CHAPTER 8

Study Guide

Study Tip

Switch Tasks When you feel yourself losing focus, switch the type of task you are working on, the subject that you are studying, or the environment you are in. Take a break and walk around a bit. Stop studying when you are no longer being productive.

Interactive Textbook

If your class subscribes to the Interactive Textbook with ChemASAP, your students can go online to access an interactive version of the Student Edition and a self-test.

with ChemASAP

CHAPTER 8

Study Guide

Key Concepts

8.1 Molecular Compounds

- Molecular compounds tend to have relatively low melting and boiling points.
- A molecular formula shows how many atoms of each element a molecule contains.

8.2 The Nature of Covalent Bonding

- Electron sharing occurs so that atoms attain the configurations of noble gases.
- An electron dot structure shows the shared electrons of a covalent bond by a pair of dots.
- Atoms form double or triple bonds by sharing two or three pairs of electrons.
- In a coordinate covalent bond, the shared electron pair comes from a single atom.
- A large bond dissociation energy corresponds to a strong covalent bond.
- In ozone, the bonding of oxygen atoms is a hybrid of the extremes represented by the resonance forms.
- The octet rule is not satisfied in molecules with an odd number of electrons, and in molecules where an atom has less, or more, than a complete octet of valence electrons.

8.3 Bonding Theories

- Just as an atomic orbital belongs to a particular atom, a molecular orbital belongs to a molecule as a whole.
- According to VSEPR theory, the repulsion between electron pairs causes molecular shapes to adjust so that the valence-electron pairs stay as far apart as possible.
- Orbital hybridization provides information about both molecular bonding and molecular shape.

8.4 Polar Bonds and Molecules

- When different atoms bond, the more electronegative atom attracts electrons more strongly and acquires a slight negative charge.
- Polar molecules between oppositely charged metal plates tend to become oriented with respect to the positive and negative plates.
- Intermolecular attractions are weaker than either an ionic or covalent bond.
- Melting a network solid requires breaking covalent bonds throughout the solid.

Vocabulary

- bond dissociation energy (p. 226)
- bonding orbital (p. 230)
- covalent bond (p. 213)
- coordinate covalent bond (p. 223)
- diatomic molecule (p. 214)
- dipole (p. 239)
- dipole interactions (p. 240)
- dispersion forces (p. 240)
- double covalent bond (p. 221)
- hybridization (p. 234)
- hydrogen bonds (p. 241)
- molecular compound (p. 214)
- molecular formula (p. 215)
- molecular orbital (p. 230)
- molecule (p. 214)
- network solids (p. 243)
- nonpolar covalent bond (p. 237)
- pi bond (p. 231)
- polar bond (p. 238)
- polar covalent bond (p. 238)
- polar molecule (p. 239)
- polyatomic ion (p. 223)
- resonance structure (p. 227)
- sigma bond (p. 230)
- single covalent bond (p. 217)
- structural formula (p. 218)
- tetrahedral angle (p. 232)
- triple covalent bond (p. 221)
- unshared pair (p. 218)
- van der Waals forces (p. 240)
- VSEPR theory (p. 232)

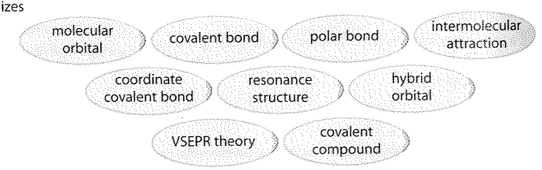
Organizing Information

Construct a concept map that organizes the major ideas of this chapter.

Interactive Textbook

Concept Map 8 Solve the Concept Map with the help of an interactive guided tutorial.

with ChemASAP



Chapter Resources

Print

- **Core Teaching Resources,** Chapter 8, Practice Problems, Vocabulary Review, Quiz, Chapter Test A, Chapter Test B

Technology

- **Computer Test Bank,** Chapter 8 Test
- **Interactive Textbook with ChemASAP,** Chapter 8

246 Chapter 8

CHAPTER 8

Assessment

Reviewing Content

8.1 Molecular Compounds

39. The melting point of a compound is 1240°C. Is this compound most likely an ionic or a molecular compound?

40. Identify the number and kinds of atoms present in a molecule of each compound.
   a. ascorbic acid (vitamin C), $C_6H_8O_6$
   b. sucrose (table sugar), $C_{12}H_{22}O_{11}$
   c. trinitrotoluene (TNT), $C_7H_5N_3O_6$

41. Which of the following gases in Earth's atmosphere would you expect to find as molecules and which as individual atoms? Explain.
   a. nitrogen b. oxygen c. argon

8.2 The Nature of Covalent Bonding

42. Explain why neon is monatomic but chlorine is diatomic.

43. Classify the following compounds as ionic or covalent.
   a. $MgCl_2$ b. Na_2S c. H_2O d. H_2S

44. Describe the difference between an ionic and a covalent bond.

45. How many electrons do two atoms in a double covalent bond share? How many in a triple covalent bond?

46. Draw plausible electron dot structures for the following substances. Each substance contains only single covalent bonds.
   a. I_2 b. OF_2 c. H_2S d. NI_3

47. Characterize a coordinate covalent bond and give an example.

48. Explain why compounds containing C—N and C—O single bonds can form coordinate covalent bonds with H^+ but compounds containing only C—H and C—C single bonds cannot.

49. Using electron dot structures, draw at least two resonance structures for the nitrite ion (NO_2^-). The oxygens in NO_2^- are attached to the nitrogen.

50. Which of these compounds contain elements that do not follow the octet rule? Explain.
   a. NF_3 b. PCl_2F_3 c. SF_4 d. SCl_2

51. Explain what is meant by bond dissociation energy.

52. What is the relationship between the magnitude of a molecule's bond dissociation energy and its expected chemical reactivity?

8.3 Bonding Theories

53. What is a pi bond? Describe, with the aid of a diagram, how the overlap of two half-filled *p* atomic orbitals produces a pi bond.

54. Use VSEPR theory to predict the shapes of the following species.
   a. CO_2 b. $SiCl_4$ c. SO_3
   d. SCl_2 e. CO f. H_2Se

55. The molecule CO_2 has two carbon–oxygen double bonds. Describe the bonding in the CO_2 molecule, which involves hybridized orbitals for carbon and oxygen.

56. What types of hybrid orbitals are involved in the bonding of the carbon atoms in the following molecules?
   a. CH_4 b. $H_2C{=}CH_2$
   c. $HC{\equiv}CH$ d. $N{\equiv}C{-}C{\equiv}N$

8.4 Polar Bonds and Molecules

57. How must the electronegativities of two atoms compare if a covalent bond between them is to be polar?

58. The bonds between the following pairs of elements are covalent. Arrange them according to polarity, listing the most polar bond first.
   a. H—Cl b. H—C c. H—F
   d. H—O e. H—H f. S—Cl

59. What is a hydrogen bond?

60. Depict the hydrogen bonding between two ammonia molecules and between one ammonia molecule and one water molecule.

61. Why do compounds with strong intermolecular attractive forces have higher boiling points than compounds with weak intermolecular attractive forces?

54. **a.** linear **b.** tetrahedral **c.** trigonal planar **d.** bent **e.** linear **f.** bent

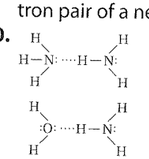
55. The 2*s* and the 2*p* orbitals form two *sp* hybrid orbitals on the carbon atom. One *sp* hybrid orbital forms a sigma bond between the carbon atom and each oxygen atom. Pi bonds between each oxygen atom and the carbon are formed by the unhybridized 2*p* orbitals.

56. **a.** sp^3 **b.** sp^2 **c.** *sp* **d.** *sp*

57. The electronegativities of the two atoms will differ by about 0.4 to 2.0.

58. c, d, a, f, b, e

59. A hydrogen bond is formed by an electrostatic interaction between a hydrogen atom that is covalently bonded to an electronegative atom, and an unshared electron pair of a nearby atom.

60. 

61. More energy is required to separate the molecules.

CHAPTER 8

king Ass

hese elements

Reviewing Conte

le 8.3 sug- difference. could be rties, com-

39. ionic

40. **a.** 6 C, 8 H, 6 O **b.** 12 C, 22 H, **c.** 7 C, 5 H, 3 N, 6 O

41. Nitrogen and oxygen achiev bility as diatomic molecules. A en exists as individual atoms becau it has a stable noble-gas electron configuration.

42. Neon has an octet of electrons. A chlorine atom achieves an octet by sharing an electron with another chlorine atom.

43. **a.** ionic **b.** ionic **c.** covalent **d.** covalent

44. Ionic bonds depend on electrostatic attraction between ions. Covalent bonds depend on electrostatic attraction between shared electrons and nuclei of combining atoms.

45. A double covalent bond has four shared electrons (two bonding pairs); a triple covalent bond has six shared electrons (three bonding pairs).

46. **a.** **b.** **c.**  **d.** 

47. One atom contributes both electrons to a coordinate covalent bond, as in CO.

48. An unshared pair of electrons is needed for a coordinate covalent bond. There are no unshared pairs in compounds with only C-H and C-C bonds.

49.

50. b and c; assuming only single bonds, the P and S atoms each have 10 valence electrons.

51. Bond dissociation energy is defined as the energy needed to break one covalent bond.

52. Increasing bond dissociation energy is linked to lower chemical reactivity.

53. A pi bond is formed by the side-by side overlap of two half-filled *p* atomic orbitals to produce a pi molecular orbital. In a pi bond, the bonding electrons are most likely to be found in sausage-shaped regions above and below the bond. See Figure 8.15.