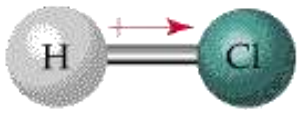
MOLECULAR SHAPE AND POLARITY

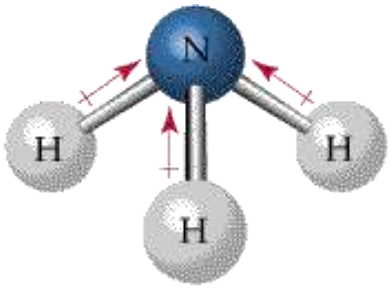
WHAT ARE POLAR MOLECULES?

- Molecules in which the charge is not distributed symmetrically among the atoms making up the molecule

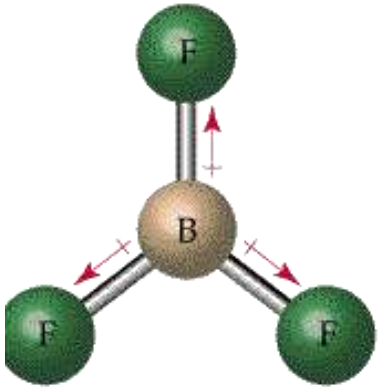
- Polarity of molecule is dependent on the **presence of polar bonds** & the **shape of the molecule**



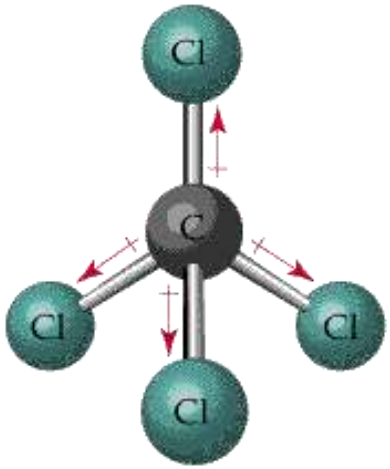
Polar



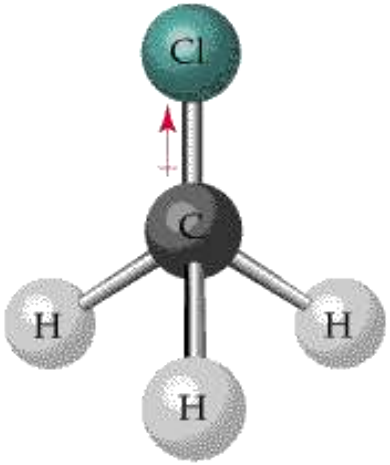
Polar



Nonpolar



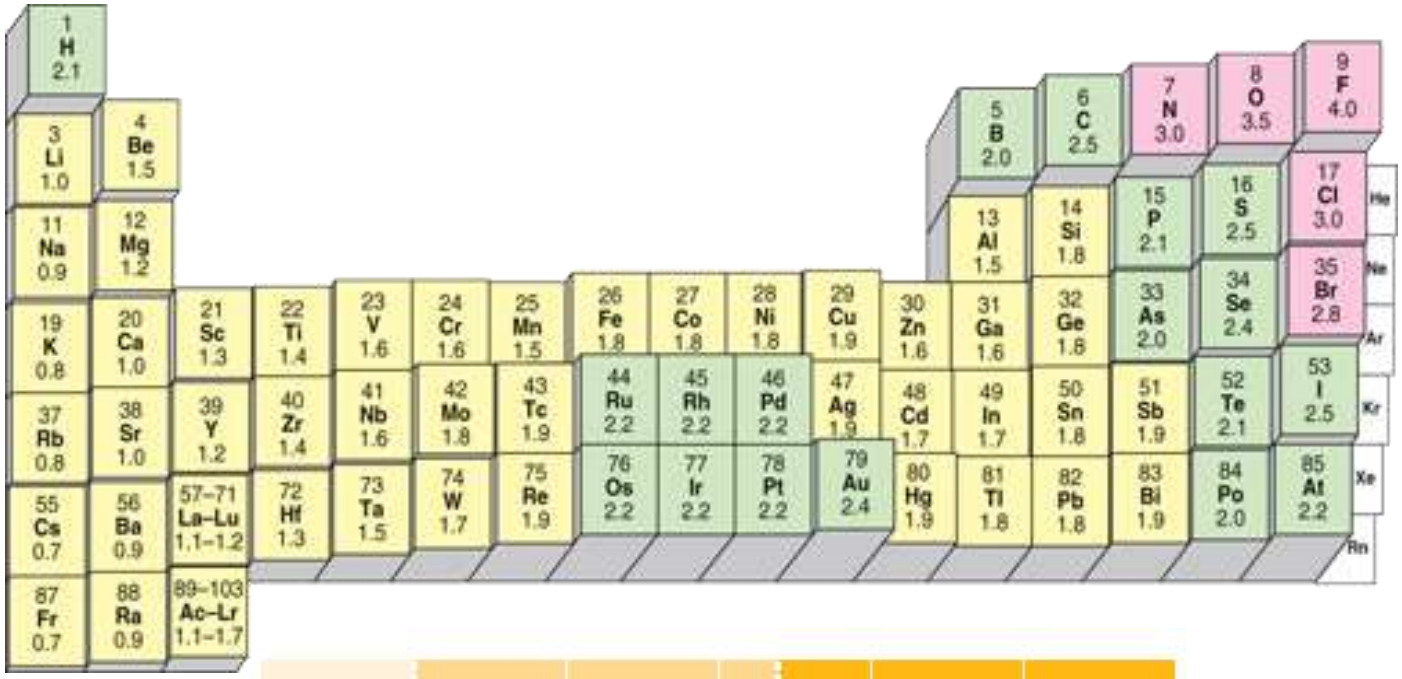
Nonpolar



Polar

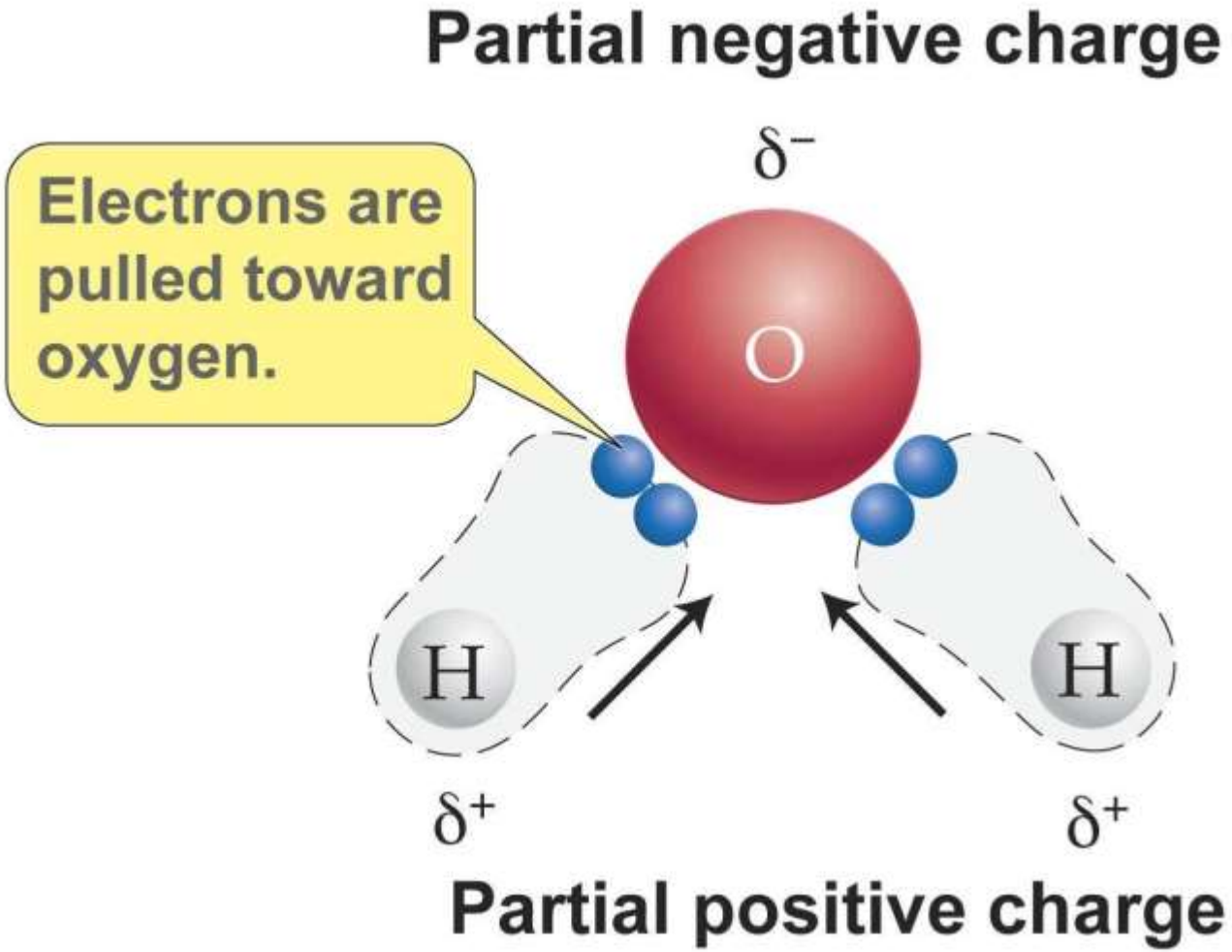
BOND POLARITY

- ΔEN between 2 atoms determines the polarity of the bond – greater the difference, the more polar the bond



POLAR COVALENT BONDS

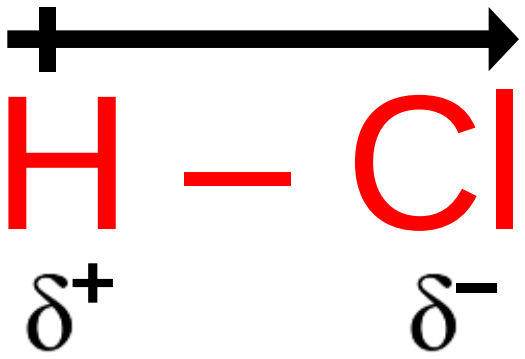
- Bond in which unequal sharing of electrons exists
- Electrons spend most of their time closer to one nucleus than the other

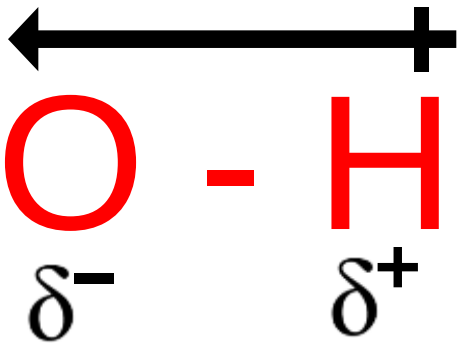


POLAR COVALENT BONDS

- Polar covalent bonds are shown by using a bond dipole (arrow indicating a ΔEN travelling from the lower (δ^+) to the higher (δ^-) EN)
- The bond dipole is a vector, and vectors can be added (tip-to-tail) to determine the overall polarity of a molecule

POLAR COVALENT BOND EXAMPLES



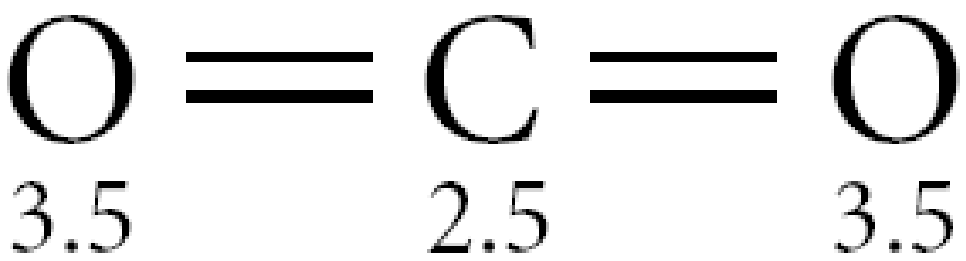


DETERMINING THE POLARITY OF A MOLECULE

A molecule may have polar bonds, but it may not be polar

Example:

CO_2 is a nonpolar molecule, but each C=O bond is polar

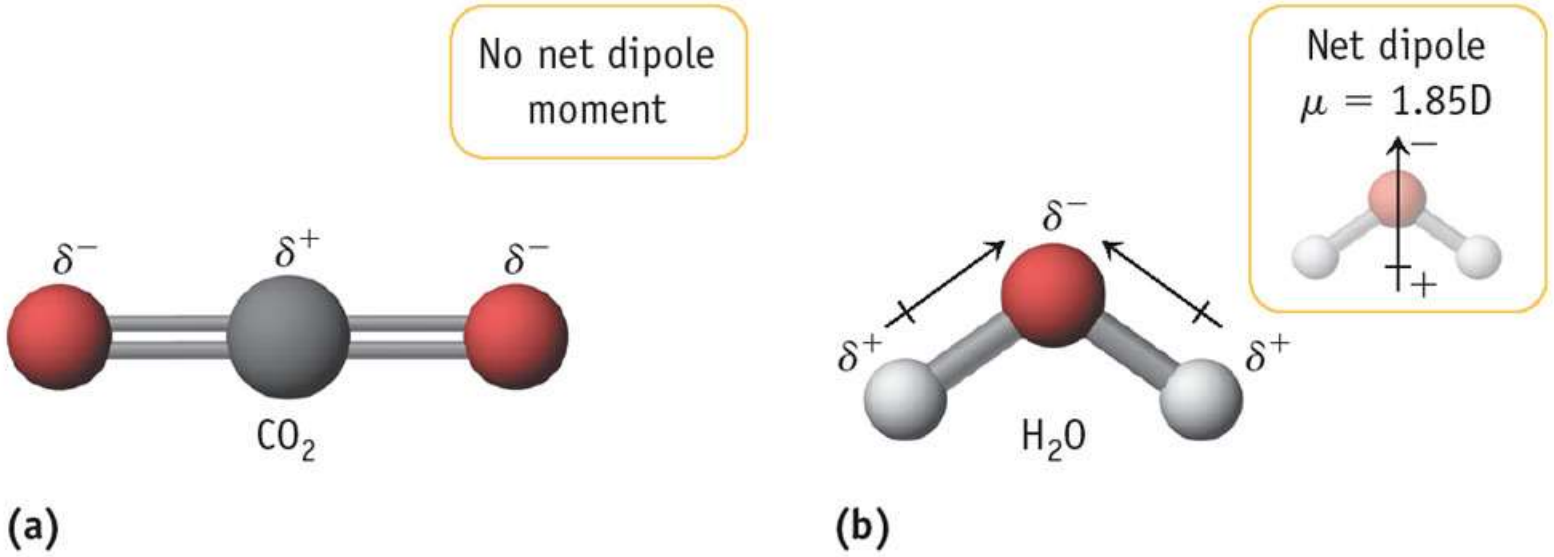


DETERMINING THE POLARITY OF A MOLECULE

- Existence of a polar bond in a molecules does not necessarily mean the molecule is polar (also must consider symmetry)

- **Nonpolar molecule**: either has nonpolar bonds or polar bonds whose dipoles cancel to zero

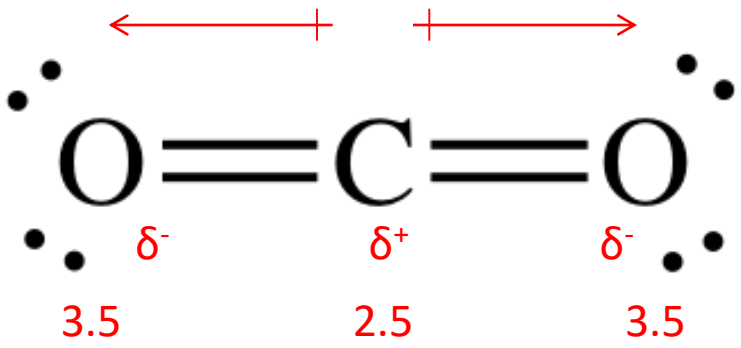
- **Polar molecule**: has polar bonds with dipoles that do not cancel to zero



HOW TO DETERMINE THE POLARITY OF A MOLECULE

Example: CO_2

1. Draw a Lewis structure
2. Use the # of electron pairs & VSEPR to determine the shape around each central atom Linear
3. Use EN differences to determine the polarity of each bond
4. Add the bond dipole vectors to determine if the final result is zero (nonpolar molecule) or non-zero (polar molecule)



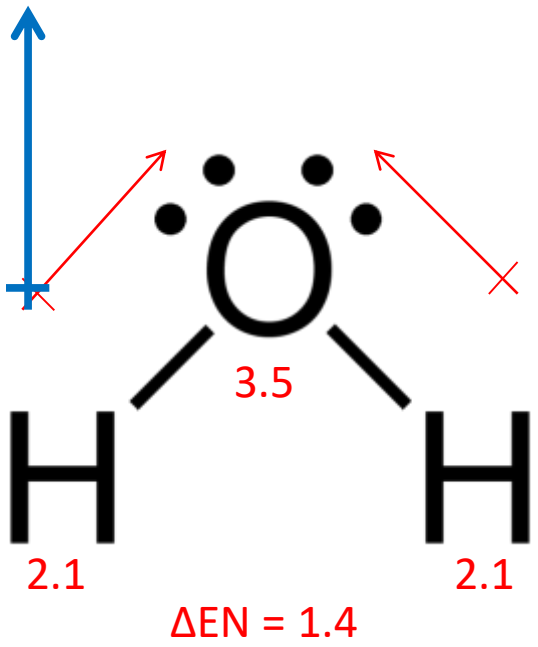
ΔEN = 1.0

Nonpolar

HOW TO DETERMINE THE POLARITY OF A MOLECULE

Example: H_2O

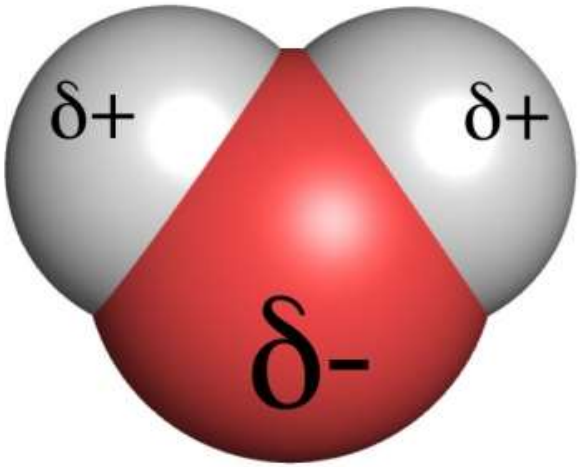
1. Draw a Lewis structure
2. Use the # of electron pairs & VSEPR to determine the shape around each central atom Angular/bent
3. Use EN differences to determine the polarity of each bond
4. Add the bond dipole vectors to determine if the final result is zero (nonpolar molecule) or non-zero (polar molecule)



Polar

HOW TO DETERMINE THE POLARITY OF A MOLECULE

Example: H_2O

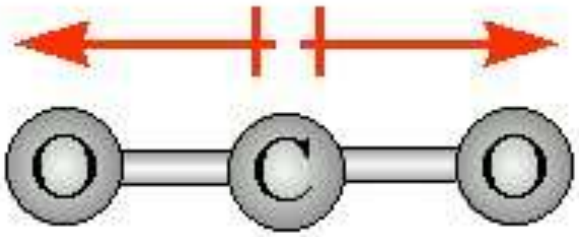


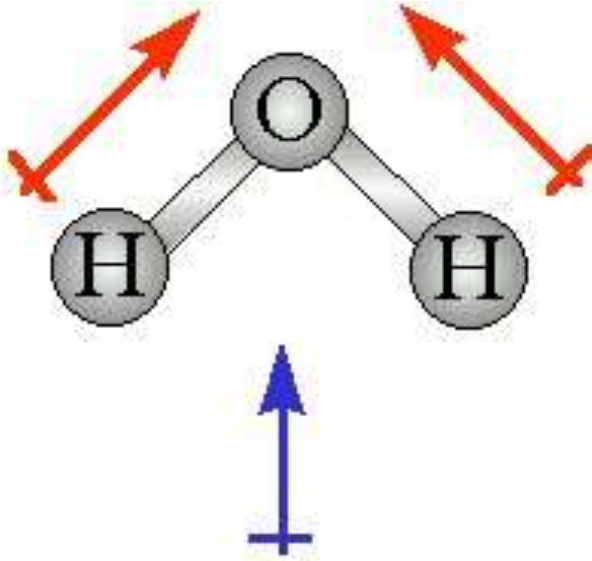
partial charges

HOW TO DETERMINE THE POLARITY OF A MOLECULE

Example: CO_2 vs. H_2O

Dipoles





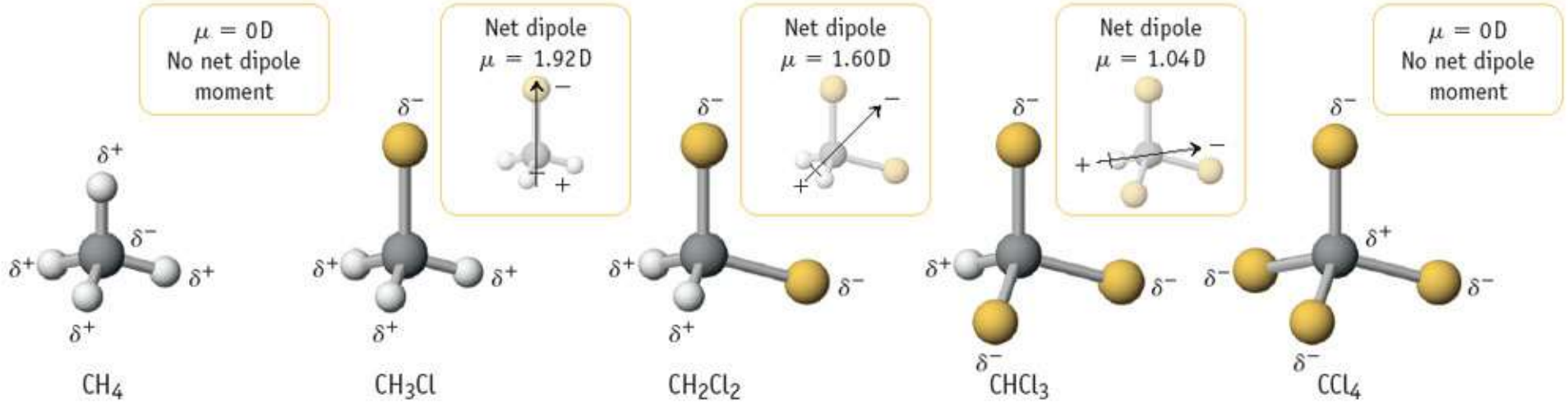
Overall Dipole:

(none)

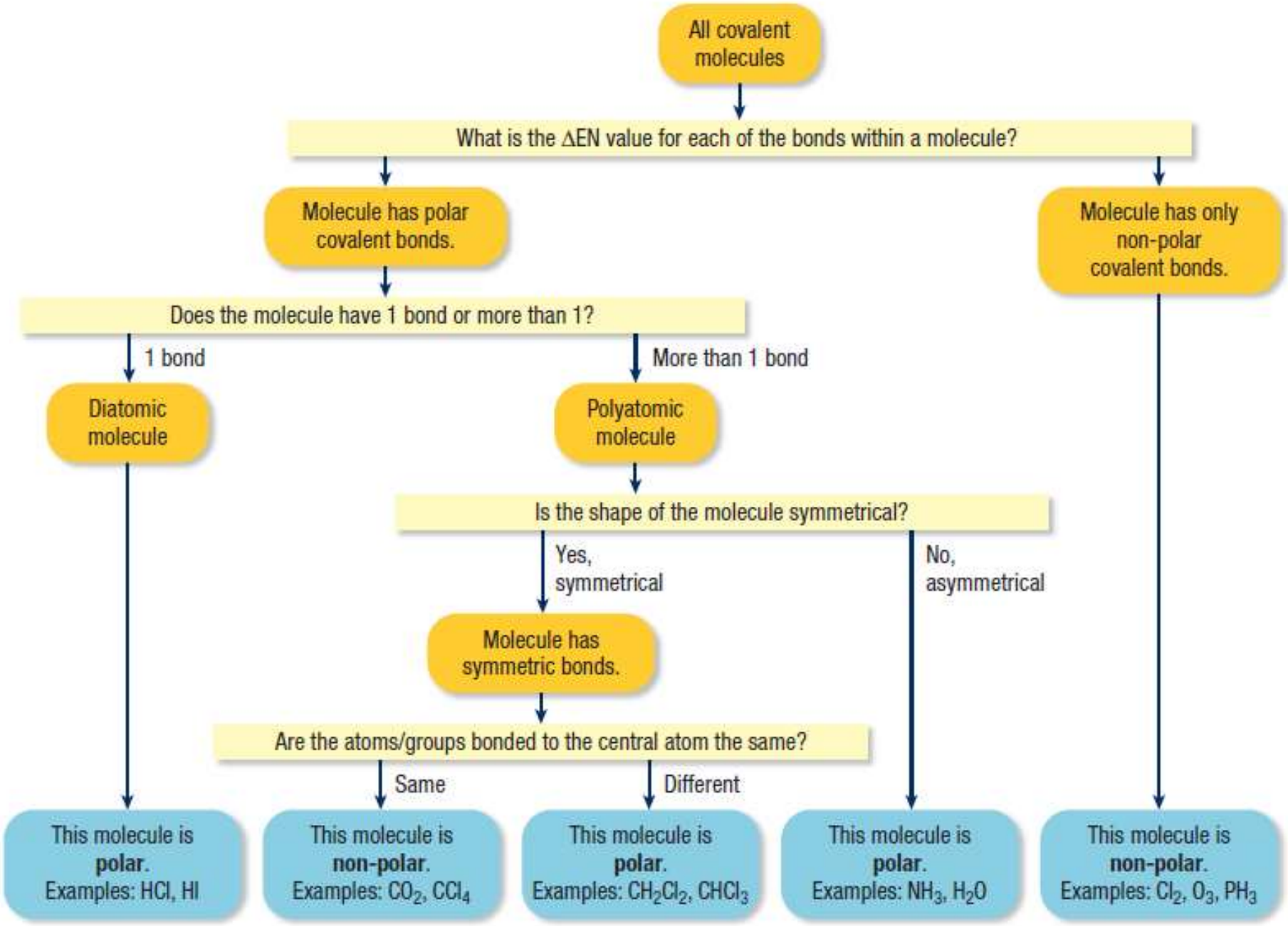
SYMMETRY AND POLARITY

- Can be difficult to add 3-D vectors so can use symmetry of the molecule instead to determine its polarity

- In all symmetrical molecules, the sum of the bond dipoles is zero & the molecule is nonpolar

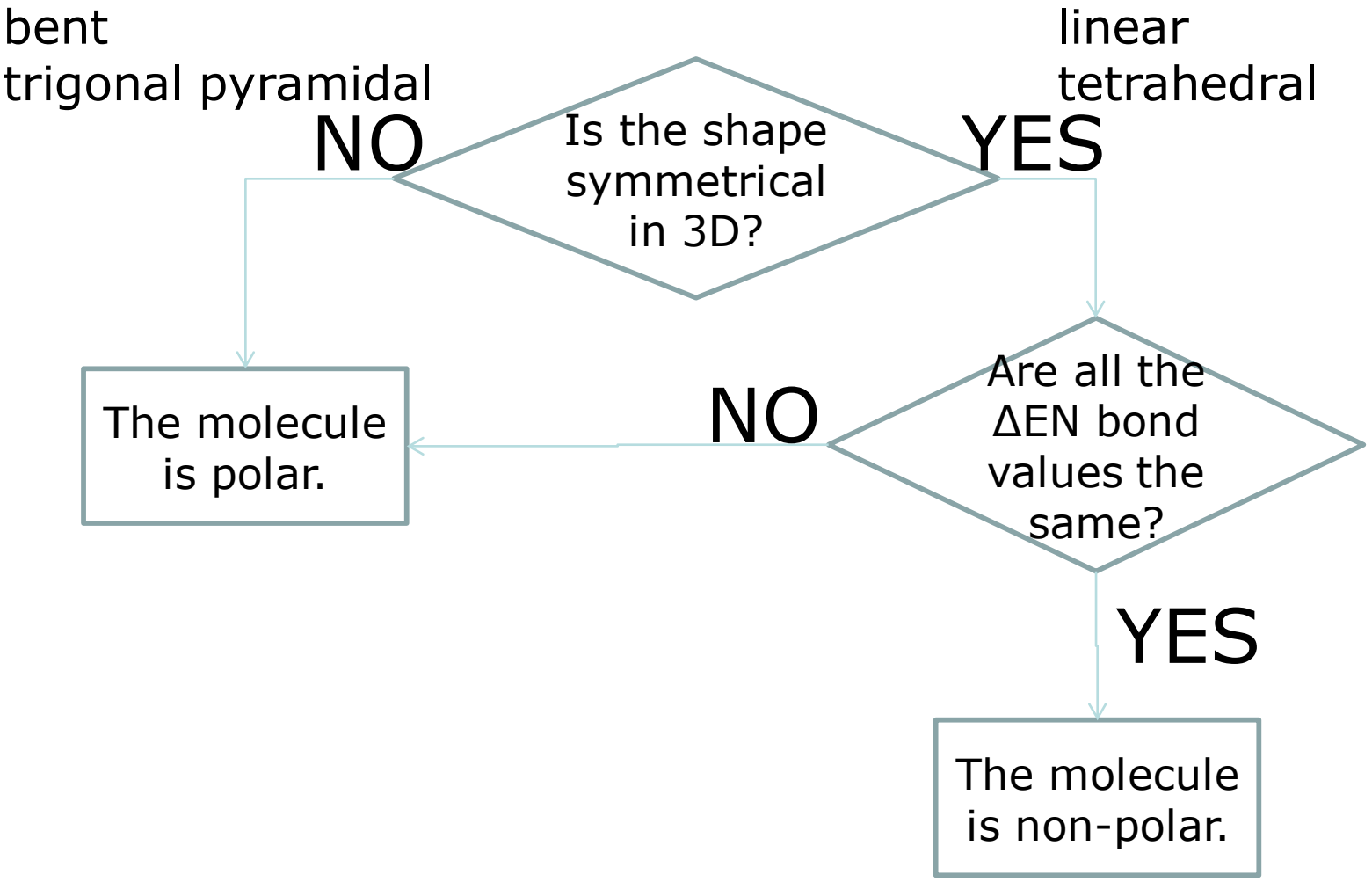


SYMMETRY AND POLARITY



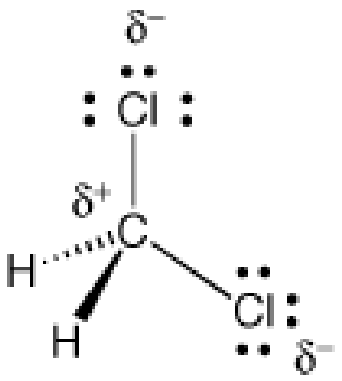
SYMMETRY AND POLARITY

Summary



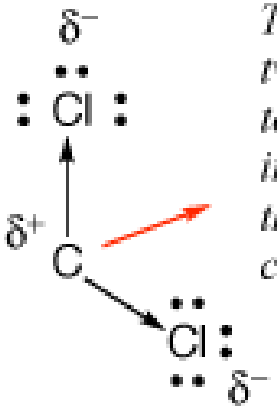
SYMMETRY AND POLARITY

Example of nonsymmetrical molecule



Methylene chloride

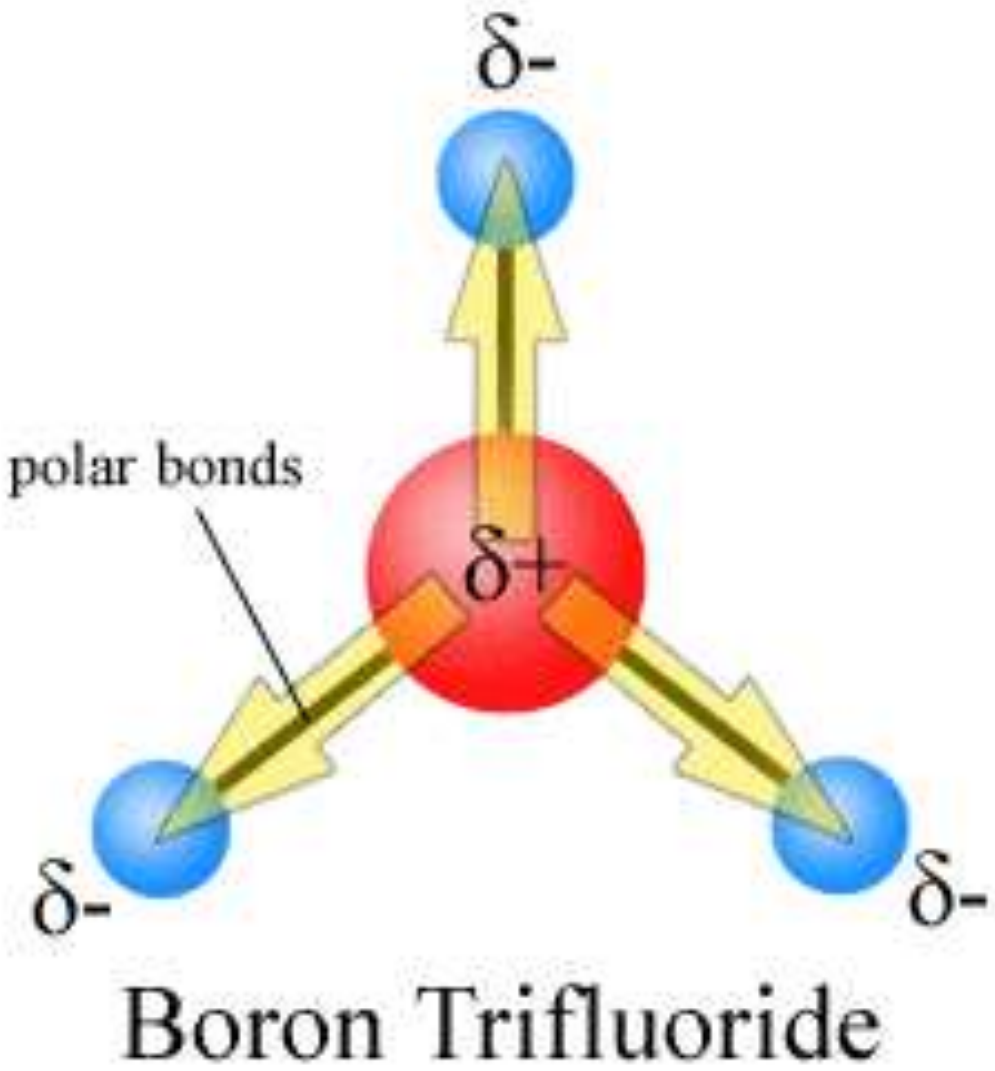
Using arrows to represent the polar bonds in methylene chloride



This molecule is pulled in two directions, which add together to produce a pull in the direction shown by the red arrow. Methylene chloride is ***polar***

SYMMETRY AND POLARITY

Example of symmetrical molecule



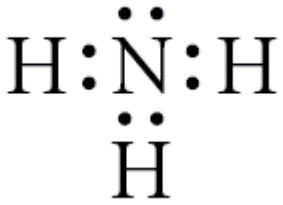
Boron Trifluoride

.: non-polar

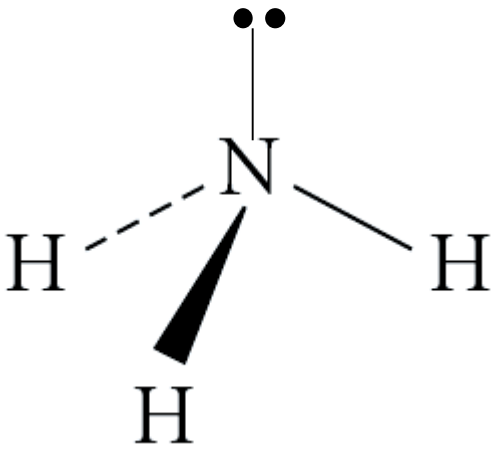
MOLECULAR SHAPE AND POLARITY

Example: NH_3

1) Draw the Lewis structure



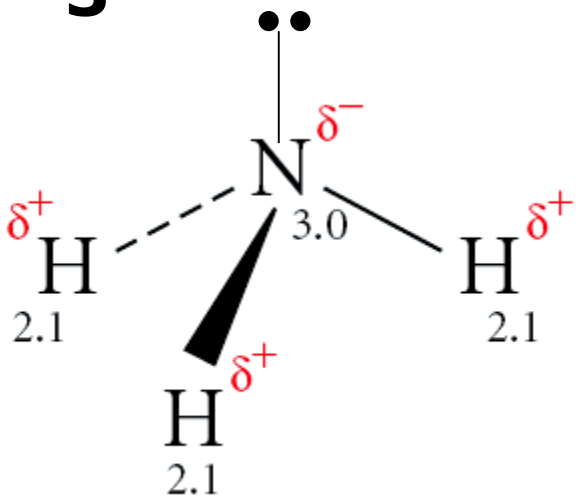
2) Based on the Lewis structure, draw the VSEPR diagram



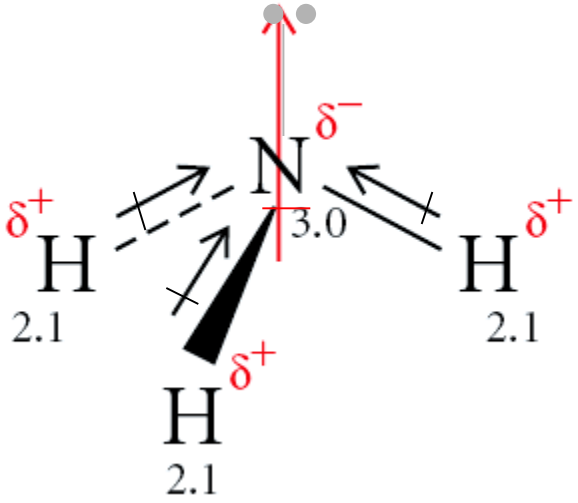
MOLECULAR SHAPE AND POLARITY

Example: NH_3

3) Add the electronegativity of the atoms and assign δ^+ and δ^- to the bonds



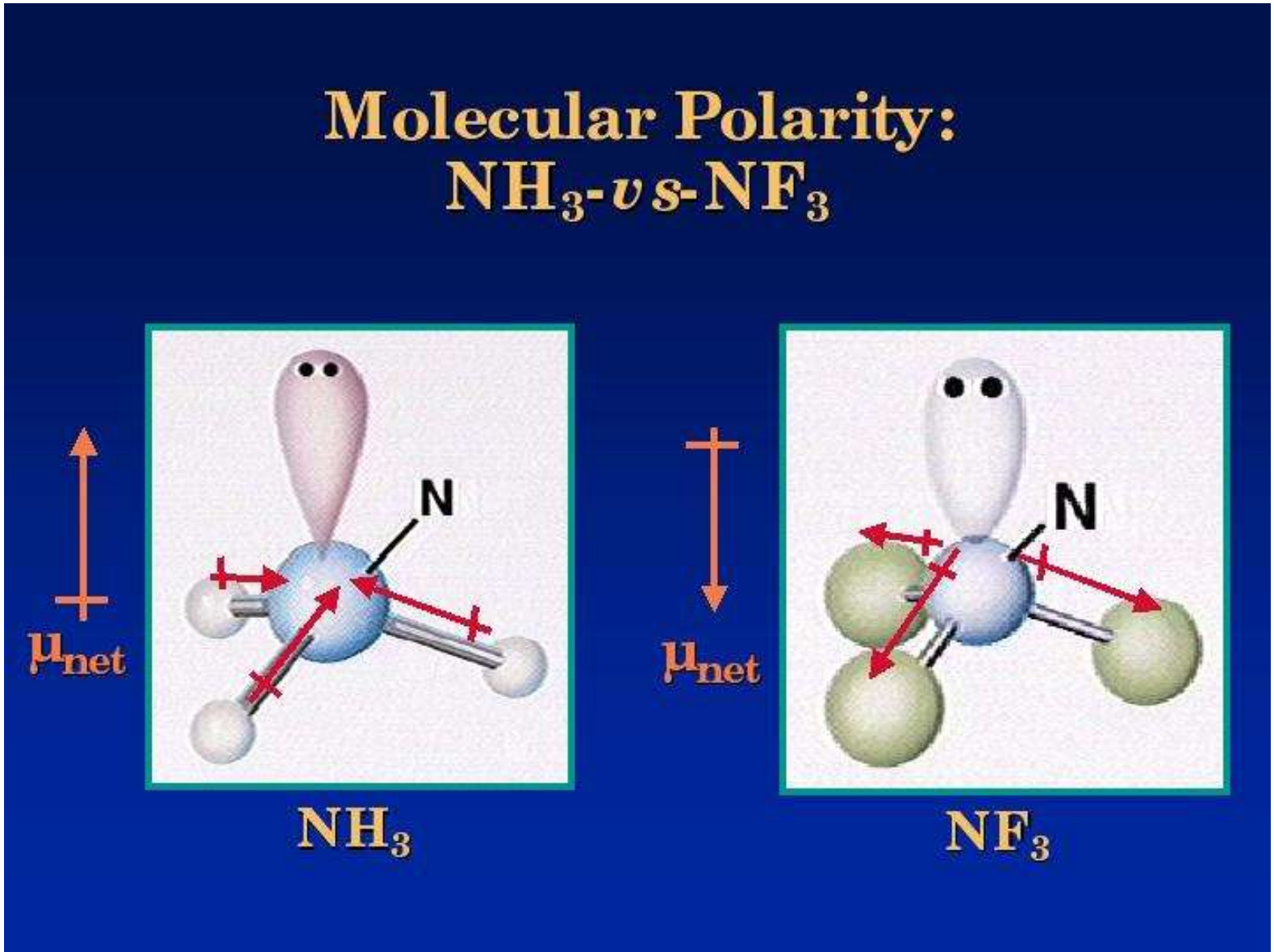
4) Draw in the bond dipoles



.: NH_3 is polar because it has polar bonds that do no cancel to zero.

MOLECULAR SHAPE AND POLARITY

Example: NH_3 vs. NF_3



Homework

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