Chapter 1: Structure and Bonding

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| 1. | What is the ground-state electronic configuration of a carbon atom? |
|  | A) 1s2, 2s2, 2p5 B) 1s2, 2s2, 2p2 C) 1s2, 2s2, 2p6 D) 1s2, 2s2, 2p4 |

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| 2. | What is the ground-state electronic configuration of a fluorine atom? |
|  | A) 1s2, 2s2, 2p2 B) 1s2, 2s2, 2p3 C) 1s2, 2s2, 2p4 D) 1s2, 2s2, 2p5 |

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| 3. | What is the ground-state electronic configuration of a magnesium cation (Mg2+)? | | | |
| A) | 1s2, 2s2, 2p6 | C) | 1s2, 2s2, 2p6, 3s2 |
| B) | 1s2, 2s2, 2p6, 3s1 | D) | 1s2, 2s2, 2p6, 3s2, 3p2 |

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| 4. | What is the ground-state electronic configuration of a chlorine anion (Cl—)? | | | |
| A) | 1s2, 2s2, 2p6 | C) | 1s2, 2s2, 2p6, 3s2, 3p5 |
| B) | 1s2, 2s2, 2p6, 3s2, 3p6 | D) | 1s2, 2s2, 2p6, 3s2, 3p4 |

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| 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. |

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| 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. |

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| 7. | Which of the following would you expect to have ionic bonds? |
|  | A) CO B) FBr C) NF3 D) NaCl |

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| 8. | Which of the following molecules has nonpolar covalent bonds? |
|  | A) HCl B) N2 C) CHCl3 D) NO |

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| 9. | Which of the following molecules contain both covalent and ionic bonds? |
|  | A) I, II B) I, IV C) II, III D) II, IV |

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| 10. | Arrange the following bonds in decreasing order of ionic character, putting the most ionic first. | | | |
| A) | I > II > III > IV | C) | IV > III > II > I |
| B) | IV > II > I > III | D) | IV > II > III > I |

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| 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. |

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| 12. | Which is not an acceptable Lewis structure for the anion CH2NCO—? |
|  | A) I B) II C) III D) IV |

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| 13. | Which of the following Lewis structures is correct? |
|  | A) I B) II C) III D) IV |

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| 14. | Which of the following Lewis structures is correct? |
|  | A) I, II B) I, III C) II, III D) III, IV |

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| 15. | Which is the correct Lewis structure for acetic acid (CH3CO2H)? |
|  | A) I B) II C) III D) IV |

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| 16. | In which of the following ions does carbon have a formal charge? |
|  | A) I B) II C) III D) None of the above |

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| 17. | In which of the following ions does carbon have a formal charge? |
|  | A) I B) II C) III D) None of the above |

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| 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 |

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| 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. |

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| 20. | How many constitutional isomers are there for a molecule having the molecular formula C2H6O? |
|  | A) 1 B) 2 C) 3 D) 4 |

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| 21. | How many constitutional isomers are there for a molecule having the molecular C3H8O? |
|  | A) 1 B) 2 C) 3 D) 4 |

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| 22. | How many constitutional isomers are there for a molecule having the molecular formula C3H6? |
|  | A) 1 B) 2 C) 3 D) 4 |

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| 23. | How many constitutional isomers are there for a molecule having the molecular formula C2H4Cl2? |
|  | A) 1 B) 2 C) 3 D) 4 |

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| 24. | How many different isomers are there for a compound having the molecular formula C3H6O? |
|  | A) 4 B) 5 C) 6 D) 7 |

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| 25. | Which of the following molecules are constitutional isomers? |
|  | A) I, II, IV B) II, III, IV C) I, III, IV D) I, II, III |

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| 26. | Which of the following compounds has an atom with an unfilled valence shell of electrons? |
|  | A) H2O B) BCl3 C) CH4 D) CO2 |

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| 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. |

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| 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. |

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| 29. | Which of the following pair does not represent resonance structures? |
|  | A) I B) II C) III D) IV |

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| 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. |

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| 31. | Which of the following is a resonance structure of the compound below? |
|  | A) I B) II C) III D) IV |

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| 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 |

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| 33. | Rank the following in order of decreasing importance as contributing structures to the resonance hybrid of formaldehyde, H2CO. |
|  | A) I > II > III B) I > III > II C) II > I > III D) III > II > I |

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| 34. | Follow the curved arrows to draw the second resonance structure for the ion below. |
|  | A) I B) II C) III D) IV |

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| 35. | Which is more important in each pair of contributing resonance structures? |
|  | A) II, IV, V B) II, III, V C) II, III, VI D) I, IV, V |

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| 36. | What is the approximate value of the H-C-H bond angle in methane, CH4? |
|  | A) 90° B) 109.5° C) 120° D) 180° |

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| 37. | What is the approximate C-C-C bond angle in propene, CH3CH=CH2? |
|  | A) 90° B) 109.5° C) 120° D) 180° |

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| 38. | What is the approximate H-C-O bond angle in formaldehyde, H2CO? |
|  | A) 90° B) 109.5° C) 120° D) 180° |

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| 39. | Determine the electron geometry around the indicated atom in each species. | |
| 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 |

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| 40. | What is the approximate bond angle for the C-C-N bond in acetonitrile, CH3CN? |
|  | A) 90° B) 109.5° C) 120° D) 180° |

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| 41. | Which of the following is the appropriate conversion of the condensed structure, CH3COCH3, to a Lewis structure? |
|  | A) I B) II C) III D) IV |

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| 42. | Which of the following is the appropriate conversion of (CH3)2CHCH2CHClCH3 to a skeletal structure? |
|  | A) I B) II C) III D) IV |

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| 43. | Which of the following is the appropriate conversion of (CH3)4C to a skeletal structure? |
|  | A) I B) II C) III D) IV |

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| 44. | What is the condensed formula of the compound below? |
|  | A) I B) II C) III D) IV |

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| 45. | Which of the following is the appropriate conversion of (CH3)2CHOCH2CH2CH2OH to a skeletal structure? |
|  | A) I B) II C) III D) IV |

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| 46. | Convert the following skeletal structure to a condensed structure. |
|  | A) I B) II C) III D) IV |

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| 47. | Avobenzone is an active ingredient in some common sunscreens. Which of the following is the correct molecular formula for avobenzone? |
|  | A) C22O22O3 B) C20H22O3 C) C21H23O3 D) C20H24O3 |

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| 48. | In which structure is the hybridization incorrect? |
|  | A) I B) II C) III D) IV |

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| 49. | What is the hybridization for each of the indicated atoms in the following compound? | | | |
| A) | I = *sp2*; II = *sp2*; III = *sp2*. | C) | I = *sp*; II = *sp2*; III = *sp3*. |
| B) | I = *sp2*; II = *sp3*; III = *sp3*. | D) | I = *sp2*; II = *sp2*; III = *sp3*. |

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| 50. | What is the hybridization of the carbon atom in the methyl cation, (CH3+)? |
|  | A) *sp3* B) *sp2* C) *sp* D) *p* |

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| 51. | What is the hybridization of the nitrogen atom in the ammonium cation, NH4+? |
|  | A) *sp3* B) *sp2* C) *sp* D) *p* |

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| 52. | Which atomic orbitals overlap to form the C-H  bonding molecular orbitals of ethane, CH3CH3? |
|  | A) C*sp2* + H1*s* B) C*sp3* + H1*s* C) C2*p* + H1*s* D) C*sp* + H1*s* |

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| 53. | Which atomic orbitals overlap to form the C-H  bonding molecular orbitals of ethylene, H2C=CH2? |
|  | A) C2*p* + H1*s* B) C*sp* + H1*s* C) C*sp3* + H1*s* D) C*sp2* + H1*s* |

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| 54. | Which atomic orbitals overlap to form the carbon-carbon  and  bonding molecular orbitals of ethylene, H2C=CH2? | | | |
| A) | C*sp3* + C*sp3*, and C2*p* + C2*p* | C) | C*sp2* + C*sp2*, and C2*p* + C2*p* |
| B) | C*sp3* + C*sp3*, and C*sp2* + C*sp2* | D) | C*sp2* + C*sp2*, and C*sp2* + C*sp2* |

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| 55. | Which atomic orbitals overlap to form the C-H  bonding molecular orbitals of acetylene, C2H2? |
|  | A) C*sp* + H1*s* B) C2*p* +H1*s* C) C*sp3* + H1*s* D) C*sp2* + H1*s* |

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| 56. | Which atomic orbitals overlap to form the carbon-carbon  bonding molecular orbital of acetylene, C2H2? |
|  | A) C*sp2* + C*sp2* B) C*sp* + C*sp* C) C*sp3* + C*sp3* D) C2*p* + C2*p* |

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| 57. | When forming molecular orbitals from atomic orbitals, what is the order of increasing C-H bond strength for the following. |
|  | A) II < I < III B) III < I < II C) III < II < I D) I < II < III |

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| 58. | What is the order of decreasing bond length for a C-C bond comprised of the following molecular orbitals? |
|  | A) I > III > II B) I > II > III C) III > II > I D) II > III > I |

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| 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. |

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| 60. | Rank the following atoms in order of increasing electronegativity, putting the least electronegative first. | | | |
| A) | I < II < III < IV | C) | III < II < IV < I |
| B) | I < IV < II < III | D) | I < II < IV < III |

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| 61. | Rank the following atoms in order of decreasing electronegativity, putting the most electronegative first. | | | |
| A) | I > IV > II > III | C) | III > IV > II > I |
| B) | II > III > IV > I | D) | III > II > IV > I |

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| 62. | Which molecule has the greatest difference in electronegativity (E) between the two different elements? |
|  | A) CO2 B) H2S C) NH3 D) H2O |

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| 63. | Which compound contains the most polar bond? |
|  | A) I B) II C) III D) IV |

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| 64. | Which of the following compounds are non-polar? |
|  | A) I, IV B) I, II C) II, III D) II, IV |

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| 65. | Which of the following molecules has non-polar covalent bonds? |
|  | A) CO2 B) N2 C) CCl4 D) HF |

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| 66. | Which of the following molecules has polar covalent bonds? |
|  | A) MgO B) NH3 C) Cl2 D) NaBr |

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| 67. | Which of the following covalent bonds has the largest dipole moment? |
|  | A) C-H B) C-C C) C-O D) H-F |

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| 68. | Which of the following molecules has the smallest dipole moment? |
|  | A) CO2 B) HCl C) H2O D) NH3 |

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| 69. | Which of the following molecules does *not* have a net dipole moment of zero? |
|  | A) CCl4 B) BF3 C) CO2 D) NH3 |

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| 70. | Which of the following molecules has a net dipole moment of zero? |
|  | A) I B) II C) III D) IV |

**Answer Key**

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| 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 |