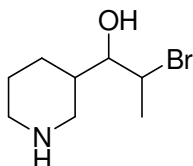


Chapter 1

1. Which is the most electronegative atom in the compound below?



- A) Carbon B) Nitrogen C) Oxygen D) Bromine

Ans: C

2. Which of the following correctly describes the electrons of a carbon atom in its ground state?

- A) 3 *s* electrons; 3 *p* electrons
B) 2 1*s* electrons; 4 2*p* electrons
C) 2 1*s* electrons; 2 2*s* electrons; 2 2*p* electrons
D) 2 1*s* electrons; 2 2*s* electrons; 4 2*p* electrons
E) None of these choices is correct.

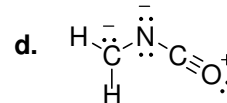
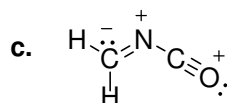
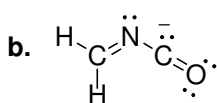
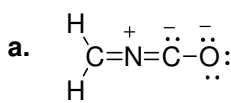
Ans: C

3. Which of the following statements correctly describes the typical bonding of carbon, nitrogen, and oxygen in organic molecules?

- A) Carbon participates in 4 covalent bonds, oxygen participates in 2 covalent bonds and nitrogen participates in 5 covalent bonds.
B) Carbon participates in 3 covalent bonds, oxygen participates in 2 covalent bonds and nitrogen participates in 5 covalent bonds.
C) Carbon participates in 4 covalent bonds, oxygen participates in 3 covalent bonds and nitrogen participates in 3 covalent bonds.
D) Carbon participates in 3 covalent bonds, oxygen participates in 3 covalent bonds and nitrogen participates in 5 covalent bonds.
E) Carbon participates in 4 covalent bonds, oxygen participates in 2 covalent bonds and nitrogen participates in 3 covalent bonds.

Ans: E

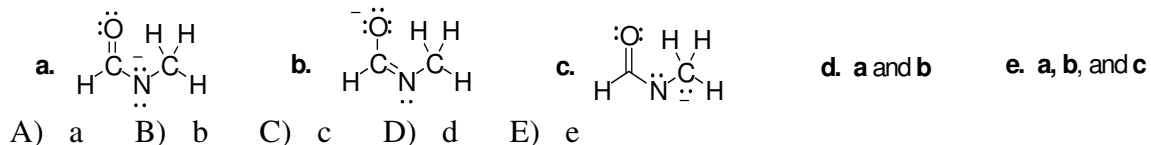
4. Which is *not* an acceptable Lewis structure for the anion $(\text{CH}_2\text{NCO})^-$?



- A) a B) b C) c D) d

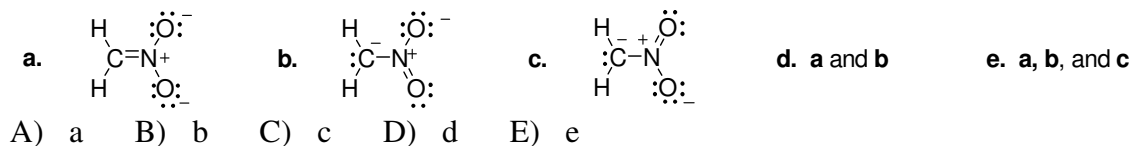
Ans: C

5. Which of the following is (are) valid Lewis structure(s) for the anion $(\text{HCONCH}_3)^-$?



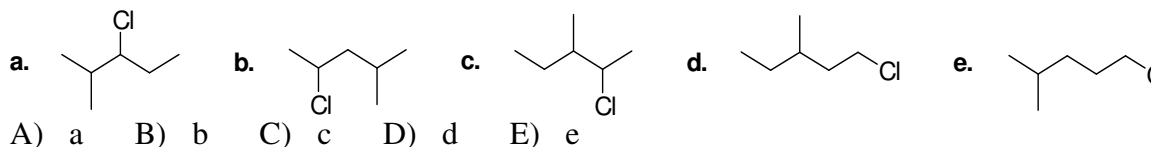
Ans: D

6. Which of the following is (are) valid Lewis structure(s) for the anion $(\text{CH}_2\text{NO}_2)^-$? Assume the atoms are arranged as drawn.



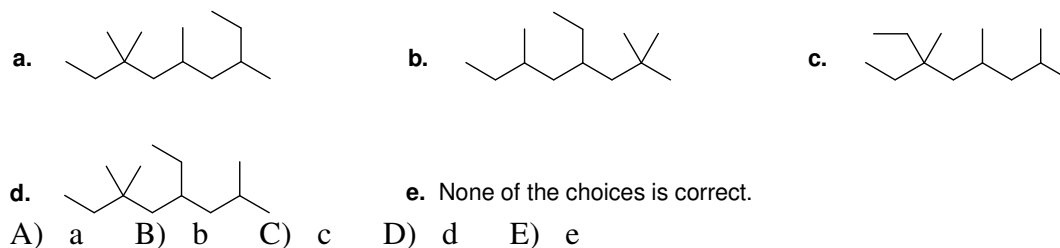
Ans: E

7. Which is the appropriate conversion of $\text{CH}_3\text{CHClCH}_2\text{CH}(\text{CH}_3)_2$ to a skeletal formula?



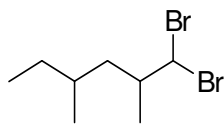
Ans: B

8. Convert the following compound from a condensed formula to a skeletal formula: $\text{CH}_3\text{CH}_2\text{C}(\text{CH}_3)_2\text{CH}_2\text{CH}(\text{CH}_2\text{CH}_3)\text{CH}_2\text{CH}(\text{CH}_3)_2$.



Ans: D

9. What is the condensed formula of the compound below?

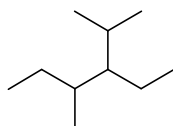


- a. $\text{CH}_3\text{CH}_2\text{CH}(\text{CH}_3)\text{CH}_2\text{CH}(\text{CH}_3)\text{CHBr}_2$
 b. $\text{CH}_3\text{CH}_2\text{CH}_2(\text{CH}_3)\text{CH}_2\text{CH}(\text{CH}_3)\text{CHBr}_2$
 c. $\text{CH}_3\text{CH}_2\text{CH}(\text{CH}_3)\text{CH}(\text{CH}_3)\text{CH}_2\text{CHBr}_2$

A) a B) b C) c

Ans: A

10. Convert the following skeletal formula to a condensed formula.

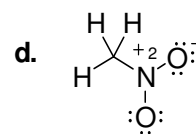
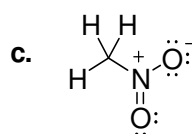
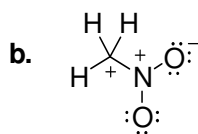
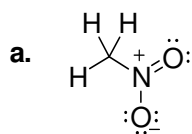


- a. $\text{CH}_3\text{CH}_2\text{CH}(\text{CH}_3)_2\text{CH}(\text{CH}_2\text{CH}_3)\text{CH}(\text{CH}_3)_2$
 b. $\text{CH}_3\text{CH}_2\text{CH}(\text{CH}_3)\text{CH}(\text{CH}_2\text{CH}_3)\text{CH}(\text{CH}_3)_2$
 c. $\text{CH}_3\text{CH}(\text{CH}_3)\text{CH}(\text{CH}_2\text{CH}_3)\text{CH}(\text{CH}_3)_2$

A) a B) b C) c

Ans: B

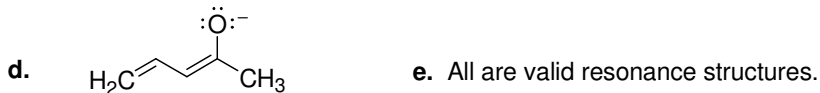
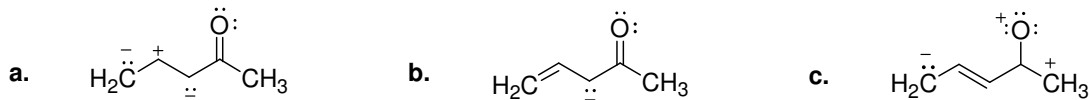
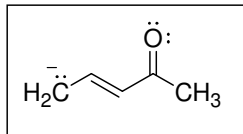
11. Which of the following is *not* a valid Lewis structure of CH_3NO_2 ?



A) a B) b C) c D) d

Ans: B

12. Which is *not* a valid resonance structure for the anion below?



A) a B) b C) c D) d E) e

Ans: C

13. How are the molecules in the following pair related?



A) They are constitutional isomers. C) They represent the same structure.
B) They are resonance structures.

Ans: B

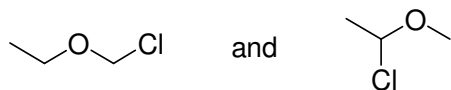
14. How are the molecules in the following pair related?



A) They are constitutional isomers. C) Neither of the choices is correct.
B) They are resonance structures.

Ans: A

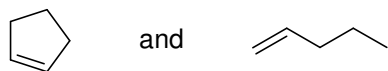
15. How are the molecules in the following pair related?



A) They are constitutional isomers. C) Neither of the choices is correct.
B) They are resonance structures.

Ans: A

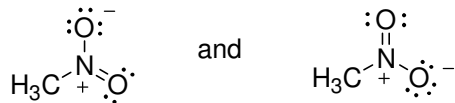
16. How are the molecules in the following pair related?



A) They are constitutional isomers. C) They are unrelated molecules.
B) They are resonance structures.

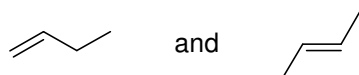
Ans: C

17. How are the molecules in the following pair related?



- A) They are constitutional isomers. C) Neither of the choices is correct.
B) They are resonance structures.
Ans: B

18. How are the molecules in the following pair related?



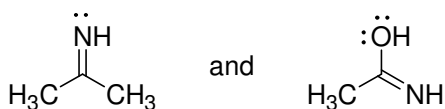
- A) They are constitutional isomers. C) Neither of the choices is correct.
B) They are resonance structures.
Ans: A

19. How are the molecules in the following pair related?



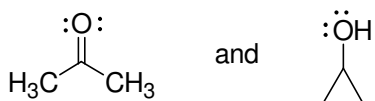
- A) They are constitutional isomers. C) Neither of the choices is correct.
B) They are resonance structures.
Ans: B

20. How are the molecules in the following pair related?



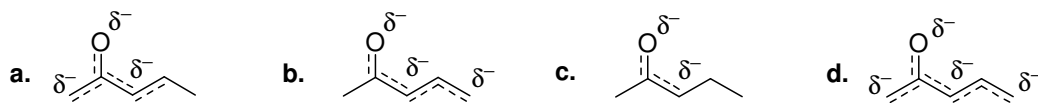
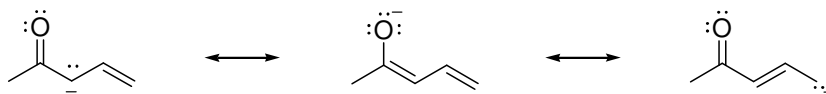
- A) They are constitutional isomers. C) They are unrelated molecules.
B) They are resonance structures.
Ans: C

21. How are the molecules in the following pair related?



- A) They are constitutional isomers. C) Neither of the choices is correct.
B) They are resonance structures.
Ans: A

22. Which is the most accurate representation of the resonance hybrid for the resonance structures shown below?

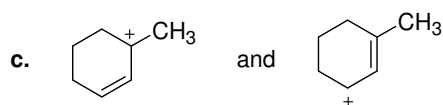


e. None of the choices is correct.

A) a B) b C) c D) d E) e

Ans: B

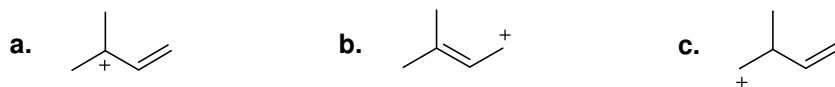
23. Which of the following pairs of compounds are resonance structures?



A) a B) b C) c

Ans: B

24. Which of the following structures are resonance structures of each other?



A) a and b

B) b and c

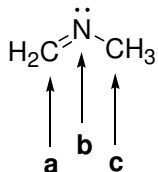
C) a and c

D) All are resonance structures.

E) None of these are resonance structures.

Ans: A

25. What is the hybridization for each of the indicated atoms in the following compound?



A) **a** - sp^2 ; **b** - sp^2 ; **c** - sp^2

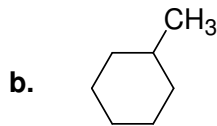
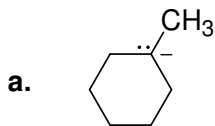
B) **a** - sp^2 ; **b** - sp^3 ; **c** - sp^3

C) **a** - sp ; **b** - sp^2 ; **c** - sp^3

D) **a** - sp^2 ; **b** - sp^2 ; **c** - sp^3

Ans: D

26. Indicate the hybridization of the carbon ion in each compound below.



A) **a** - sp^2 ; **b** - sp^2

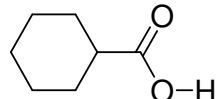
B) **a** - sp^2 ; **b** - sp^3

C) **a** - sp^3 ; **b** - sp^3

D) **a** - sp^3 ; **b** - sp^2

Ans: D

27. Consider the organic molecule drawn below. Describe which orbitals are used to form the C=O bond. Since there are two bonds, you must identify two different sets of orbitals.



A) $C_{sp^2} - O_{sp^2}$ and $C_s - O_p$

B) $C_{sp} - O_{sp}$ and $C_p - O_p$

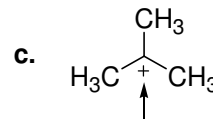
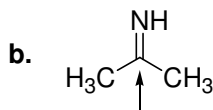
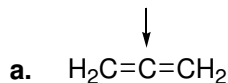
C) $C_{sp^2} - O_{sp^2}$ and $C_s - O_s$

D) $C_{sp^3} - O_{sp^2}$ and $C_p - O_p$

E) $C_{sp^2} - O_{sp^2}$ and $C_{2p} - O_{2p}$

Ans: E

28. Which of the following compounds has a labeled carbon atom that is sp^2 hybridized?



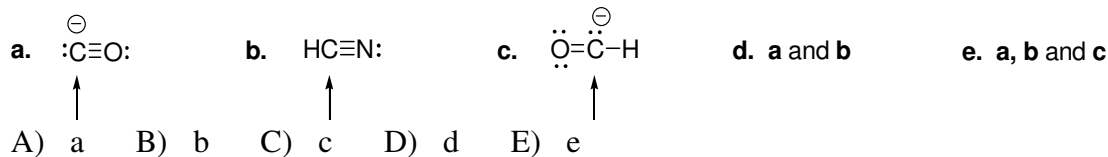
d. Compounds **b** and **c**

e. **a**, **b** and **c** all have sp^3 hybridized carbon.

A) **a** B) **b** C) **c** D) **d** E) **e**

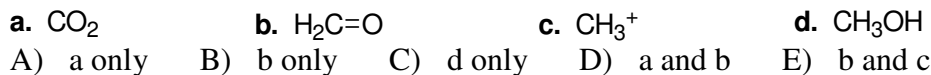
Ans: D

29. Which of the following compounds contains a labeled atom that is sp hybridized? (All nonbonded electron pairs have been drawn in.)



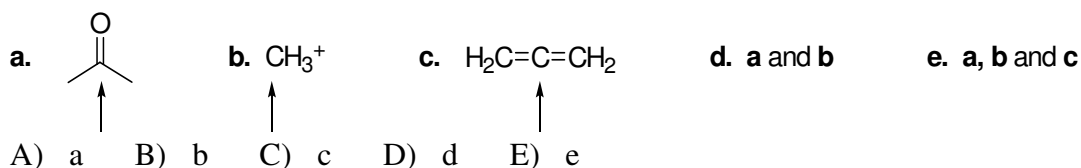
Ans: D

30. Which of the compounds drawn below contains an sp^2 hybridized carbon atom? Select any and all structures that apply.



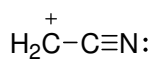
Ans: E

31. Which of the labeled carbon atoms is (are) sp^2 hybridized?



Ans: D

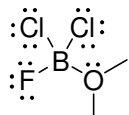
32. Which statement best describes the orbital hybridization used to form bonds in the cation below?



- A) The σ bond between the two carbon atoms is formed between two sp^2 hybridized atoms.
 B) The σ bond between the C and N is formed between an sp^2 hybridized C and an sp hybridized N.
 C) The σ bond between the two carbons is formed between one sp^3 hybridized C and one sp hybridized C.
 D) The lone pair of electrons on N is in an sp hybridized orbital.
 E) None of the statements is correct.

Ans: D

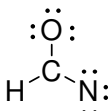
33. Indicate the formal charge on the B, O, and F atoms in the following compound.



- A) B: +1; O: +1; F: 0
 B) B: -1; O: -1; F: 0
 C) B: +1; O: -1; F: 0
 D) B: -1; O: +1; F: 0
 E) None of the choices is correct.

Ans: D

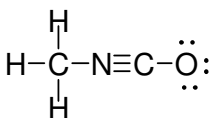
34. In the following compound, indicate the formal charge on all atoms except hydrogen.



- A) Carbon +1; Oxygen +1; Nitrogen -2
 B) Carbon -1; Oxygen +1; Nitrogen -2
 C) Carbon +1; Oxygen -1; Nitrogen -2
 D) Carbon +1; Oxygen -1; Nitrogen -1
 E) None of the choices is correct.

Ans: C

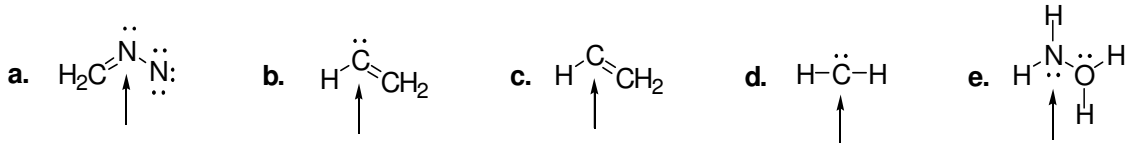
35. In the following compound, indicate the formal charge on all atoms except hydrogen, from left to right.



- A) Carbon 0; Nitrogen -1; Carbon +1; Oxygen 0
 B) Carbon -0; Nitrogen -1; Carbon 0; Oxygen -1
 C) Carbon 0; Nitrogen -1; Carbon 0; Oxygen -1
 D) Carbon 0; Nitrogen +1; Carbon 0; Oxygen -1
 E) None of the choices is correct.

Ans: D

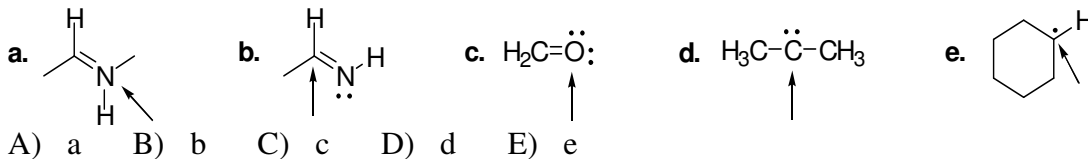
36. Which of the following compounds has a labeled atom with a +1 formal charge? (All nonbonded electron pairs have been drawn in.)



- A) a B) b C) c D) d E) e

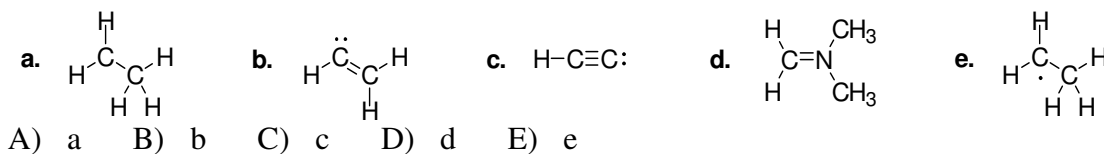
Ans: C

37. Which of the following species has a labeled atom with a +1 formal charge? (All nonbonded electron pairs have been drawn in.)



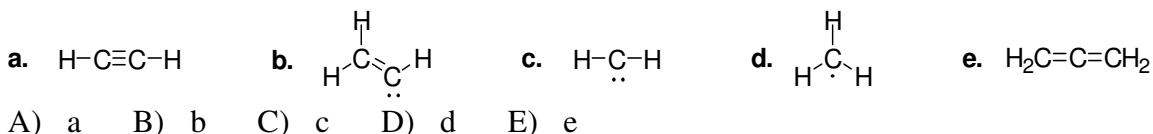
Ans: A

38. Which of the following species contains a carbon atom with a +1 formal charge? (All nonbonded electron pairs have been drawn in.)



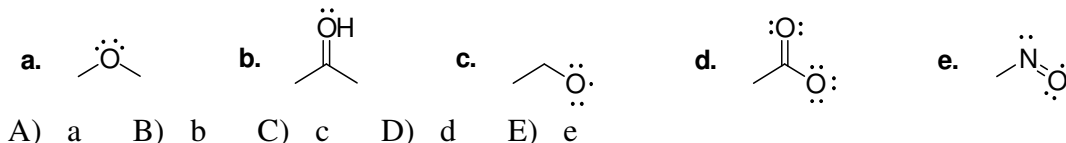
Ans: A

39. Which of the following species contains a carbon atom with a -1 formal charge? (All nonbonded electron pairs have been drawn in.)



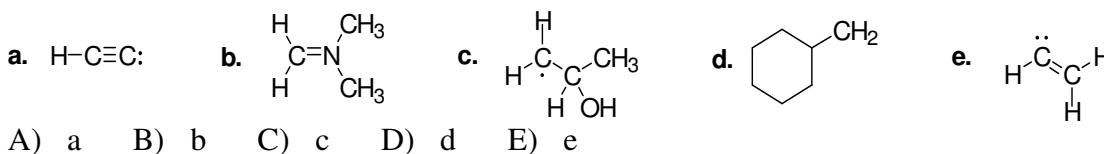
Ans: B

40. Which of the following species contains an O atom with a +1 formal charge? (All nonbonded electron pairs have been drawn in.)



Ans: B

41. Which of the following species contains a carbon atom with a +1 formal charge? (All nonbonded electrons and electron pairs have been drawn in.)

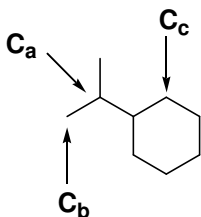


Ans: D

47. Which of the following statements is (are) correct?
- A) The carbon-carbon distance in acetylene is longer than in ethylene.
- B) The carbon-hydrogen bond in acetylene is weaker than the carbon-hydrogen bond in ethane.
- C) The carbon-carbon distance in acetylene is shorter than in ethane.
- D) The statements (The carbon-carbon distance in acetylene is longer than in ethylene) and (The carbon hydrogen bond in acetylene is weaker than the carbon hydrogen bond in ethane) are correct.
- E) The statements (The carbon hydrogen bond in acetylene is weaker than the carbon hydrogen bond in ethane) and (The carbon-carbon distance in acetylene is shorter than in ethane) are correct.

Ans: C

48. How many hydrogens are directly bonded to each of the indicated carbon atoms?



- A) C_a 1; C_b 3; C_c 2
- B) C_a 2; C_b 3; C_c 2
- C) C_a 1; C_b 2; C_c 2
- D) C_a 1; C_b 3; C_c 3
- E) None of the choices is correct.

Ans: A

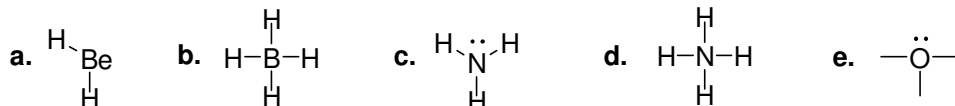
49. Of the molecules listed, which does *not* have a dipole moment?
- A) HCl B) NCl_3 C) CO D) BF_3 E) All molecules have a dipole moment.

Ans: D

50. For the elements Rb, F, and O, the order of increasing electronegativity is:
- A) $\text{Rb} < \text{F} < \text{O}$
- B) $\text{Rb} < \text{O} < \text{F}$
- C) $\text{O} < \text{F} < \text{Rb}$
- D) $\text{F} < \text{Rb} < \text{O}$
- E) The order cannot be determined.

Ans: B

51. Which of the following Lewis dot structure(s) below bear(s) a positive charge?



- A) a B) b C) c D) c and d E) d and e

Ans: E

52. Which of the following species has (have) a trigonal planar structure?

- a. $\overset{-}{\text{C}}\text{H}_3$ b. $\overset{+}{\text{C}}\text{H}_3$ c. $\ddot{\text{N}}\text{H}_3$ d. BF_3 e. $\overset{+}{\text{O}}\text{H}_3$
- A) a, b, and c D) b, d, and e
B) b and d E) All of the choices are correct.
C) d

Ans: B

53. What is the molecular shape of methyl anion?

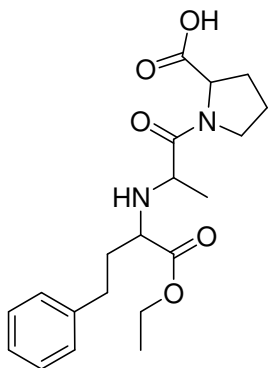


- A) Octahedral D) Trigonal pyramidal
B) Tetrahedral E) Linear
C) Trigonal planar

Ans: D

Challenge Questions

54. **Enalapril** is currently in clinical trials for congestive heart failure, and its structure is given below. What is the correct molecular formula for this interesting antihypertensive agent?



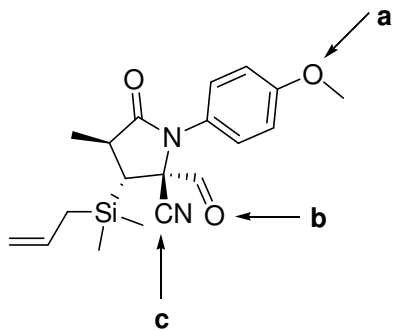
- a. $\text{C}_{20}\text{H}_{28}\text{N}_2\text{O}_5$ d. $\text{C}_{20}\text{H}_{26}\text{N}_2\text{O}_5$
b. $\text{C}_{18}\text{H}_{26}\text{N}_2\text{O}_5$ e. $\text{C}_{18}\text{H}_{25}\text{N}_2\text{O}_5$
c. $\text{C}_{16}\text{H}_{24}\text{N}_2\text{O}_5$

Enalapril

- A) a B) b C) c D) d E) e

Ans: A

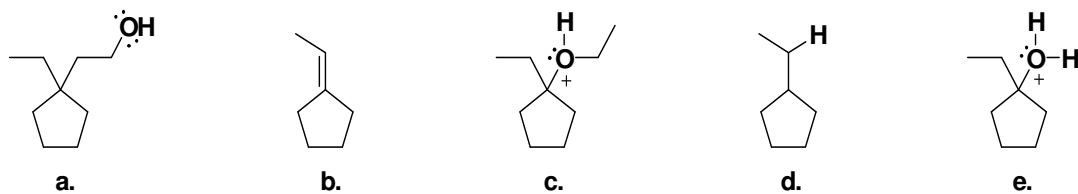
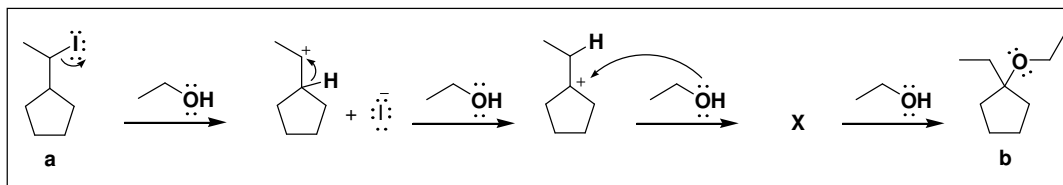
55. The following compound is a synthetic intermediate in the production of **lactacystin**. Identify the orbital hybridization and geometry of the atoms next to the three arrows.



- A) $\mathbf{a} - sp^3$; $\mathbf{b} - sp^2$; $\mathbf{c} - sp^3$
 B) $\mathbf{a} - sp^2$; $\mathbf{b} - sp$; $\mathbf{c} - sp^3$
 C) $\mathbf{a} - sp^2$; $\mathbf{b} - sp^3$; $\mathbf{c} - sp^2$
 D) $\mathbf{a} - sp^3$; $\mathbf{b} - sp^2$; $\mathbf{c} - sp$
 E) None of the choices is correct.

Ans: D

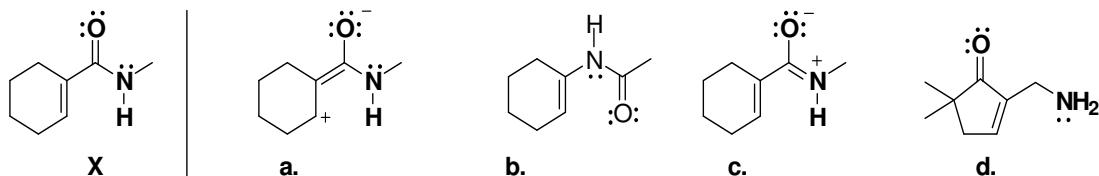
56. The following scheme represents an S_N1 mechanism for the conversion of alkyl halide "a" to ether "b." Determine the correct structure for intermediate "X" based on the curved arrow formalism shown.



- A) a B) b C) c D) d E) e

Ans: C

57. With reference to compound **X** drawn below, label each compound as an isomer, a resonance structure or neither.

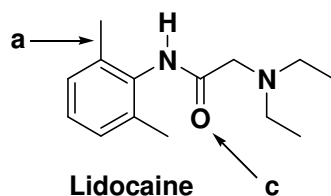


- A) **a.** resonance structure; **b.** isomer; **c.** neither; **d.** isomer
 B) **a.** isomer; **b.** resonance structure; **c.** isomer; **d.** neither
 C) **a.** isomer; **b.** neither; **c.** isomer; **d.** resonance structure
 D) **a.** resonance structure; **b.** isomer; **c.** resonance structure; **d.** isomer
 E) None of the choices are correct.

Ans: D

Use the following to answer questions 58-60:

Answer the following questions about **lidocaine**, a commonly used dental anesthetic.



58. What orbitals are used to form the bond indicated by **a**?
 A) Csp^2-Csp^2 B) Csp^3-Csp^2 C) Csp^2-Csp D) $Csp-Csp^2$ E) Csp^3-Csp

Ans: B

59. How many carbon atoms have sp^2 hybridization?

- A) 7 B) 5 C) 6 D) 10 E) 8

Ans: A

60. Predict the geometry around the oxygen atom indicated by arrow **c**.

- A) Linear D) Trigonal planar
 B) Tetrahedral E) Square planar
 C) Trigonal bipyramidal

Ans: D