جامعة الأميرة نورة بنت عبدالرحمن
Princess Nourah Bint Abdulrahman University

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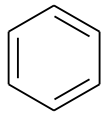
CHEM 141
Organic Chemistry

Organic compounds
Hydrocarbons

Aromatic compounds



Aliphatic compounds

Saturated
Has only Single bonds
(Alkane (-)

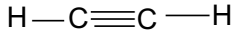
Open chain
$CH_3CH_2CH_3$

Cyclic

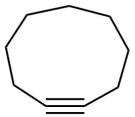
Unsaturated
Has double bonds or
triple bonds

Alkyne (≡)

Open chain



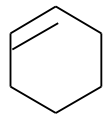
Cyclic



Alkene (=)

Open chain
$CH_3CH{=}CHCH_3$

Cyclic



Hybridization in the carbon atom and the shape of organic molecules

Hybridization :

The S orbital overlaps with p orbitals , forming four hybrid bonds of equal energy symbolized by the symbol sp^3.

Types Of hybridization :

There are three types of hybridization that a carbon atom behaves during a reaction:

sp , sp^2, sp^3.

Hybridization process :

Hybridization goes under tow step

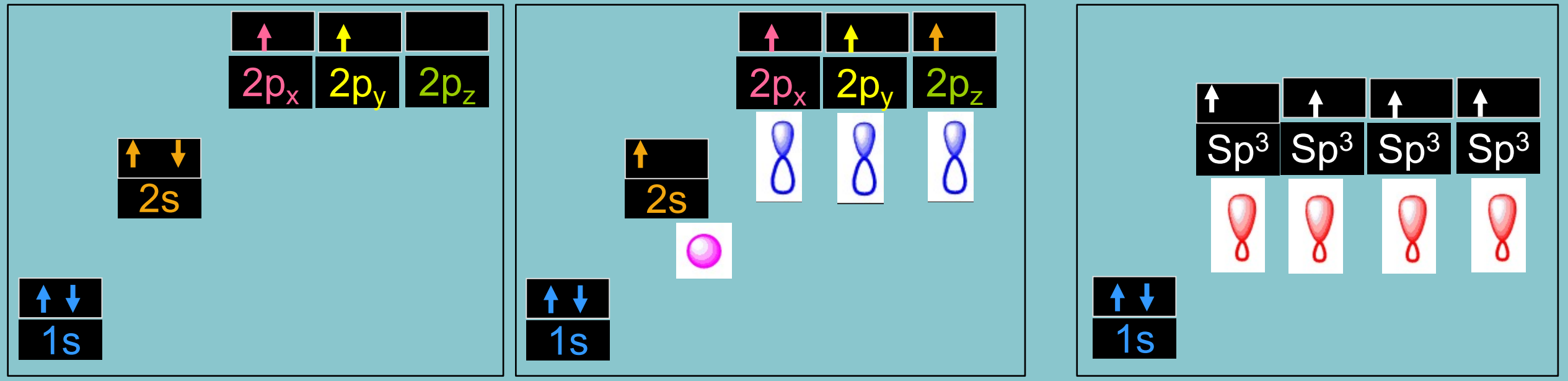
1- Excitation(Promote): Where the ground state of the C atom takes a certain amount of energy.

2- Hybridization: Where orbitals overlap.

Methane (CH_4):

$Sp^3 = S + P + P + P$

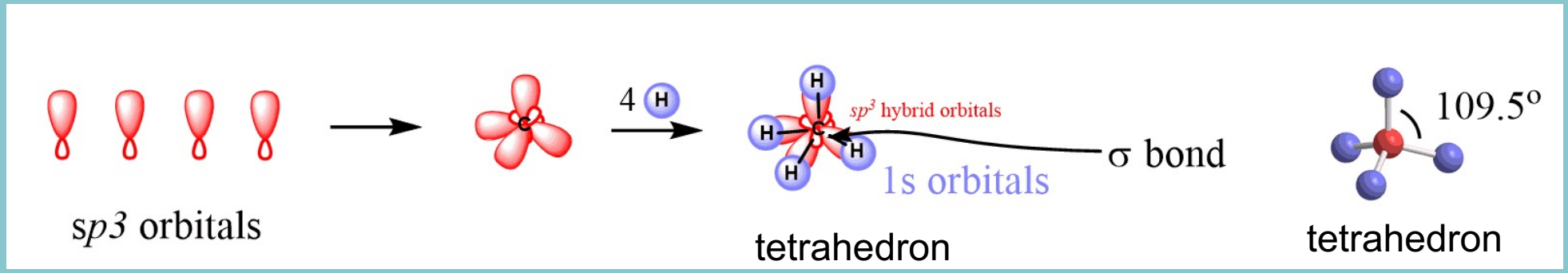
Ground state of C → **1- Excitation** → **2- Hybridization**

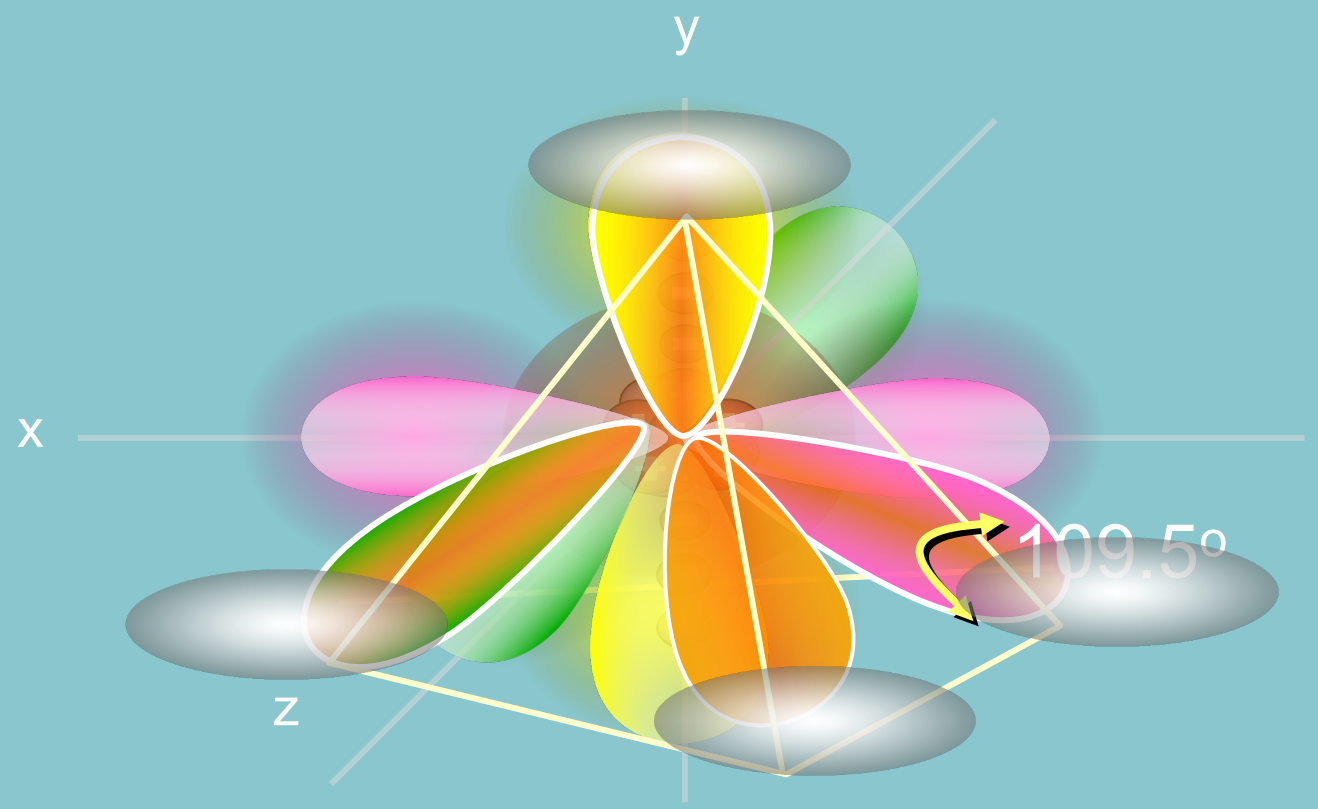


Promote

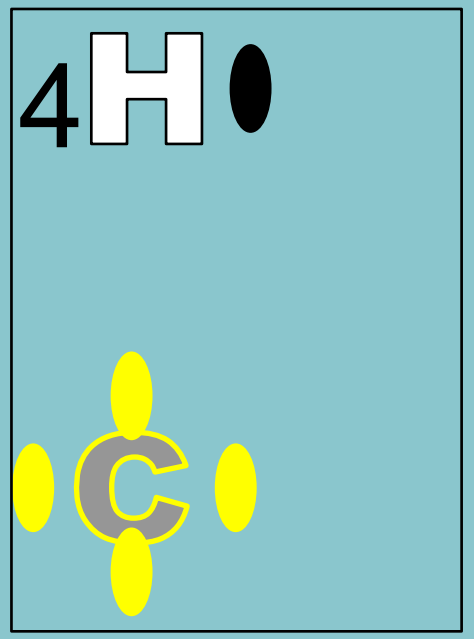
Hybridize

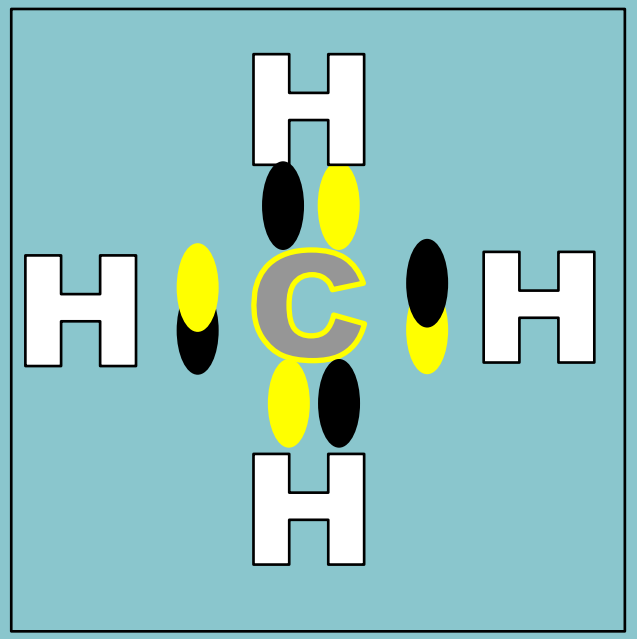
sp^3

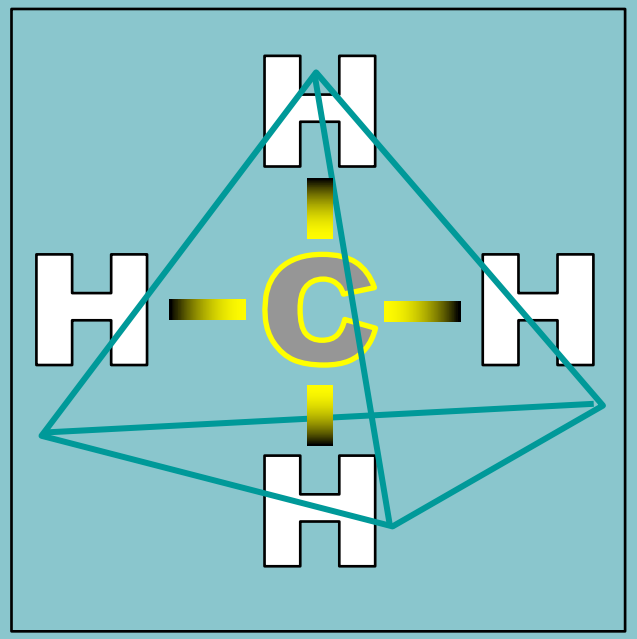

4 H
sp³ hybrid orbitals
σ bond
1s orbitals
109.5°
sp3 orbitals
tetrahedron
tetrahedron


y
x
z
109.5°

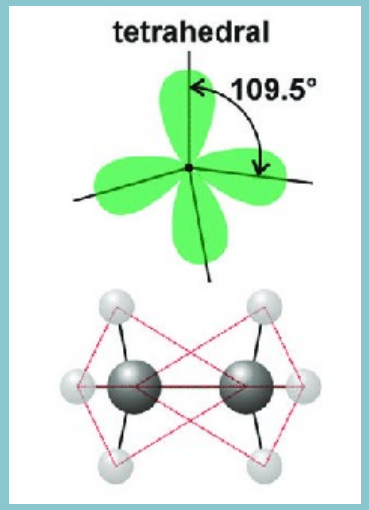
Methane(CH_4) building blocks



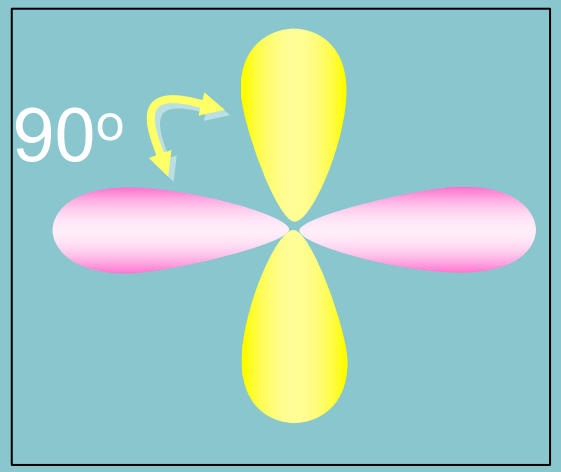


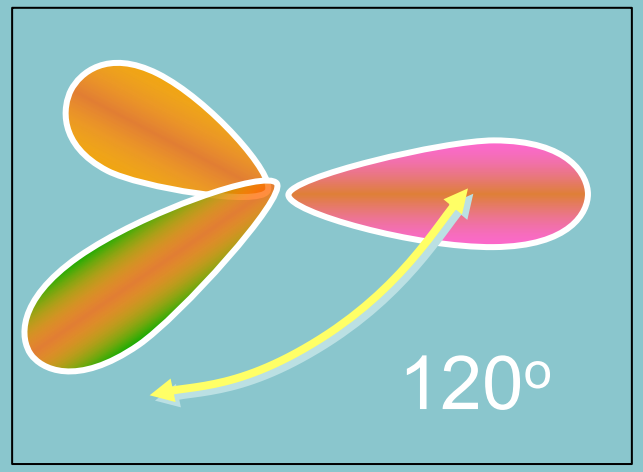


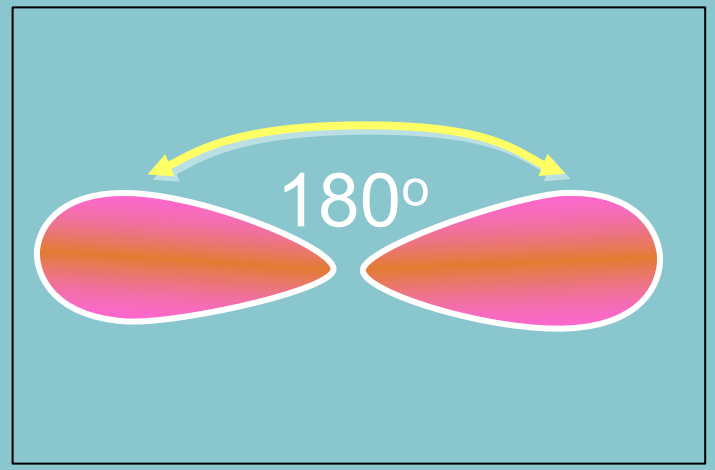
CH_3-CH_3

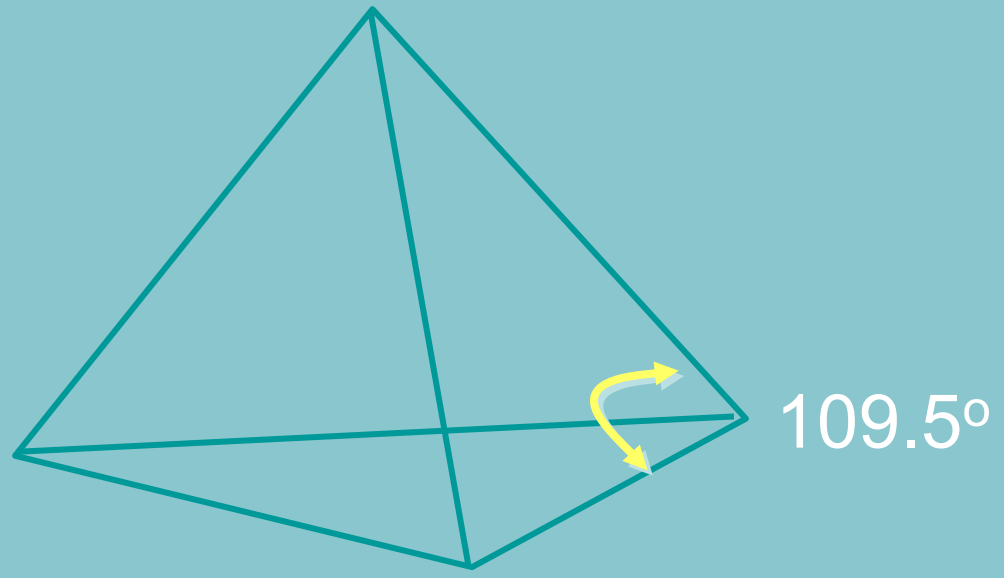


MATHEMATICS: Bond Angles





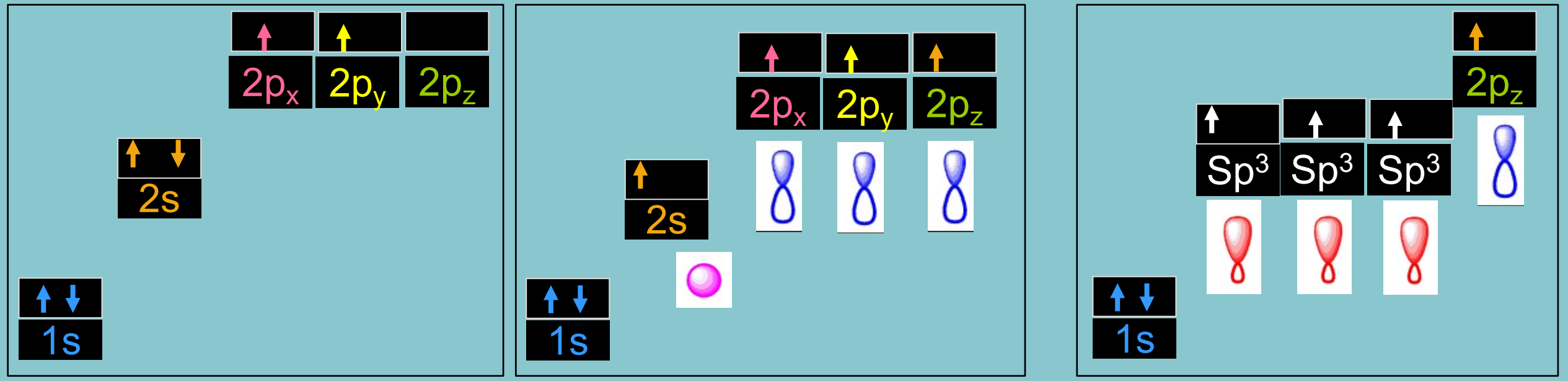




Ethene ($H_2C=CH_2$): (C=)

$Sp^2 = S + P + P$

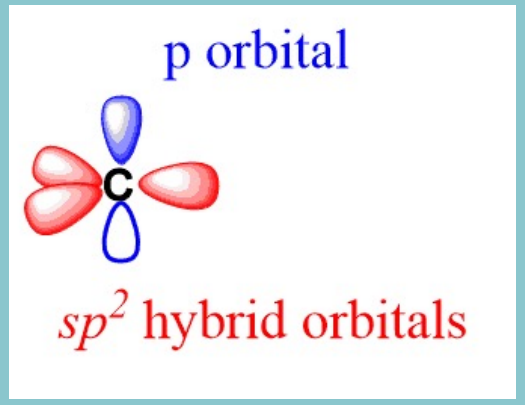
Ground state of C → **1- Excitation** → **2- Hybridization**



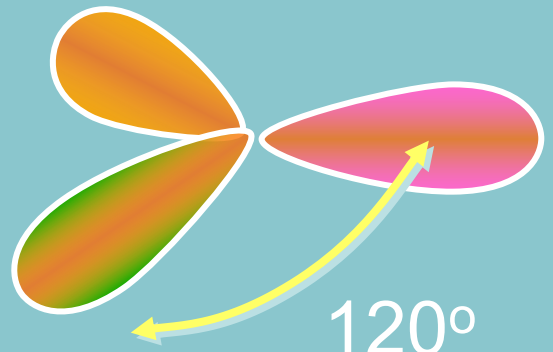
Promote

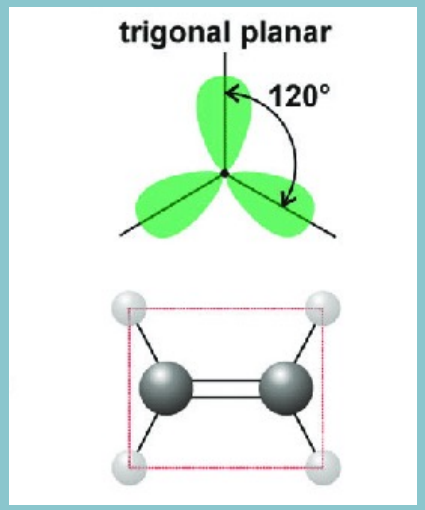
Hybridize

C=

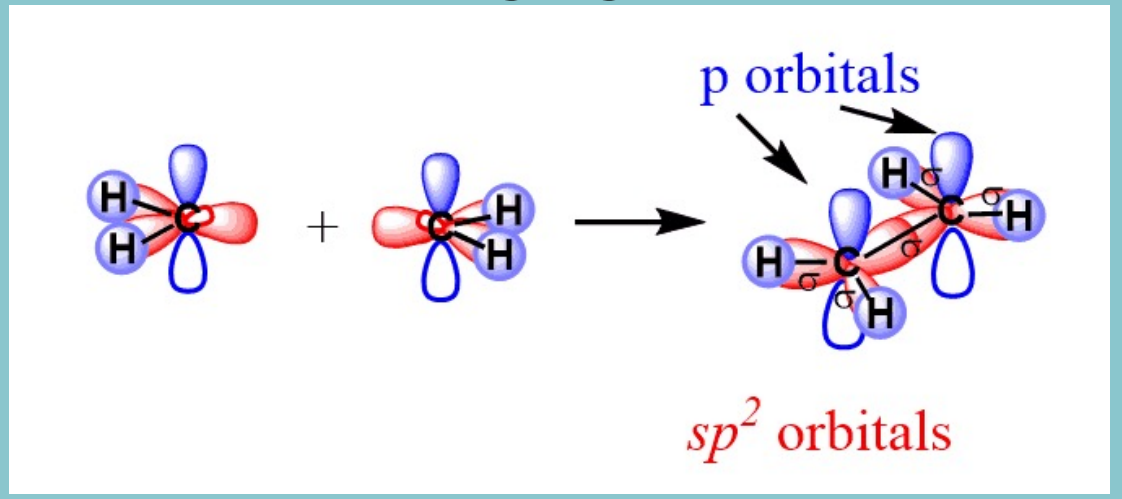


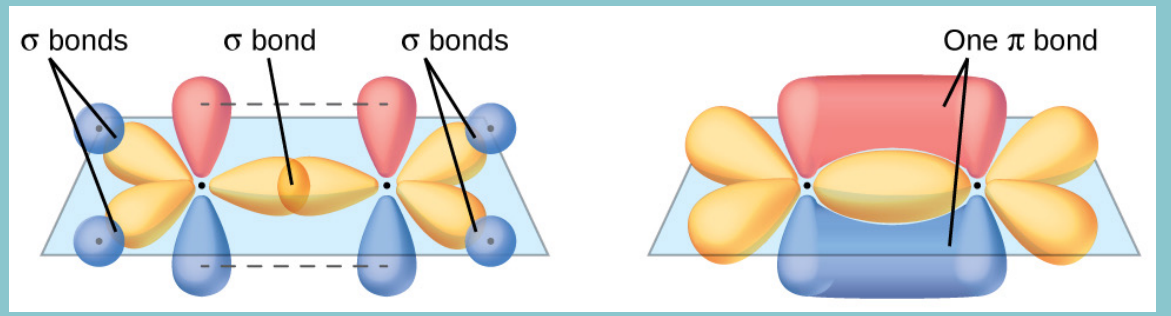
SP²

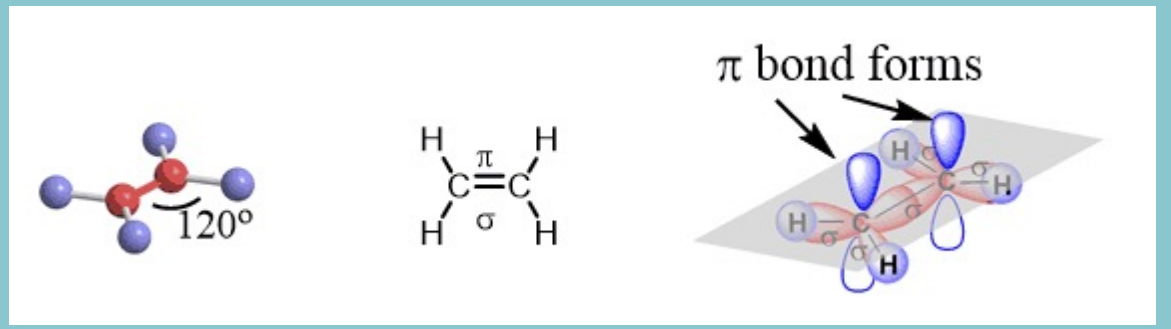




C=C







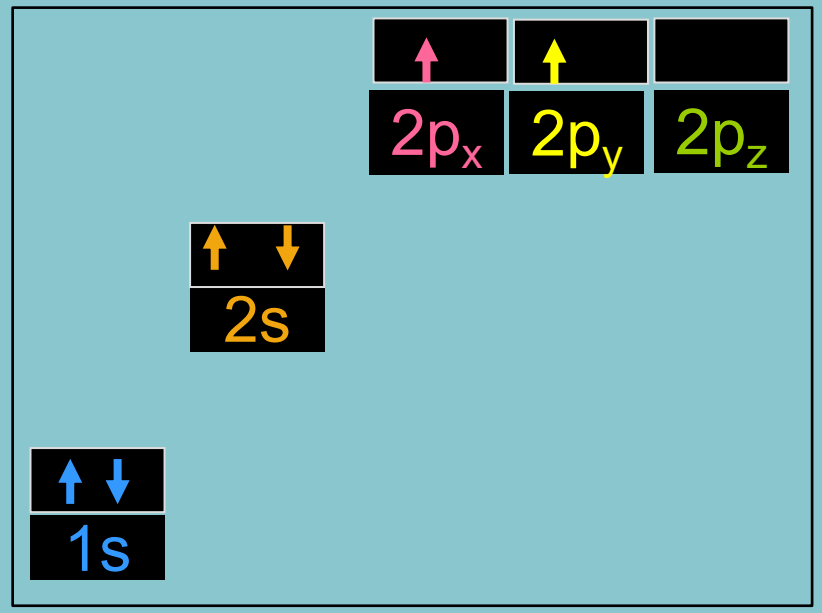
$H_2C=CH_2$

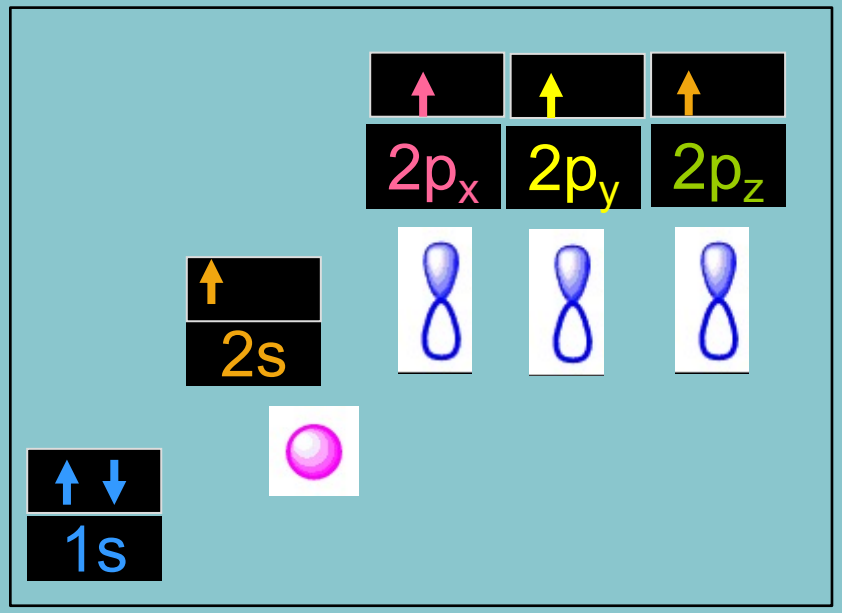
https://cooljargon.com/ebooks/chemistry/m51058/index.cnxml.html
https://www.chemistrysteps.com/sp3-sp2-and-sp-hybridization-organic-chemistry/

Ethyne (HC≡CH): (C≡)

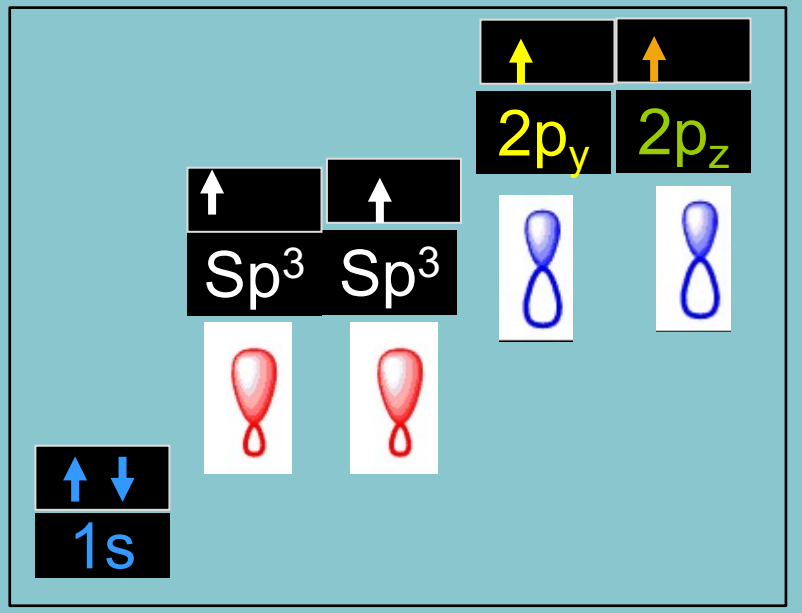
Sp= S+ P

Ground state of C → **1- Excitation** → **2- Hybridization**





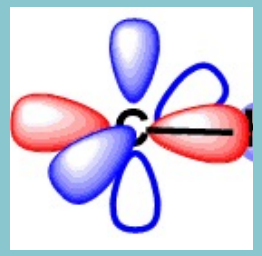
Promote

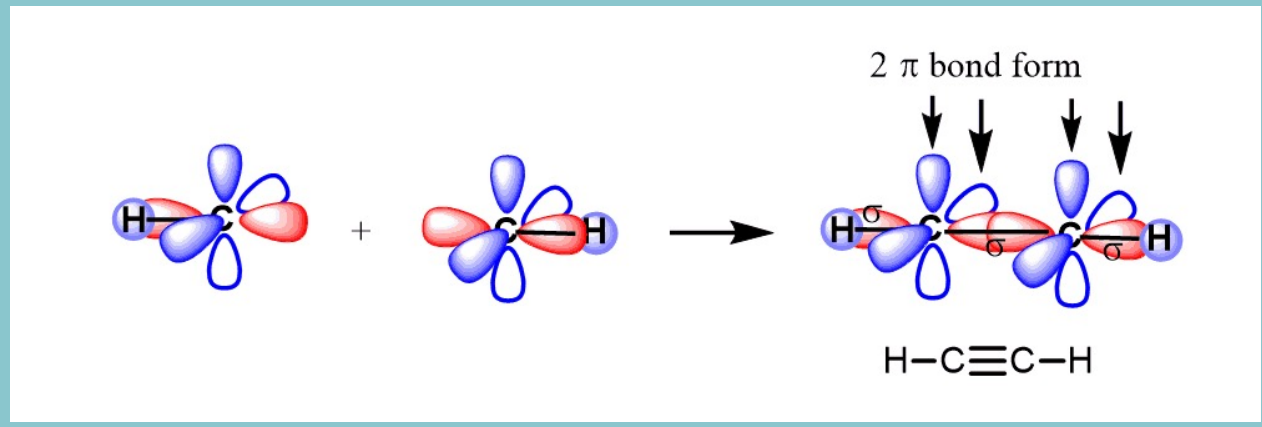


Hybridize

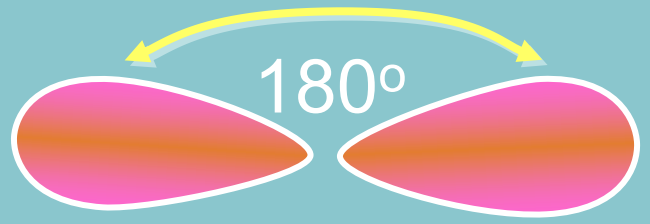
C≡

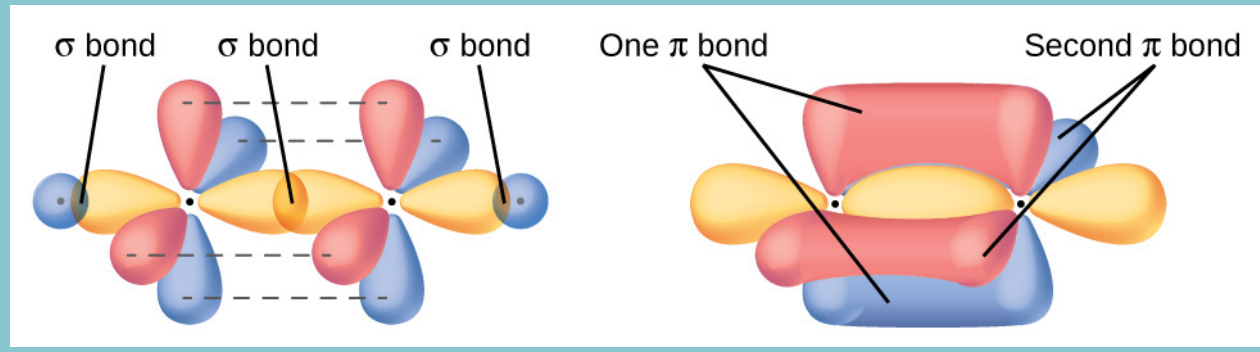
C≡C



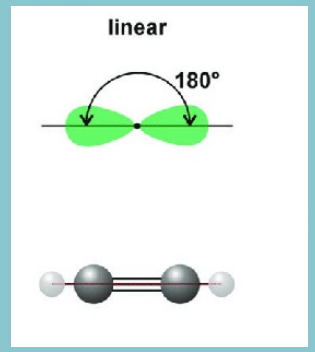


SP





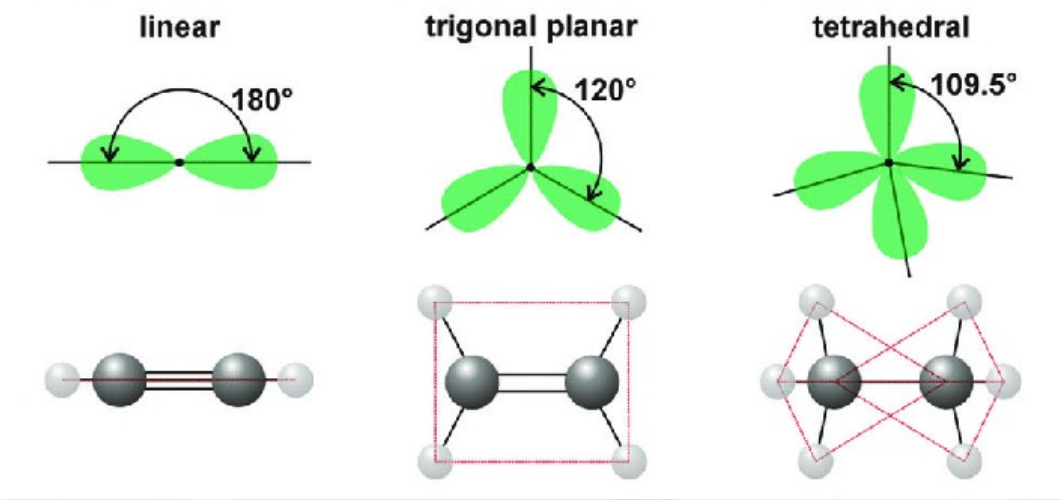
HC≡CH



https://cooljargon.com/ebooks/chemistry/m51058/index.cnxml.html

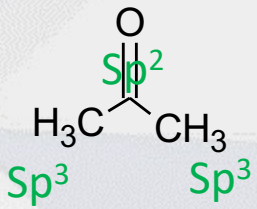
https://www.chemistrysteps.com/sp3-sp2-and-sp-hybridization-organic-chemistry/

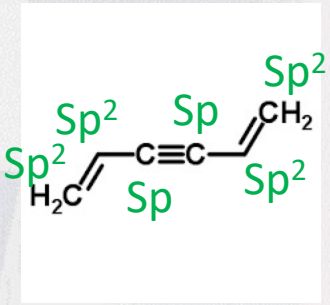
Hydrocarbon	Hybridization	subshells	Bond	Bond Angles	Shape
Alkane	Sp^3	S+ P + P +P	4 σ = 4 singl bond	109.5°	Tetrahedral
Alkene	Sp^2	S+P+P	3 σ = 3 singl bond 1 ∏ = 1 double bond	120°	trigonal
Alkyne	Sp	S+P	2σ = 2singl bond 2 ∏ = 1 Triple bond	180°	liner

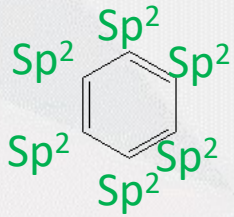


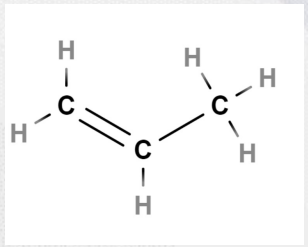
Questions

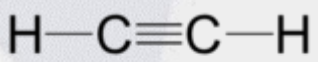
Determine the type of hybridization of all carbon atoms in the following compounds:



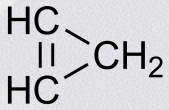




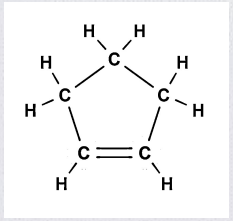




CH_3-CH_3



How many sigma and pi bonds in the following compound?



13 sigma
1 pi

Bond energy (BE) and Bond length

➢ **Bond energy (BE) :**

- The energy necessary to break a mole of covalent bonds =The amount of energy on the type of bond broken .

ex: To break apart 1 mole of hydrogen molecules into atoms requires 104 Kcal

➢ **Bond length :** The average distance between the two atoms nuclei .

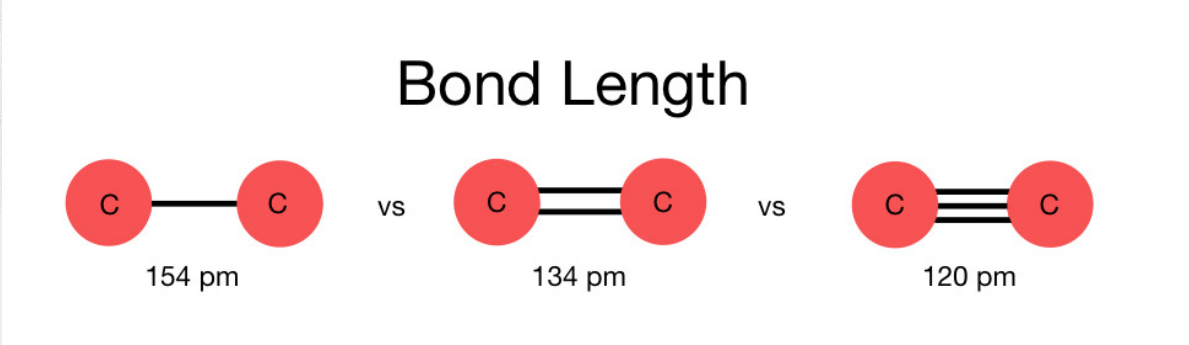
ex: For H_2 = 0.76 ^oA

$$\textbf{Bond energy} \propto \textbf{Bond strength} \propto \textbf{electron density} \propto \frac{1}{\textbf{Bond length}}$$

Bond strength : Single bond < douple bond < triple bond
Bond length : Single bond > douple bond > triple bond

Carbon -Carbon Bonds

	Bond strength	Bond length
C-C	346 KJ/mol	1.54 A˚
C=C	612KJ/mol	1.34 A˚
C≡C	835 KJ/mol	1.20 A˚



EXAMPLE

- Using dashes for bonds , draw a structure for C_3H_4.

- H.W/ Draw structural formulas for the three possible isomers of C_3H_8O , C_4H_{10}

Structural Isomerism :Writing Structural Formulas

Structural Isomerism: compounds have the same molecular formula and different Structural Formulas

- Suppose : want to write out all possible structural formulas that correspond to molecular formula C_5H_{12}

1) continuous chain: writing all five carbons in a continuous chain

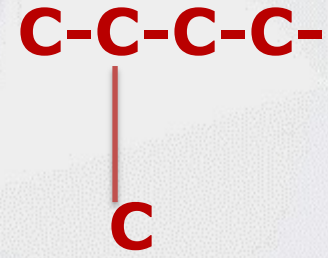
-C-C-C-C-C-

This chain uses up one valence for each and two valence for the carbons in the middle of the Each end carbon therefore has three valences

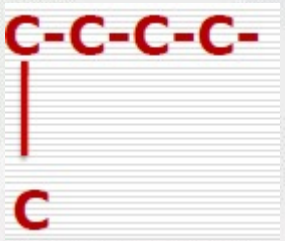
Structural Isomerism :Writing Structural Formulas

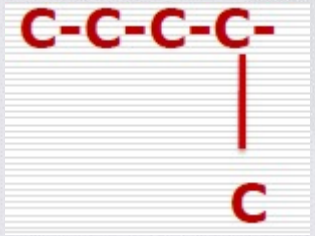
2)branched chains: To find structural formulas for other isomers, we must consider branched chains.

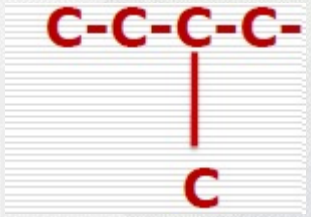
- We can reduce that longest chain to only four carbons and connect the the fifth carbon to one of the middle carbons.



- Suppose we keep the chain of four carbons and try to connect the fifth carbon some where else, Consider the following Chains

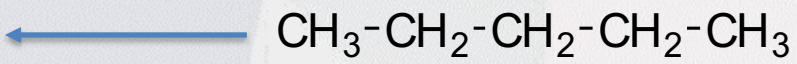






Structural Isomerism :Writing Structural Formulas

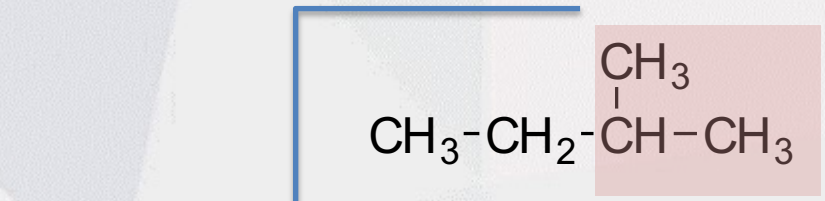
continuous chain



$CH_3\text{-}CH_2\text{-}CH_2\text{-}CH_2\text{-}CH_3$

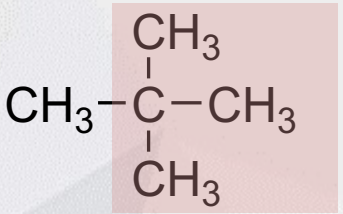
n-pentane

Branched chains



$CH_3\text{-}CH_2\text{-}CH(CH_3)\text{-}CH_3$

Isopentane



$CH_3\text{-}C(CH_3)_2\text{-}CH_3$

Neopentane

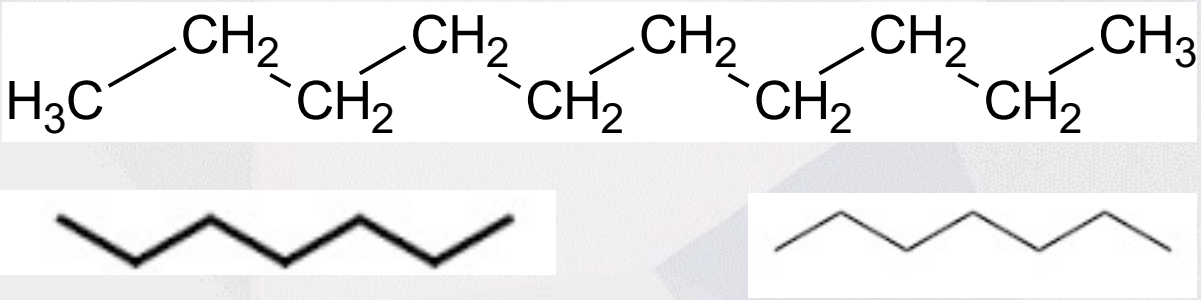
2,2-dimethylpropane, bp10 ^{0}C

Structural Isomerism :Writing Structural Formulas

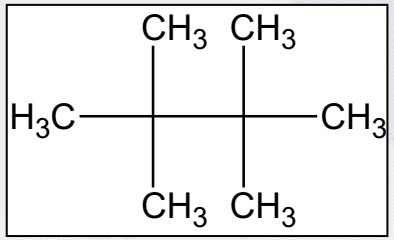
Writing Structural Formulas can be:

- Structures is of the lines to represent the carbon framework

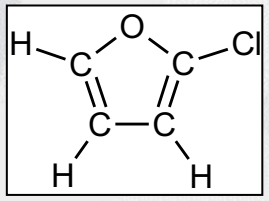
1-continuous Chain

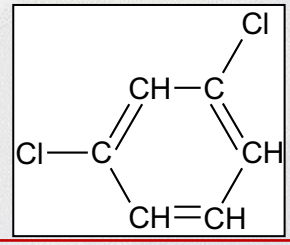


2-Branched Chain



3-Cyclic compounds





EXAMPLES

Write a structural formulas that shows all bonds for each of the following :

$CH_3CCl_2CH_3$

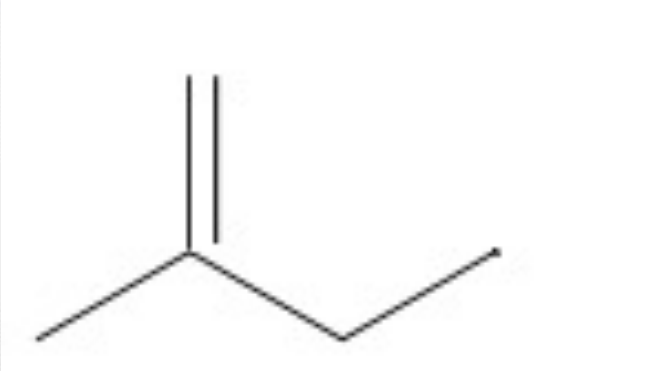
$(CH_3)_2C(CH_2CH_3)_2$

$CH_3CH_2CH_2CH_3$

$Cl_2C{=}CCl_2$

EXAMPLE

- ✓ Write a more detailed structural formulas



QUIZE 4

- Write a line segment formula for

$$(CH_3\,CH_2CH) = CH\,CH_2\,CH\,(\,CH_3)_2$$

Thank you