CHAPTER 1

STRUCTURE AND BONDING

I. STRUCTURE OF ATOMS

1. Distribution of electrons
   a. Shapes of orbitals (s, p, d, f)
   b. Distribution of electrons in atomic orbitals

2. Electronic Configuration
   a. Aufbau Principle
   b. Pauli Exclusion Principle
   c. Hund's Rule
   d. Ground-State configuration of atoms

II. CHEMICAL BONDS

1. Bonding Theory (tetrahedral carbon)

2. Ionic Bonds

3. Covalent Bonds (Lewis structures, bonding in halogens, oxygen, nitrogen, boron, carbon)
   a. Molecular geometry (bond strength, bond length)
   b. Molecular Orbital Theory (MO's)
   c. Bonding and Anti-bonding Orbitals (relative energy, sigma and pi bonds)
   d. Orbital Hybridization (sp, sp², sp³ orbitals, shapes and bond angles)

4. Structure of common organic fragments
   a. ethane
   b. ethylene
c. formaldehyde

d. acetylene

5. Hybridization in other atoms

a. nitrogen, oxygen, boron (relative electronegativity versus carbon?)

Note general bonding trends: Both CH and CC bond strength increases (bond length decreases) as hybridization of bonding carbons goes from sp³ to sp. Bond length (Angstroms) strength: C-C 1.5 (368 kJ/mol), C=C 1.3 (635 kJ/mol), C-C 1.2 (836 kJ/mol).

Chapter 1 Worksheet

What are the four types of atomic orbitals?

What are the shapes of s and p orbitals?

What suggestion did Van't Hoff make regarding the positioning of atoms about tetravalent carbon?

Define ionic bonding. What is characteristic of the atoms involved in ionic bonding?

Define covalent bonding.

What do the dots represent in Lewis structures? Draw the Lewis dot structure of methanol [CH₃OH].

How does the molecular orbital theory picture the formation of covalent bonds?

Two molecular orbitals are formed when two atomic orbitals are combined. One is the ----- orbital, the other is the ----- orbital, which is higher in energy?

Define a sigma bond.

What is the principal of maximum orbital overlap?

What two types of bonds can p-orbitals form?

What is the shape of a single sp³ hybrid orbital?

What is the strength of a C-H bond in methane? What is its length?

What is the bond angle between C-H bonds in methane?
How can the formation of sp² hybrids be rationalized?

Draw a molecular orbital picture of a C-C double bond.

How does the length of the carbon-carbon bond in ethylene compare with that of the C-C bond in ethane?

How can the formation of sp hybrids be rationalized?

Draw a molecule of acetylene. What is the angle between the C-H and the C-C bond?

Which is stronger, a C-C single bond or a C-C triple bond?

What type of hybridization is present in ammonia? In what notable respect does ammonia differ from methane?

What is the structure of a water molecule? How can this structure be explained by hybridization theory?