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| 1. How many total valence electrons are represented in the following electron configuration?  1*s*22*s*22*px*2 2*py*2 2*pz*1 or 1*s*22*s*22*p*5   |  |  |  | | --- | --- | --- | |  | a. | 1 | |  | b. | 3 | |  | c. | 5 | |  | d. | 7 | |  | e. | 9 |  |  |  | | --- | --- | | *ANSWER:* | d | |

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| **Instructions:** Write valid Lewis (electron-dot) structures for each formula below. Show all electrons as dots and show all nonbonding electrons. |

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| 2. Write:  CH3CH2OH ethanol   |  |  | | --- | --- | | *ANSWER:* |  | |

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| 3. The structure of urea is shown below. Fill in any nonbonding valence electrons that are missing from the line-bond structure.   |  |  | | --- | --- | | *ANSWER:* |  | |

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| **Instructions:** Determine the hybridization for the indicated atoms in each structure below. |

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| 4. Refer to instructions. The hybridization of carbon atom A is \_\_\_\_\_.   |  |  | | --- | --- | | *ANSWER:* | *sp*2 | |

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| 5. Refer to instructions. The hybridization of carbon atom B is \_\_\_\_\_.   |  |  | | --- | --- | | *ANSWER:* | *sp* | |

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| 6. How many nonbonding electron pairs are in the structure shown below?   |  |  |  | | --- | --- | --- | |  | a. | 2 | |  | b. | 4 | |  | c. | 6 | |  | d. | 8 | |  | e. | none of these |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 7. The molecular formula C2H4O can be converted into three-line bond (Kekulé) structures that are consistent with valence rules. Which one of the following Kekulé structures is ***not*** consistent with valence rules?   |  |  |  | | --- | --- | --- | |  | a. |  | |  | b. |  | |  | c. |  | |  | d. |  |  |  |  | | --- | --- | | *ANSWER:* | d | |

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| **Instructions:** Propose a structure for a molecule that meets the following description. |

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| 8. Refer to instructions. Contains only two *sp*3 hybridized carbons and two *sp* hybridized carbons.   |  |  | | --- | --- | | *ANSWER:* |  | |

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| 9. Refer to instructions. Contains only one *sp*3 hybridized carbon and two *sp*2 hybridized carbons.   |  |  | | --- | --- | | *ANSWER:* |  | |

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| 10. Consider the formation of an *sp*2 hybrid orbital. Which of the following is true?   |  |  |  | | --- | --- | --- | |  | a. | Four equivalent hybrid orbitals are produced. | |  | b. | One *s* and one *p* atomic orbital are involved. | |  | c. | One *p* atomic orbital remains unhybridized. | |  | d. | The hybrid orbitals produced can form π bonds. | |  | e. | none of these |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 11. According to atomic theory:   |  |  |  | | --- | --- | --- | |  | a. | the nucleus is positively charged. | |  | b. | the nucleus contains both charged and uncharged particles. | |  | c. | the electrons contribute very little to the total mass of the atom. | |  | d. | the electrons are located in the atomic space outside the nucleus. | |  | e. | all of these |  |  |  | | --- | --- | | *ANSWER:* | e | |

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| 12. In drawing the Lewis structure for an organic compound, the carbon atoms should always be shown with   |  |  |  | | --- | --- | --- | |  | a. | lone pairs of electrons. | |  | b. | four single bonds. | |  | c. | eight total electrons. | |  | d. | a positive charge. | |  | e. | none of these |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 13. Covalent bonding   |  |  |  | | --- | --- | --- | |  | a. | involves a transfer of electrons from one atom to another. | |  | b. | occurs when atoms share all their valence electrons. | |  | c. | occurs when unpaired valence electrons are shared between atoms. | |  | d. | occurs when nonvalence electrons are shared between atoms. | |  | e. | none of these |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 14. Which of the following best represents the shape of a 2*p* atomic orbital of carbon?   |  |  | | --- | --- | | A |  | | B |  | | C |  | | D |  |  |  |  |  | | --- | --- | --- | |  | a. | A | |  | b. | B | |  | c. | C | |  | d. | D |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 15. Which of the following best represents the shape of a *sp*3 hybrid orbital of carbon?   |  |  | | --- | --- | | A |  | | B |  | | C |  | | D |  |  |  |  |  | | --- | --- | --- | |  | a. | A | |  | b. | B | |  | c. | C | |  | d. | D |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 16. How many electrons are there in the valence shell of the carbon atom of a methyl anion, CH3−?   |  |  |  | | --- | --- | --- | |  | a. | 5 | |  | b. | 6 | |  | c. | 7 | |  | d. | 8 |  |  |  | | --- | --- | | *ANSWER:* | d | |

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| 17. Which of the following statements is **not** true?   |  |  |  | | --- | --- | --- | |  | a. | The carbon−carbon single bond of an alkane is weaker than the carbon−carbon triple bond of an alkyne. | |  | b. | The carbon−carbon triple bond of an alkyne is shorter than the carbon−carbon double bond of an alkene. | |  | c. | The carbon−carbon triple bond of an alkyne is exactly three times as strong as a carbon−carbon single bond of an alkane. | |  | d. | The carbon−carbon single bond of an alkane is longer than the carbon−carbon triple bond of an alkyne. |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 18. Draw all the lone pairs (nonbonding valence electrons) on the structure of phosgene, a poisonous gas once used as a chemical warfare agent.   |  |  | | --- | --- | | *ANSWER:* |  | |

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| 19. Specify the hybridization of each carbon atom of limonene, a natural product present in citrus fruits, and thujone, which is derived from wormwood, a traditional component of the notorious liquor, Absinthe.   |  |  | | --- | --- | |  |  | | limonene | thujone |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | *ANSWER:* | |  |  | | --- | --- | |  |  | | limonene | thujone | | |

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| 20. Convert the skeletal drawing of the pharmaceutical Vioxx into a molecular formula.   |  |  | | --- | --- | | *ANSWER:* | C17H14O4S | |

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| 21. Draw a picture showing the orbitals involved in the π-bonds of cyclopenta-1,3-diene, a commonly encountered reagent in organic synthesis.   |  |  | | --- | --- | | *ANSWER:* |  | |

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| 22. Draw all possible structures of CFnClm where n and m vary from 0 to 4.   |  |  | | --- | --- | | *ANSWER:* |  | |

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| 23. Draw two possible isomers of C6H6 in which all the carbon atoms are *sp*2 hybridized.   |  |  | | --- | --- | | *ANSWER:* |  | |

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| 24. Draw the structure for CCl2F2 using solid, wedged, and dashed lines to show the tetrahedral geometry.   |  |  | | --- | --- | | *ANSWER:* |  | |

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| **Instructions:** Consider the two structures below to answer the following question.  CH3CH2OH CH3OCH3 |

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| 25. Refer to instructions. Which of the following correctly describes the structure of these compounds?   |  |  |  | | --- | --- | --- | |  | a. | All carbon atoms are *sp*3 hybridized. | |  | b. | All of the bonds are sigma bonds. | |  | c. | Each oxygen atom has two nonbonding pairs of electrons. | |  | d. | The bond angle around each oxygen atom is ideally about 109.5°. | |  | e. | All of these |  |  |  | | --- | --- | | *ANSWER:* | e | |

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| 26. What is the expected hybridization around the sulfur atom in diethyl sulfide?  CH3CH2⎯S⎯CH2CH3   |  |  |  | | --- | --- | --- | |  | a. | *sp* | |  | b. | *sp*2 | |  | c. | *sp*3 | |  | d. | The sulfur atom is not hybridized. |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 27. Which of the following statements is **not** true according to molecular orbital (MO) theory?   |  |  |  | | --- | --- | --- | |  | a. | Antibonding orbitals are higher in energy than the corresponding bonding orbital. | |  | b. | The head-on overlap of an *s* and a *p* atomic orbital can produce a σ molecular orbital. | |  | c. | A π molecular orbital forms only from the combination of *p* atomic orbital wave functions. | |  | d. | The subtractive combination of atomic orbital wave functions produces a bonding molecular orbital. |  |  |  | | --- | --- | | *ANSWER:* | d | |

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| 28. The molecular orbital shown below is most likely of what type?   |  |  |  | | --- | --- | --- | |  | a. | σ bonding | |  | b. | σ antibonding | |  | c. | π bonding | |  | d. | π antibonding |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 29. In the two structures shown below, what do the positions labeled with the arrow have in common?   |  |  |  | | --- | --- | --- | |  | a. | the same type of hybridization on the carbon atom | |  | b. | the same geometry around the carbon atom | |  | c. | the same number of hydrogen atoms bonded to the carbon atom | |  | d. | both carbon atoms are involved in a π bond |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 30. The following species forms during an organic reaction.    What is the formal charge on the carbon atom indicated by the arrow?   |  |  |  | | --- | --- | --- | |  | a. | 0 | |  | b. | +1 | |  | c. | −1 | |  | d. | +2 | |  | e. | −2 |  |  |  | | --- | --- | | *ANSWER:* | b | |