Chapter 7.2 - Molecular Geometry
Reading Sheet

1. The basis for determining the spatial geometry of the atoms of a molecule is _____.
   a. electron pair repulsion  
   b. the photoelectric effect  
   c. formal charge considerations  
   d. resonance structures

2. Analyze Figure 7.4. The balloons in the diagram represent _____.
   a. atoms in a molecule  
   b. electron pairs surrounding the central atom  
   c. the bonds of the central atom  
   d. the p-orbitals surrounding the central atom

3. In a trigonal planar molecule such as BF$_3$, the F-B-F bond angle is _____.
   a. 90 degrees  
   b. 120 degrees  
   c. 180 degrees  
   d. ... nonsense! This angle varies from one molecule to the next.

4. Study Figure 7.5. Which of the following molecules might exhibit an octahedral structure?
   a. SCl$_6$  
   b. CH$_4$  
   c. PCl$_5$  
   d. C$_2$H$_4$

Now carefully read (and maybe even re-read) the section titled *Effect of Unshared Pairs on Molecular Geometry*. Then answer the following questions.

5. When referring to the molecular geometry, one must focus on the spatial positions of the _____.
   a. electron pairs  
   b. unshared pairs  
   c. atoms  
   d. double bonds

6. The electron pair geometry is different than the molecular geometry whenever _____.
   a. all the electron pairs surrounding the central atom are bonding pairs  
   b. the central atom has an expanded octet  
   c. the central atom has less than an octet of electrons  
   d. there are unshared (nonbonding) electron pairs around the central atom

7. Observe Figure 7.6 and the accompanying Lewis structure of NH$_3$. The four atoms of NH$_3$ form a _____.
   a. square planar  
   b. trigonal pyramid  
   c. tetrahedral  
   d. trigonal planar

8. Based on the discussion in the text, the H-O-H bond angle in water is closest to _____.
   a. 105  
   b. 109  
   c. 120  
   d. 180

9. Consider the three Lewis structures shown below for H$_2$S, PCl$_3$, I$_3^-$, and BH$_3$.

   ![](structure.png)

Notes from Class Discussion:

Valence Shell Electron Pair Repulsion (VSEPR) theory envisions the electron groups (pairs) surrounding the central atom repelling each other so as to maximize their spatial separation.

VSEPR theory allows one to predict the molecular geometry (or shape) based on the Lewis electron dot structure.

Two-atom molecules such as HCl and CO of course have a linear geometry.

Three-atom, four-atom, five-atom, etc molecules are more complicated cases; the geometry is expressed in terms of the spatial orientation of the terminal atoms which surround the central atom.

VSEPR is also able to predict bond angles.

Vocabulary:

- central atom
- terminal atom
- shared electron pair (i.e., bonding pair)
- unshared electron pair (i.e., lone pair)
- electron pair geometry
- molecular geometry
a. The number of terminal atoms on H$_2$S is ____; the number of unshared electron pairs is ____.
b. The number of terminal atoms on PCl$_3$ is ____; the number of unshared electron pairs is ____.
c. The number of terminal atoms on I$_3^-$ is ____; the number of unshared electron pairs is ____.
d. The number of terminal atoms on BH$_3^-$ is ____; the number of unshared electron pairs is ____.

10. Using Table 7.3 and the surrounding text (and the Lewis structures shown in the previous question), predict the molecular geometry of ...
   a. ... H$_2$S: __________________________
   b. ... PCl$_3$: __________________________
   c. ... I$_3^-$: ____________________________
   d. ... BH$_3^-$: __________________________

11. Now consider the Lewis structures shown below and the information in Figure 7.8 to determine the molecular geometry of ....

   ![Lewis structures]

   a. ... CO$_2$: __________________________
   b. HCN: _______________________________
   c. ... SO$_4^{2-}$: _________________________
   d. NO$_2^-$: _____________________________

12. Using the book's notation of AX$_i$E$_j$ where X is the number of terminal atoms and E is the number of unshared electron pairs, the molecule CO$_2$ would be classified as _____.
   a. AX$_2$  b. AX$_3$  c. AX$_2$E$_2$  d. AX$_3$E  e. AX$_4$

13. Using the book's notation of AX$_i$E$_j$ where X is the number of terminal atoms and E is the number of unshared electron pairs, the molecule NO$_2^-$ would be classified as _____.
   a. AX$_2$  b. AX$_3$  c. AX$_2$E$_2$  d. AX$_3$E  e. AX$_4$

14. Study the discussion of C$_2$H$_2$ on page 182. Each carbon atom in this molecule would be classified as _____.
   a. AX$_2$  b. AX$_3$  c. AX$_3$E$_2$  d. AX$_3$E  e. AX$_4$