Practice Problems for Chapter 21

1. Name the following:

\[
\begin{align*}
\text{CH}_3\text{CH}_2\text{CCH}_3 \\
\text{CH}_3
\end{align*}
\]

A) isopropane  
B) methylpentane  
C) methylbutane  
D) \(n\)-pentane  
E) dodecane

2. Name the following:

\[
\begin{align*}
\text{CH}_3 \\
\text{CH}_3\text{CH}_2\text{CCH}_3 \\
\text{CH}_2\text{CH}_3
\end{align*}
\]

A) \(n\)-heptane  
B) 2-methyl-2-ethylbutane  
C) 3,3-dimethylpentane  
D) 2,2-diethylpropane

3. Name the following:

\[
\begin{align*}
\text{H} \\
\text{HCH} \\
\text{H} \text{ HCH} \text{ H} \text{ H} \text{ H} \\
\text{H} \text{ C} \text{ C} \text{ C} \text{ C} \text{ C} \text{ H} \\
\text{H} \text{ H} \text{ H} \text{ HCH} \text{ H} \\
\text{HCH} \\
\text{HCH} \\
\text{H}
\end{align*}
\]

A) 2,4-diethylpentane  
B) 3,5-dimethylheptane  
C) secondary ethylpentane  
D) 2,3-dimethyl-2,3-diethylpropane  
E) none of these
4. In lecture, a professor named a molecule 2-ethyl-4-tert-butylpentane. A student pointed out that the name was incorrect. What is the correct systematic name for the molecule?
   A) 2-ethyl-5-methylhexane
   B) 2-ethyl-4,5,5-trimethylhexane
   C) 3,5,6,6-tetramethylheptane
   D) 2,2,3,5-tetramethylheptane
   E) undecane
5. Structural isomers have
   A) different molecular formulas and different structures.
   B) different molecular formulas but the same structure.
   C) the same molecular formula and the same structure.
   D) the same molecular formula but different structures.
   E) none of these
6. How many structural isomers does propane have?
   A) 3
   B) 2
   C) 1
   D) 5
   E) 4
7. The product of ethane undergoing dehydrogenation is called
   A) propene.
   B) methene.
   C) ethene.
   D) propane.
   E) none of these
8. Which of the following, upon reacting with oxygen, would form the greatest amount of carbon dioxide?
   A) n-pentane
   B) isopentane
   C) neopentane
   D) Two of these would form equal amounts.
   E) All of these would form equal amounts.
9. Which of the following has the lowest boiling point?
   A) methane
   B) butane
   C) ethane
   D) propane
   E) All of these have the same boiling point.
10. Which of the following names is a correct one?
    A) 3,4-dichloropentane
    B) 1-chloro-2,4-methyl-3-ethylcyclohexane
    C) 1,1-dimethyl-2,2-diethylpentane
    D) cis-1,3-dimethylbutane
    E) 2-bromo-1-chloro-4,4-diethyloctane
11. What is the compound whose carbon skeleton (minus any hydrogen atoms) appears below?
    \[
    \begin{array}{c}
    \text{C} \\
    \text{C} \\
    \text{C}--\text{C}--\text{C}--\text{C}--\text{C}--\text{C} \\
    \text{C}--\text{C}--\text{C}--\text{C}--\text{C} \end{array}
    \]
    A) 2,4-diethyl-3,6-dimethylheptane
    B) 2,5-diethyl-4,6-diethylheptane
    C) 1,4-diethyl-3,6-dimethyl-tridecane
    D) 5-ethyl-3,4,6-trimethylloctane
    E) 4-ethyl-2,5,6-trimethylloctane
12. The compound below is the carbon skeleton (minus any hydrogen atoms) of
\[
\begin{array}{ccc}
  & C-C & \\
\mid & \mid & \\
C-C & C-C & C-C-C-C-C-C-C
\end{array}
\]

i. a \( \text{C}_{12}\text{H}_{26} \)

ii. a substituted octane

iii. a compound with 3 tertiary carbons

iv. a compound with 3 secondary carbons

v. a compound with 2 isopropyl groups

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

13. A student gave a molecule the following name:

3-methyl-4-isopropylpentane

However, the teacher pointed out that although the molecule could be correctly drawn from this name, the name violates the IUPAC rules. What is the correct (IUPAC) name for the molecule?

A) 4-isopropyl-3-methylpentane
B) 2-isopropyl-3-methylpentane
C) 1,1,2,3-tetramethylpentane
D) 2,3,4-trimethylhexane
E) 3,4-dimethylheptane

14. A student gave a molecule the following name:

2-ethyl-3-methyl-5-butylhexane

However, his TA pointed out that although the molecule could be correctly drawn from this name, the name violates the systematic rules. What is the correct (IUPAC) name for the molecule?

A) 3,4-dimethyl-6-butylheptane
B) 2-butyl-4,5-dimethylheptane
C) 5,7,8-trimethyldecane
D) 1,2-diethyl-3,6,7-trimethylnonane
E) 3,4,6-trimethyldecane
15. Name the following:

\[
\begin{align*}
&\text{A)} \quad \text{2,2,3,5-tetramethyl-7-propyl-7-\text{-}t\text{-}butyldecane} \\
&\text{B)} \quad \text{6-propyl-2,6-di-\text{-}t\text{-}butylnonane} \\
&\text{C)} \quad \text{2,2,5,7,8,8-hexamethyl-3,3-dipropynonane} \\
&\text{D)} \quad \text{isonanane} \\
&\text{E)} \quad \text{none of these}
\end{align*}
\]

16. How many isomers of C\textsubscript{4}H\textsubscript{10} are there?

A) 3  \\
B) 5  \\
C) 4  \\
D) 2  \\
E) 6

17. How many isomers are there with the formula C\textsubscript{3}H\textsubscript{4}? Include both structural and geometric isomers.

A) 3  \\
B) 2  \\
C) 5  \\
D) 6  \\
E) 4

18. 1-Propene undergoes hydrogenation. The product of this is

A) methane.  \\
B) ethane.  \\
C) propane.  \\
D) 2-propane.  \\
E) none of these

19. Which of the following is not a structural isomer of 1-pentene?

A) 2-pentene  \\
B) 2-methyl-2-butene  \\
C) cyclopentane  \\
D) 3-methyl-1-butene  \\
E) 1-methyl-cyclobutene

20. Which of the following is an incorrect name?

A) trans-1,2-dichloroethene  \\
B) butene  \\
C) ethyne  \\
D) cis-1,1-dichloropropane  \\
E) 1,1-dichloropropane

21. H\textsubscript{2}C\textsubscript{3}C\textsubscript{4}H\textsubscript{2}N(CH\textsubscript{3})\textsubscript{2} is

A) an alkyne and a secondary amine.  \\
B) an alkene and a primary amine.  \\
C) an alkene and a tertiary amine.  \\
D) an alkyne and a tertiary amine.  \\
E) none of these
22. Name the following:

\[ \text{CH}_2\text{CH}_3 \]
\[ \text{CH}_3 - \text{C} - \text{C}\equiv\text{C} - \text{H} \]

A) 1-hexyne  
B) 2-ethynyl butane  
C) 2-ethyl-3-butyne  
D) 3-methyl-1-pentyne  
E) 3-methyl-4-pentyne

23. Name the following:

\[ \text{Cl} \quad \text{CH}_3 \]
\[ \text{H}_3\text{C} - \text{C} = \text{C} - \text{Cl} \]

A) 2-chloro-3-chloro-cis-2-butene  
B) 2,3-dichloro-cis-2-butene  
C) 2,3-dichloro-trans-2-butene  
D) 1-chloro-1-methyl-2-chloro-propene  
E) 2,3-dichloro-1-methyl-propene

24. Name the following:

\[ \text{Br} \quad \text{H} \quad \text{H} \quad \text{H} \quad \text{Cl} \]
\[ \text{H} - \text{C} - \text{C} - \text{C} - \text{C} - \text{Cl} \]

A) 1,1,1-trichloro-5-bromo-3-pentene  
B) 5,5,5-trichloro-1-bromo-2-pentene  
C) 1,1,1-trichloro-5-bromo-2-pentene  
D) 1,1,1-trichloro-5-bromo-3-pentyne  
E) none of these

25. How many structural and geometric isomers are there of chloropropene?

A) 2  
B) 3  
C) 4  
D) 5  
E) more than 5

26. Consider the molecule \textit{trans}-2-butene. Which statement is true?

A) The molecule has two \( \pi \) bonds.  
B) There is free rotation around every bond in the molecule.  
C) \textit{Cis}-2-butene is its structural isomer.  
D) Carbon #2 exhibits sp\(^2\) hybridization.  
E) None of these
27. Which of the following compounds can exhibit geometric isomerism?
   A)  
   B)  
   C)  
   D)  
   E)  

28. Consider the following four compounds:

   Which of these compounds would have the same physical properties (melting point, boiling point, density, and so on)?
   A) I and II
   B) I and III
   C) II and III
   D) III and IV
   E) I and IV

29. Which of the following types of compounds lacks an \( sp^2 \)-hybridized carbon center?
   A) aldehydes
   B) ketones
   C) alcohols
   D) alkenes
30. For which of the following compound(s) are cis and trans isomers possible?
   A) 3,4-diethyl-3-hexene
   B) 2,3-dichloro-2-butene
   C) 2,2-dimethylcyclohexanol
   D) ortho-chloroaniline
   E) dibromoethyne

31. How many different possible tetramethylbenzenes exist?
   A) 2
   B) 3
   C) 4
   D) 5
   E) 6

32. Which of the following have a -C-O-C- functional group?
   A) esters
   B) ethers
   C) amines
   D) aldehydes
   E) alcohols

33. The common name for 2-propanol is
   A) n-propyl alcohol.
   B) ethanol.
   C) methanol.
   D) isopropyl alcohol.
   E) none of these

34. In which of the following lists do all members have a C=O bond?
   A) ester, aldehyde, secondary alcohol, ketone
   B) any alcohol, ether, ester
   C) secondary alcohol, ketone, aldehyde
   D) ester, aldehyde, ketone
   E) carboxylic acid, ether, tertiary alcohol

35. Identify the type of organic compound shown:
   \((\text{CH}_3)_2\text{CHNH}_2\)
   A) primary alcohol
   B) primary amine
   C) tertiary amine
   D) carboxylic acid
   E) ether

36. Name the following:
   \(\text{H} \quad \text{H}_3\text{CO}-\text{C} \quad \text{H} \quad \text{H}_2\text{C} \quad \text{CH} \quad \text{H} \quad \text{H}_3\text{CO} \quad \text{C} \quad \text{H} \quad \text{H} \quad \text{H}_3\text{CO} \quad \text{C} \quad \text{H} \quad \text{H} \quad \text{H}
   
   A) \(n\)-propyl acetate
   B) isopropyl formate
   C) isopropyl acetate
   D) ethyl propanoate
   E) none of these
37. Name the following:

\[ \begin{align*}
&\text{H} \quad \text{H} \quad \text{H} \\
&\text{H} - \text{C} - \text{C} - \text{C} - \text{H} \\
&\text{H} \quad \text{OH} \quad \text{H}
\end{align*} \]

A) methyl alcohol  
B) ethyl alcohol  
C) propyl alcohol  
D) isopropyl alcohol  
E) butanol

38. Name the following:

\[ \begin{align*}
&\text{H} \quad \text{H} \quad \text{H} \quad \text{H} \\
&\text{H} - \text{C} - \text{C} - \text{C} - \text{C} - \text{H} \\
&\text{H} \quad \text{H} \quad \text{H} \quad \text{H} \quad \text{H}
\end{align*} \]

A) acetone  
B) butyraldehyde  
C) diethylketone  
D) diethyl ether  
E) none of these

39. Name the following:

\[ \begin{align*}
&\text{CH}_3 - \text{CH} - \text{CH} - \text{C} - \text{CH(CH}_3)_2 \\
&\text{CH}_2 \\
&\text{CH}_3
\end{align*} \]

A) 2-chloro-3-ethyl-1-isopropylbutanone  
B) isopropyl-chloro, methylbutyl ketone  
C) 2-butylchloro, isobutanoyl methane  
D) 4-chloro-2,5-dimethyl-3-heptanone  
E) 3-methyl-4-chloro-1-isopropylpentanone

40. Identify the type of organic compound shown:

\[ \begin{align*}
&\text{CH}_3 - \text{C} = \text{O} \\
&\text{C} \\
&\text{CH}_3
\end{align*} \]

A) aldehyde  
B) ester  
C) amine  
D) ketone  
E) none of these
41. Identify the type of organic compound shown:

\[ \begin{array}{c}
\text{H} \\
\text{H} \\
\text{H} \quad \text{C} \quad \text{C} \quad \text{C} = \text{O} \\
\text{H} \\
\text{H} \\
\text{H} \\
\end{array} \]

A) aldehyde
B) ester
C) amine
D) ketone
E) none of these

42. Classify the following molecule:

\[ \begin{array}{c}
\text{CH}_3 \\
\text{H} \\
\text{H}_3\text{C} - \text{C} - \text{C} - \text{CH}_2 - \text{CH}_3 \\
\text{H} \\
\text{H} \\
\end{array} \]

A) primary alcohol
B) secondary alcohol
C) tertiary alcohol
D) ether
E) phenol

43. Identify the secondary amine.
A) \( \text{CH}_3\text{CH}_2\text{NH}_2 \)
B) \( \text{CH}_2\text{NHCH}_3\text{CH}_3 \)
C) \( \begin{array}{c}
\text{H} \\
\text{H} \\
\text{H} \\
\text{H} \\
\text{H} \\
\text{H} \\
\text{NH}_2 \\
\text{H} \\
\end{array} \)
D) \( \text{NH}_2\text{OH} \)
E) \( (\text{CH}_3)_2\text{NCH}_2\text{CH}_3 \)

44. Classify the following molecule:

\[ \begin{array}{c}
\text{CH}_3 \\
\text{H} \\
\text{NH}_2 \\
\text{CH} - \text{CH} - \text{CH}_3 \\
\end{array} \]

A) primary amine
B) secondary amine
C) tertiary amine
D) amino acid
E) peptide

45. Classify the following molecule:

\[ \begin{array}{c}
\text{H}_3\text{C} - \text{C} - \text{H} \\
\text{H} \\
\text{O} \\
\end{array} \]

A) acid
B) aldehyde
C) amine
D) ketone
E) carbonyl
46. If you were to heat pentanoic acid and 2-butanol with an acid catalyst, which of the following would you be most likely discover in your flask?
   A) a ketone
   B) an ester
   C) an amine
   D) an alkane
   E) an aldehyde

47. Classify the following molecule:
   \[ \text{H}_3\text{C} \quad \text{C} \quad \text{CH}_2\text{CH}_3 \]
   A) acid
   B) aldehyde
   C) amine
   D) ketone
   E) carbonyl

48. Refer to the following structures. Which of the statements below is true of them?
   A) I and II have different molecular formulas.
   B) I and III are structural isomers of each other.
   C) II and III are stereoisomers of each other.
   D) II and III are different conformations of the same compound.
   E) I and III are the same compound.

49. Which structure represents an optically active aldehyde?
   A)\[
   \text{H} \quad \text{C} \quad \text{O} \quad \text{CH}_2\text{CH}_2\text{OH}
   \]
   B) \[
   \text{HOCH}_2\text{CH}_2 \quad \text{C} \quad \text{OH}
   \]
   C) \[
   \text{HOCH}_2\text{CH}_2 \quad \text{O} \quad \text{C} \quad \text{H}
   \]
   D)\[
   \text{CH}_3\text{CH}_2 \quad \text{C} \quad \text{OH}
   \]
   E)\[
   \text{CH}_3\text{CH}_2 \quad \text{C} \quad \text{NH}_2
   \]
   F)\[
   \text{CH}_3\text{C} \quad \text{CH}_2\text{CHO}
   \]
50. Pick the optically active molecule among the following:
A) \[
\begin{array}{c}
\text{H} \\
\text{H} \\
\text{H} - \text{C} - \text{C} - \text{H} \\
\text{H} \\
\text{H}
\end{array}
\]
B) \[
\begin{array}{c}
\text{H} \\
\text{H} \\
\text{H} - \text{C} - \text{O} - \text{H} \\
\text{H}
\end{array}
\]
C) \[
\begin{array}{c}
\text{HO} \\
\text{H} \\
\text{H} - \text{C} - \text{C} - \text{H} \\
\text{Cl} \\
\text{H}
\end{array}
\]
D) \[
\begin{array}{c}
\text{HO} \\
\text{H} \\
\text{H} - \text{C} - \text{C} - \text{H} \\
\text{HO} \\
\text{H}
\end{array}
\]
E) none of these

51. Which of the following molecules exhibits chirality?
A) \(\text{CH}_4\)
B) \(\text{CH}_3\text{OH}\)
C) \(\text{CH}_3\text{CH}_2\text{OH}\)
D) \(\text{HO} - \text{C} - \text{C} - \text{H} - \text{OH} - \text{H}\)
E) \(\text{CH}_3\text{CCIFOH}\)

52. Which of the following is optically active (that is, chiral)?
A) diethylamine
B) difluoromethane
C) 2-bromopropane
D) 2-chloropentane
E) 1-chlorohexane

53. The boiling point of methanol is much higher than that of ethane. This is primarily due to
A) the difference between the molar mass of methanol and that of ethane.
B) the hydrogen bonding in methanol.
C) the significant molecular size difference between methanol and ethane.
D) the carbon-oxygen double bond in the methanol.
E) none of these

54. No atoms are lost from starting material in making which kind of polymer?
A) condensation polymer
B) polyester polymer
C) addition polymer
D) vulcanized polymer
E) branched polymer

55. Which of the following is the best description of a protein?
A) an alternating chain of amino acids and nucleic acids
B) a chain of amino acids connected by ester bonds
C) two antiparallel chains of nucleic acids connected by hydrogen bonding
D) a chain of amino acids formed by condensation polymerization
E) a chain of nucleotides connected by phosphodiester bonds
56. Which of the following pairs of substances could form a polyester?
   A) \( \text{H}_2\text{C} = \text{CHCH}_3 + \text{CH}_3\text{CH}_2\text{CH}_2\text{COOH} \)
   B) \( \text{HOOC(CH}_2)_2\text{COOH} + \text{H}_2\text{NCH}_2\text{CH} = \text{CHCH}_3 \)
   C) \( \text{H}_2\text{C} = \text{CH}_2 + \text{H}_2\text{C} = \text{CHCH}_3 \)
   D) \( \text{HOCH}_2\text{CH}_2\text{OH} + \text{HOOCCH}_2\text{COOH} \)
   E) \( \text{H}_2\text{NCH}_2\text{COOH} + \text{H}_2\text{NCOCH}_2\text{CH}_2\text{COOH} \)

57. Consider the polymer drawn below:

   \[
   \begin{array}{ccc}
   \text{CH}_3 & \text{CH}_3 & \text{CH}_3 \\
   \text{C} & \text{CH}_2 & \text{C} & \text{CH}_2 & \text{C} & \text{CH}_2 & \text{C} \\
   \text{CH}_3 & \text{CH}_3 & \text{CH}_3 & \text{CH}_3
   \end{array}
   \]

   What monomer(s) is (are) needed to produce the above polymer?
   A) \( \text{CH}_2 = \text{CH}_2 \) and \( \text{CH}_3\text{CH} = \text{CH}_2 \)
   B) \( \text{CH}_3\text{CH} = \text{CH}_2 \)
   C) \( \text{CH}_3 = \text{CH} = \text{CH}_2 \)
   D) \( \text{CH}_2 = \text{CH} - \text{CH} - \text{CH}_2 \)
   E) none of the above

58. What is added to form the polymer below?

   \[
   \begin{array}{ccc}
   \text{CH} & \text{CH} & \text{CH} & \text{CH} \\
   \text{CH}_3 & \text{CH}_3 & \text{CH}_3 & \text{CH}_3
   \end{array}
   \]

   A) \( \text{CH}_2 = \text{CH} - \text{CH}_3 \)
   B) \( \text{CH}_3\text{CH}_2\text{CH}_3 \)
   C) \( \text{CH}_3 - \text{CH} = \text{CH} - \text{CH}_3 \)
   D) \( \text{H}_2\text{C} = \text{CH} - \text{CH} - \text{CH}_2 \)
   E) \( \text{CH}_3\text{CH} = \text{C}(\text{CH}_3)_2 \)

59. Which of the following pairs of substances could form an addition copolymer?
   A) \( \text{HOOCCH}_2\text{OCH}_2\text{COOH} + \text{HOCH}_2\text{CH}_2\text{OH} \)
   B) \( \text{HO}(\text{CH}_2)_2\text{COOH} + \text{HOCH}_2\text{CH}_2\text{CH}_2\text{NH}_2 \)
   C) \( \text{H}_2\text{C} = \text{CHCH} = \text{CH}_2 + \text{H}_2\text{CCH} = \text{CHCH}_3 \)
   D) \( \text{HOCH}_2\text{CH}_2\text{OH} + \text{HOOCCH}_2\text{COOH} \)
   E) \( \text{H}_2\text{NCH}_2\text{COOH} + \text{H}_2\text{NCOCH}_2\text{CH}_2\text{COOH} \)

60. The structure of the polymer used in a freezer wrap can be described mainly as follows:

   \[
   \text{[CCl}_2 - \text{CH}_2 - \text{CCl}_2 - \text{CH}_2 - \text{CCl}_2 - \text{CH}_2 - \text{CCl}_2 - \text{CH}_2]_n
   \]

   The chief monomer of this wrap would have which structure?
   A) \( \text{CCl}_2 = \text{CH}_2 \)
   B) \( \text{Cl}_2\text{C} - \text{CH}_2 \)
   C) \( \text{Cl}_2\text{C} = \text{CH}_2 = \text{CCl}_2 \)
   D) \( \text{CCl}_2 \)
   E) none of these
61. Indicate which of the following monomers is(are) used to produce the polymer

\[ \left[ \begin{array}{ccc}
  & CH_3 & O \\
  O-CH-C-O-CH-C-O & CH_3 & O \\
  & CH-C-O-CH-C & \\
  & O & \\
\end{array} \right] \]

\[ n \]

I. \( HOOC-CH-COOH \)

II. \( HO-CH-COOH \)

III. \( HO-CH-C-OH \)

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

62. The formula below is the repeating unit of a

\[ \text{C} \quad \text{C} \quad \text{O} \quad \text{O} \quad \text{NH-CH}_2-\text{CH}_2-\text{NH} \quad n \]

A) homopolymer formed by an addition reaction.
B) homopolymer formed by a condensation reaction.
C) copolymer formed by an addition reaction.
D) copolymer formed by a condensation reaction.
E) polyester formed by an addition reaction.

63. What monomer(s) is(are) needed to make the polymer shown here?

\[ \left( \begin{array}{ccc}
  & O \\
  O-CH_2-CH_2-O & C & CH_2CH_2-C \\
  & O \\
\end{array} \right) \]

I. \( HOCH_2CH_2OH \)
II. \( HOOCCH_2CH_2COOH \)
III. \( HOCH_2CH_2COOH \)
IV. \( HOCH = CHOH \)
V. \( HOOCCH = CHCOOH \)

A) II only
B) III only
C) I and II
D) IV and V
E) II and III
### Answer Key

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