9: Molecular Geometry and Bonding Theories

OVERVIEW OF THE CHAPTER

9.1, 9.2, 9.3 VSEPR Model: A Tool for Qualitatively Predicting Molecular Shapes and Molecular Polarity

Review: Lewis structures (8.1, 8.5); bond polarity (8.4)

Learning Goals: You should be able to:

1. Relate the number of electron domains in the valence shell of a central atom in a molecule to the geometrical arrangement of atoms around it.
2. Explain why nonbonding electron domains exert a greater repulsive interaction on other domains than do bonding electron domains.
3. Use the VSEPR model to predict the geometrical structure of bonded atoms about a central atom in a molecule.
4. Predict if a molecule has a molecular dipole by analyzing the magnitude and direction of bond dipoles about the central atom in the molecule.

9.4, 9.5 Covalent Bonding, Hybrid Orbitals, and Molecular Structure

Review: Orbital diagrams (6.6); orbital types and shapes (6.6); concept of valence orbitals (6.8).

Learning Goals: You should be able to:

1. Describe the principles of the valence-bond model and use them to describe covalent bonding between atoms in molecules.
2. Explain the concept of hybridization and its relationship to geometrical structure.
3. Assign hybrid orbitals to an atom in a covalent molecule when required to explain its geometry or bonding between atoms.

9.5, 9.6 Hybridization in Molecules Containing Both Sigma and Pi Bonds

Review: Lewis structures containing multiple bonds (8.5, 8.6); resonance (8.7)

Learning Goals: You should be able to:

1. Formulate the bonding in a molecule in terms of σ bonds and π bonds from its Lewis structure.
2. Explain the concept of delocalization of electrons in π bonds in molecules such as benzene.

9.7, 9.8 Molecular Orbitals

Review: Hund's Rule (6.8); the Pauli principle (6.7); orbital shapes (6.6).

Learning Goals: You should be able to:

1. Explain the concept of orbital overlap and the reason why overlap may in some cases be zero because of symmetry.
2. Describe how molecular orbitals are formed by overlap of atomic orbitals.
3. Explain the relationship between bonding and antibonding molecular orbitals.

4. Construct the molecular-orbital energy-level diagram for diatomic molecule or ion built from elements of the first or second row and predict the bond order and number of unpaired electrons.