|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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 |

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|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 45. Electrons in ó bonds can be delocalized.

|  |  |  |
| --- | --- | --- |
|   | a.  | True |
|   | b.  | False |

|  |  |
| --- | --- |
| *ANSWER:* | False |

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|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 46. Electronegativity is used to determine the polarity of a bond.

|  |  |  |
| --- | --- | --- |
|   | a.  | True |
|   | b.  | False |

|  |  |
| --- | --- |
| *ANSWER:* | True |

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|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 47. A carbanion contains a carbon atom with a formal negative charge.

|  |  |  |
| --- | --- | --- |
|   | a.  | True |
|   | b.  | False |

|  |  |
| --- | --- |
| *ANSWER:* | True |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 48. Carbocations break the octet rule.

|  |  |  |
| --- | --- | --- |
|   | a.  | True |
|   | b.  | False |

|  |  |
| --- | --- |
| *ANSWER:* | True |

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|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 49. In a O-H bond, the electron density is skewed towards the hydrogen atom.

|  |  |  |
| --- | --- | --- |
|   | a.  | True |
|   | b.  | False |

|  |  |
| --- | --- |
| *ANSWER:* | False |

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|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 50. A carbon atom with two ð bonds and two ó bonds is sp2 hybridized.

|  |  |  |
| --- | --- | --- |
|   | a.  | True |
|   | b.  | False |

|  |  |
| --- | --- |
| *ANSWER:* | False |

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|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 51. Resonance structures contain delocalized electrons.

|  |  |  |
| --- | --- | --- |
|   | a.  | True |
|   | b.  | False |

|  |  |
| --- | --- |
| *ANSWER:* | True |

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|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 52. Anti-bonding orbitals are lower in energy than bonding orbitals.

|  |  |  |
| --- | --- | --- |
|   | a.  | True |
|   | b.  | False |

|  |  |
| --- | --- |
| *ANSWER:* | False |

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|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 53. ó\* represents an anti-bonding molecular orbital.

|  |  |  |
| --- | --- | --- |
|   | a.  | True |
|   | b.  | False |

|  |  |
| --- | --- |
| *ANSWER:* | True |

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|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 54. According to molecular orbital theory, all bonds contain a bonding and an anti-bonding orbital.

|  |  |  |
| --- | --- | --- |
|   | a.  | True |
|   | b.  | False |

|  |  |
| --- | --- |
| *ANSWER:* | True |

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|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 55. A ó molecular orbital contains out-of-phase overlap of atomic orbitals.

|  |  |  |
| --- | --- | --- |
|   | a.  | True |
|   | b.  | False |

|  |  |
| --- | --- |
| *ANSWER:* | False |

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|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 56. To form a ó bond, two atomic orbitals overlap to form a single molecular orbital.

|  |  |  |
| --- | --- | --- |
|   | a.  | True |
|   | b.  | False |

|  |  |
| --- | --- |
| *ANSWER:* | False |

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|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 57. Only filled molecular orbitals contribute to bonding.

|  |  |  |
| --- | --- | --- |
|   | a.  | True |
|   | b.  | False |

|  |  |
| --- | --- |
| *ANSWER:* | True |

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|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 58. An sp2 hybridized atom has a trigonal pyramidal geometry.

|  |  |  |
| --- | --- | --- |
|   | a.  | True |
|   | b.  | False |

|  |  |
| --- | --- |
| *ANSWER:* | False |

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|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 59. An sp3 hybridized atom has a tetrahedral geometry.

|  |  |  |
| --- | --- | --- |
|   | a.  | True |
|   | b.  | False |

|  |  |
| --- | --- |
| *ANSWER:* | True |

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|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 60. The resonance hybrid is the most stable resonance form of a compound.

|  |  |  |
| --- | --- | --- |
|   | a.  | True |
|   | b.  | False |

|  |  |
| --- | --- |
| *ANSWER:* | False |

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|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 61. Resonance requires atoms with neighbouring aligned p orbitals.

|  |  |  |
| --- | --- | --- |
|   | a.  | True |
|   | b.  | False |

|  |  |
| --- | --- |
| *ANSWER:* | True |

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|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 62. Hybridized orbitals are capable of resonance.

|  |  |  |
| --- | --- | --- |
|   | a.  | True |
|   | b.  | False |

|  |  |
| --- | --- |
| *ANSWER:* | False |

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|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 63. Triple bonds are not capable of contributing to resonance.

|  |  |  |
| --- | --- | --- |
|   | a.  | True |
|   | b.  | False |

|  |  |
| --- | --- |
| *ANSWER:* | False |

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|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 64. A triple bond contains three ð bonds.

|  |  |  |
| --- | --- | --- |
|   | a.  | True |
|   | b.  | False |

|  |  |
| --- | --- |
| *ANSWER:* | False |

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|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 65. Empty p orbitals are incapable of contributing to resonance structures.

|  |  |  |
| --- | --- | --- |
|   | a.  | True |
|   | b.  | False |

|  |  |
| --- | --- |
| *ANSWER:* | False |

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|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 66. The two ð bonds in an triple bond are 180º from each other.

|  |  |  |
| --- | --- | --- |
|   | a.  | True |
|   | b.  | False |

|  |  |
| --- | --- |
| *ANSWER:* | False |

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|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 67. Only carbon atoms can hybridize.

|  |  |  |
| --- | --- | --- |
|   | a.  | True |
|   | b.  | False |

|  |  |
| --- | --- |
| *ANSWER:* | False |

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|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 68. Anti-bonding orbitals involve out of plane overlap of atomic orbitals

|  |  |  |
| --- | --- | --- |
|   | a.  | True |
|   | b.  | False |

|  |  |
| --- | --- |
| *ANSWER:* | True |

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|  |  |  |
| --- | --- | --- |
| 69. An sp2 hybridized carbon has an orbital geometry of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ .

|  |  |
| --- | --- |
| *ANSWER:* | trigonal planar |

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|  |  |  |
| --- | --- | --- |
| 70. An sp hybridized carbon has an orbital geometry of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ .

|  |  |
| --- | --- |
| *ANSWER:* | linear |

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|  |  |  |
| --- | --- | --- |
| 71. Electrons shared among atoms are said to be \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ .

|  |  |
| --- | --- |
| *ANSWER:* | delocalized |

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|  |  |  |
| --- | --- | --- |
| 72. Overlap of p orbitals is known as a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ bond.

|  |  |
| --- | --- |
| *ANSWER:* | ð |

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|  |  |  |
| --- | --- | --- |
| 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 |

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|  |  |  |
| --- | --- | --- |
| 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 rightNitrogen-Linear, spCarbon – Linear, spCarbon – Trigonal planar, sp2Oxygen – Trigonal planar sp2Carbon – 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, sp2Carbon – Trigonal planar sp2Carbon – Trigonal planar sp2Carbon – tetrahedral, sp3Resonance 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. |

 |