PRACTICE *Answers in Appendix E*

1. Use VSEPR theory to predict the molecular geometry of the following molecules:
   a. HI **b.** CBr_4 **c.** CH_2Cl_2

extension
Go to **go.hrw.com** for more practice problems that ask you to predict molecular geometry.
Keyword: HC6BNDX

VSEPR Theory and Unshared Electron Pairs

Ammonia, NH_3, and water, H_2O, are examples of molecules in which the central atom has both shared and unshared electron pairs (see **Table 5** on the next page for their Lewis structures). How does VSEPR theory account for the geometries of these molecules?

The Lewis structure of ammonia shows that in addition to the three electron pairs it shares with the three hydrogen atoms, the central nitrogen atom has one unshared pair of electrons.

VSEPR theory postulates that the lone pair occupies space around the nitrogen atom just as the bonding pairs do. Thus, as in an AB_4 molecule, the electron pairs maximize their separation by assuming the four corners of a tetrahedron. Lone pairs do occupy space, but our description of the observed shape of a molecule refers to the *positions of atoms only*. Consequently, as shown in **Figure 22a,** the molecular geometry of an ammonia molecule is that of a pyramid with a triangular base. The general VSEPR formula for molecules such as ammonia is AB_3E, where E represents the unshared electron pair.

A water molecule has two unshared electron pairs. It is an AB_2E_2 molecule. Here, the oxygen atom is at the center of a tetrahedron, with two corners occupied by hydrogen atoms and two by the unshared pairs **(Figure 22b)**. Again, VSEPR theory states that the lone pairs occupy space around the central atom but that the actual shape of the molecule is determined by the positions of the atoms only. In the case of water, this results in a "bent," or angular, molecule.

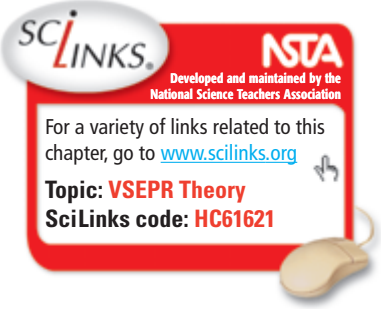
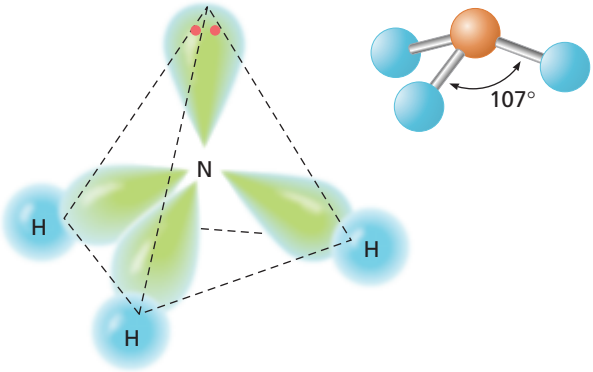
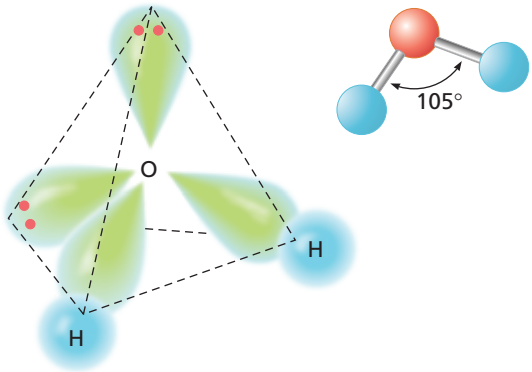


FIGURE 22 The locations of bonds and unshared electrons are shown for molecules of (a) ammonia and (b) water. Although unshared electrons occupy space around the central atoms, the shapes of the molecules depend only on the position of the molecules' atoms, as clearly shown by the ball-and-stick models.



(a) Ammonia, NH_3



(b) Water, H_2O