65. What is the formal charge on the nitrogen atom in the following compound?

A) -1  
B) -2  
C) +1  
D) +2  
E) 0  
Ans: C

Diazomethane has the molecular formula CH₂N₂. Draw the preferred Lewis structure for diazomethane and assign formal charges to all atoms, if any.

110. Which of the following is a correct resonance structure for compound A?

A) I  
B) II  
C) III  
D) IV  
E) None of these  
Ans: C
49. Which of the following compounds is most basic?

I

II

III

IV

A) I  
B) II  
C) III  
D) IV  
E) All of these  
Ans: D

66. Which of the indicated protons is most acidic? Explain your choice.

Ans: H-I is most acidic because the conjugate base is resonance stabilized. The negative charge is delocalized over four atoms, one oxygen atom and three carbon atoms.

122. Predict the product(s) for the following reaction and draw the curved arrow mechanism.

Ans:

8. What is the IUPAC name of the following compound?

A. 1-ethyl-2-methylcyclohexane  
B. 2-ethyl-1-methylcyclohexane  
C. 1-ethyl-2-methylhexane  
D. cyclononane  
Ans: A
41. Which of the following is a Newman projection for the following compound as viewed down the indicated bond in the conformation shown?

\[ \text{Ans: A} \]

63. Draw an energy diagram for rotation around the indicated bond of the following compound.

\[ \text{Ans:} \]

Draw the most stable chair conformer of the most stable isomer of 1,3,5-trimethylcyclohexane.

\[ \text{Ans:} \]

99. Draw the most stable chair conformation of the following cyclohexane.
107. Are the two substituents cis or trans?

A. trans  
B. cis  
C. neither  
Ans: A

18. Shown below is the structure of the drug nicotine. Locate the chirality center(s) in the following compound.

Ans:

23. Identify the relationship between the following two structures.

A. Enantiomers  
B. Identical  
C. Neither  
Ans: A

36. Assign the absolute configuration of the chirality center as R or S.

Ans: R
41. Drawn below is the structure of Cymbalta® (duloxetine), a medication used to manage depression. Assign the absolute configuration of the chirality center as R or S.

Ans: S

68. What is the relationship of the following two structures?

A. Enantiomers
B. Diastereomers
C. Constitutional isomers
D. Identical

Ans: D

91. Draw the meso isomer of the following compound.

Ans:

95. Draw the Fischer projection of the following compound.
103. Which of the following structures is the correct wedge/dash drawing of the following Fischer projection?

![Fischer projection]

Ans: B

122. Identify the relationship between these two structures.

![Stereochemistry structures]

A. Diastereomers
B. Enantiomers
C. The same compound
D. Unrelated compounds

Ans: A

18. Is the geometry of the following alkene E, Z, or neither?

![Alkene structure]

Ans: E

28. Rank the following from most to least stable.

![Stereochemistry structures]

A. B. C.

Ans: B, C, A
14. The expected major product of the following reaction is:

\[
\begin{align*}
\text{HBr} & \quad \text{?} \\
\end{align*}
\]

A)  
\[
\begin{align*}
\text{Br} & \quad \text{Br} \\
\end{align*}
\]
B)  
\[
\begin{align*}
\text{Br} & \\
\end{align*}
\]
C)  
\[
\begin{align*}
\text{Br} & \quad \text{Br} \\
\end{align*}
\]
D)  
\[
\begin{align*}
\text{Br} & \\
\end{align*}
\]
E)  
\[
\begin{align*}
\text{Br} & \quad \text{Br} \\
\end{align*}
\]

Ans: C

16. What is the expected major product for the following reaction?

\[
\begin{align*}
\text{HBr} & \quad \text{ROOR} & \quad \text{?} \\
\end{align*}
\]

A)  
\[
\begin{align*}
\text{Br} & \quad \text{Br} \\
\end{align*}
\]
B)  
\[
\begin{align*}
\text{Br} & \\
\end{align*}
\]
C)  
\[
\begin{align*}
\text{Br} & \quad \text{Br} \\
\end{align*}
\]
D)  
\[
\begin{align*}
\text{Br} & \\
\end{align*}
\]
E)  
\[
\begin{align*}
\text{Br} & \quad \text{Br} \\
\end{align*}
\]

Ans: D

20. Which of the alkenes below would be expected to produce at least one chirality center upon hydrohalogenation in the presence of peroxide?

A)  
\[
\begin{align*}
\text{Br} & \quad \text{Br} \\
\end{align*}
\]
B)  
\[
\begin{align*}
\text{Br} & \\
\end{align*}
\]
C)  
\[
\begin{align*}
\text{Br} & \quad \text{Br} \\
\end{align*}
\]
24. Which of the following carbocations is (are) likely to undergo rearrangement through a hydride shift?

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

Ans: D

30. Identify the expected product(s) for the reaction shown below:

\[ \text{HBr} \rightarrow \]

- A)
- B)
- C)
- D)
- E)

Ans: C
46. What is the expected major product for the following reaction?

\[
\begin{align*}
\text{1. } & \text{Hg(OAc)}_2, \text{H}_2\text{O} \\
\text{2. } & \text{NaBH}_4, \text{NaOH}
\end{align*}
\]

\[\text{enantiomer} + \text{enantiomer}\]

A) \[\text{enantiomer} + \text{enantiomer}\]

B) \[\text{enantiomer} + \text{enantiomer}\]

C) \[\text{enantiomer} + \text{enantiomer}\]

D) \[\text{enantiomer} + \text{enantiomer}\]

E) \[\text{enantiomer} + \text{enantiomer}\]

Ans: C

53. What is (are) the expected major product(s) for the following reaction sequence?

\[
\begin{align*}
\text{1. } & \text{BH}_3\cdot\text{THF} \\
\text{2. } & \text{H}_2\text{O}_2, \text{NaOH}
\end{align*}
\]

\[\text{enantiomer} + \text{enantiomer} + \text{enantiomer}\]

I \[\text{enantiomer}\]

II \[\text{enantiomer}\]

III \[\text{enantiomer}\]

A) I

B) II

C) III
55. What is the expected major product for the following reaction sequence?

\[
\text{1. } \text{BD}_3 \cdot \text{THF} \\
\text{2. } \text{H}_2\text{O}_2, \text{NaOH}
\]

\[
\text{I} \quad \text{II} \quad \text{III} \quad \text{IV} \quad \text{V}
\]

A) I  
B) II  
C) III  
D) IV  
E) V  
Ans: D

79. Which of the statements is most correct regarding the products expected from the halogenation reaction shown below?

\[
\text{Br}_2, \text{CCl}_4
\]

I  
II  
III  
IV  
A) Equal amounts of I and II are produced.
B) Equal amounts of III and IV are produced.
C) Equal amounts of I and IV are produced.
D) Equal amounts of II and III are produced.
E) Equal amounts of I and III are produced.
Ans: B

88. Treatment of 1,2-dimethylcyclopentene with OsO₄, followed by aqueous NaHSO₃, produces which of the following:
97. What are the expected major products from the reaction sequence shown below? 

\[
\text{C}_6\text{H}_6 \xrightarrow{1. O_3} ? \xrightarrow{2. \text{Zn/H}_2\text{O}} \]

A) I 
B) II 
C) III 
D) IV 
E) V 
Ans: A

103. The expected product(s) resulting from addition of Br₂ to (E)-3-hexene would be:
A) a meso dibromide.
B) a mixture of optically active enantiomeric dibromides.
C) a mixture of optically inactive enantiomeric dibromides.
D) (Z)-3,4-dibromo-3-hexene.
E) (E)-3,4-dibromo-3-hexene.
Ans: A

105. What is the expected major product resulting from the acid-catalyzed hydration of 2,5-
117. For the reaction sequence shown, what are the expected *major* organic products?

\[
\begin{array}{c}
\text{CH}_3\text{CO} + \\
\text{CH}_3\text{CO} + \\
\text{CH}_3\text{CHO} + \\
\text{CH}_3\text{CO} + \\
\text{CH}_3\text{CO} + \\
\text{H}_3\text{C}-\text{COOH} \quad \text{O}=\text{C}=\text{O} \\
\text{II} \quad \text{III} \quad \text{IV} \quad \text{V}
\end{array}
\]

A) I  
B) II  
C) III  
D) IV  
E) V  
Ans: B
30. According to molecular orbital theory, how many $\pi$-antibonding molecular orbitals are there for benzene?
A) 1
B) 2
C) 3
D) 4
E) 5
Ans: C

39. Using a Frost circle, draw the molecular orbital energy diagram for the tropylium cation and predict if it is aromatic.
Ans: It is aromatic.

40. Using a Frost circle, draw the molecular orbital energy diagram for the cyclononatetraenyl cation and predict if it is aromatic.
Ans: It is not aromatic.
44. Which one of the following compound is aromatic?

A) I
B) II
C) III
D) IV

Ans: C

17. Provide the curved arrow mechanism for the following reaction.

\[
\begin{align*}
\text{C}_6\text{H}_6 & \xrightarrow{\text{HNO}_3/\text{H}_2\text{SO}_4} \text{C}_6\text{H}_4\text{NO}_2 \\
\text{Ans:} & \\
\text{O} & + \text{H}_3\text{O}^- + \text{H}_2\text{O} \\
& \xrightarrow{\text{O} = \text{N} = \text{O} + \text{H}_2\text{O}}
\end{align*}
\]
28. Predict the major product for the following reaction.

\[ \text{Ans:} \]

55. Arrange the following compounds in order of decreasing reactivity towards electrophilic aromatic substitution:

A) V>II>I>III>IV
B) II>V>III>I>IV
C) IV>I>III>V>II
D) III>II>I>IV>V
E) IV>V>II>I>III

Ans: C

72. Predict the major product for the following reaction.

\[ \text{Ans:} \]
19. Which one of the following is the strongest acid?
   A) benzoic acid
   B) 4-nitrobenzoic acid
   C) 4-ethylbenzoic acid
   D) 4-chlorobenzoic acid
   E) 4-hydroxybenzoic acid
   Ans: B

25. Predict the product for the following reaction.

   A) I
   B) II
   C) III
   D) IV
   E) V
   Ans: B
34. Predict the product for the following reaction sequence.
2-methyl-1-propanol $\xrightarrow{\text{PBr}_3}$ Mg/ether $\xrightarrow{1. \text{CO}_2}$ $\xrightarrow{2. \text{H}_3\text{O}^+}$

![Chemical Structures]

A) I  
B) II  
C) III  
D) IV  
E) none of these  
Ans: C

43. Provide the reagents necessary to carry out the following conversion.

![Conversion Diagram]

Ans: 1. PBr$_3$  
2. Mg/ether  
3. H$_2$C=O  
4. H$_2$O  
OR  
1. PBr$_3$  
2. Mg/ether  
3. CO$_2$  
4. H$_3$O$^+$  
5. LiAlH$_4$  
6. H$_2$O

44. Predict the product for the following reaction sequence.

![Conversion Diagram]

A) 2,2-dimethylpropanoic acid  
B) 3,3-dimethyl-2-butanone  
C) 2,2-dimethyl-1-propanol  
D) 2,2-dimethylbutanoic acid  
E) none of these  
Ans: C
73. Predict the product for the following reaction.

\[ \text{Ans: } \]

104. Predict the product for the following reaction sequence.

\[ \text{Ans: } \text{B} \]
60. Predict the product for the following reaction.

\[
\begin{align*}
\text{C}_8\text{H}_{16} & \xrightarrow{\text{excess CH}_3\text{OH}} \text{C}_8\text{H}_{16} \xrightarrow{\text{H}_2\text{SO}_4} \text{C}_8\text{H}_{16} \\
\text{I} & \quad \text{II} & \quad \text{III} \\
\text{IV} & \quad \text{V}
\end{align*}
\]

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

Ans: B

62. Provide the reagents necessary to carry out the following conversion.

\[
\begin{align*}
\text{C}_8\text{H}_{16} & \xrightarrow{1 \text{ mol OH} \; / \; \text{H}_2\text{SO}_4} \text{C}_8\text{H}_{16} \\
\text{Ans:} & \\
\end{align*}
\]

76. Predict the product for the following reaction and provide a curved arrow mechanism for the formation of the product.

\[
\text{Ans: }
\]