Matching - Match each item with the correct statement below.

a. substituent  
et. asymmetric carbon
b. structural isomers  
f. trans configuration
c. geometric isomers  
g. cis configuration
d. stereoisomers

____ 1. atom or group of atoms that can take the place of a hydrogen in a parent hydrocarbon molecule
____ 2. compounds that have the same molecular formula, but the atoms are joined in a different order
____ 3. arrangement in which substituted groups are on the same side of a double bond
____ 4. molecules in which atoms are joined in the same order but differ in the arrangements of their atoms in space
____ 5. arrangement in which substituted groups are on opposite sides of a double bond
____ 6. compounds that differ in the orientation of groups around a double bond
____ 7. carbon atom to which four different atoms or groups are attached

Match each item with the correct statement below.

a. condensed structural formula  
d. saturated compound
b. homologous series  
e. complete structural formula
c. unsaturated compound

____ 8. group of compounds in which there is a constant increment of change in molecular structure from one compound in the series to the next
____ 9. formula showing all the atoms and bonds in a molecule
____ 10. structural formula in which some bonds and/or atoms are left out
____ 11. organic compound that contains the maximum number of hydrogens per carbon atom
____ 12. organic compound that contains at least one double or triple carbon-carbon bond

Match each item with the correct statement below.

a. aromatic compound  
d. lignite
b. aliphatic hydrocarbon  
e. bituminous coal
c. anthracite coal

____ 13. any straight-chain or branched-chain alkane, alkene, or alkyne
____ 14. any hydrocarbon compound in which a ring has bonding similar to benzene
____ 15. hard coal, having a carbon content of over 80%
____ 16. brown coal, having a carbon content of approximately 50%
____ 17. soft coal, having a carbon content of 70–80%

Match each item with the correct statement below.

a. functional group  
f. halogen
b. hydroxyl group  
g. fatty acids
c. carbonyl group  
h. alcohol
d. carboxyl group  
i. glycerol
e. ether

____ 18. a specific arrangement of atoms in an organic compound that is capable of characteristic chemical reactions
____ 19. reacts with an alkane by a substitution reaction
____ 20. the OH functional group in alcohols
____ 21. a main component of fats and oils
____ 22. a compound in which oxygen is bonded to two carbon atoms
23. a carbon atom and an oxygen atom joined by a double bond
24. a carbonyl group attached to a hydroxyl group
25. carboxylic acids with long hydrocarbon chains
26. reacts with a carboxylic acid to form an ester

Match each item with the correct statement below.

a. substitution reaction
b. addition reaction
c. hydration reaction
d. hydrogenation reaction
e. dehydrogenation reaction

27. a reaction in which an atom or group of atoms replaces another atom or group of atoms
28. a reaction in which a substance is added at the double or triple bond of an alkene or alkyne
29. a reaction involving the addition of hydrogen to a carbon—carbon double bond to produce an alkane
30. a reaction involving the addition of water to an alkene
31. a reaction involving the loss of hydrogen

Multiple Choice - Identify the letter of the choice that best completes the statement or answers the question.

32. How many valence electrons does a carbon atom have?
   a. 1  
   b. 2  
   c. 3  
   d. 4

33. How many covalent bonds can each carbon atom form?
   a. 1  
   b. 2  
   c. 3  
   d. 4

34. How many double covalent bonds are in an alkane?
   a. 0  
   b. 1  
   c. 2  
   d. 3

35. Alkanes are hydrocarbons that contain what type of bonds?
   a. single covalent bonds only  
   b. at least one double bond  
   c. at least one triple bond  
   d. ionic bonds

36. What is the simplest alkane?
   a. butane  
   b. ethane  
   c. methane  
   d. pentane

37. How many carbons are in a molecule of hexane?
   a. 3  
   b. 4  
   c. 5  
   d. 6

38. What is the name of the alkane having five carbons?
   a. propane  
   b. methane  
   c. octane  
   d. pentane

39. What is the simplest straight-chain alkane?
   a. graphite  
   b. ammonia  
   c. methane  
   d. ethane

40. Which of the following is a condensed structural formula for propane?
   a. C\(_3\)H\(_8\)  
   b. CH\(_3\)CH\(_2\)CH\(_3\)  
   c. CH\(_2\)CH\(_2\)CH\(_3\)  
   d. CH\(_3\)CH\(_2\)CH\(_2\)CH\(_3\)

41. The names of the straight-chain alkanes all end with the suffix ____.
   a. -ene  
   b. -ine  
   c. -ane  
   d. -ino

42. The longest continuous carbon chain of a branched-chain hydrocarbon is called a(n) ____.
43. The name for an alkyl group that contains two carbon atoms is ____.
   a. diphenyl
   b. dimethyl
   c. ethyl
   d. propyl

44. What is the physical state of the smallest alkanes at room temperature?
   a. gas
   b. liquid
   c. solid
   d. gas or liquid

45. What is the general formula for a straight-chain alkane?
   a. C\textsubscript{n}H\textsubscript{2n}
   b. C\textsubscript{n}H\textsubscript{2n+2}
   c. C\textsubscript{n}H\textsubscript{2n+1}
   d. C\textsubscript{n}H\textsubscript{2n+3}

46. What is the increment of change in a series of straight-chain alkanes?
   a. CH
   b. CH\textsubscript{2}
   c. CH\textsubscript{3}
   d. CH\textsubscript{4}

47. What is the condensed structural formula for 2,2-dimethylbutane?
   a. CH\textsubscript{3}(CH\textsubscript{2})\textsubscript{2}CH\textsubscript{3}
   b. CH\textsubscript{3}CH\textsubscript{2}CH\textsubscript{2}CH\textsubscript{3}
   c. (CH\textsubscript{3})\textsubscript{2}C(CH\textsubscript{3})\textsubscript{2}
   d. C\textsubscript{6}H\textsubscript{14}\textsubscript{}(CH\textsubscript{3})\textsubscript{2}

48. What is the name of the compound CH\textsubscript{2}CH(CH\textsubscript{3})\textsubscript{2}C(CH\textsubscript{3})\textsubscript{3}?
   a. 1,1,2-trimethylpropane
   b. tetramethylpropane
   c. 2,2,3-trimethylbutane
   d. isoheptane

49. The condensed structural formula for 2,2,3-trimethylbutane is ____.
   a. CH\textsubscript{3}(CH\textsubscript{2})\textsubscript{3}CH\textsubscript{2}CH\textsubscript{3}
   b. CH\textsubscript{3}CH\textsubscript{2}CH\textsubscript{2}CH\textsubscript{3}
   c. CH\textsubscript{2}(CH\textsubscript{2})\textsubscript{2}CH(CH\textsubscript{3})\textsubscript{2}
   d. CH\textsubscript{3}CH\textsubscript{2}CH(CH\textsubscript{3})\textsubscript{2}C(CH\textsubscript{3})\textsubscript{3}

50. In which of the following liquids is hexane most likely to dissolve?
   a. aqueous ammonium hydroxide
   b. vinegar
   c. rubbing alcohol
   d. octane

51. Why are the molecules of hydrocarbons nonpolar?
   a. The intermolecular attractions are strong.
   b. All the bonds are single covalent bonds.
   c. The electron pair is shared almost equally in all the bonds.
   d. Van der Waals forces overcome polarity.

52. Which of the following compounds is an unsaturated hydrocarbon?
   a. methane
   b. propyne
   c. nonane
   d. methyl

53. In which of the following compounds does rotation occur around all covalent bonds between carbons?
   a. octene
   b. octyne
   c. ethene
   d. all of the above

54. A saturated straight-chain hydrocarbon with two carbons is ____.
   a. ethene
   b. decane
   c. propane
   d. ethane

55. The general name for hydrocarbons with at least one triple covalent bond is ____.
   a. alkenes
   b. alkyls
   c. alkanes
   d. alkynes

56. Which of these compounds is an alkene?
   a. methane
   b. nonene
   c. butyne
   d. propanone

57. What is the name of the smallest alkyne?
   a. butyne
   b. vinyl
   c. methyne
58. An organic compound that contains only carbon and hydrogen and at least one carbon-carbon triple bond is classified as an ____.
   a. alkane  
   b. alken 
   c. alkyne  
   d. arene

59. How are hydrogen atoms arranged in ethene?
   a. in the same plane, separated by angles of 120°  
   b. in different planes, separated by angles of 120°  
   c. in the same plane, separated by angles of 180°  
   d. in different planes, separated by angles of 180°

60. Which of the following compounds is a structural isomer of butane?
   a. 2-methylbutane  
   b. 2,2-di methylbutane  
   c. 2-methylpropane  
   d. 2,2-diethylpropane

61. Which of the following is true about structural isomers?
   a. Structural isomers have the same molecular formula.  
   b. Structural isomers have different physical and chemical properties.  
   c. Structural isomers have the same elemental composition.  
   d. all of the above

62. A structural isomer of hexane is ____.
   a. 2,2-dimethylbutane  
   b. cyclohexane  
   c. benzene  
   d. 2-methylpentene

63. In the *cis* configuration, the methyl groups are placed ____.
   a. in between the double bonds  
   b. on opposite sides of the double bond  
   c. to the left of the double bond  
   d. on the same side of the double bond

64. Alkanes do not have geometric isomers because the carbon atoms in their carbon-carbon bonds are ____.
   a. double bonds  
   b. quite polar  
   c. free to rotate  
   d. asymmetric

65. How many different atoms or groups are attached to an asymmetric carbon?
   a. 2  
   b. 4  
   c. 6  
   d. 8

66. Hydrocarbons containing a saturated carbon ring are called ____.
   a. cyclic hydrocarbons  
   b. aromatic hydrocarbons  
   c. aliphatic hydrocarbons  
   d. alkylated hydrocarbons

67. Which hydrocarbon rings are most common in nature?
   a. rings with 3 or 4 carbon atoms  
   b. rings with 4 or 5 carbon atoms  
   c. rings with 5 or 6 carbon atoms  
   d. rings with 6 or 7 carbon atoms

68. In a cyclic hydrocarbon with only carbon-carbon single bonds and *n* number of carbon atoms, how many hydrogen atoms are there in terms of *n*?
   a. 2 − *n*  
   b. 2* n*  
   c. 2 + *n*  
   d. 2<n>

69. What compound is the simplest aromatic compound?
   a. methane  
   b. ethene  
   c. ethyne  
   d. benzene

70. Which of the following molecules does NOT display resonance?
   a. benzene  
   b. phenylethane  
   c. *m*-xylene  
   d. cyclohexane

71. Which of the following is NOT an important fossil fuel?
   a. petroleum  
   b. hydrogen  
   c. natural gas  
   d. coal

72. What is the first stage in the formation of coal?
73. What is the main hydrocarbon component of natural gas?
   a. benzene  
   b. ethane  
   c. ethene  
   d. methane

74. Which type of coal has the highest carbon content?
   a. anthracite  
   b. bituminous  
   c. lignite  
   d. peat

75. The controlled process by which hydrocarbons are broken down or rearranged into smaller, more useful molecules is called ____.
   a. vaporizing  
   b. cracking  
   c. distillation  
   d. fractionating

76. What is the first step in the refining of petroleum?
   a. cracking  
   b. drilling  
   c. cooling  
   d. distillation

77. Which of the following is NOT a fraction obtained from crude oil?
   a. ammonia  
   b. natural gas  
   c. gasoline  
   d. kerosene

78. Which of the following is NOT a product obtained from the distillation of coal tar?
   a. benzene  
   b. coke  
   c. phenol  
   d. toluene

79. What is the name of the functional group in the following compound?

   O
   CH₃—O—C—CH₂—CH₃

   a. halogen  
   b. ester  
   c. carbonyl  
   d. carboxylic acid

80. The most important way to classify organic compounds is by ____.
   a. the number of carbon atoms in the longest chain  
   b. functional group  
   c. the type of carbon—carbon bonds  
   d. reactivity

81. What is the common name of the following compound?

   CH₃  
   CH₃—C—Br  
   CH₃

   a. isopropyl bromide  
   b. tert-butyl bromide  
   c. isobutyl bromide  
   d. sec-butyl bromide

82. Which halocarbon has the highest boiling point?
   a. 1-chloropropane  
   b. 2-chloropropane  
   c. 1,2,3-trichloropropane  
   d. 2-dichloropropane

83. What is the carbon skeleton of the product formed in the following reaction?

   C₂H₅ + HBr →

   a. C—C—C—Br  
   b. C—C=Br

84. Which of the following compounds is trichloromethane?
   a.  
   b.  
   c.  
   d.  

85. An example of a secondary alcohol is shown by the structure____.
   a.  
   b.  
   c.  
   d.  

86. Which of the following compounds is a secondary alcohol?
   a.  
   b.  
   c.  
   d. none of the above

87. Phenols are characterized by____.
   a. their behavior as gases  
   b. ether linkages  
   c. an —OH group on a benzene ring  
   d. their use as flavoring agents

88. What is the common name of the following alcohol?
   a. sec-hexyl alcohol  
   b. tert-hexyl alcohol  
   c. isohexyl alcohol  
   d. hexyl alcohol

89. Which of the following compounds is a glycol?
   a.  
   b.  
   c.  
   d.  

90. Which pair of formulas represents the same compound?
   a.  
   b.  
   c.  
   d.  
91. Which of the following is true about isopropyl alcohol?
   a. It has a relatively high boiling point.  
   b. It is insoluble in water.  
   c. It is completely odorless.  
   d. It is white.

92. Which of the following alcohols is used in antifreeze?
   a. ethanol  
   b. isopropyl alcohol  
   c. ethylene glycol  
   d. glycerol

93. What substance is added to an organic molecule to test for the degree of saturation?
   a. water  
   b. hydrogen gas  
   c. bromine  
   d. hydrogen bromide

94. In an addition reaction, which bond of the reactant is broken?
   a. carbon—carbon single bond  
   b. carbon—hydrogen single bond  
   c. carbon—carbon double bond  
   d. carbon—hydrogen double bond

95. What type of compound is \( \text{CH}_3\text{--O--CH}_2\text{--CH}_2\text{--CH}_3 \)?
   a. alcohol  
   b. aldehyde  
   c. ether  
   d. ketone

96. Which of the following compounds has the lowest boiling point?
   a. diethyl ether  
   b. 2-butanol  
   c. diphenyl ether  
   d. 4-octanol

97. The functional group in \( \text{CH}_3\text{--O--CH}_2\text{--CH}_2\text{--CH}_2\text{--CH}_3 \) is a(n) ___.
   a. ester  
   b. ether  
   c. carbonyl  
   d. carboxyl

98. Name the following compound.
   \( \text{CH}_3\text{--CH}_2\text{--CH}_2\text{--O--C}_6\text{H}_5 \)
   a. cyclohexylbutyl ether  
   b. butylcyclohexyl ether  
   c. phenylbutyl ether  
   d. butylphenyl ether

99. Name the compound \( \text{CH}_2\text{CH}_2\text{O CH}_2\text{CH}_2\text{CH}_3 \).
   a. diethyl ether  
   b. dipropyl ether  
   c. ethylpropyl ether  
   d. pentane oxide

100. Which of these compounds would you expect to be most soluble in water?
   a. \( \text{CH}_3\text{CH}_2\text{Cl} \)  
   b. \( \text{CH}_3\text{CH}_2\text{CH}_2\text{F} \)  
   c. \( \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3 \)  
   d. \( \text{CH}_3\text{CH}_2\text{CH}_2\text{OH} \)

101. Which carbon skeleton represents an ether?
   a. \( \text{C--C--O--C--C--C} \)  
   b. \( \text{C--C--C--C--C--C} \)  
   c. \( \text{C--C--C--C--O} \)  
   d. none of the above

102. What type of compound is the following?
   \( \text{CH}_3\text{--C--CH}_2\text{--CH}_3 \)
   a. alcohol  
   b. aldehyde  
   c. ether  
   d. ketone

103. What is the name of the following compound?
104. What is the name of the following compound?

\[
\text{C}_6\text{H}_5-\text{C}-\text{H}
\]

a. phenylhyde  

b. cyclohexylhyde  

c. benzaldehyde  

d. phenol aldehyde

105. Which carbon skeleton represents an aldehyde?

- a. \(\text{C}-\text{C}-\text{C}=\text{O}\)  

- b. \(\text{C}-\text{C}=\text{O}\)  

- c. \(\text{C}-\text{C}=\text{O}\)  

- d. none of the above

106. Which carbon skeleton represents a ketone?

- a. \(\text{C}-\text{C}-\text{C}=\text{O}\)  

- b. \(\text{C}=\text{C}-\text{C}\)  

- c. \(\text{C}-\text{C}=\text{O}\)  

- d. \(\text{C}-\text{C}=\text{O}\)

107. Aldehydes have the general structure ___________.

- a. \(\text{R}-\text{C}=\text{O}\)  

- b. \(\text{R}-\text{C}=\text{H}\)  

- c. \(\text{R}-\text{C}=\text{OH}\)  

- d. \(\text{R}-\text{C}=\text{OR}\)

108. A ketone has the general structure ___________.

- a. \(\text{R}=\text{O}=\text{R}\)  

- b. \(\text{R}-\text{C}=\text{H}\)  

- c. \(\text{R}-\text{C}=\text{O}\)  

- d. \(\text{R}-\text{C}=\text{OR}\)
109. Based on your knowledge of intermolecular forces, which of the following would you expect to have the highest boiling point?
   a. hexanol  
   b. hexane  
   c. hexanal  
   d. hexanone

110. What is the name of the following compound?
   CH₃CCH₂CH₃
   a. butane  
   b. butanal  
   c. butanol  
   d. butanone

111. Which of the following compounds has the highest boiling point?
   a. 2-pentanone  
   b. pentane  
   c. pentene  
   d. chloropentane

112. Which carbon skeleton contains a carboxyl group?
   a.  
   b.  
   c.  
   d.  

113. Which of the following carbon skeletons represents a carboxylic acid?
   a.  
   b.  
   c.  
   d.  

114. Which of the following compounds is known as acetic acid?
   a.  
   b.  
   c.  
   d.  

115. Which of the following compounds is the most soluble in water?
   a. propanal  
   b. 1-bromopropane  
   c. propane  
   d. propanoic acid

116. The IUPAC name for a carboxylic acid with two carbons in a straight chain would be _____.
   a. ethanalic acid  
   b. dimethylmethanoic acid  
   c. methacarboxylic acid  
   d. ethanoic acid
117. Which of the following compounds has the highest boiling point?
   a. butane
   b. butanoic acid
   c. butanal
   d. ethyl acetate

118. Esters contribute which property to fruits?
   a. odor
   b. color
   c. texture
   d. skin thickness

119. Which carbon skeleton represents an ester?
   a.  
   b.  
   c.  
   d.  

120. When an oxygen atom is attached to a carbon atom, the carbon atom becomes more ____.
   a. oxidized
   b. reduced
   c. acidic
   d. basic

121. Which of the following is a test for aldehydes?
   a. Fehling's test
   b. flame test
   c. Butler's test
   d. acid test

122. If a primary alcohol is oxidized, the type of molecule it becomes is called a(n) ____.
   a. carboxylic acid
   b. ketone
   c. alcohol
   d. aldehyde

123. Which of the following compounds is the most reduced?
   a. ethene
   b. carbon dioxide
   c. propanone
   d. ethane

124. Which of the following compounds will produce the least energy when completely oxidized?
   a. hexanoic acid
   b. hexanol
   c. hexane
   d. hexanal

125. What is the expected product when 1-propanol is oxidized?
   a. propanal
   b. propanone
   c. propanoic acid
   d. propene

126. The monomer used as the building block in polyethylene is ____.
   a. ethane
   b. ethene
   c. monoethane
   d. amino acid

127. What type of chemical bond links the monomers in a polymer?
   a. ionic bond
   b. hydrogen bond
   c. metallic bond
   d. covalent bond

128. What happens in a condensation reaction?
   a. head-to-tail joining of monomers
   b. side-by-side joining of monomers
   c. cross-linking of monomers
   d. substitution of a halogen on monomers

Short Answer

129. How many carbon and hydrogen atoms are in a methane molecule?
130. How many carbon and hydrogen atoms are in a 1-octene molecule?

131. How many more hydrogen atoms does a cyclohexane molecule have than a benzene molecule?

132. Write the general structure for halocarbon compounds.

133. Write an equation using structural formulas for the reaction of benzene and chlorine.

134. Write complete, balanced equations for the reaction of 2-pentene and water. Use structural formulas.

135. Write the general structure for aldehyde compounds.

136. Draw the structure of benzaldehyde.

137. Write the general structure for carboxylic acid compounds.

138. Write the general structure for ester compounds.

139. What is the expected product when the following compound is oxidized?

\[
\text{CH}_3\text{CH}=	ext{CH}\text{CH}=	ext{CH}\text{CH}_2\text{OH}
\]

140. Complete the condensation polymerization reaction between two amino acids to form a peptide bond:

\[
\begin{align*}
\text{H} & -\text{N} - \text{C} - \text{C} - \text{OH} + \text{H} -\text{N} - \text{C} - \text{C} - \text{OH} \\
\text{H} & \text{H} & \text{R} & \text{O} & \text{O} & \text{R} & \text{H} & \text{H}
\end{align*}
\]

**Numeric Response**

141. How many arrangements are possible for two methyl groups with respect to a rigid double bond?

142. How many forms of coal are there?

143. What percent of the composition of natural gas is methane?

**Essay**

144. Explain why carbon is able to form such a large number of compounds.

145. Explain why hydrocarbon compounds are not soluble in water.

146. Why does the presence of a double or triple bond have little effect on the physical properties of an aliphatic hydrocarbon?

147. Describe in your own words what the difference is between unsaturated and saturated hydrocarbons. What is a saturated compound saturated with?

148. Describe the arrangement of atoms in ethyne. What is the significance of this arrangement?

149. Explain how geometric isomers differ from each other. Describe the difference between the *trans* and *cis* configurations of geometric isomers. Provide an example of each configuration for a molecule that has geometric isomers.

150. What are optical isomers? Provide examples.

151. Why is benzene not as reactive as other six-carbon alkenes?

152. Why is burning coal a major source of pollution?
153. Describe how fractional distillation is used to refine petroleum. Relate the structure of hydrocarbons present in crude oil to their boiling points.

154. Describe what happens in a substitution reaction. Give an example of a substitution reaction and name the atoms involved in the replacement.

155. Compare the properties of the alcohols with the properties of the halocarbons and the alkanes.

156. Give an example of an addition reaction and describe what happens in the reaction.

157. Compare the properties of the aldehydes and ketones with the properties of alcohols, ethers, alkanes, and halocarbons.

158. Compare the properties of carboxylic acids with the properties of compounds with other functional groups.


160. Describe a polymerization condensation reaction. Give an example.