

Chapter 1: Structure and Bonding

1. What is the ground-state electronic configuration of a carbon atom?
A) $1s^2, 2s^2, 2p^5$ B) $1s^2, 2s^2, 2p^2$ C) $1s^2, 2s^2, 2p^6$ D) $1s^2, 2s^2, 2p^4$
2. What is the ground-state electronic configuration of a fluorine atom?
A) $1s^2, 2s^2, 2p^2$ B) $1s^2, 2s^2, 2p^3$ C) $1s^2, 2s^2, 2p^4$ D) $1s^2, 2s^2, 2p^5$
3. What is the ground-state electronic configuration of a magnesium cation (Mg^{2+})?
A) $1s^2, 2s^2, 2p^6$ C) $1s^2, 2s^2, 2p^6, 3s^2$
B) $1s^2, 2s^2, 2p^6, 3s^1$ D) $1s^2, 2s^2, 2p^6, 3s^2, 3p^2$
4. What is the ground-state electronic configuration of a chlorine anion (Cl^-)?
A) $1s^2, 2s^2, 2p^6$ C) $1s^2, 2s^2, 2p^6, 3s^2, 3p^5$
B) $1s^2, 2s^2, 2p^6, 3s^2, 3p^6$ D) $1s^2, 2s^2, 2p^6, 3s^2, 3p^4$
5. Which of the following statements about valence electrons is true?
A) They are the most tightly held electrons.
B) They do not participate in chemical reactions.
C) They are the outermost electrons.
D) They reveal the period number of a second-row element.
6. Which of the following statements about bonding is true?
A) Covalent bonds result from the transfer of electrons from one element to another.
B) Ionic bonds result from the transfer of electrons from a metal to a non-metal.
C) Ionic bonds result from the sharing of electrons between two non-metals.
D) Covalent bonds result from the sharing of electrons between two metals.
7. Which of the following would you expect to have ionic bonds?
A) CO B) FBr C) NF_3 D) NaCl
8. Which of the following molecules has nonpolar covalent bonds?
A) HCl B) N_2 C) $CHCl_3$ D) NO
9. Which of the following molecules contain both covalent and ionic bonds?

NaCl

 NH_4OH CH_3OH $MgCO_3$ **I****II****III****IV**

- A) I, II B) I, IV C) II, III D) II, IV

10. Arrange the following bonds in decreasing order of ionic character, putting the most ionic first.

**I****II****III****IV**

A) I > II > III > IV

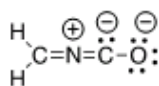
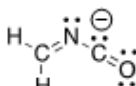
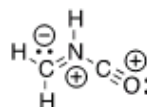
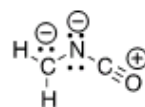
C) IV > III > II > I

B) IV > II > I > III

D) IV > II > III > I

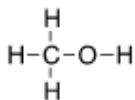
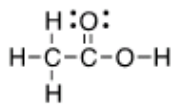
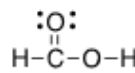
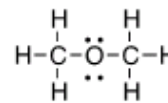
11. Which of the following statements correctly describes the typical number of bonds for carbon, nitrogen, and oxygen in most neutral organic molecules?
- A) Carbon forms 4 covalent bonds, nitrogen forms 2 covalent bonds and oxygen forms 3 covalent bonds.
- B) Carbon forms 4 covalent bonds, nitrogen forms 3 covalent bonds and oxygen forms 2 covalent bonds.
- C) Carbon forms 4 covalent bonds, nitrogen forms 5 covalent bonds and oxygen forms 2 covalent bonds.
- D) Carbon forms 4 covalent bonds, nitrogen forms 5 covalent bonds and oxygen forms 4 covalent bonds.

12. Which is not an acceptable Lewis structure for the anion CH_2NCO^- ?

**I****II****III****IV**

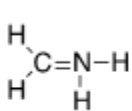
A) I B) II C) III D) IV

13. Which of the following Lewis structures is correct?

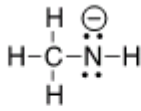
**I****II****III****IV**

A) I B) II C) III D) IV

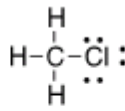
14. Which of the following Lewis structures is correct?



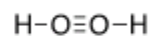
I



II



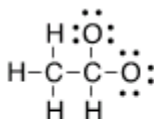
III



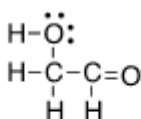
IV

A) I, II B) I, III C) II, III D) III, IV

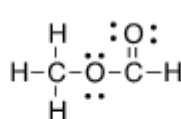
15. Which is the correct Lewis structure for acetic acid ($\text{CH}_3\text{CO}_2\text{H}$)?



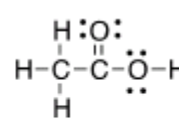
I



II



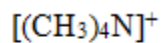
III



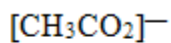
IV

A) I B) II C) III D) IV

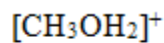
16. In which of the following ions does carbon have a formal charge?



I



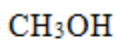
II



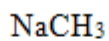
III

A) I B) II C) III D) None of the above

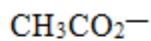
17. In which of the following ions does carbon have a formal charge?



I



II



III

A) I B) II C) III D) None of the above

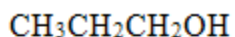
18. What is the formal charge of carbon in carbon monoxide (CO) when drawn with a triple bond?

A) 0 B) -2 C) -1 D) +1

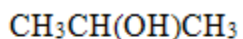
19. Which of the following statements about constitutional isomers is true?

- A) Constitutional isomers are different molecules having different molecular formula.
- B) Constitutional isomers are different molecules having same molecular formula.
- C) Constitutional isomers are same molecules having different molecular formula.
- D) Constitutional isomers are same molecules having the same molecular formula.

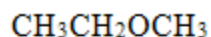
20. How many constitutional isomers are there for a molecule having the molecular formula C_2H_6O ?
A) 1 B) 2 C) 3 D) 4
21. How many constitutional isomers are there for a molecule having the molecular formula C_3H_8O ?
A) 1 B) 2 C) 3 D) 4
22. How many constitutional isomers are there for a molecule having the molecular formula C_3H_6 ?
A) 1 B) 2 C) 3 D) 4
23. How many constitutional isomers are there for a molecule having the molecular formula $C_2H_4Cl_2$?
A) 1 B) 2 C) 3 D) 4
24. How many different isomers are there for a compound having the molecular formula C_3H_6O ?
A) 4 B) 5 C) 6 D) 7
25. Which of the following molecules are constitutional isomers?



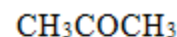
I



II



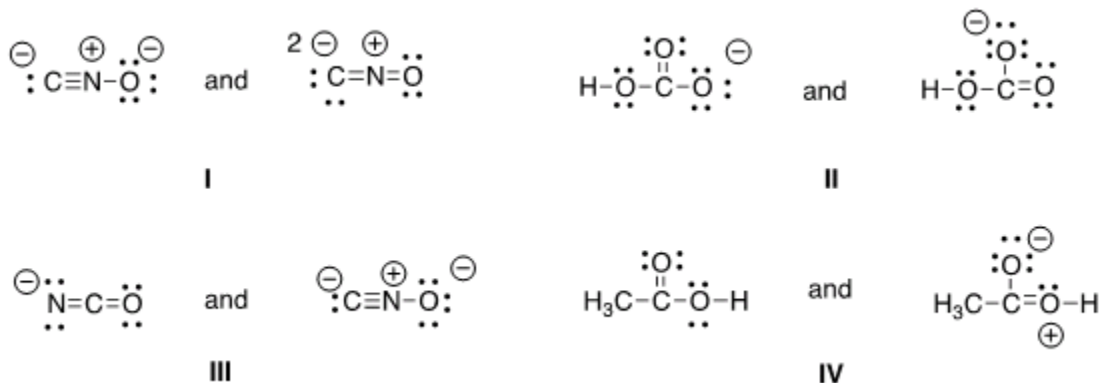
III



IV

- A) I, II, IV B) II, III, IV C) I, III, IV D) I, II, III
26. Which of the following compounds has an atom with an unfilled valence shell of electrons?
A) H_2O B) BCl_3 C) CH_4 D) CO_2
27. Which of the following statements about resonance structures is true?
A) Resonance structures have the same placement of electrons but different arrangement of atoms.
B) Resonance structures have the same placement of atoms but different arrangement of electrons.
C) Resonance structures have the same placement of atoms and the same arrangement of electrons.
D) Resonance structures have different placement of atoms and different arrangement of electrons.
28. Which of the following statements about resonance structures is *not* true?
A) There is no movement of electrons from one form to another.
B) Resonance structures are not isomers.
C) Resonance structures differ only in the arrangement of electrons.
D) Resonance structures are in equilibrium with each other.

29. Which of the following pair does not represent resonance structures?

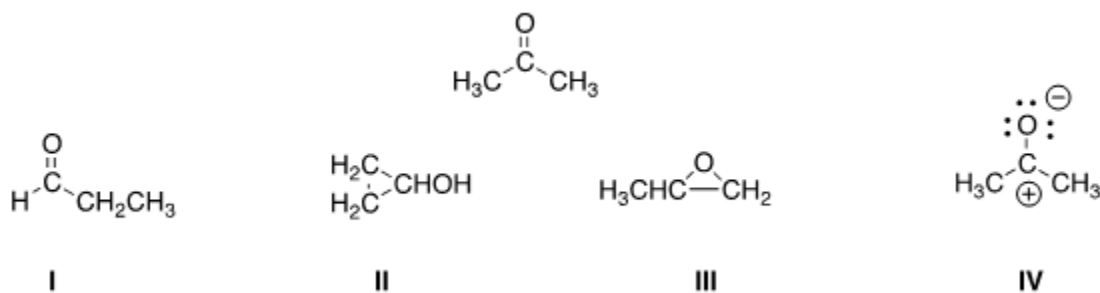


A) I B) II C) III D) IV

30. What 2 things will change between two resonance structures?

- A) The position of multiple bonds and non-bonded electrons.
- B) The position of multiple bonds and single bonds.
- C) The placement of atoms and single bonds.
- D) The placement of atoms and non-bonded electrons.

31. Which of the following is a resonance structure of the compound below?



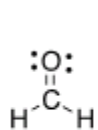
A) I B) II C) III D) IV

32. Which of the following resonance structures is the least important contributor to the resonance hybrid of the formate anion, HCOO^- ?

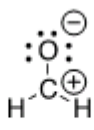


A) I B) II C) III D) IV

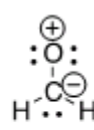
33. Rank the following in order of decreasing importance as contributing structures to the resonance hybrid of formaldehyde, H_2CO .



I



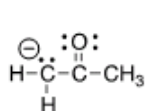
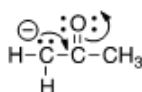
II



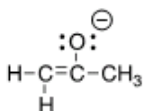
III

- A) I > II > III B) I > III > II C) II > I > III D) III > II > I

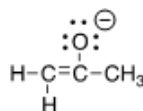
34. Follow the curved arrows to draw the second resonance structure for the ion below.



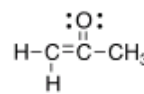
I



II



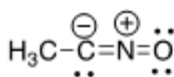
III



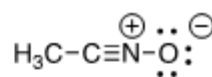
IV

- A) I B) II C) III D) IV

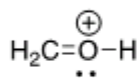
35. Which is more important in each pair of contributing resonance structures?



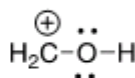
I



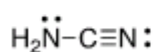
II



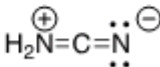
III



IV



V



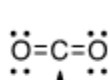
VI

- A) II, IV, V B) II, III, V C) II, III, VI D) I, IV, V

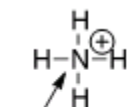
36. What is the approximate value of the H-C-H bond angle in methane, CH_4 ?

- A) 90° B) 109.5° C) 120° D) 180°

37. What is the approximate C-C-C bond angle in propene, $\text{CH}_3\text{CH}=\text{CH}_2$?
 A) 90° B) 109.5° C) 120° D) 180°
38. What is the approximate H-C-O bond angle in formaldehyde, H_2CO ?
 A) 90° B) 109.5° C) 120° D) 180°
39. Determine the electron geometry around the indicated atom in each species.



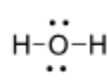
I



II

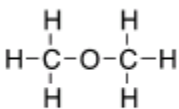


III

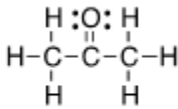


IV

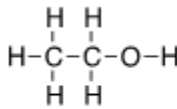
- A) I = Linear; II = tetrahedral; III = trigonal planar; IV = tetrahedral
 B) I = Linear; II = tetrahedral; III = trigonal planar; IV = linear
 C) I = Trigonal planar; II = linear; III = tetrahedral; IV = trigonal planar
 D) I = Tetrahedral; II = trigonal planar; III = linear; IV = tetrahedral
40. What is the approximate bond angle for the C-C-N bond in acetonitrile, CH_3CN ?
 A) 90° B) 109.5° C) 120° D) 180°
41. Which of the following is the appropriate conversion of the condensed structure, CH_3COCH_3 , to a Lewis structure?



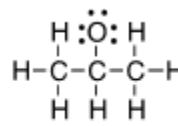
I



II



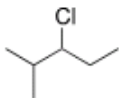
III



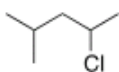
IV

- A) I B) II C) III D) IV

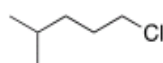
42. Which of the following is the appropriate conversion of $(\text{CH}_3)_2\text{CHCH}_2\text{CHClCH}_3$ to a skeletal structure?



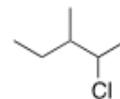
I



II



III



IV

- A) I B) II C) III D) IV

43. Which of the following is the appropriate conversion of $(\text{CH}_3)_4\text{C}$ to a skeletal structure?



I



II



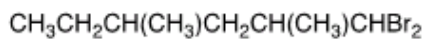
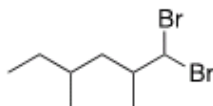
III



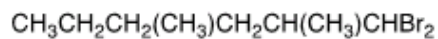
IV

A) I B) II C) III D) IV

44. What is the condensed formula of the compound below?



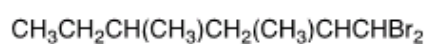
I



II



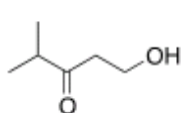
III



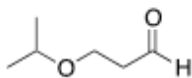
IV

A) I B) II C) III D) IV

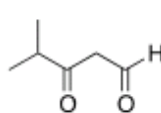
45. Which of the following is the appropriate conversion of $(\text{CH}_3)_2\text{CHOCH}_2\text{CH}_2\text{CH}_2\text{OH}$ to a skeletal structure?



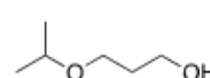
I



II



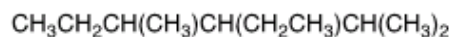
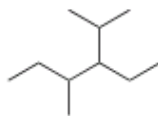
III



IV

A) I B) II C) III D) IV

46. Convert the following skeletal structure to a condensed structure.



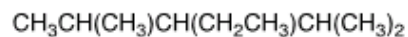
I



II



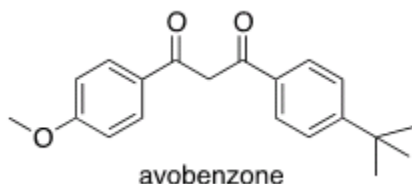
III



IV

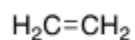
A) I B) II C) III D) IV

47. Avobenzone is an active ingredient in some common sunscreens. Which of the following is the correct molecular formula for avobenzone?



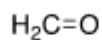
A) $\text{C}_{22}\text{O}_{22}\text{O}_3$ B) $\text{C}_{20}\text{H}_{22}\text{O}_3$ C) $\text{C}_{21}\text{H}_{23}\text{O}_3$ D) $\text{C}_{20}\text{H}_{24}\text{O}_3$

48. In which structure is the hybridization incorrect?



sp^2

I



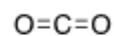
sp

II



sp^2

III

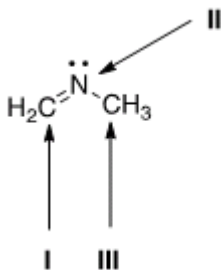


sp

IV

A) I B) II C) III D) IV

49. What is the hybridization for each of the indicated atoms in the following compound?



- A) I = sp^2 ; II = sp^2 ; III = sp^2 .
 B) I = sp^2 ; II = sp^3 ; III = sp^3 .
 C) I = sp ; II = sp^2 ; III = sp^3 .
 D) I = sp^2 ; II = sp^2 ; III = sp^3 .
50. What is the hybridization of the carbon atom in the methyl cation, (CH_3^+) ?
 A) sp^3 B) sp^2 C) sp D) p
51. What is the hybridization of the nitrogen atom in the ammonium cation, NH_4^+ ?
 A) sp^3 B) sp^2 C) sp D) p
52. Which atomic orbitals overlap to form the C-H σ bonding molecular orbitals of ethane, CH_3CH_3 ?
 A) $Csp^2 + H1s$ B) $Csp^3 + H1s$ C) $C2p + H1s$ D) $Csp + H1s$
53. Which atomic orbitals overlap to form the C-H σ bonding molecular orbitals of ethylene, $H_2C=CH_2$?
 A) $C2p + H1s$ B) $Csp + H1s$ C) $Csp^3 + H1s$ D) $Csp^2 + H1s$
54. Which atomic orbitals overlap to form the carbon-carbon σ and π bonding molecular orbitals of ethylene, $H_2C=CH_2$?
 A) $Csp^3 + Csp^3$, and $C2p + C2p$
 B) $Csp^3 + Csp^3$, and $Csp^2 + Csp^2$
 C) $Csp^2 + Csp^2$, and $C2p + C2p$
 D) $Csp^2 + Csp^2$, and $Csp^2 + Csp^2$
55. Which atomic orbitals overlap to form the C-H σ bonding molecular orbitals of acetylene, C_2H_2 ?
 A) $Csp + H1s$ B) $C2p + H1s$ C) $Csp^3 + H1s$ D) $Csp^2 + H1s$
56. Which atomic orbitals overlap to form the carbon-carbon σ bonding molecular orbital of acetylene, C_2H_2 ?
 A) $Csp^2 + Csp^2$ B) $Csp + Csp$ C) $Csp^3 + Csp^3$ D) $C2p + C2p$

57. When forming molecular orbitals from atomic orbitals, what is the order of increasing C-H bond strength for the following.

sp^3
I

sp^2
II

sp
III

- A) II < I < III B) III < I < II C) III < II < I D) I < II < III

58. What is the order of decreasing bond length for a C-C bond comprised of the following molecular orbitals?

sp^3-sp^3
I

sp^2-sp^2
II

$sp-sp$
III

- A) I > III > II B) I > II > III C) III > II > I D) II > III > I

59. Which of the following statements about electronegativity and the periodic table is true?

- A) Electronegativity decreases across a row of the periodic table.
B) Electronegativity increases down a column of the periodic table.
C) Electronegativity increases across a row of the periodic table.
D) Electronegativity does not change down a column of the periodic table.

60. Rank the following atoms in order of increasing electronegativity, putting the least electronegative first.

S
I

Cl
II

F
III

N
IV

- A) I < II < III < IV C) III < II < IV < I
B) I < IV < II < III D) I < II < IV < III

61. Rank the following atoms in order of decreasing electronegativity, putting the most electronegative first.

Si
I

N
II

O
III

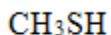
C
IV

- A) I > IV > II > III C) III > IV > II > I
B) II > III > IV > I D) III > II > IV > I

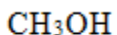
62. Which molecule has the greatest difference in electronegativity (ΔE) between the two different elements?

- A) CO₂ B) H₂S C) NH₃ D) H₂O

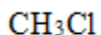
63. Which compound contains the most polar bond?



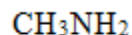
I



II



III



IV

A) I B) II C) III D) IV

64. Which of the following compounds are non-polar?



I



II



III



IV

A) I, IV B) I, II C) II, III D) II, IV

65. Which of the following molecules has non-polar covalent bonds?

A) CO_2 B) N_2 C) CCl_4 D) HF

66. Which of the following molecules has polar covalent bonds?

A) MgO B) NH_3 C) Cl_2 D) NaBr

67. Which of the following covalent bonds has the largest dipole moment?

A) C-H B) C-C C) C-O D) H-F

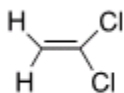
68. Which of the following molecules has the smallest dipole moment?

A) CO_2 B) HCl C) H_2O D) NH_3

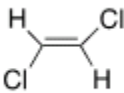
69. Which of the following molecules does *not* have a net dipole moment of zero?

A) CCl_4 B) BF_3 C) CO_2 D) NH_3

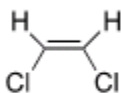
70. Which of the following molecules has a net dipole moment of zero?



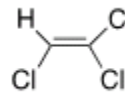
I



II



III



IV

A) I B) II C) III D) IV

Answer Key

1. B
2. D
3. A
4. B
5. C
6. B
7. D
8. B
9. D
10. C
11. B
12. C
13. D
14. C
15. D
16. D
17. B
18. C
19. B
20. B
21. C
22. B
23. B
24. D
25. D
26. B
27. B
28. D
29. C
30. A
31. D
32. B
33. A
34. C
35. B
36. B
37. C
38. C
39. A
40. D
41. B
42. B
43. D
44. A

- 45. D
- 46. A
- 47. B
- 48. B
- 49. D
- 50. B
- 51. A
- 52. B
- 53. D
- 54. C
- 55. A
- 56. B
- 57. D
- 58. B
- 59. C
- 60. B
- 61. D
- 62. D
- 63. B
- 64. A
- 65. B
- 66. B
- 67. D
- 68. A
- 69. D
- 70. B