**Problem 1.3**
Draw a molecule of chloroform, CHCl₃, using solid, wedged, and dashed lines to show its tetrahedral geometry.

**Problem 1.6**
Write line-bond structures for the following substances, showing all nonbonding electrons:
(a) CHCl₃, chloroform  
(b) H₂S, hydrogen sulfide  
(c) CH₃NH₂, methylamine  
(d) CH₃Li, methyllithium

**Problem 1.8**
Draw a line-bond structure for propane, CH₃CH₂CH₃. Predict the value of each bond angle, and indicate the overall shape of the molecule.

**Problem 1.9**
Convert the following molecular model of hexane, a component of gasoline, into a line-bond structure (gray = C, ivory = H).

![Hexane](image)

**Problem 1.10**
Draw a line-bond structure for propene, CH₃CH=CH₂. Indicate the hybridization of the orbitals on each carbon, and predict the value of each bond angle.

**Problem 1.11**
Draw a line-bond structure for 1,3-butadiene, H₂C=CH—CH=CH₂. Indicate the hybridization of the orbitals on each carbon, and predict the value of each bond angle.

**Problem 1.12**
Following is a molecular model of aspirin (acetylsalicylic acid). Identify the hybridization of the orbitals on each carbon atom in aspirin, and tell which atoms have lone pairs of electrons (gray = C, red = O, ivory = H).

![Aspirin](image)

**Problem 1.13**
Draw a line-bond structure for propyne, CH₃C≡CH. Indicate the hybridization of the orbitals on each carbon, and predict a value for each bond angle.
**Problem 1.14**
Identify all nonbonding lone pairs of electrons in the following molecules, and tell what geometry you expect for each of the indicated atoms.

(a) The oxygen atom in dimethyl ether, CH$_3$–O–CH$_3$

(b) The nitrogen atom in trimethylamine, H$_3$C–N–CH$_3$

(c) The phosphorus atom in phosphine, PH$_3$

(d) The sulfur atom in the amino acid methionine, CH$_3$–S–CH$_2$CH$_2$CH$_2$CH$_2$COH

**Problem 1.15**
Tell how many hydrogens are bonded to each carbon in the following compounds, and give the molecular formula of each substance:

(a) ![Adrenaline](image)

(b) ![Estrone (a hormone)](image)

1.28 Fill in any nonbonding valence electrons that are missing from the following structures:

(a) H$_3$C–S–S–CH$_3$

(b) H$_3$C–C–NH$_2$

(c) H$_3$C–C–O$^-$

**Dimethyl disulfide**  **Acetamide**  **Acetate ion**

1.34 Potassium methoxide, KOCH$_3$, contains both covalent and ionic bonds. Which do you think is which?

1.38 What bond angles do you expect for each of the following, and what kind of hybridization do you expect for the central atom in each?

(a) H$_2$N–CH$_2$–C–OH

(b) H$_2$C–N=C–H

(c) CH$_3$–CH–C–OH

**Glycine**  (an amino acid)  **Pyridine**  **Lactic acid**  (in sour milk)
1.42 Convert the following structures into skeletal drawings:

(a) ![Indole](image)

(b) ![1,3-Pentadiene](image)

(c) ![1,2-Dichlorocyclopentane](image)

(d) ![Benzoquinone](image)

1.47 Allene, $\text{H}_2\text{C}≡\text{C}\equiv\text{CH}_2$, is somewhat unusual in that it has two adjacent double bonds. Draw a picture showing the orbitals involved in the $\sigma$ and $\pi$ bonds of allene. Is the central carbon atom $sp^2$- or $sp$-hybridized? What about the hybridization of the terminal carbons? What shape do you predict for allene?

1.50 Most stable organic species have tetravalent carbon atoms, but species with trivalent carbon atoms also exist. *Carbocations* are one such class of compounds.

![A carbocation](image)

(a) How many valence electrons does the positively charged carbon atom have?

(b) What hybridization do you expect this carbon atom to have?

(c) What geometry is the carbocation likely to have?

1.51 A *carbanion* is a species that contains a negatively charged, trivalent carbon.

![A carbanion](image)

(a) What is the electronic relationship between a carbanion and a trivalent nitrogen compound such as $\text{NH}_3$?

(b) How many valence electrons does the negatively charged carbon atom have?

(c) What hybridization do you expect this carbon atom to have?

(d) What geometry is the carbanion likely to have?