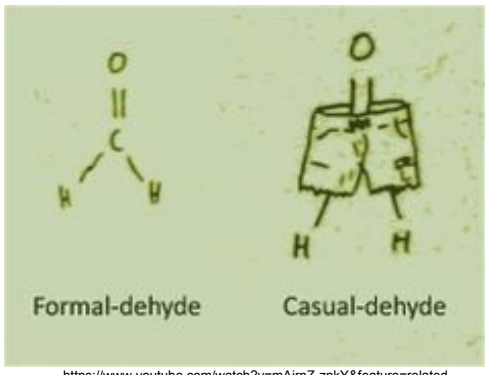
Naming Organic Molecules



https://www.youtube.com/watch?v=mAjrnZ-znkY&feature=related

Three Categories:

1. Naming Hydrocarbons

2. Cyclic Hydrocarbons

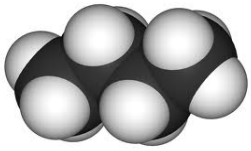
3. Functional Groups

Hydrocarbons are the simplest of all organic compounds and contain ONLY carbon and hydrogen

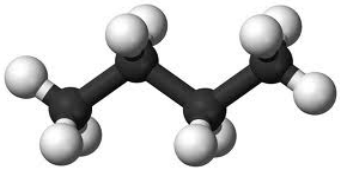
Types of Hydrocarbons

1. Alkanes: hydrocarbons with only single bonds between atoms

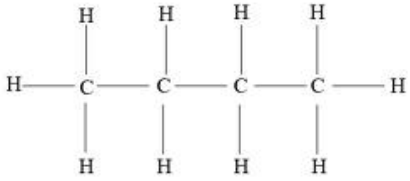
ex) Butane $C_4 H_{10}$



space filling model



ball and stick model



structural formula

$CH_3—CH_2-CH_2-CH_3$

$CH_3CH_2CH_2CH_3$

chemical formula

Given the number of C atoms in an alkane, you can determine the molecular formula by utilizing the following relationship

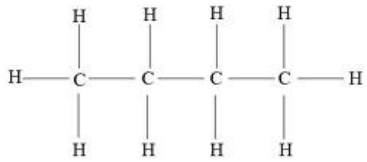
$C_n H_{2n+2}$

Thus, a 13-carbon alkane has a molecular formula of:

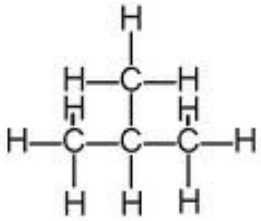
Isomers are molecules that have the same molecular formula but different structural formulas

Branched Alkanes

ex) Butane $C_4 H_{10}$



ex) Iso-Butane (aka Methyl-propane) $C_4 H_{10}$



Isomers differ in physical properties that can be determined experimentally.

Naming Alkanes

1. Straight Chained Alkanes

- prefix to denote the number of carbon atoms + ending "ane"

ex) $C_3 H_8$ = propane

Number of 'C' atoms	Word root	IUPAC name	Structure	Molecular formula
1	Meth	Methane	CH_4	CH_4
2	Eth	Ethane	$CH_3—CH_3$	C_2H_6
3	Prop	Propane	$CH_3—CH_2—CH_3$	C_3H_8
4	But	Butane	$CH_3—(CH_2)_2—CH_3$	C_4H_{10}
5	Pent	Pentane	$CH_3—(CH_2)_3—CH_3$	C_5H_{12}
6	Hex	Hexane	$CH_3—(CH_2)_4—CH_3$	C_6H_{14}
7	Hept	Heptane	$CH_3—(CH_2)_5—CH_3$	C_7H_{16}
8	Oct	Octane	$CH_3—(CH_2)_6—CH_3$	C_8H_{18}
9	Non	Nonane	$CH_3—(CH_2)_7—CH_3$	C_9H_{20}
10	Dec	Decane	$CH_3—(CH_2)_8—CH_3$	$C_{10}H_{22}$

Naming Alkanes

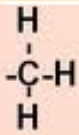
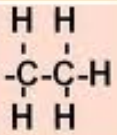
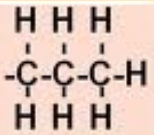
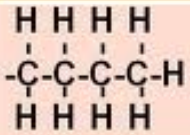
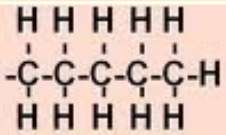
Branched-Chain Alkanes

- Parent Chain: Longest continuous chain of atoms
- Substituent Groups: All side branches

Steps:

1. Count and label the number of atoms in the parent chain
   - use this to determine parent chain name

2. Name each Alkyl substiuent group
   - name using the same prefixes as the parent chain, but the ending becomes -yl instead of -ane

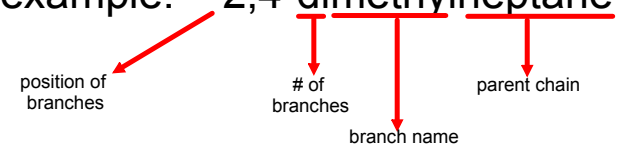
-methyl	-ethyl	-prophyl	-butyl	-pentyl
				

3. If the Alkyl group occurs more than once as a branch on the parent structure, use a prefix (di, tri, tetra, etc) before its name to indicate how many times it appears

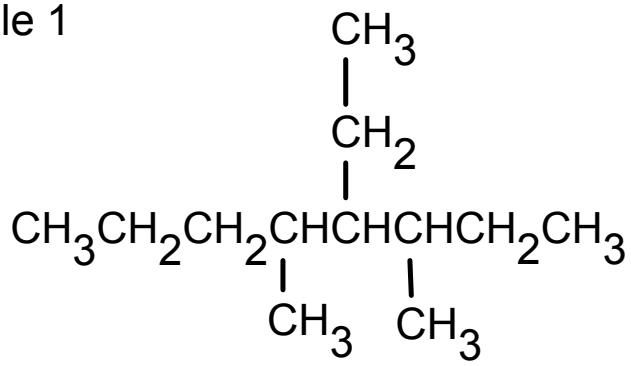
4. Whenever different Alkyl groups are attached to the same parent structure, place their names in *alphabetical order* (do not consider prefixes)

5. Write the entire name using hyphens to separate numbers from words and commas to separate numbers

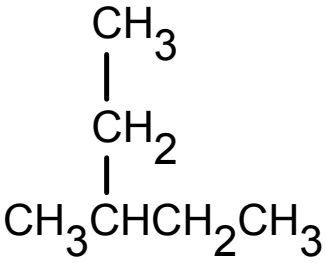
For example: 2,4-dimethylheptane



Example 1



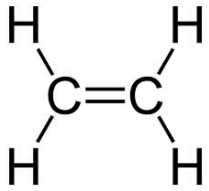
Example 2



Hydrocarbons are said to be SATURATED if it contains only single bonded. An UNSATURATED hydrocarbon has at least 1 double and/or triple bonds

2. Alkenes: hydrocarbons that contain 1 or more double bonds

ex: ethene



Given the number of C atoms in an alkene, you can determine the molecular formula by utilizing the following relationship

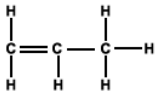
$C_n H_{2n}$

Thus, a 9-carbon alkene has a molecular formula of:

Naming to specify the location of the double bond in an ALKENE

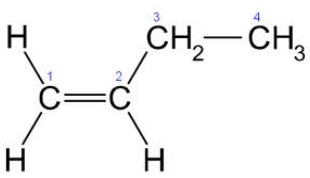
1. Use the same prefixes as when naming alkanes. However, ending now becomes "ene" not "ane"

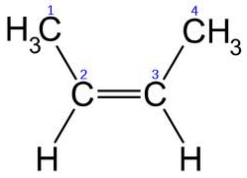
ex: Propene



When there are more than 3 carbon atoms, we must specify where the double bond is in the molecule.

ex) 1-Butene vs. 2-Butene





**1-Butene and 2-Butene are 2 different substances with their own properties.

***Numbering of the parent chain is determined by the location of the double bond(s)

Branched Alkenes:

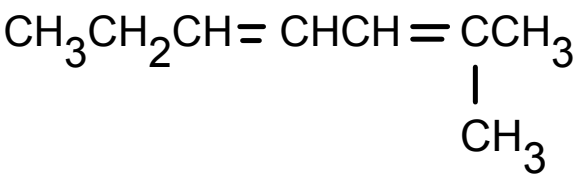
1. the parent chain is always the longest chain the contains a double bond

2. the positions of the double bond determines how the chain is numbered (not the branches) - give the carbons with the double bond(s) the lowest numbers possible

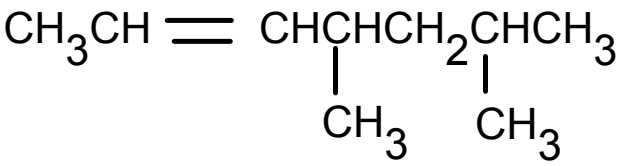
3. The number of double bonds is denoted by prefixes (di, tri,tetra, etc) before the suffix "ene"

4. Otherwise follow the same naming rules as alkanes

Example 1



Example 2



3. Alkynes: unsaturated hydrocarbons that contain 1 or more triple bonds

ex: ethyne (aka Acetylene)

Given the number of C atoms in an alkyne, you can determine the molecular formula by utilizing the following relationship

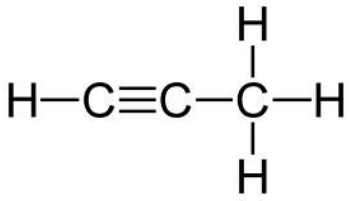
$C_n H_{2n-2}$

Thus, a 5-carbon alkene has a molecular formula of:

Naming an Alkyne is similar to naming an alkene

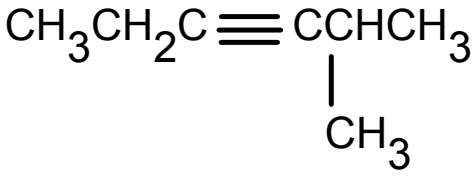
1. Use the same strategies as when naming alkenes. Only the suffix now becomes "yne" not "ene"

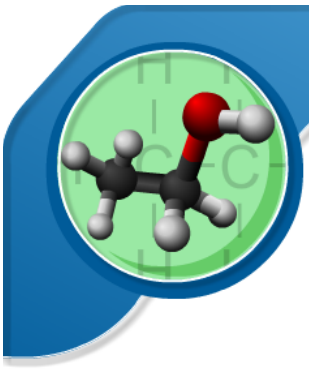
ex: Propyne



Example 1

Example 2



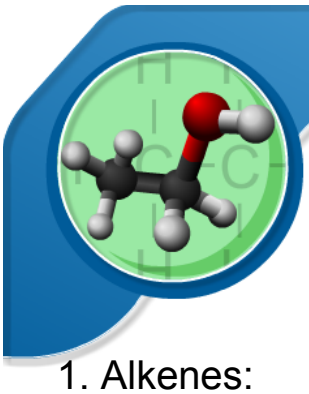


Properties of Hydrocarbons:

Hydrocarbons have predictable properties determined by number of atoms and type of bonds.

1. Alkanes:

- Boiling point and melting point increase with number of C atoms
- dissolve in nonpolar substances (as we know a C-H bond is nonpolar)
- have lower melting and boiling points than polar molecules
- low reactivity (due to nonpolar and strong C-C and C-H bonds)
- combust with oxygen (common fuel source)

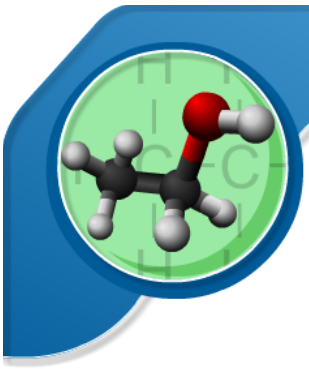


Properties of Hydrocarbons:

Hydrocarbons have predictable properties determined by number of atoms and type of bonds.

1. Alkenes:

- Boiling point and melting point increase with number of C atoms
- dissolve in nonpolar substances (as we know a C-H bond is nonpolar)
- Higher reactivity than alkanes due to double bonds, but still relatively unreactive
- are smelly (gives lemons/limes their scents)



Properties of Hydrocarbons:

Hydrocarbons have predictable properties determined by number of atoms and type of bonds.

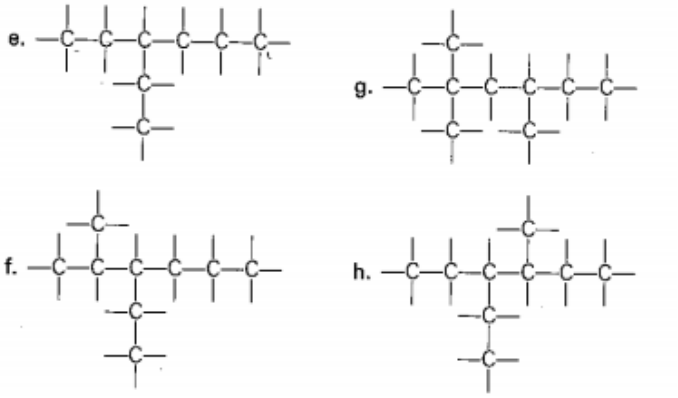
1. Alkynes:

- Boiling point and melting point increase with number of C atoms
- dissolve in nonpolar substances (as we know a C-H bond is nonpolar)
- Higher reactivity than alkenes due to triple bonds, but still relatively unreactive

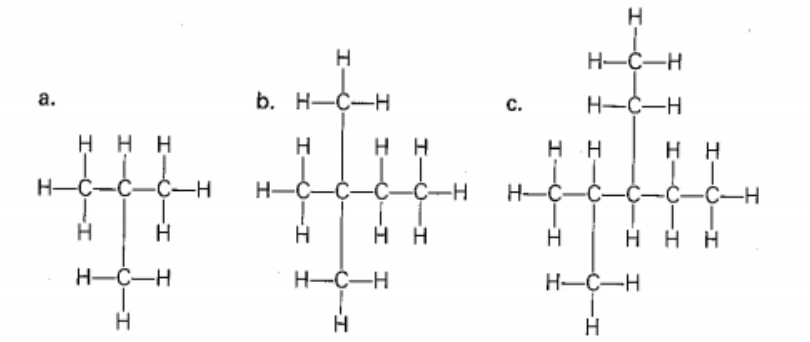
3.2 Assignment

1. Match each name in a-d below with the correct structure in e-h.

a. 3-ethyl-2-methylhexane
b. 3-ethyl-4-methylhexane
c. 2,2,4-trimethylhexane
d. 3-ethylhexane



2. Write the names of the following alkanes

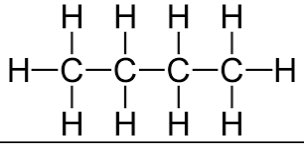


3. Distinguish between 1-butene and 2-butene by drawing their structural formulas.

4. Challenge! Which of the following would have the highest boiling point?
a. butane
b. ethene
c. butanol

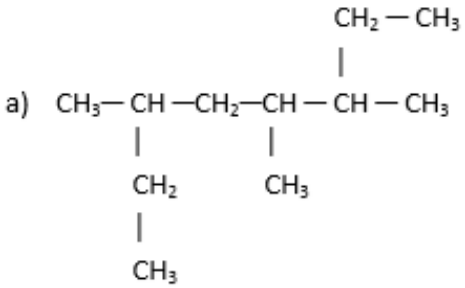
3.2 Assignment Cont...

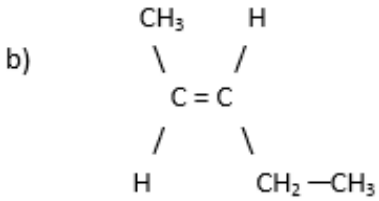
5. Complete the following table

IUPAC Name	Complete Structural Formula	Condensed Chemical Formula
butane		C_4H_{10}
2-methylhexane		
3-ethyl-2-methylnonane		
propene		
4-methyl-2-heptene		
ethyne		
5,6-dimethyl-2-octyne		

3.2 Assignment Cont...

6. Name the following hydrocarbons.

a) 

b) 

d) $CH \equiv C-CH_3$

e) $CH_3\text{-}CH_2\text{-}CH_2\text{-}CH{=}CH\text{-}CH_3$

f) $CH_2{=}CH\text{-}CH_2\text{-}CH{=}CH\text{-}CH_3$

g) $CH_3-CH_2\text{-}C \equiv C\text{-}CH_2\text{-}CH_3$