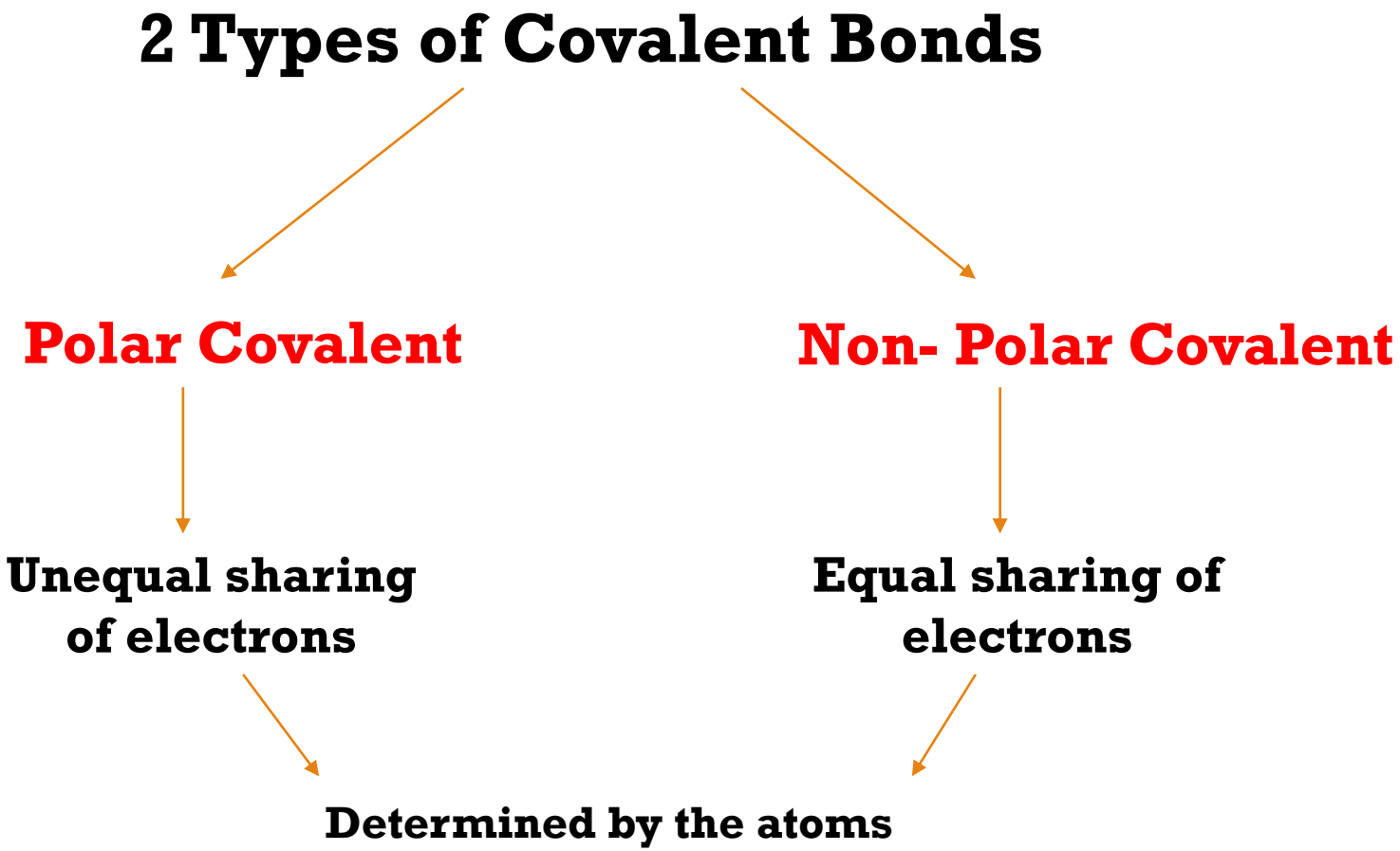
Molecular Shape and Polarity

SBI4U

Remember . . . Polarity



Remember . . . Electronegativity

Pauling Electronegativity Values

1 **H** 2.20																
3 **Li** 0.98	4 **Be** 1.57											5 **B** 2.04	6 **C** 2.55	7 **N** 3.04	8 **O** 3.44	9 **F** 3.98
11 **Na** 0.93	12 **Mg** 1.31											13 **Al** 1.61	14 **Si** 1.90	15 **P** 2.19	16 **S** 2.58	17 **Cl** 3.16
19 **K** 0.82	20 **Ca** 1.00	21 **Sc** 1.36	22 **Ti** 1.54	23 **V** 1.63	24 **Cr** 1.66	25 **Mn** 1.55	26 **Fe** 1.83	27 **Co** 1.88	28 **Ni** 1.91	29 **Cu** 1.90	30 **Zn** 1.65	31 **Ga** 1.81	32 **Ge** 2.01	33 **As** 2.18	34 **Se** 2.55	35 **Br** 2.96
37 **Rb** 0.82	38 **Sr** 0.95	39 **Y** 1.22	40 **Zr** 1.33	41 **Nb** 1.6	42 **Mo** 2.16	43 **Tc** 1.9	44 **Ru** 2.2	45 **Rh** 2.28	46 **Pd** 2.20	47 **Ag** 1.93	48 **Cd** 1.69	49 **In** 1.78	50 **Sn** 1.96	51 **Sb** 2.05	52 **Te** 2.1	53 **I** 2.66
55 **Cs** 0.79	56 **Ba** 0.89	57 **La** 1.1	72 **Hf** 1.3	73 **Ta** 1.5	74 **W** 2.36	75 **Re** 1.9	76 **Os** 2.2	77 **Ir** 2.20	78 **Pt** 2.28	79 **Au** 2.54	80 **Hg** 2.00	81 **Ti** 1.62	82 **Pb** 2.33	83 **Bi** 2.02	84 **Po** 2.0	85 **At** 2.2
87 **Fr** 0.7	88 **Ra** 0.9															

Pauling Scale set electronegativities on a scale from **0.7 to 4.0**

Remember . . . Lewis Dot Diagrams

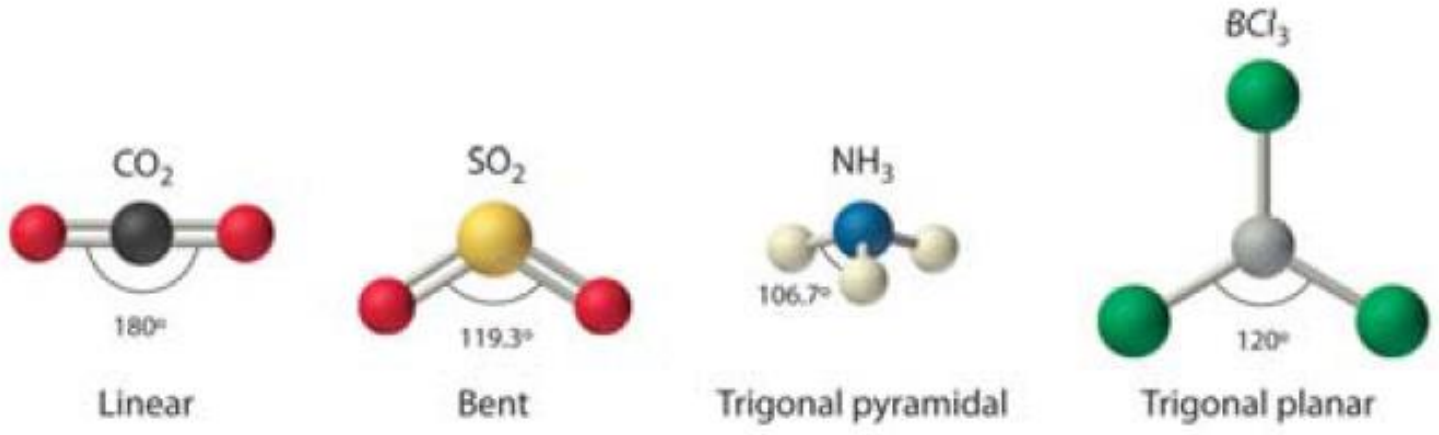
Complete the following Lewis Dot Diagrams:

CH_4 NH_3 O_2

Molecular Shapes

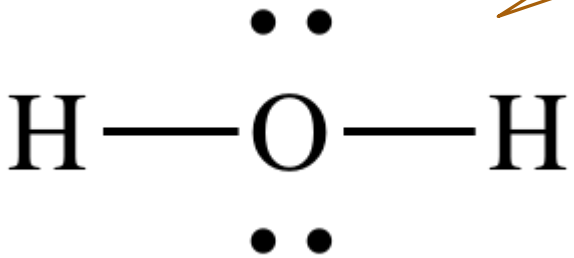
- The shape of a molecule is dictated by the electron arrangement within the molecule.
  - ***Bonding pairs:***
  - ***Lone pairs:***

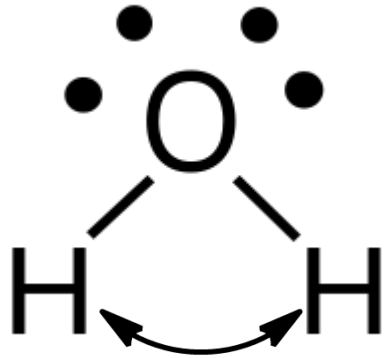
Some common molecular shapes



Molecular Shapes

The lone pairs will push the bonding pairs away. Thus the molecule will not have a linear shape.

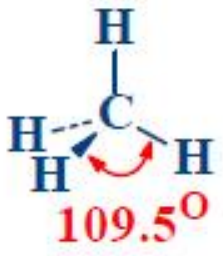


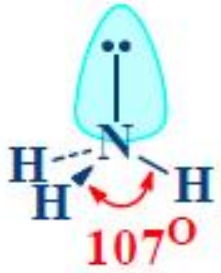


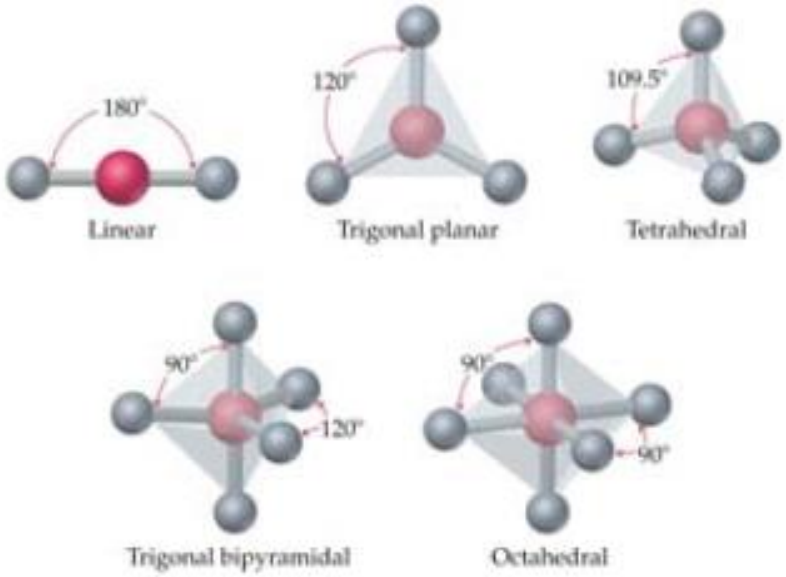
104.5°

Effect of Nonbonding Electrons

The H-X-H bond angle decreases when 'X' changes from a carbon atom (C) to a nitrogen (N) atom.

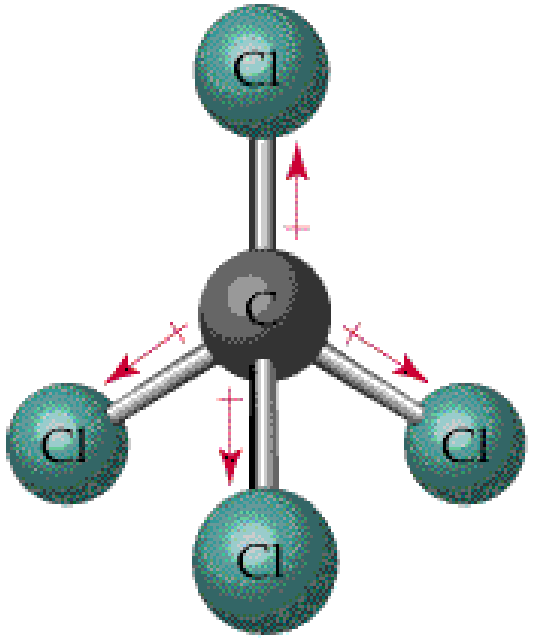






Molecular Shape and Polarity

If the bonds between the central atom are all nonpolar, the overall molecule is nonpolar. If the bonds between the central atom are polar, one must consider the **SHAPE** of the overall molecule.

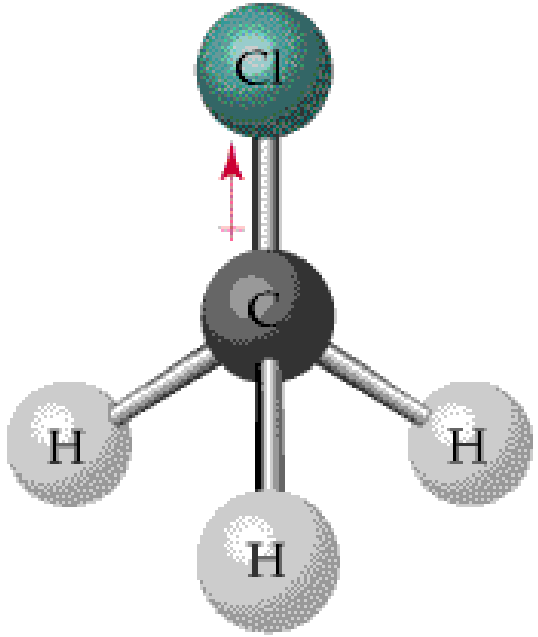


Nonpolar

*If the polar bonds are **symmetrical**, they offset one another and the molecule becomes **NONPOLAR**.*

Molecular Shape and Polarity

If the bonds between the central atom are all nonpolar, the overall molecule is nonpolar. If the bonds between the central atom are polar, one must consider the **SHAPE** of the overall molecule.



Polar

*If the polar bonds are **asymmetrical**, then one of the bonds will be slightly more polar. The molecule is **POLAR**.*

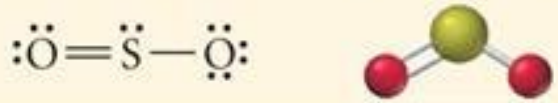
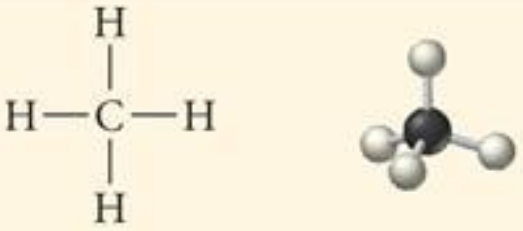
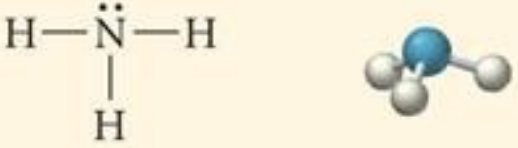
Electron Geometry vs. Molecular Geometry

The overall shape and polarity of the molecule can be determined using the **VSEPR Theory**
(Valence Sheel Electron Pair Repulsion Theory)

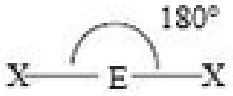
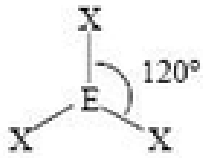
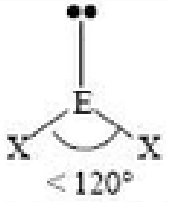
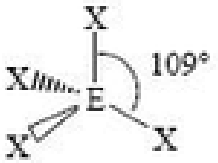
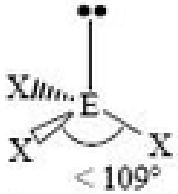
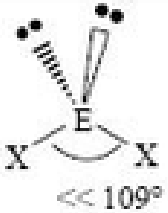
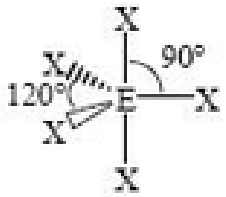
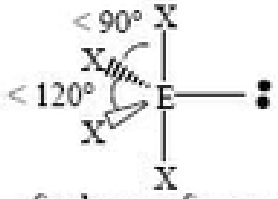
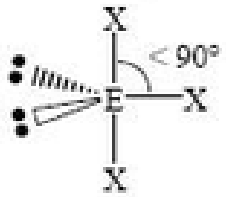
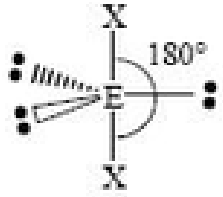
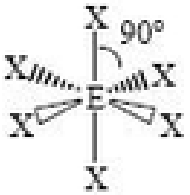
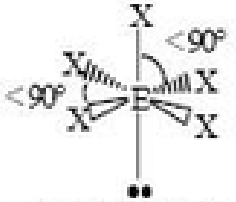
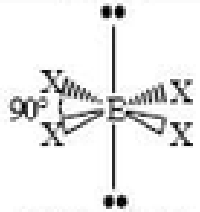
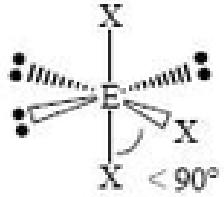
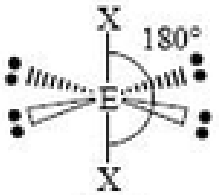
Electron Geometry:

Molecular Geometry:

TABLE 10.1 Electron and Molecular Geometries

Electron Groups*	Bonding Groups	Lone Pairs	Electron Geometry	Molecular Geometry	Approximate Bond Angles	Example
2	2	0	Linear	Linear	180°	
3	3	0	Trigonal planar	Trigonal planar	120°	
3	2	1	Trigonal planar	Bent	<120°	
4	4	0	Tetrahedral	Tetrahedral	109.5°	
4	3	1	Tetrahedral	Trigonal pyramidal	<109.5°	
4	2	2	Tetrahedral	Bent	<109.5°	

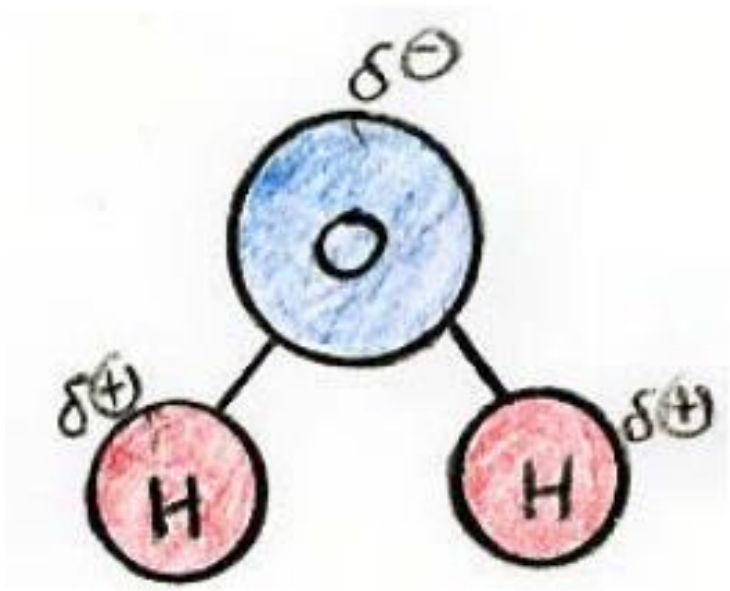
VSEPR Geometries

Steric No.	Basic Geometry 0 lone pair	1 lone pair	2 lone pairs	3 lone pairs	4 lone pairs
2	 Linear				
3	 Trigonal Planar	 Bent or Angular			
4	 Tetrahedral	 Trigonal Pyramid	 Bent or Angular		
5	 Trigonal Bipyramid	 Sawhorse or Seesaw	 T-shape	 Linear	
6	 Octahedral	 Square Pyramid	 Square Planar	 T-shape	 Linear

Molecular Polarity

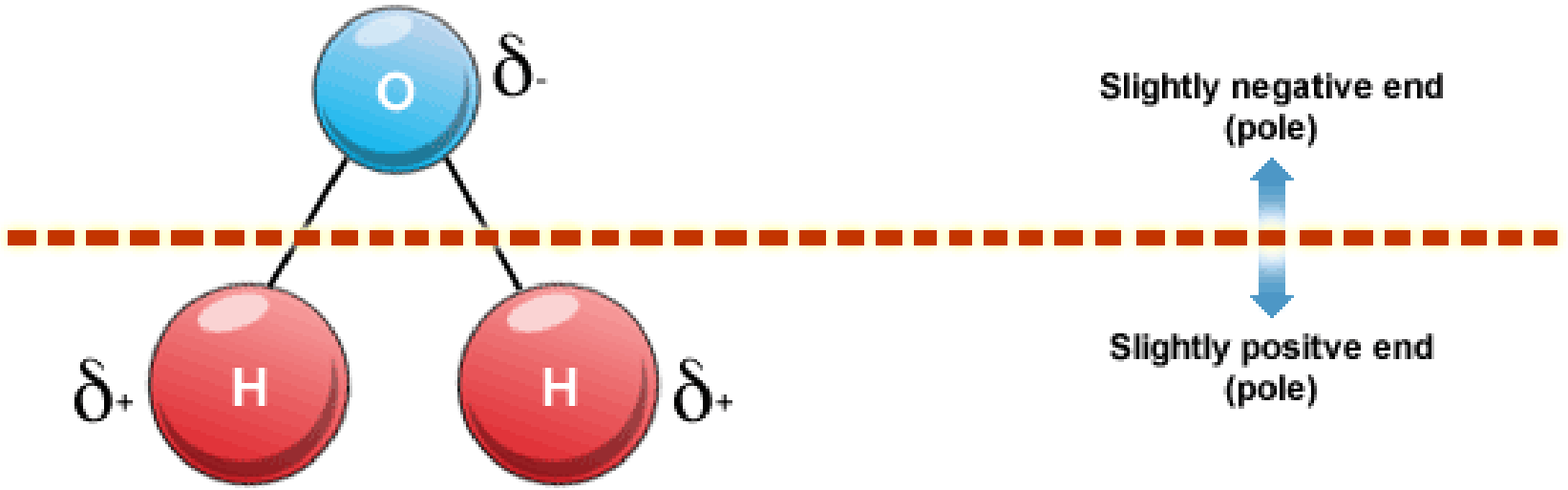
Shape determines whether the entire molecule is ***polar or non-polar.***

- Polar molecules have ends with partial charges (+ / -)
- Influences interactions with other molecules



What makes a molecule polar?

- Contains polar bonds (Δ EN > 0.4)
- Shape: Electrons are distributed asymmetrically



Molecular Shape

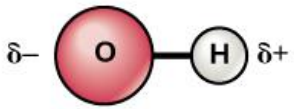
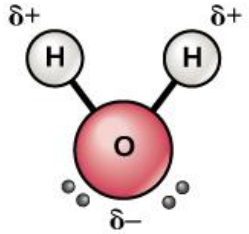
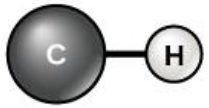
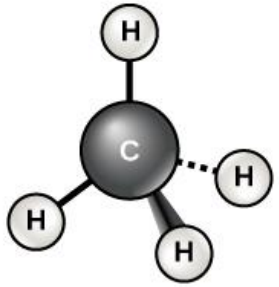
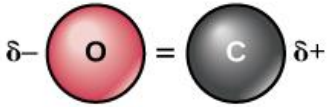
- Covalent bonds can be polar or nonpolar depending on the electronegativity of the atoms involved.

- ***The shape of a molecule can also influence its polarity.***

  a) Symmetrical structures containing more than two atoms only produce nonpolar molecules.

  b) Non-symmetrical structures can produce both polar or nonpolar depending on the atoms involved.

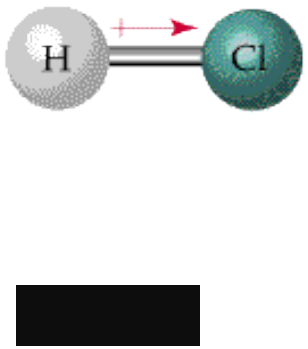
Determining Polarity

	Bond type	Molecular shape	Molecular type
Water	 Polar covalent	 Bent	Polar
Methane	 Nonpolar covalent	 Tetrahedral	Nonpolar
Carbon dioxide	 Polar covalent	 Linear	Nonpolar

Even if the bonds withing a compound is polar, the overall shape must be asymmetrical for it to be considered a polar molecule.

Practice Problems. . .

Are the following molecules **polar** or **nonpolar**?



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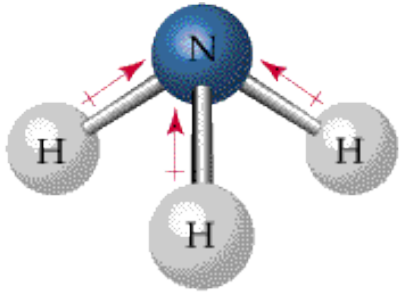

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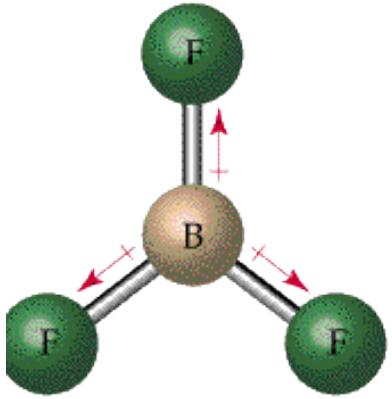

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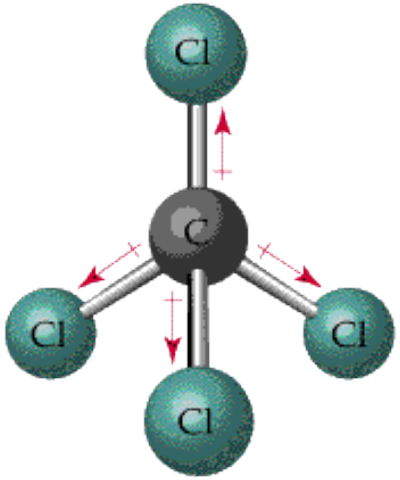

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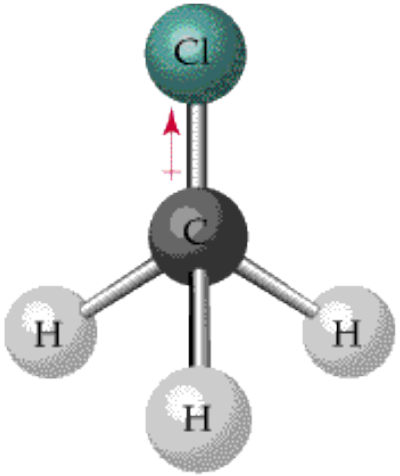

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How to Determine the Polarity

1. Draw the Lewis Dot Structure
2. Identity the number of bond pairs and lone pairs in the molecule
3. Identify the electron-group geometry
4. Determine whether the molecule is Symmetrical or Asymmetrical

Practice Problems

Determine whether the molecules below are **polar** or **nonpolar**.

1. SiH_4	**2. CS_2**
3. N_2	**4. SH_2**

Homework

- Complete the Molecular Shape and Polarity Worksheet
- Textbook Review Questions: pg. 13 # 4 & 5 pg. 17 # 8 & 11