Chapter 2: Alkanes

LEARNING OBJECTIVES

Recognize functional groups
Multiple Choice: 1
Short Answer: 1

Create hybrid orbitals from atomic orbitals
Multiple Choice: 2, 3
Short Answer: 4

Understand %s character
Multiple Choice: 4
Short Answer: 5

Understand bonding in methane and derivatives
Multiple Choice: 5, 6
Short Answer: 2

Draw Newman projections
Multiple Choice: 7, 8, 15, 19-21, 30
Short Answer: 8-10, 12, 14

Understand conformational preferences of ethane
Multiple Choice: 9
Short Answer: 11

Interpret line drawings
Multiple Choice: 10, 11

Recognize constitutional isomers
Multiple Choice: 12-14

Identify degrees of carbon attachment
Multiple Choice: 16-18
Short Answer: 13, 20

Interconvert IUPAC nomenclature and molecular structure
Multiple Choice: 22-24
Short Answer: 15-18, 21

Explain how molecular shape impacts boiling/melting points
Multiple Choice: 26, 27

Determine the expected number of ^{13}C NMR signals
Multiple Choice: 28, 31
Short Answer: 27, 28

Determine the expected number and ratio of ^{1}H NMR signals
Multiple Choice: 29
Short Answer: 25, 26

Recognize hybridization states
Short Answer: 3, 6, 7

Draw all isomers of a given molecular formula
Short Answer: 19, 22-24

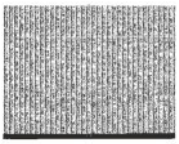
Use the curved arrow formalism
Short Answer: 31, 32

Recognize Lewis acids and bases
Short Answer: 29, 30, 33, 34

Understand molecular unsaturation
Multiple Choice: 25

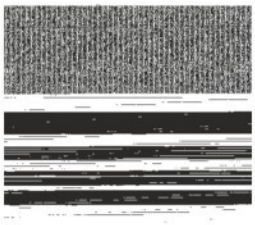
MULTIPLE CHOICE

1. Which molecule contains a ketone?

a. 

b. 

c. 

d. 

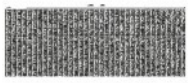
e. 

ANS: D DIF: Easy REF: 2.1
OBJ: Recognize functional groups MSC: Remembering

2. Which combination of atomic orbitals will produce an sp^2 hybrid orbital?
   a. $2p_x + 1s$
   b. $2p_x + 2s$
   c. $2p_x + 2p_y + 2p_z$
   d. $2p_x + 2p_z + 2s$
   e. $2p_x + 2p_y + 2p_z + 2s$

ANS: D DIF: Easy REF: 2.2
OBJ: Create hybrid orbitals from atomic orbitals MSC: Remembering

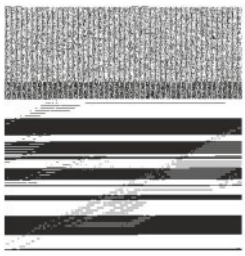
3. Dibromocarbene is an example of a chemical species called a carbene

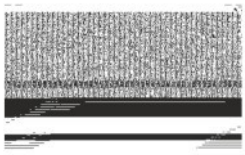


Carbenes exist in one of two forms. In one of these forms, called a singlet, both of the nonbonding electrons on carbon occupy the same orbital. Approximately what type of orbital does the lone pair occupy?
   a. *sp*
   b. sp^2
   c. sp^3
   d. 2*s*
   e. 2*p*

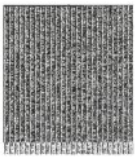
ANS: B DIF: Difficult REF: 2.2
OBJ: Create hybrid orbitals from atomic orbitals MSC: Applying

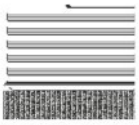
4. Which structure contains a hybrid orbital with a higher %*s* character than the hybrids found in any of the others?

a. 

b. 

c. 

d. 

e. 

ANS: B DIF: Easy REF: 2.2
MSC: Analyzing OBJ: Understand %s character

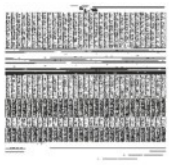
5. Which of the following statements about methane, CH_4, is *false*?
   a. The carbon-hydrogen bonds in methane are formed by the combination of an sp^3 orbital on carbon and a 1*s* orbital on hydrogen.
   b. The C—H bonding molecular orbital has cylindrical symmetry.
   c. The C—H antibonding molecular orbital does not have cylindrical symmetry.
   d. The hybrid orbitals on carbon are 25% *s* character and 75% *p* character.
   e. All bond angles are 109.5°.

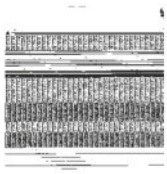
ANS: C DIF: Medium REF: 2.2
OBJ: Understand bonding in methane and derivatives MSC: Understanding

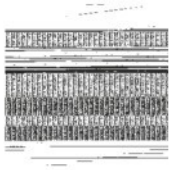
6. Which statement about bonding in the ammonium ion ($^+NH_4$) is *false*?
   a. The molecule is tetrahedral.
   b. There are four bonding molecular orbitals.
   c. There are four antibonding molecular orbitals.
   d. All bonding orbitals are occupied.
   e. The N hybrid orbitals are made by combining $2p_x$, $2p_y$, and 2*s* atomic orbitals.

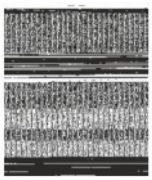
ANS: E DIF: Difficult REF: 2.2
OBJ: Understand bonding in methane and derivatives MSC: Understanding

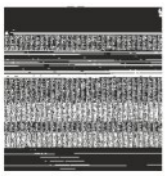
7. Which of the following Newman projections shows a dihedral angle of 60° between H_A and H_B?

a. 

b. 

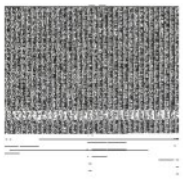
c. 

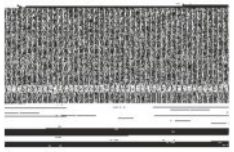
d. 

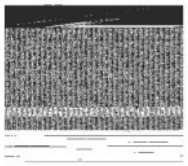
e. 

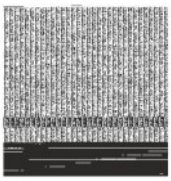
ANS: E DIF: Easy REF: 2.5
OBJ: Draw Newman projections MSC: Understanding

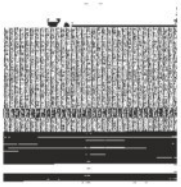
8. Which of the following structures is a depiction of structure A?

a. 

b. 

c. 

d. 

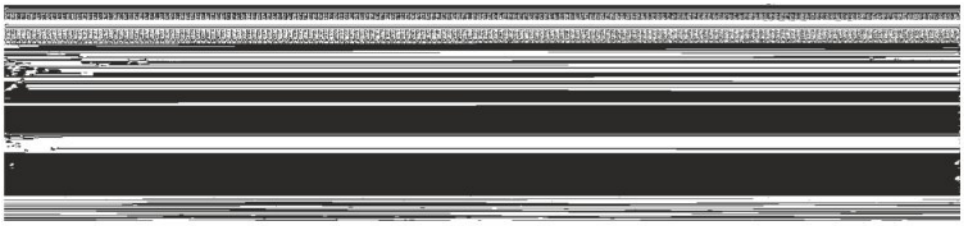
e. 

ANS: A DIF: Difficult REF: 2.5
OBJ: Draw Newman projections MSC: Analyzing

9. Which of the following statements about ethane is *false*?
   a. Staggered ethane is destabilized by interactions between filled C—H σ and empty C—H σ∗ orbitals.
   b. Staggered ethane is stabilized by interactions between filled C—H σ and empty C—H σ∗ orbitals.
   c. All staggered conformations are identical in energy, and all eclipsed conformations are identical in energy.
   d. The eclipsed conformation of ethane is an energy maximum between staggered conformations.
   e. The eclipsed conformation is stabilized by interactions between filled C—H σ bonds.

ANS: A DIF: Difficult REF: 2.5
OBJ: Understand conformational preferences of ethane MSC: Analyzing

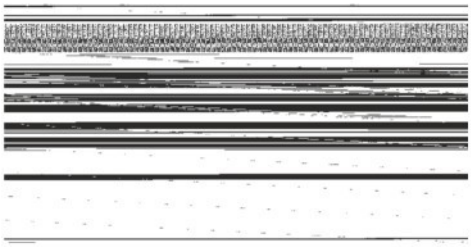
10. Which of these structures represent the *same* compound?

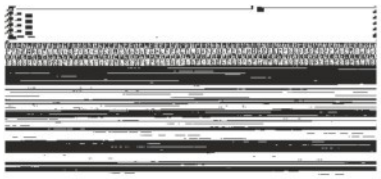


a. I and II
b. I and III
c. II and III
d. I, II, and III
e. They are all different compounds.

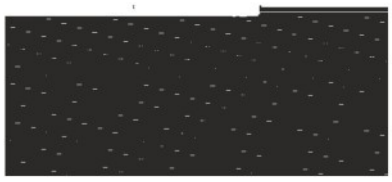
ANS: B DIF: Easy REF: 2.6 OBJ: Interpret line drawings
MSC: Understanding

11. Which of the following line structures corresponds to the Lewis structure shown here?

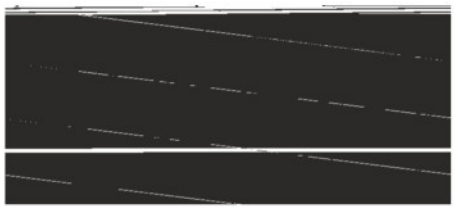


a. 

d.

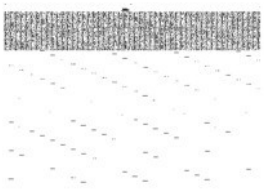
b. 

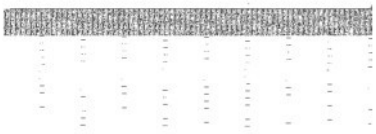
e. 

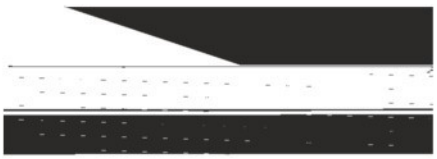
c. 

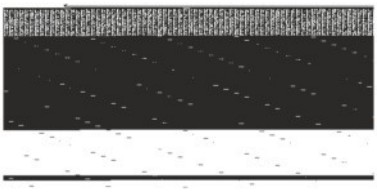
ANS: E DIF: Medium REF: 2.6 OBJ: Interpret line drawings
MSC: Understanding

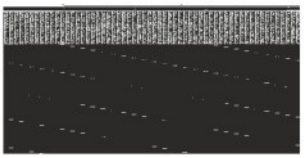
12. Which of the following compounds is *not* a constitutional isomer of the others?

a. 

b. 

c. 

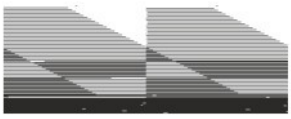
d. 

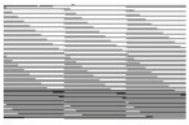
e. 

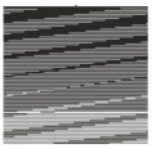
ANS: D DIF: Easy REF: 2.7
OBJ: Recognize constitutional isomers MSC: Understanding

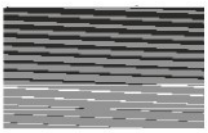
13. Which of the following compounds is *not* a constitutional isomer of the others?

a. 

b. 

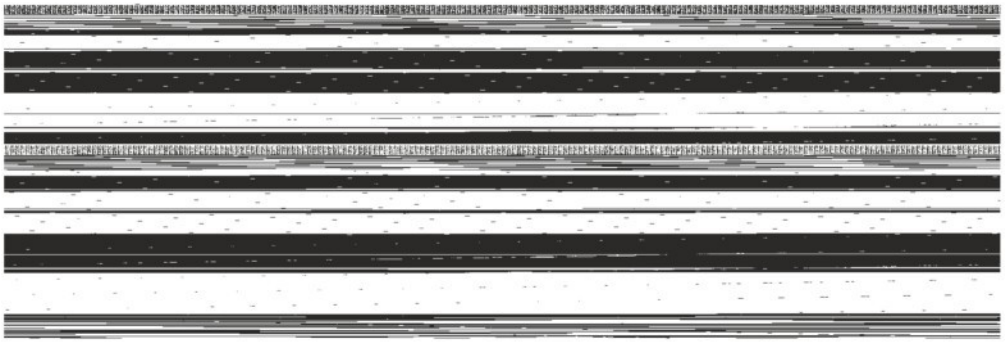
c. 

d. 

e. 

ANS: B DIF: Easy REF: 2.7
OBJ: Recognize constitutional isomers MSC: Understanding

14. Which of the following compounds are pairs of constitutional isomers?

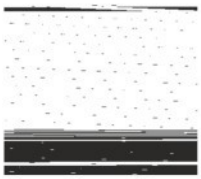


a. I and IV
b. I and III
c. II and III
d. II and IV
e. I and II

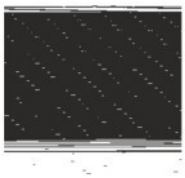
ANS: B DIF: Easy REF: 2.7
OBJ: Recognize constitutional isomers MSC: Analyzing

15. Which of the following structures is *not* a representation of 2-methylbutane?

a. 

b. 

c. 

d. 

e. 

ANS: B DIF: Medium REF: 2.7
OBJ: Draw Newman projections MSC: Applying