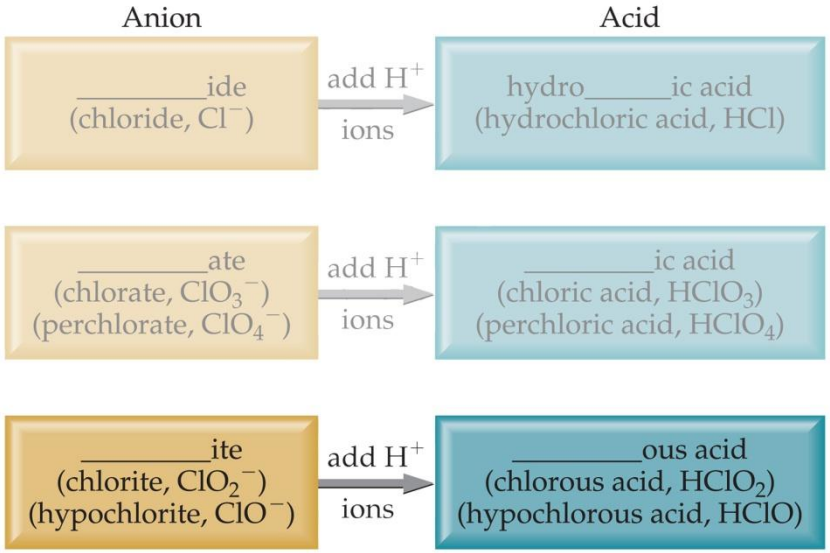


Acid Nomenclature



- If the anion in the acid ends in *-ide*, change the ending to *-ic acid* and add the prefix *hydro-* .
  - HCl: hydrochloric acid
  - HBr: hydrobromic acid
  - HI: hydroiodic acid

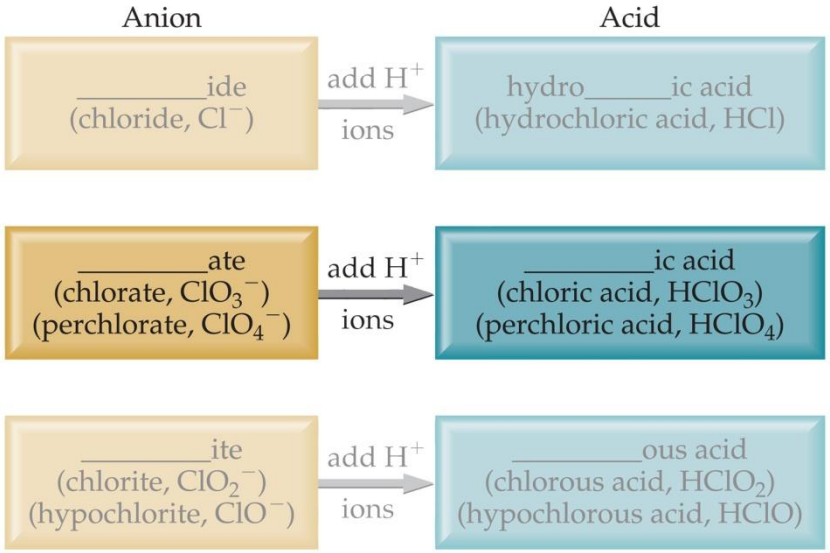
Acid Nomenclature



- If the anion in the acid ends in -*ite*, change the ending to -*ous acid*.
  - HClO: hypochlorous acid
  - $HClO_2$: chlorous acid

Atoms, Molecules, and Ions

Acid Nomenclature



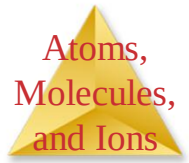
- If the anion in the acid ends in -*ate*, change the ending to -*ic acid*.
  - $HClO_3$: chloric acid
  - $HClO_4$: perchloric acid

Atoms, Molecules, and Ions

Nomenclature of Binary Compounds

Prefix	Meaning
Mono-	*1*
Di-	*2*
Tri-	*3*
Tetra-	*4*
Penta-	*5*
Hexa-	*6*
Hepta-	*7*
Octa-	*8*
Nona-	*9*
Deca-	*10*

- The less electronegative atom is usually listed first.
- A prefix is used to denote the number of atoms of each element in the compound (*mono*- is not used on the first element listed, however) .



Nomenclature of Binary Compounds

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Penta-	*5*
Hexa-	*6*
Hepta-	*7*
Octa-	*8*
Nona-	*9*
Deca-	*10*

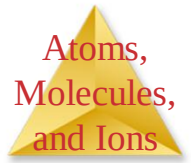
- The ending on the more electronegative element is changed to -*ide*.
  - CO_2: carbon dioxide
  - CCl_4: carbon tetrachloride

Nomenclature of Binary Compounds

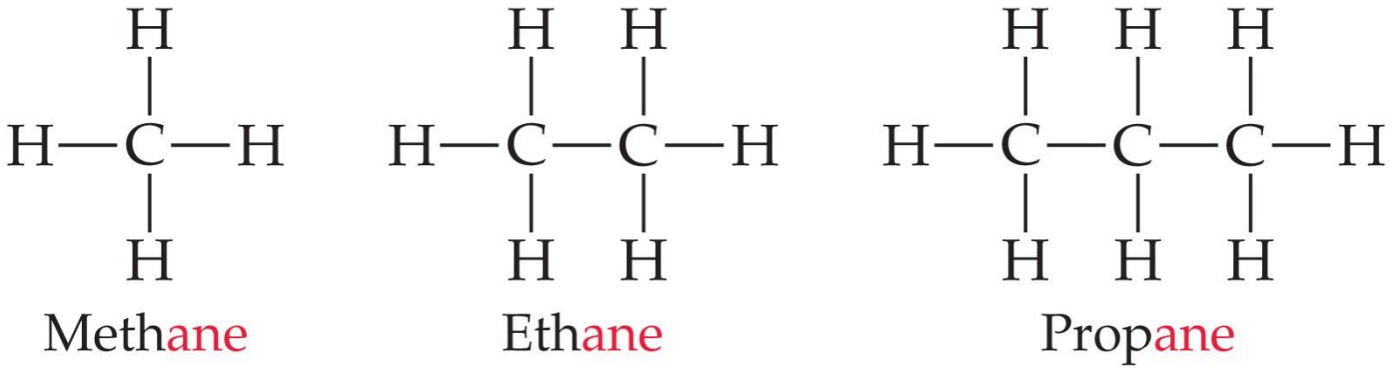
Prefix	Meaning
Mono-	*1*
Di-	*2*
Tri-	*3*
Tetra-	*4*
Penta-	*5*
Hexa-	*6*
Hepta-	*7*
Octa-	*8*
Nona-	*9*
Deca-	*10*

- If the prefix ends with *a* or *o* and the name of the element begins with a vowel, the two successive vowels are often elided into one.

N_2O_5: dinitrogen pentoxide

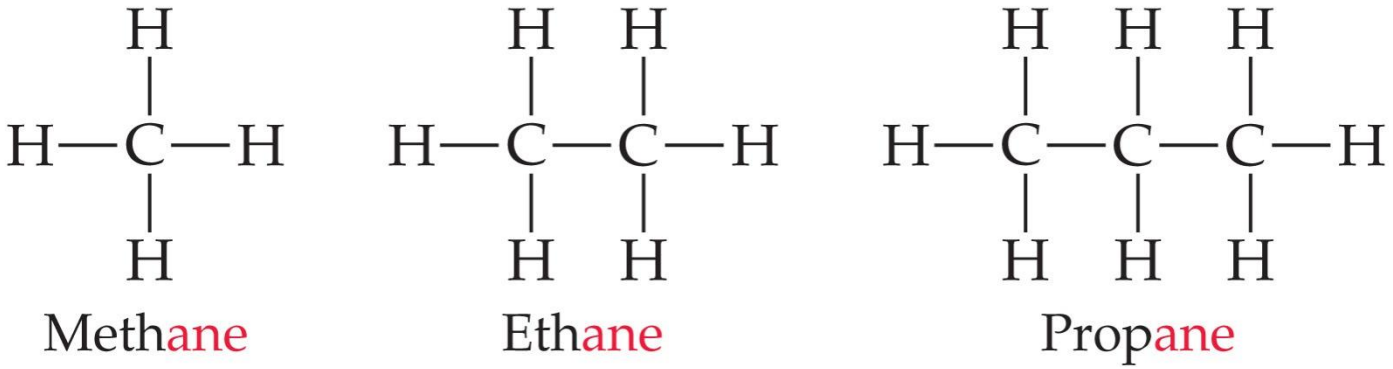


Nomenclature of Organic Compounds



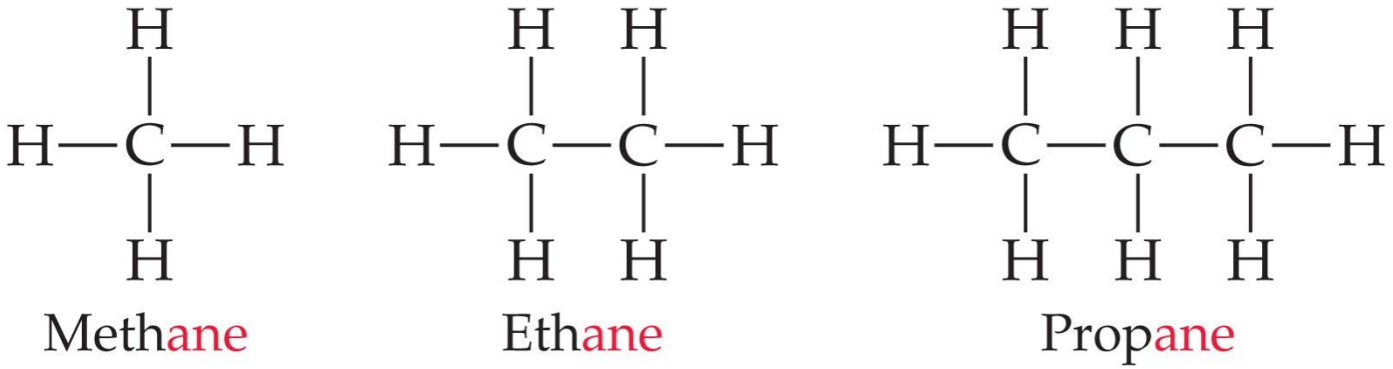
- Organic chemistry is the study of carbon.
- Organic chemistry has its own system of nomenclature.

Nomenclature of Organic Compounds



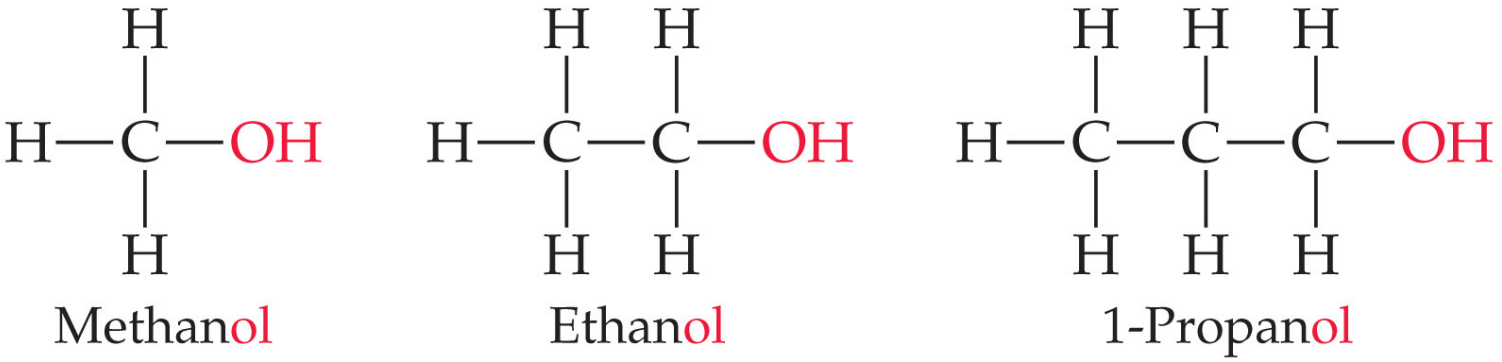
The simplest hydrocarbons (compounds containing only carbon and hydrogen) are alkanes.

Nomenclature of Organic Compounds



The first part of the names above correspond to the number of carbons (*meth-* = 1, *eth-* = 2, *prop-* = 3, etc.).

Nomenclature of Organic Compounds



- When a hydrogen in an alkane is replaced with something else (a functional group, like -OH in the compounds above), the name is derived from the name of the alkane.
- The ending denotes the type of compound.
  - An alcohol ends in *-ol*.