

## CHAPTER SEVEN

### Molecular Geometry

**7.13** How is the geometry of a molecule defined and why is the study of molecular geometry important?

**7.14** Sketch the shape of a linear triatomic molecule, a trigonal planar molecule containing four atoms, a tetrahedral molecule, a trigonal bipyramidal molecule, and an octahedral molecule. Give the bond angles in each case.

**7.15** How many atoms are directly bonded to the central atom in a tetrahedral molecule, a trigonal bipyramidal molecule, and an octahedral molecule?

**7.16** Discuss the basic features of the VSEPR model. Explain why the magnitude of repulsion decreases in the following order: lone pair-lone pair > lone pair-bonding pair > bonding pair-bonding pair.

**7.17** In the trigonal bipyramidal arrangement, why does a lone pair occupy an equatorial position rather than an axial position?

**7.18** The geometry of  $\text{CH}_4$  could be square planar, with the four H atoms at the corners of a square and the C atom at the center of the square. Sketch this geometry and compare its stability with that of a tetrahedral  $\text{CH}_4$  molecule.

**7.19** Predict the geometries of the following species using the VSEPR method: (a)  $\text{PCl}_3$ , (b)  $\text{CHCl}_3$ , (c)  $\text{SiH}_4$ , (d)  $\text{TeCl}_4$ .

**7.20** Predict the geometries of the following species: (a)  $\text{AlCl}_3$ , (b)  $\text{ZnCl}_2$ , (c) Zn.

**7.21** Predict the geometry of the following molecules using the VSEPR method: (a)  $\text{HgBr}_2$ , (b)  $\text{N}_2\text{O}$  (arrangement of atoms is NNO), (c)  $\text{SCN}^-$  (arrangement of atoms is SCN).

**7.22** Predict the geometries of the following ions:  
(a)  $\text{NH}_4^+$ , (b)  $\text{NH}_2^-$ , (c)  $\text{CO}_3^{2-}$ , (d)  $\text{ICl}_2^-$ , (e)  $\text{ICl}_4^-$ ,  
(f)  $\text{AlH}_4^-$ , (g)  $\text{SnCl}_5^-$ , (h)  $\text{H}_3\text{O}^+$ , (i)  $\text{BeF}_2^{2-}$ .

**7.23** Describe the geometry around each of the three central atoms in the  $\text{CH}_3\text{COOH}$  molecule.

**7.24** Which of the following species are tetrahedral?  $\text{SiCl}_4$ ,  $\text{SeF}_4$ ,  $\text{XeF}_4$ ,  $\text{Cl}_4$ , Cd

**7.25** Which of the following species is not likely to have a tetrahedral shape? (a)  $\text{SiBr}_4$ , (b)  $\text{NF}_4^+$ , (c)  $\text{SF}_4$ , (d)  $\text{BeCl}_2^{2-}$ , (e)  $\text{BF}_4^-$ , (f)  $\text{AlCl}_4^-$

**7.26** Draw the Lewis structure of mercury(II) bromide. Is this molecule linear or bent? How would you establish its geometry?

**7.27** Predict the geometry of sulfur dichloride ( $\text{SCl}_2$ ) and the hybridization of the sulfur atom.

**7.28** Antimony pentafluoride,  $\text{SbF}_5$ , reacts with  $\text{XeF}_4$  and  $\text{XeF}_6$  to form ionic compounds,  $\text{XeF}_3^+\text{SbF}_6^-$  and  $\text{XeF}_5^+\text{SbF}_6^-$ . Describe the geometries of the cations and anion in these two compounds.

**7.29** Draw Lewis structures and give the other information requested for the following molecules: (a)  $\text{BF}_3$ . Shape: planar or nonplanar? (b)  $\text{ClO}_3$ . Shape: planar or nonplanar? (c)  $\text{NO}_2$ . Estimate the ONO bond angle.

**7.30** Predict the bond angles for the following molecules: (a)  $\text{BeCl}_2$ , (b)  $\text{BCl}_3$ , (c)  $\text{CCl}_4$ , (d)  $\text{CH}_3\text{Cl}$ , (e)  $\text{Hg}_2\text{Cl}_2$  (arrangement of atoms:  $\text{ClHgHgCl}$ ), (f)  $\text{SnCl}_2$ , (g)  $\text{H}_2\text{O}_2$ , (h)  $\text{SnH}_4$ .

**7.31** Draw Lewis structures and give the other information requested for the following: (d)  $\text{SiH}_3$ . Planar or pyramidal shape?

**7.32** Which of the following molecules are linear?  $\text{ICl}_2$ ,  $\text{IF}_2^+$ ,  $\text{OF}_2$ ,  $\text{SnI}_2$ ,  $\text{CdBr}_2$

**7.33** Draw the Lewis structure for the  $\text{BeCl}_2^{2-}$  ion. Predict its geometry and describe the hybridization state of the Be atom.

**7.34** The following molecules ( $\text{AX}_4\text{Y}_2$ ) all have octahedral geometry. Group the molecules that are equivalent to each other.

