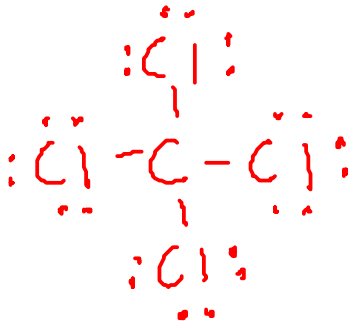
Examples:

CCl_4

C: 1 x 4

Cl: 4 x 7

32 e^-



Shape? Tetrahedral. The central atom has FOUR OTHER ATOMS bonded to it, and no lone pairs.

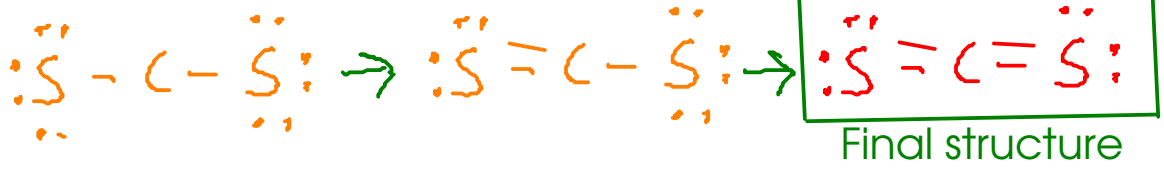
CS_2

C: 1 x 4

S: 2 x 6

16 e^-

Skeletal structure



Final structure

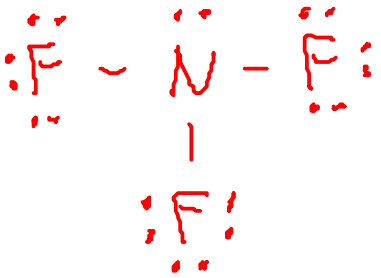
This is a LINEAR molecule. The two double-bonded sulfur atoms get 180 degrees apart. The carbon atoms has no other atoms or lone pairs attached.

NF_3

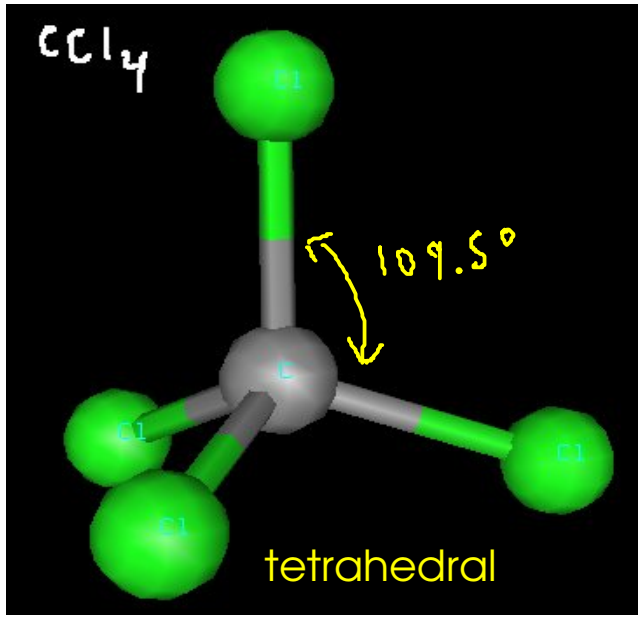
N: 1 x 5

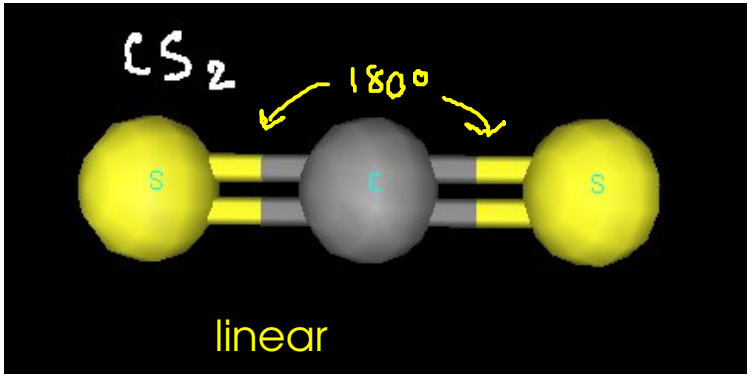
F: 3 x 7

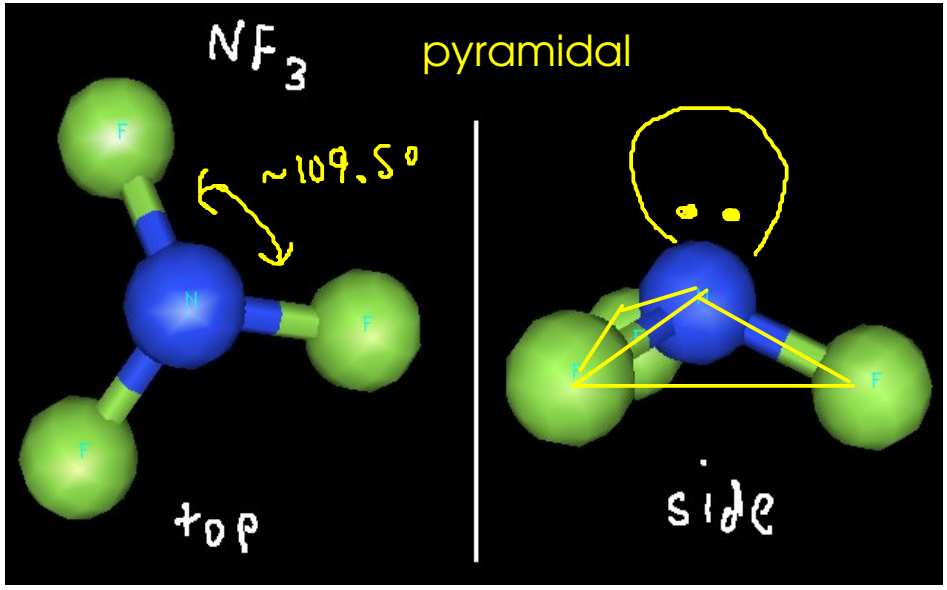
26 e^-



Shape? There are THREE ATOMS and ONE LONE PAIR around the central notrogen atom. This gives a PYRAMIDAL molecule - there are four groups around the central nitrogen atom (tetrahedral angles), but the shape is described based on the location or ATOMS: pyramidal.


CCl_4
Cl
109.5°
C
Cl
Cl
Cl
tetrahedral


CS_2
180°
S
C
S
linear


NF_3
pyramidal
F
~109.5°
N
F
F
top
F
F
F
side

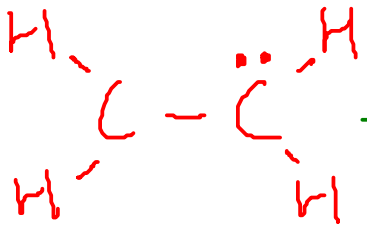
C_2H_4

C: 2 x 4

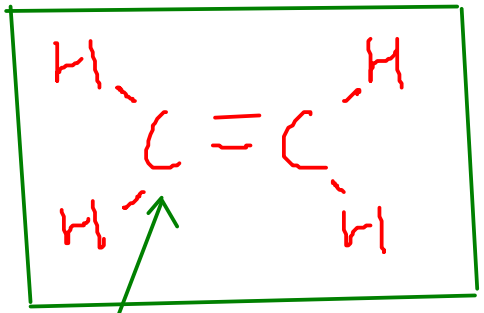
H: 4 x 1

12 e⁻

skeletal

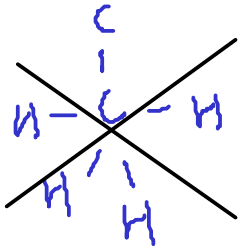


final structure



Shape? Since this molecule has TWO "central" atoms, we will describe the shape around each "center".

Each carbon center has a TRIGONAL PLANAR shape!



Multiple carbon atoms usually mean multiple "central" atoms!

This carbon has THREE atoms surrounding it and no lone pairs

H_2CO

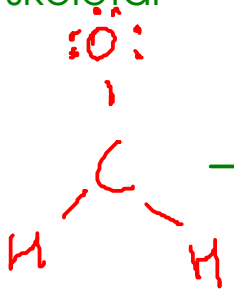
H: 2 x 1

C: 1 x 4

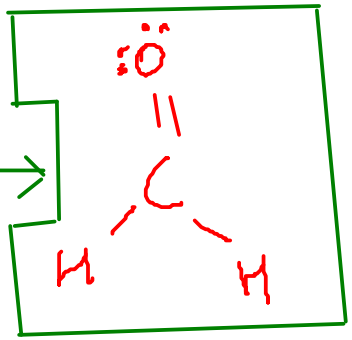
O: 1 x 6

12 e⁻

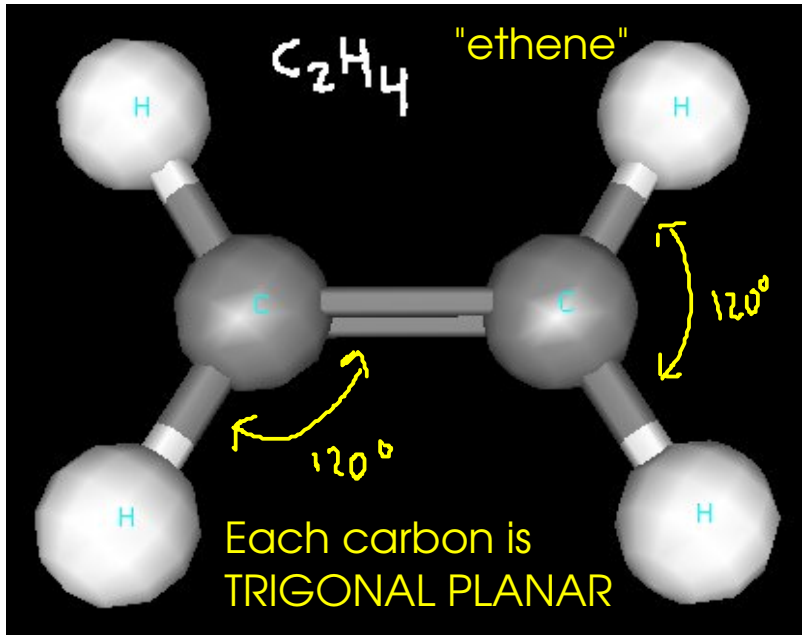
skeletal

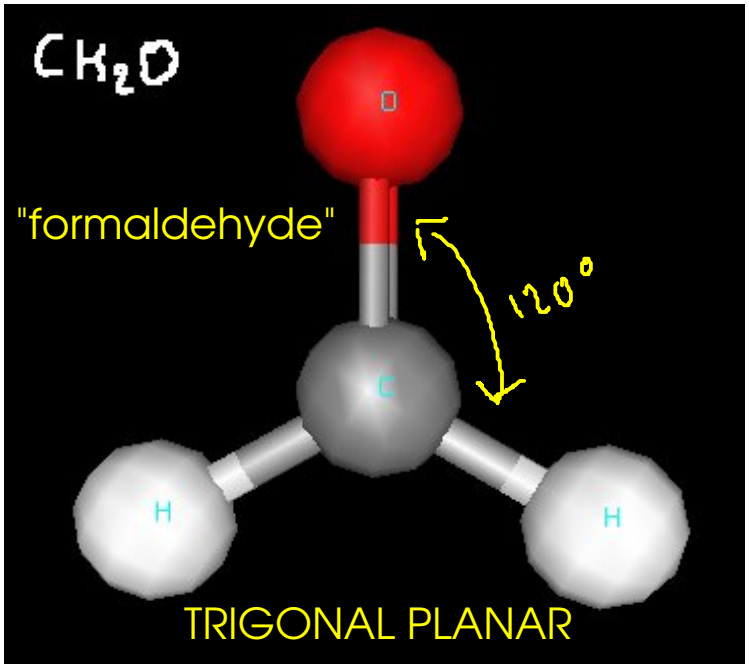


final structure



Shape? The carbon central atom has THREE ATOMS around it (and no lone pairs). so this molecule is TRIGONAL PLANAR.


C_2H_4
"ethene"
H
H
C
C
120°
120°
H
H
Each carbon is
TRIGONAL PLANAR

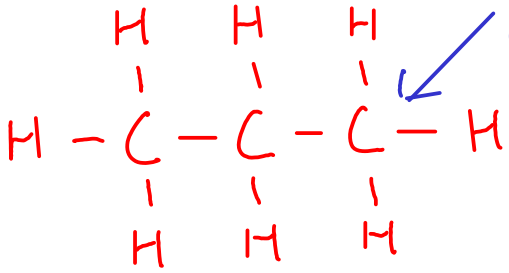

CH_2O
O
"formaldehyde"
120°
C
H
H
TRIGONAL PLANAR

VSEPR and large molecules

- Large molecules have more than one "center" atom

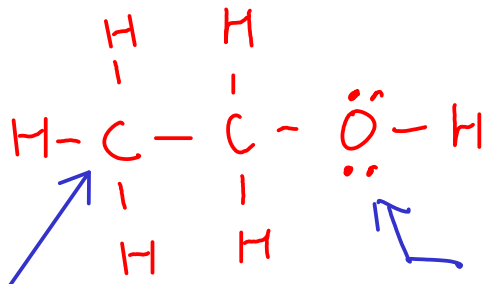
- Describe the molecule by describing the shape around each "center".

C_3H_8:



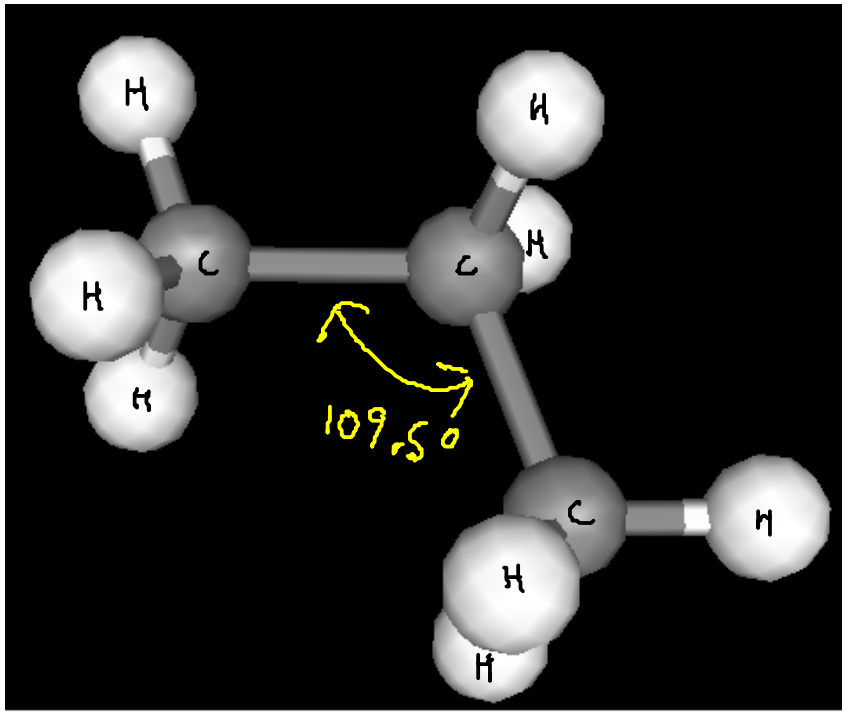
Each of the three carbon centers is TETRAHEDRAL, since each are surrounded by four groups.

CH_3CH_2OH:



The geometry around this oxygen atom is BENT.

These carbon atoms have TETRAHEDRAL geometry.

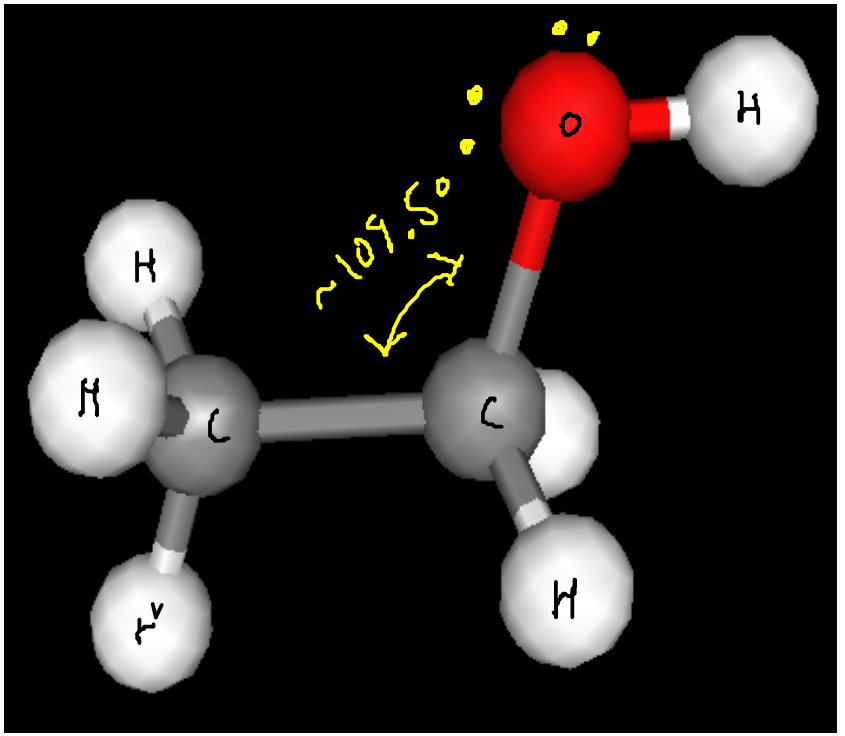


C_3H_8 ←

All bond angles in the propane molecule are 109.5 degrees

CH_3CH_2OH →

Like propane, the bond angles in ethanol are also close to 109.5 degrees.



POLARITY and shape:

- A polar molecule has an uneven distribution of electron density, making it have ends (poles) that are slightly charged.

POLARITY influences several easily observable properties.

- Melting point. (Polar substances have higher melting points than nonpolar substances of similar molecular weight.)

- Boiling point. (Polar substances have higher boiling points than nonpolar substances of similar molecular weight.)

- Solubility. (Polar substances tend to dissolve in other polar substances, while being insoluble in nonpolar substances. Nonpolar substances dissove other nonpolar substances, and generally have poor solubility in polar solvents.)

- Polar molecules contain POLAR BONDS arranged in such a way that they do not cancel each other out.

... but how can we tell whether or not a bond will be POLAR? Use experimental data on ELECTRONEGATIVITY!

ELECTRONEGATIVITY:
-A measure of how closely to itself an atom will hold shared electrons

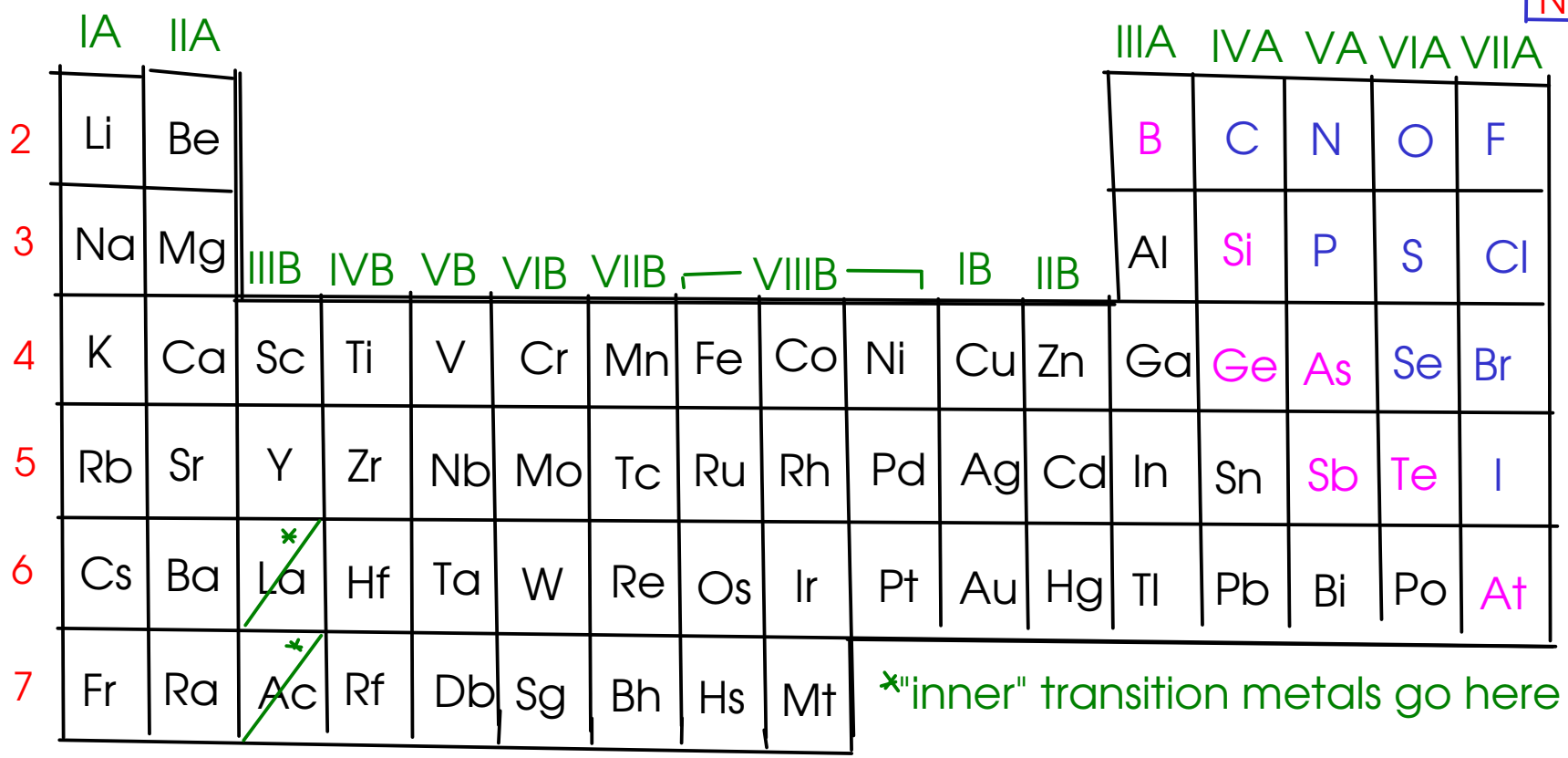
- A bond where there is a LARGE electronegativity difference between atoms will be either POLAR or (for very large differences) IONIC! (chart, p 346)

- A bond with little or no electronegativity difference between atoms will be NONPOLAR

ELECTRONEGATIVITY TRENDS

- You may look up elecronegativity data in tables, but it helps to know trends!

INCREASING ELECTRO-NEGATIVITY



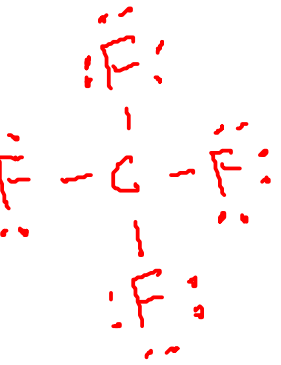
Notes:

1. - FLUORINE is the most elecronegative element, while FRANCIUM is the least!
2. - All the METALS have low electronegativity, and metal/nonmetal combinations form IONIC bonds
3. - HYDROGEN is similar in electronegativity to CARBON, so C-H bonds are considered NONPOLAR

Examples:

CF_4:

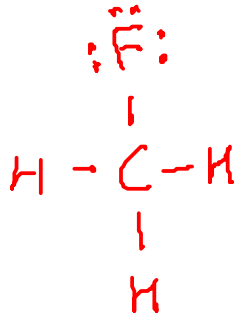
C: 1 x 4
F: 4 x 7
32 e⁻



Polar molecule?
* POLAR BONDS - Yes. The C-F bond should be polar since there is a large electronegativity difference between C and F.
* GEOMETRY - The molecule is TETRAHEDRAL in shape, and all the bonds are arranged symmetrically around hte carbon center. Therefore, electrons can't be pulled towards one "side" of the molecule - making it NONPOLAR

CH_3F

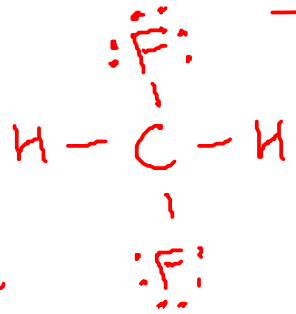
C: 1 x 4
H: 3 x 1
F: 1 x 7
14 e⁻



Polar molecule?
* POLAR BONDS - Yes. The C-F bond should be polar since there is a large electronegativity difference between C and F. The C-H bonds are nonpolar.
* GEOMETRY - The molecule is TETRAHEDRAL in shape. Electron density will be pulled towards the FLUORINE tip of the molecule and away from the other side, making the molecule POLAR.

CH_2F_2.

C: 1 x 4
H: 2 x 1
F: 2 x 7
20 e⁻

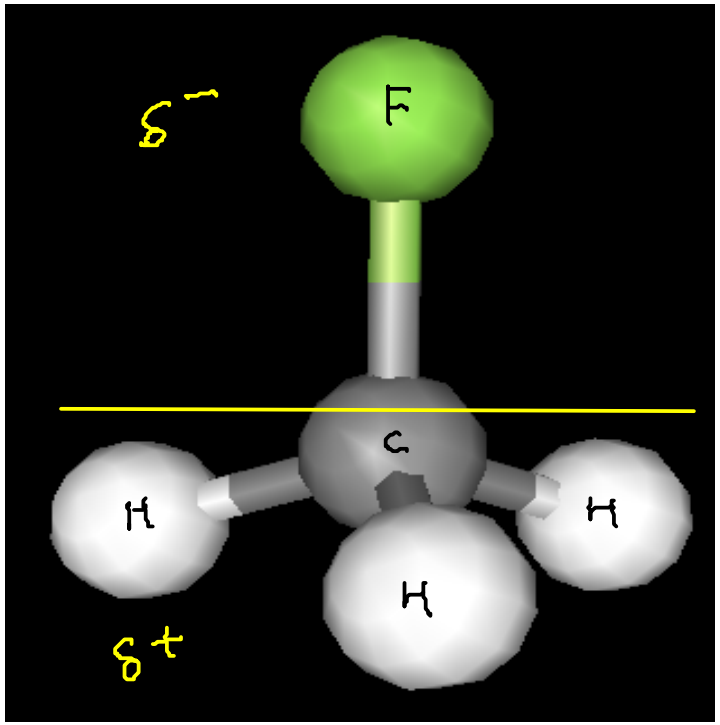


Polar molecule?
* POLAR BONDS - Yes. The C-F bond should be polar. The C-H bonds are nonpolar.
* GEOMETRY - The molecule is TETRAHEDRAL in shape. Electron density is pulled towards the FLUORINE side of the molecule (see the 3 Dmodel on the next page), making a POLAR molecule!

CO_2

C: 1 x 4
O: 2 x 6
16 e⁻

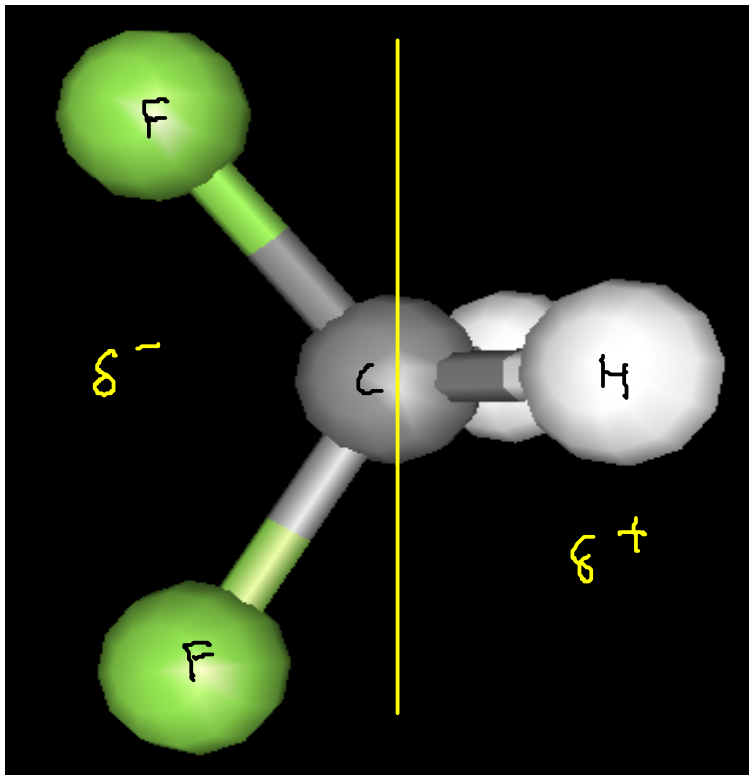
Polar molecule?
* POLAR BONDS - Yes. The C=O bond should be polar.
* GEOMETRY - The molecule is LINEAR, meaning the two oxygen aroms are directly opposite. It is NONPOLAR.



← CH_3F "fluoromethane"

Fluorine is able to pull electron density through the molecule, as it is being opposed by much less electronegative hydrogen atoms.

"difluoromethane" CH_2F_2 →



In 2D, the fluorine atoms appear to be on the opposite sides of the molecule, but in 3D they are on the same side.