BSc. Part 1
Organic Chemistry
Paper 1C
Group A

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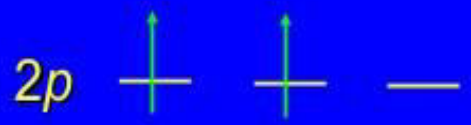
- **Hybridization : The concept of mixing atomic orbitals in to new hybrid orbitals (with different energies , shapes , etc. , than the componenet atomic orbitals) suitable for the pairing of electrons to form chemical bonds in valence bond theory.**

sp^3 *Orbital Hybridization*



Promote an electron from the 2*s* to the 2*p* orbital

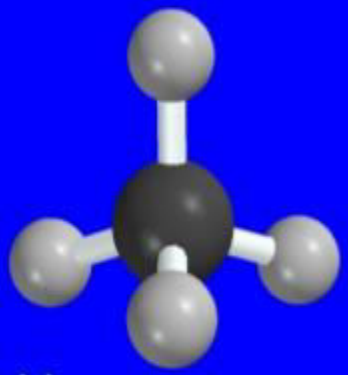
Structure of Methane

tetrahedral

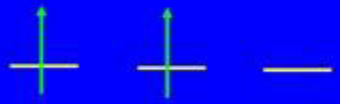
bond angles = 109.5°

bond distances = 110 pm

but structure seems inconsistent with electron configuration of carbon

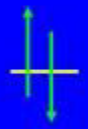


Electron configuration of carbon

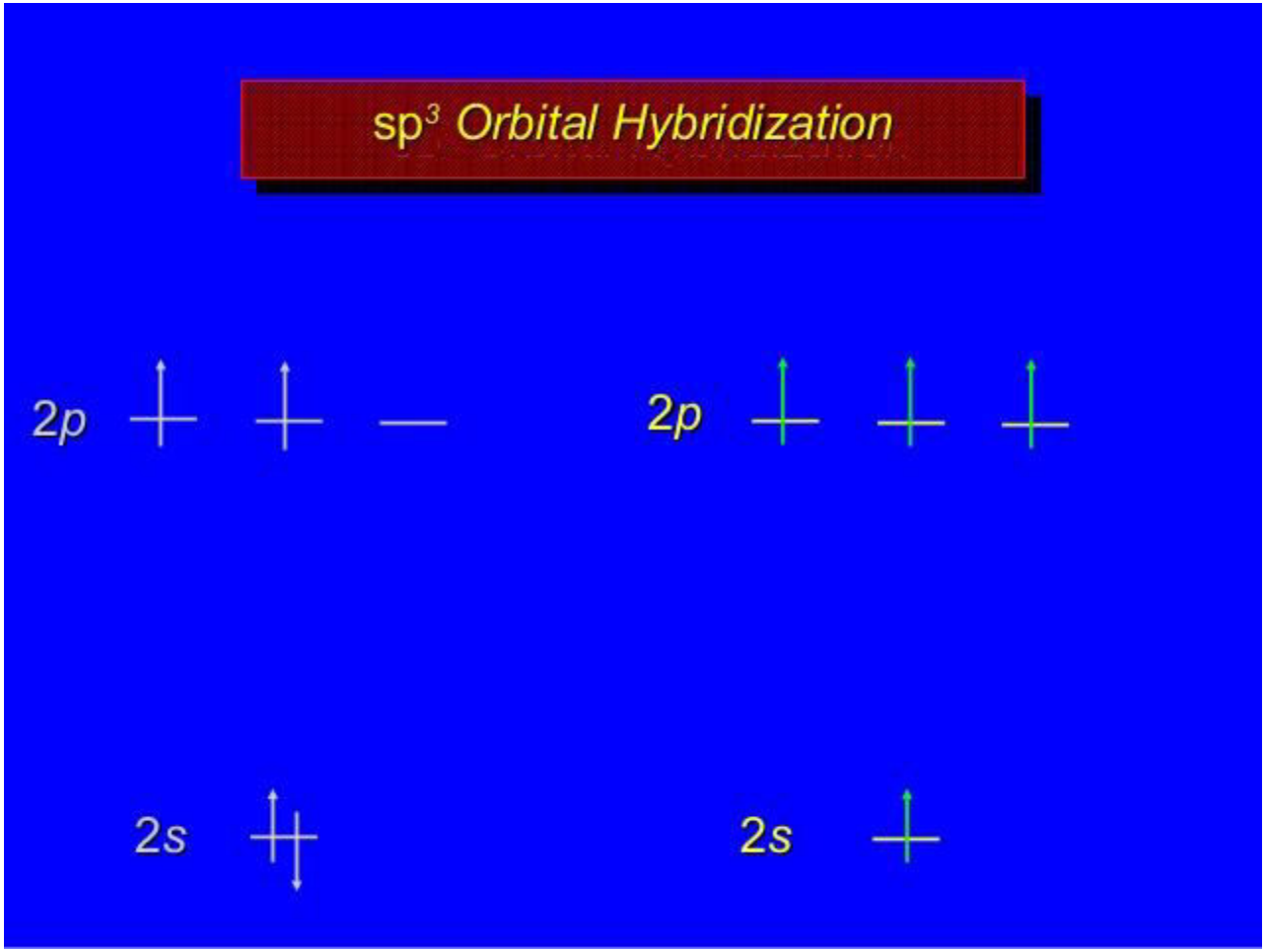
2p 

only two unpaired electrons

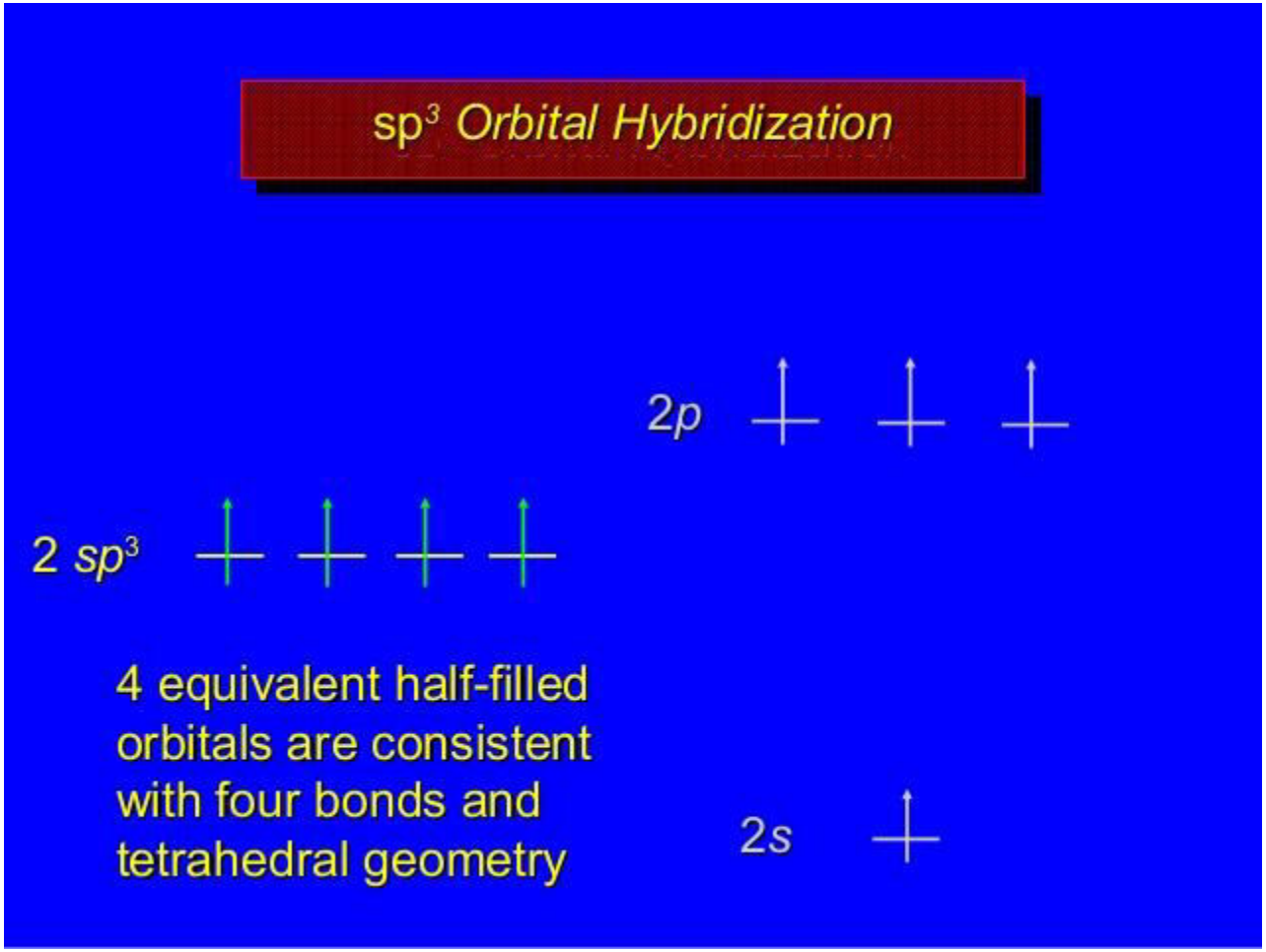
should form σ bonds to only two hydrogen atoms

2s 

bonds should be at right angles to one another

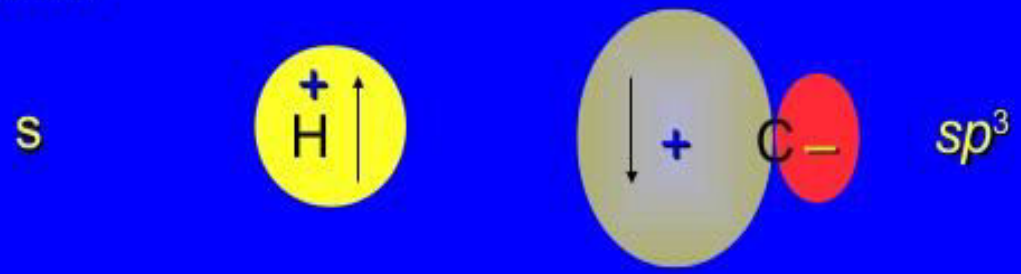

sp3 Orbital Hybridization
2p
2p
2s
2s

sp^3 Orbital Hybridization

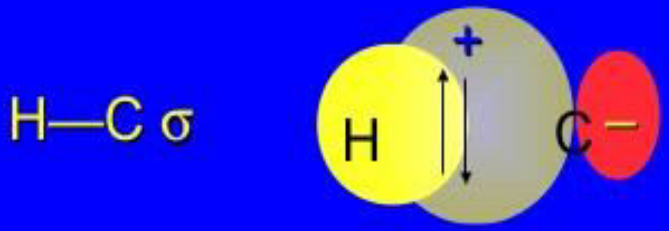


The C—H σ Bond in Methane

In-phase overlap of a half-filled 1*s* orbital of hydrogen with a half-filled sp^3 hybrid orbital of carbon:



gives a σ bond.



Structure of Ethylene

C_2H_4

$H_2C{=}CH_2$

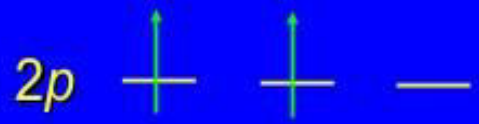
planar

bond angles: close to 120°

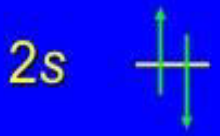
bond distances: C—H = 110 pm

C=C = 134 pm

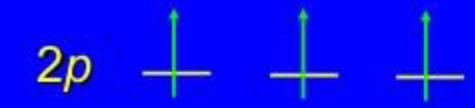
sp^2 *Orbital Hybridization*



Promote an electron from the 2*s* to the 2*p* orbital

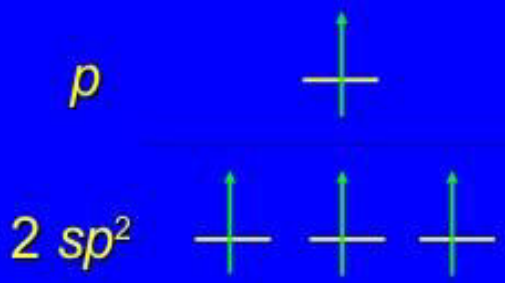


sp^2 *Orbital Hybridization*



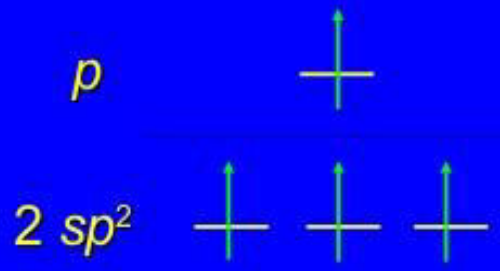
Mix together (hybridize) the 2*s* orbital and two of the three 2*p* orbitals

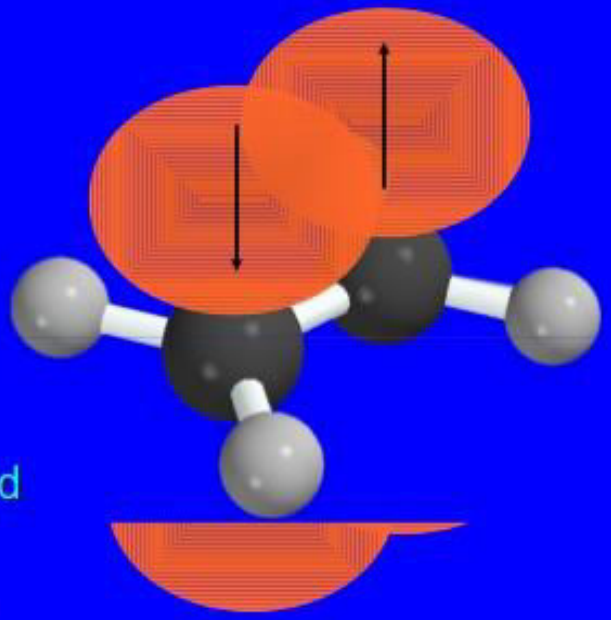
π Bonding in Ethylene



the unhybridized *p* orbital of carbon is involved in π bonding to the other carbon

π Bonding in Ethylene





side-by-side overlap of half-filled *p* orbitals gives a π bond

double bond in ethylene has a σ component and a π component

Structure of Acetylene

C_2H_2

$HC \equiv CH$

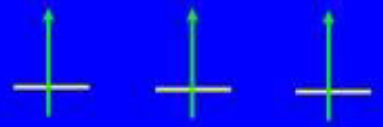
linear

bond angles: 180°

bond distances: C—H = 106 pm

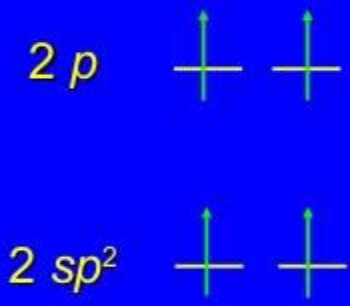
CC = 120 pm

sp *Orbital Hybridization*



Mix together (hybridize) the 2*s* orbital and <u>one</u> of the three 2*p* orbitals

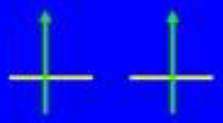
sp *Orbital Hybridization*



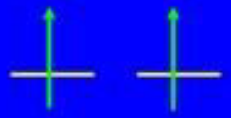
1 of the 2 *sp* orbitals is involved in a σ bond to hydrogen; the other is involved in a σ bond to carbon

π Bonding in Acetylene

2 *p*



2 sp^2

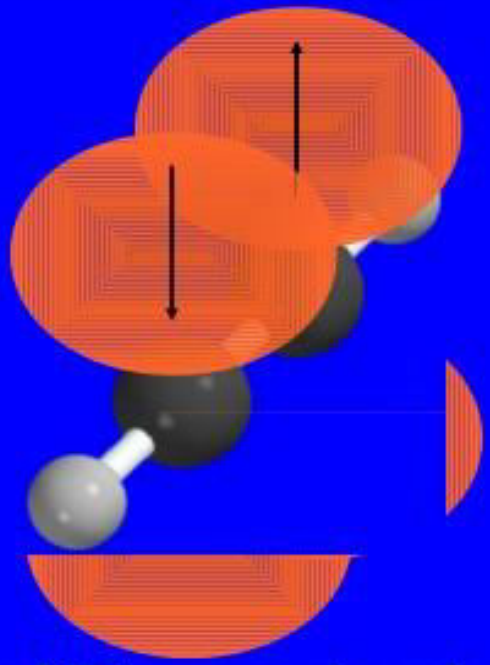


the unhybridized *p* orbitals of carbon are involved in separate π bonds to the other carbon

π Bonding in Acetylene

2 *p*

2 sp^2



one π bond involves one of the p orbitals on each carbon

there is a second π bond perpendicular to this one