9.1 Multiple-Choice and Bimodal Questions

1) For a molecule with the formula AB_2 the molecular shape is _____.

A) linear or bent
B) linear or trigonal planar
C) linear or T-shaped
D) T-shaped
E) trigonal planar

2) According to VSEPR theory, if there are five electron domains in the valence shell of an atom, they will be arranged in a(n) _____ geometry.

A) octahedral
B) linear
C) tetrahedral
D) trigonal planar
E) trigonal bipyramidal

3) According to VSEPR theory, if there are four electron domains in the valence shell of an atom, they will be arranged in a(n) _____ geometry.

A) octahedral
B) linear
C) tetrahedral
D) trigonal planar
E) trigonal bipyramidal

4) The electron-domain geometry and molecular geometry of iodine trichloride are _____ and _____, respectively.

A) trigonal bipyramidal, trigonal planar
B) tetrahedral, trigonal pyramidal
C) trigonal bipyramidal, T-shaped
D) octahedral, trigonal planar
E) T-shaped, trigonal planar

5) The molecular geometry of ____ is square planar.

A) CCl_4
B) XeF_4
C) PH_3
D) XeF_2
E) ICl_3

6) The molecular geometry of the CS_2 molecule is _____.

A) linear
B) bent
C) tetrahedral
D) trigonal planar
E) T-shaped

7) The molecular geometry of the SiH_2Cl_2 molecule is _____.

A) trigonal planar
B) tetrahedral
C) trigonal pyramidal
D) octahedral
E) T-shaped

8) The molecular geometry of the $PHCl_2$ molecule is _____.

A) bent
B) trigonal planar
C) trigonal pyramidal
D) tetrahedral
E) T-shaped

9) The molecular geometry of the $CHCl_3$ molecule is _____.

A) bent
B) trigonal planar
C) trigonal pyramidal
D) tetrahedral
E) T-shaped

10) The molecular geometry of the SF_2 molecule is_.

A) linear
B) bent
C) trigonal planar
D) tetrahedral
E) octahedral

11) The molecular geometry of the PF_4^+ ion is ____.

A) octahedral
B) tetrahedral
C) trigonal pyramidal
D) trigonal planar
E) trigonal bipyramidal

12) The $F-B-F$ bond angle in the BF_2^- on is approximately _____.

A) 90 °
B) 109.5 °
C) 120 °
D) 180 °
E) 60 °

13) The Cl-Si-Cl bond angle in the $SiCl_2F_2$ molecule is approximately _____.

A) 90 °
B) 109.5 °
C) 120 °
D) 180 °
E) 60 °

14) The F-B-F bond angle in the BF_3 molecule is _____.

A) 90 °
B) 109.5 °
C) 120 °
D) 180 °
E) 60 °

15) The O-S-O bond angle in SO_2 is slightly less than _____.

A) 90 °
B) 109.5 °
C) 120 °
D) 180 °
E) 60 °

16) The F-N-F bond angle in the NF_3 molecule is slightly less than _____.

A) 90 °
B) 109.5 °
C) 120 °
D) 180 °
E) 60 °

17) The molecular geometry of the H_3O^+ ion is _____.
A) linear
B) tetrahedral
C) bent
D) trigonal pyramidal
E) octahedral

18) According to valence bond theory, which orbitals on bromine atoms overlap in the formation of the bond in Br_2?

A) 3s
B) 3p
C) 4s
D) 4p
E) 3d

19) The electron-domain geometry of a sulfur-centered compound is trigonal bipyramidal. The hybridization of the central nitrogen atom is _____.

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

20) The hybridization of orbitals on the central atom in a molecule is sp. The electron-domain geometry around this central atom is _____.

A) octahedral
B) linear
C) trigonal planar
D) trigonal bipyramidal
E) tetrahedral

21) The hybridization of orbitals on the central atom in a molecule is sp^2. The electron-domain geometry about this central atom is _____.

A) octahedral
B) linear
C) trigonal planar
D) trigonal bipyramidal
E) tetrahedral

22) The hybridization of the carbon atom in carbon dioxide is _____.

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

23) The hybridization of the central atom in the XeF_4 molecule is _____.

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

24) The electron-domain geometry of the AsF_6^- ion is octahedral. The hybrid orbitals used by the As atom for bonding are _____ orbitals.

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

25) In order to produce sp^3 hybrid orbitals, _____ s atomic orbital(s) and _____ p atomic orbital(s) must be mixed.

A) one, two
B) one, three
C) one, one
D) two, two
E) two, three

26) The angles between sp^2 orbitals are _____.

A) 45 °
B) 180 °
C) 90 °
D) 109.5 °
E) 120 °

27) There are _____ σ and _____ π bonds in the $H-C\equiv C-H$ molecule.

A) 3 and 2
B) 3 and 4
C) 4 and 3
D) 2 and 3
E) 5 and 0

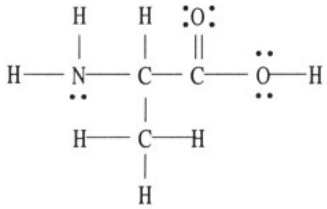
28) There are _____ σ and _____ π bonds in the $H_2C{=}C{=}CH_2$ molecule.

A) 4, 2
B) 6, 4
C) 2, 2
D) 2, 6
E) 6, 2

29) The total number of π bonds in the $H-C\equiv C-C\equiv C-C\equiv N$ molecule is _____.

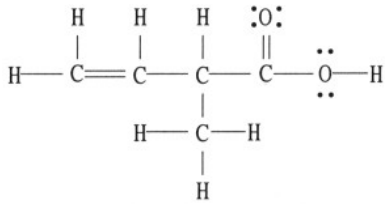
A) 3
B) 4
C) 6
D) 9
E) 12

30) There is/are _____ σ bond(s) in the molecule below.



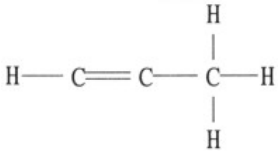
A) 1
B) 2
C) 12
D) 13
E) 18

31) There is/are _____ π bond(s) in the molecule below.



A) 0
B) 1
C) 2
D) 4
E) 16

32) There is/are __ π bond(s) in the molecule below.



A) 7
B) 6
C) 2
D) 1
E) 0

33) The Lewis structure of carbon monoxide is given below. The hybridizations of the carbon and oxygen atoms in carbon monoxide are _____ and _____, respectively.

:C ≡ O:

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

9.2 Multiple-Choice Questions

1) The basis of the VSEPR model of molecular bonding is _____.

A) regions of electron density on an atom will organize themselves so as to maximize *s*-character
B) regions of electron density in the valence shell of an atom will arrange themselves so as to maximize overlap
C) atomic orbitals of the bonding atoms must overlap for a bond to form
D) electron domains in the valence shell of an atom will arrange themselves so as to minimize repulsions
E) hybrid orbitals will form as necessary to, as closely as possible, achieve spherical symmetry

2) According to VSEPR theory, if there are three electron domains in the valence shell of an atom, they will be arranged in a(n) _____ geometry.

A) octahedral
B) linear
C) tetrahedral
D) trigonal planar
E) trigonal bipyramidal

3) ClF_3 has "T-shaped" geometry. There are _____ non-bonding domains in this molecule.

A) 0
B) 1
C) 2
D) 3
E) 4

4) The electron domain and molecular geometry of BrO_2^- is _____.

A) tetrahedral, trigonal planar
B) trigonal planar, trigonal planar
C) trigonal pyramidal, linear
D) tetrahedral, bent
E) trigonal pyramidal, seesaw

5) In counting the electron domains around the central atom in VSEPR theory, a _____ is not included.

A) nonbonding pair of electrons
B) single covalent bond
C) core level electron pair
D) double covalent bond
E) triple covalent bond

6) The electron-domain geometry of _____ is tetrahedral.

A) CBr_4
B) PH_3

C) CCl_2Br_2

D) XeF_4

E) all of the above except XeF_4

7) The $O-C-O$ bond angle in the CO_3^{2-} ion is approximately _____.

A) 90 °
B) 109.5 °
C) 120 °
D) 180 °
E) 60 °

8) Of the following species, _____ will have bond angles of 120 °.

A) PH_3

B) ClF_3

C) NCl_3

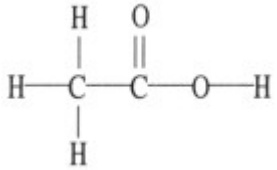
D) BCl_3

E) All of these will have bond angles of 120 °.

9) The molecular geometry of the BrO_3^- ion is _____.

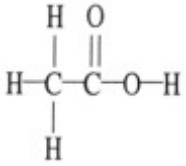
A) trigonal pyramidal
B) trigonal planar
C) bent
D) tetrahedral
E) T-shaped

10) The molecular geometry of the left-most carbon atom in the molecule below is _____.



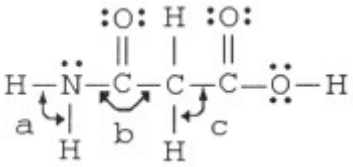
A) trigonal planar
B) trigonal bipyramidal
C) tetrahedral
D) octahedral
E) T-shaped

11) The molecular geometry of the right-most carbon in the molecule below is _____.



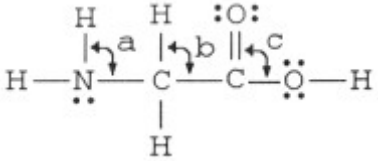
A) trigonal planar
B) trigonal bipyramidal
C) tetrahedral
D) octahedral
E) T-shaped

12) The bond angles marked a, b, and c in the molecule below are about _____, _____, and _____, respectively.



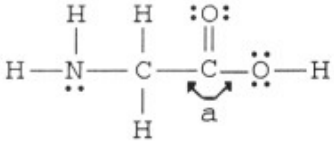
A) 90 °, 90 °, 90 °
B) 120 °, 120 °, 90 °
C) 120 °, 120 °, 109.5 °
D) 109.5 °, 120 °, 109.5 °
E) 109.5 °, 90 °, 120 °

13) The bond angles marked a, b, and c in the molecule below are about _____, _____, and _____, respectively.



A) 109.5 °, 109.5 °, 109.5 °
B) 120 °, 109.5 °, 120 °
C) 109.5 °, 109.5 °, 120 °
D) 90 °, 180 °, 90 °
E) 109.5 °, 109.5 °, 90 °

14) The bond angle marked a in the following molecule is about _____.



A) 90 °
B) 109.5 °
C) 120 °
D) 180 °
E) 60 °

15) The central iodine atom in the ICl_4^- ion has _____ nonbonded electron pairs and _____ bonded electron pairs in its valence shell.

A) 2, 2
B) 3, 4
C) 1, 3
D) 3, 2
E) 2, 4

16) The central iodine atom in IF_5 has _____ unbonded electron pairs and _____ bonded electron pairs in its valence shell.

A) 1, 5
B) 0, 5
C) 5, 1
D) 4, 1
E) 1, 4

17) The central Xe atom in the XeF_4 molecule has _____ unbonded electron pairs and _____ bonded electron pairs in its valence shell.

A) 1, 4
B) 2, 4
C) 4, 0
D) 4, 1
E) 4, 2

18) An electron domain consists of _____.
a) a nonbonding pair of electrons
b) a single bond
c) a multiple bond

A) a only
B) b only
C) c only
D) a, b, and c
E) b and c

19) According to VSEPR theory, if there are three electron domains on a central atom, they will be arranged such that the angles between the domains are _____.

A) 90 °
B) 180 °
C) 109.5 °
D) 360 °
E) 120 °

20) According to VSEPR theory, if there are four electron domains on a central atom, they will be arranged such that the angles between the domains are _____.

A) 120 °
B) 109.5 °
C) 180 °
D) 360 °
E) 90 °

21) According to VSEPR theory, if there are two electron domains on a central atom, they will be arranged such that the angles between the domains are _____.

A) 360 °
B) 120 °
C) 109.5 °
D) 180 °
E) 90 °

22) The electron-domain geometry and the molecular geometry of a molecule of the general formula AB_n are _____.

A) never the same
B) always the same
C) sometimes the same
D) not related
E) mirror images of one another

23) The electron-domain geometry and the molecular geometry of a molecule of the general formula AB_n will always be the same if _____.

A) there are no lone pairs on the central atom

B) there is more than one central atom
C) n is greater than four
D) n is less than four
E) the octet rule is obeyed

24) The bond angles in a trigonal planar molecule are _____ degrees.

A) 120
B) 109.5
C) 90
D) 45
E) < 45

25) A molecule has the formula AB_3 and the central atom is in a different plane from the surrounding three atoms. Its molecular shape is _____.

A) tetrahedral
B) trigonal pyramidal
C) linear
D) T-shaped
E) bent

26) PCl_5 has _____ electron domains and a _____ molecular arrangement.

A) 6, trigonal bipyramidal
B) 6, tetrahedral
C) 5, square pyramidal
D) 5, trigonal bipyramidal
E) 6, seesaw

27) For molecules of the general formula AB_n n can be greater than four _____.

A) for any element A
B) only when A is an element from the third period or below the third period
C) only when A is boron or beryllium
D) only when A is carbon
E) only when A is Xe

Consider the following species when answering the following questions:

(i) PCl_3 (ii) CCl_4 (iii) $TeCl_4$ (iv) XeF_4 (v) SF_6

28) For which of the molecules is the molecular geometry (shape) the same as the VSEPR electron domain arrangement (electron domain geometry)?

A) (i) and (ii)
B) (i) and (iii)
C) (ii) and (v)
D) (iv) and (v)
E) (v) only

29) Of the molecules below, only _____ is polar.

A) SbF_5
B) AsH_3
C) I_2
D) SF_6
E) CH_4

30) Of the molecules below, only _____ is nonpolar.

A) CO_2
B) H_2O
C) NH_3
D) HCl
E) $TeCl_2$

31) Of the molecules below, only _____ is polar.

A) CCl_4
B) CH_4
C) SeF_4
D) $SiCl_4$

32) Of the molecules below, only _____is nonpolar.

A) BF_3
B) NF_3
C) IF_3
D) PBr_3
E) $BrCl_3$

33) Three monosulfur fluorides are observed: SF_2, SF_4, and SF_6. Of these, _____ is/are polar.

A) SF_2 only
B) SF_2 and SF_4 only
C) SF_4 only
D) SF_6 only
E) SF_2, SF_4 and SF_6

34) The molecular geometry of the $BeCl_2$ molecule is _____, and this molecule is _____.

A) linear, nonpolar
B) linear, polar
C) bent, nonpolar
D) bent, polar
E) trigonal planar, polar

35) The molecular geometry of the PF_3 molecule is _____, and this molecule is _____.

A) trigonal planar, polar
B) trigonal planar, nonpolar
C) trigonal pyramidal, polar
D) trigonal pyramidal, nonpolar
E) tetrahedral, unipolar

36) Of the following molecules, only _____is polar.

A) $BeCl_2$
B) BF_3
C) CBr_4
D) SiH_2Cl_2
E) Cl_2

37) Of the following molecules, only _____ is polar.

A) CCl_4
B) BCl_3
C) NCl_3
D) $BeCl_2$
E) Cl_2

38) For molecules with only one central atom, how many lone pairs on the central atom guarantees molecular polarity?

A) 1
B) 2
C) 1 or 2
D) 3
E) 1 or 3

39) The molecular geometry of the CHF_3 molecule is _____, and the molecule is _____.

A) trigonal pyramidal, polar
B) tetrahedral, nonpolar
C) seesaw, nonpolar
D) tetrahedral, polar
E) seesaw, polar

40) The molecular geometry of the BCl_3 molecule is _____, and this molecule is _____.

A) trigonal pyramidal, polar
B) trigonal pyramidal, nonpolar
C) trigonal planar, polar
D) trigonal planar, nonpolar
E) trigonal bipyramidal, polar

41) According to valence bond theory, which orbitals overlap in the formation of the bond in HBr?

A) 1s on H and 4p on Br
B) 1s on H and 4s on Br
C) 1s on H and 3p on Br
D) 2s on H and 4p on Br
E) 2s on H and 3p on Br

Consider the following species when answering the following questions:

(i) PCl_3 (ii) CCl_4 (iii) $TeCl_4$ (iv) XeF_4 (v) SF_6

42) Which of the molecules has a see-saw shape?

A) (i)
B) (ii)
C) (iii)
D) (iv)
E) (v)

43) The combination of two atomic orbitals results in the formation of _____ molecular orbitals.

A) 1
B) 2
C) 3
D) 4
E) 0

44) The electron-domain geometry of a carbon-centered compound is tetrahedral. The hybridization of the central carbon atom is _____.

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

45) Of the following, only _____ has sp^2 hybridization of the central atom.

A) PH_3
B) CO_3^{2-}
C) ICl_3
D) I_3^-
E) PF_5

46) Of the following, the central atom is sp^3d^2 hybridized only in _____.

A) PCl_5
B) XeF_4
C) PH_3
D) Br_3^-
E) BeF_2

47) The sp^3d^2 atomic hybrid orbital set accommodates _____ electron domains.

A) 2
B) 3
C) 4
D) 5
E) 6

48) The sp^2 atomic hybrid orbital set accommodates _____ electron domains.

A) 2
B) 3
C) 4
D) 5
E) 6

49) The hybridizations of nitrogen in NF_3 and NH_3 are _____ and _____, respectively.

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

50) The hybridizations of iodine in IF_3 and IF_5 are _____ and _____, respectively.

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

51) The hybridizations of bromine in BrF_5 and of arsenic in AsF_5 are _____ and _____, respectively.

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

52) The hybrid orbitals used for bonding by the sulfur atom in the SF_4 molecule are _____ orbitals.

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

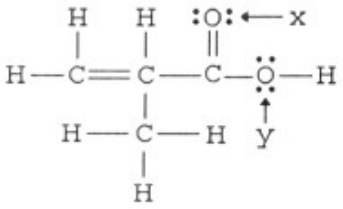
53) The hybrid orbitals used for bonding by Xe in the unstable XeF_2 molecule are _____ orbitals.

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

54) The hybridization scheme for BeF_2 is _____.

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

55) The hybridization of the oxygen atom labeled y in the structure below is _____. The $C-O-H$ bond angle is _____.



A) sp, 180 °
B) sp^2, 109.5 °
C) sp^3, 109.5 °
D) sp^3d^2, 90 °
E) sp, 90 °

56) The electron-domain geometry of the AsF_5 molecule is trigonal bipyramidal. The hybrid orbitals used by the As atom for bonding are _____ orbitals.

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

57) _____ hybrid orbitals are used for bonding by Xe in the XeF_4 molecule.

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

Consider the following species when answering the following questions:

(i) PCl_3 (ii) CCl_4 (iii) $TeCl_4$ (iv) XeF_4 (v) SF_6

58) In which of the molecules does the central atom utilize d orbitals to form hybrid orbitals?

A) (i) and (ii)
B) (iii) only
C) (i) and (v)
D) (iii), (iv), and (v)
E) (v) only

59) In which of the molecules is the central atom sp^3d^2 hybridized?

A) (i) and (ii)
B) (iii) only
C) (iii) and (iv)
D) (iv) and (v)
E) (v) only

60) There are _____ unhybridized p atomic orbitals in an sp-hybridized carbon atom.

A) 0
B) 1
C) 2

D) 3
E) 4

61) When three atomic orbitals are mixed to form hybrid orbitals, how many hybrid orbitals are formed?

A) one
B) six
C) three
D) four
E) five

62) The blending of one s atomic orbital and two p atomic orbitals produces _____.

A) three sp hybrid orbitals
B) two sp^2 hybrid orbitals
C) three sp^3 hybrid orbitals
D) two sp^3 hybrid orbitals
E) three sp^2 hybrid orbitals

63) A triatomic molecule cannot be linear if the hybridization of the central atoms is _____.

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

64) Valence bond theory does not address the issue of _____.

A) excited states of molecules
B) molecular shape
C) covalent bonding
D) hybridization
E) multiple bonds

65) A typical double bond _____.

A) is stronger and shorter than a single bond
B) consists of one σ bond and one π bond
C) imparts rigidity to a molecule
D) consists of two shared electron pairs
E) All of the above answers are correct.

66) A typical triple bond _____.

A) consists of one σ bond and two π bonds
B) consists of three shared electrons
C) consists of two σ bonds and one π bond
D) consists of six shared electron pairs
E) is longer than a single bond

67) In a polyatomic molecule, "localized" bonding electrons are associated with _____.

A) one particular atom
B) two particular atoms
C) all of the atoms in the molecule
D) all of the π bonds in the molecule
E) two or more σ bonds in the molecule

68) There are _____ σ bonds and _____ π bonds in $H_3C-CH_2-CH=CH-CH_2-C\equiv CH$.

A) 14, 2
B) 10, 3
C) 12, 2
D) 13, 2
E) 16, 3

69) Which of the following molecules or ions will exhibit delocalized bonding?

SO_2 SO_3 SO_3^{2-}

A) SO_2, SO_3, and SO_3^{2-}
B) SO_3^{2-} only
C) SO_2 and SO_3
D) SO_3 and SO_3^{2-}
E) None of the above will exhibit delocalized bonding.

70) Which of the following molecules or ions will exhibit delocalized bonding?

NO_2^- NH_4^+ N_3^-

A) NH_4^+ and N_3^-
B) NO_2^- only
C) NO_2^-, NH_4^+, and N_3^-

D) N_3^- only

E) NO_2^- and N_3^-

71) In order to exhibit delocalized π bonding, a molecule must have _____.

A) at least two π bonds
B) at least two resonance structures
C) at least three σ bonds
D) at least four atoms
E) trigonal planar electron domain geometry

72) In a typical multiple bond, the σ bond results from overlap of _____ orbitals and the π bond(s) result from overlap of _____ orbitals.

A) hybrid, atomic
B) hybrid, hybrid
C) atomic, hybrid
D) hybrid, hybrid or atomic
E) hybrid or atomic, hybrid or atomic

73) The carbon-carbon σ bond in ethylene, $H_2C=C$, results from the overlap of _____.

A) sp hybrid orbitals
B) sp^3 hybrid orbitals
C) sp^2 hybrid orbitals
D) s atomic orbitals
E) p atomic orbitals

74) The π bond in ethylene, $H_2C=CH_2$, results from the overlap of _____.

A) sp^3 hybrid orbitals
B) s atomic orbitals
C) sp hybrid orbitals
D) sp^2 hybrid orbitals
E) p atomic orbitals

75) A typical triple bond consists of _____.

A) three sigma bonds
B) three pi bonds
C) one sigma and two pi bonds
D) two sigma and one pi bond
E) three ionic bonds

76) The $N-N$ bond in HNNH consists of _____.

A) one σ bond and one π bond
B) one σ bond and two π bonds
C) two σ bonds and one π bond
D) two σ bonds and two π bonds
E) one σ bond and no π bonds

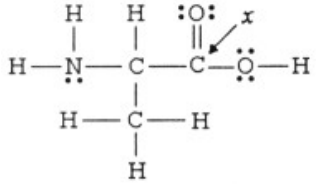
77) The hybridization of the terminal carbons in the $H_2C=C=CH_2$ molecule is _____.

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

78) The hybridization of nitrogen in the $H-C\equiv N:$ molecule is _____.

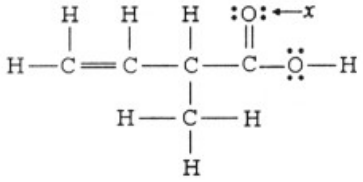
A) sp
B) s^2p
C) s^3p
D) sp^2
E) sp^3

79) The hybridization of the carbon atom labeled x in the molecule below is _____.



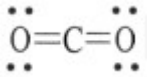
A) sp
B) sp^2
C) sp^3
D) sp^3d
E) sp^3d^2

80) The hybridization of the oxygen atom labeled x in the structure below is _____.



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

81) The Lewis structure of carbon dioxide is given below. The hybridization of the carbon atom in carbon dioxide is _____.



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

82) Electrons in _____ bonds remain localized between two atoms. Electrons in _____ bonds can become delocalized between more than two atoms.

A) pi, sigma
B) sigma, pi
C) pi, pi
D) sigma, sigma
E) ionic, sigma

83) Structural changes around a double bond in the _____ portion of the rhodopsin molecule trigger the chemical reactions that result in vision.

A) protein
B) opsin
C) retinal
D) cones
E) rods

84) The bond order of any molecule containing equal numbers of bonding and antibonding electrons is _____.

A) 0
B) 1
C) 2
D) 3
E) 1/2

85) In comparing the same two atoms bonded together, the _____ the bond order, the _____ the bond length, and the _____ the bond energy.

A) greater, shorter, greater
B) greater, greater, greater
C) greater, longer, greater
D) greater, greater, smaller
E) smaller, greater, greater

86) In molecular orbital theory, the σ_{1s} orbital is _____ and the σ_{1s}^{*} orbital is _____ in the H_2 molecule.

A) filled, filled
B) filled, empty
C) filled, half-filled
D) half-filled, filled
E) empty, filled

87) Based on molecular orbital theory, the bond orders of the $H-H$ bonds in H_2, H_2^+, and H_2^- are _____, respectively

A) 1, 0, and 0
B) 1, 1/2, and 0
C) 1, 0, and 1/2
D) 1, 1/2, and 1/2
E) 1, 2, and 0

88) Based on molecular orbital theory, the bond order of the $H-H$ bond in the H_2^+ ion is _____.

A) 0
B) 1/2
C) 1
D) 3/2
E) 2

89) An antibonding π orbital contains a maximum of _____ electrons.

A) 1
B) 2
C) 4
D) 6
E) 8

90) According to MO theory, overlap of two s atomic orbitals produces _____.

A) one bonding molecular orbital and one hybrid orbital
B) two bonding molecular orbitals
C) two bonding molecular orbitals and two antibonding molecular orbitals
D) two bonding molecular orbitals and one antibonding molecular orbital
E) one bonding molecular orbital and one antibonding molecular orbital

91) A molecular orbital can accommodate a maximum of _____ electron(s).

A) one
B) two
C) four
D) six
E) twelve

92) Molecular Orbital theory correctly predicts paramagnetism of O_2. This is because ____.

A) the bond order in O_2 can be shown to be equal to 2.
B) there are more electrons in the bonding orbitals than in the antibonding orbitals.
C) the energy of the $\pi 2p$ MOs is higher than that of the $\sigma 2p$ MO
D) there are two unpaired electrons in the MO electron configuration of O_2
E) the $O-O$ bond distance is relatively short

93) Molecular Orbital theory correctly predicts diamagnetism of fluorine gas, F_2. This is because _____.

A) the bond order in F_2 can be shown to be equal to 1.
B) there are more electrons in the bonding orbitals than in the antibonding orbitals.
C) all electrons in the MO electron configuration of F_2 are paired.
D) the energy of the $\pi 2p$ MOs is higher than that of the $\sigma 2p$ MO
E) the $F-F$ bond enthalpy is very low

94) Based on molecular orbital theory, the only molecule in the list below that has unpaired electrons is _____.

A) C_2
B) N_2
C) F_2
D) O_2
E) Li_2

95) Based on molecular orbital theory, there are _____ unpaired electrons in the OF^+ ion.

A) 0
B) 3
C) 1
D) 2
E) 1/2

96) Based on molecular orbital theory, the bond order of the $N-N$ bond in the N_2 molecule is _____.

A) 0
B) 1
C) 2
D) 3
E) 5

97) Based on molecular orbital theory, the bond order of the $N-N$ bond in the N_2^{2+} ion is _____.

A) 0
B) 3
C) 1

D) 2
E) 1/2

98) Based on molecular orbital theory, the bond order of the $Be-Be$ bond in the Be_2 molecule is _____.

A) 0
B) 1
C) 2
D) 3
E) 4

99) Based on molecular orbital theory, the bond order of the $C-C$ bond in the C_2 molecule is _____.

A) 0
B) 1
C) 2
D) 3
E) 4

100) Of the following, only _____ appears to gain mass in a magnetic field.

A) C_2
B) N_2
C) F_2
D) O_2
E) Li_2

101) Of the following, _____ appear(s) to gain mass in a magnetic field.
B_2 N_2 O_2

A) O_2 only
B) N_2 only
C) B_2 and N_2
D) N_2 and O_2
E) B_2 and O_2

102) According to MO theory, overlap of two p atomic orbitals produces _____.

A) two bonding molecular orbitals
B) one bonding molecular orbital and one antibonding molecular orbital
C) two bonding molecular orbitals and two antibonding molecular orbitals
D) two bonding molecular orbitals and one antibonding molecular orbital
E) three bonding molecular orbitals and three antibonding molecular orbitals

103) According to MO theory, overlap of two p atomic orbitals produces _____.

A) one π MO and one σ^* MO
B) one π MO and one σ MO
C) one π MO and one π^* MO <u>or</u> one σ MO and one σ^* MO
D) one π^+ MO and one σ^* MO
E) two π MOs, two π^+ MOs, one σ MO, and one σ^* MO

104) An antibonding MO _____ the corresponding bonding MO.

A) is always lower in energy than
B) can accommodate more electrons than
C) can accommodate fewer electrons than
D) is always higher in energy than
E) is always degenerate with

105) The more effectively two atomic orbitals overlap, _____.

A) the more bonding MOs will be produced by the combination
B) the higher will be the energy of the resulting bonding MO and the lower will be the energy of the resulting antibonding MO
C) the higher will be the energies of both bonding and antibonding MOs that result
D) the fewer antibonding MOs will be produced by the combination
E) the lower will be the energy of the resulting bonding MO and the higher will be the energy of the resulting antibonding MO

106) The bond order of a homonuclear diatomic

molecule can be decreased by _____.

A) removing electrons from a bonding MO or adding electrons to an antibonding MO
B) adding electrons to a bonding MO or removing electrons from an antibonding MO
C) adding electrons to any MO
D) removing electrons from any MO
E) The bond order of a homonuclear diatomic molecule cannot be decreased by any means.

107) The order of MO energies in B_2, C_2, and $N_2(\sigma 2p > \pi 2p)$, is different from the order in O_2, F_2, and $Ne_2(\sigma 2p < \pi 2p)$ This is due to _____.

A) less effective overlap of p orbitals in O_2, F_2, and Ne_2
B) the more metallic character of boron, carbon and nitrogen as compared to oxygen, fluorine, and neon
C) greater 2s-2p interaction in O_2, F_2, and Ne_2
D) greater 2s-2p interaction in B_2 C_2, and N_2
E) less effective overlap of p orbitals in B_2, C_2, and N_2

9.3 Short Answer Questions

1) What is the molecular geometry of a molecule that has three bonding and two non-bonding domains?

2) In the valence shell of an atom there are six electron domains. They will be arranged in a (an) _____ geometry.

3) What are the three bond angles in the trigonal bipyramidal structure?

4) Three molecules have similar electron domains, but different molecular shapes. Why?

5) The 1s hydrogen orbital overlaps with the _____ iodine orbital in HI.

6) A covalent bond in which overlap regions lie above and below an internuclear axis is called a(n) _____.

7) The sensation of vision results from a nerve impulse that is triggered by the separation of retinal from _____.

8) In molecular orbital theory the stability of a covalent body is related to its _____.

9) Each molecular orbital can accommodate, at most, two electrons with their spins paired. This is called the _____.

10) The more unpaired electrons in a species, the stronger is the force of magnetic attraction. This is called _____.

9.4 True/False Questions

1) Possible shapes of AB_3 molecules are linear, trigonal planar, and T-shaped.

2) Boron trifluoride has three bonding domains and its electron domain geometry is trigonal planar.

3) Electron domains for single bonds exert greater force on adjacent domains than the electron domains for multiple bonds.

4) The quantitative amount of charge separation in a diatomic molecule contributes to the dipole moment of that molecule.

5) XeF_4 is a polar molecule.

6) Hybridization is the process of mixing atomic orbitals as atoms approach each other to form a bond.

7) Electrons in core orbitals contribute to atom bonding.

8) Nitrogen is colorless because the minimum energy to excite an electron is in the ultraviolet section of the spectrum.

9.5 Algorithmic Questions

1) Using the VSEPR model, the electron-domain geometry of the central atom in BF_3 is _____.

A) linear
B) trigonal planar
C) tetrahedral
D) trigonal bipyramidal
E) octahedral

2) Using the VSEPR model, the electron-domain geometry of the central atom in SF_2 is _____.

A) linear
B) trigonal planar
C) tetrahedral
D) trigonal bipyramidal
E) octahedral

3) Using the VSEPR model, the electron-domain geometry of the central atom in ClF_3 is _____.

A) linear
B) trigonal planar
C) tetrahedral
D) trigonal bipyramidal
E) octahedral

4) Using the VSEPR model, the electron-domain geometry of the central atom in BrF_4^- is _____.

A) linear
B) trigonal planar
C) tetrahedral
D) trigonal bipyramidal
E) octahedral

5) Using the VSEPR model, the molecular geometry of the central atom in XeF_2 is _____.

A) linear
B) trigonal planar
C) tetrahedral
D) bent
E) trigonal pyramidal

6) Using the VSEPR model, the molecular geometry of the central atom in BCl_3 is _____.

A) linear
B) trigonal planar
C) tetrahedral
D) bent
E) trigonal pyramidal

7) Using the VSEPR model, the molecular geometry of the central atom in CF_4 is _____.

A) linear
B) trigonal planar
C) tetrahedral
D) bent
E) trigonal pyramidal

8) Using the VSEPR model, the molecular geometry of the central atom in SO_2 is _____.

A) linear
B) trigonal planar
C) tetrahedral
D) bent
E) trigonal pyramidal

9) Using the VSEPR model, the molecular geometry of the central atom in NCl_3 is _____.

A) linear
B) trigonal planar
C) tetrahedral
D) bent
E) trigonal pyramidal

10) Using the VSEPR model, the molecular geometry of the central atom in PF_5 is _____.

A) tetrahedral
B) square planar
C) trigonal bipyramidal
D) seesaw
E) square pyramidal

11) The hybrid orbital set used by the central atom in NO_3^- is _____.

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

12) The hybrid orbital set used by the central atom in BF_4^- is _____.

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

13) The hybrid orbital set used by the central atom in KrF_2 is _____.

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