(15) **Today**

Section 3.1 Functional Groups

Section 3.2: Alkanes and Isomers

Next Class (16)

Section 3.4: Nomenclature

Section 3.5 - 3.7: Properties and Conformations of Alkanes

Chap 4 Cycloalkanes
Section 4.1 Naming Cycloalkanes and Halogen Substituents

(17) **Second Class from Today**

Chap 4 Cycloalkanes
Section 4.1 Naming Cycloalkanes and Halogen Substituents

Section 4.2 cis-trans isomerism Chap 4 Cycloalkanes

Sections 4.3 – 4.8 Stability of Cycloalkanes and Conformations of Cyclohexanes

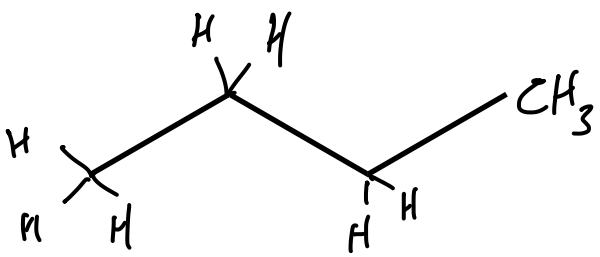
Third Class from Today (18)

Sections 4.3 – 4.8 Stability of Cycloalkanes and Conformations of Cyclohexanes

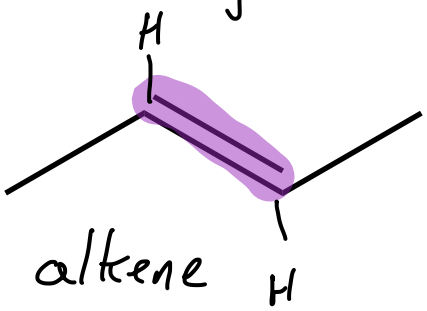
Chap 5

Office Hours moved from 12:20 to 1:20 to 3:00 to 4:00 for the foreseeable future

Rework Test 1 and hand in on Wednesday, October 15. Rework means that you should, on a separate piece of paper, write a more complete answer for any question that you did not received full credit for. I do NOT need the test back.

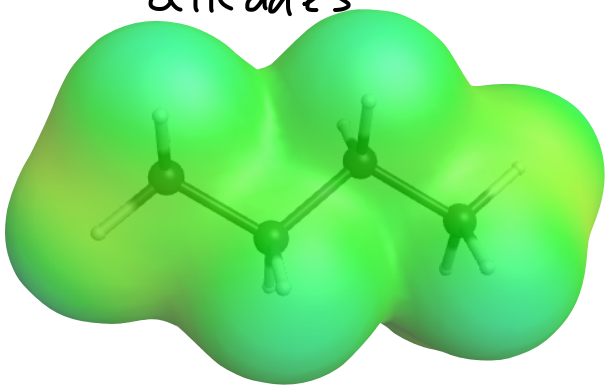


alkanes

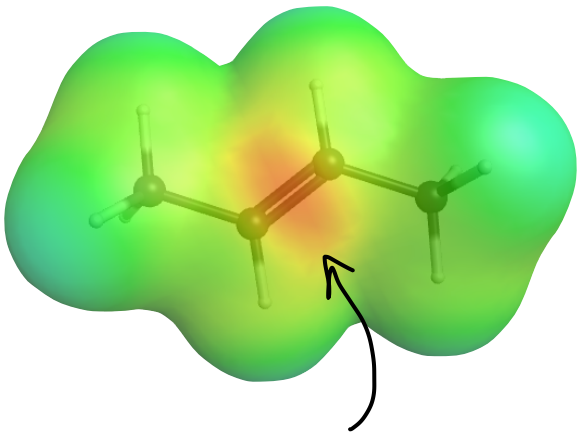


alkene

alkyne



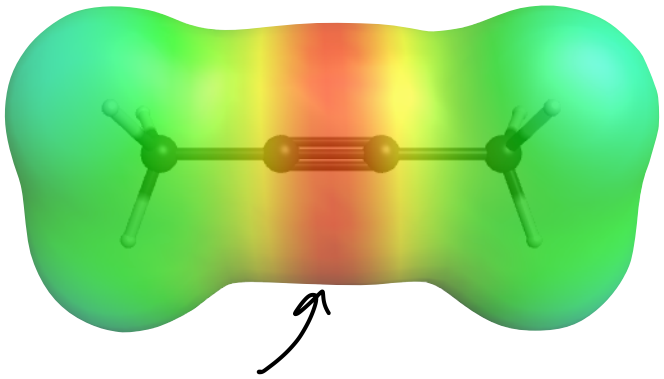
alkane



alkene

C=C creates a e⁻ rich region

δ⁻



even more e⁻ rich

Formulas?

saturated hydrocarbon

C_4H_{10}

C's bonded to as many H's as possible

unsaturated hydrocarbons

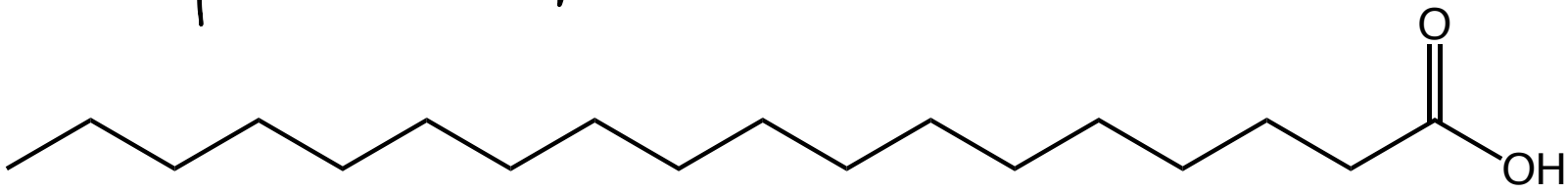
C_4H_8

"missing" 2 H's

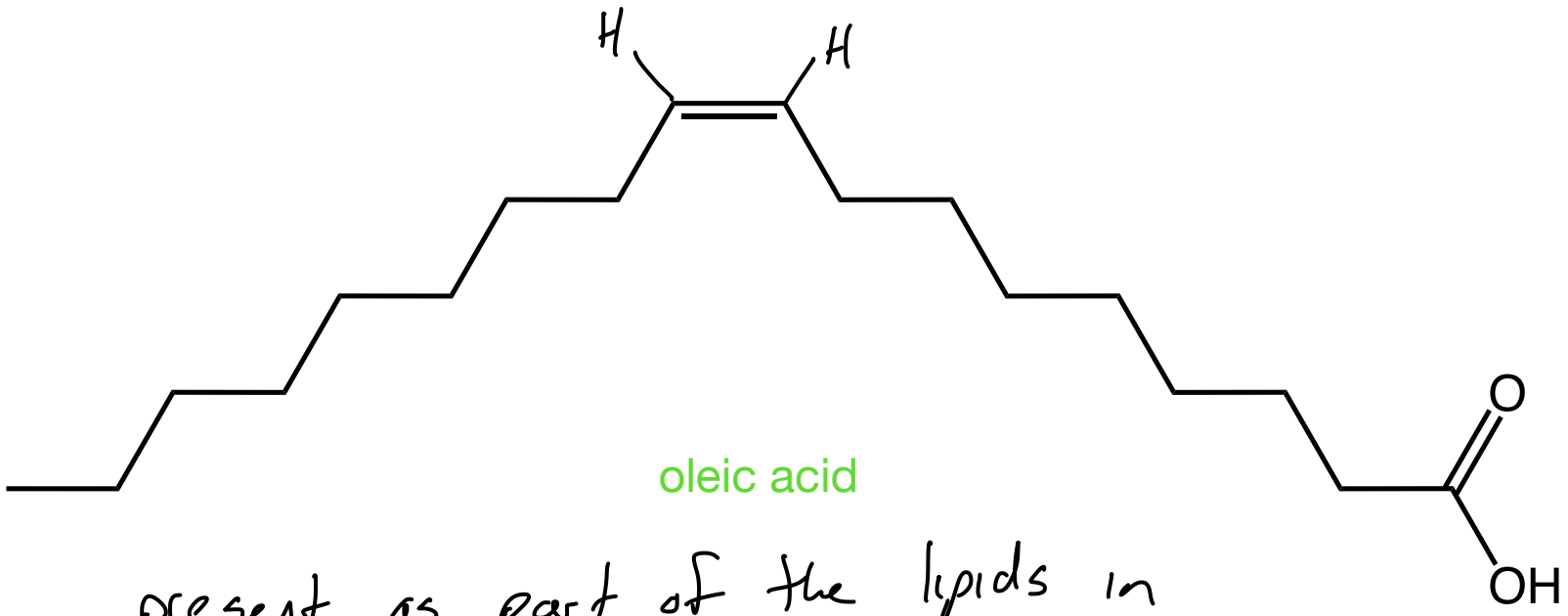
C_4H_6

"missing" 4 H's

present as part of the lipid in butter



palmitic acid



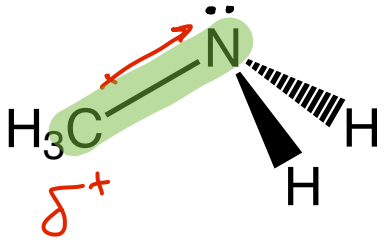
oleic acid

present as part of the lipids in olive oil

polar Functional groups

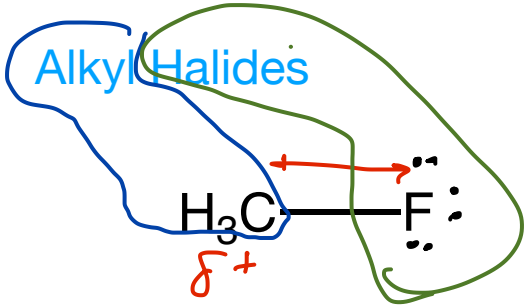
alkane

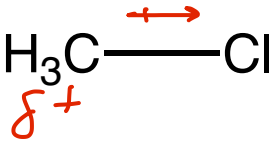
Amines



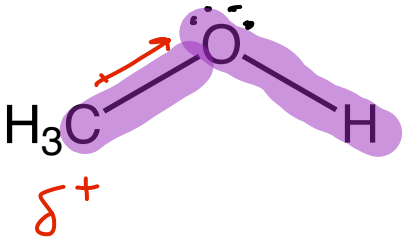
C atoms are δ+ which makes them attractive to ⊖ things

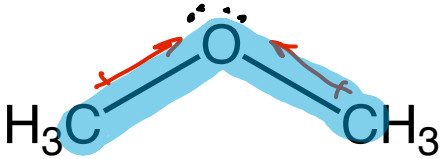
Alkyl Halides

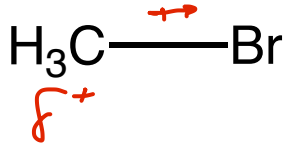




Alcohols and Ethers

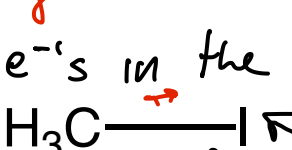






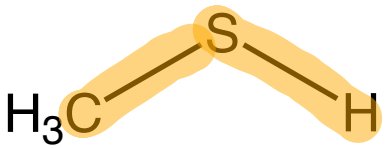
bring in a ⊖

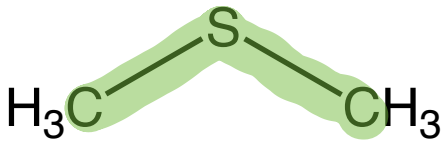
e⁻'s in the bond are pushed to here



Thiols and Thioethers

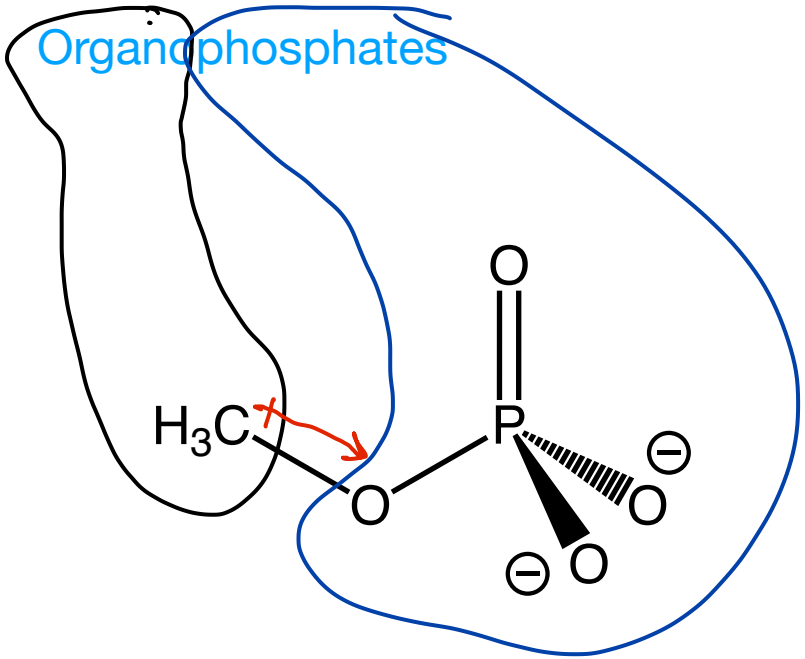
2.55 2.58

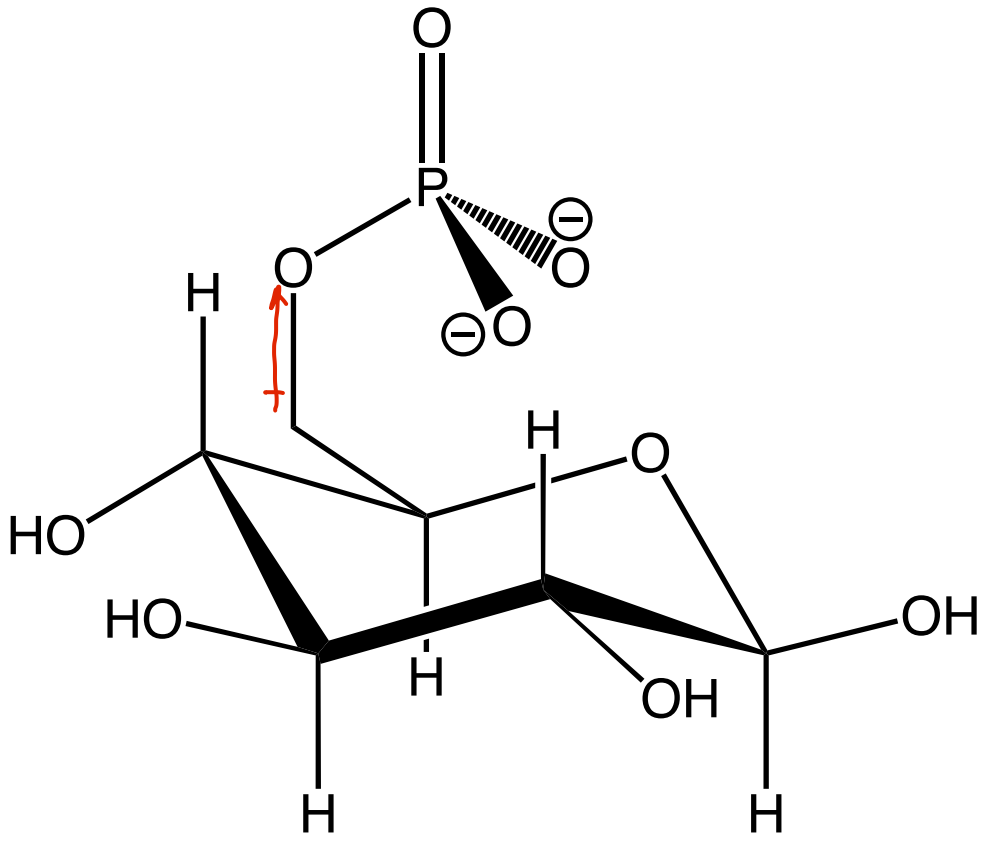




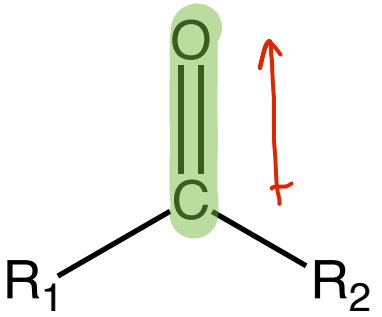
S, Br, I are polarizable

S, Br, & I are large atoms their valence e⁻'s are relatively far away from the nucleus, which means they are easy to push around.

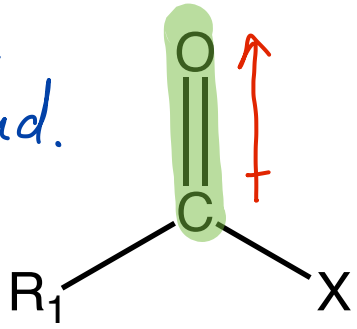




glucose-6-phosphate



all carbonyls have this very polar bond.
C=O C's are δ^+ and attractive ⊖

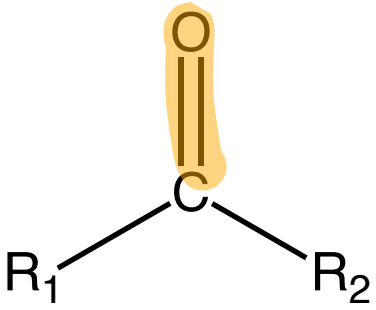


R is an organic variable
R is for H or C

R_1 = CH_3, CH_2CH_3, $CH_2CH_2CH_3$
R_2 = ...

X is a variable used for electronegative (or have lp e⁻'s)
X is typically O, N, Cl, Br, I (F), S

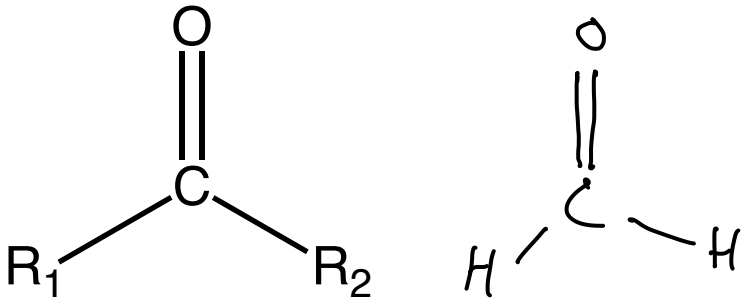
Ketones



R_1 or $R_2 \neq H$

carbonyl with C atoms on both sides

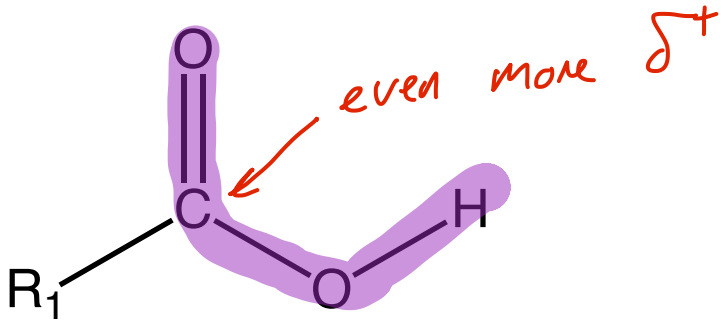
Aldehydes



R_1 or $R_2 = H$

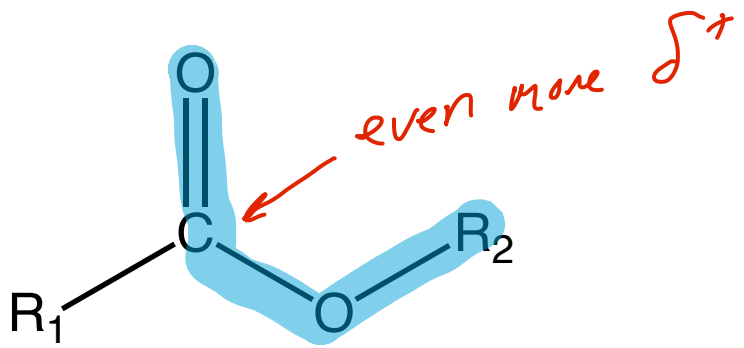
carbonyl with at least 1 H atom bonded to carbonyl C

Carboxylic Acids and Esters



alcohol + C=O on same C atom

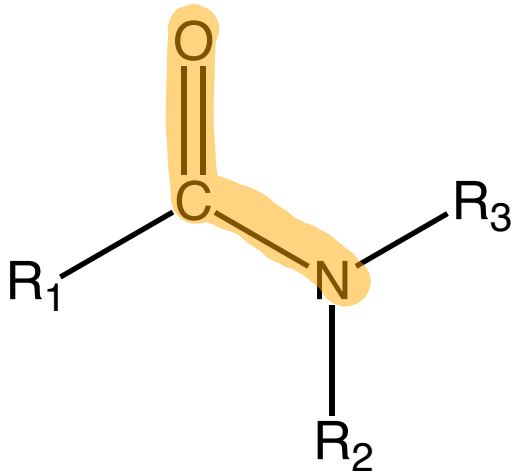
R_1 = H or $R_1 \neq$ H



ether + C=O on same C atom

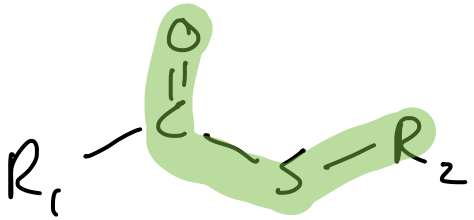
R_1 = H or $R_1 \neq$ H but $R_2 \neq$ H

Amides

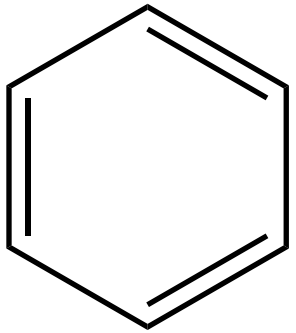


N bonded to C=O C atom

Thioester



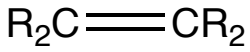
thioether bonded to the C atom of the carbonyl



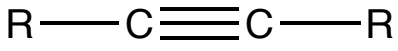
e⁻ rich

surprisingly unreactive

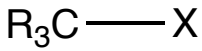
For the Fall semester we are not doing chemistry on this ring.



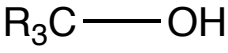
alkenes



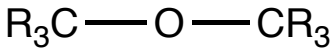
alkynes



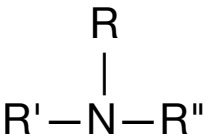
X = Cl, Br, I
Alkyl Halides



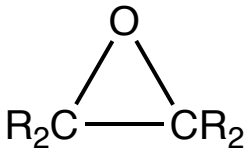
alcohols & thiols



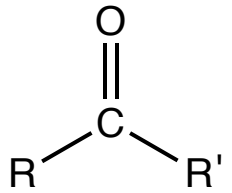
ethers & thioethers



at least one R = carbon
amines



epoxides



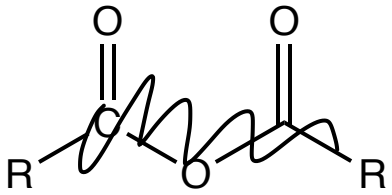
ketones (R, R'≠ H) and
aldehydes (R or R' = H)

$RC(=O)NR_2$
amides

$RC(=O)OR$
esters (R ≠ H)

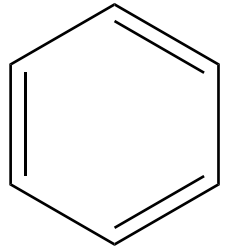
$RC(=O)SR$
thioesters (R ≠ H)

$RC(=O)OH$
carboxylic acids



anhydrides

acid chlorides



aromatics

and more…

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)" + hȳlē (Greek for "forest, wood, timber, material")[1]

CH_3CH_2OH "eth" to distinguish it from méthylène derived from French and German chemists "äthyl" in German[2]

$CH_3CH_2CO_2H$ 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[3]

$CH_3CH_2CH_2CO_2H$ isolated from butter => butyric acid[4]

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[1] https://en.wikipedia.org/wiki/Methanol#History

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

[3] https://en.wikipedia.org/wiki/Propionic_acid

[4] 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

1	methane	weak LDF	CH_4
2	ethane		C_2H_6
3	propane		C_3H_8
4	butane	stronger LDF	C_4H_{10} higher
	pentane		C_5H_{12}
	hexane		C_6H_{14}
	heptane		C_7H_{16}
	octane		C_8H_{18}
	nonane		C_9H_{20}
	decane		$C_{10}H_{22}$
	undecane		$C_{11}H_{24}$
	dodecane		$C_{12}H_{26}$

natural gas

Lower BP

propane tanks

metal

Bic lighters

higher BP

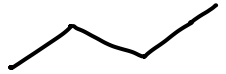
plastic

liquid at RT + 1 atm

Nomenclature of Alkanes: Original Scheme based names on number of C atoms present but nonsystematic nomenclature becomes problematic quickly….

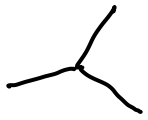
methane	CH_4	1 isomer
ethane	C_2H_6	1 isomer
propane	C_3H_8	1 isomer
butane	C_4H_{10}	2 isomers
pentane	C_5H_{12}	3 isomers
hexane	C_6H_{14}	5 isomers
heptane	C_7H_{16}	…
octane	C_8H_{18}	
nonane	C_9H_{20}	
decane	$C_{10}H_{22}$	
undecane	$C_{11}H_{24}$	
dodecane	$C_{12}H_{26}$	

butane



$CH_3CH_2CH_2CH_3$

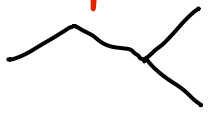
isobutane



$CH(CH_3)_3$

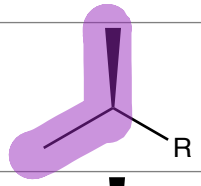
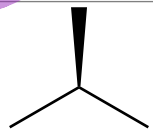
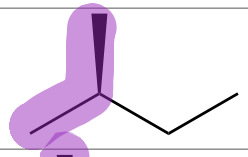
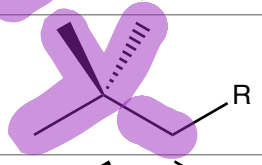
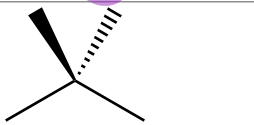
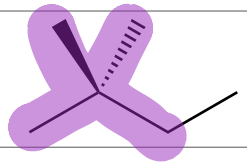
pentane

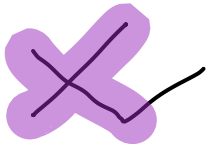
isopentane



neopentane

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

the "iso" group		
isobutane	R = CH_3 (4 C's)	
isopentane	R = CH_2CH_3 (5 C's)	
isohexane	R = $CH_2CH_2CH_3$ (6 C's)	
the "neo" group		
neopentane	R = H (5 C's)	
neohexane	R = CH_3 (6 C's)	

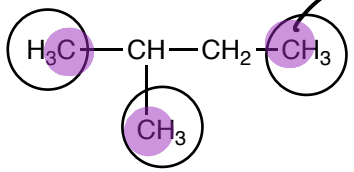


Each of these molecules could be used as an adjective to describe a group; for example, the top one where the R is not defined we could say that the defined parts are an isopropyl group. It's three carbons (propane) in the shape of the iso group.

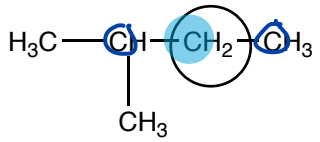
But before getting into the systematic nomenclature of Substituted Alkanes: non-IUPAC names based on total number of C atoms present and position of functional group

Degree of Substitution

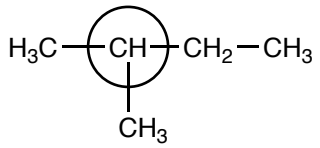
1° primary (*n*-)



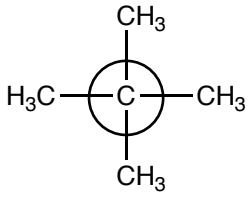
2° secondary (*sec*-, *s*-)



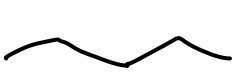
3° tertiary (*tert*-, *t*-)



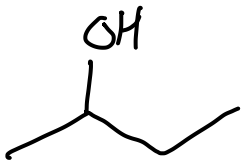
4° quaternary



this carbon is "primary" (1°) because it is directly bonded to 1 C atom

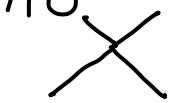
n-pentane  n-pentanol 

1°

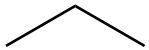
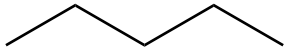
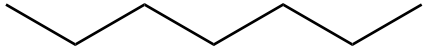
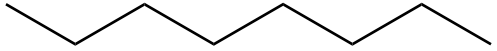
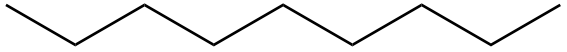
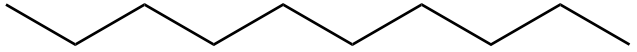
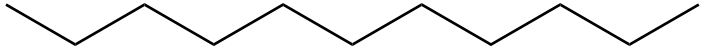
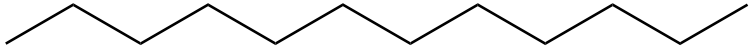


sec-butanol because OH on 2° C

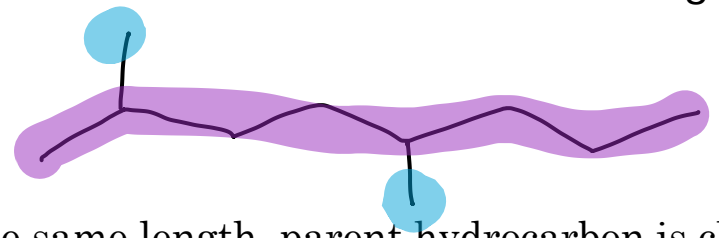
t-butanol tertiary alcohol with 4 C atoms



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

methane	CH_4	
ethane	CH_3CH_3	
propane	$CH_3CH_2CH_3$	
butane	$CH_3CH_2CH_2CH_3$	
pentane	$CH_3CH_2CH_2CH_2CH_3$	
hexane	$CH_3CH_2CH_2CH_2CH_2CH_3$	
heptane	$CH_3CH_2CH_2CH_2CH_2CH_2CH_3$	
octane	$CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_3$	
nonane	$CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_3$	
decane	$CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_3$	
undecane	$CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_3$	
dodecane	$CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_3$	

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 chainlongest chain of C atomsfunctional group ending**