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Practice problems

True or False

1. Covalent bonds arise from the tendency of atoms to attain their stable configuration of electrons. T or F
2. All molecules with dipoles must have at least one polar bond. T or F
3. All resonance contributors have the same number of bonding electrons. T or F
4. Compounds with the same molecular formula but different structures are called constitutional isomers. T or F
5. Orbitals are filled with electrons in order of increasing energy. T or F
6. A triple bond is the combination of one σ bond and two π bonds. T or F

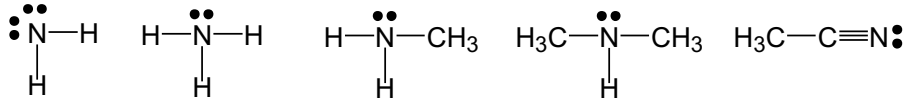
8. Lewis structures with delocalized charge are more stable than Lewis structures with localized charge. T or F
9. 1,2-dichloroethane has two gauche conformations. T or F
10. Pasteur resolved crystals of sodium ammonium tartrate by visually separating left- and right-handed crystals. T or F
11. Pyrimidal inversion is the rapid oscillation of the nitrogen lone pair form one side of the molecule to the other. T or F
12. Enantiomers of drugs can have different biological effects. T or F
13. A meso compound is an achiral compound. T or F
14. Compounds containing more than one chiral center are not necessarily chiral. T or F

Multiple Choice

1. VSEPR theory predicts an identical geometry for all of the following, except:

A) NH_3
B) H_3O^+
C) BH_3
D) CH_3^-
E) All have the same geometry

2. Which of the following molecules has a nitrogen atom with a formal charge of –1?



(A) (B) (C) (D) (E)

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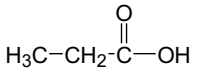
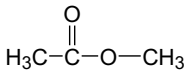
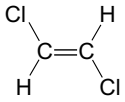
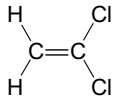
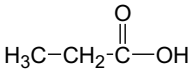
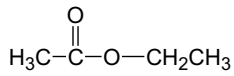
3. Identify the atomic orbitals in the C-C sigma bond in ethene ($H_2C=CH_2$).

A) ($2sp^2$, $2sp^2$)
B) ($2sp^3$, $2sp^3$)
C) (2sp, 2sp)
D) (2p, 2p)
E) (2sp, 1s)

4. a) Which of the following represents pairs of constitutional isomers

I  and 

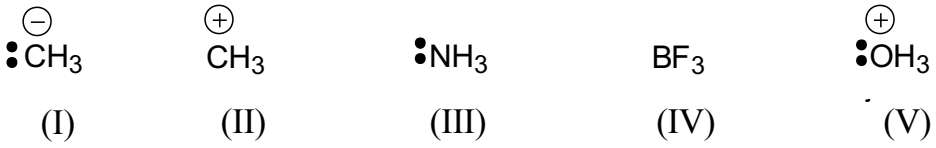
II  and 

III  and 

A) I B) II C) III D) I and II E) II and III

b) Add any missing lone pair electrons to the structures above.

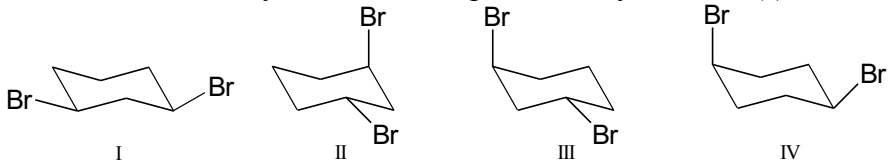
5. Which of the following would have a trigonal planar shape?



(I) (II) (III) (IV) (V)

A) I, II, and IV
B) II and IV
C) IV
D) II, IV, and V
E) I, II, III, IV, and V

6. Cis-1,3-dibromocyclohexane is represented by structure(s):



I II III IV

a) I b) II c) III d) IV e) II & III f) I & IV

7. Which of the following is the enantiomer of:

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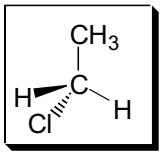
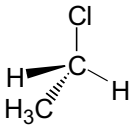
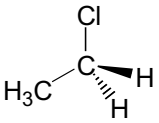
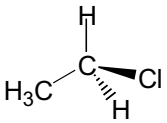




I



II



III

a) I b) II c) III d) both II & III e) there are no enantiomers.

8. Which of the following contains an sp-hybridyzed carbon?

A) CH_4 B) $CH_3{:}^-$ C) CH_3CH_3 D) CH_3^+ E) $HC \equiv CH$

9. A molecule with the molecular formula C_6H_7NO has how many degrees of unsaturation?

a) 1 b) 2 c) 3 d) 4 e) 5

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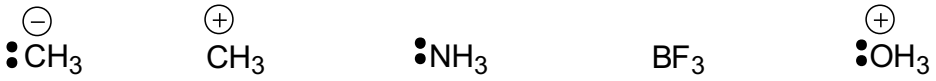
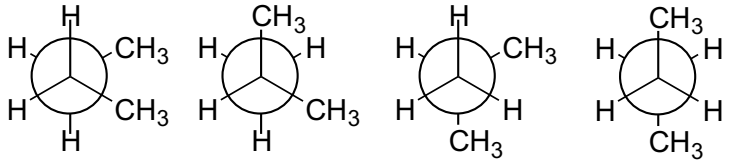
10. Which of the following would have a tetrahedral structure?



(I) (II) (III) (IV) (V)

A) I, III, and V
B) I and IV
C) II
D) II and V
E) I, II, III, IV, and V

11. Which Newman projection(s) represent(s) gauche butane?



I II III IV

a) I
b) II
c) III
d) IV
e) II and III

12. The hybridization state of the charged carbon in a carbocation is:

a) sp^4 b) sp^3 c) sp^2 d) sp e) s

13. Draw the structure of the following compounds:

a) (2S)-2-chloropentane
b) (2Z)-but-2-en-1-ol
c) cis-1,4-dichloro-cyclohexane
d) (S)-1-bromo-3-chloro-2-methylpropane

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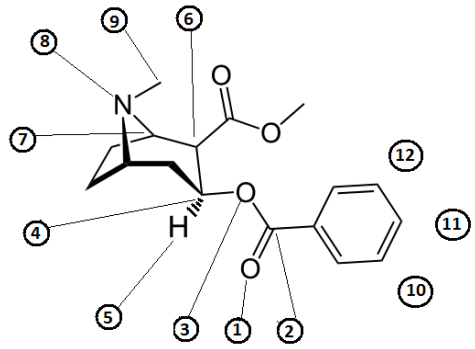
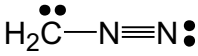
Short Answer

1. Hybridization in cocaine:

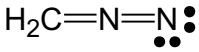


1) What is the hybridization of C9?
2) What is the hybridization of N8?
3) What is the hybridization of O3?
4) What is the hybridization of C11?
5) What is the bond angle between C10, C11 and C12?
6) What is the bond angle between C2, O3 and C4?
7) What is the angle in C9?
8) What orbitals are overlapping between C7 and N8?
9) What orbitals are overlapping between C2 and O1?

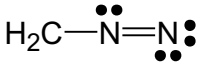
2. Given the following Lewis structures for CH_2N_2



A



B



C

a) Add the proper formal charges to the Lewis structures.

b) Which structure is the least stable? Briefly explain.

c) Show the mechanism (arrow pushing) to go from B to A and from C to B.

d) What are the relationships between A, B, and C.

e) What is the geometry and hybridization of the central nitrogen in each case?

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3. Give the electronic configuration diagram of:
(a) the ground state of nitrogen;
(b) the sp^2 hybridized state of nitrogen; and
(c) the sp^3 hybridized state of nitrogen.

4. The reaction of 2-pentene with HCl gives two constitutional isomers. a) Draw the two separate products, b) give the mechanisms (arrow pushing) for the formation of one of these products and c) give the IUPAC name for each product.

5. A compound has a specific rotation of +100º. A solution of this compound (0.1 g/mL) has an observed rotation of +2º when placed in a polarimeter tube 10 cm long. What is the optical purity of the sample? What is the percentage of each enantiomer in the mixture. Show your calculations.

6. a) Draw the two possible chair conformations for cis-1,3-dimethylcyclohexane and circle the preferred (lower energy) conformer.

b) does this molecule have any stereocenters?

c) Is this molecule chiral?

7. (a) Provide a SEPARATE mechanism (arrow pushing) for the formation of each of the four products A, B, C & D. (b) What is the product of the acid catalyzed hydration of product D? - provide the mechanism (arrow pushing) for the formation of this product. (c) Provide the IUPAC name for the starting material and each of the products (including the product of part (b).

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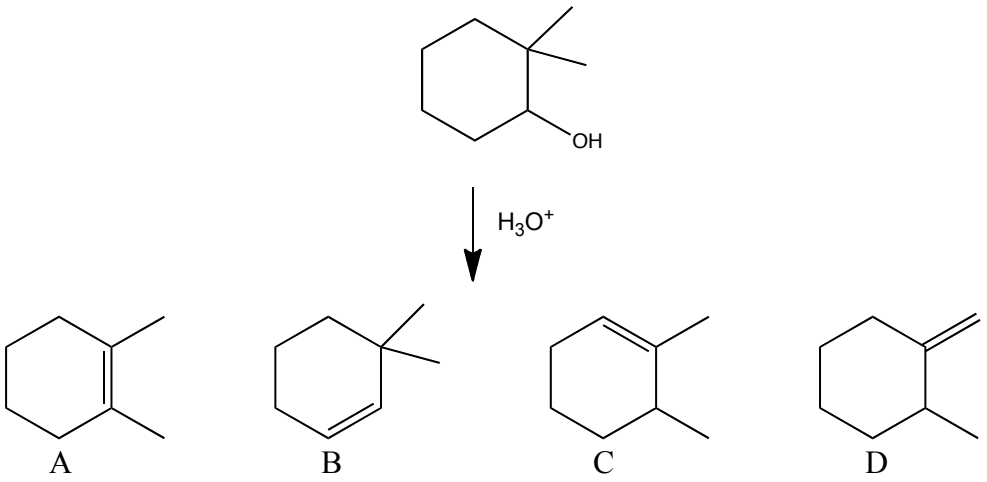

8. Label each pair as **enantiomers**, **diastereomers**, or **same molecule**.