Chapter 10: Chemical Bonding II: Molecular Geometry and Hybridization of Atomic Orbitals

1. Give the number of lone pairs around the central atom and the molecular geometry of CBr_4.
   A) 0 lone pairs, square planar
   B) 0 lone pairs, tetahedral
   C) 1 lone pair, square pyramidal
   D) 1 lone pair, trigonal bipyramidal
   E) 2 lone pairs, square planar

3. Give the number of lone pairs around the central atom and the molecular geometry of XeF_2.
   A) 0 lone pairs, linear
   B) 1 lone pair, bent
   C) 2 lone pairs, bent
   D) 3 lone pairs, bent
   E) 3 lone pairs, linear

5. Give the number of lone pairs around the central atom and the molecular geometry of XeF_4.
   A) 0 lone pairs, tetrahedral
   B) 1 lone pair, distorted tetrahedron (seesaw)
   C) 1 lone pair, square pyramidal
   D) 1 lone pair, tetrahedral
   E) 2 lone pairs, square planar

7. Give the number of lone pairs around the central atom and the geometry of the ion SeO_4^{2-}.
   A) 0 lone pairs, square planar
   B) 0 lone pairs, tetrahedral
   C) 1 lone pair, distorted tetrahedron (seesaw)
   D) 1 lone pair, square pyramidal
   E) 2 lone pairs, square planar

9. Give the number of lone pairs around the central atom and the geometry of the ion IBr_2^-.
   A) 0 lone pairs, linear
   B) 1 lone pair, bent
   C) 2 lone pairs, bent
   D) 3 lone pairs, bent
   E) 3 lone pairs, linear

11. Give the number of lone pairs around the central atom and the geometry of the ion ClO_3^-.
    A) 0 lone pairs, trigonal
    B) 1 lone pair, bent
    C) 1 lone pair, trigonal pyramidal
    D) 2 lone pairs, T-shaped
    E) 2 lone pairs, trigonal

13. According to the VSEPR theory, the geometry of the SO_3 molecule is
    A) pyramidal.
    B) tetrahedral.
    C) trigonal planar.
    D) distorted tetrahedron (seesaw).
    E) square planar.

15. Use VSEPR theory to predict the geometry of the PCl_3 molecule.
    A) linear B) bent C) trigonal planar D) trigonal pyramidal E) tetrahedral

17. The geometry of the CS_2 molecule is best described as
    A) linear. B) trigonal planar. C) tetrahedral. D) bent. E) trigonal pyramidal.

19. According to the VSEPR theory, the molecular geometry of the carbonate ion, CO_3^{2-}, is
    A) square planar.
    B) tetrahedral.
    C) pyramidal.
    D) trigonal planar.
    E) octahedral.

21. According to the VSEPR theory, the molecular geometry of $SiCl_4$ is
    A) linear. B) trigonal planar. C) bent. D) tetrahedral. E) trigonal pyramidal.

23. According to the VSEPR theory, the molecular geometry of ammonia is
    A) linear. B) trigonal planar. C) bent. D) tetrahedral. E) trigonal pyramidal.

25. According to VSEPR theory, which one of the following molecules should have a geometry that is *trigonal bipyramidal*?
    A) SF_4 B) XeF_4 C) NF_3 D) SF_6 E) PF_5

27. Which one of the following molecules has tetrahedral geometry?
    A) XeF_4 B) BF_3 C) AsF_5 D) CF_4 E) NH_3

29. According to VSEPR theory, which one of the following species has a tetrahedral geometry?
A) IF_4^+ B) IF_4^- C) PCl_4^+ D) PCl_4^- E) SeF_4

31. Predict the geometry around the central atom in SO_4^{2-}.
A) trigonal planar
B) trigonal pyramidal
C) tetrahedral
D) trigonal bipyramidal
E) octahedral

33. Which of the following substances is/are *bent*?
(i) H_2S (ii) CO_2 (iii) ClNO (iv) NH_2^- (v) O_3
A) only (iii)
B) only (i) and (v)
C) only (i), (iii), and (v)
D) all are bent except for (iv)
E) all are bent except for (ii)

35. The bond angle in SCl_2 is expected to be
A) a little less than 109.5°.
B) 109.5°.
C) a little more than 109.5°.
D) 120°.
E) 180°.

37. The bond angles in SF_5^+ are expected to be
A) 90°.
B) 120°.
C) 90° and 120°.
D) 90° and 180°.
E) 90°, 120°, and 180°.

39. The bond angle in Cl_2O is expected to be approximately
A) 90°. B) 109.5°. C) 120°. D) 145°. E) 180°.

41. The F –Cl –F bond angles in ClF_3 are expected to be approximately
A) 90° only.
B) 109.5° only.
C) 120° only.
D) 180° only.
E) 90° and 180°.

43. The C–N–O bond angle in nitromethane, CH_3NO_2, is expected to be approximately
A) 60°. B) 90°. C) 109.5°. D) 120°. E) 180°.

45. Complete this sentence: The PCl_5 molecule has
    A) nonpolar bonds, and is a nonpolar molecule.
    B) nonpolar bonds, but is a polar molecule.
    C) polar bonds, and is a polar molecule.
    D) polar bonds, but is a nonpolar molecule.

47. Which one of the following molecules has a zero dipole moment?
    A) CO B) CH_2Cl_2 C) SO_3 D) SO_2 E) NH_3

49. Predict the molecular geometry and polarity of the SO_2 molecule.
    A) linear, polar
    B) linear, nonpolar
    C) bent, polar
    D) bent, nonpolar
    E) None of the above.

51. Which of the following species has the largest dipole moment (i.e., is the most polar)?
    A) CH_4 B) CH_3Br C) CH_3Cl D) CH_3F E) CH_3I

53. *N*,*N*-diethyl-*m*-tolumide (DEET) is the active ingredient in many mosquito repellents. What is the hybridization state of carbon indicated by the arrow in the structure of DEET shown below?

    A) sp B) sp^2 C) sp^3 D) sp^3d E) sp^3d^2

55. *N*,*N*-diethyl-*m*-tolumide (DEET) is the active ingredient in many mosquito repellents. What is the hybridization state of the nitrogen atom in the structure of DEET shown below?

A) sp B) sp^2 C) sp^3 D) sp^3d E) sp^3d^2

57. Ibuprofen is used as an analgesic for the relief of pain, and also to help reduce fever. What is the hybridization state of carbon indicated by the arrow in the structure of ibuprofen shown below?

A) sp B) sp^2 C) sp^3 D) sp^3d E) sp^3d^2

59. Ibuprofen is used as an analgesic for the relief of pain, and also to help reduce fever. What is the hybridization state of oxygen indicated by the arrow in the structure of ibuprofen shown below?

A) sp B) sp^2 C) sp^3 D) sp^3d E) sp^3d^2

61. Indicate the type of hybrid orbitals used by the central atom in CCl_4.
A) sp B) sp^2 C) sp^3 D) sp^3d E) sp^3d^2

63. What is the hybridization of the As atom in the AsF_5 molecule?
A) *sp* B) sp^2 C) sp^3 D) sp^3d E) sp^3d^2

65. Indicate the type of hybrid orbitals used by the central atom in BrF_3.
A) *sp* B) sp^2 C) sp^3 D) sp^3d E) sp^3d^2

67. What is the hybridization on the central atom in NO_3^- ?
A) *sp* B) sp^2 C) sp^3 D) sp^3d E) sp^3d^2

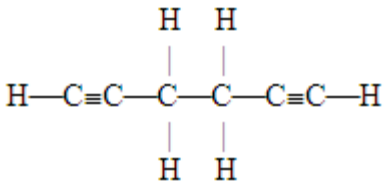
69. What is the hybridization of As in the AsF_4^- ion?
A) *sp* B) sp^2 C) sp^3 D) sp^3d E) sp^3d^2

71. The hybridization of the central nitrogen atom in the molecule N_2O is
A) *sp*. B) sp^2. C) sp^3. D) sp^3d. E) sp^3d^2.

73. In which of these molecules do the two nitrogen atoms have different hybridizations?
A) NH_4NO_3 B) N_2H_4 C) N_2O_4 D) N_2O_5 E) none of these

75. Which of the following molecules have the same geometries?
A) SF_4 and CH_4 B) CO_2 and H_2O C) CO_2 and BeH_2 D) N_2O and NO_2

77. The number of pi bonds in the molecule below is



A) 2. B) 4. C) 6. D) 10. E) 15.

79. Consider the species Cl_2^+, Cl_2, and Cl_2^-. Which of these species will be paramagnetic?
A) only Cl_2
B) Cl_2^+ and Cl_2
C) Cl_2 and Cl_2^-
D) Cl_2^+ and Cl_2^-
E) all three are paramagnetic

81. Consider the species N_2^-, N_2, and N_2^+. Which of these species will be paramagnetic?
    A) N_2 and N_2^-
    B) N_2^+ and N_2
    C) N_2^+ and N_2^-
    D) only N_2^-
    E) none are paramagnetic

83. In which of the following would the bonding be *strengthened* with the addition of an electron to form the negative molecular ion?
    A) C_2 B) O_2 C) N_2 D) all of these E) none of these

85. In which of the following would the bonding be *weakened* with the addition of an electron to form the negative molecular ion?
    A) N_2 B) O_2 C) F_2 D) all of these E) none of these

87. Which of the following correctly lists species in order of *increasing* bond length?
    A) $O_2 < O_2^+ < O_2^-$
    B) $O_2^- < O_2 < O_2^+$
    C) $O_2^+ < O_2 < O_2^-$
    D) $O_2^- < O_2^+ < O_2$
    E) $O_2^+ < O_2^- < O_2$

89. Which of the following correctly lists species in order of *increasing* bond order?
    A) $C_2 < Li_2 < Be_2 < N_2$
    B) $Be_2 < Li_2 < C_2 < N_2$
    C) $N_2 < Be_2 < Li_2 < C_2$
    D) $N_2 < C_2 < Li_2 < Be_2$
    E) $Be_2 < C_2 < N_2 < Li_2$