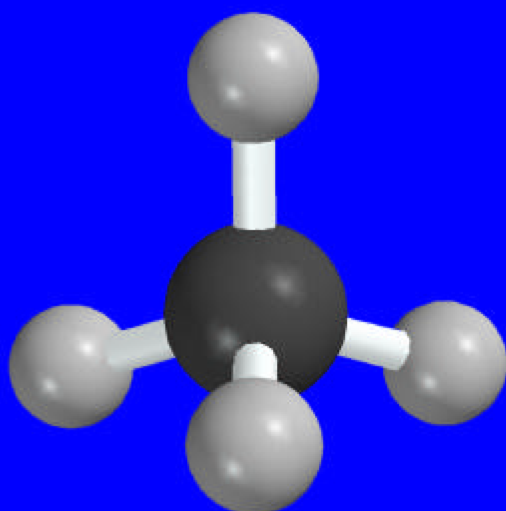
1.10
The Shapes of Some Simple Molecules

Methane

tetrahedral geometry

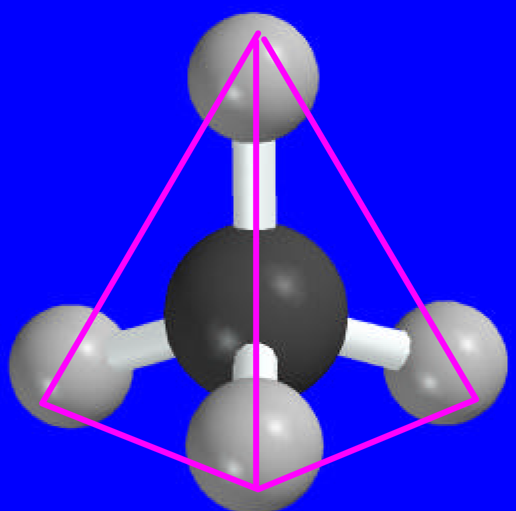
H—C—H angle = 109.5°



Methane

tetrahedral geometry

each H—C—H angle = 109.5°



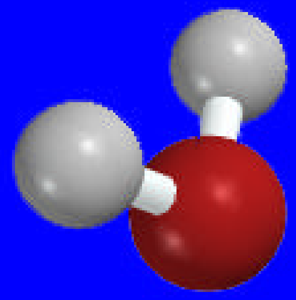
Valence Shell Electron Pair Repulsions

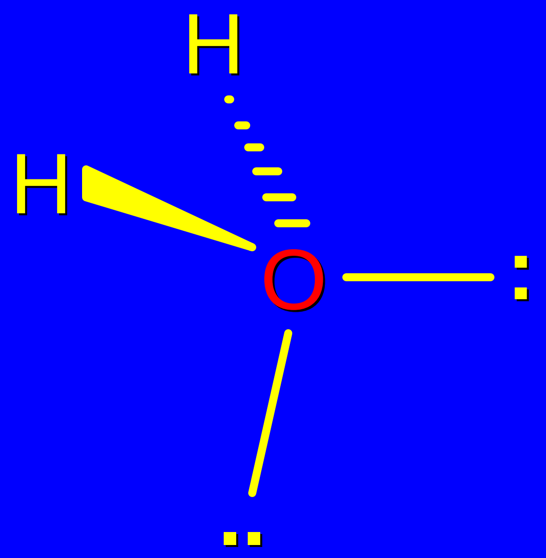
The most stable arrangement of groups attached to a central atom is the one that has the maximum separation of electron pairs (bonded or nonbonded).

Figure 1.9 (a): Water

bent geometry

H—O—H angle = 105°



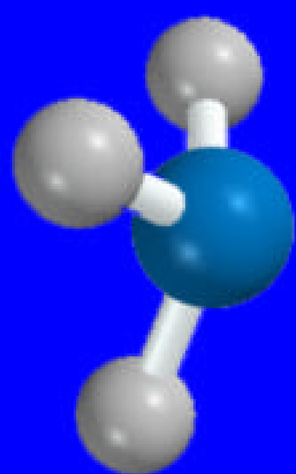


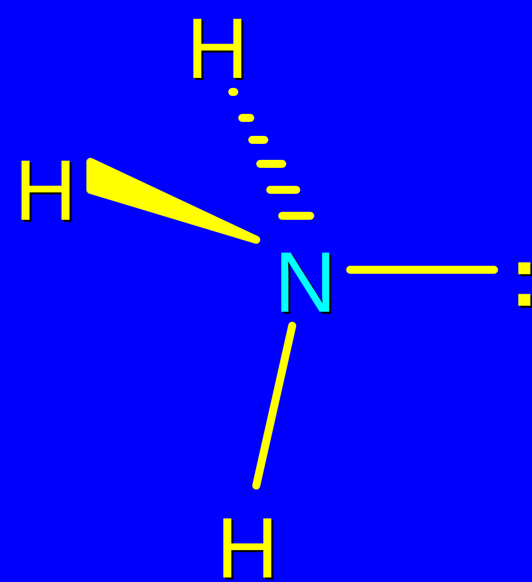
but notice the tetrahedral arrangement of electron pairs

Figure 1.9 (b): Ammonia

trigonal pyramidal geometry

H—N—H angle = 107°

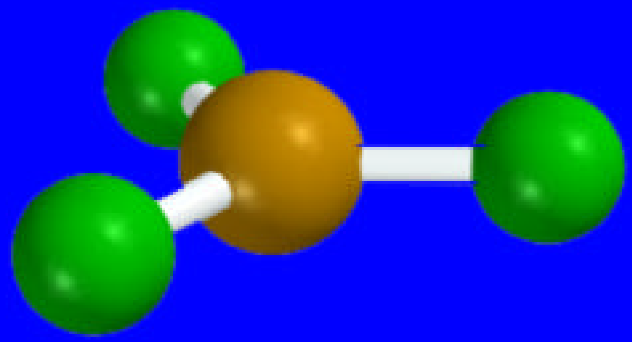




but notice the tetrahedral arrangement of electron pairs

Figure 1.9 (c): Boron Trifluoride

F—B—F angle = 120°
trigonal planar geometry
allows for maximum separation
of three electron pairs

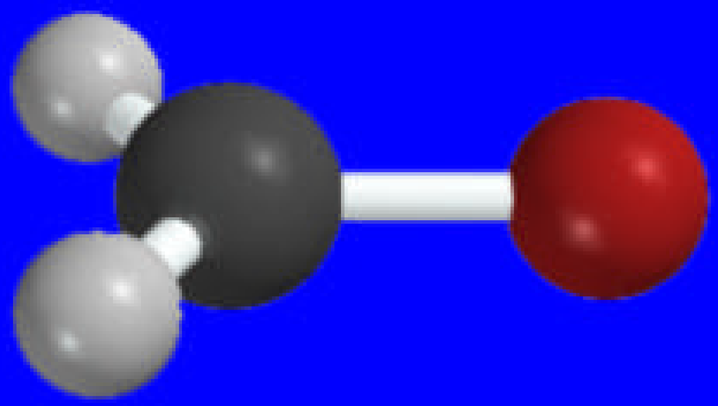


Multiple Bonds

Four-electron double bonds and six-electron triple bonds are considered to be similar to a two-electron single bond in terms of their spatial requirements.

Figure 1.11: Formaldehyde

H—C—H and H—C—O
angles are close to 120°
trigonal planar geometry



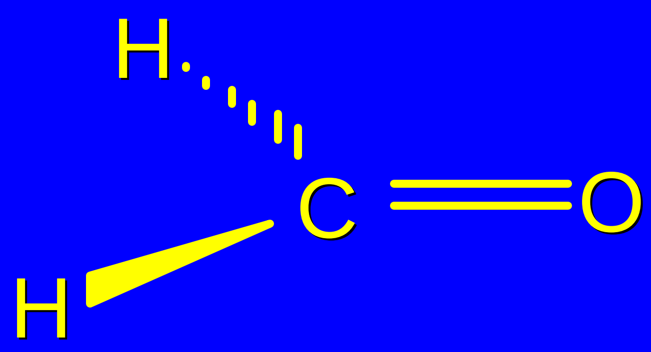
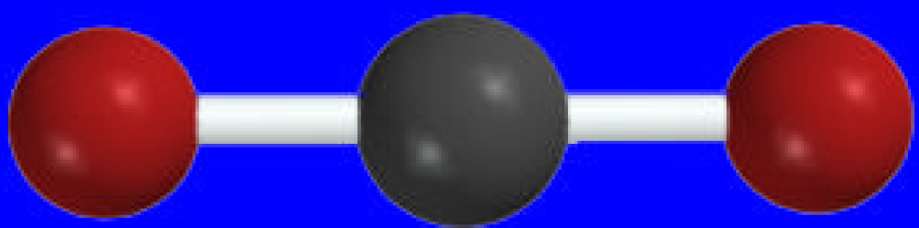


Figure 1.12: Carbon Dioxide

O—C—O angle = 180°
linear geometry



$O=C=O$

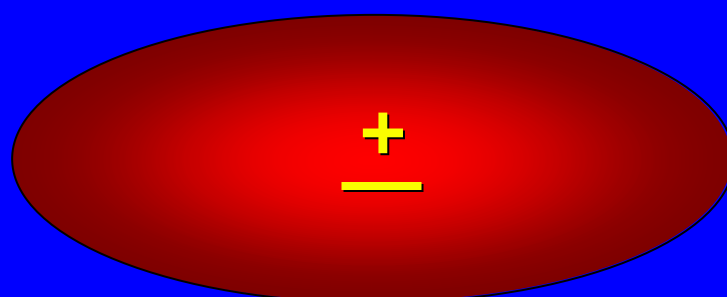
1.11
Molecular Dipole Moments

Dipole Moment

A substance possesses a dipole moment if its centers of positive and negative charge do not coincide.

m = e x d

(expressed in Debye units)



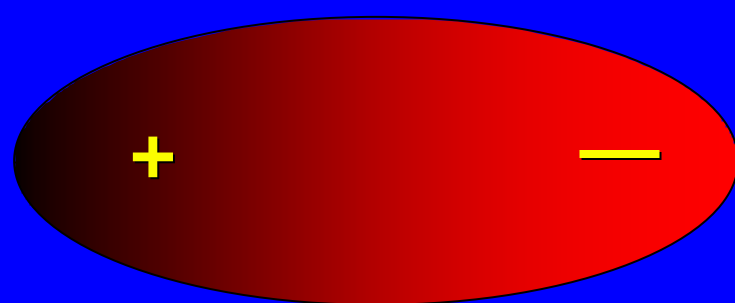
not polar

Dipole Moment

A substance possesses a dipole moment if its centers of positive and negative charge do not coincide.

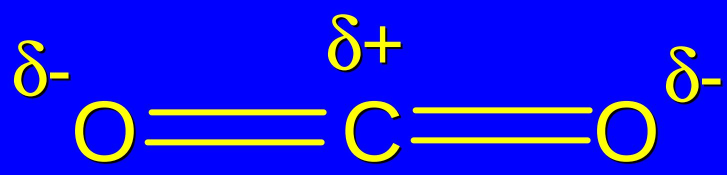
m = e x d

(expressed in Debye units)



polar

Molecular Dipole Moments



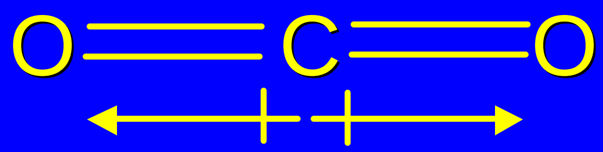
molecule must have polar bonds

necessary, but not sufficient

need to know molecular shape

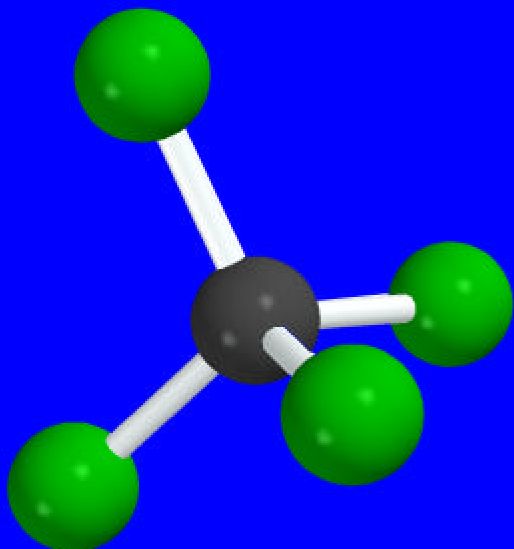
because individual bond dipoles can cancel

Molecular Dipole Moments



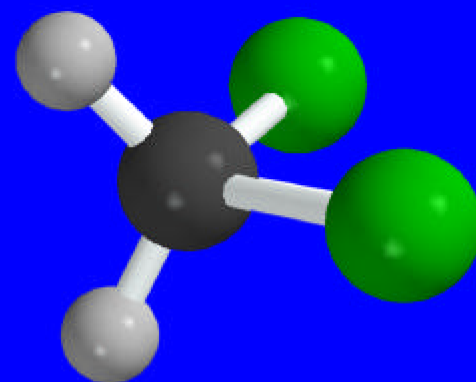
Carbon dioxide has no dipole moment; $\mu = 0$ D

Figure 1.13



Carbon tetrachloride

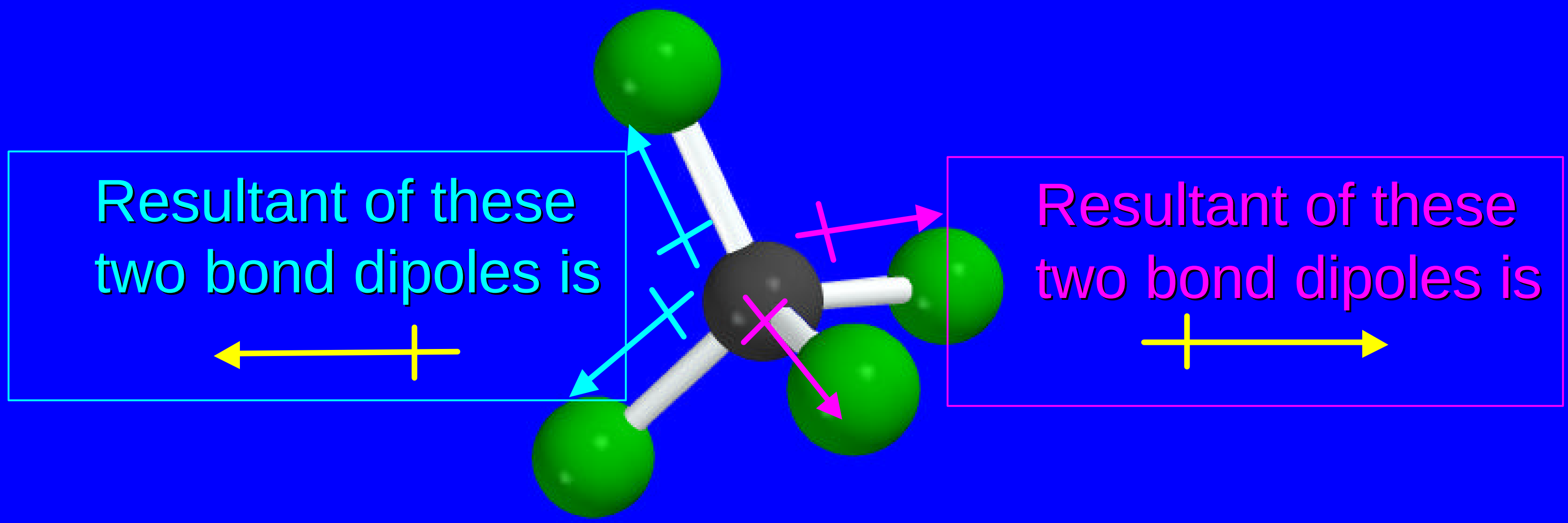
m = 0 D



Dichloromethane

m = 1.62 D

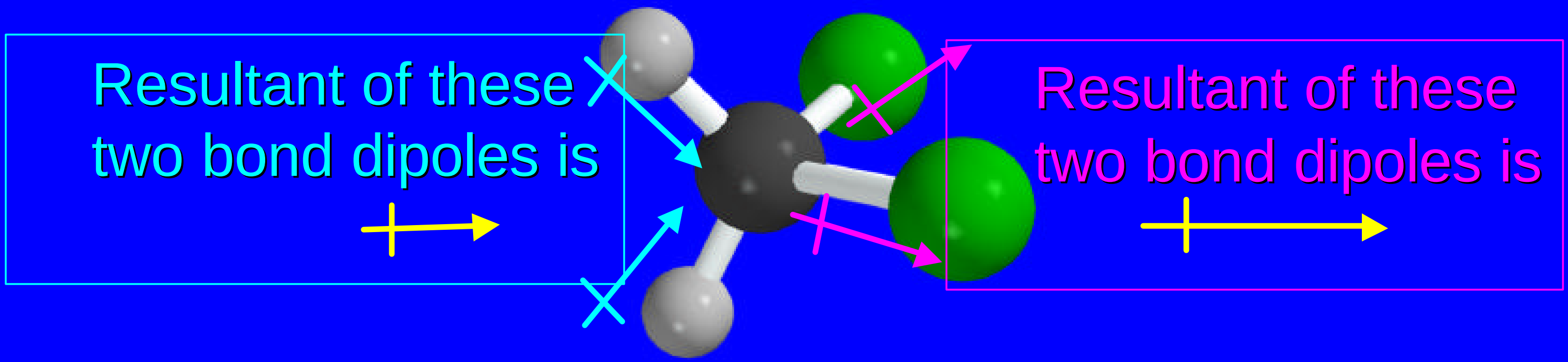
Figure 1.13



m = 0 D

Carbon tetrachloride has no dipole moment because all of the individual bond dipoles cancel.

Figure 1.13



m = 1.62 D

The individual bond dipoles do not cancel in dichloromethane; it has a dipole moment.