

Periodic Table

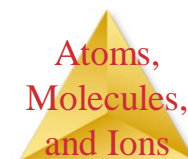
- The rows on the periodic chart are periods.
- Columns are groups.
- Elements in the same group have similar chemical properties.

1A 1																	3A 13	4A 14	5A 15	6A 16	7A 17	8A 18			
1 1 H	2A 2																	5 B	6 C	7 N	8 O	9 F	2 He		
2 3 Li	4 Be																	13 Al	14 Si	15 P	16 S	17 Cl	18 Ar		
3 11 Na	12 Mg	3B 3	4B 4	5B 5	6B 6	7B 7	8B 8 9 10			1B 11	2B 12						13 Al	14 Si	15 P	16 S	17 Cl	18 Ar			
4 19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr								
5 37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe								
6 55 Cs	56 Ba			71 Lu	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn						
7 87 Fr	88 Ra			103 Lr	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg						113	114	115	116	118			
		Metals																							
												57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb
		Metalloids										89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No
		Nonmetals																							

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.

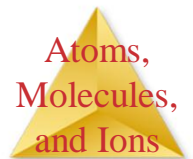


Periodic Table

1A 1	2A 2																	3A 13	4A 14	5A 15	6A 16	7A 17	8A 18
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6 Cs	56 Ba	71 Lu	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg							113	114	115	116		
7 Fr	88 Ra	103 Lr	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112												118

Metals	57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb
Metalloids	89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No
Nonmetals														

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



Periodic Table

1A 1																	3A 13	4A 14	5A 15	6A 16	7A 17	8A 18
1 1 H	2A 2											5 B	6 C	7 N	8 O	9 F	10 Ne					
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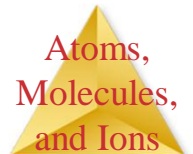
Metals

Metalloids

Nonmetals

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



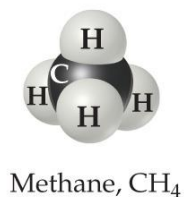
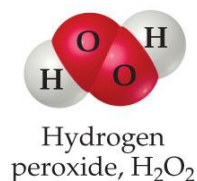
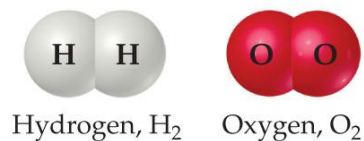
Periodic Table

Metals are on the left side of the chart.

	1A 1												8A 18					
1	1 H	2A 2											3A 13	4A 14	5A 15	6A 16	7A 17	2 He
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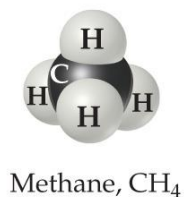
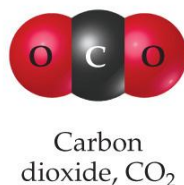
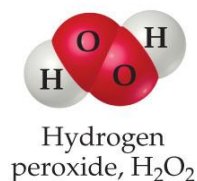
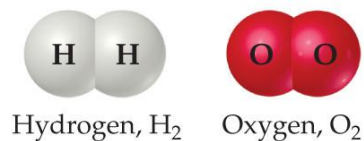
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	Nonmetals														

Chemical Formulas



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



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

Diatomic Molecules

Diagram illustrating the relative energies of molecular orbitals (MOs) for H_2 , N_2 , O_2 , and F_2 . The energy levels are shown for the 5A, 6A, and 7A atomic orbitals (AOs) and the resulting MOs.

The diagram shows the following energy levels (from lowest to highest):

- H_2 (1s)
- N_2 (1s)
- O_2 (1s)
- F_2 (1s)
- N_2 (2s)
- O_2 (2s)
- F_2 (2s)
- N_2 (2p)
- O_2 (2p)
- F_2 (2p)
- F_2 (3s)

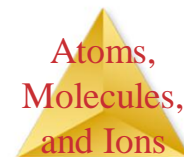
The molecular orbitals (MOs) are labeled as follows:

- σ_{1s} , σ_{1s}^*
- σ_{2s} , σ_{2s}^*
- π_{2p} , π_{2p}^*
- σ_{2p} , σ_{2p}^*
- π_{3s} , π_{3s}^*

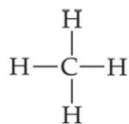
These seven elements occur naturally as molecules containing two atoms.

Types of Formulas

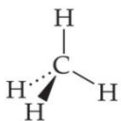
- Empirical formulas give the lowest whole-number ratio of atoms of each element in a compound.
- Molecular formulas give the exact number of atoms of each element in a compound.



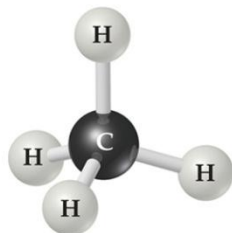
Types of Formulas



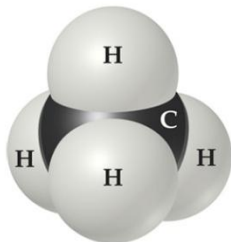
Structural formula



Perspective drawing



Ball-and-stick model



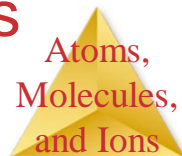
Space-filling model

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

Ions

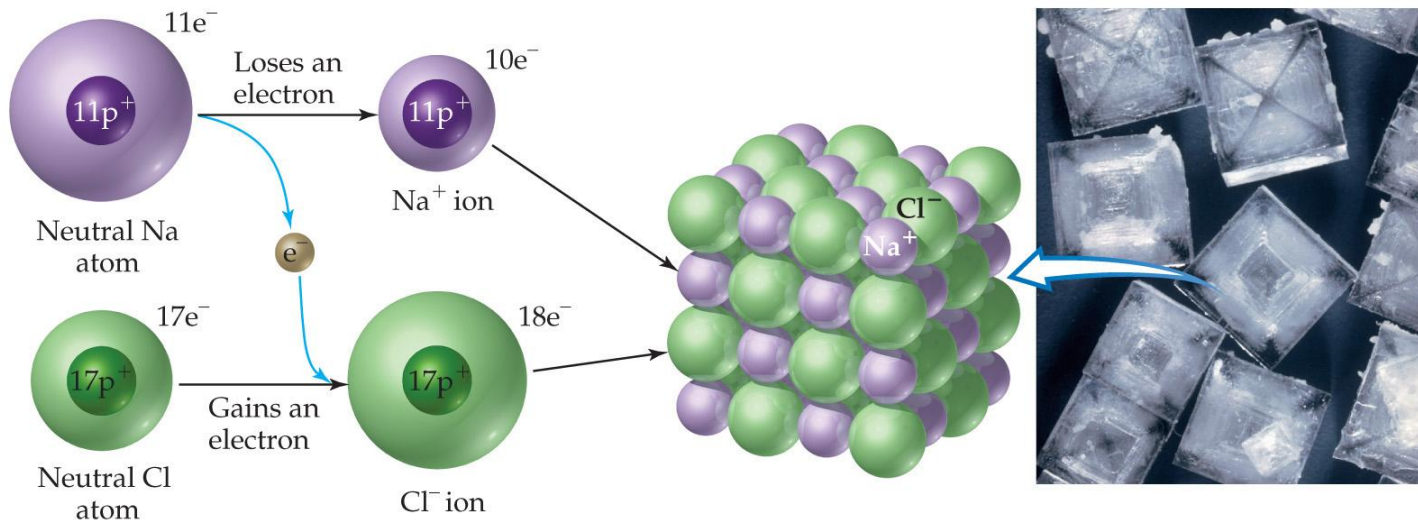
1A		2A							3A	4A	5A	6A	7A	8A
H ⁺											N ³⁻	O ²⁻	F ⁻	N O B L E G A S E S
Li ⁺									Al ³⁺			S ²⁻	Cl ⁻	
Na ⁺	Mg ²⁺	Transition metals										Se ²⁻	Br ⁻	
K ⁺	Ca ²⁺											Te ²⁻	I ⁻	
Rb ⁺	Sr ²⁺													
Cs ⁺	Ba ²⁺													

- 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.

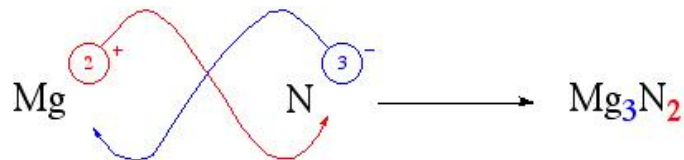


Ionic Bonds

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



Writing Formulas

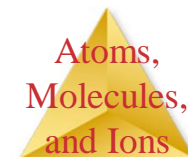


- Because compounds are electrically neutral, one can determine the formula of a compound this way:
 - The charge on the cation becomes the subscript on the anion.
 - The charge on the anion becomes the subscript on the cation.
 - If these subscripts are not in the lowest whole-number ratio, divide them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

Common Cations

Charge	Formula	Name	Formula	Name
1+	H⁺	Hydrogen ion	NH₄⁺	Ammonium ion
	Li ⁺	Lithium ion	Cu ⁺	Copper(I) or cuprous ion
	Na⁺	Sodium ion		
	K⁺	Potassium ion		
	Cs ⁺	Cesium ion		
	Ag⁺	Silver ion		
2+	Mg²⁺	Magnesium ion	Co ²⁺	Cobalt(II) or cobaltous ion
	Ca²⁺	Calcium ion	Cu²⁺	Copper(II) or cupric ion
	Sr ²⁺	Strontium ion	Fe²⁺	Iron(II) or ferrous ion
	Ba ²⁺	Barium ion	Mn ²⁺	Manganese(II) or manganous ion
	Zn²⁺	Zinc ion	Hg ₂ ²⁺	Mercury(I) or mercurous ion
	Cd ²⁺	Cadmium ion	Hg²⁺	Mercury(II) or mercuric ion
			Ni ²⁺	Nickel(II) or nickelous ion
			Pb²⁺	Lead(II) or plumbous ion
			Sn ²⁺	Tin(II) or stannous ion
3+	Al³⁺	Aluminum ion	Cr ³⁺	Chromium(III) or chromic ion
			Fe³⁺	Iron(III) or ferric ion

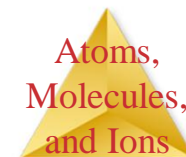
*The most common ions are in boldface.



Common Anions

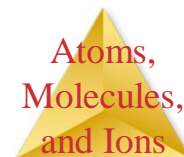
Charge	Formula	Name	Formula	Name
1-	H ⁻	Hydride ion	CH₃COO⁻ (or C ₂ H ₃ O ₂ ⁻)	Acetate ion
	F⁻	Fluoride ion	ClO ₃ ⁻	Chlorate ion
	Cl⁻	Chloride ion	ClO₄⁻	Perchlorate ion
	Br⁻	Bromide ion	NO₃⁻	Nitrate ion
	I⁻	Iodide ion	MnO ₄ ⁻	Permanganate ion
	CN ⁻	Cyanide ion		
	OH⁻	Hydroxide ion		
2-	O²⁻	Oxide ion	CO₃²⁻	Carbonate ion
	O ₂ ²⁻	Peroxide ion	CrO ₄ ²⁻	Chromate ion
	S²⁻	Sulfide ion	Cr ₂ O ₇ ²⁻	Dichromate ion
			SO₄²⁻	Sulfate ion
3-	N ³⁻	Nitride ion	PO₄³⁻	Phosphate ion

* The most common ions are in boldface.



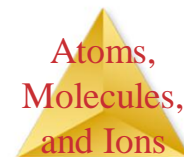
Inorganic Nomenclature

- 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.



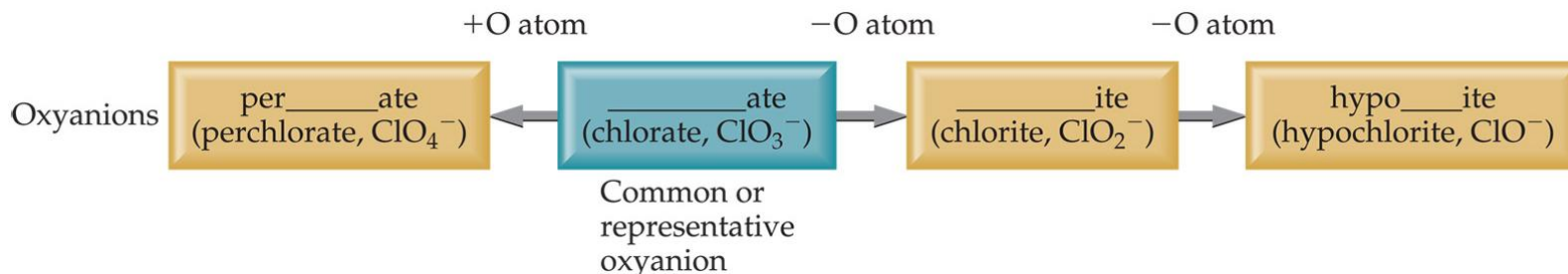
Patterns in Oxyanion Nomenclature

- 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



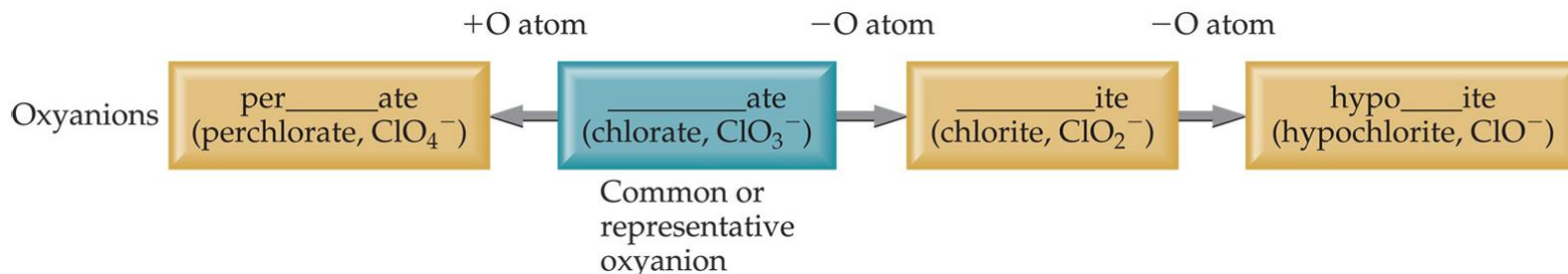
Patterns in Oxyanion Nomenclature

- 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



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

Anion		Acid
____ide (chloride, Cl^-)	add H^+ ions	hydro____ic acid (hydrochloric acid, HCl)
____ate (chlorate, ClO_3^-) (perchlorate, ClO_4^-)	add H^+ ions	____ic acid (chloric acid, HClO_3) (perchloric acid, HClO_4)
____ite (chlorite, ClO_2^-) (hypochlorite, ClO^-)	add H^+ ions	____ous acid (chlorous acid, HClO_2) (hypochlorous acid, HClO)

- 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

Anion		Acid
____ide (chloride, Cl^-)	add H^+ ions	hydro____ic acid (hydrochloric acid, HCl)
____ate (chlorate, ClO_3^-) (perchlorate, ClO_4^-)	add H^+ ions	____ic acid (chloric acid, HClO_3) (perchloric acid, HClO_4)
____ite (chlorite, ClO_2^-) (hypochlorite, ClO^-)	add H^+ ions	____ous acid (chlorous acid, HClO_2) (hypochlorous acid, HClO)

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

Acid Nomenclature

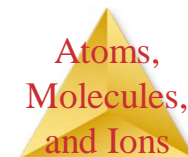
Anion		Acid
____ide (chloride, Cl^-)	add H^+ ions	hydro____ic acid (hydrochloric acid, HCl)
____ate (chlorate, ClO_3^-) (perchlorate, ClO_4^-)	add H^+ ions	____ic acid (chloric acid, HClO_3) (perchloric acid, HClO_4)
____ite (chlorite, ClO_2^-) (hypochlorite, ClO^-)	add H^+ ions	____ous acid (chlorous acid, HClO_2) (hypochlorous acid, HClO)

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

Nomenclature of Binary Compounds

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

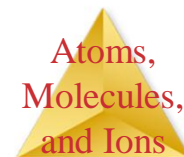
- The less electronegative atom is usually listed first.
- A prefix is used to denote the number of atoms of each element in the compound (*mono-* is not used on the first element listed, however) .



Nomenclature of Binary Compounds

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

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

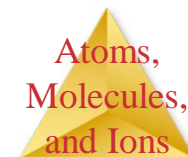


Nomenclature of Binary Compounds

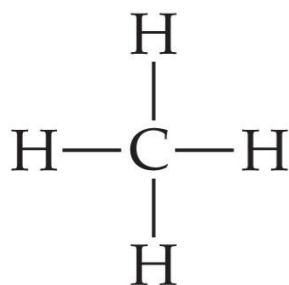
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<i>Hexa-</i>	6
<i>Hepta-</i>	7
<i>Octa-</i>	8
<i>Nona-</i>	9
<i>Deca-</i>	10

- 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.

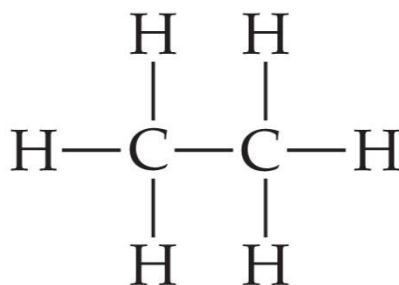
N_2O_5 : dinitrogen pentoxide



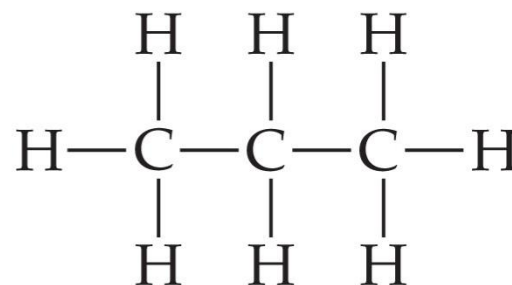
Nomenclature of Organic Compounds



Methane



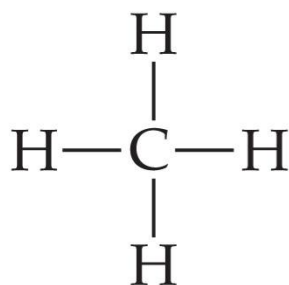
Ethane



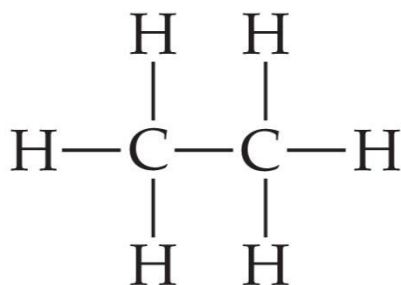
Propane

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

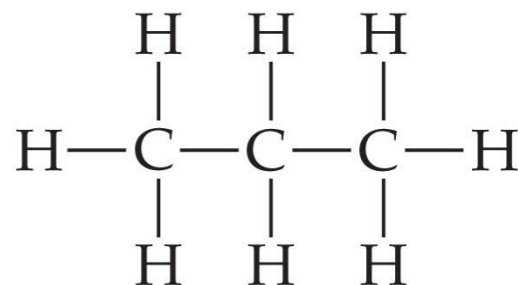
Nomenclature of Organic Compounds



Methane

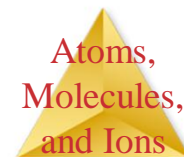


Ethane

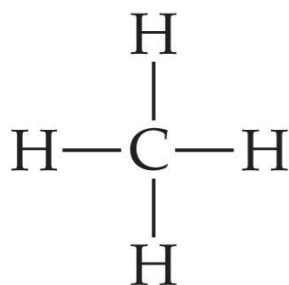


Propane

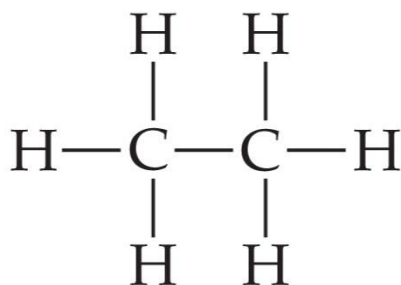
The simplest hydrocarbons (compounds containing only carbon and hydrogen) are alkanes.



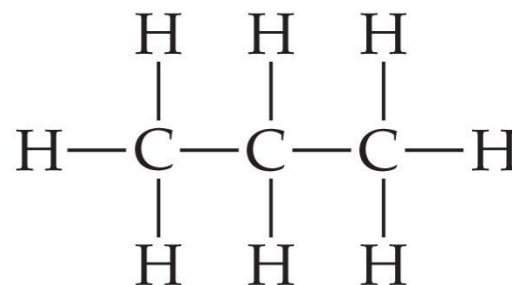
Nomenclature of Organic Compounds



Methane

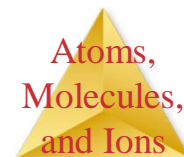


Ethane

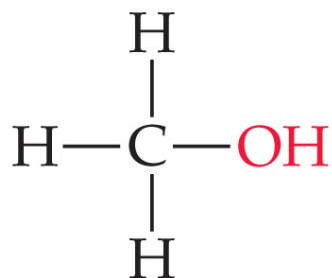


Propane

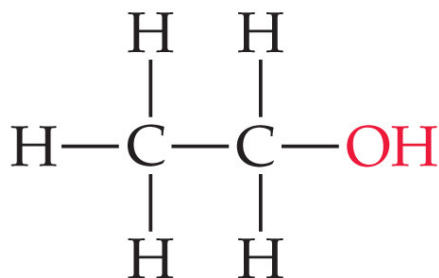
The first part of the names above correspond to the number of carbons (*meth-* = 1, *eth-* = 2, *prop-* = 3, etc.).



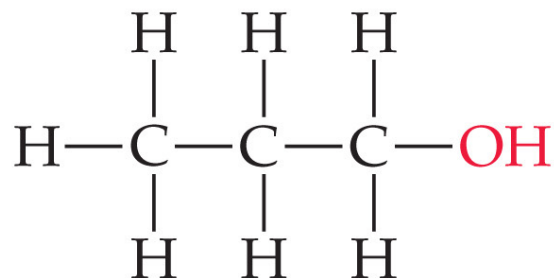
Nomenclature of Organic Compounds



Methanol



Ethanol



1-Propanol

- 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.

