Chapter 01 - Structure and Bonding

1. How many total valence electrons are represented in the following electron configuration?

$1s^2 2s^2 2p_x^2\ 2p_y^2\ 2p_z^1$ or $1s^2 2s^2 2p^5$

a. 1
b. 3
c. 5
d. 7
e. 9

ANSWER: d
POINTS: 1

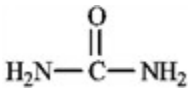
Instructions: Write valid Lewis (electron-dot) structures for each formula below. Show all electrons as dots and show all nonbonding electrons.

2. Write:

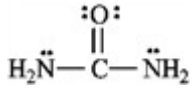
CH_3CH_2OH ethanol
ANSWER:

POINTS: 1

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

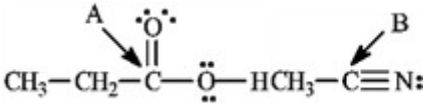


ANSWER:



POINTS: 1

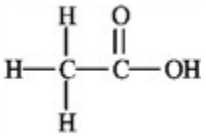
Instructions: Determine the hybridization for the indicated atoms in each structure below.



4. Refer to instructions. The hybridization of carbon atom A is _____.
ANSWER: sp^2
POINTS: 1

5. Refer to instructions. The hybridization of carbon atom B is _____.
ANSWER: *sp*
POINTS: 1

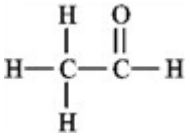
6. How many nonbonding electron pairs are in the structure shown below?

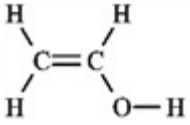


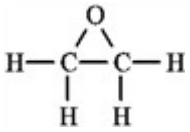
a. 2
b. 4
c. 6
d. 8
e. none of these

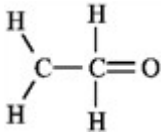
ANSWER: b
POINTS: 1

7. The molecular formula C_2H_4O 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. 

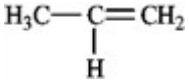
c. 

d. 

ANSWER: d
POINTS: 1

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

8. Refer to instructions. Contains only two sp^3 hybridized carbons and two *sp* hybridized carbons.
ANSWER: $CH_3—C\equiv C—CH_3$ or $CH_3—CH_2—C\equiv CH$
POINTS: 1

9. Refer to instructions. Contains only one sp^3 hybridized carbon and two sp^2 hybridized carbons.
ANSWER: 
POINTS: 1

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
POINTS: 1

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
POINTS: 1

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
POINTS: 1

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
POINTS: 1

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
POINTS: 1

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
POINTS: 1

16. How many electrons are there in the valence shell of the carbon atom of a methyl anion, CH_3^-?

a. 5
b. 6
c. 7
d. 8

ANSWER: d
POINTS: 1

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.

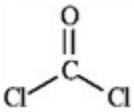
c. The carbon−carbon triple bond of an alkyne is exactly three times as strong as a carbon−carbon single bond of an alkane.

d. The carbon−carbon single bond of an alkane is longer than the carbon−carbon triple bond of an alkyne.

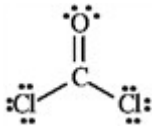
ANSWER: c

POINTS: 1

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

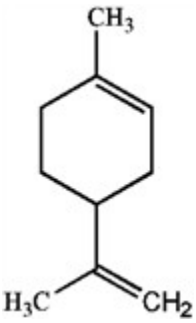


ANSWER:

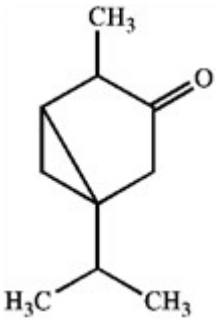


POINTS: 1

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.

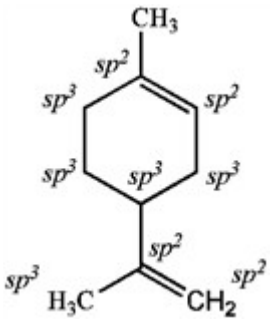


limonene

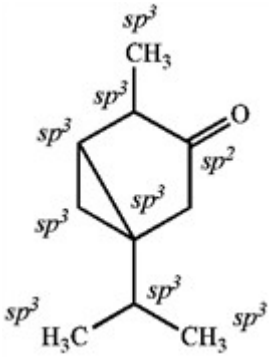


thujone

ANSWER:



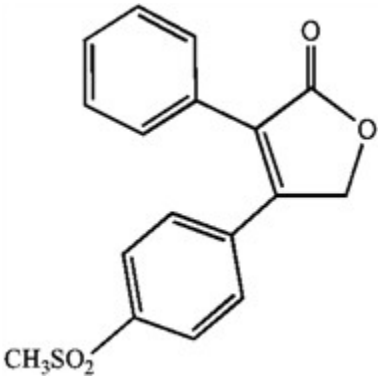
limonene



thujone

POINTS: 1

20. Convert the skeletal drawing of the pharmaceutical Vioxx into a molecular formula.



ANSWER: $C_{17}H_{14}O_4S$

POINTS: 1

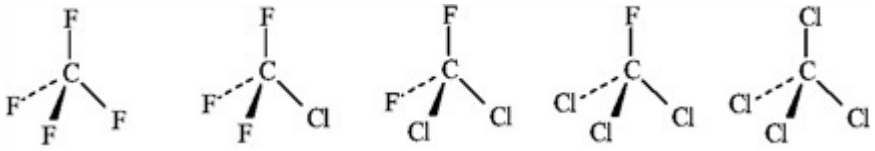
21. Draw a picture showing the orbitals involved in the π-bonds of cyclopenta-1,3-diene, a commonly encountered reagent in organic synthesis.

ANSWER:

POINTS: 1

22. Draw all possible structures of CF_nCl_m where n and m vary from 0 to 4.

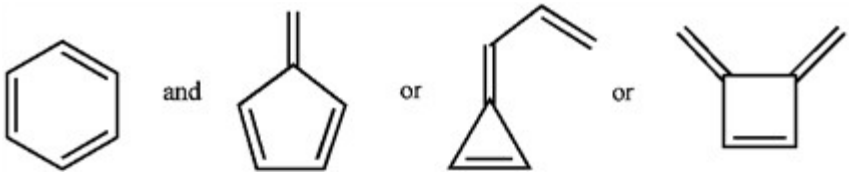
ANSWER:



POINTS: 1

23. Draw two possible isomers of C_6H_6 in which all the carbon atoms are sp^2 hybridized.

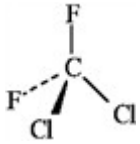
ANSWER:



POINTS: 1

24. Draw the structure for CCl_2F_2 using solid, wedged, and dashed lines to show the tetrahedral geometry.

ANSWER:



POINTS: 1

Instructions: Consider the two structures below to answer the following question.

CH_3CH_2OH CH_3OCH_3

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
POINTS: 1

26. What is the expected hybridization around the sulfur atom in diethyl sulfide?

CH_3CH_2–S–CH_2CH_3

a. *sp*
b. sp^2
c. sp^3
d. The sulfur atom is not hybridized.

ANSWER: c
POINTS: 1

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.

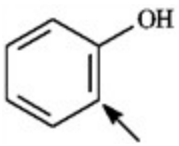
ANSWER: d
POINTS: 1

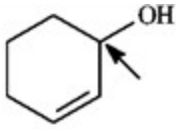
28. The molecular orbital shown below is most likely of what type?

a. σ bonding
b. σ antibonding
c. π bonding
d. π antibonding

ANSWER: c
POINTS: 1

29. In the two structures shown below, what do the positions labeled with the arrow have in common?

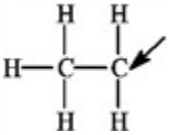




a. the same type of hybridization on the carbon atom
b. the same geometry around the carbon atom
c. the same number of hydrogen atoms bonded to the carbon atom
d. both carbon atoms are involved in a π bond

ANSWER: c
POINTS: 1

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
POINTS: 1