**1. What is the ground state electron configuration of carbon?**

1. 1s22s22px1
2. 1s22s22px2
3. 1s22s22px12py1
4. 1s22s22px22py1

*Accessibility: Keyboard Navigation*

*Bloom's Level: 3. Apply*

*Chapter: 01*

*Difficulty: Medium*

*Gradable: automatic*

*Section: 01.01*

*Subtopic: Periodic table trends*

*Topic: Structure and Bonding*

**2. Which of the following has (have) the same electron configuration as Ne?**

**Na- Mg2+ O2- Mg+**

1. Na- and O2-
2. Mg2+ and O2-
3. Mg+ and O2-
4. only Mg2+

*Accessibility: Keyboard Navigation*

*Bloom's Level: 4. Analyze*

*Chapter: 01*

*Difficulty: Medium*

*Gradable: automatic*

*Section: 01.02*

*Subtopic: Periodic table trends*

*Topic: Structure and Bonding*

**3. What is the letter designation given to dumbbell shaped orbitals like the one depicted below?**



1. s
2. p
3. d
4. f

*Bloom's Level: 1. Remember*

*Chapter: 01*

*Difficulty: Easy*

*Gradable: automatic*

*Section: 01.01*

*Subtopic: Atomic orbitals*

*Topic: Molecular Shape*

1. **Which of the following atoms has vacant d orbitals that permit it to accommodate more than eight electrons in its valence shell?**
2. N
3. C
4. Ne
5. S

*Accessibility: Keyboard Navigation*

*Bloom's Level: 2. Understand*

*Chapter: 01*

*Difficulty: Easy*

*Gradable: automatic*

*Section: 01.08*

*Subtopic: Octet rule exceptions*

*Topic: Structure and Bonding*

**5. Predict which bond is the most polar in ethanol, CH3CH2OH?**

1. C-C
2. C-H
3. C-O
4. O-H

*Accessibility: Keyboard Navigation*

*Bloom's Level: 4. Analyze*

*Chapter: 01*

*Difficulty: Medium*

*Gradable: automatic*

*Section: 01.04*

*Subtopic: Bond properties*

*Subtopic: Types of bonds*

*Topic: Structure and Bonding*

**6. Which one of the following is the conjugate base of NH3?**

1. NH4+
2. H+

C. N3-

**D.** NH2-

*Accessibility: Keyboard Navigation*

*Bloom's Level: 3. Apply*

*Chapter: 01*

*Difficulty: Medium*

*Gradable: automatic*

*Section: 01.12*

*Subtopic: Acid/Base definitions*

*Topic: Acids and Bases*

**7. What can be said about the polarity of the C=O bond?**

1. C and O have the same electronegativity; the bond is nonpolar
2. the C=O bond is polar; the O atom bears a partial negative charge
3. the C=O bond is nonpolar; the C atom bears a partial positive charge
4. the C=O bond is polar; the C atom bears a partial negative charge

*Accessibility: Keyboard Navigation*

*Bloom's Level: 2. Understand*

*Chapter: 01*

*Difficulty: Medium*

*Gradable: automatic*

*Section: 01.04*

*Subtopic: Bond properties*

*Subtopic: Types of bonds*

*Topic: Structure and Bonding*

**8. Identify the condensed formula of the following structure:**



A. (CH3)2CHCHClCH(CH3)2

B. CH3CH(CH3)CHClCH(CH3)2

**C.** (CH3)2CHCHClC(CH3)3

D. (CH3)3CCHClCH(CH3)3

*Bloom's Level: 3. Apply*

*Chapter: 01*

*Difficulty: Medium*

*Gradable: automatic*

*Section: 01.06*

*Subtopic: Condensed formula*

*Subtopic: Skeletal/bond-line structures*

*Topic: Drawing Organic Molecules*

**9. What is the chemical formula of the following carbon skeleton diagram?**



1. C8H14
2. C8H16
3. C8H18
4. C8H20

*Bloom's Level: 2. Understand*

*Chapter: 01*

*Difficulty: Easy*

*Gradable: automatic*

*Section: 01.06*

*Subtopic: Skeletal/bond-line structures*

*Topic: Drawing Organic Molecules*

**10. How many hydrogen atoms are there on carbon atoms 1 and 2, respectively, in the structure below?**



1. 4, 1
2. 4, 0
3. 3, 1
4. 3, 0

*Bloom's Level: 2. Understand*

*Chapter: 01*

*Difficulty: Medium*

*Gradable: automatic*

*Section: 01.06*

*Subtopic: Skeletal/bond-line structures*

*Topic: Drawing Organic Molecules*

**11. How many C3H8O constitutional isomers are possible?**

1. one
2. two
3. three
4. four

*Accessibility: Keyboard Navigation*

*Bloom's Level: 3. Apply*

*Chapter: 01*

*Difficulty: Medium*

*Gradable: automatic*

*Section: 01.06*

*Subtopic: Constitutional isomers*

*Topic: Drawing Organic Molecules*

**12. Which of the following best describes the relationship between the two structures?**



1. identical compounds
2. resonance structures
3. constitutional isomers
4. different compounds with different constitutions

*Bloom's Level: 2. Understand*

*Chapter: 01*

*Difficulty: Medium*

*Gradable: automatic*

*Section: 01.06*

*Subtopic: Skeletal/bond-line structures*

*Topic: Drawing Organic Molecules*

**13. How many constitutional isomers of C4H9Br are possible?**

1. one
2. two
3. three
4. four

*Accessibility: Keyboard Navigation*

*Bloom's Level: 3. Apply*

*Chapter: 01*

*Difficulty: Medium*

*Gradable: automatic*

*Section: 01.06*

*Subtopic: Constitutional isomers*

*Topic: Drawing Organic Molecules*

**14. How many constitutional isomers of C3H6Cl2 are possible?**

1. three
2. four
3. five
4. six

*Accessibility: Keyboard Navigation*

*Bloom's Level: 3. Apply*

*Chapter: 01*

*Difficulty: Medium*

*Gradable: automatic*

*Section: 01.06*

*Subtopic: Constitutional isomers*

*Topic: Drawing Organic Molecules*

**15. What is the formal charge on the carbon atom?**



1. +1
2. 0
3. -1
4. -2

*Bloom's Level: 3. Apply*

*Chapter: 01*

*Difficulty: Medium*

*Gradable: automatic*

*Section: 01.05*

*Subtopic: Formal charges*

*Topic: Structure and Bonding*

**16. Which of the following describes the relationship between the following two structures?**



1. identical structures
2. resonance forms
3. constitutional isomers
4. different compounds with different compositions

*Bloom's Level: 2. Understand*

*Chapter: 01*

*Difficulty: Medium*

*Gradable: automatic*

*Section: 01.06*

*Subtopic: Skeletal/bond-line structures*

*Topic: Drawing Organic Molecules*

**17. Which of the following describes the relationship between the following two *ions*?**



1. identical structures
2. resonance forms
3. constitutional isomers
4. different compounds with different compositions

*Bloom's Level: 2. Understand*

*Chapter: 01*

*Difficulty: Easy*

*Gradable: automatic*

*Section: 01.07*

*Subtopic: Resonance*

*Topic: Structure and Bonding*

**18. What is the formal charge on the oxygen atom in the structure below?**



1. -1
2. 0
3. +1
4. +2

*Bloom's Level: 3. Apply*

*Chapter: 01*

*Difficulty: Medium*

*Gradable: automatic*

*Section: 01.05*

*Subtopic: Formal charges*

*Topic: Structure and Bonding*

**19. What is the formal charge on the nitrogen atom in the structure below?**



1. -1
2. 0
3. +1
4. +2

*Bloom's Level: 3. Apply*

*Chapter: 01*

*Difficulty: Medium*

*Gradable: automatic*

*Section: 01.05*

*Subtopic: Formal charges*

*Topic: Structure and Bonding*

**20. The formal charges on the nitrogen and oxygen in the following structures are, respectively**



1. +1, -1
2. 0, -1
3. +1, 0
4. 0, 0

*Bloom's Level: 3. Apply*

*Chapter: 01*

*Difficulty: Medium*

*Gradable: automatic*

*Section: 01.05*

*Subtopic: Formal charges*

*Topic: Structure and Bonding*

1. **In which of the following compounds would you expect Cl to have a partial positive charge?**
2. HCl
3. CCl4
4. NaCl
5. HOCl

*Accessibility: Keyboard Navigation*

*Bloom's Level: 2. Understand*

*Chapter: 01*

*Difficulty: Medium*

*Gradable: automatic*

*Section: 01.04*

*Subtopic: Bond properties*

*Subtopic: Types of bonds*

*Topic: Structure and Bonding*

**22. Based on the VSEPR model, which of the following species has (have) a trigonal planar geometry?**

**I. BCl3 II. NH3 III. NO3¯**

1. only I
2. I and II
3. I and III
4. I, II, and III

*Accessibility: Keyboard Navigation*

*Bloom's Level: 3. Apply*

*Chapter: 01*

*Difficulty: Hard*

*Gradable: automatic*

*Section: 01.09*

*Subtopic: VSEPR theory*

*Topic: Molecular Shape*

**23. Based on VSEPR theory, which of the following species has (have) a trigonal pyramidal geometry?**

**I. CO32- II. NH3** **III. CH3+**

1. only I
2. only II
3. I and II
4. II and III

*Accessibility: Keyboard Navigation*

*Bloom's Level: 3. Apply*

*Chapter: 01*

*Difficulty: Hard*

*Gradable: automatic*

*Section: 01.09*

*Subtopic: VSEPR theory*

*Topic: Molecular Shape*

**24. Which of the following species has(have) a linear geometry?**

**I. CO2 II. NO2 + III. NO2¯**

1. only I
2. only II
3. I and II
4. I, II, and III

*Accessibility: Keyboard Navigation*

*Bloom's Level: 3. Apply*

*Chapter: 01*

*Difficulty: Hard*

*Gradable: automatic*

*Section: 01.09*

*Subtopic: VSEPR theory*

*Topic: Molecular Shape*

**25. Which of the following molecules would you expect to have a dipole moment?**

* 1. **CO2 II. HCN III. CHCl3**
1. II and III
2. only II
3. only III
4. I, II, and III

*Accessibility: Keyboard Navigation*

*Bloom's Level: 4. Analyze*

*Chapter: 01*

*Difficulty: Hard*

*Gradable: automatic*

*Section: 01.10*

*Subtopic: Dipole moments*

*Subtopic: Polarity of molecules*

*Topic: Molecular Shape*

**26. Which of the following molecules would you expect to have a dipole moment?**

* 1. **CH2Cl2 II. CH3Cl III. CCl4**
1. only I
2. only II
3. I and II
4. I, II, and III

*Accessibility: Keyboard Navigation*

*Bloom's Level: 4. Analyze*

*Chapter: 01*

*Difficulty: Hard*

*Gradable: automatic*

*Section: 01.10*

*Subtopic: Dipole moments*

*Subtopic: Polarity of molecules*

*Topic: Molecular Shape*

**27. The H-C-H bond angles in ethylene, C2H4, are closest to**

1. 90°.
2. 109.5°.
3. 120°.
4. 180°.

*Accessibility: Keyboard Navigation*

*Bloom's Level: 2. Understand*

*Chapter: 01*

*Difficulty: Medium*

*Gradable: automatic*

*Section: 01.09*

*Subtopic: Hybridization*

*Topic: Molecular Shape*

**28. The C-C-C bond angle in propane, C3H8, is closest to**

1. 90°.
2. 109.5°.
3. 120°.
4. 180°.

*Accessibility: Keyboard Navigation*

*Bloom's Level: 2. Understand*

*Chapter: 01*

*Difficulty: Medium*

*Gradable: automatic*

*Section: 01.09*

*Subtopic: Hybridization*

*Topic: Molecular Shape*

**29. What are the formal charges of boron and nitrogen, respectively, in the following structure?**



1. -1 and +1
2. -1 and 0
3. 0 and +1
4. 0 and 0

*Bloom's Level: 3. Apply*

*Chapter: 01*

*Difficulty: Medium*

*Gradable: automatic*

*Section: 01.05*

*Subtopic: Formal charges*

*Topic: Structure and Bonding*

**30. Which one of the following is isoelectronic with CO2?**

1. NO2¯
2. NO2+
3. NO2
4. O3

*Accessibility: Keyboard Navigation*

*Bloom's Level: 4. Analyze*

*Chapter: 01*

*Difficulty: Hard*

*Gradable: automatic*

*Section: 01.10*

*Subtopic: Dipole moments*

*Subtopic: Polarity of molecules*

*Subtopic: VSEPR theory*

*Topic: Molecular Shape*

1. **In which of the following does hydrogen have a partial negative charge based on electronegativity?**
2. BH3
3. CH4
4. NH3
5. H2O

*Accessibility: Keyboard Navigation*

*Bloom's Level: 2. Understand*

*Chapter: 01*

*Difficulty: Medium*

*Gradable: automatic*

*Section: 01.04*

*Subtopic: Bond properties*

*Subtopic: Types of bonds*

*Topic: Structure and Bonding*

**32. Which of the following species have a zero formal charge on its carbon atom?**



1. I and II
2. II and IV
3. III and IV
4. I, II, and III

*Bloom's Level: 3. Apply*

*Chapter: 01*

*Difficulty: Medium*

*Gradable: automatic*

*Section: 01.05*

*Subtopic: Formal charges*

*Topic: Structure and Bonding*

**33. Which one of the following species is formed when diazomethane loses a nitrogen molecule?**



**diazomethane**



1. A
2. B
3. C
4. D

*Bloom's Level: 3. Apply*

*Chapter: 01*

*Difficulty: Hard*

*Gradable: automatic*

*Section: 01.11*

*Subtopic: Bond formation and bond breaking*

*Subtopic: Drawing and interpretation*

*Topic: Curved Arrows*

**34. Which species is formed when the CH3N2+ cation loses a nitrogen molecule?**



1. A
2. B
3. C
4. D

*Bloom's Level: 3. Apply*

*Chapter: 01*

*Difficulty: Hard*

*Gradable: automatic*

*Section: 01.11*

*Subtopic: Bond formation and bond breaking*

*Subtopic: Drawing and interpretation*

*Topic: Curved Arrows*

**35. Give the molecular formula of the compound shown below:**



1. C8H16O
2. C9H18O
3. C10H18O
4. C10H20O

*Bloom's Level: 2. Understand*

*Chapter: 01*

*Difficulty: Medium*

*Gradable: automatic*

*Section: 01.06*

*Subtopic: Skeletal/bond-line structures*

*Topic: Drawing Organic Molecules*

**36. The electron pair movement depicted below produces a second resonance form for the species. What is the formal charge on the nitrogen atom for this second resonance form?**



1. -2
2. -1
3. 0
4. +1

*Bloom's Level: 3. Apply*

*Chapter: 01*

*Difficulty: Hard*

*Gradable: automatic*

*Section: 01.07*

*Subtopic: Bond formation and bond breaking*

*Subtopic: Drawing and interpretation*

*Subtopic: Formal charges*

*Subtopic: Resonance*

*Topic: Curved Arrows*

*Topic: Structure and Bonding*

**37. Which statement correctly describes the structures of BH3 and NH3?**

1. Both are trigonal and planar.
2. Both are pyramidal.
3. BH3 is trigonal planar and NH3 is trigonal pyramidal.
4. BH3 is trigonal pyramidal and NH3 is trigonal planar.

*Accessibility: Keyboard Navigation*

*Bloom's Level: 3. Apply*

*Chapter: 01*

*Difficulty: Hard*

*Gradable: automatic*

*Section: 01.09*

*Subtopic: VSEPR theory*

*Topic: Molecular Shape*

**38. Which one of the following is the conjugate acid of ethanol?**

1. CH3CH2O-
2. CH3CH2O+
3. CH3CH2OH2+
4. CH3CH2OH3+

*Accessibility: Keyboard Navigation*

*Bloom's Level: 2. Understand*

*Chapter: 01*

*Difficulty: Medium*

*Gradable: automatic*

*Section: 01.12*

*Subtopic: Acid/Base definitions*

*Topic: Acids and Bases*

**39. In the equilibrium below, the strongest base is: (pKa H2O = 15.7, pKa NH3 = 36)**



1. A
2. B
3. C
4. D

*Bloom's Level: 2. Understand*

*Chapter: 01*

*Difficulty: Medium*

*Gradable: automatic*

*Section: 01.14*

*Subtopic: Predicting acid/base reaction equilibrium*

*Topic: Acids and Bases*

**40. In the equilibrium below, the strongest acid is:**



1. A
2. B
3. C
4. D

*Bloom's Level: 2. Understand*

*Chapter: 01*

*Difficulty: Medium*

*Gradable: automatic*

*Section: 01.14*

*Subtopic: Factors affecting acid strength*

*Subtopic: Predicting acid/base reaction equilibrium*

*Topic: Acids and Bases*

**41. Which one of the following is the strongest base?**



1. A
2. B
3. C
4. D

*Bloom's Level: 2. Understand*

*Chapter: 01*

*Difficulty: Medium*

*Gradable: automatic*

*Section: 01.13*

*Subtopic: Factors affecting acid strength*

*Topic: Acids and Bases*

**42. Which one of the following mechanistically depicts the protonation of methanol by hydrogen bromide?**



1. A
2. B
3. C
4. D

*Bloom's Level: 2. Understand*

*Chapter: 01*

*Difficulty: Medium*

*Gradable: automatic*

*Section: 01.11*

*Subtopic: Curved arrow notation*

*Topic: Curved Arrows*

**43. Which one of the following is the strongest acid?**

1. FCH2CO2H
2. ClCH2CO2H
3. BrCH2CO2H
4. ICH2CO2H

*Accessibility: Keyboard Navigation*

*Bloom's Level: 4. Analyze*

*Chapter: 01*

*Difficulty: Hard*

*Gradable: automatic*

*Section: 01.13*

*Subtopic: Factors affecting acid strength*

*Topic: Acids and Bases*

**44. Which one of the following has the largest acid equilibrium constant, Ka?**

1. CH3CO2H
2. CH2ClCO2H
3. CHCl2CO2H
4. CCl3CO2H

*Accessibility: Keyboard Navigation*

*Bloom's Level: 4. Analyze*

*Chapter: 01*

*Difficulty: Hard*

*Gradable: automatic*

*Section: 01.13*

*Subtopic: Factors affecting acid strength*

*Subtopic: pKa*

*Topic: Acids and Bases*

**45. For which of the following does the equilibrium favor reactants?**



1. A
2. B
3. C
4. D

*Bloom's Level: 4. Analyze*

*Chapter: 01*

*Difficulty: Hard*

*Gradable: automatic*

*Section: 01.14*

*Subtopic: Predicting acid/base reaction equilibrium*

*Topic: Acids and Bases*

**46. Identify the resonance structure that results from the following "electron pair movements."**



1. A
2. B
3. C
4. D

*Bloom's Level: 3. Apply*

*Chapter: 01*

*Difficulty: Medium*

*Gradable: automatic*

*Section: 01.07*

*Subtopic: Resonance*

*Topic: Structure and Bonding*

**47. A Lewis structure of the azide ion, N3¯, is shown below. The formal charge on the middle nitrogen atom is:**



1. +2
2. +1
3. 0
4. -1

*Bloom's Level: 3. Apply*

*Chapter: 01*

*Difficulty: Medium*

*Gradable: automatic*

*Section: 01.05*

*Subtopic: Formal charges*

*Topic: Structure and Bonding*

**48. Identify the species that results from the following movement of electron pairs.**



1. A
2. B
3. C
4. D

*Bloom's Level: 3. Apply*

*Chapter: 01*

*Difficulty: Hard*

*Gradable: automatic*

*Section: 01.11*

*Subtopic: Bond formation and bond breaking*

*Subtopic: Curved arrow notation*

*Subtopic: Drawing and interpretation*

*Topic: Curved Arrows*

**49. The most stable resonance contributor of this would be:**



1. A
2. B
3. C
4. D

*Bloom's Level: 4. Analyze*

*Chapter: 01*

*Difficulty: Medium*

*Gradable: automatic*

*Section: 01.07*

*Subtopic: Resonance*

*Topic: Structure and Bonding*

**50. What is the molecular formula of aspirin?**



1. C6H4O4
2. C8H8O4
3. C9H8O4
4. C9H10O4

*Bloom's Level: 2. Understand*

*Chapter: 01*

*Difficulty: Medium*

*Gradable: automatic*

*Section: 01.06*

*Subtopic: Skeletal/bond-line structures*

*Topic: Drawing Organic Molecules*

**51. Which of the following is not identical to the others?**



1. A
2. B
3. C
4. D

*Bloom's Level: 2. Understand*

*Chapter: 01*

*Difficulty: Easy*

*Gradable: automatic*

*Section: 01.06*

*Subtopic: Skeletal/bond-line structures*

*Topic: Drawing Organic Molecules*

**52. Which of the line-bond structures below cannot represent a stable molecule?**



1. A
2. B
3. C
4. D

*Bloom's Level: 2. Understand*

*Chapter: 01*

*Difficulty: Medium*

*Gradable: automatic*

*Section: 01.06*

*Subtopic: Skeletal/bond-line structures*

*Topic: Drawing Organic Molecules*

**53. Which of the electron-movement arrows below are NOT valid?**



1. A
2. B
3. C
4. D

*Bloom's Level: 2. Understand*

*Chapter: 01*

*Difficulty: Medium*

*Gradable: automatic*

*Section: 01.07*

*Subtopic: Resonance*

*Topic: Structure and Bonding*

**54. What atom would have a formal charge in this structure?**



1. A
2. B
3. C
4. D

*Bloom's Level: 2. Understand*

*Chapter: 01*

*Difficulty: Medium*

*Gradable: automatic*

*Section: 01.05*

*Subtopic: Formal charges*

*Topic: Structure and Bonding*

**55. Rank the following in order of decreasing acidity. (more acidic > less acidic)**



1. I > IV > III > II
2. IV > I > II > III
3. III > II > I > IV
4. I > III > IV > II

*Bloom's Level: 4. Analyze*

*Chapter: 01*

*Difficulty: Hard*

*Gradable: automatic*

*Section: 01.13*

*Subtopic: Acid/Base definitions*

*Subtopic: Factors affecting acid strength*

*Topic: Acids and Bases*

**56. Using resonance principles, what atom is acid *first* protonated *in* the molecule shown?**



1. A
2. B
3. C
4. D

*Bloom's Level: 4. Analyze*

*Chapter: 01*

*Difficulty: Hard*

*Gradable: automatic*

*Section: 01.13*

*Subtopic: Acid/Base definitions*

*Subtopic: Factors affecting acid strength*

*Subtopic: Resonance*

*Topic: Acids and Bases*

*Topic: Structure and Bonding*

**57. What structure would result from these electron movement arrows?**



1. A
2. B
3. C
4. D

*Bloom's Level: 3. Apply*

*Chapter: 01*

*Difficulty: Medium*

*Gradable: automatic*

*Section: 01.07*

*Subtopic: Bond formation and bond breaking*

*Subtopic: Curved arrow notation*

*Subtopic: Drawing and interpretation*

*Topic: Curved Arrows*

**58. What would be the line-bond structure for (CH3)3CCH2CH(CH3)2?**



1. A
2. B
3. C
4. D

*Bloom's Level: 2. Understand*

*Chapter: 01*

*Difficulty: Medium*

*Gradable: automatic*

*Section: 01.06*

*Subtopic: Condensed formula*

*Subtopic: Skeletal/bond-line structures*

*Topic: Drawing Organic Molecules*

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