

# Polarity

Andy Schweitzer

# What does it mean to be polar?

- A molecule is polar if it contains + and – somewhere in the molecule.
- Remember: Protons can not move. So for a molecule to get a +/- it must somehow have its electrons dragged from one atom to another!

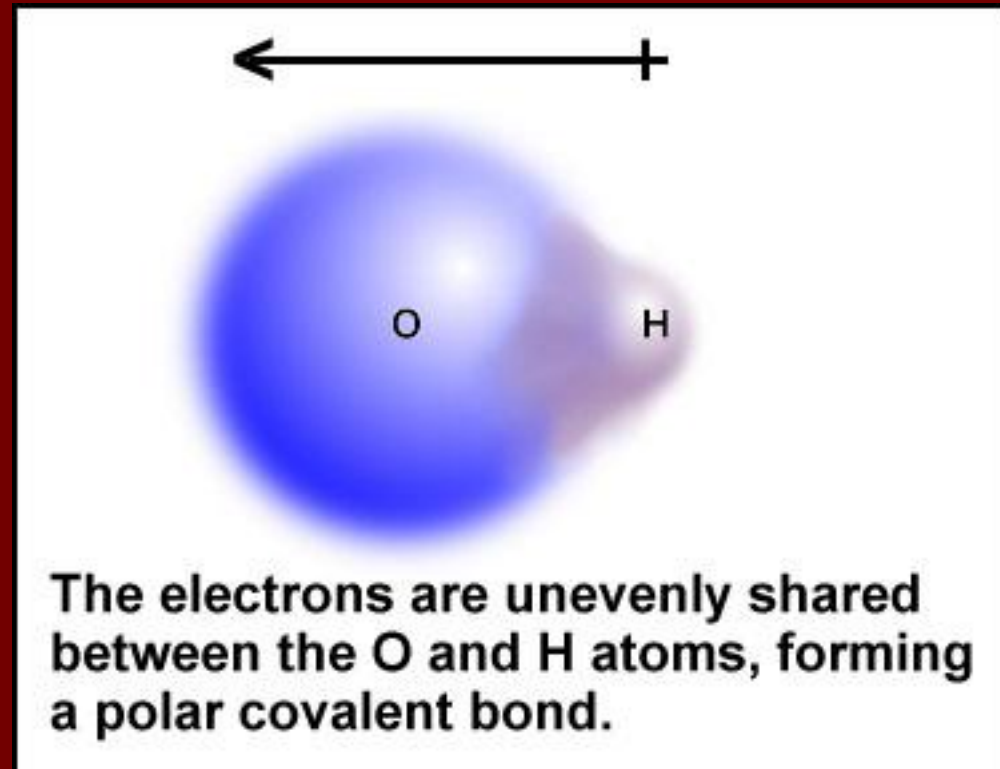
# How does polarity affect a molecules properties?

- Solute dissolving in a solvent?
  - “Likes dissolve likes”
    - Non-polar solutes dissolve in non-polar solvents
    - Polar solutes dissolve in polar solvents.
  - Biologically
    - Drugs are absorbed into the brain (past the blood brain barrier) based upon their polarity.
    - Morphine and Heroine are very similar
    - Your body converts heroine to morphine after it enters the brain.
    - Heroin is 90% more polar there for it absorbs a lot faster.

# How does a molecule become polar.

- Must have at least one polar bond.
- What is a polar bond?
  - A covalent bond where the electrons are not being shared equally.

Electrons are being dragged from one atom to another



# Why are or why aren't the electrons being shared equally

- Electronegativity: An atoms attraction for electrons in a bond.
  - Some atoms, when bonded suck the electrons toward them.
- Electronegativity Difference: When you get two atoms bonded where one is highly electronegative and the other is not there will be unequal sharing.

# Electronegativity difference? Tug of war

Mr. Schweitzer



Baby



Who wins this contest????

# Electronegativity difference? Tug of war

Mr. Schweitzer



Superman



Who wins this contest???

# Electronegativity difference? Tug of war

Mr. Schweitzer



Superman



STALEMATE



# Electronegativity

1	Group 1		Group 2										Group 13						Group 14		Group 15		Group 16		Group 17		Group 18		
1	1 H 2.1																					2 He —							
2	3 Li 1.0	4 Be 1.5											5 B 2.0	6 C 2.5	7 N 3.0	8 O 3.5	9 F 4.0	10 Ne —											
3	11 Na 0.9	12 Mg 1.2	Group 3			Group 4		Group 5		Group 6		Group 7		Group 8		Group 9		Group 10		Group 11		Group 12		13 Al 1.5	14 Si 1.8	15 P 2.1	16 S 2.5	17 Cl 3.0	18 Ar —
4	19 K 0.8	20 Ca 1.0	21 Sc 1.3	22 Ti 1.5	23 V 1.6	24 Cr 1.6	25 Mn 1.5	26 Fe 1.8	27 Co 1.8	28 Ni 1.8	29 Cu 1.9	30 Zn 1.6	31 Ga 1.6	32 Ge 1.8	33 As 2.0	34 Se 2.4	35 Br 2.8	36 Kr 3.0											
5	37 Rb 0.8	38 Sr 1.0	39 Y 1.2	40 Zr 1.4	41 Nb 1.6	42 Mo 1.8	43 Tc 1.9	44 Ru 2.2	45 Rh 2.2	46 Pd 2.2	47 Ag 1.9	48 Cd 1.7	49 In 1.7	50 Sn 1.8	51 Sb 1.9	52 Te 2.1	53 I 2.5	54 Xe 2.6											
6	55 Cs 0.7	56 Ba 0.9	57 La 1.1	72 Hf 1.3	73 Ta 1.5	74 W 1.7	75 Re 1.9	76 Os 2.2	77 Ir 2.2	78 Pt 2.2	79 Au 2.4	80 Hg 1.9	81 Tl 1.8	82 Pb 1.8	83 Bi 1.9	84 Po 2.0	85 At 2.2	86 Rn 2.4											
7	87 Fr 0.7	88 Ra 0.9	89 Ac 1.1	104 Rf —	105 Db —	106 Sg —	107 Bh —	108 Hs —	109 Mt —																				

6 — Atomic number

C — Symbol

2.5 — Electronegativity

Lanthanide series

58 Ce 1.1	59 Pr 1.1	60 Nd 1.1	61 Pm 1.1	62 Sm 1.2	63 Eu 1.1	64 Gd 1.2	65 Tb 1.1	66 Dy 1.2	67 Ho 1.2	68 Er 1.2	69 Tm 1.3	70 Yb 1.1	71 Lu 1.3
90 Th 1.3	91 Pa 1.5	92 U 1.4	93 Np 1.4	94 Pu 1.3	95 Am 1.3	96 Cm 1.3	97 Bk 1.3	98 Cf 1.3	99 Es 1.3	100 Fm 1.3	101 Md 1.3	102 No 1.3	103 Lr —

Actinide series

# Electronegativity

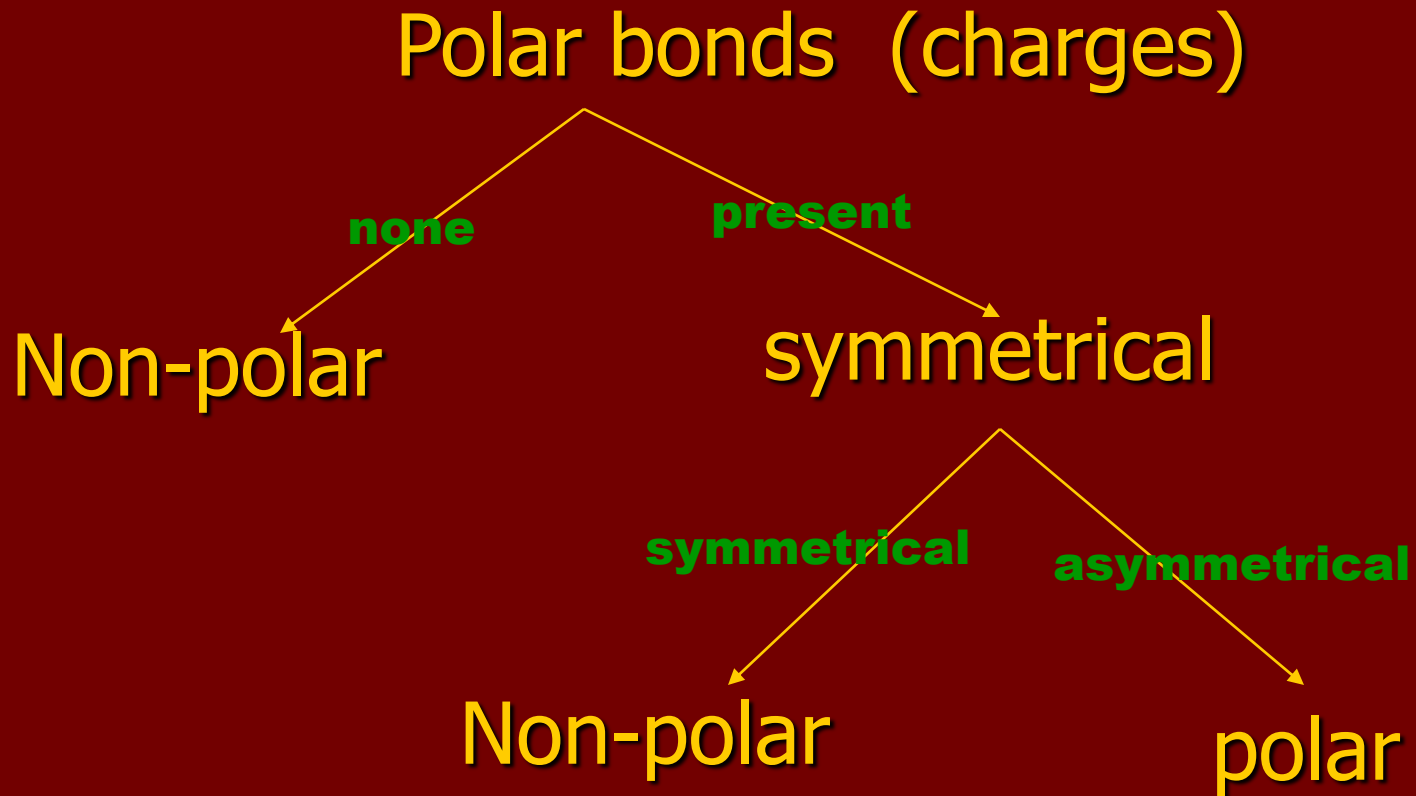
- Electronegativity difference
- Dipole moment: numerical measurement of the difference of charge.
  - Ionic dipole moment: ( $> 1.7$ )
    - $\text{NaCl} = 3 - .9 = 2.1$
  - Polar covalent ( $.5 > x < 1.7$ )
  - Pure covalent ( $< .5$ )

These values are estimates

# Which of these are polar covalent molecules

	■ Dipole moments
■ H-F	1.9
■ H-Cl	.9
■ NO <sub>2</sub>	.5
■ H <sub>2</sub>	0

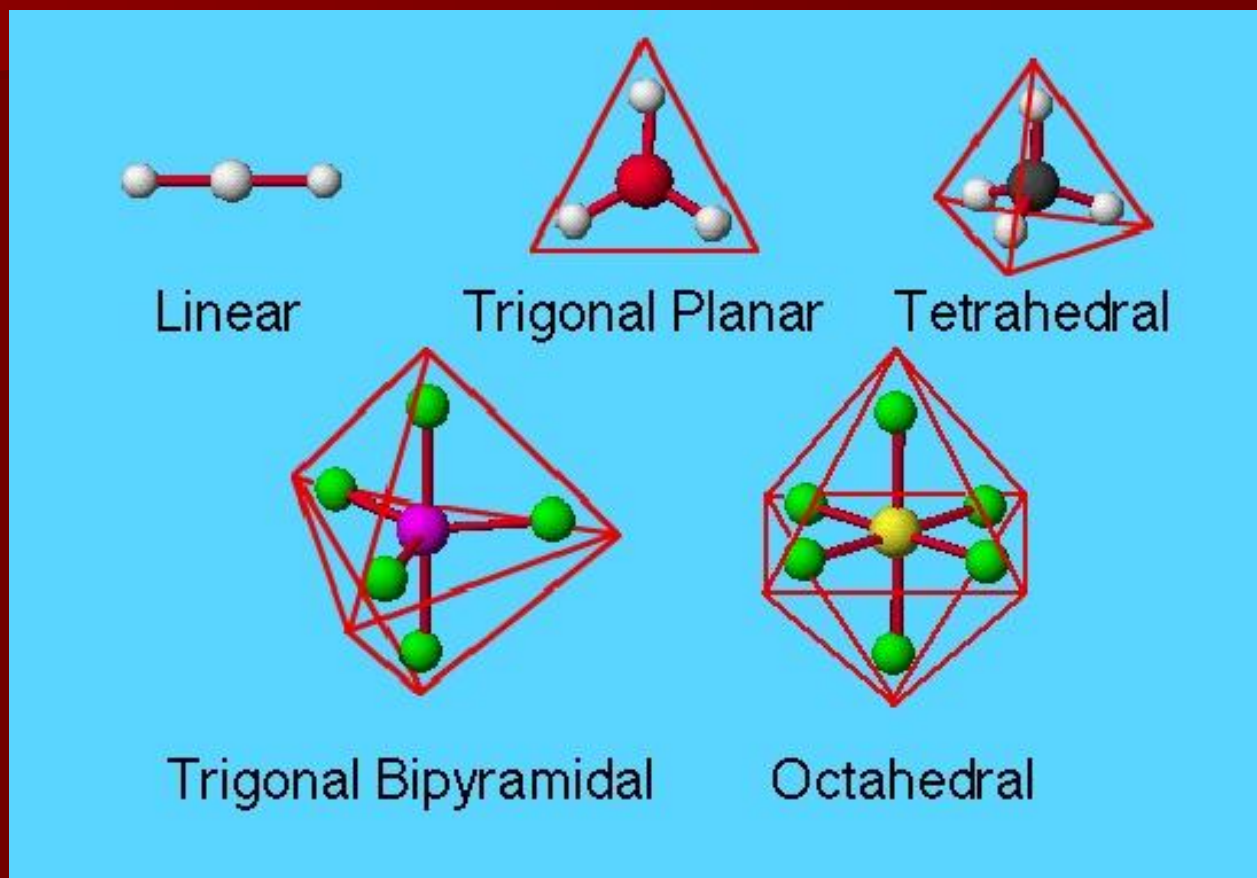
# Structure also affects polarity



# Symmetrical vs. Asymmetrical

- If a molecule is symmetrical then there will not be any unequal disposition of charges.
- How do you know if a molecule is symmetrical?

# Structures



- These are the general structures. They all start out symmetrical.

# MOLECULAR GEOMETRY

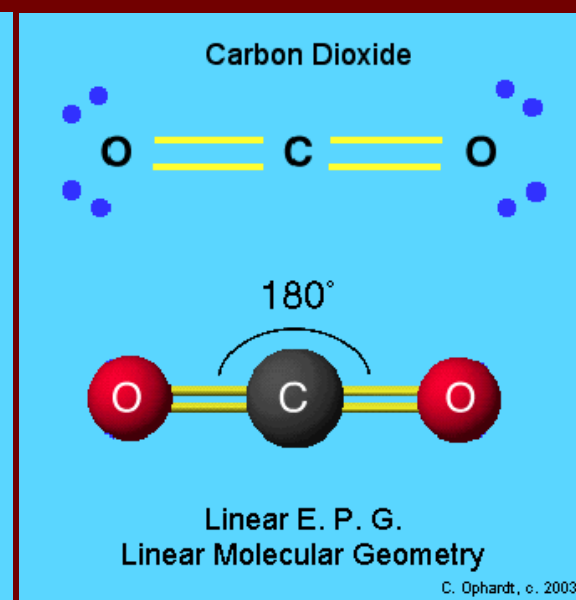
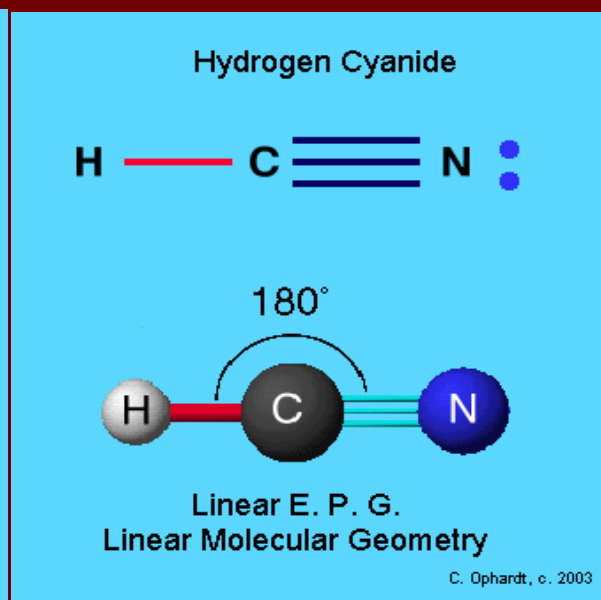
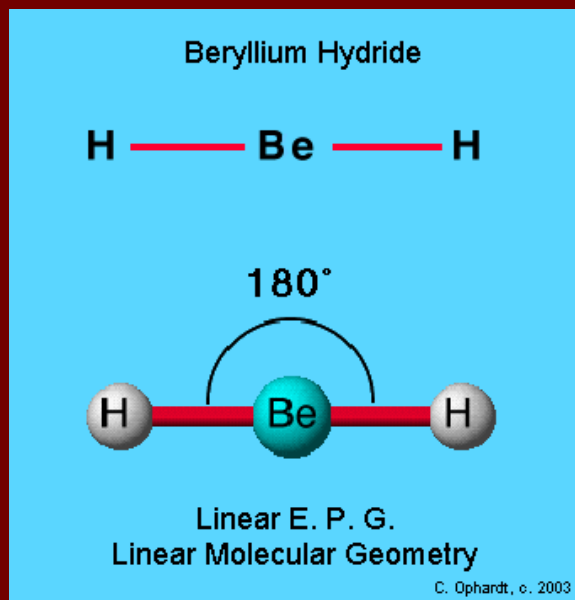
2 bonded/0 non-bonded

Linear

Symmetrical

Hybridization = sp

Are these polar molecules?  
What do we need to be polar?



No stealers so not polar

Stealer + not symmetrical = polar

Stealers = yes  
Symmetrical = yes

Polar = no

# MOLECULAR GEOMETRY

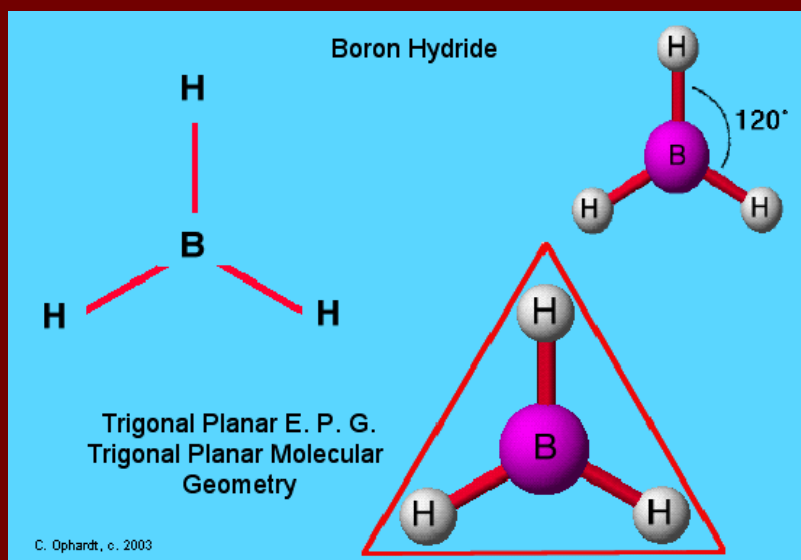
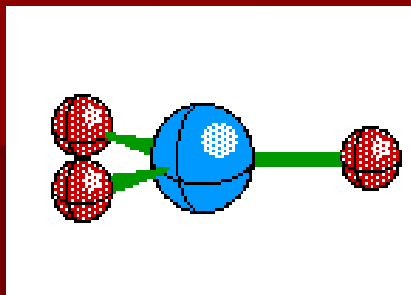
2 bonded/0 non-bonded

Trigonal planer

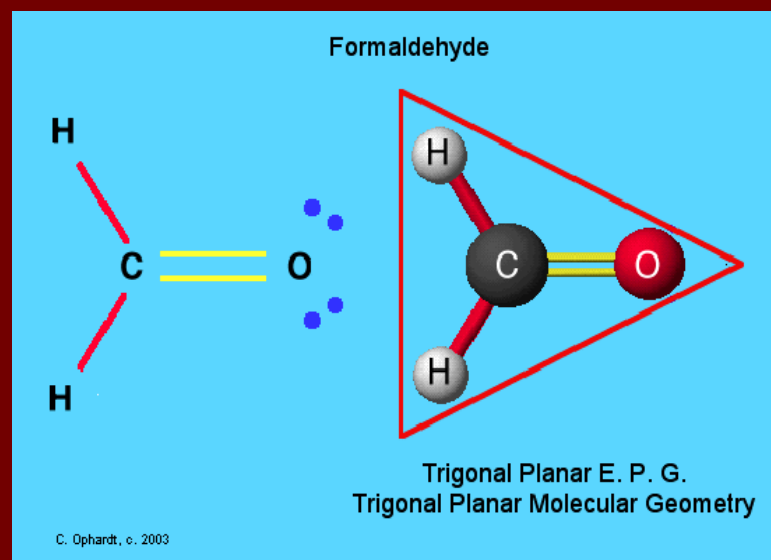
Symmetrical

Hybridization =  $sp^2$

Are these polar?



**No stealer!**  
**Non-polar**



**Stealer = yes**  
**Symmetrical = no**  
**Polar**



# MOLECULAR GEOMETRY

**Bent**

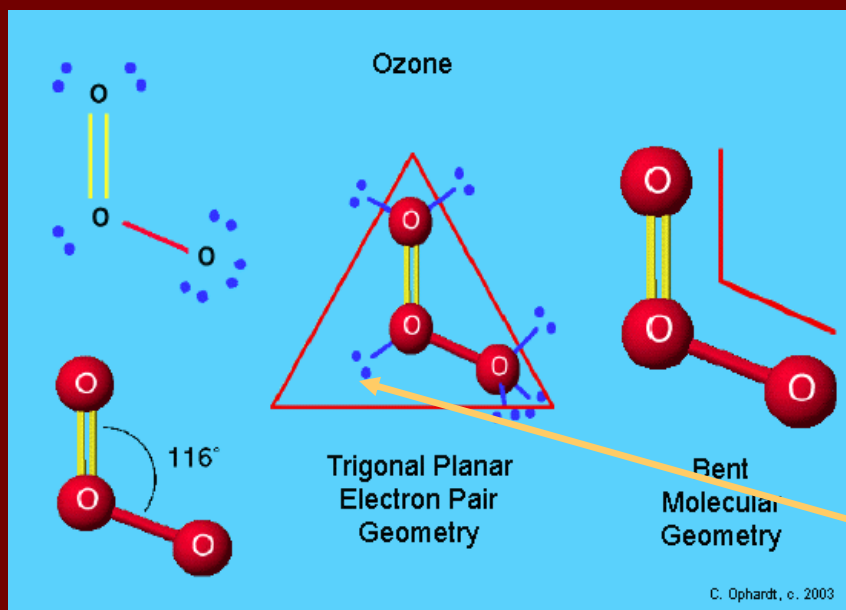
**2 bonded/1 non-bonded**

**Asymmetrical**

**Bond angle <120**

**Hybridization =  $sp^2$**

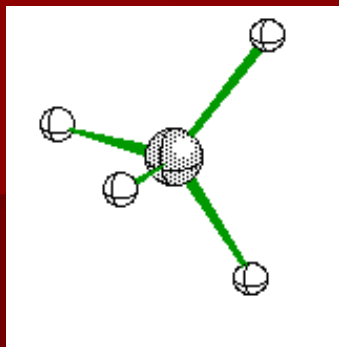
**Are these polar?**



**Dipole moment = 0**  
**Non-polar**

**Un-bonded pairs  
take more space  
than bonded  
pushing angle to  
slightly less than  
120**

# MOLECULAR GEOMETRY

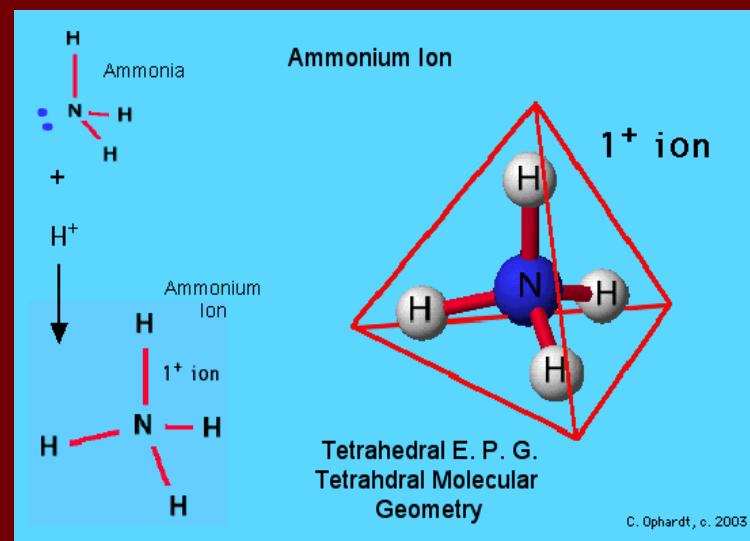
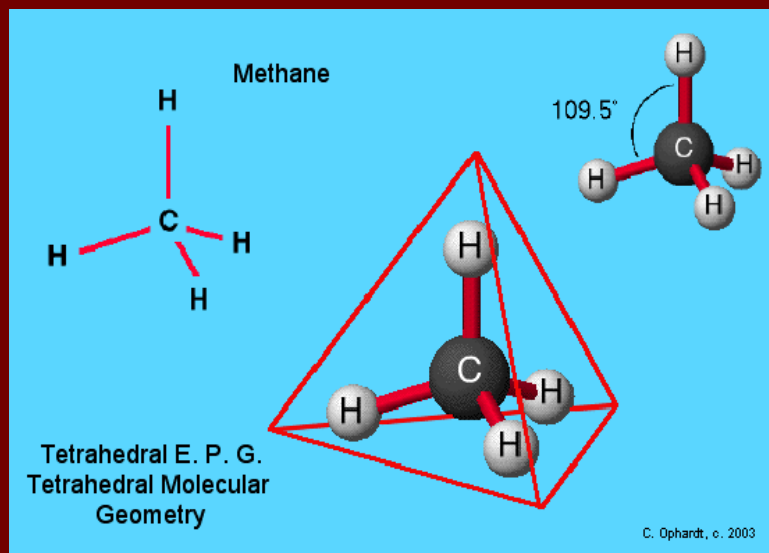


**tetrahedral**  
**Symmetrical**  
**4 bonded/0 non-bonded**  
**Bond angle: 109.5°**

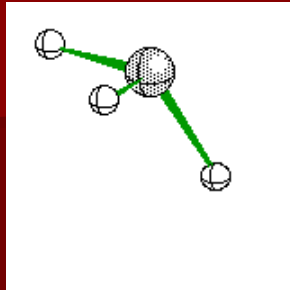
**Are these polar?**

**2 bonded/0 non-bonded**  
**Linear**  
**Symmetrical**

**2 bonded/0 non-bonded**  
**Linear**  
**Symmetrical**



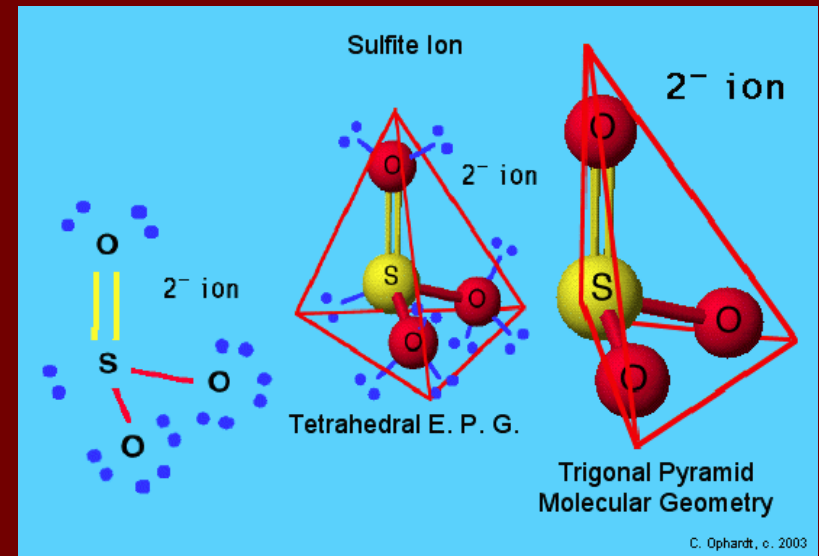
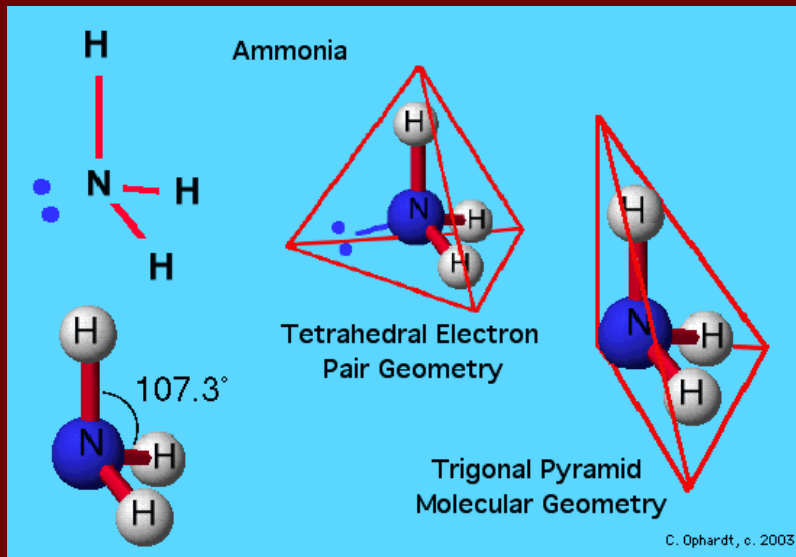
# MOLECULAR GEOMETRY



**Trigonal pyramidal**  
**3 bonded/ 1 non-bonded**  
**Bond angle < 109.5**  
**Asymmetrical**

**Stealer = Yes**  
**Symmetrical = No**  
**Polar**

**Stealer = Yes**  
**Symmetrical = no**  
**Polar**



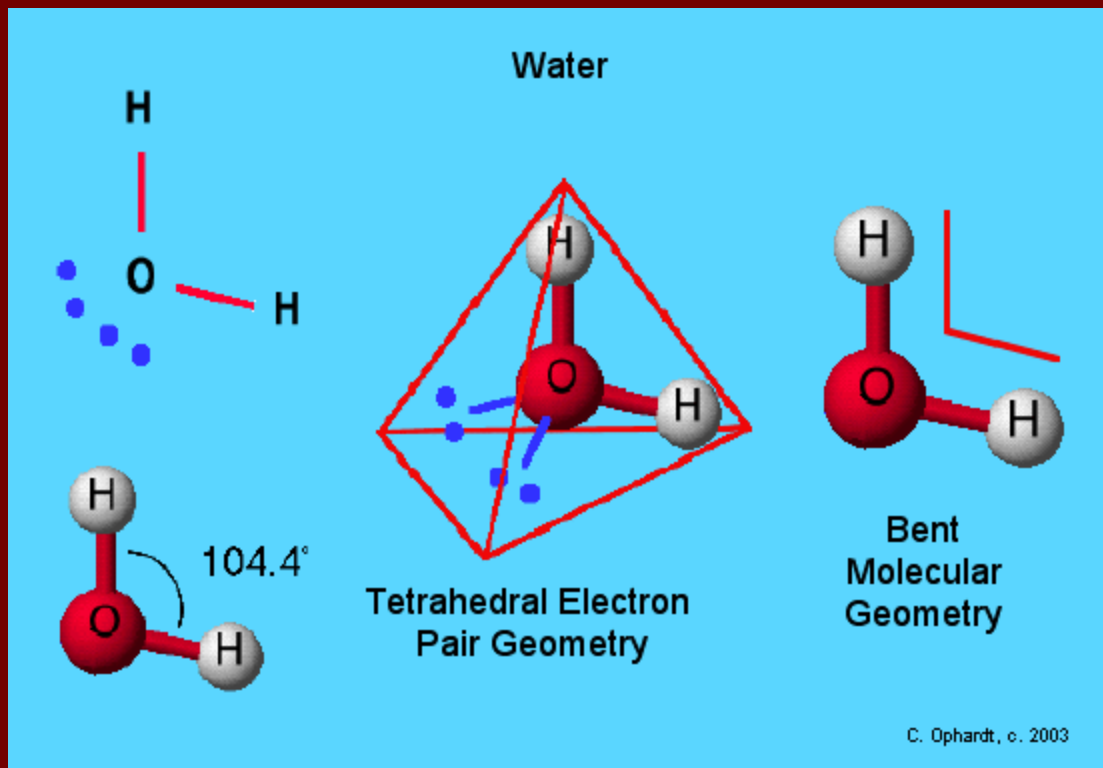
# MOLECULAR GEOMETRY

**Bent**

**2 bonded/ 2 non-bonded**

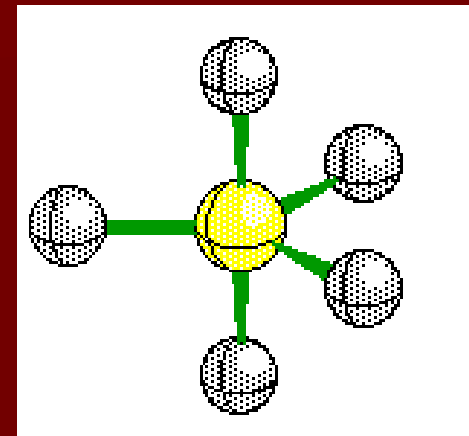
**Bond angle:  $< 109.5$**

**Asymmetrical**

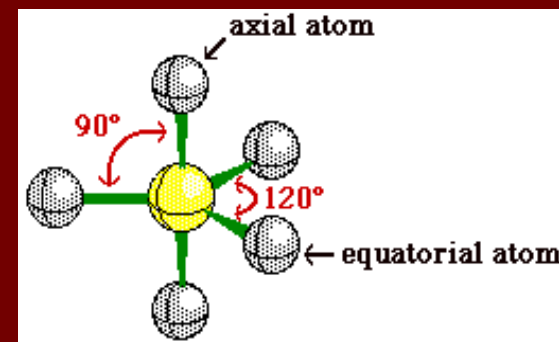
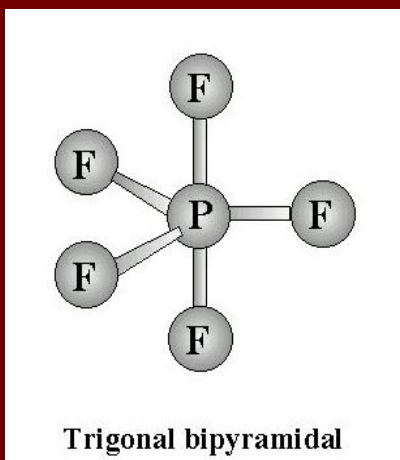


# MOLECULAR GEOMETRY

Trigonal bipyramidal  
Bond angle  
Equatorial:  $120^\circ$   
vertical:  $90^\circ$   
Symmetrical  
Hybridization =  $sp^3d$



Polar molecule?



# MOLECULAR GEOMETRY

See-Saw

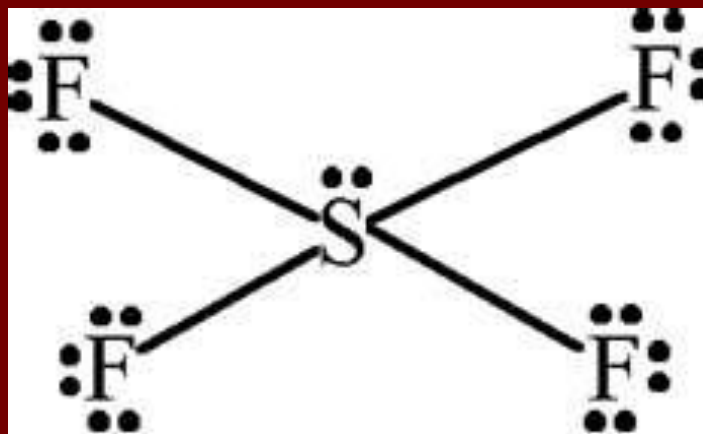
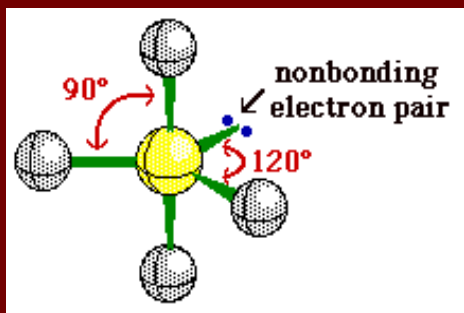
4 Bonded/1 Non-bonded

Bond angle

Equatorial:  $120^\circ$

vertical:  $90^\circ$

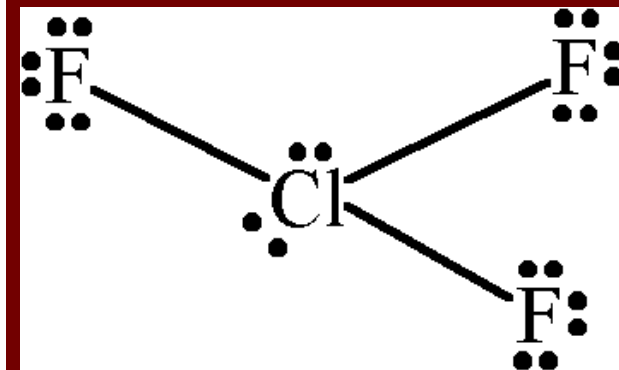
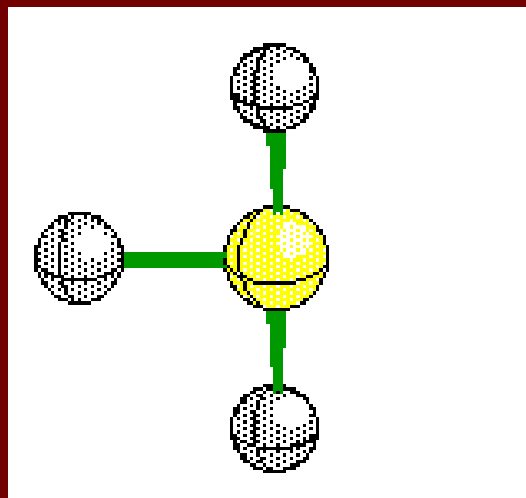
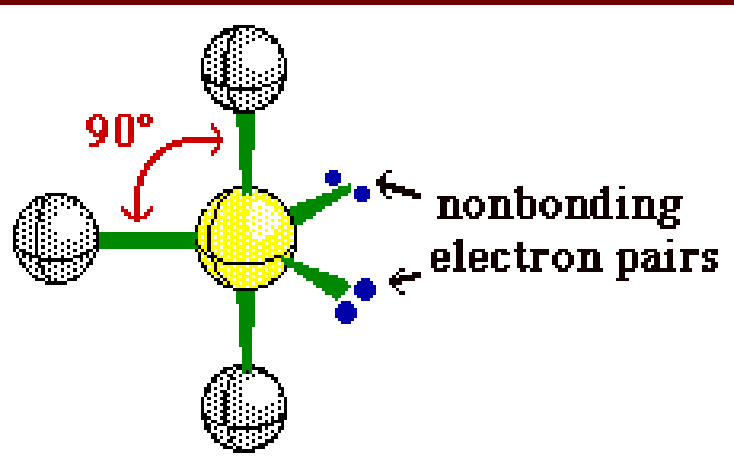
Asymmetrical



# MOLECULAR GEOMETRY

**T-Shaped**  
**3-bonded/2 non-bonded**  
**Bond angle**  
**Equatorial:  $120^\circ$**   
**Vertical:  $90^\circ$**   
**asymmetrical**

**Polar?**



# MOLECULAR GEOMETRY

**2-bonded/3 non-bonded**

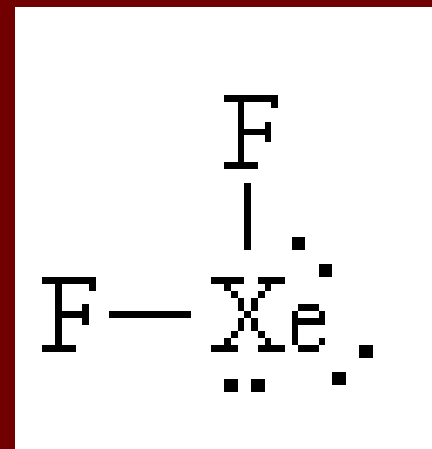
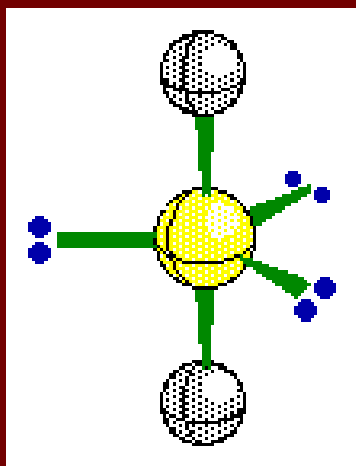
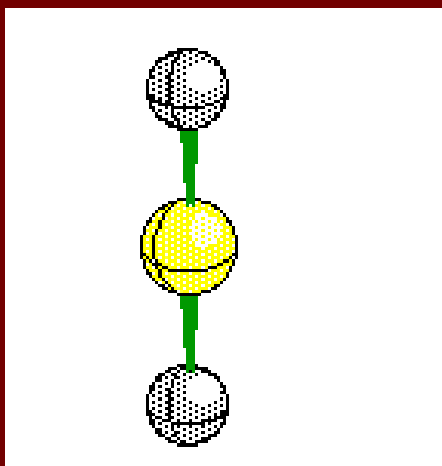
**Linear**

**Bond angle: 180**

**Symmetrical**

**Hybridization =  $sp^3d$**

**Polar?**





# MOLECULAR GEOMETRY

Octahedral or square bipyramidal

6 bonded/ 0 non-bonded

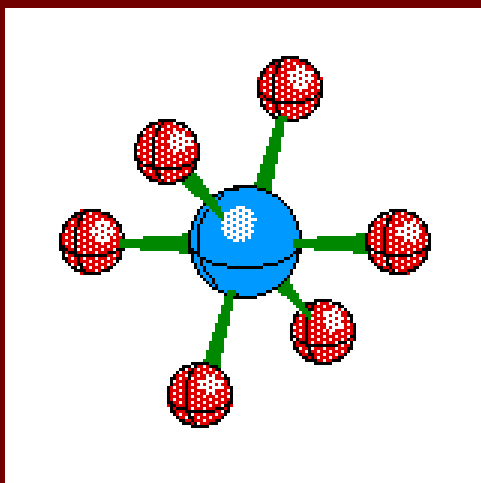
Bond angle

equatorial:  $90^\circ$

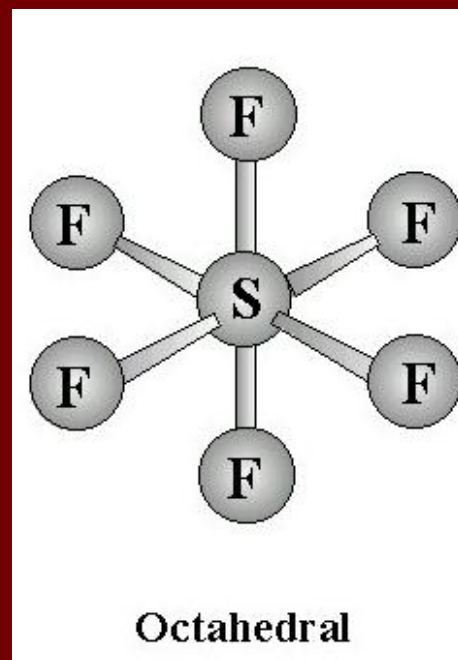
vertical:  $90^\circ$

Symmetrical

Hybridization =  $sp^3d^2$



**Polar?**



# MOLECULAR GEOMETRY

**Square pyramidal**

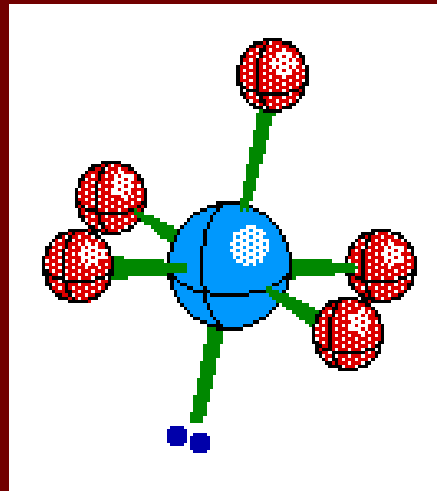
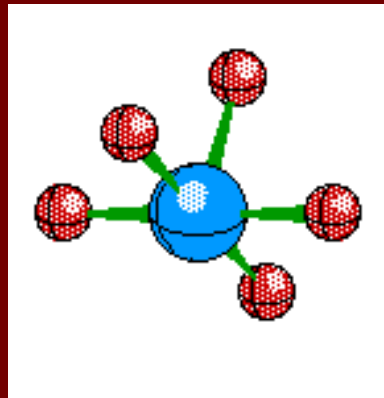
**5 bonded/1 non-  
bonded**

**Bond angle**

**Equatorial:  $90^\circ$**

**Vertical:  $90^\circ$**

**Asymmetrical**



# MOLECULAR GEOMETRY

Square Planar

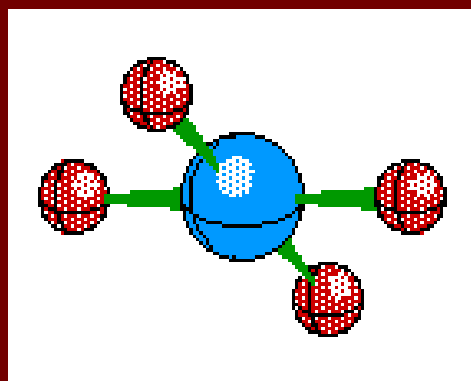
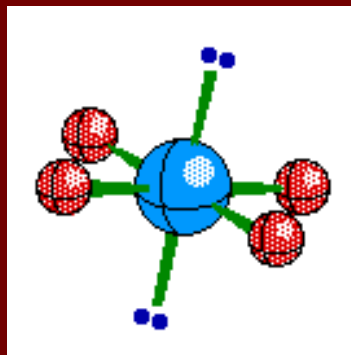
4 bonded / 2 non-bonded

Bond angle

Equatorial:  $90^\circ$

vertical:  $90^\circ$

Symmetrical



Polar?

