Assignment 5 (1524883)

Question 123456789101112131415161718192021222324252627282930313233

1. Question Details: Chang10 10. A. 03. [1135911]
Sigma-Pi Bonding

Use the animation to answer the following questions.

This animation will begin with a narration when you click “Open in New Window” below. To restart the narration, click “Open in New Window” again.

(a) In the acetylene molecule there are:
- 1 π bond.
- 2 VSEPR electron pairs around C₁ and C₂.
- 3 σ and 1 π bond.
- 2 σ bonds.

(b) In ethylene C₁ and C₂ are joined:
- to each other by 1 π and 2 σ bonds
- to each other by 2 VSEPR pairs
- by a π bond formed from the overlap of their 2pₓ orbitals.
- to the hydrogens by 4 σ bonds

(c) Consider the molecules as shown at the beginning of the animation. In this series which of the following does not decrease from left to right?
- total number of σ bonds
- total number of bonds of all types
- total number of π bonds
- total number of VSEPR pairs

(d) Rotation can occur around:
- the C to C bond in ethylene.
- the C to C bond in acetylene.
- the C to C bond in ethane.
- all the C to C bonds shown in the animation.
(e) In ethylene, **VSEPR** predicts:
- unhybridized d orbitals.
- formation of no σ and π bonds.
- trigonal planar geometry.
- sp³ hybridization occurs.

3.  Question DetailsChang10 10.Supp.3.05. [1133012]
A "p-p" overlap of atomic orbitals would occur in which of the following bonds?
- H-F
- H-H
- Li-H
- S-S

Solution or Explanation
Two (empty) p orbitals are available for overlap.

4.  Question DetailsChang10 10.Supp.3.02. [1132386]
A π orbital is formed from _____ atomic orbitals aligned _______ .
- p, end-to-end
- hybrid, parallel to one another
- p, parallel to one another
- hybrid, end-to-end

Solution or Explanation
Parallel overlap of "p" orbitals form π bonds.

5.  Question DetailsChang10 10.Supp.3.01. [1132226]
Which of the following is a hybrid orbital?
- 3d
- pi
- sigma
- sp²

Solution or Explanation
Combination of orbitals written as one.

6.  Question DetailsBurdgeChem2 9.EOCP.037. [1416010]
Specify which hybrid orbitals are used by carbon atoms in the following species.

(a) NCO⁻
7. Question Details BurdgeChem2 9.EOC.040.  [1413715]

How many sigma bonds and pi bonds are there in each of the following molecules?

(a) 
\[ \text{sigma bonds} \quad 4 \quad \text{pi bonds} \quad 0 \]

(b) 
\[ \text{sigma bonds} \quad 5 \quad \text{pi bonds} \quad 1 \]

(c) 
\[ \text{sigma bonds} \quad 10 \quad \text{pi bonds} \quad 3 \]

8. Question Details BurdgeChem2 9.EOC.042.  [1413920]

Tryptophan is one of the 20 amino acids in the human body. Describe the hybridization state of the C and N atoms, and determine the number of sigma and pi bonds in the molecule.

- N-1: \( \text{sp}^3 \)
- C-2: \( \text{sp}^2 \)
number of $\sigma$ bonds $\boxed{28}$
number of $\pi$ bonds $\boxed{5}$

What is the ideal Cl-C-Cl bond angle in $C_2\text{Cl}_4$?
- $60^\circ$
- $109.5^\circ$
- $180^\circ$
- $\boxed{120^\circ}$

Solution or Explanation
AX$_3$ arrangement predicts 120 degree bond angle.

Which of the following molecules has both an electron group geometry and a molecular geometry described as trigonal planar?
- SiH$_4$
- BF$_3$
- OF$_2$
- CHF$_3$

Solution or Explanation
AX$_3$ is indicated with no nonbonding pairs present in the structure.

11. Question Details LairdUCHEM1 4.TB.026. [953285]
Indicate the type of hybrid orbitals used by the central atom in CCl$_4$.
- $\boxed{sp^3}$
- $sp^3d^2$
- $sp$
- $sp^3d$
- $sp^2$

12. Question Details LairdUCHEM1 4.TB.030. [953637]
In which one of the following molecules is the central atom $sp^2$ hybridized?
- SO$_2$
- PF$_5$
- NF$_3$
- N$_2$O
- BeCl$_2$

13. Question Details LairdUCHEM1 4.TB.035. [953098]
The number of pi bonds in the molecule below is
$$\text{H} - \text{C} = \text{C} = \text{N}$$
$$\text{H} \quad \text{H}$$
14. Question DetailsLairdUChem1 4.TB.036. [953476]
The number of pi bonds in the molecule below is

\[
\begin{array}{c}
\text{H} \\
\text{H} \\
\text{H} \\
\text{H} \\
\text{H}
\end{array}
\begin{array}{c}
\text{C} = \text{C} \\
\text{C} = \text{C} \\
\text{C} = \text{C}
\end{array}
\begin{array}{c}
\text{H} \\
\text{H}
\end{array}
\]

- 15
- 4
- 10
- 2
- 6

15. Question DetailsLairdUChem1 4.TB.038. [953360]
Consider the species Cl\(_2^+\), Cl\(_2\), and Cl\(_2^-\). Which of these species will be paramagnetic?
- Cl\(_2\) and Cl\(_2^-\)
- All three are paramagnetic
- Only Cl\(_2\)
- Cl\(_2^+\) and Cl\(_2^-\)
- Cl\(_2^+\) and Cl\(_2\)

The electron pairs on the central nitrogen atom can be considered to be in sp\(^2\)-hybridized orbitals in all of the following species except
- HNNH
- NNN\(^-\)
- NO\(^2-\)
- NO\(^3-\)

Solution or Explanation
Since NNN\(^-\) is linear, sp hybridization is indicated.

For which of the following species can the bonds formed by the central atom be described in terms of sp\(^2\) hybrid orbitals?
- H\(_2\)O
- CO\(_3^{2-}\)
- SO\(_4^{2-}\)
- ClF\(_3\)
Solution or Explanation
Triangular arrangement of orbitals indicates sp$^2$.

18. Question Details
Which statement is incorrect?
- An sp hybridization produces a tetrahedral molecule.
- Hybrid orbitals are combination of atomic orbitals.
- The bond length is the internuclear distance.
- There are the same number of hybrid orbitals produced as the number of atomic orbitals combined.

Solution or Explanation
Sp$^3$ is characteristic of tetrahedral geometry.

19. Question Details
For BeCl$_2$, what is the hybridization on the central atom?
- sp$^2$
- sp$^3$
- sp$^3$d
- sp$^3$

Solution or Explanation
Linear shape indicates sp hybridization.

20. Question Details
All of the following are true concerning the bonding in methane, CH$_4$, except:
- these sp$^3$ orbitals combine with the s orbitals of the hydrogen to form molecular orbitals.
- the compound has tetrahedral geometry.
- some of the C-H bonds are stronger than others.
- the carbon s and p orbitals combine to form four equivalent sp$^3$ orbitals.

Solution or Explanation
All the C-H would have the same bond dissociation energy and are equivalent.

21. Question Details
Which of the pairs of molecules below have the same hybridization on the central atom in each molecule? (The central atom is in bold.)
- HOCl, ClF$_2$
- HCN, CO$_2$
- BeH$_2$, NH$_3$
- H$_2$O, HNO

Solution or Explanation
Both compounds are linear and sp hybridized.
22. Consider the following three molecules, and identify the compound(s) that contain both sp and sp\(^3\)-hybridized carbon atoms:

1. 

2. 

3. 

- 2 only
- 1 only
- 2 and 3 only
- 3 only

Solution or Explanation

The carbon-carbon triple shows "sp" while the tetrahedral part or C-H 's indicate sp\(^3\).

23. One resonance structure of \(\text{N}_2\text{O}\) is shown in the diagram \([\text{N} = \text{N-O}]\). The hybridized atomic orbitals of the central nitrogen atom, which are consistent with this structure, are:

- four sp\(^3\) orbitals
- three sp\(^2\) orbitals and a "p" orbital
- two sp\(^2\) orbitals and two sp orbitals
- two sp orbitals and two "p" orbitals

Solution or Explanation

Linear shape suggests sp hybridization.

24. The geometry of sp\(^3\) hybridized orbitals is

- tetrahedral
- linear
- octahedral
- triangular

Solution or Explanation

sp\(^3\) is characteristic of tetrahedral geometry.

25. What is the type of hybridization used by carbon in \(\text{C}_2\text{H}_2\), (acetylene)?

- sp
- sp\(^2\)
- sp\(^3\)
- sp\(^2\)d
Solution or Explanation
Only two orbitals are needed which suggests sp hybridization.

According to the valence-bond method, which of the following molecules involves sp\(^2\) hybridization of orbitals on the carbon atom?
- C\(_2\)H\(_6\)
- CO\(_2\)
- CO
- C\(_2\)H\(_4\)

Solution or Explanation
C=\(\equiv\) bonds involve sp\(^2\) due to the triangular arrangement of orbitals.

How many sigma bonds and pi bonds are there in each of the following molecules?

(a)
\[
\begin{array}{c}
\text{Cl} \\
\text{C} \\
\text{Cl}
\end{array}
\]
- \(\text{sigma bonds}\) 4
- \(\text{pi bonds}\) 0

(b)
\[
\begin{array}{c}
\text{H} \\
\text{C} \\
\text{C} \\
\text{H}
\end{array}
\]
- \(\text{sigma bonds}\) 5
- \(\text{pi bonds}\) 1

(c)
\[
\begin{array}{c}
\text{H} \\
\text{C} \\
\text{C} \equiv \text{C} \\
\text{H}
\end{array}
\]
- \(\text{sigma bonds}\) 10
- \(\text{pi bonds}\) 3

Hybrid Orbitals
(a) The fact that the BCl\(_3\) molecule is planar means that the B atom is which of the following?
- unhybridized
- \(sp^3\) hybridized
- \(sp^2\) hybridized
- \(sp\) hybridized

(b) Hybridizing one s atomic orbital and one p atomic orbital would not yield which of the following?
- a linear geometry
- 2 equivalent hybrid orbitals
- \(sp^2\) hybridization
(c) Which combination of hybrid orbitals and electron pair geometries is incorrect?
- $sp^2$ = trigonal planar
- $sp^3$ = tetrahedral
- $sp^3d$ = square planar
- $sp^3d^2$ = octahedral

(d) Which of the following statements is true concerning $sp^3d$ hybrid orbitals?
- One s atomic orbital, three p atomic orbitals and 2 d atomic orbitals combine to make $sp^3d$ hybrid orbitals.
- The resulting angles of $sp^3d$ hybrid orbitals are 90° and 109.5°
- Trigonal bipyramidal geometry is a result of $sp^3d$ hybrid orbitals.
- There are four equivalent $sp^3d$ hybrid orbitals produced.

(e) What is a common feature of $sp$, $sp^2$, $sp^3$, $sp^3d$, and $sp^3d^2$ hybrid orbitals?
- They all incorporate at least one s atomic orbital and one p atomic orbital.
- There are at least 3 equivalent hybrid orbitals of each type.
- They all only use s atomic orbitals.
- They all use at least 1 s atomic orbital, one p atomic and one d atomic orbital.

Practice Exercise 10.3
Enter the hybridization state of the underlined atoms in the following compounds.

(a) CO$_2$

(b) CCl$_4$

Practice Exercise 10.5
Describe the bonding in the thiocyanate ion, SCN$^-$. Assume that N is $sp$-hybridized.

geometry
31. Question Details Chang10 10.Supp.3.16. \[1132111\]
According to the valence-bond method, which of the following molecules involves \( sp^2 \) hybridization of orbitals on the carbon atom?

- \( C_2H_6 \)
- \( C_2H_4 \)
- \( CO_2 \)
- \( CO \)

Solution or Explanation
\( C=\equiv C \) bonds involve \( sp^2 \) due to the triangular arrangement of orbitals.

32. Question Details Chang10 10.Supp.4.04. \[1134011\]
The geometry of \( sp^3 \) hybridized orbitals is

- tetrahedral
- linear
- octahedral
- triangular

Solution or Explanation
\( sp^3 \) is characteristic of tetrahedral geometry.

33. Question Details Chang10 10.Supp.6.03. \[1133382\]
In which of the following molecules would you expect the nitrogen to nitrogen bond to be the shortest?

- \( N_2H_4 \)
- \( N_2O_4 \)
- \( N_2 \)
- \( N_2O \)

Solution or Explanation
\( N_2 \) has the highest bond order.