

(14) Today

Finish Chap 2

Section 3.1: Functional Groups

Section 3.2: Alkanes and Isomers

Next Class (15)

Test 1 on Chap 1 and 2 though section 2.10
(Monday's class)

(16) Second Class from Today

Section 3.2: Alkanes and Isomers

Section 3.3: Alkyl Groups

Section 3.4: Nomenclature

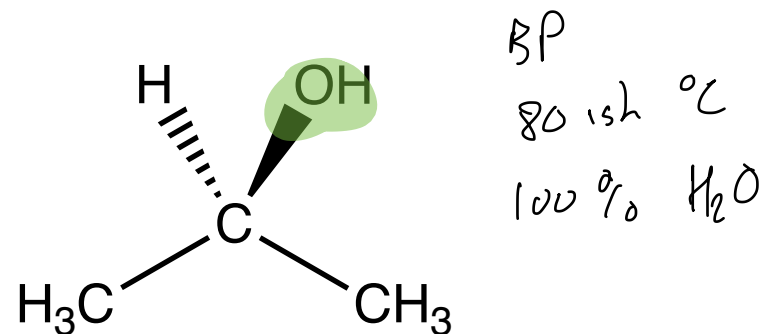
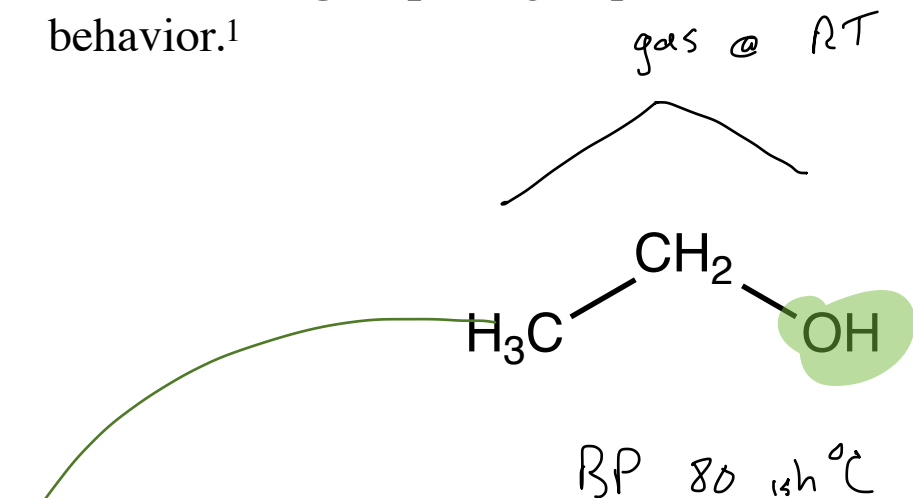
Third Class from Today (17)

Section 3.4 Nomenclature

Section 3.5 - 3.7 Properties and
Conformations of Alkanes

Chap 4 Cycloalkanes

A **functional group** is a group of atoms within a molecule that has a characteristic chemical behavior.¹



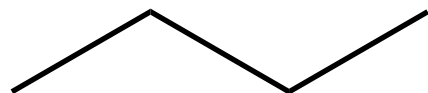
these molecules inherit properties based on the presence of the OH functional group

¹ Organic Chemistry, 10th ed. McMurry. (2023) Openstax

Functional Groups: Alkanes and Alkenes and Alkynes

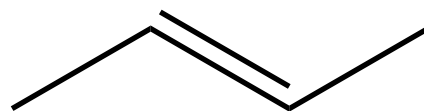
Section 3.1

steric # = 2
bond angle = 180°



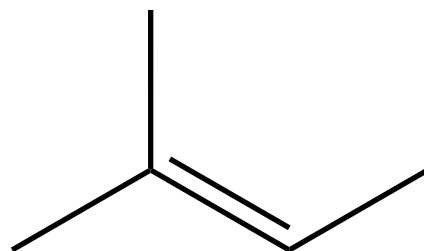
linear, acyclic alkane

hydrocarbon
all sp^3 hybridized C atoms
all single bonds



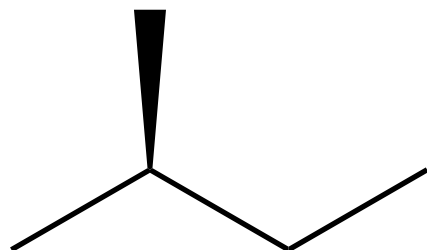
linear, acyclic alkene

hydrocarbon

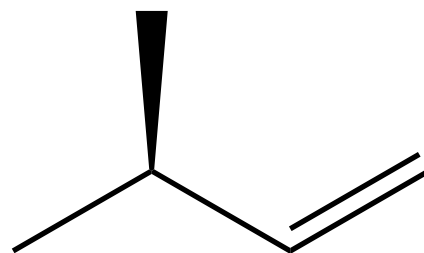


branched, acyclic alkenes

at least 1 C to C
double bond



branched, acyclic alkane



linear, acyclic alkyne

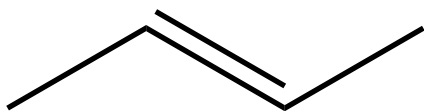
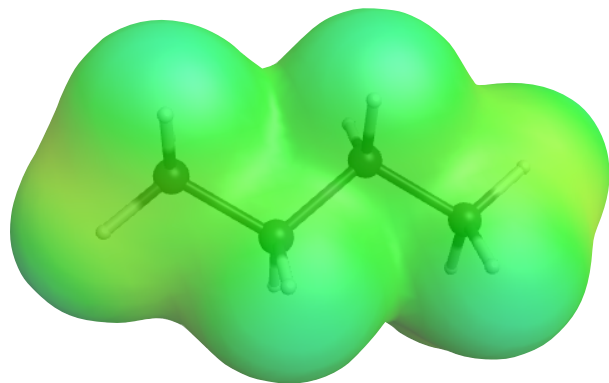
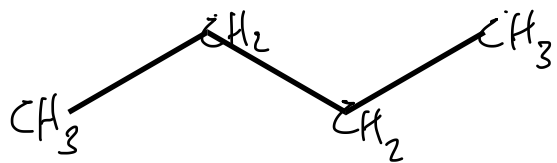
hydrocarbon

at least 1

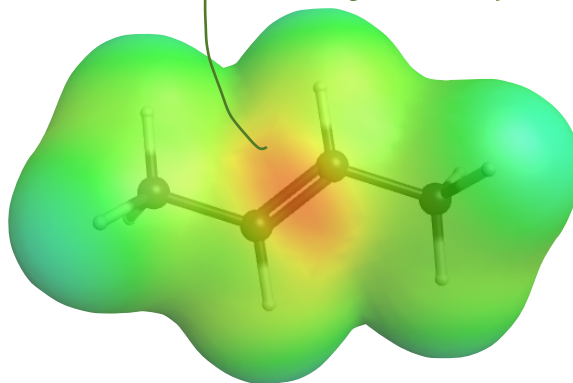
C to C

triple bond

2 sp hybrids on
this C pointing
in opposite directions

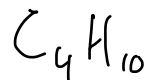


e^- density in π bond is



out away from the nuclei, so alkenes have a spot that is e^- rich

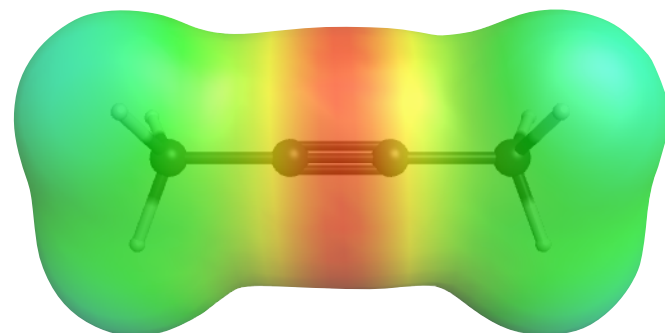
Formulas?



This molecule is saturated with H atoms. We cannot add any more H atoms to the 4 C atoms



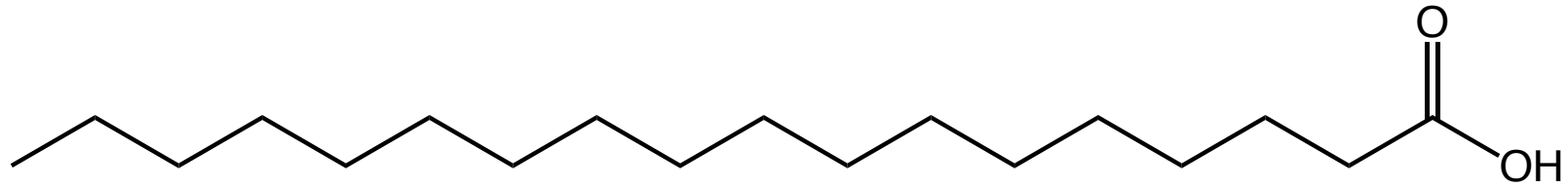
e^- density in both π bonds



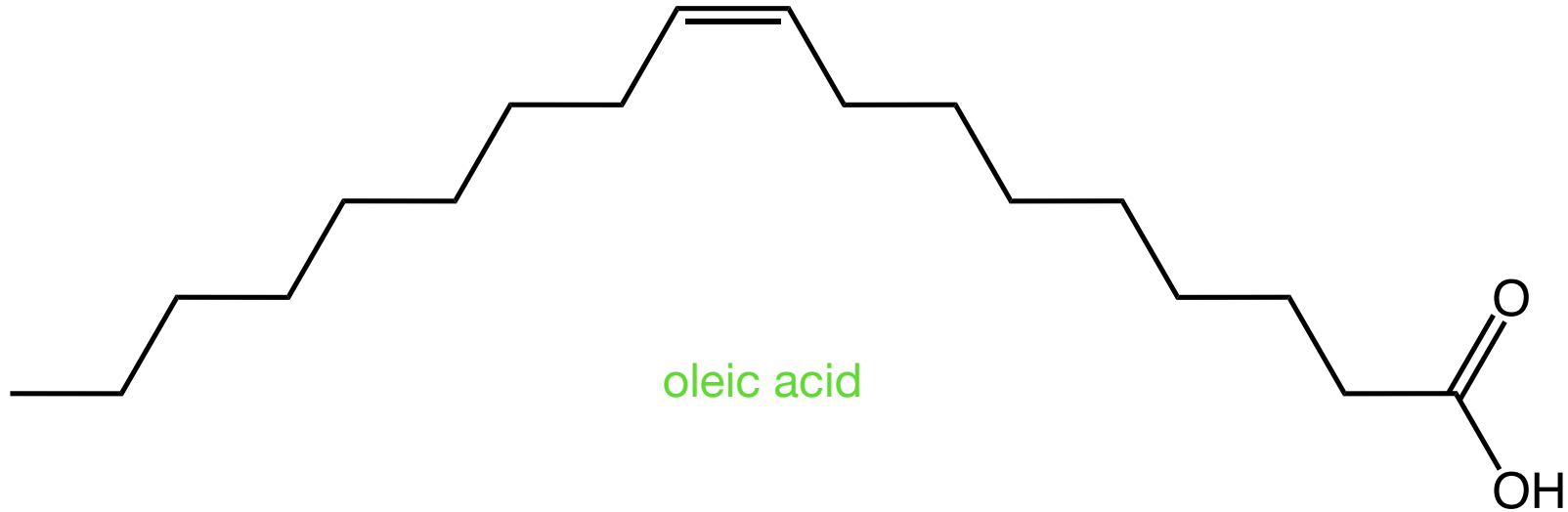
sticks out away from the nuclei



degree of unsaturation each pair of "missing" H's represents 1 degree of unsaturation

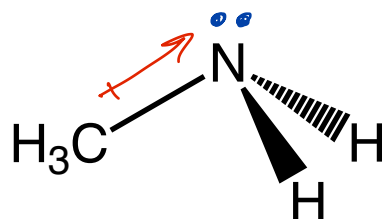


palmitic acid

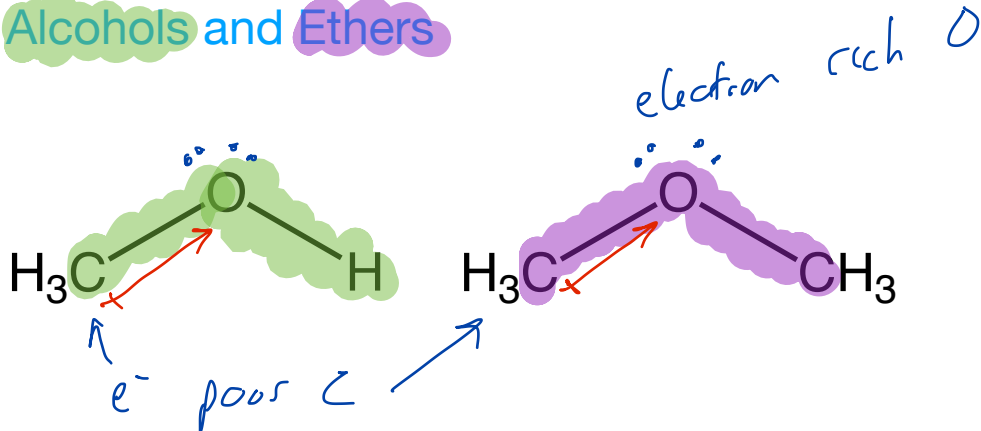


oleic acid

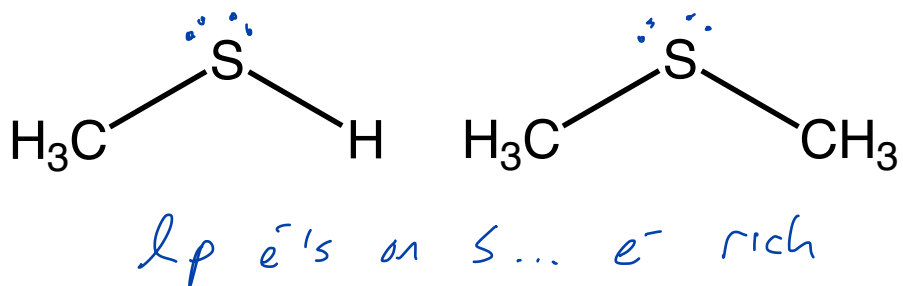
Amines



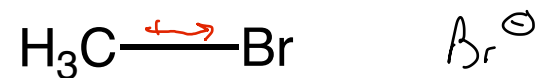
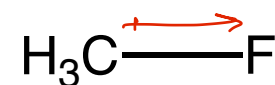
Alcohols and Ethers



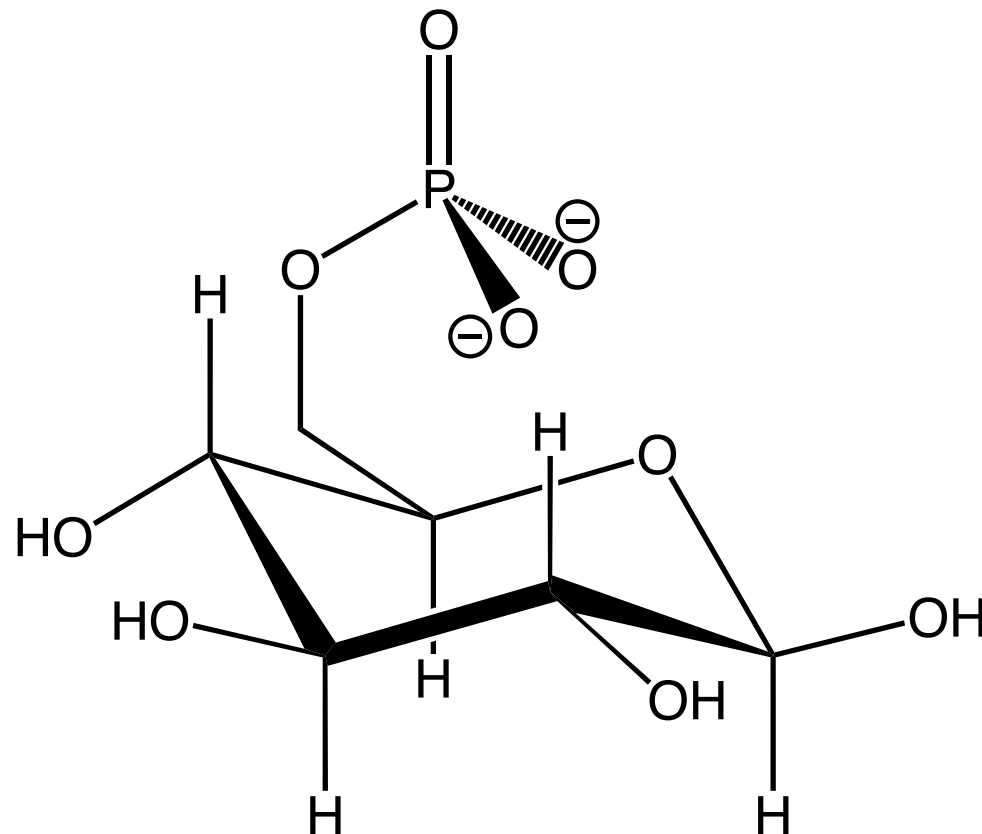
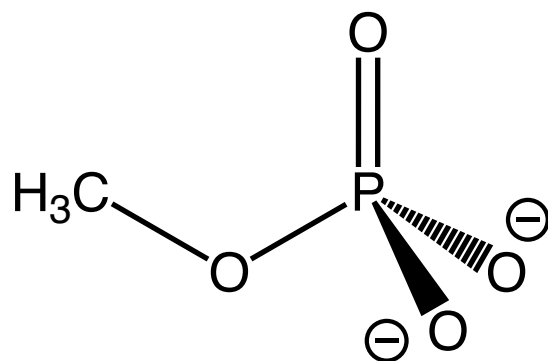
Thiols and Thioethers

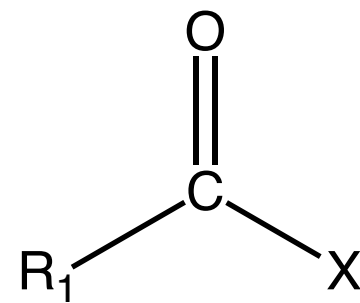
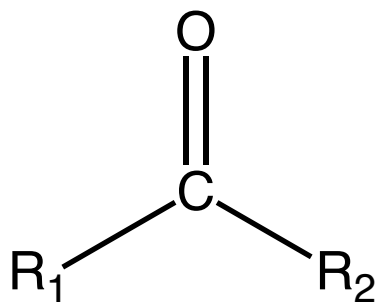


Alkyl Halides



Organophosphates





(18) Today

Section 3.1
Functional Groups

Section 3.2
Alkanes and Isomers

Section 3.3
Alkyl Groups

Section 3.4
Nomenclature

(20) Second Class from Today

Chap 4 Cycloalkanes

Next Class (19)

Section 3.4
Nomenclature

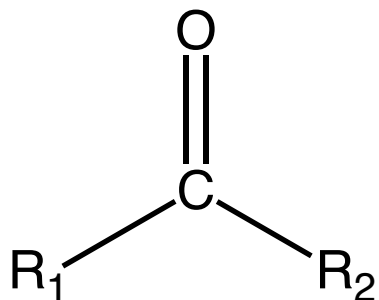
Section 3.5 - 3.7 Properties and
Conformations of Alkanes

Chap 4 Cycloalkanes

Third Class from Today (21)

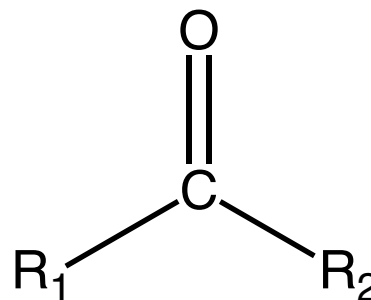
Chap 4 Cycloalkanes

Ketones



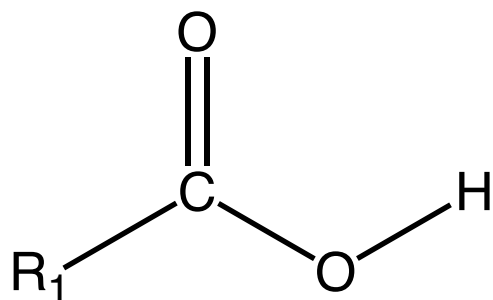
R_1 or $R_2 \neq H$

Aldehydes

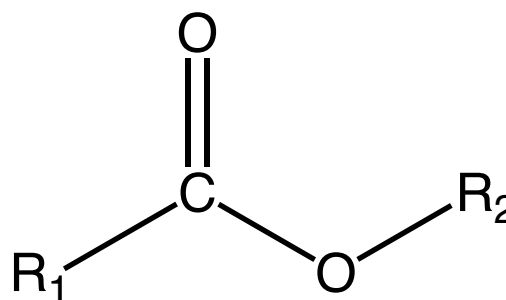


R_1 or $R_2 = H$

Carboxylic Acids and Esters

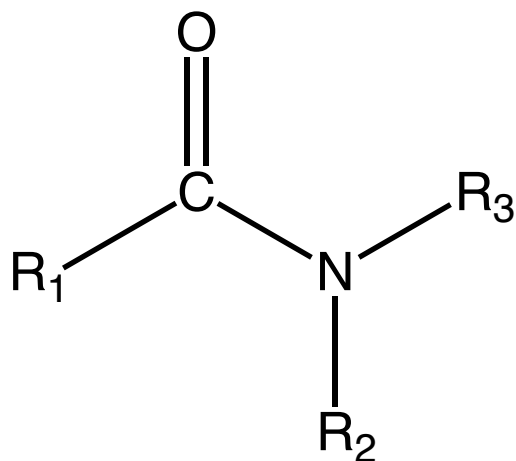


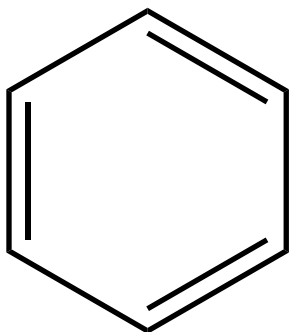
$R_1 = \text{H}$ or $R_1 \neq \text{H}$



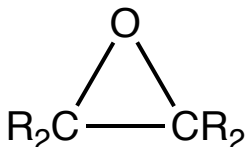
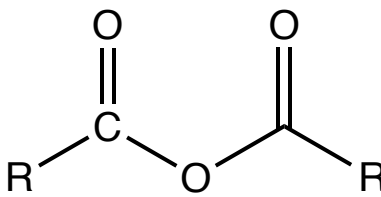
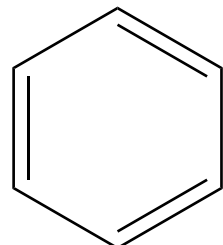
$R_1 = \text{H}$ or $R_1 \neq \text{H}$ but $R_2 \neq \text{H}$

Amides





Grouped to highlight which ones have similar reactivities

$\text{R}_2\text{C}=\text{CR}_2$ <p>alkenes</p> $\text{R}-\text{C}\equiv\text{C}-\text{R}$ <p>alkynes</p>	$\text{R}_3\text{C}-\text{X}$ <p>X = Cl, Br, I Alkyl Halides</p> $\text{R}_3\text{C}-\text{OH}$ <p>alcohols</p> $\text{R}_3\text{C}-\text{O}-\text{CR}_3$ <p>ethers</p>  <p>epoxides</p> <p>and more...</p>	$\begin{array}{c} \text{O} \\ \\ \text{R}-\text{C}-\text{R}' \end{array}$ <p>ketones (R, R' ≠ H) and aldehydes (R or R' = H)</p> $\text{RC}(=\text{O})\text{NR}_2$ <p>amides</p> $\text{RC}(=\text{O})\text{OR}$ <p>esters (R ≠ H)</p> $\text{RC}(=\text{O})\text{OH}$ <p>carboxylic acids</p>  <p>anhydrides</p> $\text{RC}(=\text{O})\text{Cl}$ <p>acid chlorides</p>	 <p>aromatics</p> <p>and more...</p>
--	---	--	---

Nomenclature of Alkanes

Early names were based on the number of C atoms in the alkane, and the names came from a variety of places — and we're “stuck” with them for the first four

CH_3OH **methanol** the name is derived from a word coined by French chemists, Jean-Baptiste Dumas and Eugene Peligot, from “**methy**” (Greek for alcoholic liquid)” + $\text{h\tilde{y}l\tilde{e}}$ (Greek for “forest, wood, timber, material”)²

$\text{CH}_3\text{CH}_2\text{OH}$ “**eth**” to distinguish it from méthylène derived from French and German chemists “äthyl” in German³

$\text{CH}_3\text{CH}_2\text{CO}_2\text{H}$ based on observation that it was the first (shortest chained) carboxylic acid that behaved like a fatty acid

pro (from protos for first) + **pion** (from pion for fat) => **propionic acid**⁴

$\text{CH}_3\text{CH}_2\text{CH}_2\text{CO}_2\text{H}$ isolated from butter => **butyric acid**⁵

² <https://en.wikipedia.org/wiki/Methanol#History>

³ <https://chemistry.stackexchange.com/questions/142839/why-is-ethane-in-methane>, <https://gallica.bnf.fr/ark:/12148/bpt6k6569005x/f15.item>

⁴ https://en.wikipedia.org/wiki/Propionic_acid

⁵ https://en.wikipedia.org/wiki/Butyric_acid

Nomenclature of Alkanes: Original Scheme based names on number of C atoms present

Sections 3.2 – 3.4

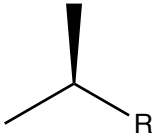
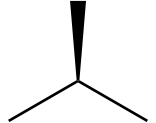
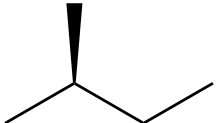
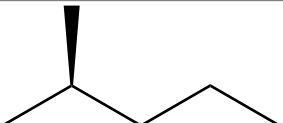
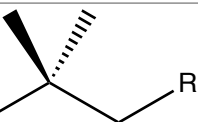
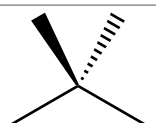
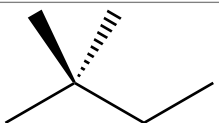
methane	CH_4
ethane	C_2H_6
propane	C_3H_8
butane	C_4H_{10}
pentane	C_5H_{12}
hexane	C_6H_{14}
heptane	C_7H_{16}
octane	C_8H_{18}
nonane	C_9H_{20}
decane	$\text{C}_{10}\text{H}_{22}$
undecane	$\text{C}_{11}\text{H}_{24}$
dodecane	$\text{C}_{12}\text{H}_{26}$

Nomenclature of Alkanes: Original Scheme based names on number of C atoms present

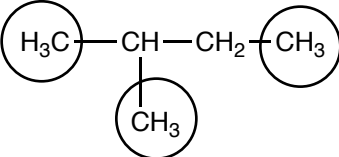
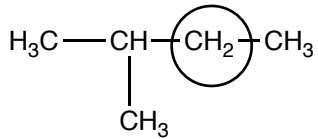
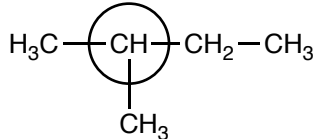
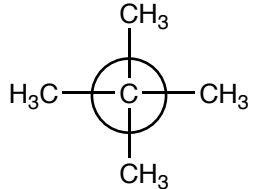
Sections 3.2 – 3.4

methane	CH ₄	1 isomer
ethane	C ₂ H ₆	1 isomer
propane	C ₃ H ₈	1 isomer
butane	C ₄ H ₁₀	2 isomers
pentane	C ₅ H ₁₂	3 isomers
hexane	C ₆ H ₁₄	5 isomers
heptane	C ₇ H ₁₆	...
octane	C ₈ H ₁₈	
nonane	C ₉ H ₂₀	
decane	C ₁₀ H ₂₂	
undecane	C ₁₁ H ₂₄	
dodecane	C ₁₂ H ₂₆	

But before getting into the systematic nomenclature of Substituted Alkanes: non-IUPAC names based on total number of C atoms present

iso-		
isobutane	R = CH ₃ (4 C's)	
isopentane	R = CH ₂ CH ₃ (5 C's)	
isohexane	R = CH ₂ CH ₂ CH ₃ (6 C's)	
neo-		
neopentane	R = H (5 C's)	
neohexane	R = CH ₃ (6 C's)	

Degree of Substitution

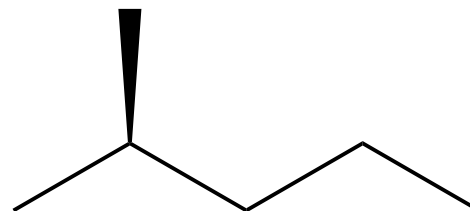
1° primary (<i>n</i> -)	
2° secondary (<i>sec</i> -, <i>s</i> -)	
3° tertiary (<i>tert</i> -, <i>t</i> -)	
4° quaternary	

Each of these molecules could be used as an adjective to describe a group; for example, the top one where the R is not defined we could say that the defined parts are an isopropyl group. It's three carbons (propane) in the shape of the iso group.

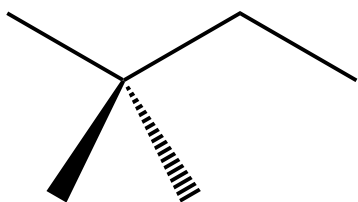
Nonsystematic Nomenclature becomes problematic quickly....



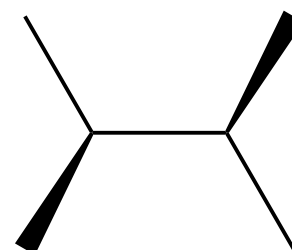
hexane



isohexane



neohexane



?ohexane

Systematic names are built up following rules

position#-**stuff hanging off longest chain**longest chain of C atoms**functional group ending**

Nomenclature of Alkanes: IUPAC Names based on the number of C's in the longest continuous chain of C atoms

Determine longest continuous chain.

- This is the **parent hydrocarbon**
- If compound has two or more chains of the same length, parent hydrocarbon is chain with greatest number of substituents

List the name of substituent(s) before the name of the parent hydrocarbon along with the number of the carbon to which it is attached--Substituents are listed in alphabetical order – neglecting prefixes such as di- tri- tert- etc.

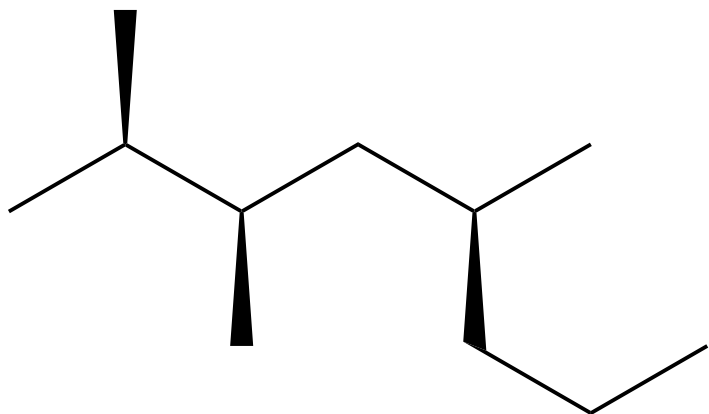
- Find and list all of the substituents
- Names of alkyl substituents are based on the length of the substituent.
- Names for branched substituent such as *sec*-butyl and *tert*-butyl are acceptable, but systematic substituent names are preferable.
 - The numbering system for a branched substituent begins with the carbon attached to the parent hydrocarbon
 - This number together with the substituent name is placed inside parentheses
- Number the substituents
 - in the direction that gives the lower number for the lowest-numbered substituent. (Lowest possible number for all substituents on the parent chain)
 - When both directions yield the same lower number for the lowest numbered substituent, select the direction that yields the lower number for the next lowest numbered substituent
 - If same substituent numbers are obtained in either direction, number in the direction giving lowest number to the first (alphabetically) named substituent

Form of name: #-followed by substituent name followed by parent hydrocarbon name

position#-**stuff hanging off longest chain**longest chain of C atoms**functional group ending)**

Nomenclature of Alkanes

position#-**stuff hanging off longest chain**longest chain of C atoms**functional group ending**)



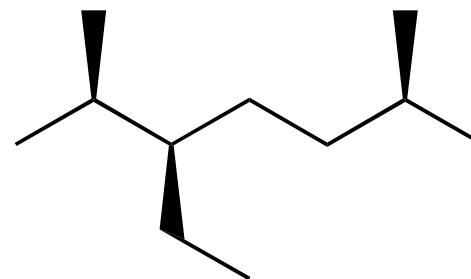
Nomenclature of Alkanes

position#-**stuff hanging off longest chain**longest chain of C atoms**functional group ending**

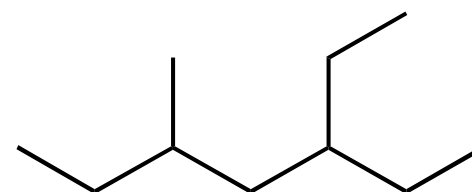
Nomenclature of Alkanes, Ethers, and Alkyl Halides

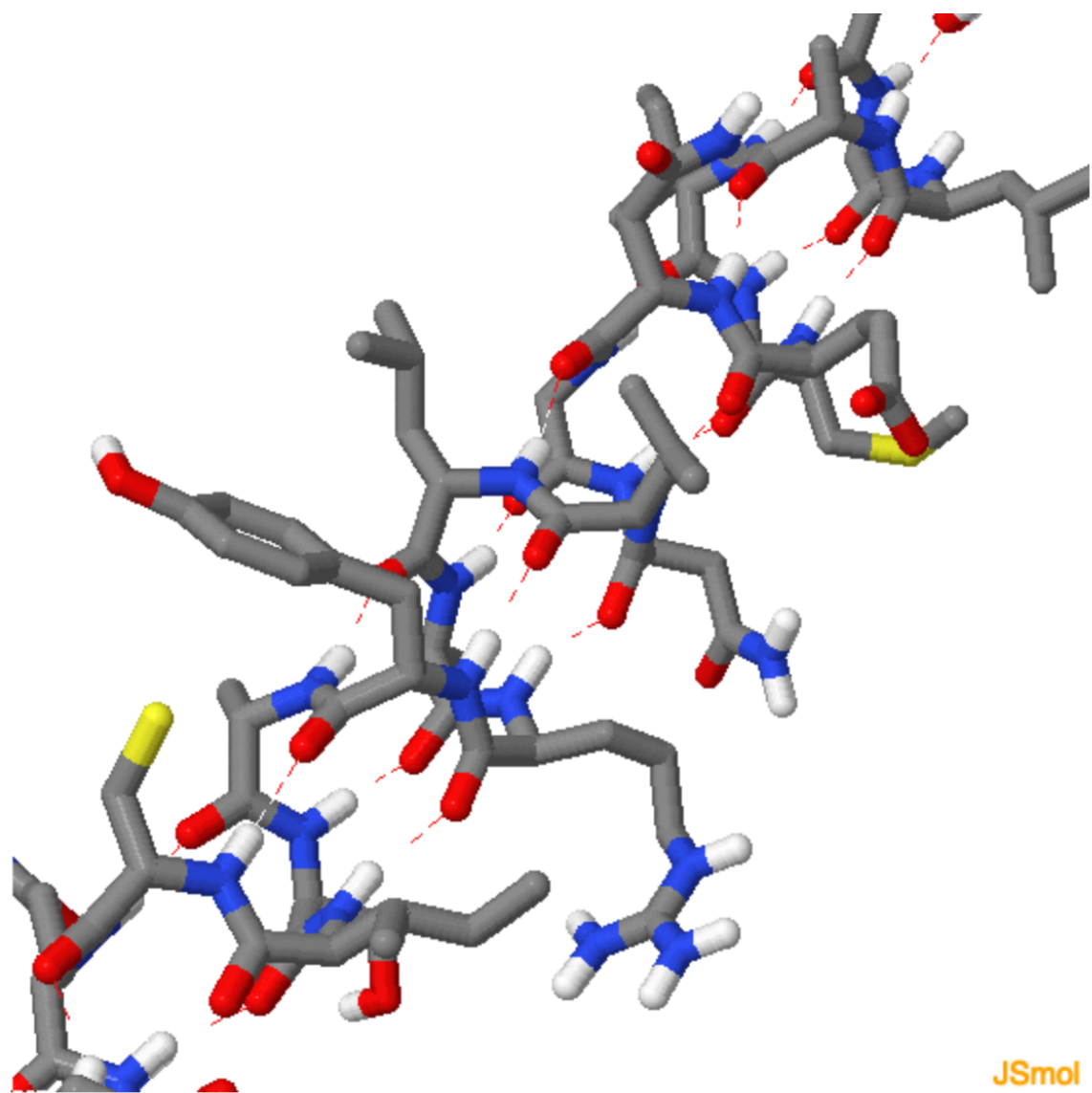
position#-**stuff hanging off longest chain**longest chain of C atoms**functional group ending**

Nomenclature of Alkanes, Ethers, and Alkyl Halides



Nomenclature of Alkanes, Ethers, and Alkyl Halides





JSmol