

Naming Inorganic Compounds

common names

systematic names

Molecular
Formula

Common
name

Systematic
name

AgCl

Lunar caustic

Silver chloride

H₂SO₄

Oil of vitriol

Sulfuric acid

MgSO₄

Epsom salts

Magnesium sulfate

H₂O

Water

~~**Dihydrogen Oxide**~~

Nomenclature

When naming chemical compounds we distinguish between

Organic compounds

- compounds containing carbon.

Exceptions: CO, CO₂, CS₂, CN⁻, CO₃²⁻, HCO₃⁻, H₂CO₃

Inorganic compounds

- all other compounds

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

Ionic compounds

Molecular compounds

Acids and Bases

Hydrates

Naming Ionic Compounds

Naming binary ionic 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

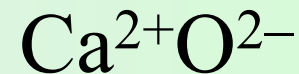
followed by -ide

Examples of binary ionic compounds of metals

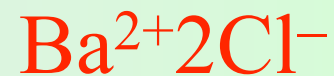
sodium bromide:



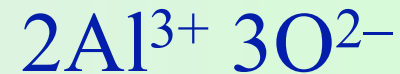
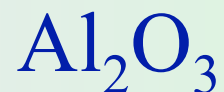
calcium oxide:



barium chloride:



aluminum oxide:



number of positive charges must equal number of negative charges

Example

Write the formulas for the following compounds:

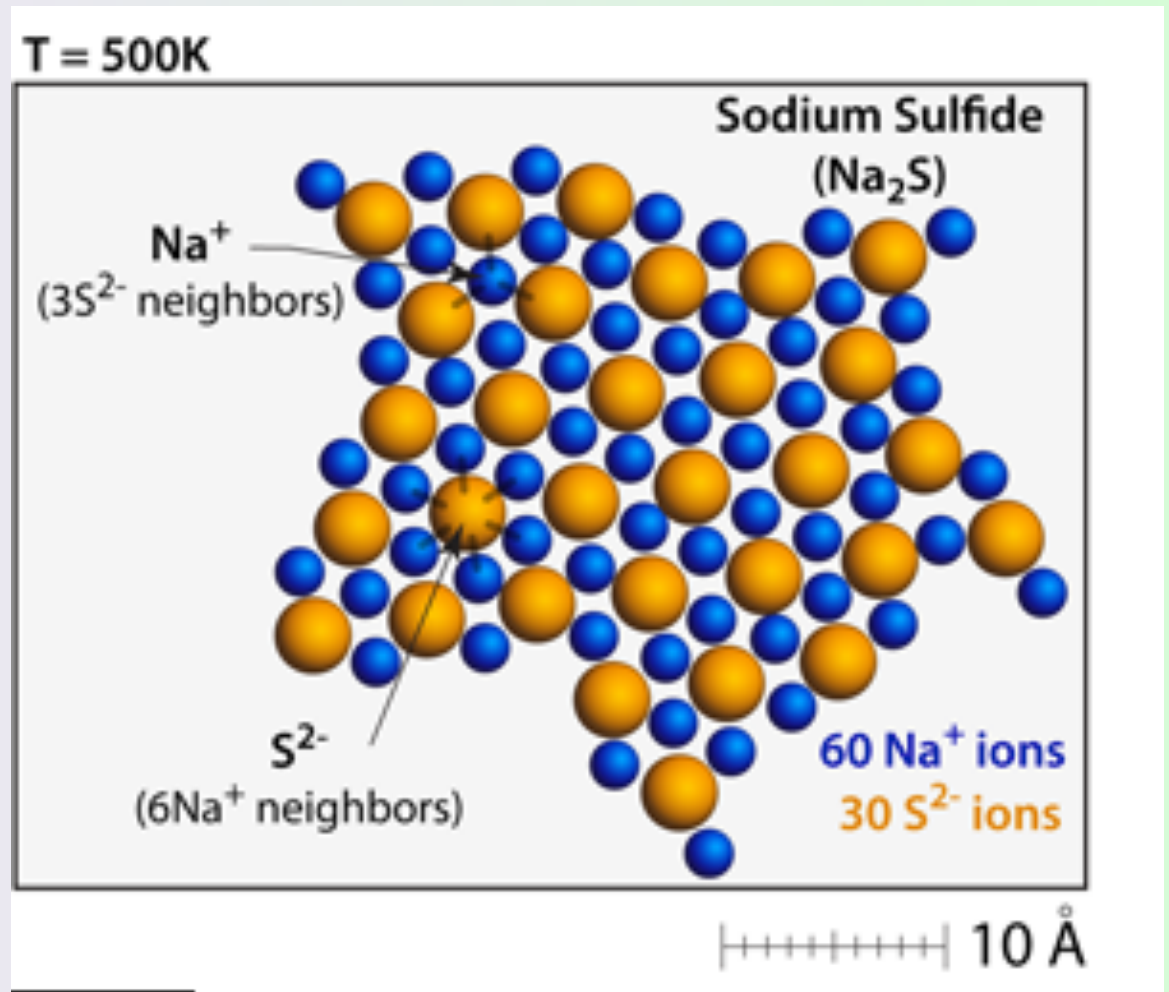
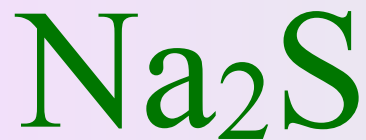
(a) sodium sulfide



Answer: Na_2S

binary compounds

contains only two different elements



Example

But some metals can form more than one type of cation

Often, but not always, a transition metal

Atomic Ions
Dominant form on top

1A	2A											3A	4A	5A	6A	7A	0	
+1	+2											+3		-3	-2	-1		
Li ⁺	Be ²⁺											B	C	N ³⁻	O ²⁻	F ⁻	He	
Na ⁺	Mg ²⁺	3B	4B	5B	6B	7B	8B				1B	2B	Al ³⁺	Si	P ³⁻	S ²⁻	Cl ⁻	Ar
K ⁺	Ca ²⁺	Sc ³⁺	Ti ³⁺ Ti ⁴⁺	V ³⁺ V ⁵⁺	Cr ³⁺ Cr ²⁺	Mn ²⁺ Mn ⁴⁺	Fe ²⁺ Fe ³⁺	Co ²⁺ Co ³⁺	Ni ²⁺ Ni ³⁺	Cu ²⁺ Cu ⁺	Zn ²⁺	Ga ³⁺	Ge ⁴⁺	As ³⁻	Se ²⁻	Br ⁻	Kr	
Rb ⁺	Sr ²⁺	Y ³⁺	Zr ⁴⁺	Nb ⁵⁺ Nb ³⁺	Mo ⁶⁺	Tc ⁷⁺	Ru ³⁺ Ru ⁴⁺	Rh ³⁺	Pd ²⁺ Pd ⁴⁺	Ag ⁺	Cd ²⁺	In ³⁺	Sn ⁴⁺ Sn ²⁺	Sb ³⁺ Sb ⁵⁺	Te ²⁻	I ⁻	Xe	
Cs ⁺	Ba ²⁺	La ³⁺	Hf ⁴⁺	Ta ⁵⁺	W ⁶⁺	Re ⁷⁺	Os ⁴⁺	Ir ⁴⁺	Pt ⁴⁺ Pt ²⁺	Au ³⁺ Au ⁺	Hg ²⁺ Hg ⁺	Tl ⁺ Tl ³⁺	Pb ²⁺ Pb ⁴⁺	Bi ³⁺ Bi ⁵⁺	Po ²⁺ Po ⁴⁺	At ⁻	Rn	
Fr ⁺	Ra ²⁺	Ac ³⁺																

transition metals

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

Mn₂O₃ manganese(III) oxide

MnO₂ manganese(IV) oxide

use of the suffixes -ous and -ic is discouraged

Example

Write the formulas for the following compounds:

(a) tin(II) fluoride



Answer: SnF_2

Example

Write the formulas for the following compounds:

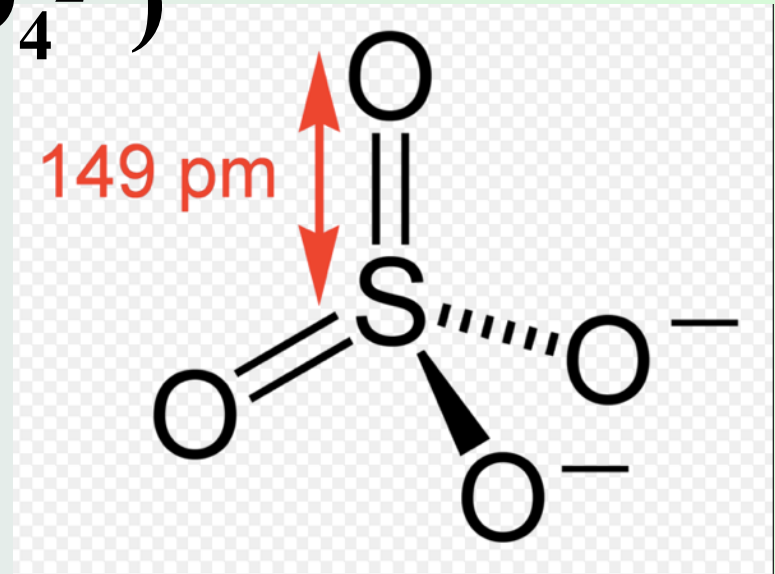
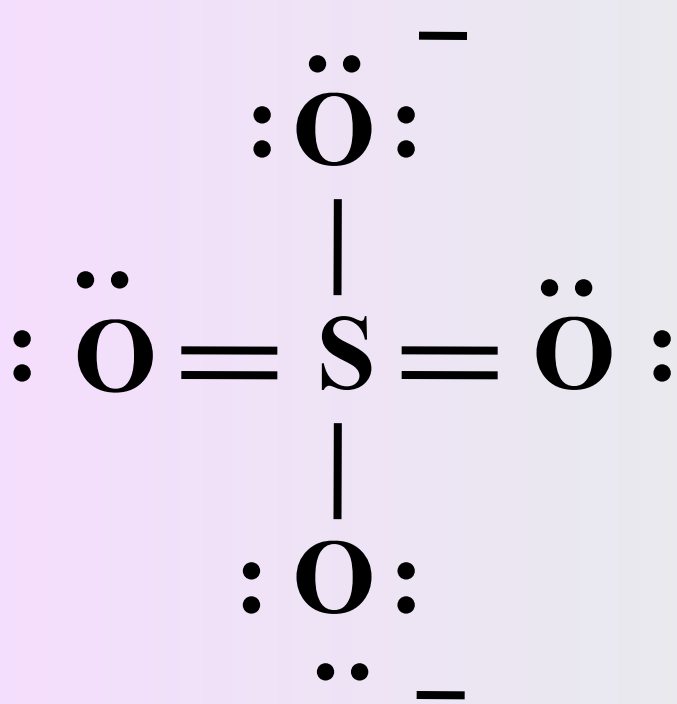
(a) mercury(II) oxide



Answer: HgO

Polyatomic Ions

molecules with a charge



Polyatomic Ions



carbonate



chromate



hydroxide



nitrate



dichromate



chlorate

bromate **(BrO₃⁻)**

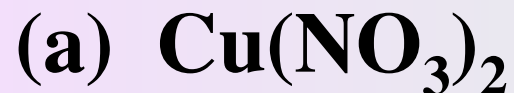
Iodate **(IO₃⁻)**

peroxide O₂²⁻
- O — O -

acetate C₂H₃O₂⁻
 H O
 | ||
 H — C — C — O⁻
 |
 H

Example

Name the following ionic compounds:



Answer: copper(II)nitrate

Naming Molecular Compounds

Definition

Molecule —is an aggregate of at least **two** atoms in a definite arrangement held together by chemical forces.

bonds



structure



Ionic Compounds

discrete molecules are not present, so ionic compounds are represented by their **empirical formulas**

some times referred to as **formula units**



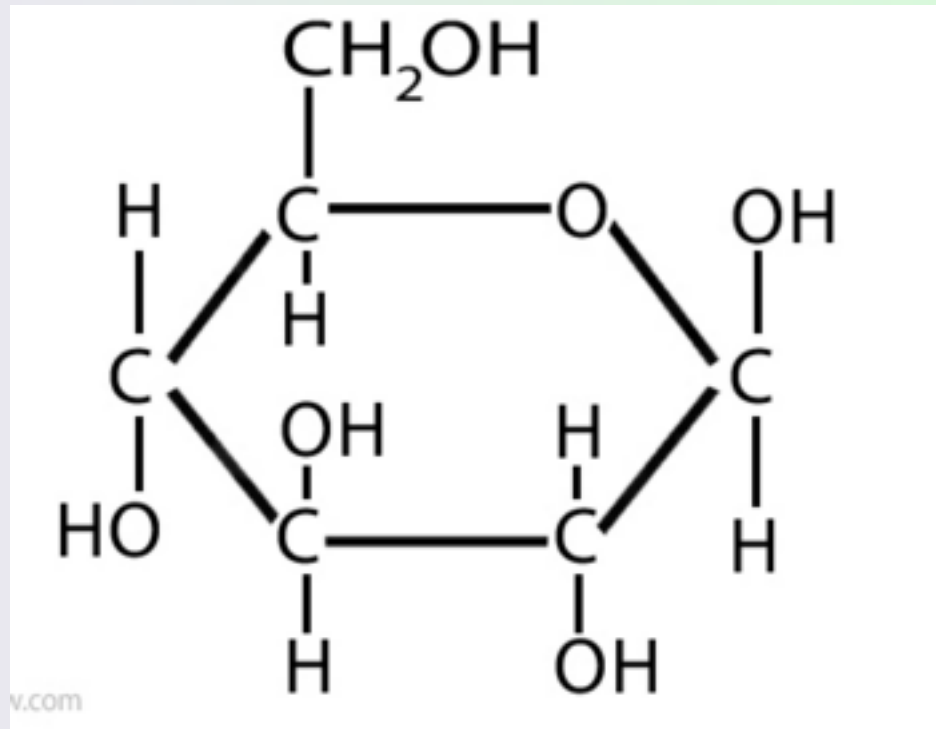
Molecular formula

shows the exact number of atoms of each element in the smallest unit of a substance



structural formula

uses symbols and bonds to show relative positions of the atoms



Molecular Compounds

Electrons are shared by the atoms.

Covalent Bonds

Electrons however are not shared equally.

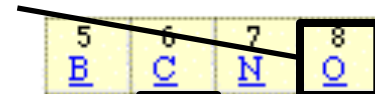
decreasing
electronegativity

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			

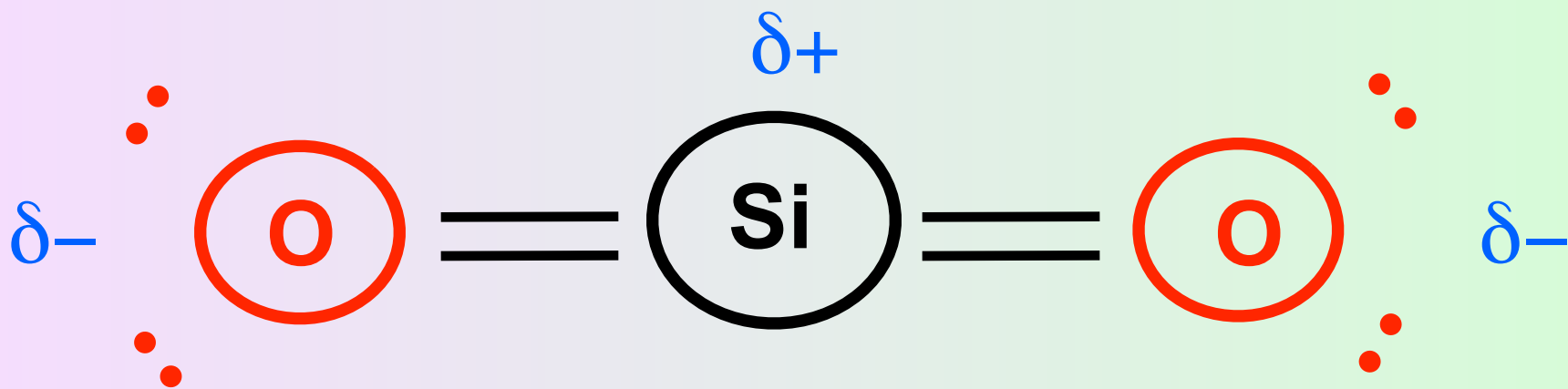
oxygen is more electronegative

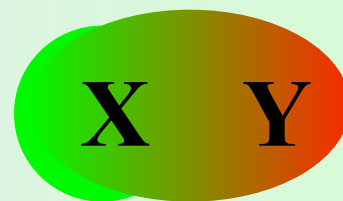


Molecular Compounds

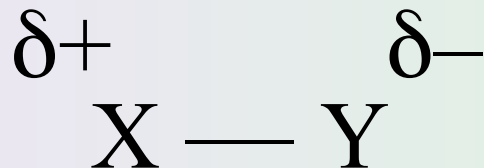
Elements that are more electronegative assume an **apparent negative charge (δ^-)**.

Elements that are less electronegative assume an **apparent positive charge (δ^+)**.

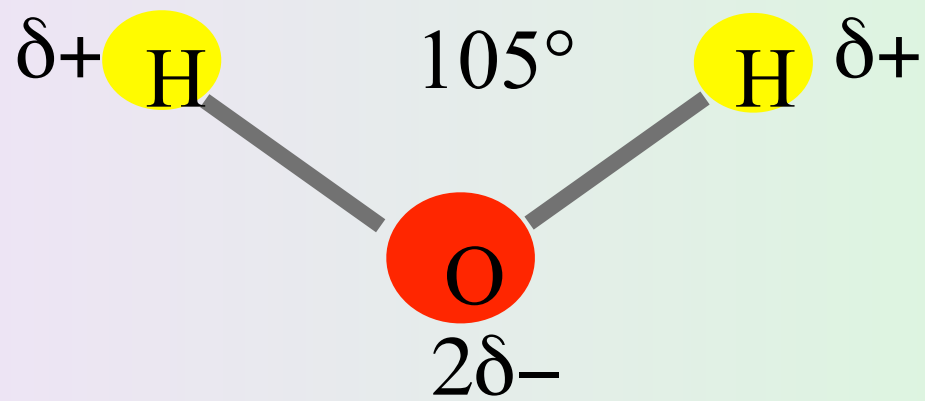




Polar Covalent Bonds



The concept of *electronegativity* guides our thinking about the polarity of bonds and the polarity of molecules.



naming binary compounds of nonmetals

- 1) less electronegative 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

<u>Prefix</u>	<u>Meaning</u>	<u>Prefix</u>	<u>Meaning</u>
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 ₂ O ₄	dinitrogen tetroxide
Cl ₂ O ₇	dichlorine heptoxide

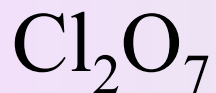
Name the following compounds



chlorine trifluoride



sulfur dichloride



dichlorine heptoxide

Naming Acids and Bases

Definitions of acids and bases

Svant Arrhenius (Sweden) 1859-1927

Johannes Bronsted (Denmark) 1879-1947

G. N. Lewis (U.S.) 1875-1946

Arrhenius definitions of acids and bases

An acid dissolves in water to yield protons



Arrhenius definitions of acids and bases

An acid dissolves in water to yield protons



A base dissolves in water to yield hydroxide
ions



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 , $\text{Ba}(\text{OH})_2$, 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)

S²⁻ (sulfide)

H₂S (hydrosulfuric acid)

Polyatomic anions

sulfite SO_3^{2-}

sulfate SO_4^{2-}

hypochlorite ClO^-

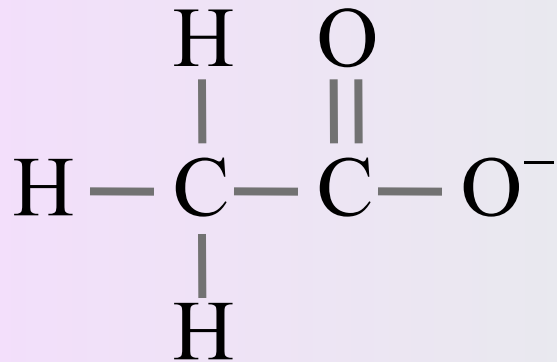
chlorite ClO_2^-

chlorate ClO_3^-

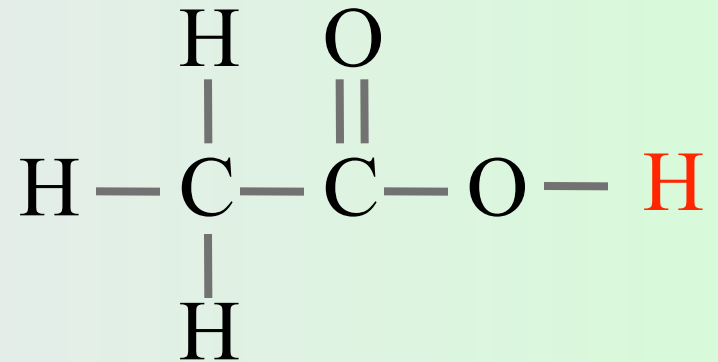
perchlorate ClO_4^-

Oxyacids

acetate anion



acetic acid



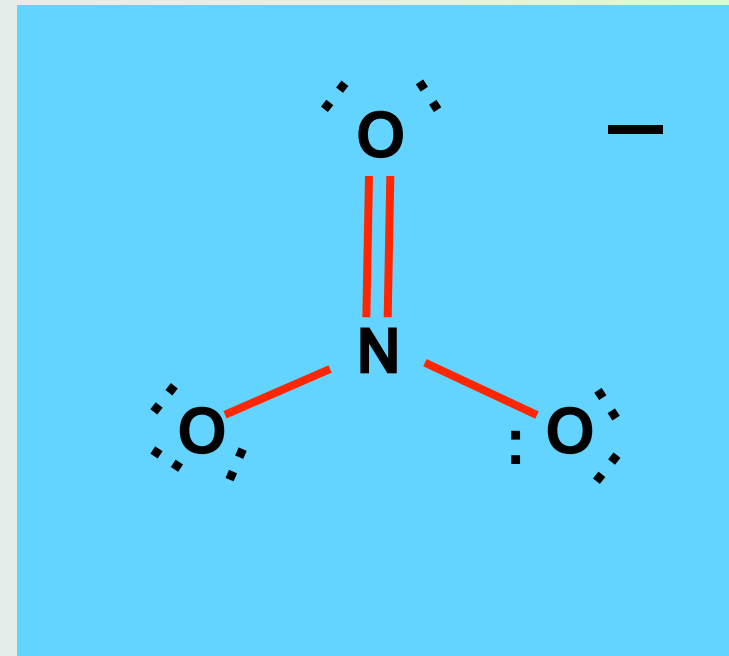
Oxyacids

h

proton

H^+

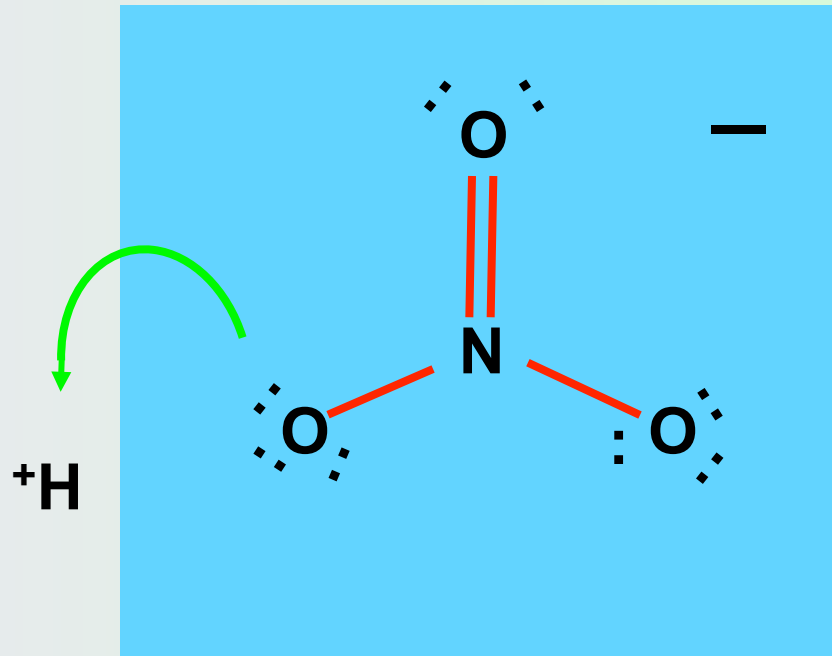
nitrate anion



Oxyacids

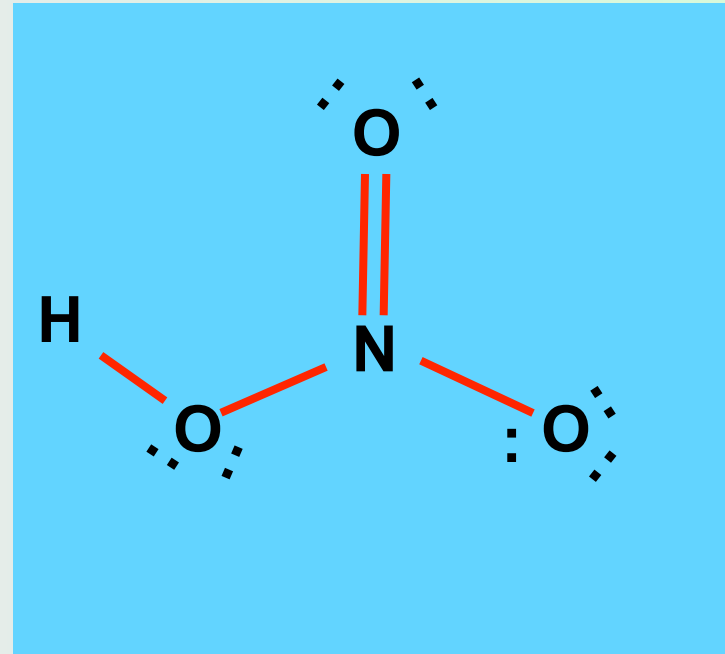
proton

nitrate anion



Oxyacids

nitric acid



Oxyacids

sulfite	SO_3^{2-}	sulfurous acid	H_2SO_3
		HOSOOH	
sulfate	SO_4^{2-}	sulfuric acid	H_2SO_4
		HOSO₂OH	

Oxyacids

sulfite	SO_3^{2-}	sulfurous acid	H_2SO_3 HOSO₂OH
sulfate	SO_4^{2-}	sulfuric acid	H_2SO_4 HOSO₂OH

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

?

a molecule
starting a
hydrogen?

is there a metal in
the formula?

acid

is there an
oxygen in the
formula ?

base

name it using
ionic
compound
rules

non-oxyacid

use Hyro ____ic acid

oxyacid

polyatomic anion ending
with *ate* ----- *ic acid*

polyatomic anion ending
with *ite* ----- *ous acid*

Hydrates

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

Copper(II) sulfate pentahydrate



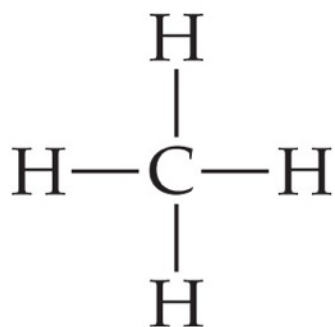
Copper(II) sulfate anhydrous



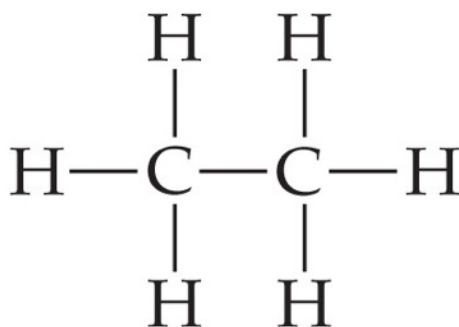
Anhydrous - the water molecules have been driven off by heating

Naming Organic Compounds *abbreviated*

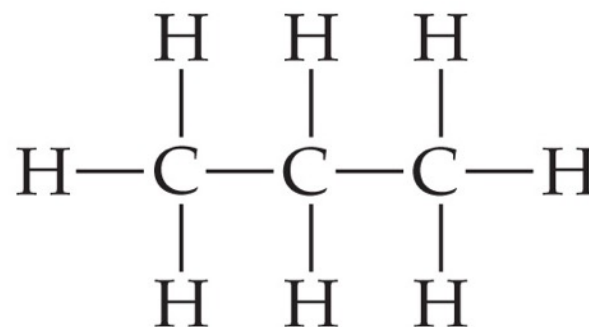
Nomenclature of Organic Compounds



Methane



Ethane

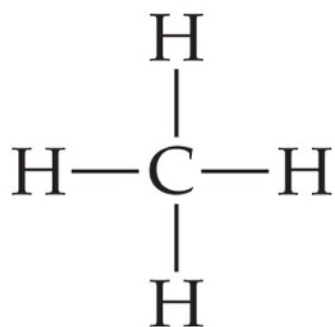


Propane

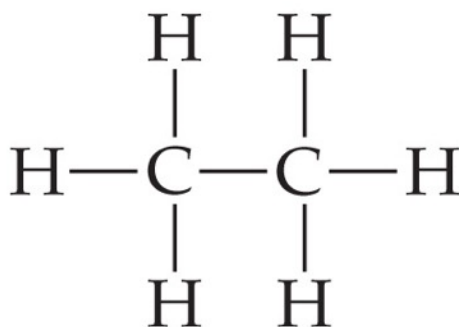
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- **Organic chemistry** is the study of carbon.
- Organic chemistry has its own system of nomenclature.

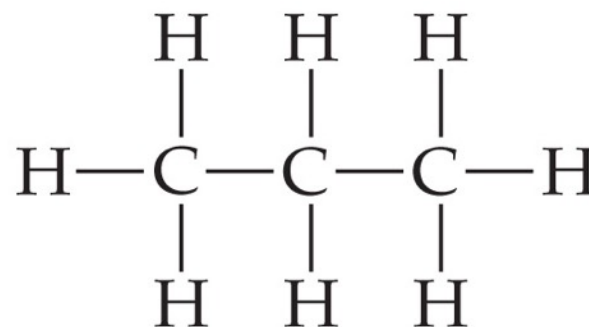
Nomenclature of Organic Compounds



Methane



Ethane

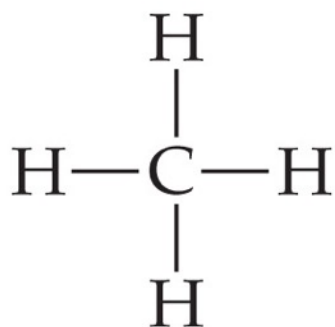


Propane

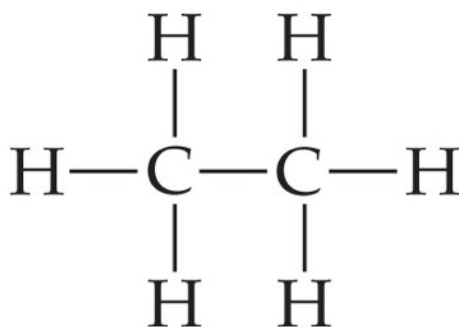
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The simplest hydrocarbons (compounds containing only carbon and hydrogen) are **alkanes**.

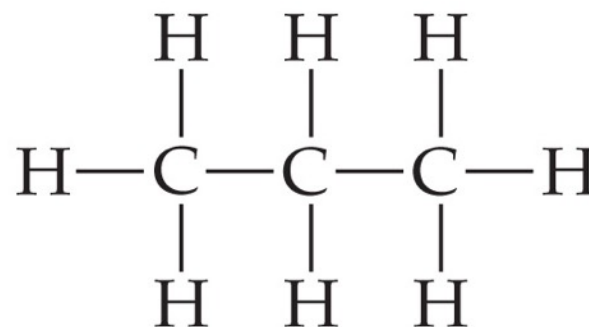
Nomenclature of Organic Compounds



Methane



Ethane

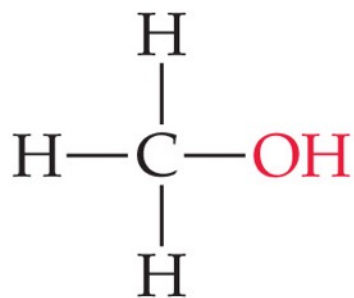


Propane

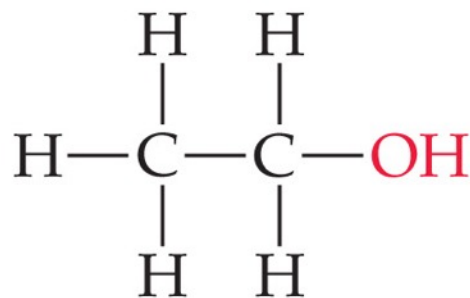
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The first part of the names just listed correspond to the number of carbons (***meth-*** = 1, ***eth-*** = 2, ***prop-*** = 3, etc.).

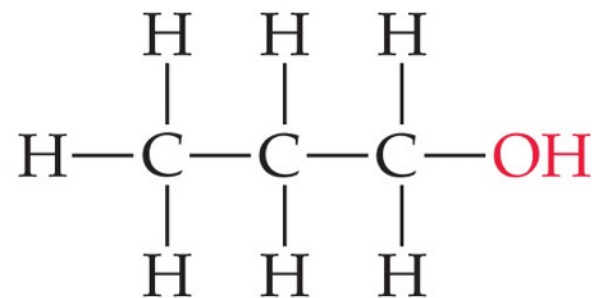
Nomenclature of Organic Compounds



Methanol



Ethanol



1-Propanol

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- 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*.

