Beth "Key"

Theories of Covalent Bonding
December 6, 2009

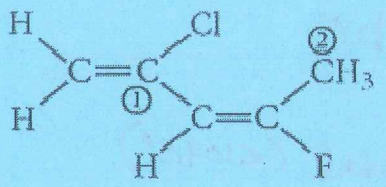
Valence Bond Theory

1. sp hybridization. In sp hybridization, 1 s orbital(s) hybridize with 1 p orbital(s) to form 2 sp orbital(s). The hybrid orbitals are oriented at 180° to each other to form a linear electron group geometry. 2 p orbitals remain unhybridized.

2. sp^2 hybridization. In sp^2 hybridization, 1 s orbital(s) hybridize with 2 p orbital(s) to form 3 sp^2 orbital(s). The hybrid orbitals are oriented at 120° to each other to form a trigonal planar electron group geometry. 1 p orbitals remain unhybridized.

3. sp^3 hybridization. In sp^3 hybridization, 1 s orbital(s) hybridize with 3 p orbital(s) to form 4 sp^3 orbital(s). The hybrid orbitals are oriented at 109.5° to each other to form a tetrahedral electron group geometry. 0 p orbitals remain unhybridized.

4. Consider the following molecule:

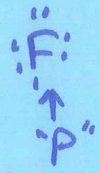


A. There are 9 sigma (σ) bonds and 2 pi (π)bonds.

B. The Carbon #1 is sp^2 hybridized and the Carbon #2 is sp^3 hybridized.

C. In the C-F bond, the Carbon sp^2 orbital is overlapped with the Flourine p orbital.

D. On Carbon #2, the Carbon sp^3 orbital is overlapped with the s Hydrogen orbital.



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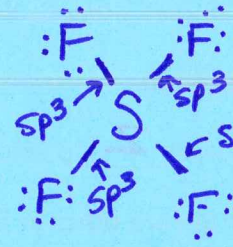
For the following molecules, indicate the molecular shape, hybridization of the central atom, the nature of the bonds on the central atom (for example: sp^2-p), number of sigma and pi bonds, and whether or not the molecule is polar.

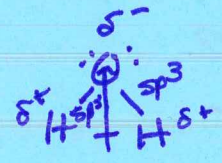
SF_4



Nonpolar

Tetrahedral Shape (109.5°)
sp^3 hybridization
4 sigma bond 0 pi

H_2O

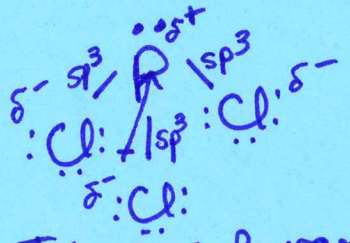


Polar

angular shape (<109.5°)
sp^3 hybridization
2 sigma 0 pi

PCl_3

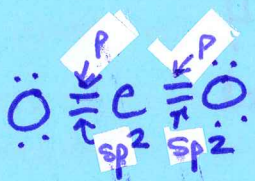
Electroneg
P = 2.19 δ+
Cl = 3.16 δ−



Polar

Trigonal Pyramidal (<109.5°)
sp^3 hybridization
3 sigma 0 pi

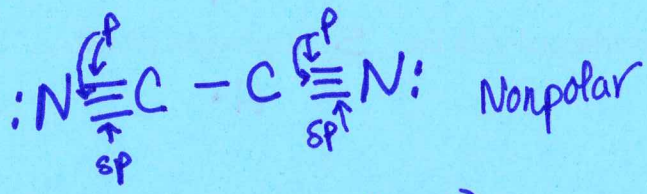
CO_2



nonpolar

Linear
sp^2 hybridization
2σ 2π

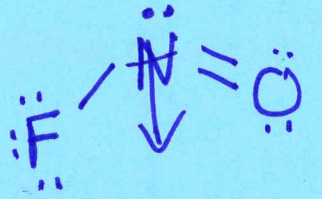
$(CN)_2$



Nonpolar

Linear (180°)
sp hybridization
2σ 4π

FNO



Polar

Angular (<120°)
sp^2 hybridization
2σ 1π