1) (5 pts). Both boron trifluoride (BF₃) and nitrogen trifluoride (NF₃) contain a central atom bonded to three fluorine atoms. One of these molecules is polar while the other is not. Identify which is which, and explain.

With only an electron sextet, B is sp² hybridized (planar) with an empty p orbital. Bond dipoles cancel; no net dipole, so BF₃ is NONPOLAR.

To lower the energy of its lone electron pair, N is sp³ hybridized (pyramidal). The bond dipoles add to yield a net dipole along molecule's 3-fold axis. So NF₃ is POLAR.

2) (5 pts). Arrange the following five valence orbitals of, say, carbon in order of decreasing (highest to lowest) energy: s, p, sp², sp³.

Since p is highest and s is lowest in the valence atomic orbital energy levels, the energy just falls in order of increasing s contribution:

\[ p > sp^3 > sp^2 > sp > s \]

3) (5 pts). Use the partially completed Newman projections below to draw the three staggered conformations of 1,2-dichloroethane. One of these is expected to be less polar than the other two; identify which is which, and explain.

In the middle structure, the C-Cl bond dipoles point in opposite directions and hence cancel each other, so it is nonpolar. In the other two structures the dipoles point partially in the same directions, adding up to a net molecular dipole.

4) (5 pts). Draw all five possible isomers for an alkane with the formula C₆H₁₄.