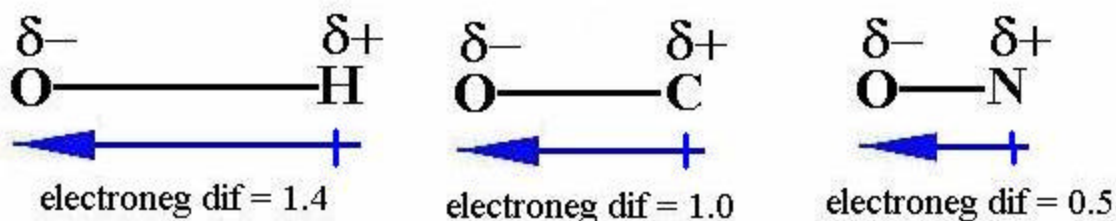


Molecular Polarity

Bond polarities originate from bonds between atoms of different electronegativity and molecular polarities result from the sum of bond polarities. Polar bonds are treated as vectors (both direction and magnitude) pointing from the positively charged atom to the negatively charged atom. The size of vector is proportional to the difference in electronegativity of the two atoms. If the two atoms are identical, the magnitude of the vector is zero and the bond is nonpolar.



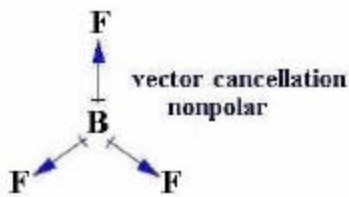
Predicting Molecular Polarity

1. Draw Lewis structure with correct geometry and identify each bond as either polar or nonpolar.
2. Molecule nonpolar if:
 - (i) No polar bonds exist.
 - (ii) Central atom has no lone pairs and all bonded atoms are the same ($\text{BF}_3/\text{CF}_4/\text{PF}_5/\text{SF}_6$).
 - (iii) Arrangement symmetrical with vector arrows (electronegativity differences) of equal length.
3. Molecule is polar if vector arrows do not cancel.

Examples

BF₃

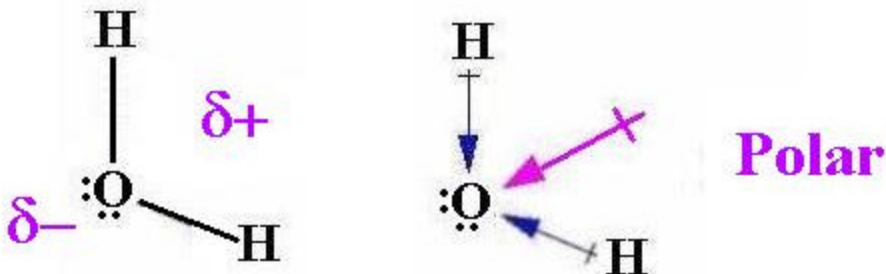
The 3 B-F bonds are polar but symmetrical arrangement about boron makes molecule nonpolar.



H₂O

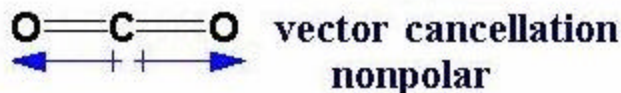
The 2 O-H bonds are polar and the bent geometry makes the distribution of these polar bonds asymmetrical. The part of the water molecule containing the more electronegative oxygen atom is partially negative while the part containing the less electronegative hydrogen atoms is partially positive.

The polarity of water can be represented using δ^- / δ^+ or arrows.

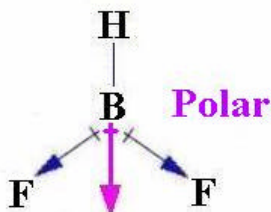


CO₂

Each C=O bond has vector arrow pointing from the carbon to the oxygen. Since the vectors are equal and pointing in opposite directions, the sum of these two vectors is zero and nonpolar molecule results.

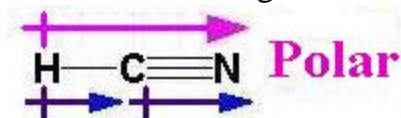


BHF₂



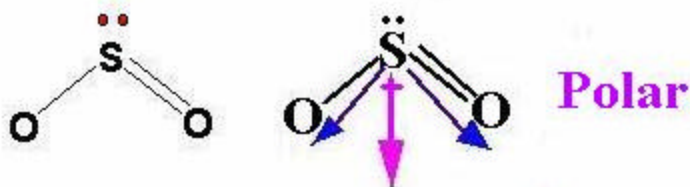
HCN

C is more electronegative than H and vector points from H to C; N is more electronegative than C and vector points from C to N. The H-C and C-N vectors add to give a total vector pointing from the H to N. HCN is polar with hydrogen end somewhat positive and nitrogen end somewhat negative.

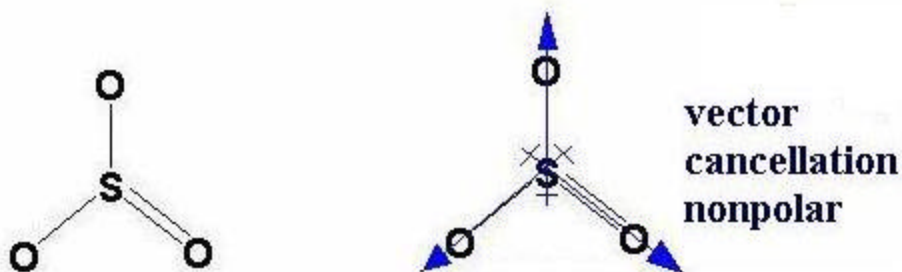


SO₂ Versus SO₃

Since SO₂ bent, the vectors add to give combined vector that bisects the O-S-O angle and points from the S to a point between the two oxygens.

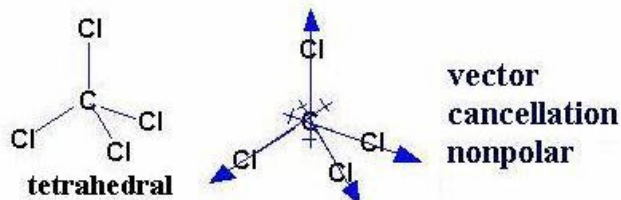


Since SO₃ trigonal planar, the three S-O vectors cancel and molecule is nonpolar.



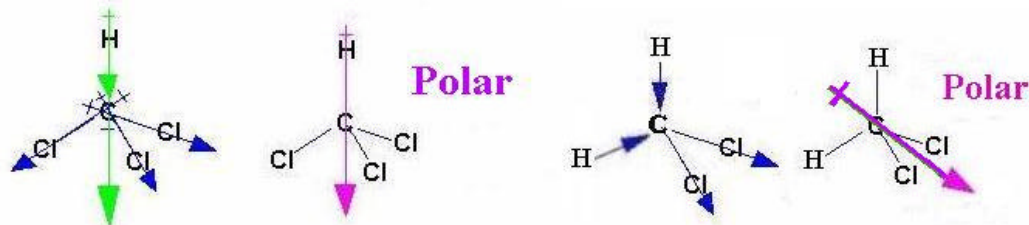
CCl₄

The four C-Cl bonds are polar and represented by vectors pointing from C to Cl. Due to the tetrahedral geometry, the four vectors cancel.



CHCl₃ & CH₂Cl₂

The bond vector for the C-H bond points to C while the bond vectors for the C-Cl bonds point toward Cl. These vectors add to give the large vector shown below:



Polarity analysis is similar for molecules of trigonal bipyramidal and octahedral shapes.

