POLARITY

- When atoms share electrons, the electrons might not be EVENLY shared. Shared electrons may spend more time around one atomic nucleus than the other.

- When electrons are shared UNEVENLY, this results in a POLAR BOND.

... 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!

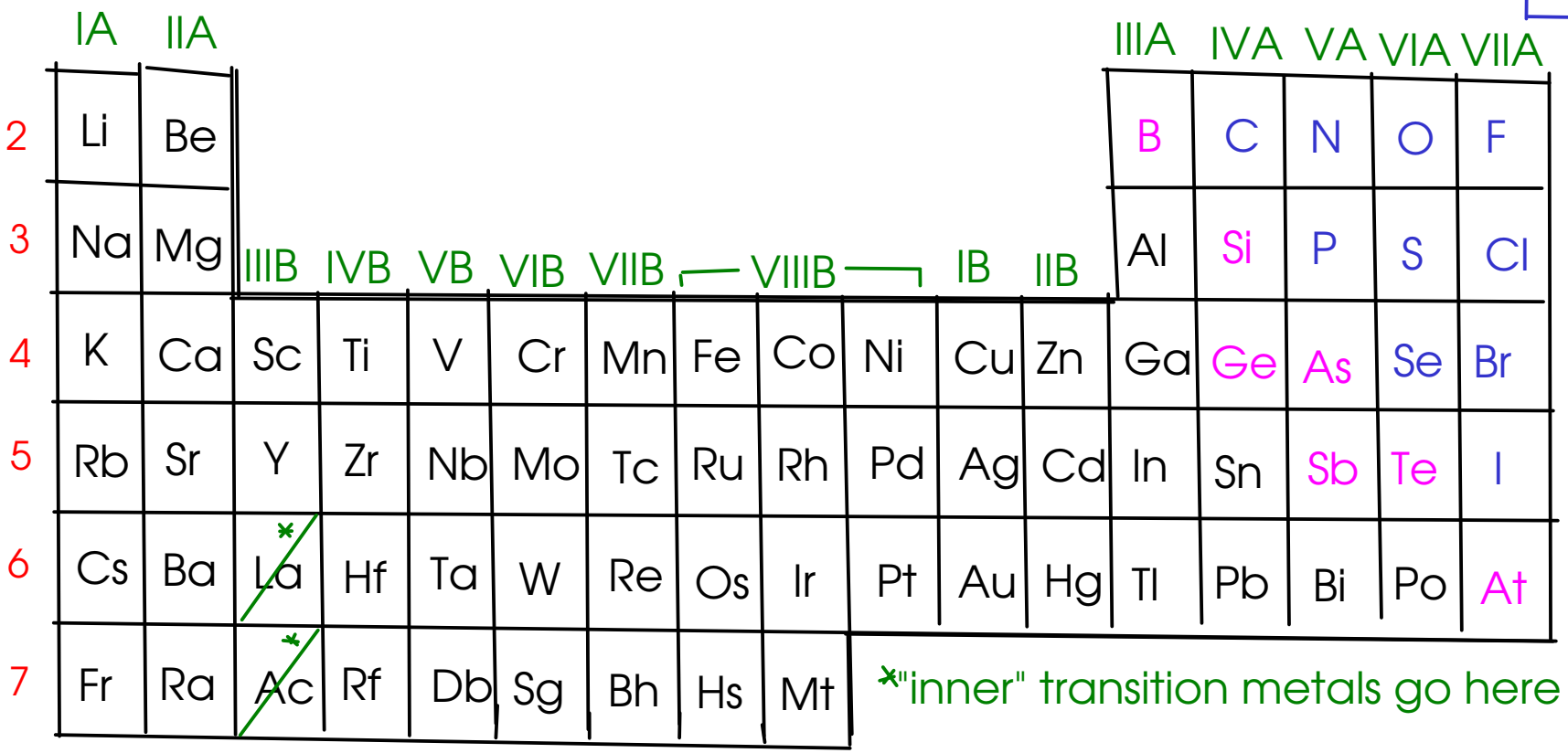
- A bond with little or no electronegativity difference between atoms will be NONPOLAR

ELECTRONEGATIVITY TRENDS

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

(p362, text) Fig 12.3

INCREASING ELECTRO-NEGATIVITY



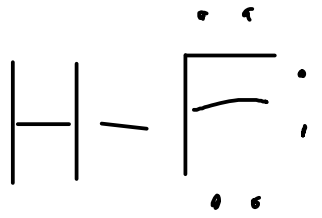
Notes:

① - FLUORINE is the most elecronegative element, while FRANCIUM is the least!

② - All the METALS have low electronegativity

③ - HYDROGEN is similar in electronegativity to CARBON, so C-H bonds are considered NONPOLAR

ELECTRONEGATIVITY EXAMPLE

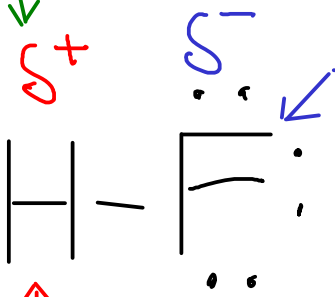


2.1 4.0 — Electronegativity values

Difference = 1.9

Fluorine is much more electronegative than hydrogen. This is a POLAR BOND, and the shared electrons will be held more closely to FLUORINE!

δ means "small"



This end of the molecule will have a slight NEGATIVE charge, since the shared electrons are closer to FLUORINE!

This end of the molecule will have a slight POSITIVE charge, since the shared electrons are pulled away from HYDROGEN!

POLARITY OF MOLECULES

So what can a molecule's LEWIS STRUCTURE, SHAPE, and the POLARITY of its bonds tell us?

... the POLARITY of the overall molecule, which will tell us (among other things) what a given molecule will mix with or dissolve in!

POLAR MOLECULES

- Will dissolve in or dissolve other polar molecules
- Will dissolve some ionic compounds
- Will NOT easily dissolve nonpolar molecules

Example: WATER

NONPOLAR MOLECULES

- Will dissolve in or dissolve other nonpolar molecules
- Will NOT easily dissolve polar molecules or ionic compounds

Example: OILS

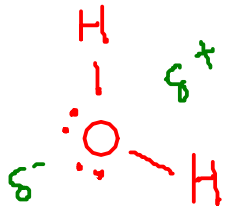
For a molecule to be polar, it must ...

1. Have polar bonds! (Any molecule that contains no polar bonds must be nonpolar!)
2. Have polar bonds arranged in such a way that they don't balance each other out! (This is why you need to know the structure and shape of the molecule)

EXAMPLES

Water, H_2O

H: 2 x 1
O: 1 x 6
8

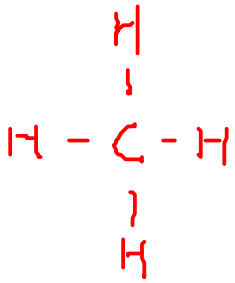


Polar bonds? O is more electronegative than H, so we think O-H bonds should be polar.

Molecule is BENT. we expect electrons to be pulled towards the oxygen "side" of the molecule, making it POLAR.

methane, CH_4

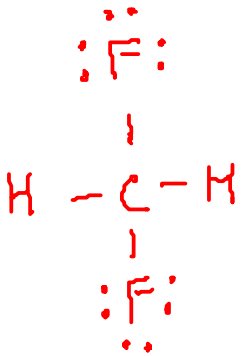
C: 1 x 4
H: 4 x 1
8



Methane is a tetrahedral molecule, and it is NONPOLAR, since all its bonds are nonpolar.

CH_2F_2

C: 1 x 4
H: 2 x 1
F: 2 x 7
20

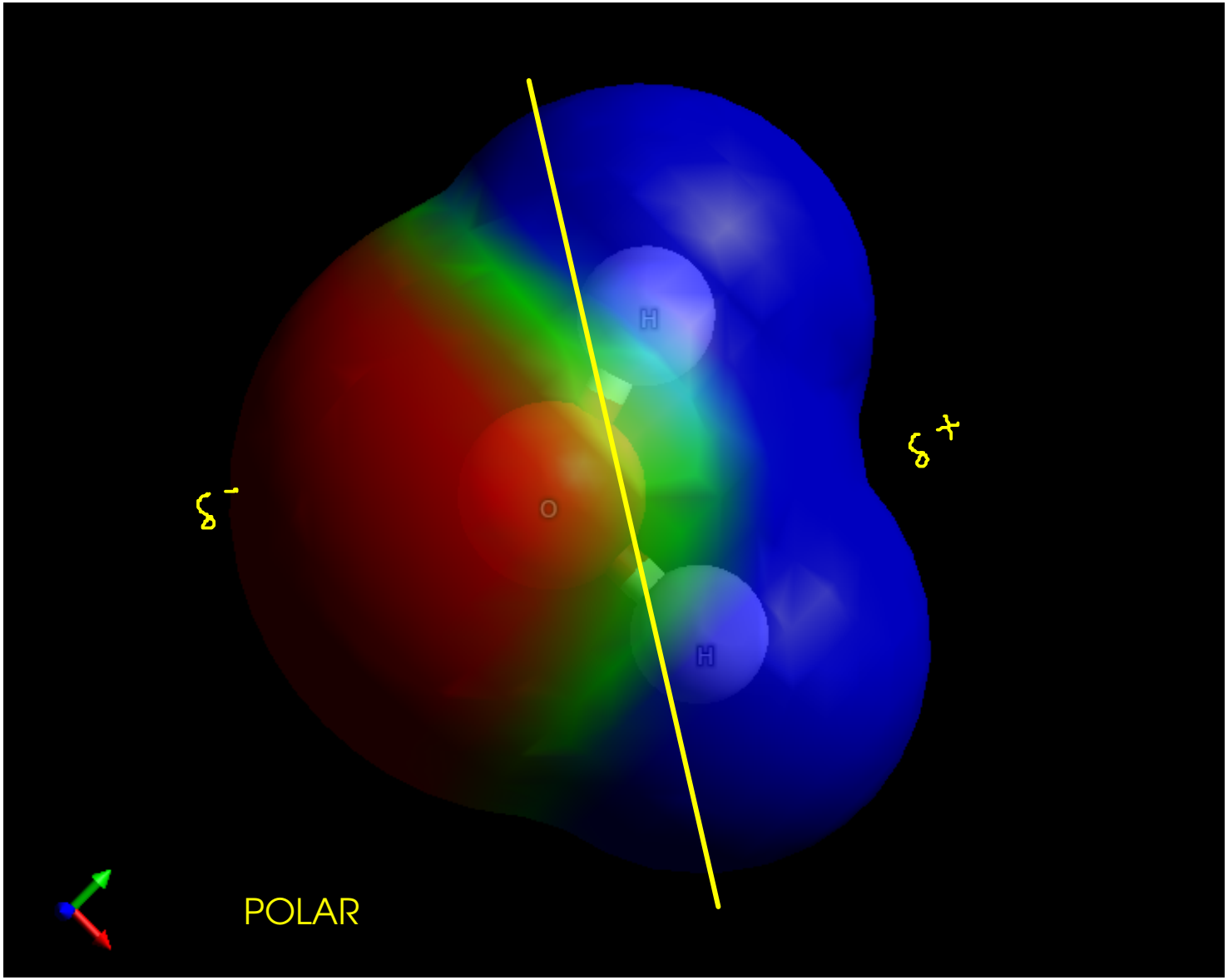


Like methane, this molecule is tetrahedral. UNLIKE methane, this molecule has some polar bonds (C-F).

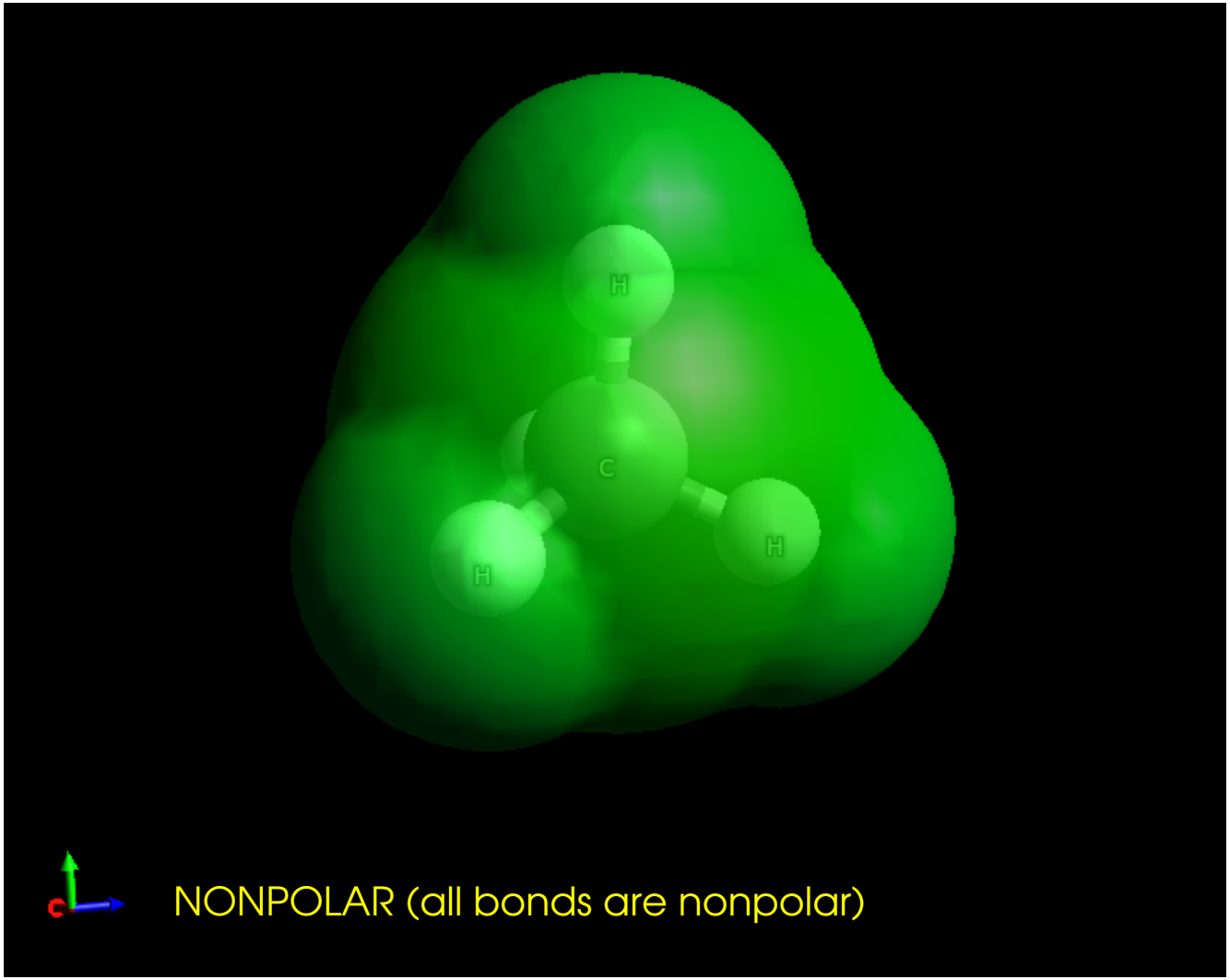
This molecule is POLAR, since fluorines will pull electrons to their "side" of the molecule. (The Lewis structure doesn't show it, but in 3D, the fluorines are on the same side!)

H_2O

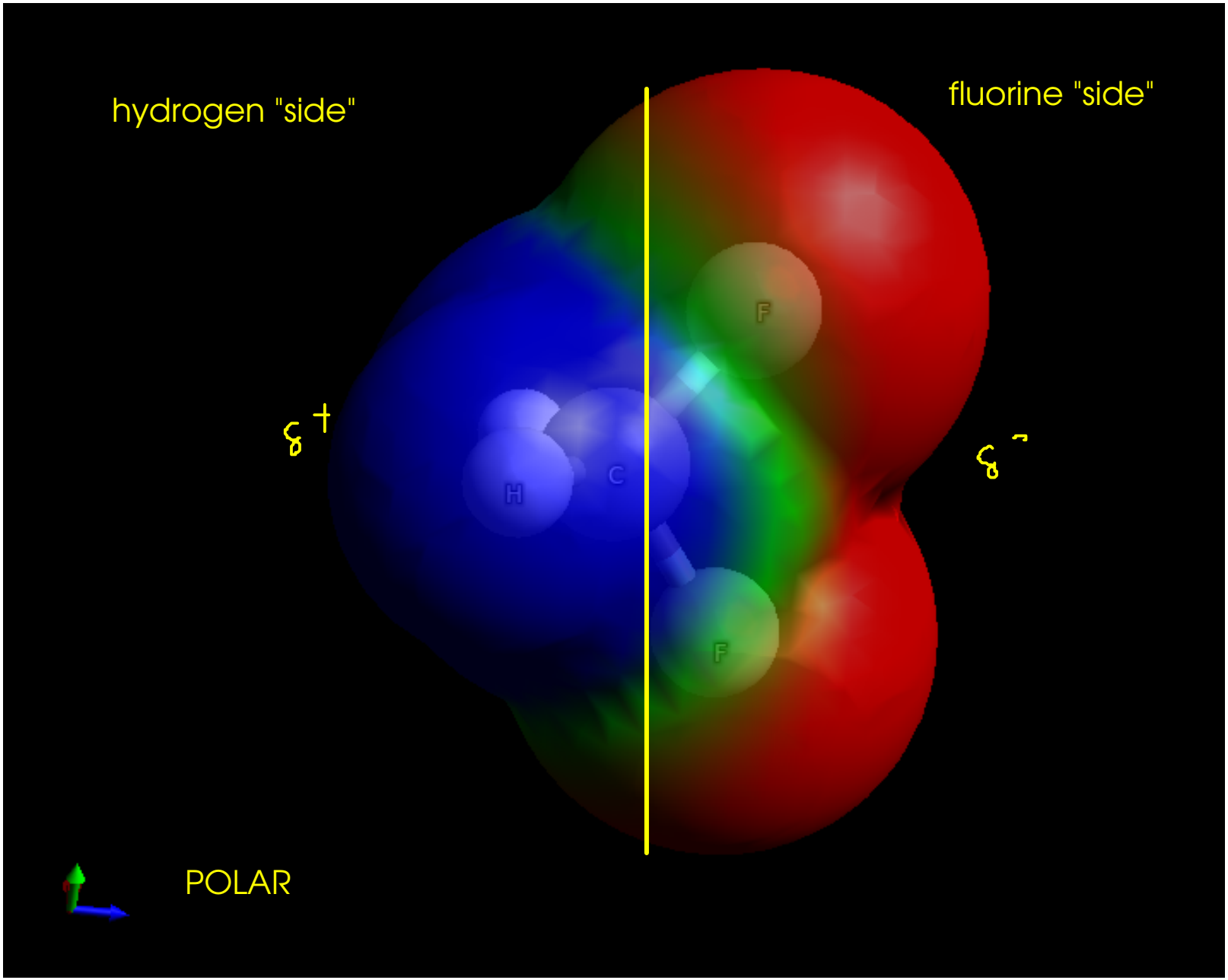
This ball-and-stick model shows electrostatic potential - red for more negative and blue for more positive



CH_4

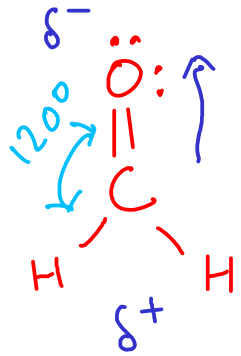


CH_2F_2



H_2CO

H: 1 x 2
C: 4
O: 6
12

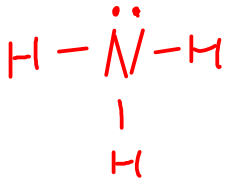


What about shape? TRIGONAL PLANAR. There are three things (=O, 2 -H) around the central carbon, so they will spread out as far as possible - 120 degrees.

Polarity? The C=O bond is a polar bond, and it is not "canceled" out by other bonds. The molecule is POLAR.

NH_3

N: 5
H: 1 x 3
8



Shape? There are FOUR groups around the central nitrogen atom - 109.5 degrees apart.(same as tetrahedral). The ATOMS in the molecule form a PYRAMID - we call the structure PYRAMIDAL.

Polarity? N-H bonds are polar, and they are arranged in such a way that electrons can be pulled towards the nitrogen "top" of the pyramid. So the nitrogen end of the pyramid will be slightly negative and the bottom hydrogens will be slightly positive. A POLAR MOLECULE!

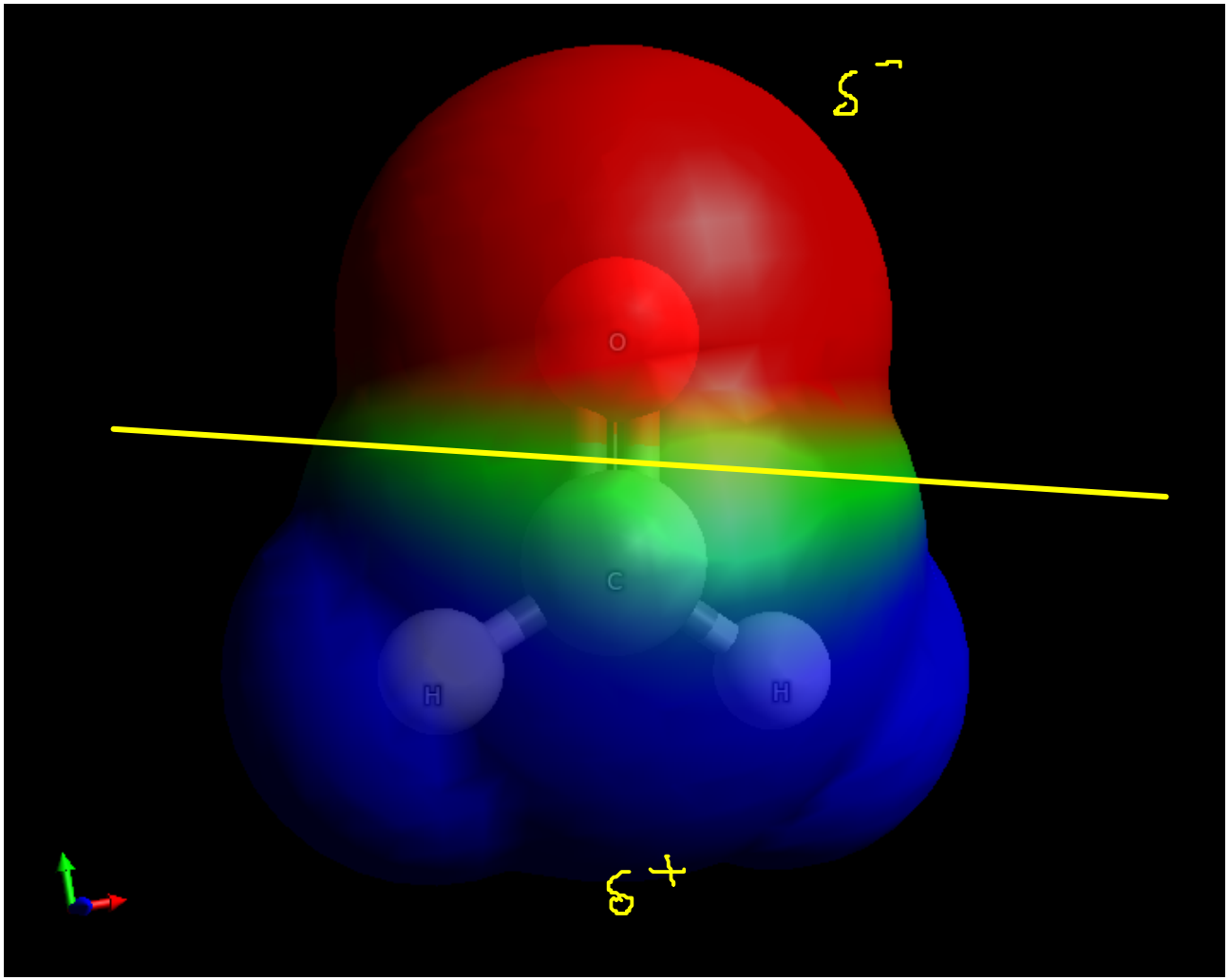
CO_2

C: 4
O: 6 x 2
16

Shape? LINEAR. The oxygen atoms can move 180 degrees apart.

Polarity? C=O bonds are polar. BUT, they are 180 degrees apart, so they cancel each other out. Carbon dioxide is NONPOLAR.

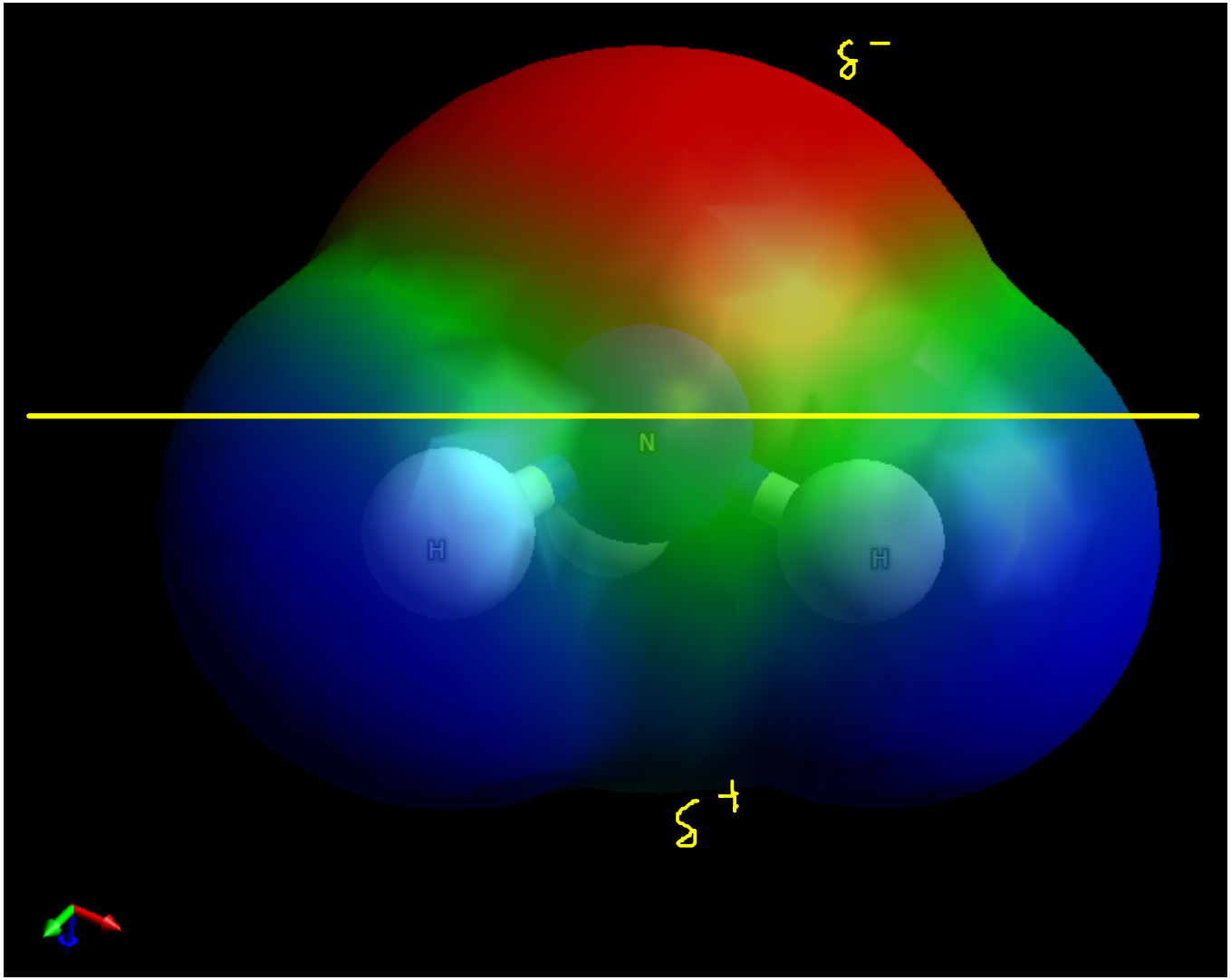
H_2CO



oxygen "side",
slightly negative

hydrogen "side",
slightly positive

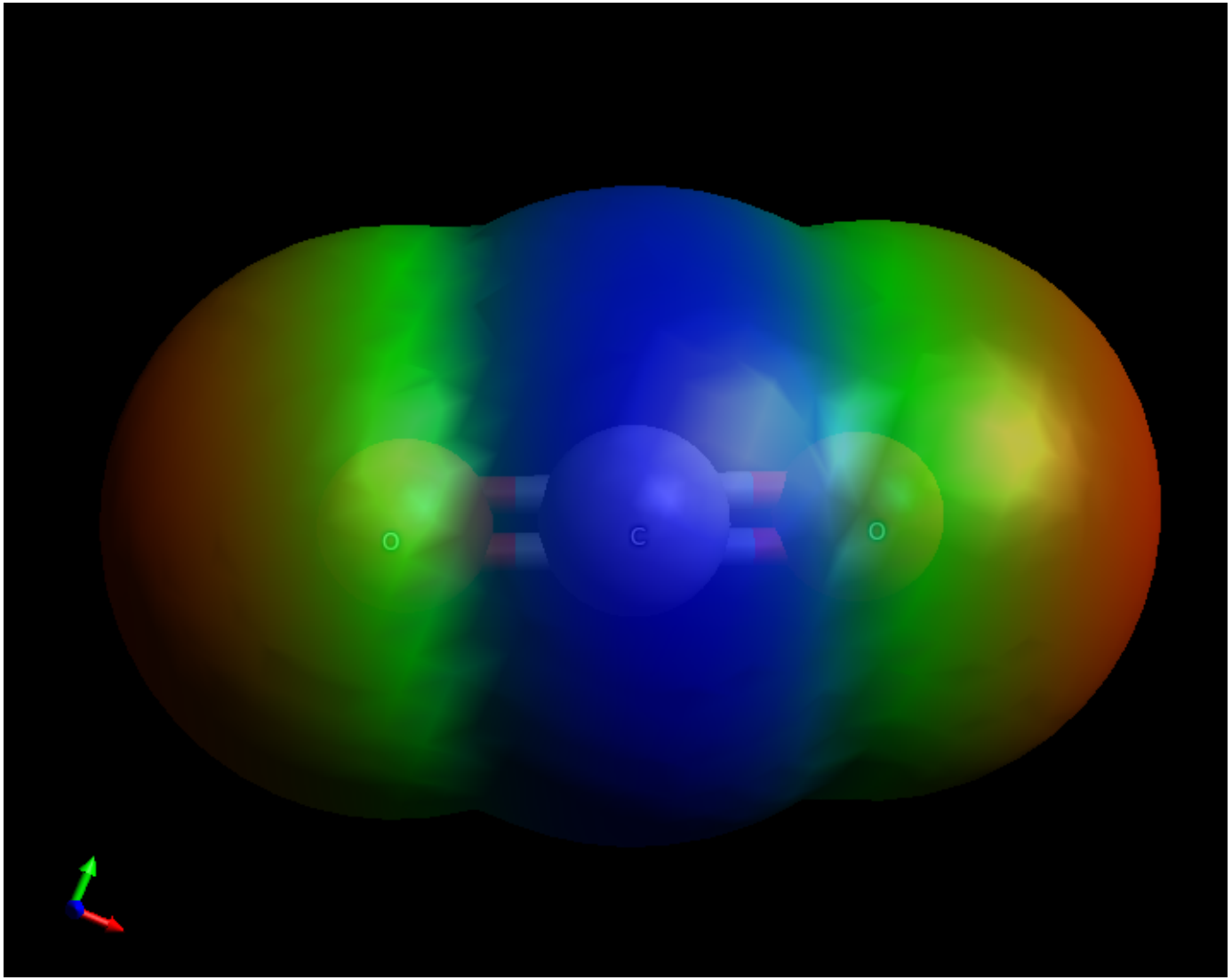
NH_3



nitrogen "side"
slightly negative

hydrogen "side"
slightly positive

CO_2



This molecule is NONPOLAR. No positive "side" or negative "side"