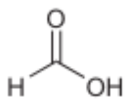
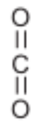
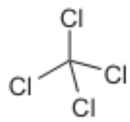
EXERCISE 4.1 Identify the hybridization state for the nitrogen atom in ammonia (NH_3).

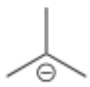
PROBLEMS For each compound below, identify the hybridization state for the central carbon atom.

4.2 

4.3 

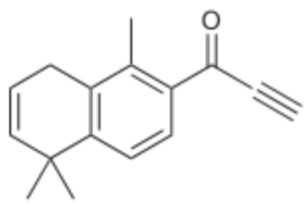
4.4 

4.5 

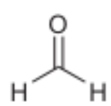
4.6 

4.7 $H-C\equiv C-CH_3$

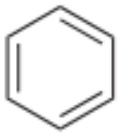
4.8 For each carbon atom in the following molecule, identify the hybridization state. Do not forget to count the hydrogen atoms (they are not shown). Use the following simple method: A carbon with 4 single bonds is sp^3 hybridized. A carbon with a double bond is sp^2 hybridized, and a carbon with a triple bond is sp hybridized.

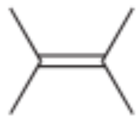


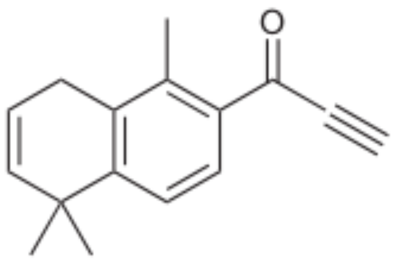
EXERCISE 4.9 Identify the geometry of the carbon atom below:

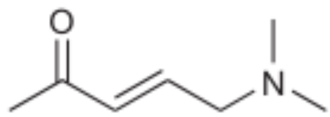


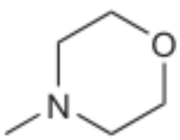
PROBLEMS Identify the hybridization state and geometry of each atom in the following compounds. Do not worry about the geometry of atoms connected to only one other atom. For example, do not worry about the geometry of any hydrogen atoms or about the geometry of the oxygen atoms in problems 4.12, 4.13, 4.15, and 4.17.

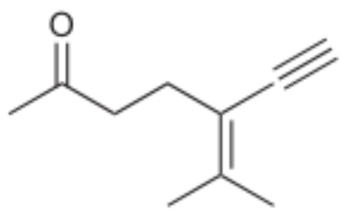
4.10 

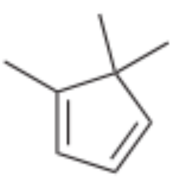
4.11 

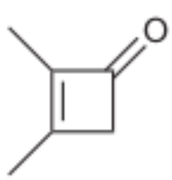
4.12 

4.13 

4.14 

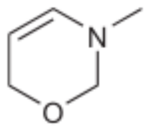
4.15 

4.16 

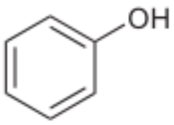
4.17 

Lone pairs

PROBLEMS Identify the hybridization state and geometry of each nitrogen atom and each oxygen atom in the following compounds.

4.18 

4.19 

4.20 

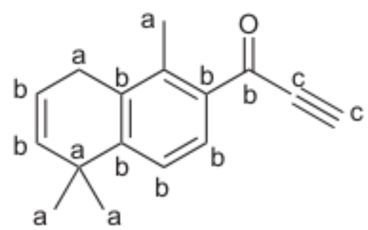
Answers:

4.1)

Answer First we need to ask how many atoms are connected to this nitrogen atom. There are three hydrogen atoms. Next we need to ask how many lone pairs the nitrogen atom has. It has 1 lone pair. Now, we take the sum. 3 + 1 = 4. If we need to have four hybridized orbitals, then the hybridization state must be sp^3.

4.2) sp^2
4.3) sp
4.4) sp^3
4.5) sp^2
4.6) sp^3
4.7) sp

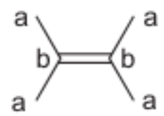
4.8)



a = tetrahedral
b = trigonal planar
c = linear

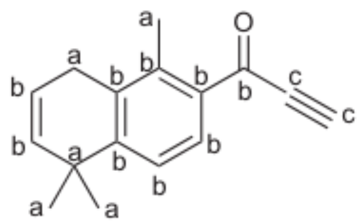
4.10) All are sp^2 and trigonal planar

4.11)



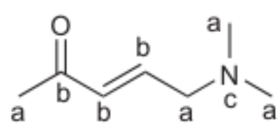
a = tetrahedral, sp^3
b = trigonal planar, sp^2

4.12)



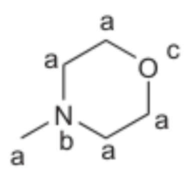
a = tetrahedral, sp^3
b = trigonal planar, sp^2
c = linear, sp

4.13)



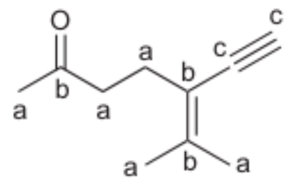
a = tetrahedral, sp^3
b = trigonal planar, sp^2
c = trigonal pyramidal, sp^3

4.14)



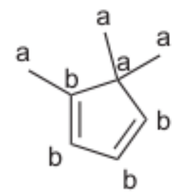
a = tetrahedral, sp^3
b = trigonal pyramidal, sp^3
c = bent, sp^3

4.15)



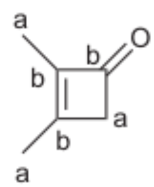
a = tetrahedral, sp^3
b = trigonal planar, sp^2
c = linear, sp

4.16)



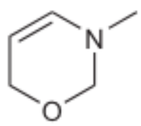
a = tetrahedral, sp^3
b = trigonal planar, sp^2

4.17)

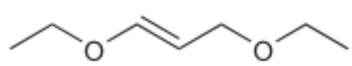


a = tetrahedral, sp^3
b = trigonal planar, sp^2

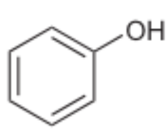
4.18) The nitrogen atom is sp^2 hybridized and trigonal planar. The oxygen atom is sp^3 hybridized and bent.



4.19) The oxygen atom on the left is sp^2 hybridized and trigonal planar. The oxygen atom on the right is sp^3 hybridized and bent.



4.20) The oxygen atom is sp^2 hybridized and bent.



4.9)

Answer First, we need to determine the hybridization state. We did this for this molecule earlier in this chapter and found that the hybridization state is sp^2 (there are 3 atoms connected and no lone pairs, so we need three hybridized orbitals; therefore, it is sp^2).

Next we remind ourselves how many lone pairs there are; in this case, there are none. So the geometry must be trigonal planar.

Once you can determine the geometry around an atom, you should have no problem determining the geometry, or shape, of a molecule. Simply repeat your analysis for each and every atom in the molecule. This may seem like a large task at first, but once you get the hang of it, you will be able to determine the geometry of an atom immediately upon seeing it.

For the next set of problems, you should get to the point where you can do these problems very quickly. The first few will take you longer than the last ones. If the last problem is still taking you a long time, then you have not mastered the process and you will need more practice. If this is the case, open to any page in the second half of your textbook. You will probably see drawings of structures. Point