

# Polar Molecules

Section 3.3

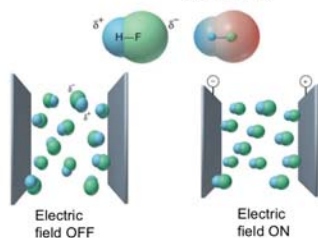
## Recap from 2.3

Polar covalent bonds:

- $\Delta EN$ : 0.5 – 1.69
- electron sharing is NOT equal between atoms
- more electronegative atom has a negative dipole ( $\delta^-$ )

Polar molecules are entire **molecules** that have partially positive and negative **ends**.

Figure 10.12 The orientation of polar molecules in an electric field.



TWO things are required to make a molecule polar:

- ✓ **presence of polar bonds** – dipole within bond
- ✓ **3-D geometry** – asymmetrical arrangement of bond dipoles in molecule
  - If symmetrical, the bond dipoles would cancel each other out



Non-polar bonds  
NON-POLAR MOLECULE

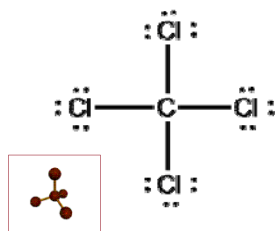
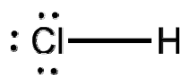


Polar bonds  
Asymmetrical dipoles  
POLAR MOLECULE

## Polarity & 3-D Geometry

If the distribution of bond dipoles around the central atom is **asymmetrical**, the overall molecule will be **polar**.

If the bond dipoles **cancel each other out**, the overall molecule is **not polar**.



Type	General example	Cancellation of polar bonds	Specific example	Ball-and-stick model
linear molecules with 2 identical bonds	B—A—B	$\leftarrow + \quad + \rightarrow$	CO <sub>2</sub>	
planar molecules with 3 identical bonds			SO <sub>3</sub>	
tetrahedral molecules with 4 identical bonds (109.5° apart)			CCl <sub>4</sub>	

### Examples:

- a. HCl ( $\Delta EN = \underline{\quad}$ )
- b. CO<sub>2</sub> ( $\Delta EN = \underline{\quad}$ )
- c. CF<sub>4</sub> ( $\Delta EN = \underline{\quad}$ )
- d. H<sub>2</sub>O ( $\Delta EN = \underline{\quad}$ )

#### Determining polarity: Stepwise

1. Calculate  $\Delta EN$  - Does molecule contain polar bonds?
2. Draw Lewis structure to determine symmetry.
3. Do dipoles cancel?

### Determining Molecule Polarity: Shortcuts

#### Always non-polar if:

- all bonds are non-polar
- all bonds to central atoms are identical, AND no lone pairs on central atom
- hydrocarbon



#### Probably polar if:

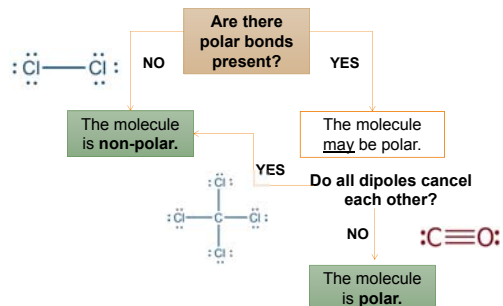
- bonds to central atom are not identical
- central atom has lone pairs
- contains -OH groups



*These are just shortcuts – always draw the dipoles to check!!*

<http://phet.colorado.edu/en/simulation/molecule-polarity>

### Determining Molecule Polarity: Flowchart



### Homework

- Pg. 108 #1-6