

## Announcements – Lecture XVII – Tuesday, June 18<sup>th</sup>

5<sup>th</sup> LAB: TODAY, 1:30-4:30, ISB 155 (B-D)

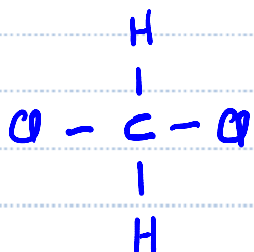
EXAM II STATS



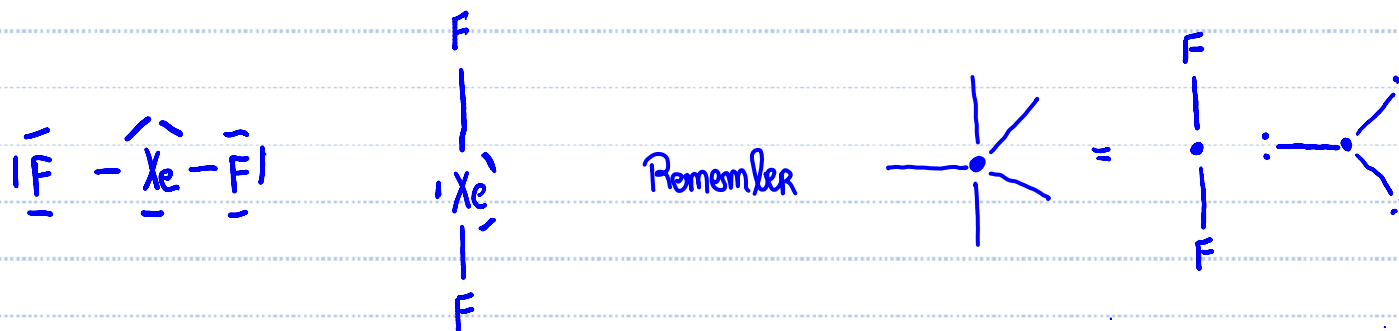
## Quiz 13

Last Name: \_\_\_\_\_

1. Label the following molecules as **polar** or **nonpolar**



a)  $\text{CH}_2\text{Cl}_2$  Polar



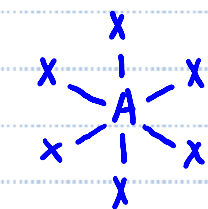
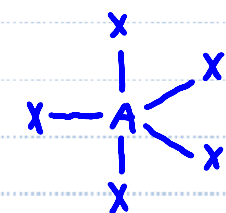
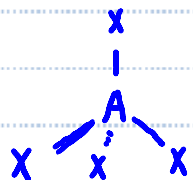
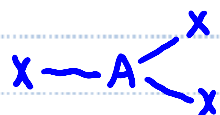
b)  $\text{XeF}_2$  Non polar



## 9.2 Hybrid Orbitals

### A: Hybridization

Electron Pair  
Geometry



# Equivalent  
Orbitals Needed

2

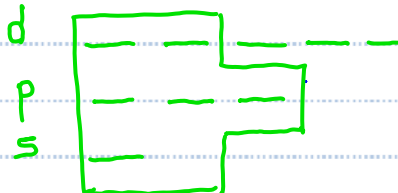
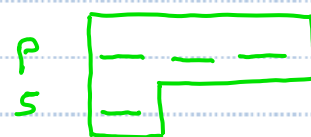
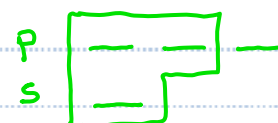
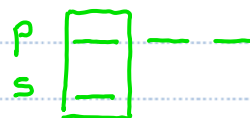
3

4

5

6

Valence Orbitals  
Available



Hybrid Orbitals

2 x  $sp$  orbitals

3 x  $sp^2$  orbitals

4 x  $sp^3$  orbitals

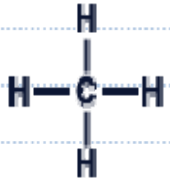
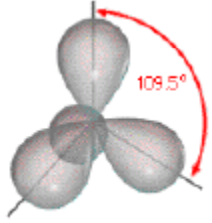
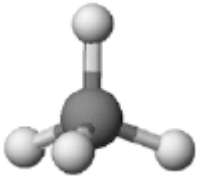
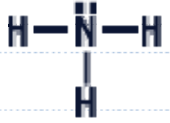
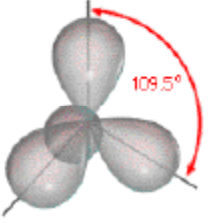


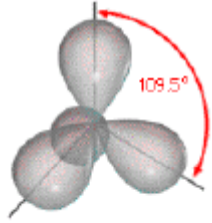
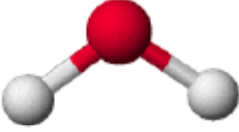
5 x  $sp^3d$  orbitals

6 x  $sp^3d^2$  orbitals



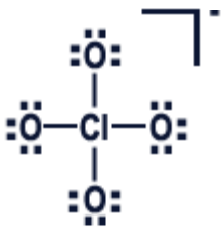
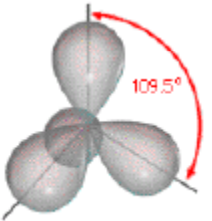
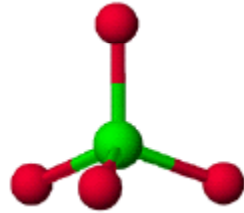
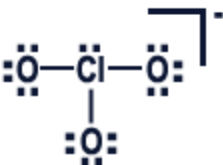
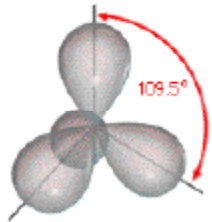
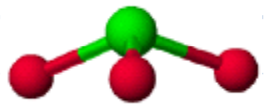
## 9.2 Hybrid Orbitals

### B: $sp^3$ Hybridization

Lewis Structure	Class	Electron Pair Geometry	Molecular Geometry	Hybridization
$\text{CH}_4$ 	$\text{AX}_4\text{E}_0$	 <b>Tetrahedron</b>	 <b>Tetrahedron</b>	$sp^3$
$\text{NH}_3$ 	$\text{AX}_3\text{E}_1$	 <b>Tetrahedron</b>	 <b>Trigonal pyramid</b>	$sp^3$
$\text{H}_2\text{O}$ 	$\text{AX}_2\text{E}_2$	 <b>Tetrahedron</b>	 <b>Bent/Angular 109°</b>	$sp^3$

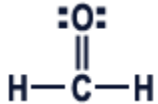
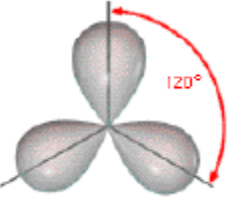
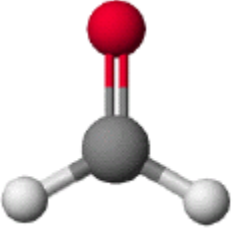
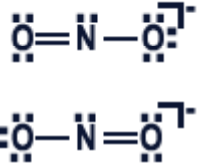
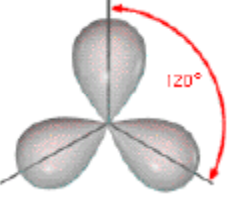
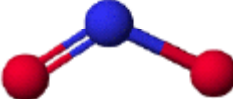
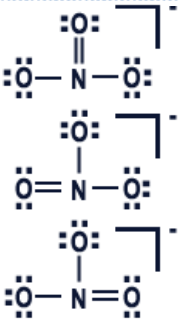
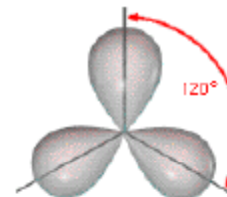
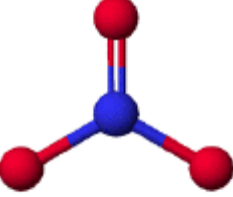
## 9.2 Hybrid Orbitals

### B: $sp^3$ Hybridization

Lewis Structure	Class	Electron Pair Geometry	Molecular Geometry	Hybridization
$\text{ClO}_4^-$ 	$\text{AX}_4\text{E}_0$	 <p>Tetrahedron</p>	 <p>Tetrahedron</p>	$sp^3$
$\text{ClO}_3^-$ 	$\text{AX}_3\text{E}_1$	 <p>Tetrahedron</p>	 <p>Trigonal pyramid</p>	$sp^3$

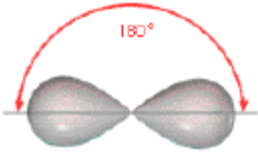

## 9.2 Hybrid Orbitals

### C: $sp^2$ Hybridization

Lewis Structure	Class	Electron Pair Geometry	Molecular Geometry	Hybridization
$H_2CO$ 	$AX_3E_0$	 <p>Trigonal Planar</p>	 <p>Trigonal Planar</p>	$sp^2$
$NO_2^-$ 	$AX_3E_1$	 <p>Trigonal Planar</p>	 <p>Bent/Angular <math>120^\circ</math></p>	$sp^2$
$NO_3^-$ 	$AX_3E_0$	 <p>Trigonal Planar</p>	 <p>Trigonal Planar</p>	$sp^2$


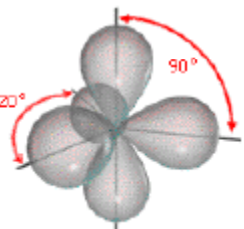

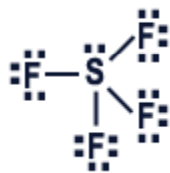
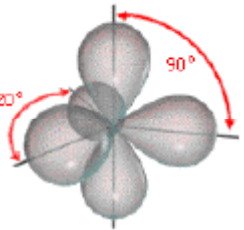

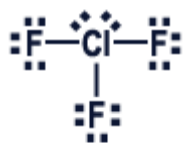
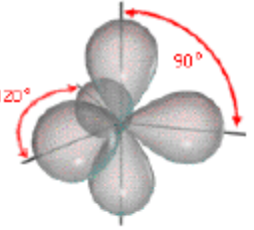
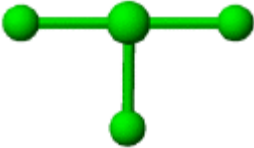
## 9.2 Hybrid Orbitals

### D: sp Hybridization

Lewis Structure	Class	Electron Pair Geometry	Molecular Geometry	Hybridization
<b>HCN</b>  H—C≡N:	<b>AX<sub>2</sub>E<sub>0</sub></b>	 <b>Linear</b>	 <b>Linear</b>	<b>sp</b>

## 9.2 Hybrid Orbitals


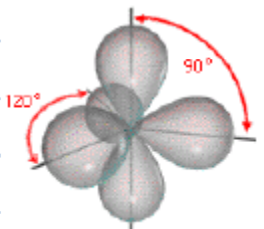

### E: $sp^3d$ Hybridization

Lewis Structure	Class	Electron Pair Geometry	Molecular Geometry	Hybridization
$PF_5$ 	$AX_5E_0$	 <p>Trigonal Bipyramid</p>	 <p>Trigonal Bipyramid</p>	$sp^3d$
$SF_4$ 	$AX_4E_1$	 <p>Trigonal Bipyramid</p>	 <p>Seesaw</p>	$sp^3d$
$ClF_3$ 	$AX_3E_2$	 <p>Trigonal Bipyramid</p>	 <p>T-shaped</p>	$sp^3d$




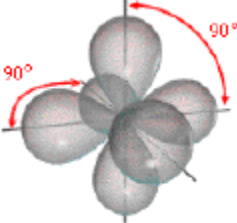
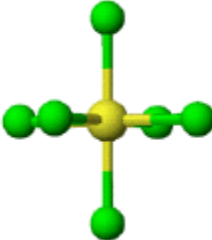
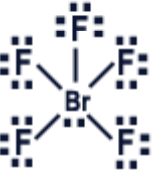
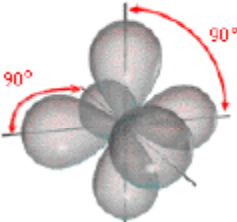
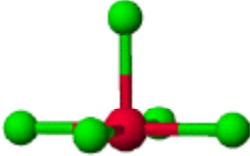

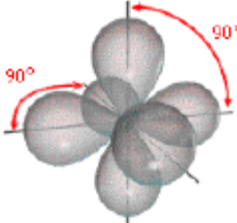

## 9.2 Hybrid Orbitals

### E: $sp^3d$ Hybridization

Lewis Structure	Class	Electron Pair Geometry	Molecular Geometry	Hybridization
$XeF_2$ 	$AX_2E_3$	 Trigonal Bipyramid	 Linear	$sp^3d$

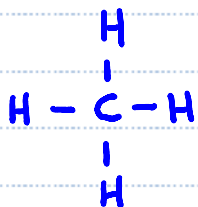
## 9.2 Hybrid Orbitals

### F: $sp^3d^2$ Hybridization

Lewis Structure	Class	Electron Pair Geometry	Molecular Geometry	Hybridization
$SF_6$ 	$AX_6E_0$	 <b>Octahedron</b>	 <b>Octahedron</b>	$sp^3d^2$
$BrF_5$ 	$AX_5E_1$	 <b>Octahedron</b>	 <b>Square Pyramid</b>	$sp^3d^2$
$XeF_4$ 	$AX_4E_2$	 <b>Octahedron</b>	 <b>Square Planar</b>	$sp^3d^2$

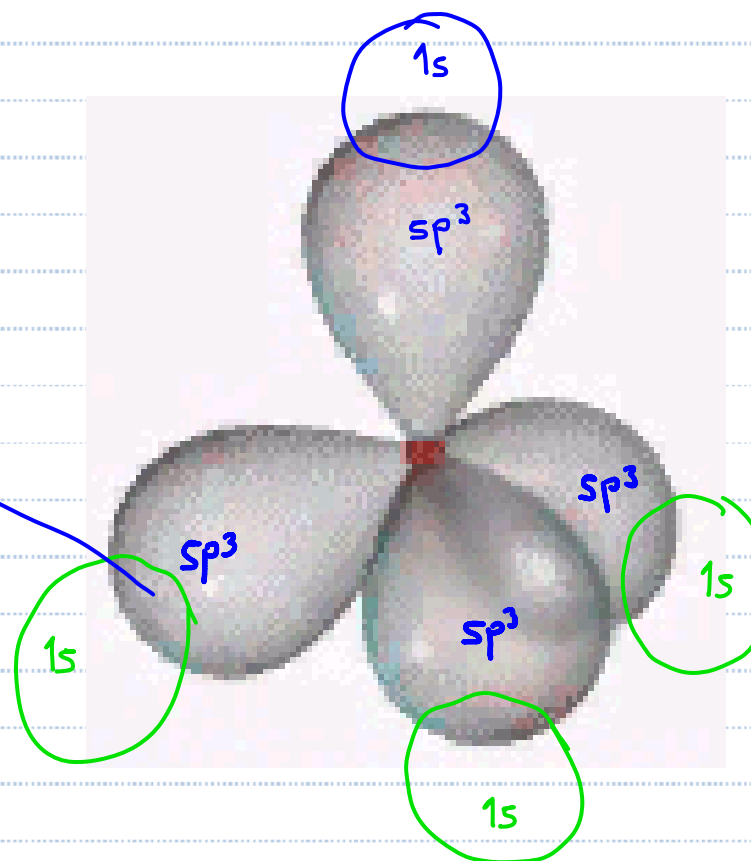
## 9.3 Pi Bonds

### Sigma Bonds – CH<sub>4</sub>



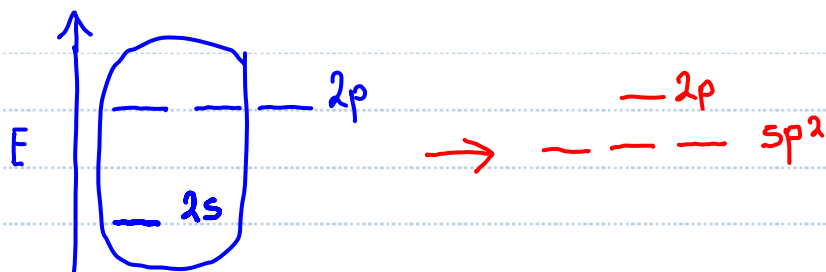
AX<sub>4</sub>E<sub>0</sub> sp<sup>3</sup> hybrid orbitals

**Sigma bond** formed by the overlap of an sp<sup>3</sup> hybrid orbital on C with the 1s orbital on H.

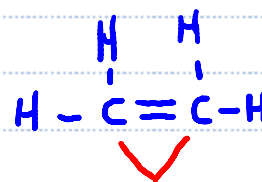


# 9.3 Pi Bonds

## B: Sigma Bonds - C<sub>2</sub>H<sub>4</sub>

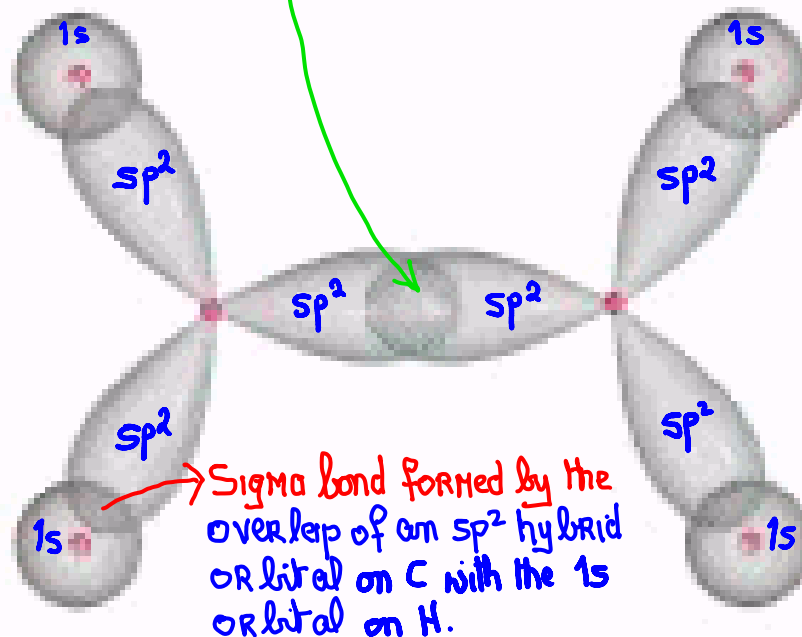


For both carbon atoms



AX<sub>3</sub>E<sub>0</sub> ... Trigonal planar ... sp<sup>2</sup>

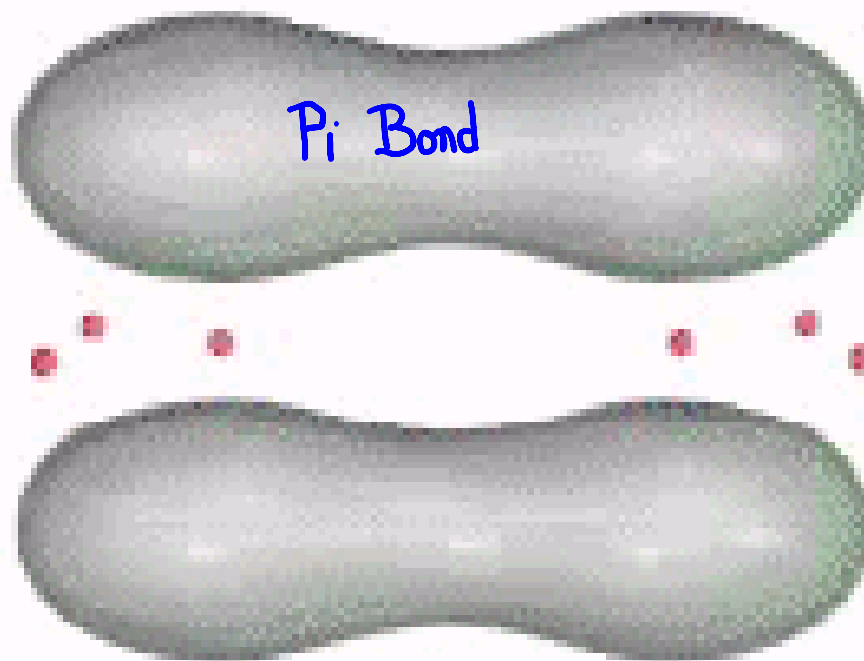
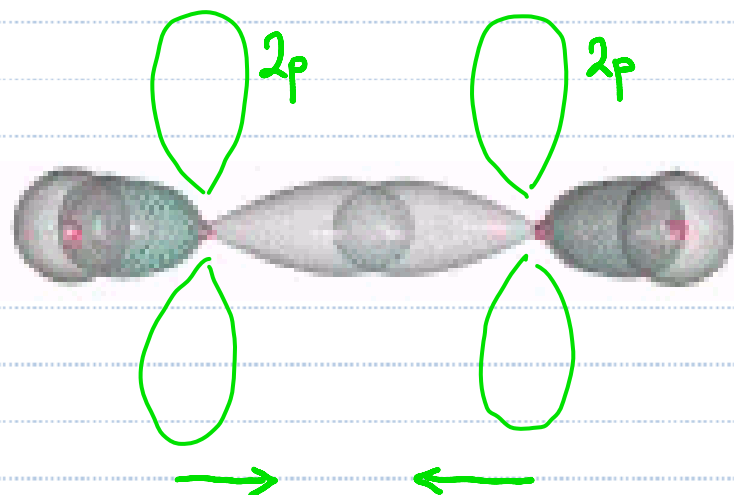
Sigma bond formed by the overlap of an sp<sup>2</sup> hybrid orbital on each of the carbon atoms.



Sigma bond formed by the overlap of an sp<sup>2</sup> hybrid orbital on C with the 1s orbital on H.

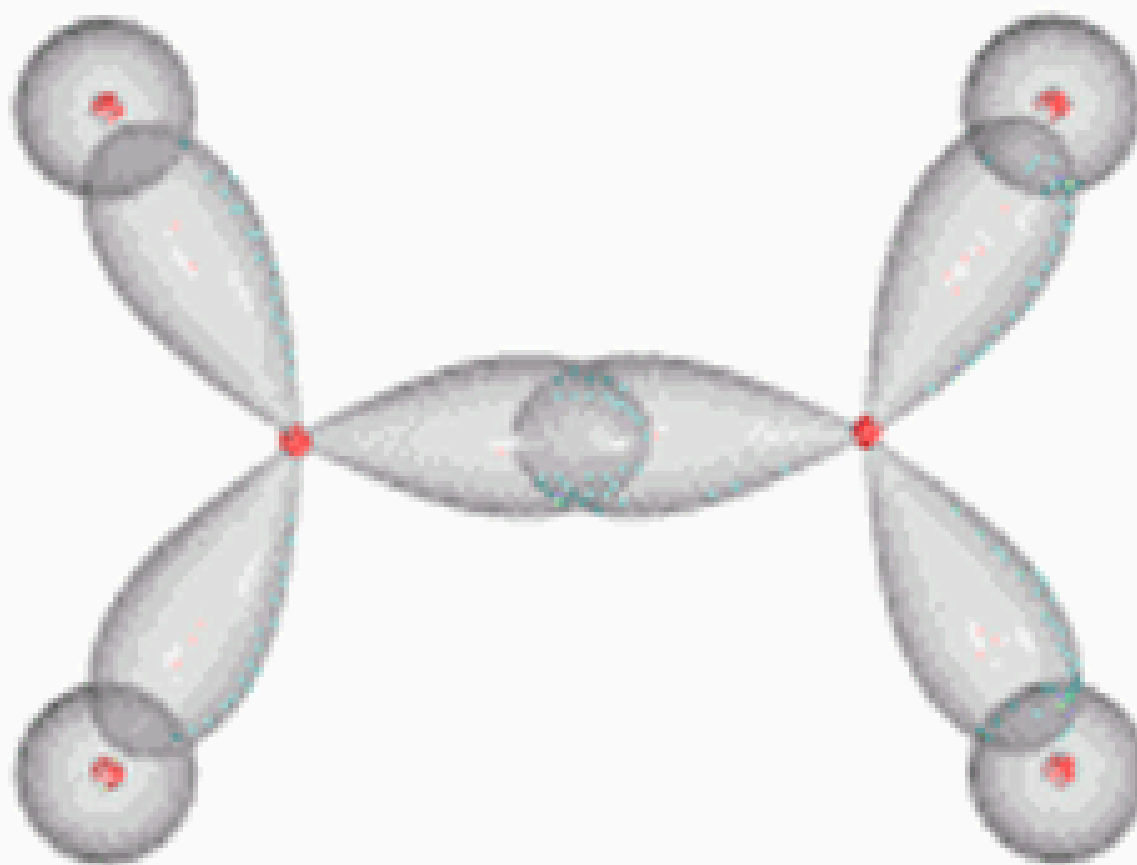
## 9.3 Pi Bonds

B: Pi Bonds –  $C_2H_4$



## 9.3 Pi Bonds

### B: Sigma and Pi Bonds – C<sub>2</sub>H<sub>4</sub>



**Sigma Bonds Only**