|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1. Which of the following represents the ground state electron configuration for a O2- ion?   |  |  |  | | --- | --- | --- | |  | a. | 1s22s22p4 | |  | b. | 1s22s22p2 | |  | c. | 1s22s22p6 | |  | d. | 2s22p4 |  |  |  | | --- | --- | | *ANSWER:* | c | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 2. How many valence electrons does a nitrogen atom contain?   |  |  |  | | --- | --- | --- | |  | a. | 2 | |  | b. | 3 | |  | c. | 5 | |  | d. | 7 |  |  |  | | --- | --- | | *ANSWER:* | c | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 3. How many valence electrons does an O2- ion contain?   |  |  |  | | --- | --- | --- | |  | a. | 2 | |  | b. | 6 | |  | c. | 8 | |  | d. | 10 |  |  |  | | --- | --- | | *ANSWER:* | c | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 4. What is the Lewis structure of a compound that has the formula of CCl3 and contains 24 valence electrons?   |  |  |  | | --- | --- | --- | |  | a. |  | |  | b. |  | |  | c. |  | |  | d. |  |  |  |  | | --- | --- | | *ANSWER:* | d | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 5. How many bonded and non-bonded electrons does a molecule with no formal charges and the formula C2H4O2 contain?   |  |  |  | | --- | --- | --- | |  | a. | 4 bonded, 4 non-bonded | |  | b. | 7 bonded. 4 non-bonded | |  | c. | 7 bonded, 5 non-bonded | |  | d. | 4 bonded, 7 non-bonded |  |  |  | | --- | --- | | *ANSWER:* | b | |

|  |
| --- |
| **Figure 1** |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 6. Referring to Figure 1, what is the formal charge of the oxygen atom at **I**?   |  |  |  | | --- | --- | --- | |  | a. | +1 | |  | b. | 0 | |  | c. | -1 | |  | d. | -2 |  |  |  | | --- | --- | | *ANSWER:* | b | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 7. Referring to Figure 1, what is the formal charge of the oxygen atom at **II**?   |  |  |  | | --- | --- | --- | |  | a. | +1 | |  | b. | 0 | |  | c. | -1 | |  | d. | -2 |  |  |  | | --- | --- | | *ANSWER:* | c | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 8. Referring to Figure 1, what is the formal charge of the oxygen atom at **III**?   |  |  |  | | --- | --- | --- | |  | a. | +1 | |  | b. | 0 | |  | c. | -1 | |  | d. | -2 |  |  |  | | --- | --- | | *ANSWER:* | a | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 9. What best represents a C-H bond in CH4?   |  |  |  | | --- | --- | --- | |  | a. | s-sp3 orbital overlap | |  | b. | sp3-sp3 orbital overlap | |  | c. | s-s orbital overlap | |  | d. | p-p orbital overlap |  |  |  | | --- | --- | | *ANSWER:* | a | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 10. What best represents the C-C bond in C2H6?   |  |  |  | | --- | --- | --- | |  | a. | s-sp3 orbital overlap | |  | b. | sp3-sp3 orbital overlap | |  | c. | s-s orbital overlap | |  | d. | p-p orbital overlap |  |  |  | | --- | --- | | *ANSWER:* | b | |

|  |
| --- |
| **Figure 2** The following questions refer to the structure of heroin (shown below). |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 11. Referring to Figure 2, what is the hybridization of the nitrogen atom?   |  |  |  | | --- | --- | --- | |  | a. | p | |  | b. | sp | |  | c. | sp2 | |  | d. | sp3 |  |  |  | | --- | --- | | *ANSWER:* | d | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 12. Referring to Figure 2, what is the geometry of the carbon atom shown at **I**?   |  |  |  | | --- | --- | --- | |  | a. | bent | |  | b. | trigonal planar | |  | c. | tetrahedral | |  | d. | trigonal pyramidal |  |  |  | | --- | --- | | *ANSWER:* | b | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 13. Referring to Figure 2, what is the geometry of the carbon atom shown at **II**?   |  |  |  | | --- | --- | --- | |  | a. | bent | |  | b. | trigonal planar | |  | c. | tetrahedral | |  | d. | trigonal pyramidal |  |  |  | | --- | --- | | *ANSWER:* | c | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 14. Referring to Figure 2, what is the hybridization of the carbon atom at **I**?   |  |  |  | | --- | --- | --- | |  | a. | p | |  | b. | sp | |  | c. | sp2 | |  | d. | sp3 |  |  |  | | --- | --- | | *ANSWER:* | c | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 15. Referring to Figure 2, what is the hybridization of the carbon atom at **II**?   |  |  |  | | --- | --- | --- | |  | a. | p | |  | b. | sp | |  | c. | sp2 | |  | d. | sp3 |  |  |  | | --- | --- | | *ANSWER:* | d | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 16. Which element or ion has the following electron configuration: 1s22s22p63s23s4?   |  |  |  | | --- | --- | --- | |  | a. | S | |  | b. | O | |  | c. | Ar | |  | d. | Si |  |  |  | | --- | --- | | *ANSWER:* | a | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 17. How many orientations exist for a *s* orbital?   |  |  |  | | --- | --- | --- | |  | a. | 1 | |  | b. | 2 | |  | c. | 3 | |  | d. | 4 |  |  |  | | --- | --- | | *ANSWER:* | a | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 18. How many orientations exist for a *p* orbital?   |  |  |  | | --- | --- | --- | |  | a. | 1 | |  | b. | 2 | |  | c. | 3 | |  | d. | 4 |  |  |  | | --- | --- | | *ANSWER:* | c | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 19. How many orientations exist for a sp3 orbital?   |  |  |  | | --- | --- | --- | |  | a. | 1 | |  | b. | 2 | |  | c. | 3 | |  | d. | 4 |  |  |  | | --- | --- | | *ANSWER:* | d | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 20. How many orientations exist for an sp orbital?   |  |  |  | | --- | --- | --- | |  | a. | 1 | |  | b. | 2 | |  | c. | 3 | |  | d. | 4 |  |  |  | | --- | --- | | *ANSWER:* | b | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 21. What is the geometry around an sp2 hybridized carbon?   |  |  |  | | --- | --- | --- | |  | a. | linear | |  | b. | trigonal planar | |  | c. | tetrahedral | |  | d. | trigonal pyramidal |  |  |  | | --- | --- | | *ANSWER:* | b | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 22. What is the geometry around an sp hybridized carbon?   |  |  |  | | --- | --- | --- | |  | a. | linear | |  | b. | trigonal planar | |  | c. | tetrahedral | |  | d. | trigonal pyramidal |  |  |  | | --- | --- | | *ANSWER:* | a | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 23. How many bonds does oxygen make while remaining neutral?   |  |  |  | | --- | --- | --- | |  | a. | 1 | |  | b. | 2 | |  | c. | 3 | |  | d. | 4 |  |  |  | | --- | --- | | *ANSWER:* | b | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 24. How many hydrogens does the following line structure contain?   |  |  |  | | --- | --- | --- | |  | a. | 1 | |  | b. | 10 | |  | c. | 19 | |  | d. | 26 |  |  |  | | --- | --- | | *ANSWER:* | c | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 25. Which of the following best describes a ó\* orbital?   |  |  |  | | --- | --- | --- | |  | a. | It is a bonding orbital with zero nodes. | |  | b. | It is an anti-bonding orbital with zero nodes. | |  | c. | It is a bonding orbital with one node. | |  | d. | It is an anti-bonding orbital with one node. |  |  |  | | --- | --- | | *ANSWER:* | d | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 26. What can be said about the carbon atom at **I**?   |  |  |  | | --- | --- | --- | |  | a. | It is sp2 hybridized and pointed out of the page. | |  | b. | It is sp2 hybridized and pointed into the page. | |  | c. | It is sp3 hybridized and pointed out of the page. | |  | d. | It is sp3 hybridized and pointed into the page. |  |  |  | | --- | --- | | *ANSWER:* | a | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 27. Which of the following molecules is represented in condensed structure?   |  |  |  | | --- | --- | --- | |  | a. |  | |  | b. |  | |  | c. | CH3CH2COCH3 | |  | d. |  |  |  |  | | --- | --- | | *ANSWER:* | c | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 28. What best describes a wedged bond?   |  |  |  | | --- | --- | --- | |  | a. | It looks like   and represents going into the page. | |  | b. | It looks like   and represents going out of the page. | |  | c. | It looks like   and represents going into the page. | |  | d. | It looks like   and represents going out of the page. |  |  |  | | --- | --- | | *ANSWER:* | d | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 29. What best represents the hydroxyl group in the molecule shown below?   |  |  |  | | --- | --- | --- | |  | a. | It is sp hybridized and pointed out of the page. | |  | b. | It is sp hybridized and pointed into the page. | |  | c. | It is sp3 hybridized and pointed out of the page. | |  | d. | It is sp3 hybridized and pointed into the page. |  |  |  | | --- | --- | | *ANSWER:* | c | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 30. Which of the following best describes a ð orbital?   |  |  |  | | --- | --- | --- | |  | a. | It is a bonding orbital with zero nodes. | |  | b. | It is an anti-bonding orbital with zero nodes. | |  | c. | It is a bonding orbital with one node. | |  | d. | It is an anti-bonding orbital with one node. |  |  |  | | --- | --- | | *ANSWER:* | c | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 31. What are the orbital angles around an sp2 hybridized atom?   |  |  |  | | --- | --- | --- | |  | a. | 180º | |  | b. | 120º | |  | c. | 109.5º | |  | d. | 90º |  |  |  | | --- | --- | | *ANSWER:* | b | |

|  |
| --- |
| **Figure 3** The following questions refer to the molecule drawn below. |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 32. Referring to Figure 3, how many hydrogen atoms are contained in the molecule shown?   |  |  |  | | --- | --- | --- | |  | a. | 16 | |  | b. | 19 | |  | c. | 21 | |  | d. | 26 |  |  |  | | --- | --- | | *ANSWER:* | c | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 33. Referring to Figure 3, how many sp2 atoms are contained in the molecule shown?   |  |  |  | | --- | --- | --- | |  | a. | 6 | |  | b. | 7 | |  | c. | 8 | |  | d. | 9 |  |  |  | | --- | --- | | *ANSWER:* | d | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 34. Referring to Figure 3, how many sp3 atoms are contained in the molecule shown?   |  |  |  | | --- | --- | --- | |  | a. | 9 | |  | b. | 10 | |  | c. | 11 | |  | d. | 12 |  |  |  | | --- | --- | | *ANSWER:* | c | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 35. Referring to Figure 3, what is the hybridization of the carbon atom at **I**?   |  |  |  | | --- | --- | --- | |  | a. | s | |  | b. | sp | |  | c. | sp2 | |  | d. | sp3 |  |  |  | | --- | --- | | *ANSWER:* | d | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 36. Referring to Figure 3, what best represents the hydroxyl group?   |  |  |  | | --- | --- | --- | |  | a. | It is sp hybridized and pointed out of the page. | |  | b. | It is sp hybridized and pointed into the page. | |  | c. | It is sp3 hybridized and pointed out of the page. | |  | d. | It is sp3 hybridized and pointed into the page. |  |  |  | | --- | --- | | *ANSWER:* | d | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 37. Referring to Figure 3, what is the orbital geometry of the carbon atom at **II**?   |  |  |  | | --- | --- | --- | |  | a. | trigonal planar | |  | b. | trigonal pyramidal | |  | c. | tetrahedral | |  | d. | trigonal bipyramidal |  |  |  | | --- | --- | | *ANSWER:* | b | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 38. Referring to Figure 3, what is the hybridization of the carbon atom at **II**?   |  |  |  | | --- | --- | --- | |  | a. | s | |  | b. | sp | |  | c. | sp2 | |  | d. | sp3 |  |  |  | | --- | --- | | *ANSWER:* | c | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 39. Referring to Figure 3, what is the orbital geometry of the carbon atom at **I**?   |  |  |  | | --- | --- | --- | |  | a. | trigonal planar | |  | b. | trigonal pyramidal | |  | c. | tetrahedral | |  | d. | trigonal bipyramidal |  |  |  | | --- | --- | | *ANSWER:* | c | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 40. Which of the labelled carbons in the molecule shown below is the most electron rich?   |  |  |  | | --- | --- | --- | |  | a. | **I** | |  | b. | **II** | |  | c. | **III** | |  | d. | **IV** |  |  |  | | --- | --- | | *ANSWER:* | b | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 41. Which of the labelled carbons in the molecule shown below is the most electron rich and which is the most electron deficient?   |  |  |  | | --- | --- | --- | |  | a. | **I** is the most electron rich; **II** is the most electron deficient. | |  | b. | **II** is the most electron rich; **I** is the most electron deficient. | |  | c. | **I** is the most electron rich; **III** is the most electron deficient. | |  | d. | **III** is the most electron rich; **I** is the most electron deficient. |  |  |  | | --- | --- | | *ANSWER:* | b | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 42. Which of the following structures is **NOT** breaking the octet rule?   |  |  |  | | --- | --- | --- | |  | a. | BF3 | |  | b. | CCl3+ | |  | c. | H3O+ | |  | d. | PO43- |  |  |  | | --- | --- | | *ANSWER:* | c | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 43. Which of the labelled carbons in the molecule shown below is the most electron deficient?   |  |  |  | | --- | --- | --- | |  | a. | **I** | |  | b. | **II** | |  | c. | **III** | |  | d. | **IV** |  |  |  | | --- | --- | | *ANSWER:* | a | |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 44. sp3 hybridization is the merging of an *s* orbital with two *p* orbitals.   |  |  |  | | --- | --- | --- | |  | a. | True | |  | b. | False |  |  |  | | --- | --- | | *ANSWER:* | False | |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 45. Electrons in ó bonds can be delocalized.   |  |  |  | | --- | --- | --- | |  | a. | True | |  | b. | False |  |  |  | | --- | --- | | *ANSWER:* | False | |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 46. Electronegativity is used to determine the polarity of a bond.   |  |  |  | | --- | --- | --- | |  | a. | True | |  | b. | False |  |  |  | | --- | --- | | *ANSWER:* | True | |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 47. A carbanion contains a carbon atom with a formal negative charge.   |  |  |  | | --- | --- | --- | |  | a. | True | |  | b. | False |  |  |  | | --- | --- | | *ANSWER:* | True | |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 48. Carbocations break the octet rule.   |  |  |  | | --- | --- | --- | |  | a. | True | |  | b. | False |  |  |  | | --- | --- | | *ANSWER:* | True | |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 49. In a O-H bond, the electron density is skewed towards the hydrogen atom.   |  |  |  | | --- | --- | --- | |  | a. | True | |  | b. | False |  |  |  | | --- | --- | | *ANSWER:* | False | |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 50. A carbon atom with two ð bonds and two ó bonds is sp2 hybridized.   |  |  |  | | --- | --- | --- | |  | a. | True | |  | b. | False |  |  |  | | --- | --- | | *ANSWER:* | False | |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 51. Resonance structures contain delocalized electrons.   |  |  |  | | --- | --- | --- | |  | a. | True | |  | b. | False |  |  |  | | --- | --- | | *ANSWER:* | True | |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 52. Anti-bonding orbitals are lower in energy than bonding orbitals.   |  |  |  | | --- | --- | --- | |  | a. | True | |  | b. | False |  |  |  | | --- | --- | | *ANSWER:* | False | |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 53. ó\* represents an anti-bonding molecular orbital.   |  |  |  | | --- | --- | --- | |  | a. | True | |  | b. | False |  |  |  | | --- | --- | | *ANSWER:* | True | |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 54. According to molecular orbital theory, all bonds contain a bonding and an anti-bonding orbital.   |  |  |  | | --- | --- | --- | |  | a. | True | |  | b. | False |  |  |  | | --- | --- | | *ANSWER:* | True | |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 55. A ó molecular orbital contains out-of-phase overlap of atomic orbitals.   |  |  |  | | --- | --- | --- | |  | a. | True | |  | b. | False |  |  |  | | --- | --- | | *ANSWER:* | False | |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 56. To form a ó bond, two atomic orbitals overlap to form a single molecular orbital.   |  |  |  | | --- | --- | --- | |  | a. | True | |  | b. | False |  |  |  | | --- | --- | | *ANSWER:* | False | |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 57. Only filled molecular orbitals contribute to bonding.   |  |  |  | | --- | --- | --- | |  | a. | True | |  | b. | False |  |  |  | | --- | --- | | *ANSWER:* | True | |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 58. An sp2 hybridized atom has a trigonal pyramidal geometry.   |  |  |  | | --- | --- | --- | |  | a. | True | |  | b. | False |  |  |  | | --- | --- | | *ANSWER:* | False | |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 59. An sp3 hybridized atom has a tetrahedral geometry.   |  |  |  | | --- | --- | --- | |  | a. | True | |  | b. | False |  |  |  | | --- | --- | | *ANSWER:* | True | |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 60. The resonance hybrid is the most stable resonance form of a compound.   |  |  |  | | --- | --- | --- | |  | a. | True | |  | b. | False |  |  |  | | --- | --- | | *ANSWER:* | False | |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 61. Resonance requires atoms with neighbouring aligned p orbitals.   |  |  |  | | --- | --- | --- | |  | a. | True | |  | b. | False |  |  |  | | --- | --- | | *ANSWER:* | True | |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 62. Hybridized orbitals are capable of resonance.   |  |  |  | | --- | --- | --- | |  | a. | True | |  | b. | False |  |  |  | | --- | --- | | *ANSWER:* | False | |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 63. Triple bonds are not capable of contributing to resonance.   |  |  |  | | --- | --- | --- | |  | a. | True | |  | b. | False |  |  |  | | --- | --- | | *ANSWER:* | False | |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 64. A triple bond contains three ð bonds.   |  |  |  | | --- | --- | --- | |  | a. | True | |  | b. | False |  |  |  | | --- | --- | | *ANSWER:* | False | |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 65. Empty p orbitals are incapable of contributing to resonance structures.   |  |  |  | | --- | --- | --- | |  | a. | True | |  | b. | False |  |  |  | | --- | --- | | *ANSWER:* | False | |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 66. The two ð bonds in an triple bond are 180º from each other.   |  |  |  | | --- | --- | --- | |  | a. | True | |  | b. | False |  |  |  | | --- | --- | | *ANSWER:* | False | |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 67. Only carbon atoms can hybridize.   |  |  |  | | --- | --- | --- | |  | a. | True | |  | b. | False |  |  |  | | --- | --- | | *ANSWER:* | False | |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 68. Anti-bonding orbitals involve out of plane overlap of atomic orbitals   |  |  |  | | --- | --- | --- | |  | a. | True | |  | b. | False |  |  |  | | --- | --- | | *ANSWER:* | True | |

|  |  |  |
| --- | --- | --- |
| 69. An sp2 hybridized carbon has an orbital geometry of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ .   |  |  | | --- | --- | | *ANSWER:* | trigonal planar | |

|  |  |  |
| --- | --- | --- |
| 70. An sp hybridized carbon has an orbital geometry of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ .   |  |  | | --- | --- | | *ANSWER:* | linear | |

|  |  |  |
| --- | --- | --- |
| 71. Electrons shared among atoms are said to be \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ .   |  |  | | --- | --- | | *ANSWER:* | delocalized | |

|  |  |  |
| --- | --- | --- |
| 72. Overlap of p orbitals is known as a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ bond.   |  |  | | --- | --- | | *ANSWER:* | ð | |

|  |  |  |
| --- | --- | --- |
| 73. A carbocation with three ó bonds is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ hybridized.   |  |  | | --- | --- | | *ANSWER:* | sp2 | |

|  |  |  |
| --- | --- | --- |
| 74. A carbocation with three ó bonds has a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ geometry.   |  |  | | --- | --- | | *ANSWER:* | trigonal planar | |

|  |  |  |
| --- | --- | --- |
| 75. A carbon atom with two ð bonds and two ó bonds is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ hybridized.   |  |  | | --- | --- | | *ANSWER:* | sp | |

|  |  |  |
| --- | --- | --- |
| 76. The combined form of all resonance structures is referred to as the\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.   |  |  | | --- | --- | | *ANSWER:* | resonance hybrid | |

|  |  |  |
| --- | --- | --- |
| 77. An sp hybridized atom has a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ angle between each electron group.   |  |  | | --- | --- | | *ANSWER:* | 180º | |

|  |  |  |
| --- | --- | --- |
| 78. A Nitrogen atom with four ó bonds has a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ formal charge.   |  |  | | --- | --- | | *ANSWER:* | +1 | |

|  |  |  |
| --- | --- | --- |
| 79. Assign non-zero formal charges to the following molecule.   |  |  | | --- | --- | | *ANSWER:* | The charges are as follows: | |

|  |  |  |
| --- | --- | --- |
| 80. Assign non-zero formal charges and the hybridization to all atoms that are not hydrogen in the following molecule.   |  |  | | --- | --- | | *ANSWER:* | The charges and hybridizations are as follows: | |

|  |  |  |
| --- | --- | --- |
| 81. Assign the electron pair geometry and hybridization around each non-hydrogen atom in the following molecule, shown below.   |  |  | | --- | --- | | *ANSWER:* | From left to right Nitrogen-Linear, sp Carbon – Linear, sp Carbon – Trigonal planar, sp2 Oxygen – Trigonal planar sp2 Carbon – tetrahedral, sp3 | |

|  |  |  |
| --- | --- | --- |
| 82. Draw the following molecule in zig-zag format: CH3(CH2)3CH(CH3)COCH2COOH   |  |  | | --- | --- | | *ANSWER:* | The structure is as follows | |

|  |  |  |
| --- | --- | --- |
| 83. Identify the electron pair geometry and hybridization of every carbon atom in the following structure. Draw a resonance structure and the resonance hybrid of the following structure.   |  |  | | --- | --- | | *ANSWER:* | From left to right: Carbon – Trigonal planar, sp2 Carbon – Trigonal planar sp2 Carbon – Trigonal planar sp2 Carbon – tetrahedral, sp3 Resonance structure =  Resonance hybrid = | |

|  |  |  |
| --- | --- | --- |
| 84. How many atoms share delocalized orbitals with the positively charged carbon, shown below. Explain your answer.   |  |  | | --- | --- | | *ANSWER:* | In order for delocalization to occur, neighbouring atoms must contain p orbitals that are aligned with each other. All four carbon atoms contain p orbitals. However, only the three right-most carbon p orbitals are in line with each other. The left-most ð bond is 90º out of plane with the carbocation p orbital. | |