

Today 4.6 \Rightarrow Molecular Polarity

Skip Chapter 5

Chapter 6

6.1 Formula mass (molar mass)

\Rightarrow 6.2 Empirical & Molecular formula

Bond Polarity

X-Y is the bond polar?

Difference in Electronegativity (ΔEN)

from Table 4.6 in book (2 SF)

$$\Delta EN = |EN_x - EN_y|$$



non-polar $0 < x \leq 0.4$

Polar $0.4 < x \leq 1.8$

Ionic $1.8 <$

Molecular Polarity ?

If no net dipole \Rightarrow non polar

If the net dipole $> 0 \Rightarrow$ polar

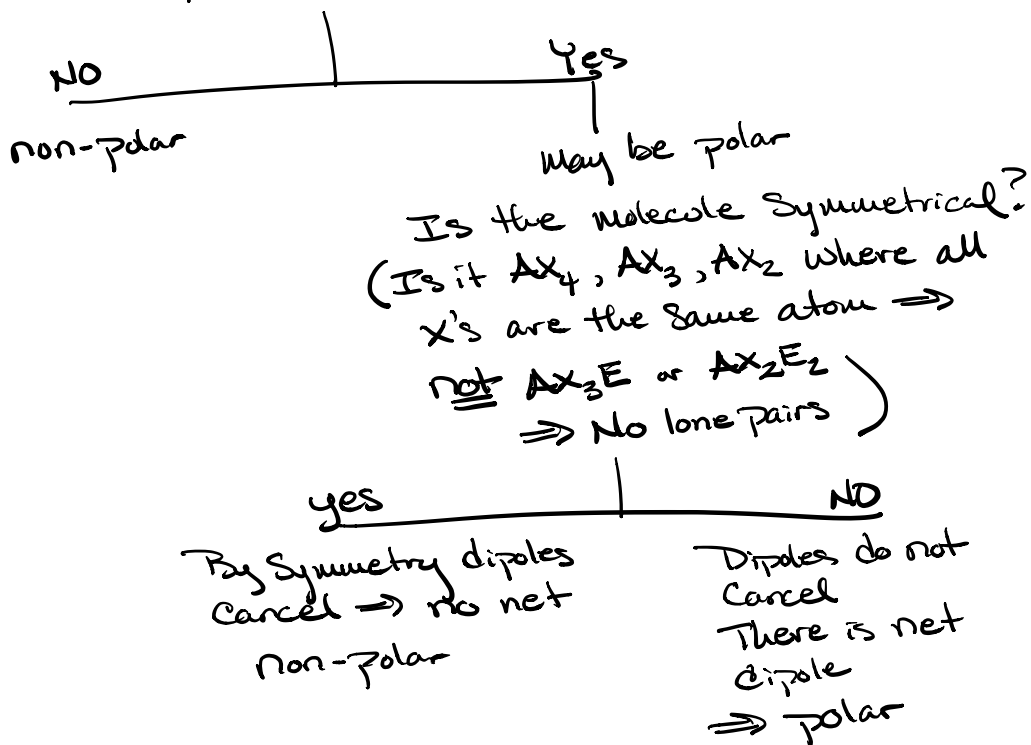
$$\text{net dipole} = \sum \text{dipole moments (vectors)}$$

???

Complicated in 3-D

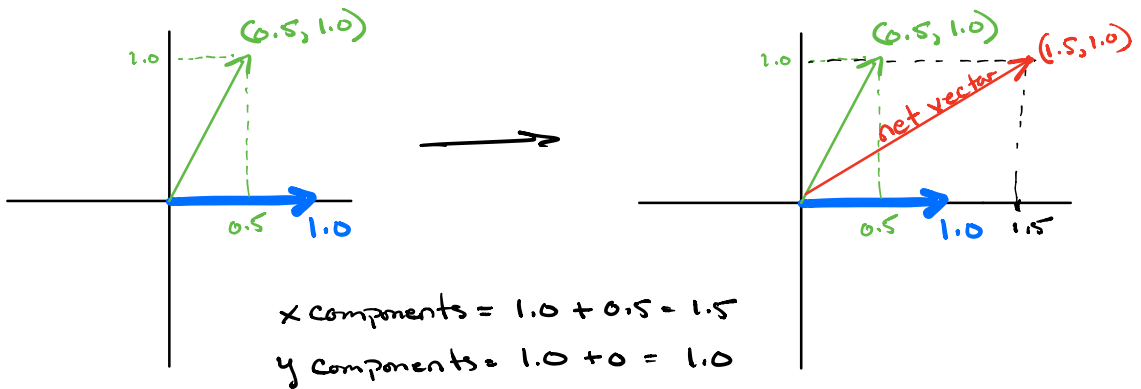
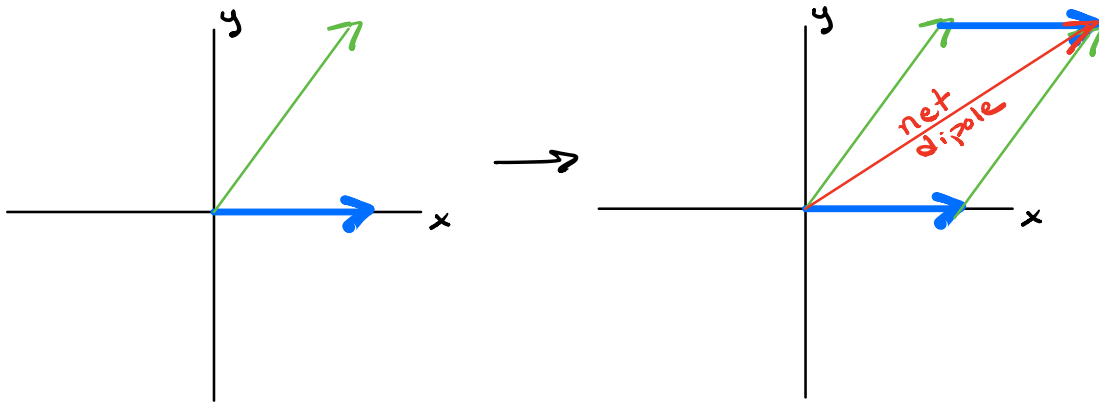
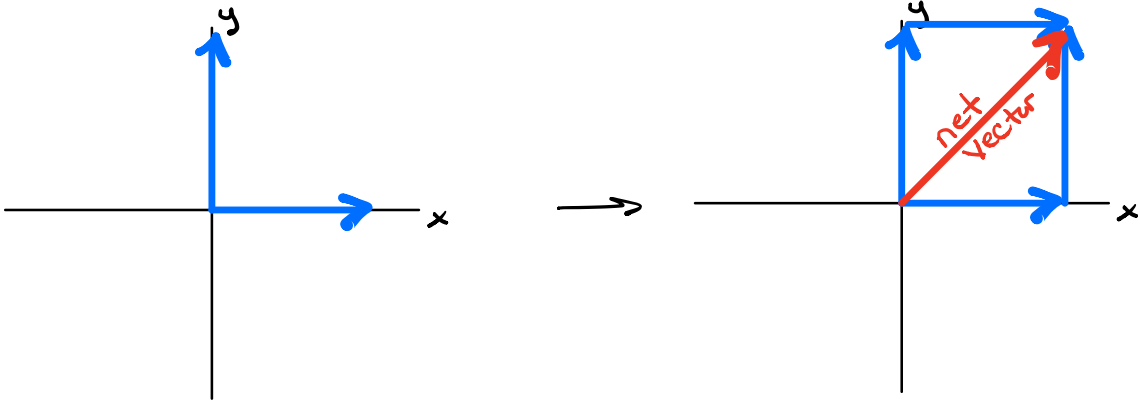
Dichotomous key (Binary)

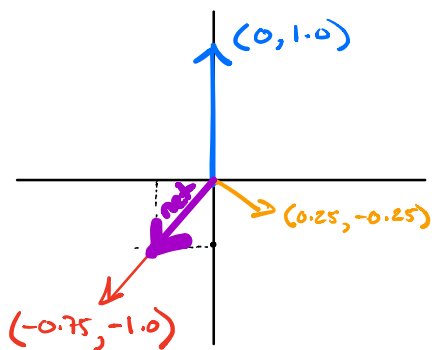
Does the molecule contain
polar bonds ?



Adding Vectors

2-D





$$x = 0 + 0.25 + -0.75 =$$

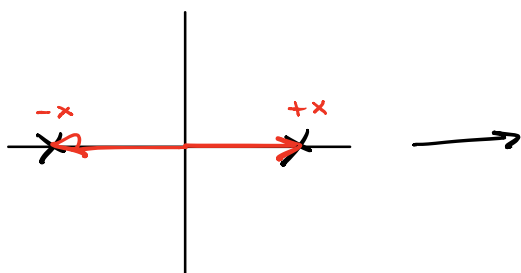
$$x = -0.50$$

$$y = 1.0 + -0.25 + -1.0$$

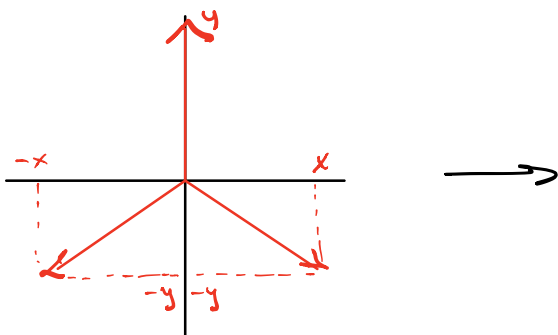
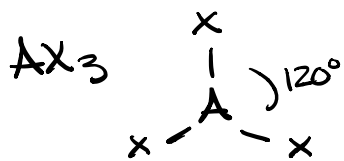
$$y = -0.25$$

$$x, y \text{ coordinate} = (-0.50, -0.25)$$

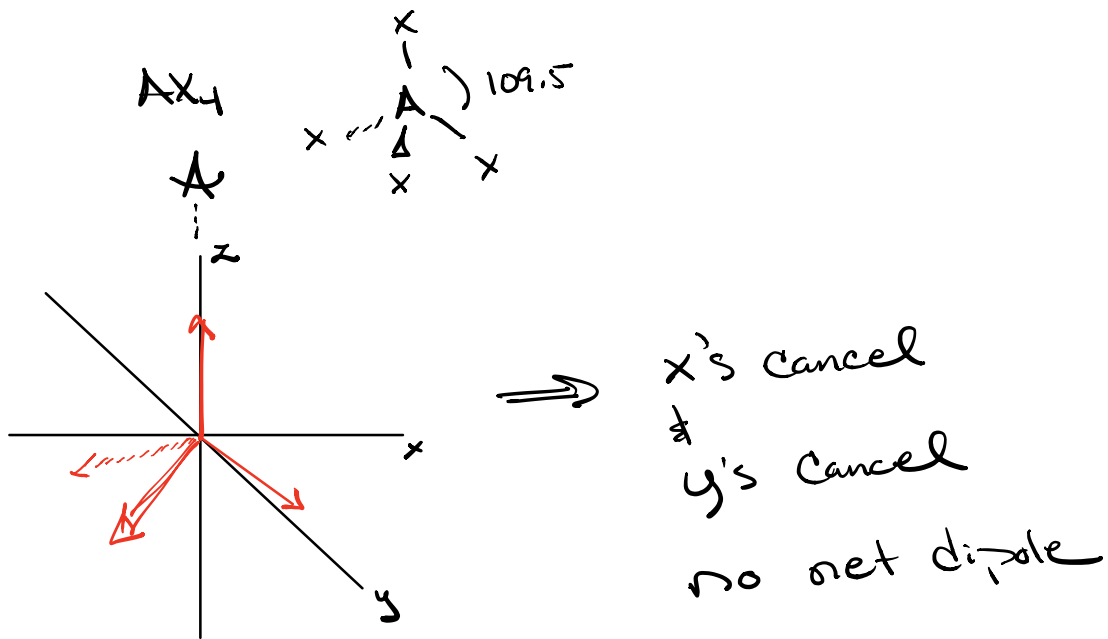
Symmetrical Molecules AX_4 , AX_3 , AX_2
(no E's)



no net vector
⇒ They cancel



no net vector
vectors cancel



In the Symmetrical case of AX_4 , AX_3 , AX_2 ,
 all dipoles mathematically cancel.

no net dipole \Rightarrow not polar

\Rightarrow Break the Symmetry & dipoles no longer
 cancel

net dipole \Rightarrow polar

Examples



$$\Delta \text{EN} = |3.5 - 2.5| = 1.0 \Rightarrow \text{polar bond}$$

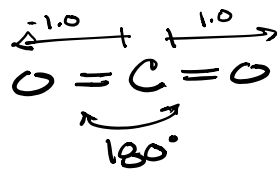
C 2.5

O 3.5

Is the molecule polar?

- Are there polar bonds \Rightarrow yes

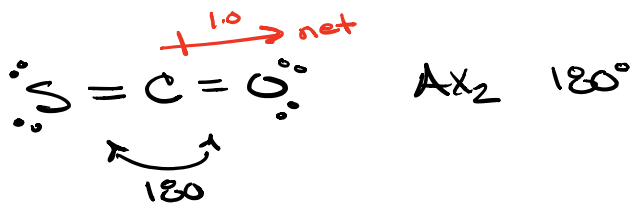
- Is it AX₂, AX₃, or AX₄ with all x's the same \Rightarrow yes



they cancel

\Rightarrow The molecule is **non-polar** because the dipoles cancel

SCO Carbonyl Sulfide



S C ΔEN
2.5 - 2.5 = 0

O C 3.5 - 2.5 = 1.0 polar ✓

S 2.5

C 2.5

O 3.5

Is the molecule symmetrical

AX₂ w/ x's the same \Rightarrow NO

\Rightarrow **polar** dipoles do not cancel

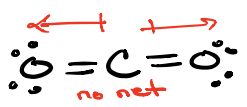
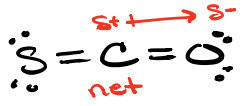
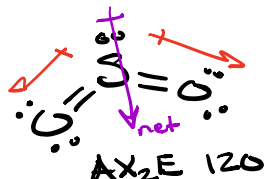
		<u>Bonds polar</u>	<u>Molecule polar</u>
AX ₂	CO ₂		yes / non-polar
	SCO		yes / polar
AX ₂ E	SO ₂		yes / polar

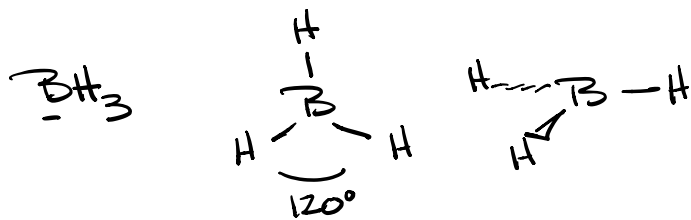
Table 4.6

S 2.5 ΔEN = 3.5 - 2.5 = 1.0
 O 3.5

Does the molecule contain polar bonds?

```

  graph TD
    Q1[Does the molecule contain polar bonds?] -- NO --> A1[non-polar]
    Q1 -- YES --> Q2[Is the molecule symmetrical?  
(Is it AX4, AX3, AX2 where all X's are the same atom => NOT AX3E or AX2E2 => No lone pairs)]
    Q2 -- YES --> A2[By symmetry dipoles cancel => no net dipole => non-polar]
    Q2 -- NO --> A3[Dipoles do not cancel. There is net dipole => polar]
  
```

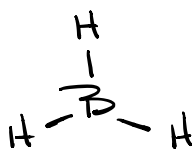
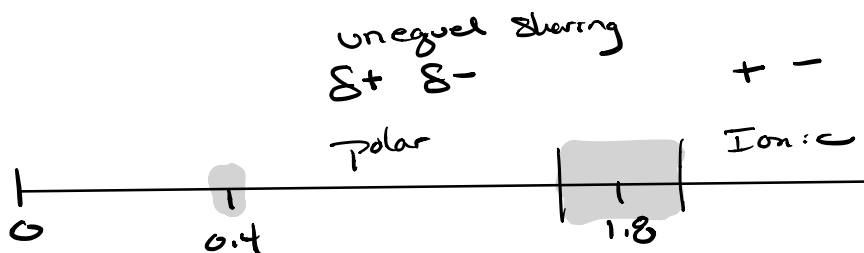


B 2.0
 H 2.1
 $\Delta EN = 0.1$ Bond non-polar molecule non-polar

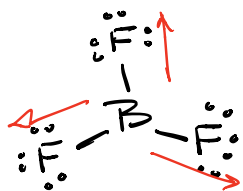


$AX_3 \Rightarrow$ non-polar by symmetry

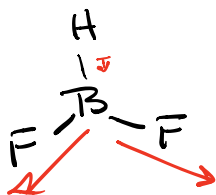
B 2.0
 F 4.0
 $\Delta EN = 2.0$ Bond Ionic (polar) molecule



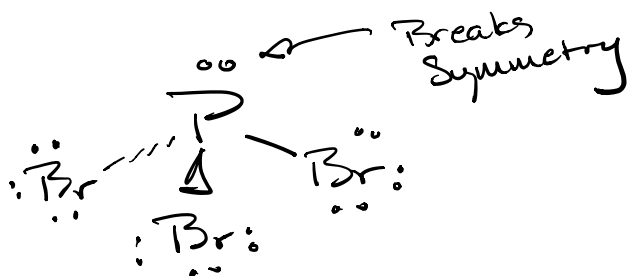
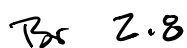
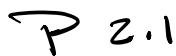
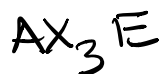
AX_3 no polar bonds \Rightarrow non-polar



AX_3 dipoles cancelled (X 's all the same)
 no net dipole \Rightarrow non-polar



AX_3 dipoles don't cancel (X ' not the same)
 net dipole \Rightarrow polar



$\Delta\text{EN} = 0.7$ polar

Bonds = polar

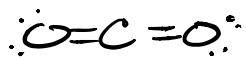
Molecule = polar

① $\Delta\text{EN} \Rightarrow$ polar bonds?
bonds non polar \rightarrow molecule non polar

② Lewis Structure

③ use flow chart

Q H₂O



Linear



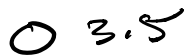
Linear



Bent 120

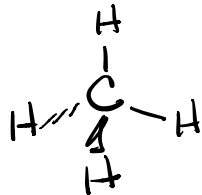


$\Delta\text{E} = 3.5 - 2.1 = 1.4$
polar bonds



Bent 109.5

CH₄ Methane



EN

C 2.5

H 2.1

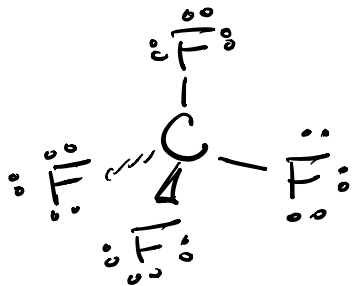
$\Delta EN = 0.4$ on the line

polar $0.4 < x \leq 1.8$

nonpolar $0 < x \leq 0.4$

Bonds non-polar
molecule also non-polar

CF₄

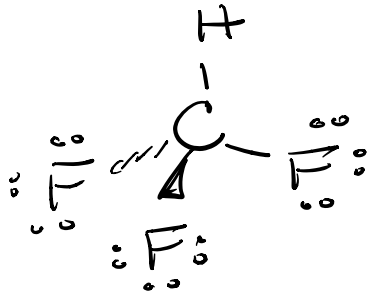
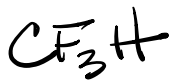


AX₄ w/ all x's the same

F 4.0
C 2.5

$\Delta EN = 1.5 = \text{polar}$

Bonds polar
molecule \Rightarrow non-polar

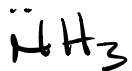


$$\Delta \text{EN C-H } 0.4$$
$$\Delta \text{EN C-F } 1.5$$

Bonds polar

molecule \Rightarrow polar

$\text{AX}_4 \Rightarrow$ But not all x's the same



Tetrahedral (109.5°)

AX_4



tetrahedral

AX_3E

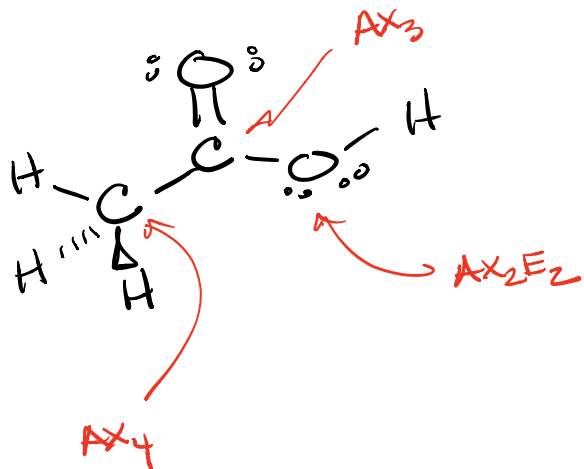


trigonal pyramidal

AX_2E_2



bent 109.5°



Multicentered molecule?

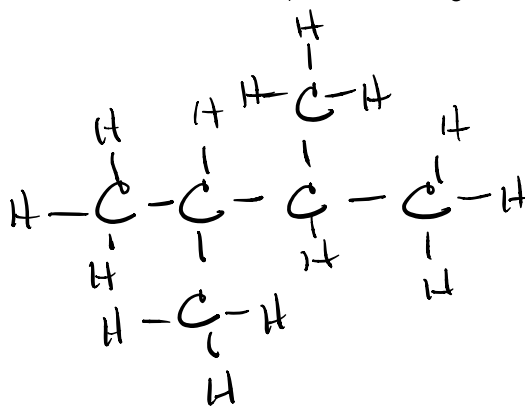
- CH non polar
- CO **polar**
- CC non polar
- OH **polar**

molecule polar?

Lack of Symmetry makes it polar

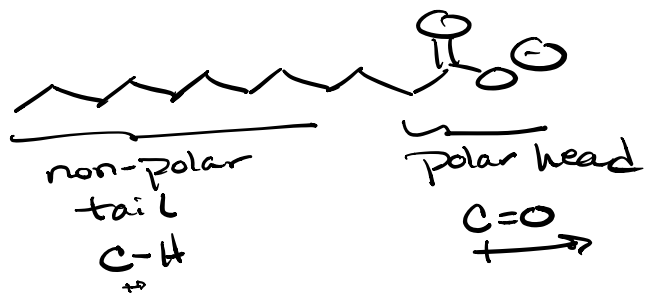
Dipoles can't cancel

There will be a net dipole



CH $\Delta EN = 0.4$
non-polar

molecule non-polar



Soap

