Naming Inorganic Compounds

common names

systematic names

Molecular Formula	Common name	Systematic name
AgCl	**Lunar caustic**	**Silver chloride**
H_2SO_4	**Oil of vitriol**	**Sulfuric acid**
$MgSO_4$	**Epsom salts**	**Magnesium sulfate**

Nonenclature

When naming chemical compounds we distinguish between

Organic compounds

- compounds containing carbon.

Exceptions: CO, CO_2, CS_2, CN^-, CO_3^{2-}, HCO_3^-, H_2CO_3

Inorganic compounds

- all other compounds

we can break the naming of inorganic compounds into four categories:

- **Ionic compounds**
- **Molecular compounds**
- **Acids and Bases**
- **Hydrates**

Binary compounds contain two different elements

Examples: $NaCl$, $FeBr_3$, Al_2O_3, N_2O_5, P_4O_{10}

Instead of concerning ourselves with whether the compound is ionic or molecular, let's reintroduce the idea of electronegativity.

Electronegativity

measure of an elements ability to attract electrons toward itself when bonded to another element

An electronegative element attracts electrons.

An electropositive element releases electrons.

decreasing electronegativity

Increasing electronegativity

Group	1	2		3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	1A	2A		3B	4B	5B	6B	7B	8B			1B	2B	3A	4A	5A	6A	7A	8A
Period																			
1	1 H																		2 He
2	3 Li	4 Be												5 B	6 C	7 N	8 O	9 F	10 Ne
3	11 Na	12 Mg												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 Uun	111 Uuu	112 Uub	113 Uut	114 Uuq	115 Uup	116 Uuh	117 Uus	118 Uuo
lanthanides			*	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		
actinides			**	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		

Naming Ionic Compounds

Naming binary compounds

binary compounds contain two elements

and are named as two words

first word is name of cation

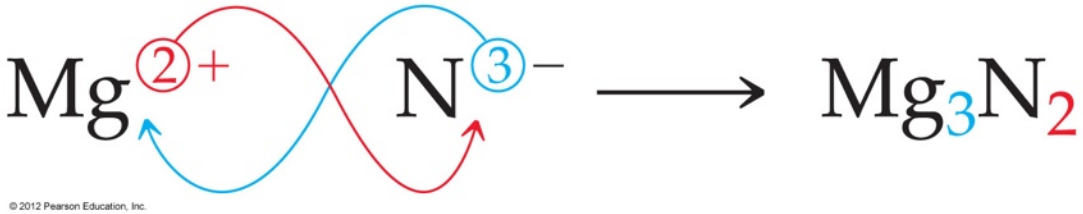
second word is first part of name of anion followed by -ide

Examples of binary compounds of metals

sodium bromide:	NaBr	$Na^{+}Br^{-}$
calcium oxide:	CaO	$Ca^{2+}O^{2-}$
barium chloride:	$BaCl_2$	$Ba^{2+}2Cl^{-}$
aluminum oxide:	Al_2O_3	$2Al^{3+}\ 3O^{2-}$

number of positive charges must equal number of negative charges

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

TABLE 2.4 • 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 ions we use most often in this course are in boldface. Learn them first.

Common Anions

TABLE 2.5 • 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 ions we use most often are in boldface. Learn them first.

Example

Write the formulas for the following compounds:

(a) potassium sulfide

K^+

S^{2-}

Answer: K_2S

Example

But some metals can form more than one type of cation

Often, but not always, a transition metal

Binary compounds of metals (cont'd)

When metal can form more than one type of cation, indicate charge by Roman numeral in parenthesis

MnO	**manganese(II) oxide**
Mn_2O_3	**manganese(III) oxide**
MnO_2	**manganese(IV) oxide**

use of the suffixes -ous and -ic is discouraged

Commonly encountered cations that can exist as two different charge types

+1, +2: **Cu, Hg**

+2, +3: **Fe, Co**

+2, +4: **Sn, Pb**

Example

Write the formulas for the following compounds:

(a) tin(II) fluoride

Sn^{2+}

F^-

Answer: SnF_2

Example

Write the formulas for the following compounds:

(a) mercury(II) oxide

Hg^{2+}

O^{2-}

Answer: HgO

Example

Write the formulas for the following compounds:

(a) mercury(I) iodide

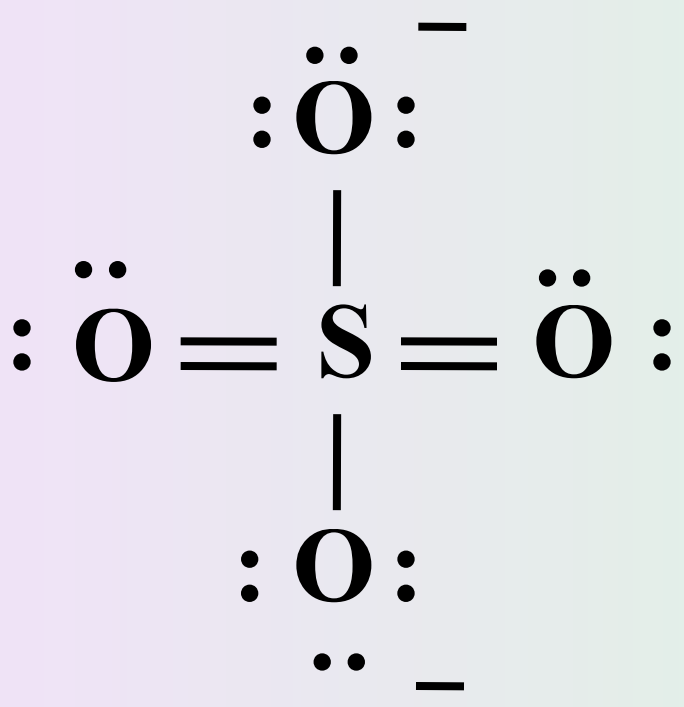
Hg^{+} actually exists as Hg_2^{2+}

I^-

Answer: Hg_2I_2

Polyatomic Ions

molecules with a charge



(SO_4^{2-})

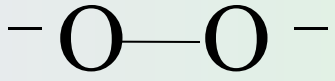
Polyatomic Ions

(CO_3^{2-})	**carbonate**
(CrO_4^{2-})	**chromate**
(OH^-)	**hydroxide**
(NO_3^-)	**nitrate**
($Cr_2O_7^{2-}$)	**dichromate**
(ClO_3^-)	**chlorate**

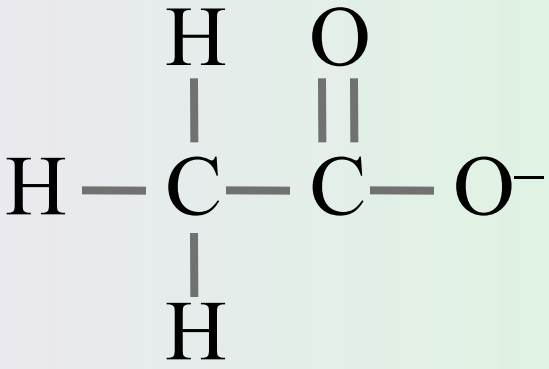
bromate **(BrO_3^-)**

Iodate **(IO_3^-)**

peroxide O_2^{2-}



acetate $C_2H_3O_2^-$



Example

Name the following ionic compounds:

(a) $Cu(NO_3)_2$

Cu^{2+}

$2NO_3^-$

Answer: copper(II)nitrate

Naming Molecular Compounds

Molecular Compounds

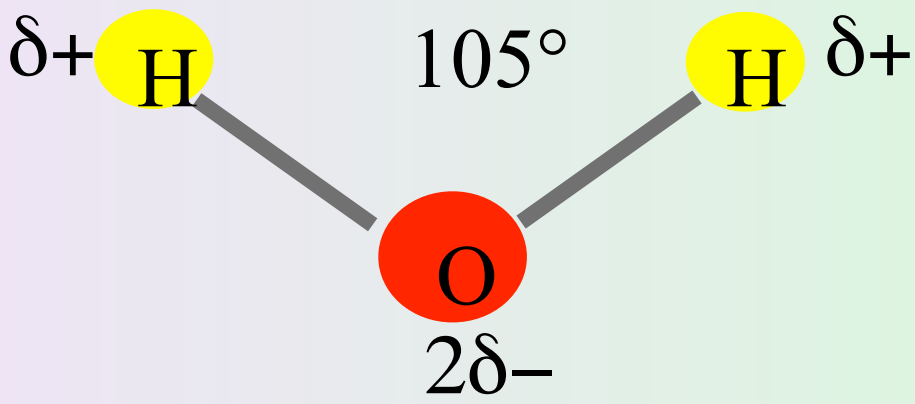
Electrons are shared by the atoms.
Covalent Bonds

Electrons however are not shared equally.

Molecular Compounds

Elements that are more electronegative assume an apparent negative charge ($\delta-$).

Elements that are more electropositive assume an apparent positive charge ($\delta+$).


δ+
H
105°
H
δ+
O
2δ–

naming binary compounds of nonmetals

1) more electropositive element named first (and listed first in chemical formula)

2) more electronegative element named in usual way (with -ide suffix)

3) counting prefixes are used with each name

but mono is not used with first name

Greek prefixes used in naming molecular compounds

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

Examples

CO	carbon monoxide
CO_2	carbon dioxide
SO_2	sulfur dioxide
SO_3	sulfur trioxide
PCl_3	phosphorus trichloride
PCl_5	phosphorus pentachloride
NO_2	nitrogen dioxide
N_2O_4	dinitrogen tetroxide
Cl_2O_7	dichlorine heptoxide

Name the following compounds

ClF_3	chlorine trifluoride
SCl_2	sulfur dichloride
Cl_2O_7	dichlorine heptoxide

Naming Acids and Bases

Acids and Bases

An acid is a substance that yields hydrogen ions (H^+) when dissolved in water.

Acids that contain hydrogen, oxygen, and another element are called oxyacids.

Acids and Bases

Bases are substances that yield hydroxide Ions (HO^-) when dissolved in water.

$NaOH$, KOH, $Ba(OH)_2$, NH_3

Naming Acids

Naming an acid depends on whether the anion contains oxygen

If the anion does not contain oxygen the acid is named with the prefix *hydro* and the suffix *--ic*

If the anion contains oxygen the acid name is formed from the root name of the anion with the suffix *-ic or -ous*

Names for some binary acids

Anion	Corresponding Acid
F^- (fluoride)	HF (hydrofluoric acid)
Cl^- (chloride)	HCl (hydrochloric acid)
Br^- (bromide)	HBr (hydrobromic acid)
I^- (iodide)	HI (hydroiodic acid)
CN^- (cyanide)	HCN (hydrocyanic acid)
S^{2-} (sulfide)	H_2S (hydrosulfuric acid)

Polyatomic anions

sulfite	SO_3^{2-}
sulfate	SO_4^{2-}
hypochlorite	ClO^-
chlorite	ClO_2^-
chlorate	ClO_3^-
perchlorate	ClO_4^-

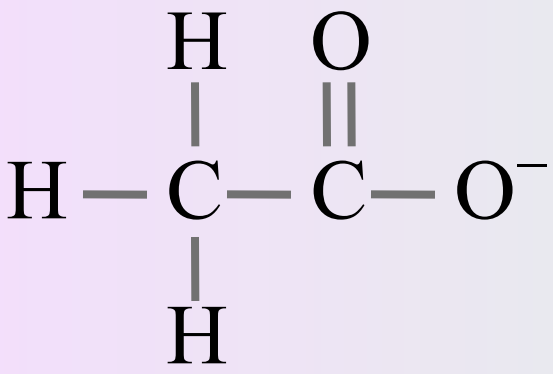
Ternary acids

three element acids

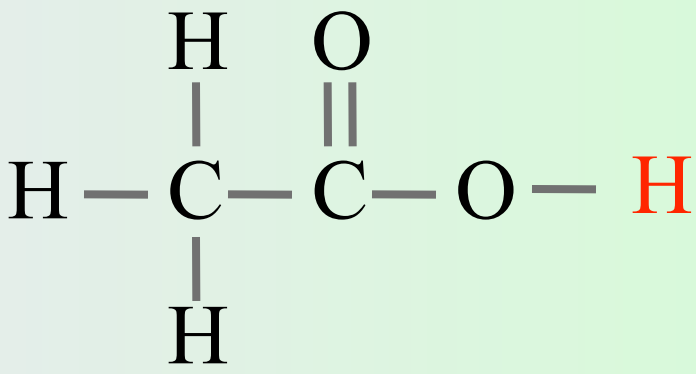
most ternary acids are oxyacids containing hydrogen, oxygen, and one other element

Oxyacids

acetate anion



acetic acid



Oxyacids

sulfite	**SO_3^{2-}**	**sulfurous acid**	**H_2SO_3**
		HOSOOH	
sulfate	**SO_4^{2-}**	**sulfuric acid**	**H_2SO_4**
		$HOSO_2OH$	

Oxyacids

perchlorate ClO_4^- **perchloric acid** $HClO_4$

$HOClO_3$

Addition of one O atom

chlorate ClO_3^- **chloric acid** $HClO_3$

$HOClO_2$

removal of one O atom

chlorite ClO_2^- **chlorous acid** $HClO_2$

$HOClO$

removal of two O atoms

hypochlorite ClO^- **hypochlorous acid** $HOCl$

Hydrates

Compounds that have a specific number of water molecules attached to them

Copper(II) sulfate pentahydrate

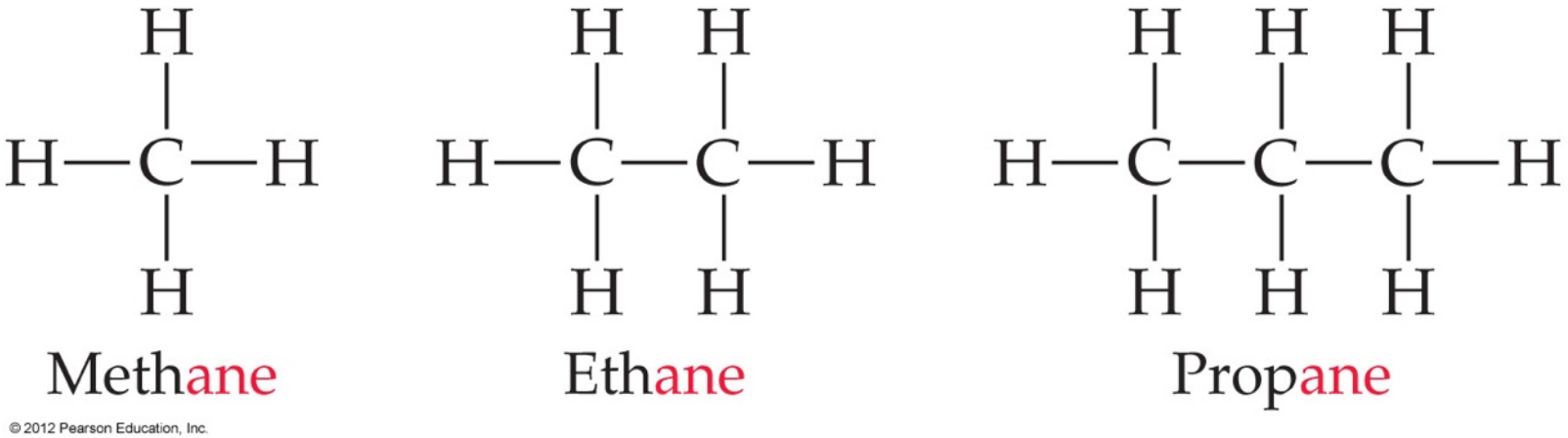
$CuSO_4 \cdot 5H_2O$

Copper(II) sulfate anhydrous

$CuSO_4$

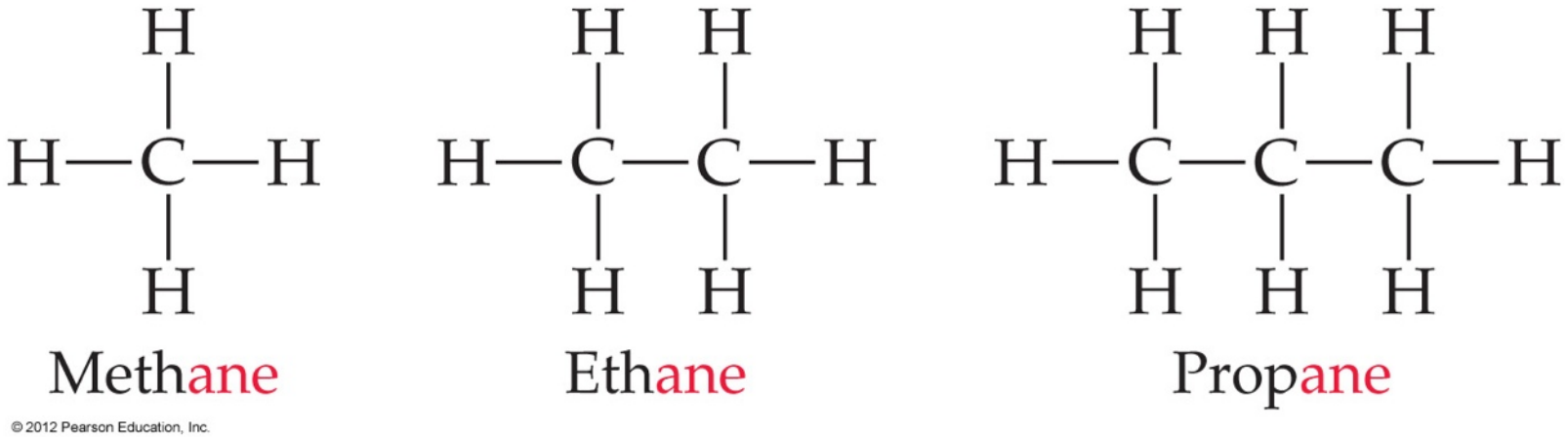
Anhydrous - the water molecules have been driven off by heating

Nomenclature of Organic Compounds



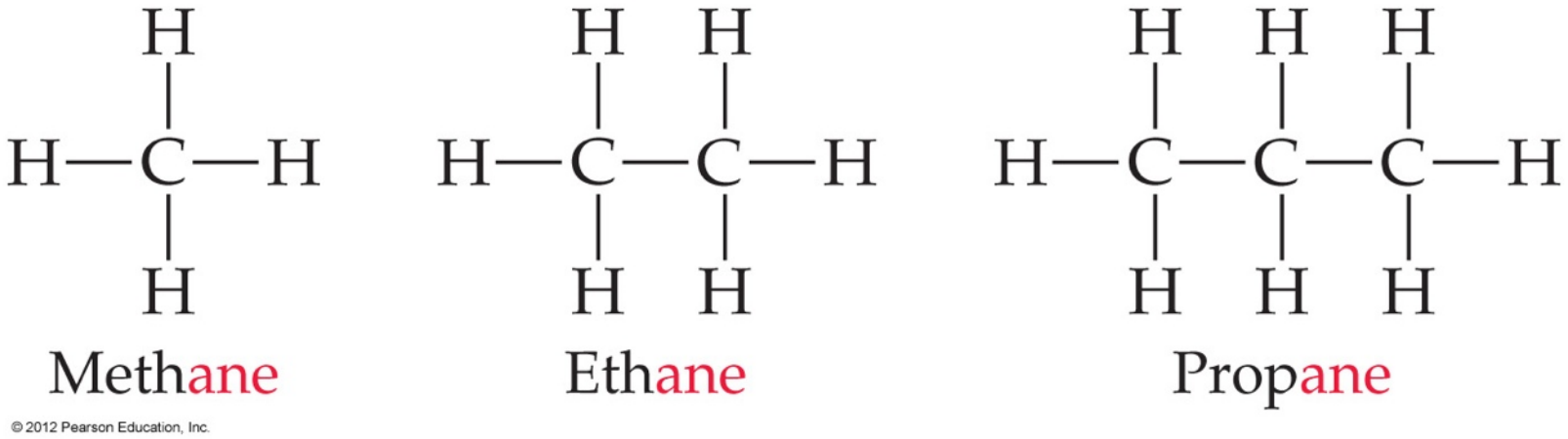
- **Organic chemistry** is the study of carbon.
- Organic chemistry has its own system of nomenclature.

Nomenclature of Organic Compounds



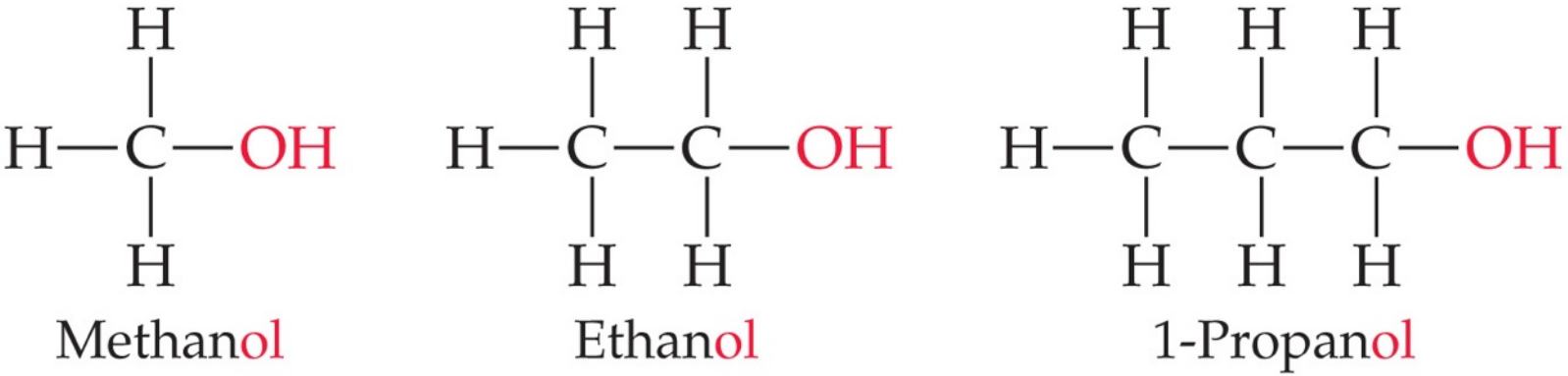
The simplest hydrocarbons (compounds containing only carbon and hydrogen) are **alkanes**.

Nomenclature of Organic Compounds



The first part of the names just listed 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*.

Polyatomic anions

hydroxide HO^-

peroxide O_2^{2-}

acetate $C_2H_3O_2^-$