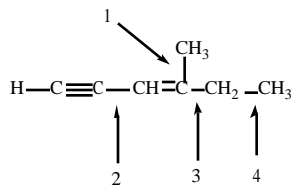


1. Which of the C-C single bonds indicated in the compound below is the shortest?

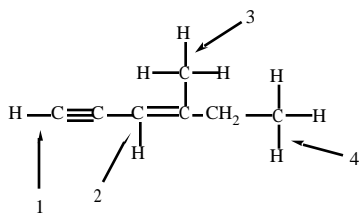


- a) 1 c) 3
b) 2 d) 4
e) 1, 2, 3, and 4 all have equivalent lengths.

2. What is the hybridization of the nitrogen atom in $\text{CH}_3\text{-CH}_2\text{-C}\equiv\text{N}$:

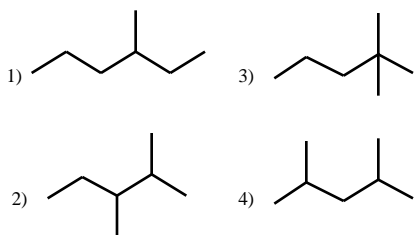
- a) sp d) s^2p
b) sp^2 e) s^3p
c) sp^3

3. Which of the C-H bonds indicated in the compound below is the shortest?

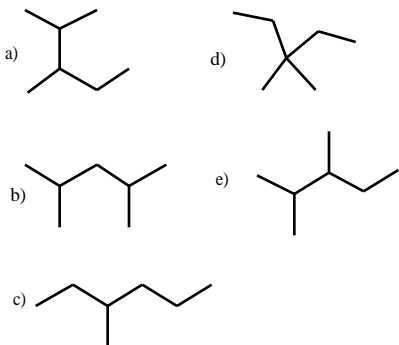


- a) 1 c) 3
b) 2 d) 4
e) 1, 2, 3, and 4 all have equivalent lengths.

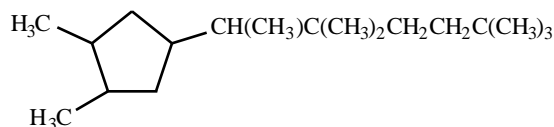
4. Given these isomers of C_7H_{16} :



Which choice below is an isomer of C_7H_{16} not shown above?

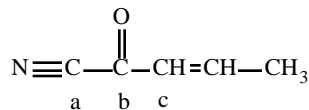


5. How many secondary carbons are in the compound below?



- a) 2 d) 5
b) 3 e) 6
c) 4

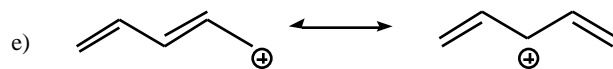
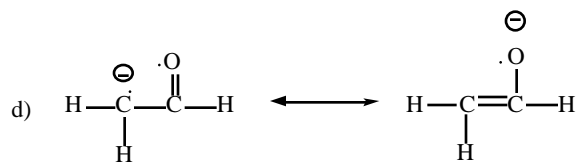
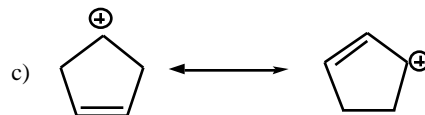
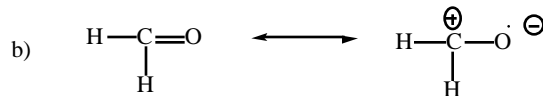
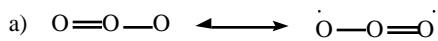
6. Given:



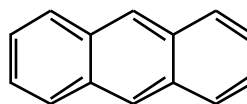
The approximate bond angle formed by atoms a, b, and c is:

- a) 180° d) 90°
b) 120° e) 60°
c) 109.5°

7. Which of the following pairs are not resonance structures?

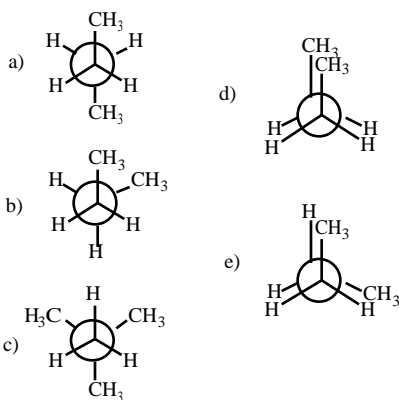
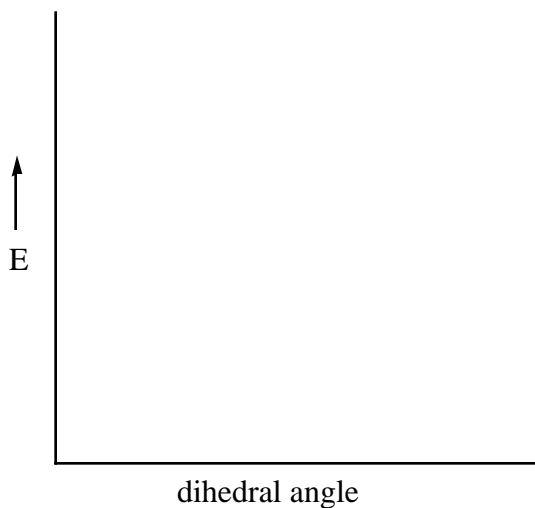


8. What is the molecular formula of anthracene, shown below?

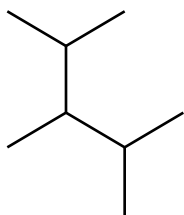


- a) $\text{C}_{14}\text{H}_{10}$
b) $\text{C}_{14}\text{H}_{12}$
c) $\text{C}_{14}\text{H}_{14}$
d) $\text{C}_{18}\text{H}_{14}$
e) $\text{C}_{18}\text{H}_{12}$

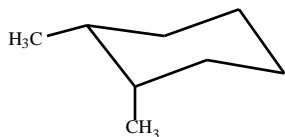
9. Which of the Newman projections corresponds to point 5 shown on the energy profile below (rotation about carbons 2 and 3 of butane)?



10. What is the IUPAC name of the compound shown?

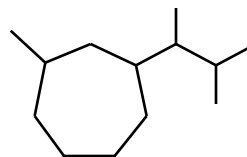


- a) 2-isopropyl-3-methylbutane
 b) 2-methyl-3-isopropylbutane
 c) 2-(1-methylethyl)-3-methylbutane
 d) 2,2,3-trimethylbutane
 e) 2,3,4-trimethylpentane
11. What is the correct name of the compound below?



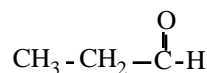
- a) *cis*-1,2-dimethylcyclohexane
 b) *trans*-1,2-dimethylcyclohexane
 c) *cis*-1,3-dimethylcyclohexane
 d) *trans*-1,3-dimethylcyclohexane
 e) *trans*-3,4-dimethylcyclohexane

12. What is the IUPAC name of the compound shown?



- a) 1-methyl-3-*sec*-butylcycloheptane
 b) 1-*sec*-butyl-3-methylcycloheptane
 c) 1-(1,2-dimethylpropyl)-3-methylcycloheptane
 d) 1-(3-methylbutyl)-3-methylcycloheptane
 e) 1-isopropyl-3-methylcycloheptane

13. Identify the functional group in the molecule below:



- a) ketone
 b) arene
 c) ether
 d) aldehyde
 e) ester
14. Which of the alkanes listed has the highest boiling point?
- a) butane
 b) 2-methylbutane
 c) pentane
 d) 3-methylpentane
 e) hexane

Part II. Short Answer.

For questions 1 and 2, use the table below:

$\text{CH}_3 \Leftrightarrow \text{H}$	1, 3 diaxial	3.8 kJ/mol
$\text{H} \Leftrightarrow \text{H}$	eclipsed	4.0 kJ/mol
$\text{H} \Leftrightarrow \text{CH}_3$	eclipsed	6.0 kJ/mol
$\text{CH}_3 \Leftrightarrow \text{CH}_3$	eclipsed	11 kJ/mol
$\text{CH}_3 \Leftrightarrow \text{CH}_3$	gauche	3.8 kJ/mol

1. Consider the molecule 2-methylbutane. Sighting along the C2-C3 axis, draw Newman projections of the two staggered conformations of this molecule. Use the data in the table above to calculate the total strain energy of each structure, determine the difference in energy between the two structures, and indicate which conformation is more stable.

2. Consider the following two molecules:

cis-1,2-dimethylcyclohexane

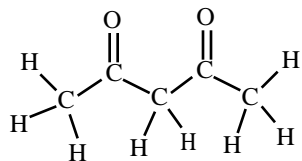
trans-1,2-dimethylcyclohexane

Draw the more stable conformation of each molecule.

Use the data in the table above to calculate the total strain energy of each structure. Indicate which, if either, is more stable, and calculate the energy difference between the two structures.

4. Draw and name all constitutional isomers with the molecular formula C_4H_9Cl .

3. 2,4-pentanedione, shown below, is a weak acid with a $pK_a = 9$.



- a) Label the hydrogens above as primary, secondary, or tertiary.

- b) Draw all resonance structures of the conjugate base of 2,4-pentanedione. (In forming the conjugate base, be sure to remove the most acidic hydrogen.)

- c) Is 2,4-pentanedione a strong enough acid to react almost completely with NaOH? (The pK_a of H_2O is 15.74.) If the answer is yes, write the balanced equation.

Answers to Multiple Choice:

- | | | |
|------|-------|-------|
| 1. b | 6. b | 11. a |
| 2. a | 7. c | 12. c |
| 3. a | 8. a | 13. d |
| 4. d | 9. b | 14. e |
| 5. c | 10. e | |