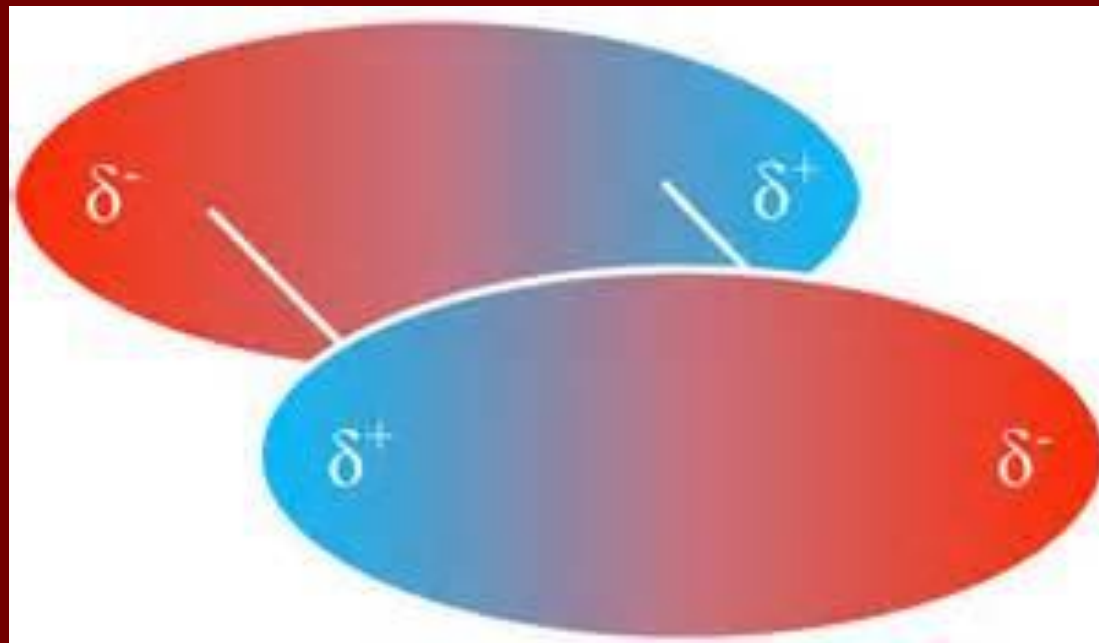


# Polarity

Andy Schweitzer

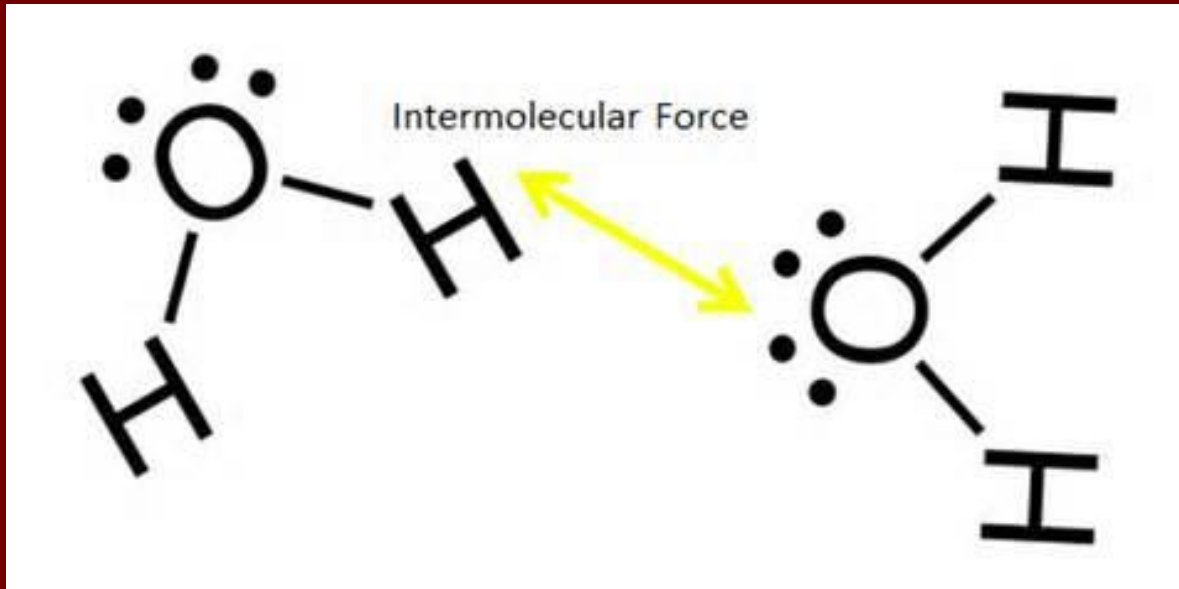
# What does it mean to be polar?

- A molecule is polar if it contains + and – somewhere in the molecule.



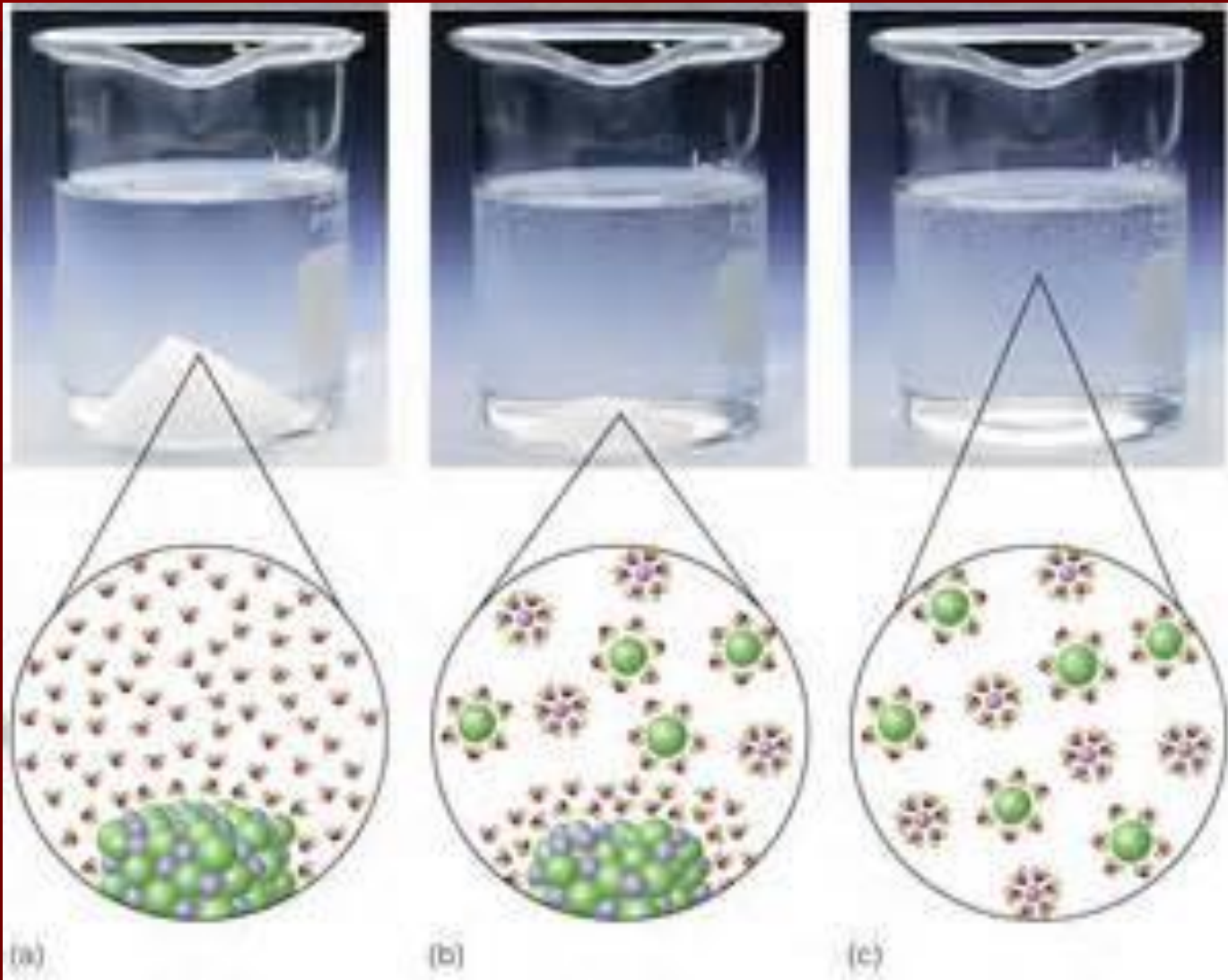
# IMF vs. Covalent

- IMF vs. Covalent



# How does polarity affect a molecules properties?

- Solute dissolving in a solvent?



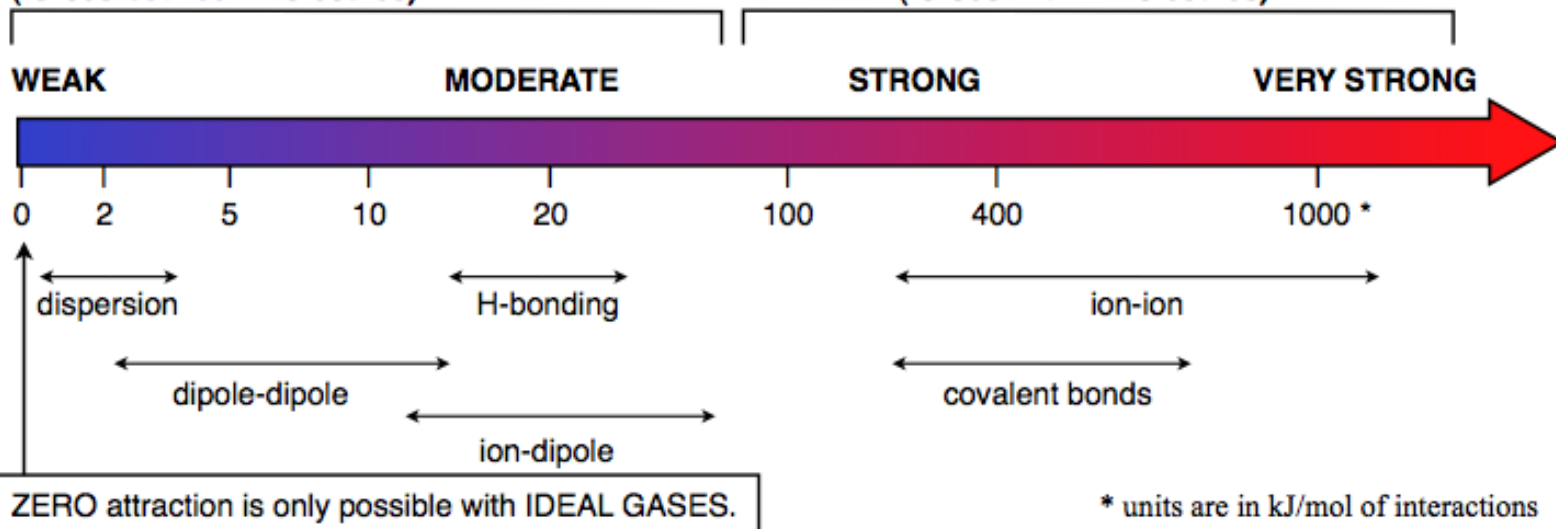
# Relative strength of Forces

## Intermolecular and Intramolecular Forces

Do realize in the following diagram that dispersion forces are capable of much more when the molecule containing them increases in size. Polarizability will increase considerably with a molecule's surface area (size). One should always assess what the conditions are as to which force is the governing force and what its magnitude is.

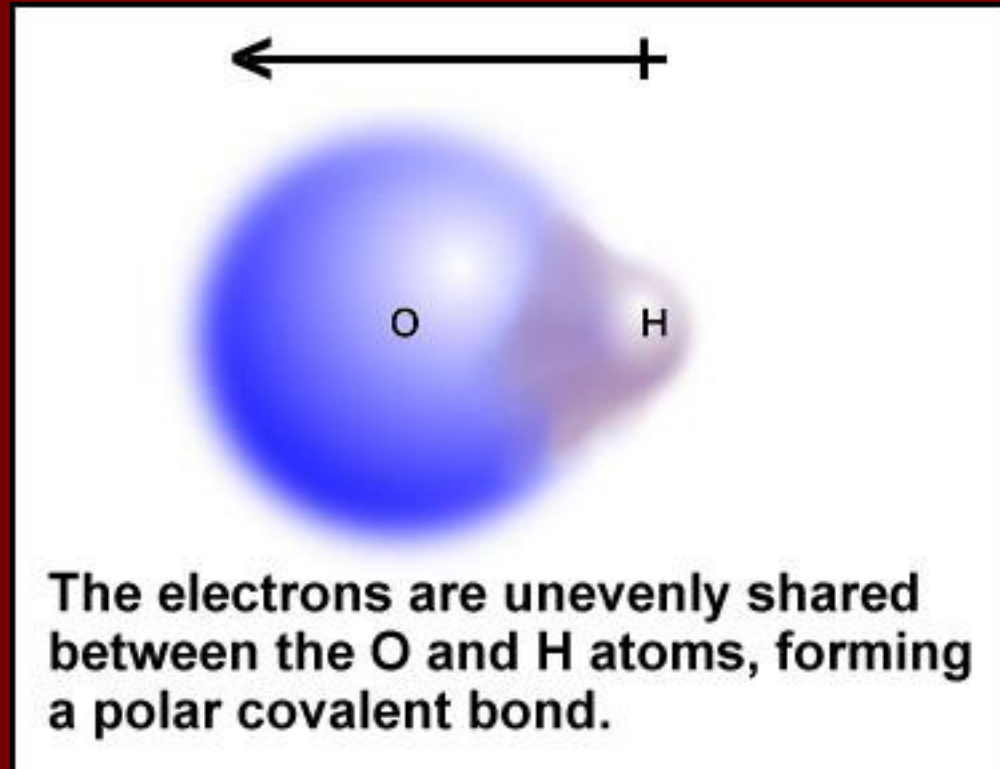
### Intermolecular Forces (forces *between* molecules)

### Intramolecular Forces (forces *within* molecules)



# 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.



# 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?

Mr. Schweitzer



\$1000 dollars

Baby



Who gets the money????



# Electronegativity difference?

Mr. Schweitzer



\$1000 dollars

Superman



Who gets the money????

# Electronegativity difference?

Mr. Schweitzer



\$500 dollars



Superman



\$500 dollars



Who gets the money????

# 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

- When ever you have an atom with a large electronegativity bonded to one that is small you will have an unequal sharing of electrons.
- Big Four
  - N, O, F, Cl -- any atom bonded to one of these three will cause a polar bond





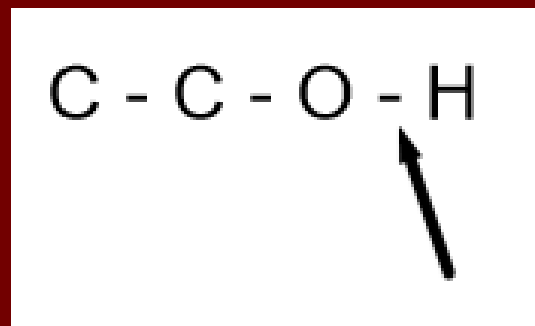
# Dipole moment

- Dipole moment is an actual numerical value for the dipole.
- Here is how you calculate?
- Each bond is done by itself

$$O = 3.5$$

$$\underline{H = 2.1}$$

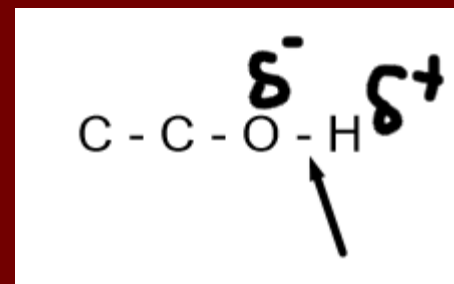
1.4 is dipole moment



# Dipole moment

- Ionic: above 1.7
- Polar covalent: above 0.45
- Pure covalent: below 0.45

This is a polar bond and a Polar molecule.



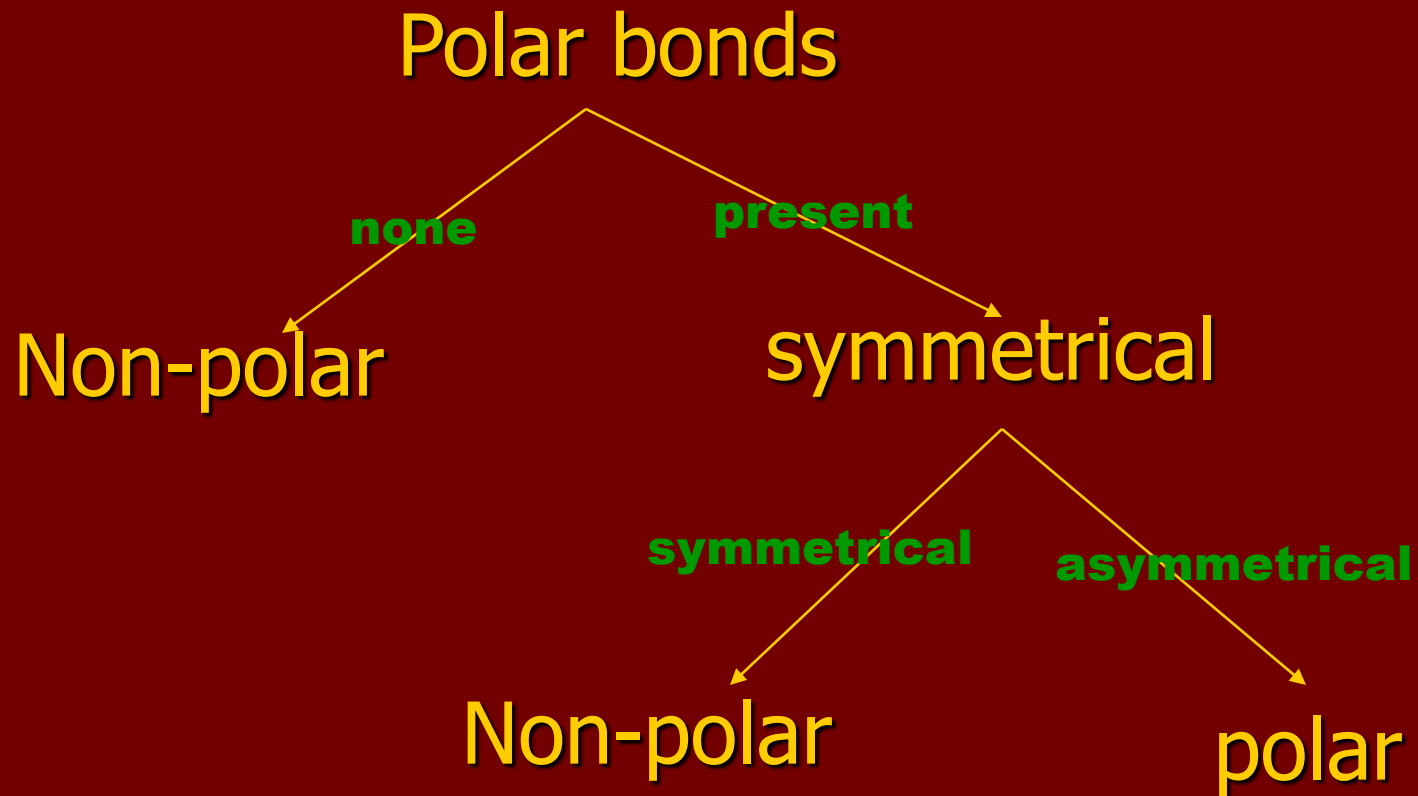
# Where will we see Dipole moment?

- We won't ever calculate in class on a test!
- F-F      What is the dipole moment of this?

Question: List the following substances in order of increasing dipole moment.

$F_2$     HF,    HCl

# Structure also affects polarity

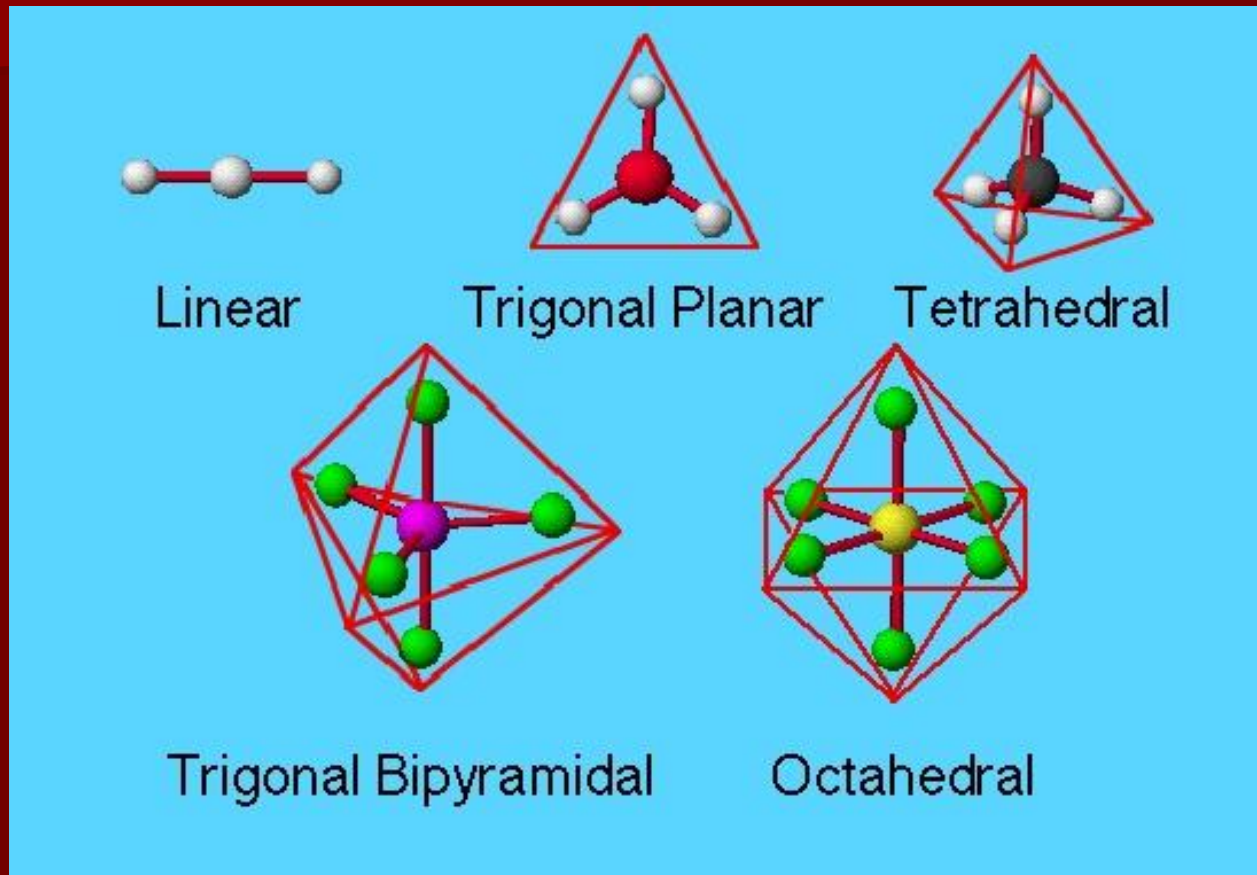




# Symmetrical vs. Asymmetrical

- 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.

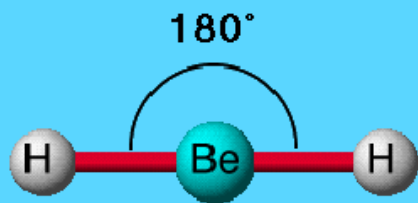
# MOLECULAR GEOMETRY

## LINEAR

### 2 BONDED/0 NON-BONDED

#### Symmetrical

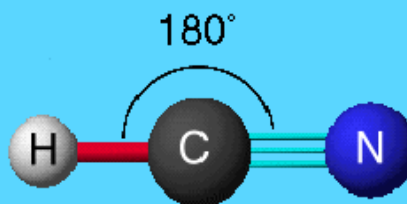
Beryllium Hydride



Linear E. P. G.  
Linear Molecular Geometry

C. Ophardt, c. 2003

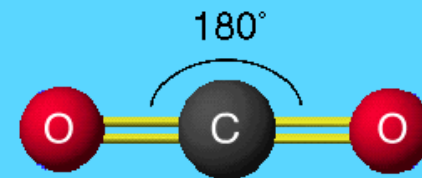
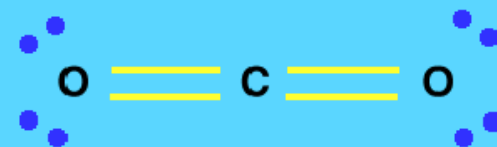
Hydrogen Cyanide



Linear E. P. G.  
Linear Molecular Geometry

C. Ophardt, c. 2003

Carbon Dioxide



Linear E. P. G.  
Linear Molecular Geometry

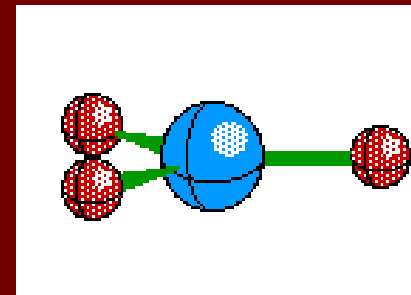
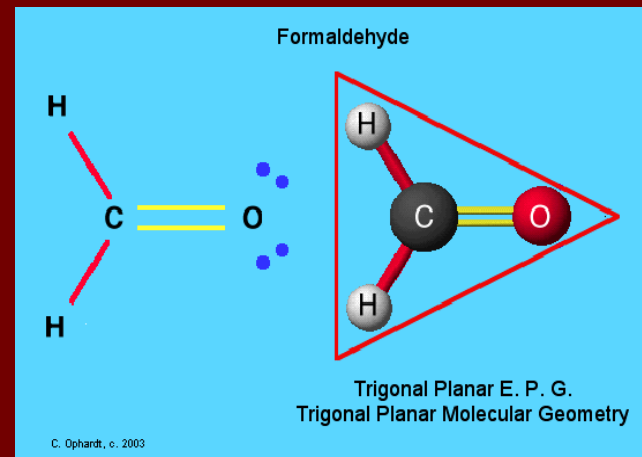
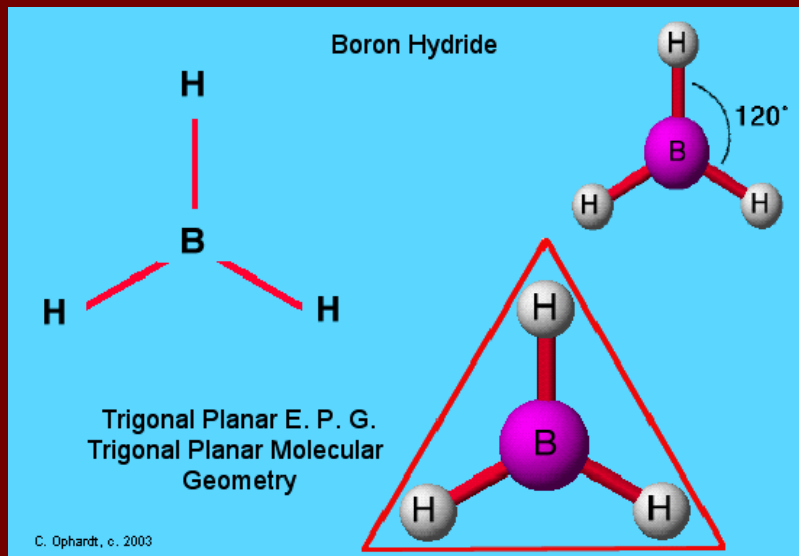
C. Ophardt, c. 2003

# MOLECULAR GEOMETRY

## TRIGONAL PLANER

### 3 BONDED/0 NON-BONDED

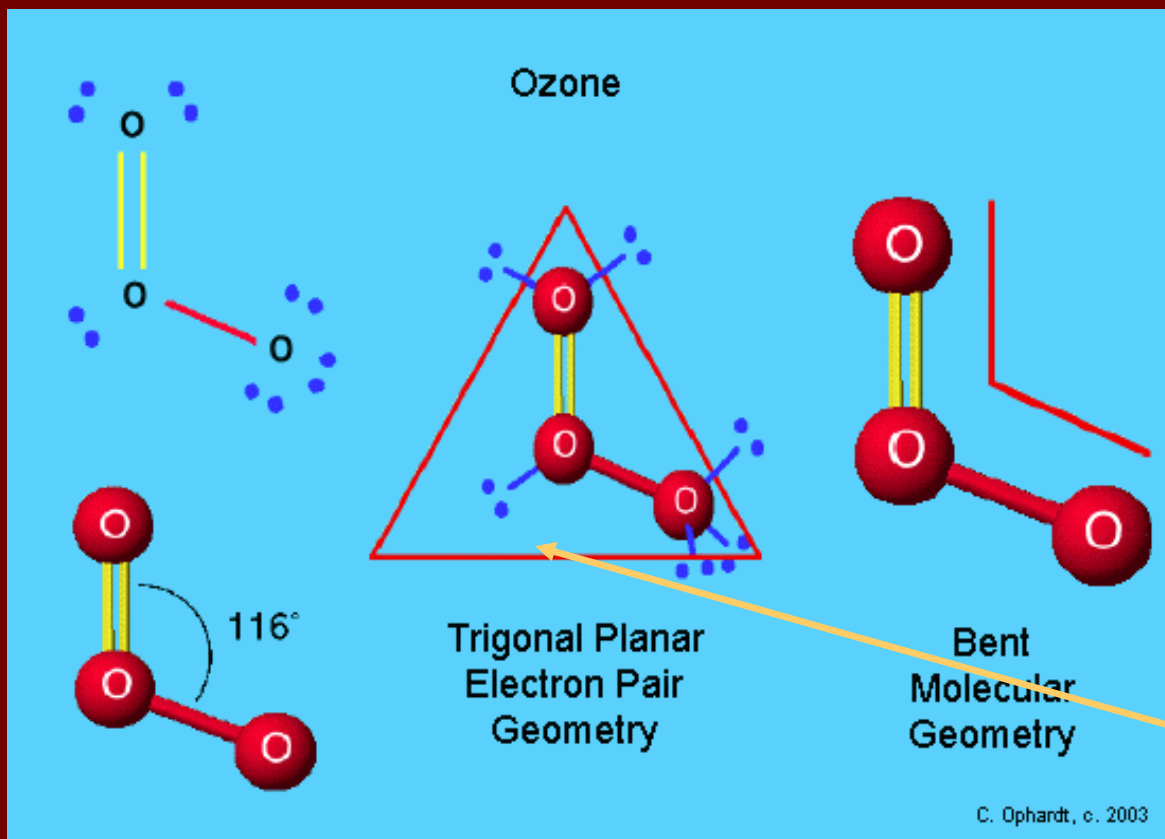
**Symmetrical**  
**120° Bond angle**



# MOLECULAR GEOMETRY

## BENT

### 2 BONDED/1 NON-BONDED



**Asymmetrical  
Bond angle <120**

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

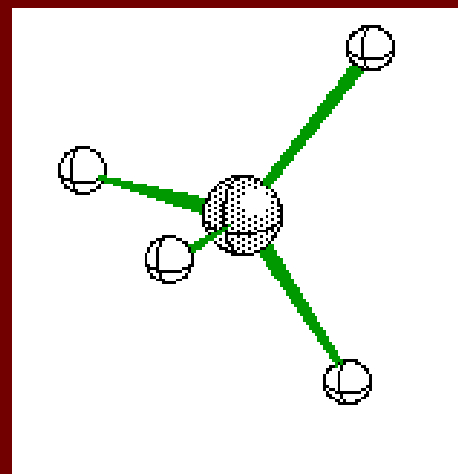
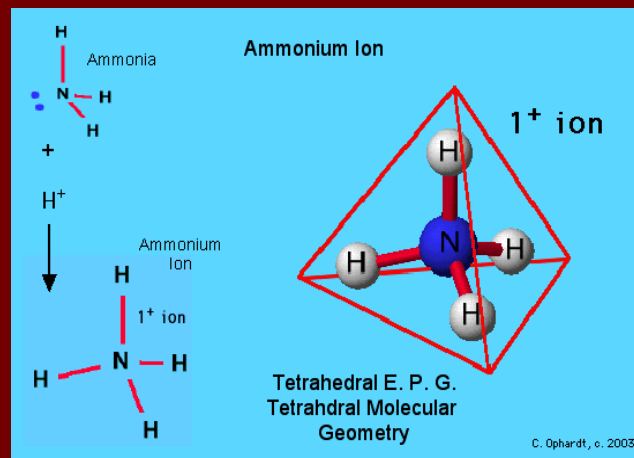
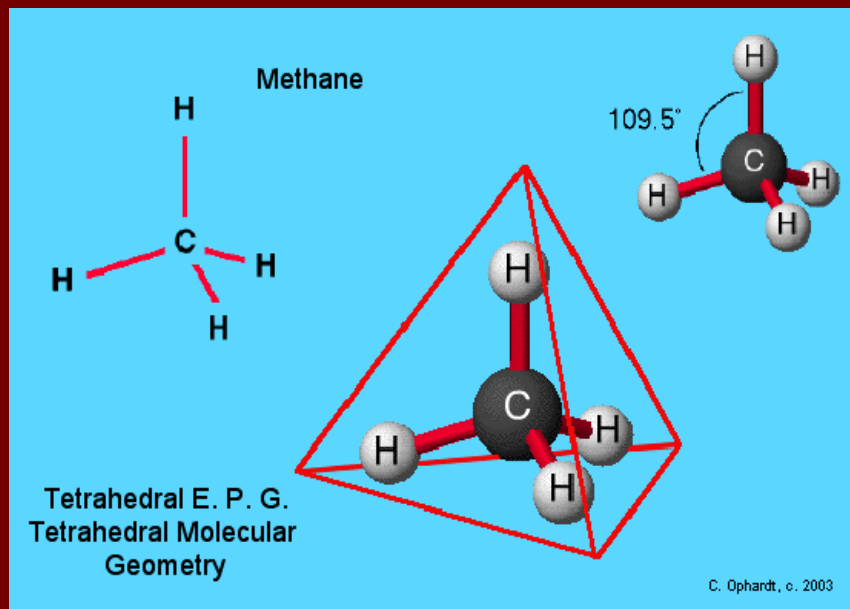
# MOLECULAR GEOMETRY

## TETRAHEDRAL

### 4 BONDED/0 NON-BONDED

**Symmetrical**

**Bond angle:  $109.5^\circ$**

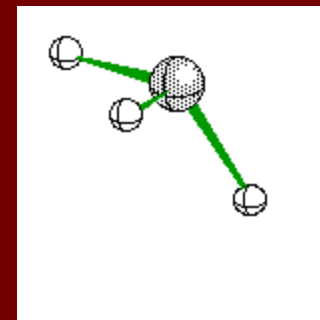
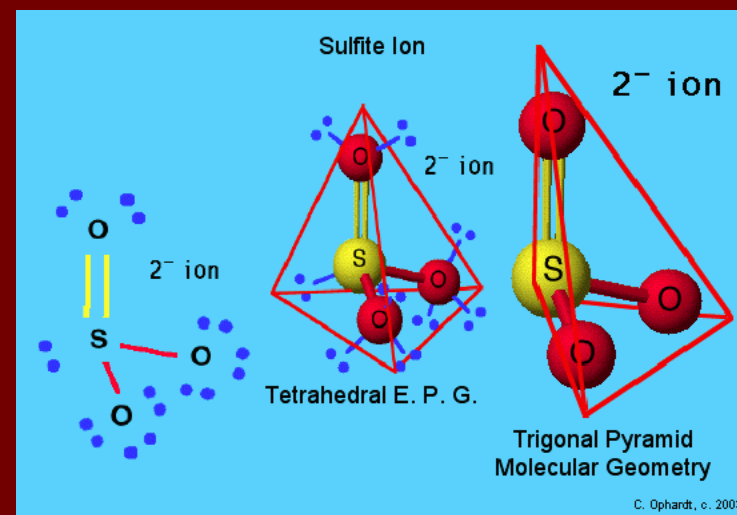
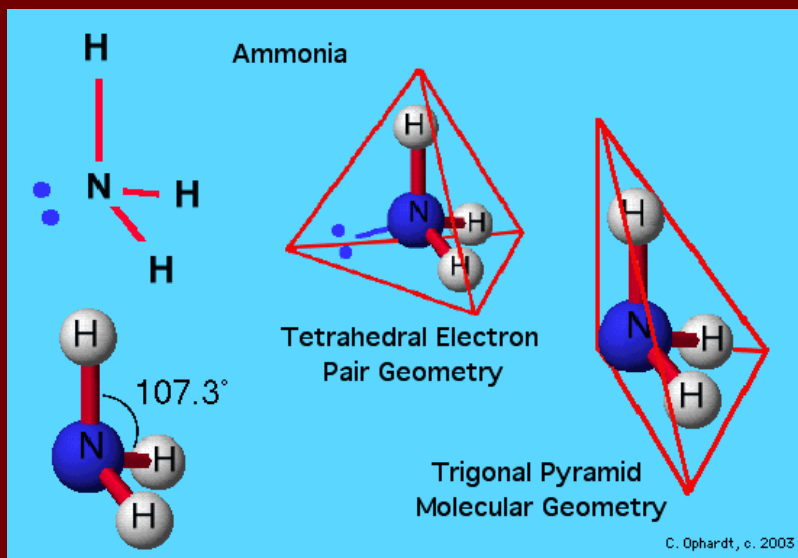


# MOLECULAR GEOMETRY

## TRIGONAL PYRAMIDAL

### 3 BONDED/1 NON-BONDED

**Bond angle < 109.5**  
**Asymmetrical**

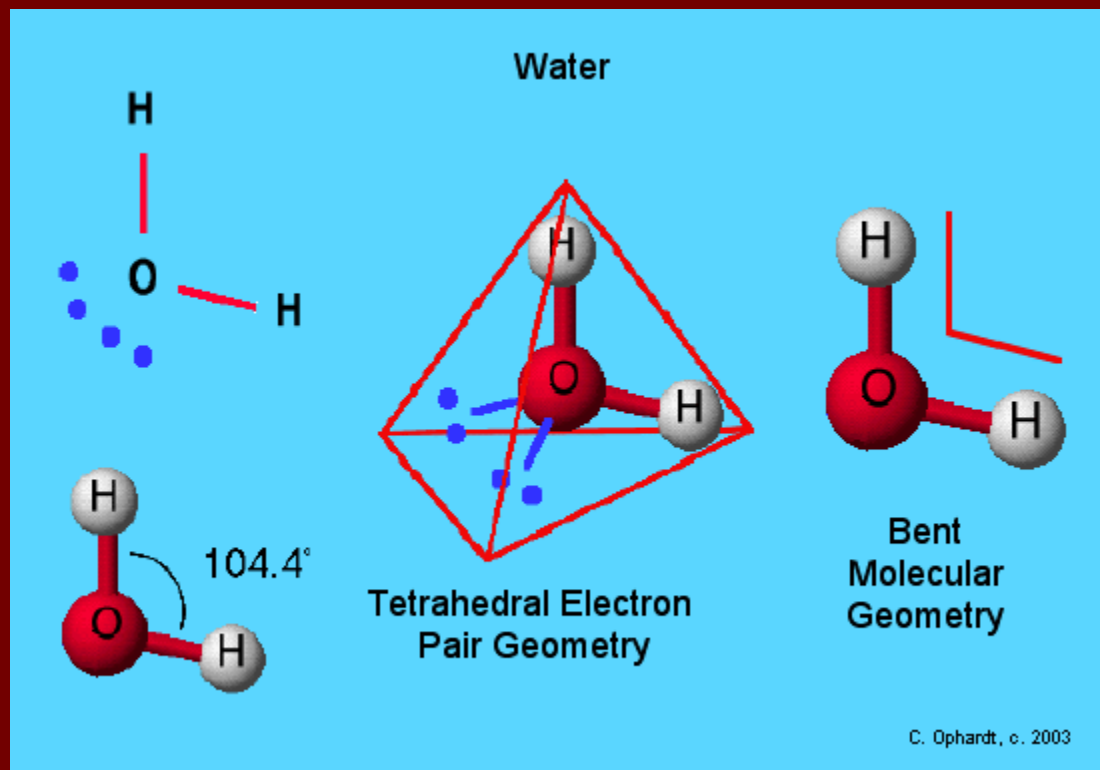


# MOLECULAR GEOMETRY

## BENT

### 2 BONDED/2 NON-BONDED

**Bond angle:  $< 109.5$   
Asymmetrical**





# MOLECULAR GEOMETRY

## TRIGONAL BIPYRAMIDAL

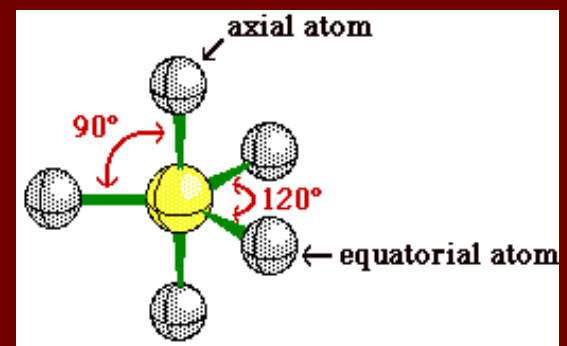
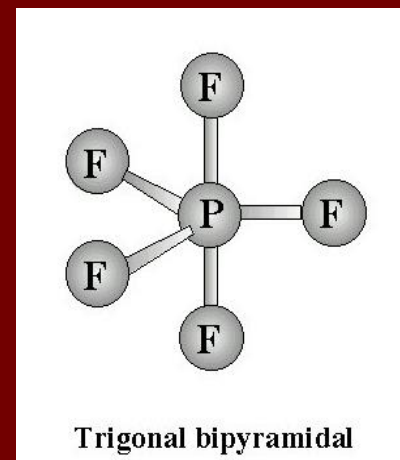
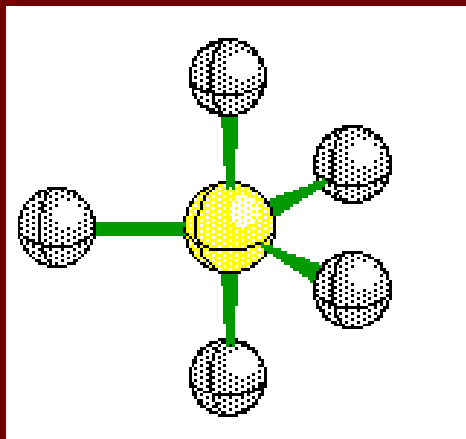
### 5 BONDED/0 NON-BONDED

Bond angle

Equatorial:  $120^\circ$

vertical:  $90^\circ$

symmetrical



# MOLECULAR GEOMETRY

## SEE-SAW

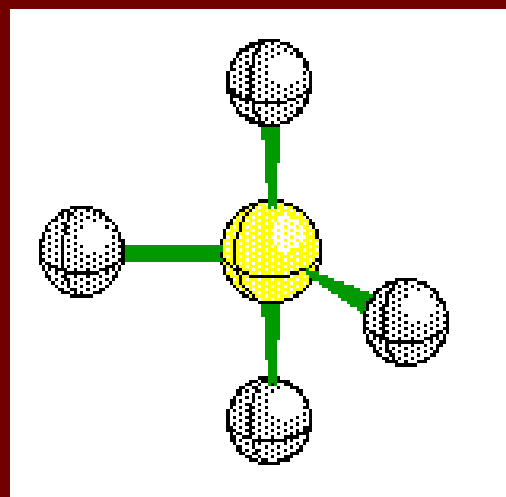
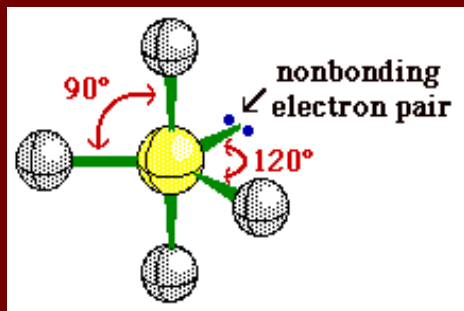
### 4 BONDED/1 NON-BONDED

Bond angle

Equatorial:  
 $120^\circ$

vertical:  $90^\circ$

Asymmetrical

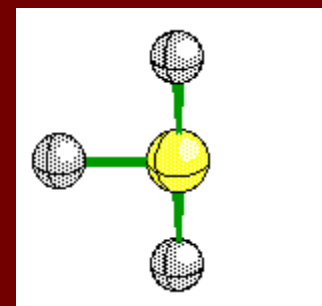
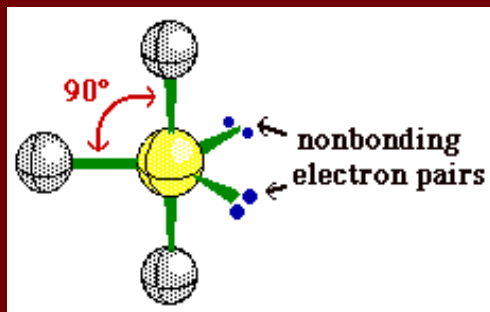


# MOLECULAR GEOMETRY

## T-SHAPED

### 3 BONDED/2 NON-BONDED

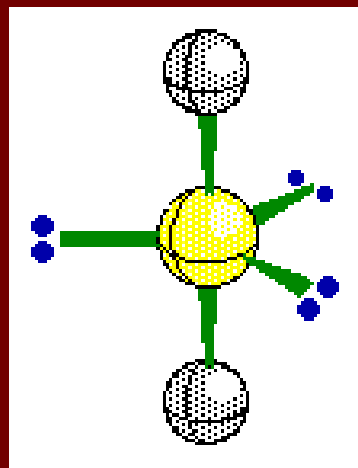
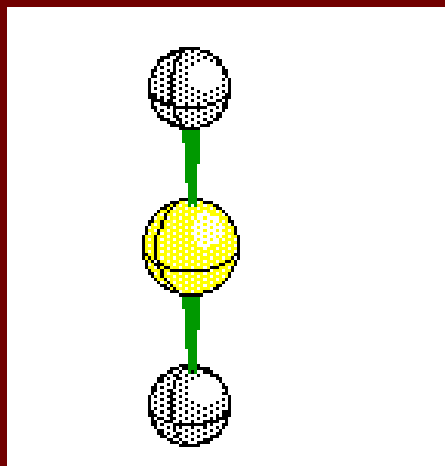
**Bond angle**  
**Equatorial:  $120^\circ$**   
**Vertical:  $90^\circ$**   
**asymmetrical**



# MOLECULAR GEOMETRY

## LINEAR

2 BONDED/3 NON-BONDED



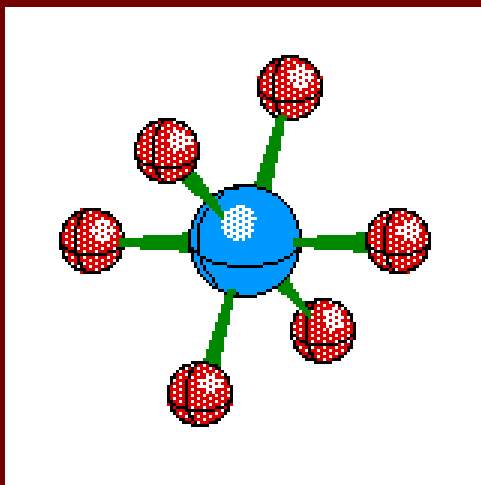
# MOLECULAR GEOMETRY

## OCTAHEDRAL

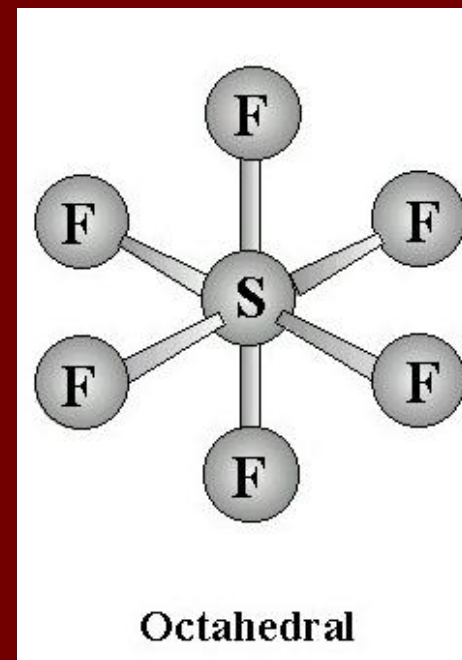
OR

## SQUARE BIPYRAMIDAL

### 6 BONDED/0 NON-BONDED



Bond angle  
equatorial:  
 $90^\circ$   
vertical:  $90^\circ$   
Symmetrical

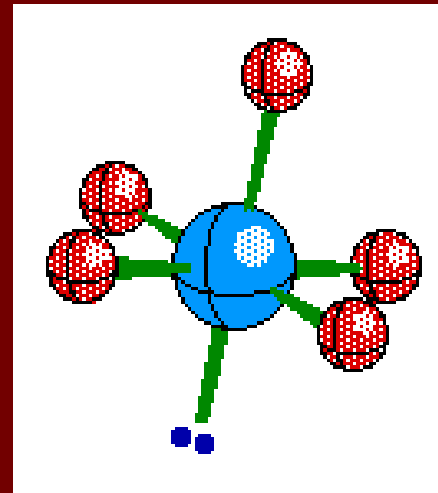
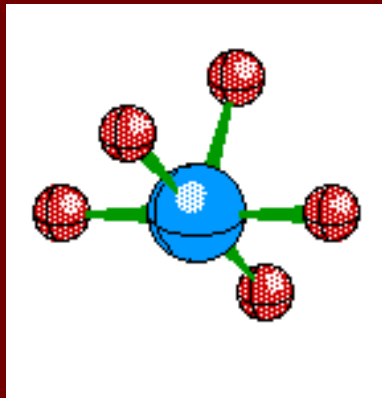


# MOLECULAR GEOMETRY

## 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

