8 COVALENT BONDING

Reviewing Content

39. ionic

40. **a.** 6 C, 8 H, 6 O **b.** 12 C, 22 H, 11 O
c. 7 C, 5 H, 3 N, 6 O

41. Nitrogen and oxygen achieve stability as diatomic molecules. Argon exists as individual atoms because 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.

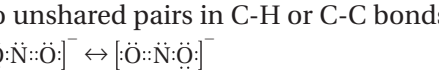
45. A double covalent bond has four shared electrons (two bonding pairs); a triple covalent bond has six shared electrons (three bonding pairs).

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 C-H or 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 axis of the bonded atoms. See Figure 8.15.

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

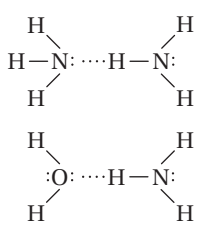
55. The 2*s* and the 2*p* orbitals form two sp^2 hybrid orbitals on the carbon atom. One sp^2 hybrid orbital forms a sigma bond with the carbon atom. Pi bonds between each oxygen atom and the carbon are formed by the unhybridized 2*p* orbitals.

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 is required to separate the molecules.

Understanding Concepts

62. The 3*s* and three 3*p* orbitals of phosphorus hybridize to form four sp^3 atomic orbitals. The resulting shape is pyramidal with a bond angle of 107° between the sigma bonds.

63. 

64. **a.** 

b. 

65. **a.** tetrahedral, 109.5°
b. trigonal planar, 120°
c. etrahedral, 109.5°
d. bent, 105°

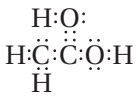
66. **a.** The percent ionic character increases as the difference in electronegativities increases.
b. 1.6
c. (1) 85% (2) 10% (3) 62% (4) 23%

67. **a.** 109.5°
b. 120°
c. 180°

68. **a.** trigonal planar
b. pyramidal
c. linear
d. tetrahedral

69. **a.** Phosphorus in PBr_5 has 10 valence electrons

70. **a.**



b. No, the molecule contains one carbon-oxygen double bond and one carbon-oxygen single bond.
c. polar bond
d. Yes, it has polar oxygen atoms at one end of the molecule and a nonpolar CH_{3-} group at the opposite end.

Critical Thinking

71. C, O, H, S, N, F, Cl, I, Br: These elements are all nonmetals.

72. Answers will vary. Table 8.3 suggests there is no clear difference. The student's argument could be based on chemical properties, such as conductivity of the compound in the liquid state.

73. **a.** two covalent bonds to both hydrogens

b. Fluorine and oxygen have only four electrons

c. Halogens form one covalent bond, not three.

d. Nitrogen forms three covalent bonds, not four.

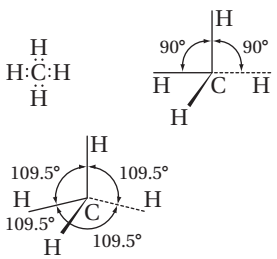
74. Ethyl alcohol can form intermolecular hydrogen bonds between its polar –OH groups, but dimethyl ether can not form hydrogen bonds.

75. **a.** bent
b. etrahedral
c. pyramidal

76. False. The bond dissociation energies exhibit no particular trend and, in fact, are fairly constant.

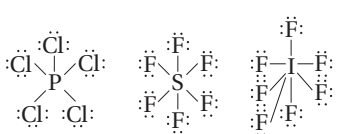
Concept Challenge

77.



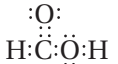
The first sketch is tetrahedral. The second sketch is a tetrahedron. The bond angles in the first sketch are not all the same; some are 90°. The bond angles in the second sketch are all 109.5° The second sketch is correct. (Note: The wedge-shaped lines come out of the page; the dotted lines recede into the page.)

78.



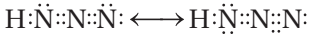
P forms 5 hybrid orbitals (dsp^3), S forms 6 hybrid orbitals (d^2sp^3), and I forms 7 hybrid orbitals (d^3sp^3).

79.

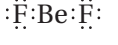


80.

81.



82.



Cumulative Review

83. formation of a gas, a change in color or odor

84. **a.** 6.65×10^4 micrometers
b. 4×10^{-4} centigrams
c. 5.62×10^{-1} decigram per liter
d. 2.4×10^1 meters per second

85. **a.** 2
b. 2
c. 3
d. 3

86. **a.** 16
b. 12
c. 8
d. 26

87. Isotopes have the same number of protons and electrons, but different numbers of neutrons.

88. Protons and electrons must be equal.

89. **a.** 6
b. 2
c. 5
d. 0

90. The wavelength decreases as the frequency increases.

91. The *d* sublevel of the third principal energy level contains 5 electrons.

92. **a.** $1s^2 2s^2 2p^6 3s^1$
b. $1s^2 2s^2 2p^6 3s^2 3p^4$
c. $1\ s^2 2s^2 2p^6 3s^2 3p^3$
d. $1s^2 2s^2 2p^3$

93. The anion is larger than the corresponding neutral atom.

94. Mendeleev arranged the elements by increasing atomic mass in vertical rows and by similarities in chemical and physical properties. Mosely arranged the elements by increasing atomic number in vertical rows and by similarities in chemical and physical properties.

95. **a.** K, $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$
b. Al, $1s^2 2s^2 2p^6 3s^2 3p^1$
c. S, $1s^2 2s^2 2p^6 3s^2 3p^4$
d. Ba, $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 4d^{10} 5s^2 5p^6 6s^2$

96. **a.** barium
b. silicon
c. sodium

97. **e.** II and III only

98. All have the same number of electrons as a noble gas.

99. **b.** cesium

100. **a.** 8
b. 3
c. 6
d. 2

101. **a.** $1s^2 2s^2 2p^6$
b. $1s^2 2s^2 2p^6$
c. $1s^2 2s^2 2p^6$
d. $1s^2 2s^2 2p^6 3s^2 3p^6$

102. No, an alloy is a homogeneous mixture.