

HYDROCARBON COMPOUNDS**SECTION 22.1 HYDROCARBONS (pages 693–701)**

This section describes the bonding in hydrocarbons and distinguishes straight-chain from branched-chain alkanes. It also provides rules for naming branch-chained alkanes.

► Organic Chemistry and Hydrocarbons (pages 693–694)

1. What is organic chemistry? _____
2. Organic compounds that contain only carbon and hydrogen are called _____.
3. Is the following sentence true or false? Hydrogen atoms are the only atoms that can bond to the carbon atoms in a hydrocarbon. _____
4. Circle the letter of each statement that is true about carbon's ability to form bonds.
 - a. Carbon atoms have four valence electrons.
 - b. Carbon atoms always form three covalent bonds.
 - c. Carbon atoms can form stable bonds with other carbon atoms.

► Alkanes (pages 694–699)

5. Is the following sentence true or false? Alkanes contain only single covalent bonds. _____
6. What is the simplest alkane? _____
7. What are straight-chain alkanes? _____

8. The names of all alkanes end with the suffix _____.

Match the name of the straight-chain alkane with the number of carbon atoms it contains.

- | | |
|-------------------|------|
| _____ 9. nonane | a. 3 |
| _____ 10. propane | b. 4 |
| _____ 11. heptane | c. 7 |
| _____ 12. butane | d. 9 |

13. The straight-chain alkanes form a(n) _____ because there is an incremental change of a CH_2 group from one compound in the series to the next.

CHAPTER 22, Hydrocarbon Compounds (continued)

14. Circle the letter of each condensed structural formula for pentane.

- a. C_5H_{12}
- b. $CH_3CH_2CH_2CH_2CH_3$
- c. $CH_3(CH_2)_3CH_3$
- d. $C - C - C - C - C$

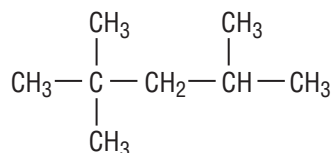
15. The IUPAC system uses _____ to show the number of carbon atoms in a straight-chain alkane.

16. A(n) _____ is an atom or group of atoms that replaces a hydrogen in a hydrocarbon molecule.

17. Alkyl groups are named by removing the *-ane* ending of the parent hydrocarbon and adding _____.

18. What is a branched-chain alkane? _____

19. Circle the letter of the correct IUPAC name for the molecule below.



- a. 2,2,4-triethylpentane
- b. 3-methylpentane
- c. 2,2,4-trimethylpentane

20. Draw a condensed structural formula for 2-methylhexane.

► Properties of Alkanes (page 700)

21. Why are hydrocarbon molecules such as alkanes nonpolar? _____

22. Hydrocarbons and other nonpolar molecules are not attracted to _____.



Reading Skill Practice

A flowchart can help you to remember the order in which events occur. On a separate sheet of paper, create a flowchart that describes the steps for naming branched-chain alkanes using the IUPAC system. This process is explained on page 698.

SECTION 22.2 UNSATURATED HYDROCARBONS (pages 702–703)

This section explains the difference between unsaturated and saturated hydrocarbons. It also describes the difference between alkenes and alkynes.

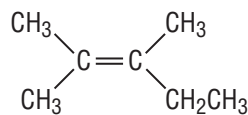
► Alkenes (page 702)

1. What is an alkene?

2. Organic compounds that contain the maximum number of hydrogen atoms per carbon atoms are called _____ compounds.

3. Which family of hydrocarbons are always saturated compounds?

4. Circle the letter of the correct name for the alkene shown below.



a. 2,3-dimethyl-3-pentene

c. 2,3-dimethyl-2-pentene

b. 2-methyl-3-methyl-2-pentene

d. 3-ethyl-2-methyl-2-butene

5. Is the following sentence true or false? Rotation can occur around a carbon-carbon double bond. _____

► Alkynes (page 703)

6. Hydrocarbons that contain one or more _____ covalent bonds between carbons are called alkynes.

7. _____ is the simplest alkyne, and is also known by the common name _____.

CHAPTER 22, Hydrocarbon Compounds (continued)

8. Circle the letter of each compound that is an aliphatic compound.
- 1-butene
 - acetylene
 - 2-methylpropane
9. What are the major attractive forces between alkane, alkene, or alkyne molecules?

10. Complete the table below with the names of the indicated alkanes, alkenes, and alkynes. For the alkenes and alkynes, assume that the multiple bond occurs between the first two carbons.

Number of Carbons	Alkane	Alkene	Alkyne
C ₆			
C ₇			
C ₈			

11. Is the following sentence true or false? The angle between the carbon atoms in a carbon-carbon triple bond is 120°. _____

SECTION 22.3 ISOMERS (pages 704–707)

This section explains how to distinguish among structural, geometric, and stereoisomers. It also describes how to identify the asymmetric carbon or carbons in stereoisomers.

► Structural Isomers (page 704)

1. What are structural isomers?

2. Is the following sentence true or false? Structural isomers have the same physical properties. _____

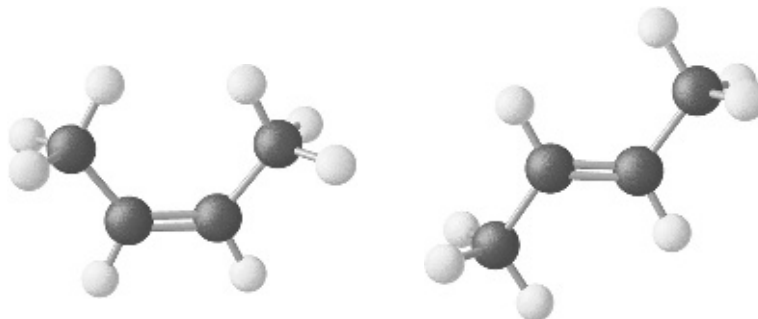
3. How many structural isomers are there for C₄H₁₀? _____

4. Name the structural isomers of C₄H₁₀. _____

5. In general, what determines which of two structural isomers will have the lower boiling point? _____

► **Stereoisomers (pages 705–706)**

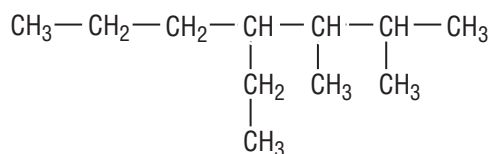
6. Stereoisomers differ only in the _____ .
7. What two things need to be present for geometric isomers to exist?
- a. _____
- b. _____
8. What are the names of the molecules represented by the ball-and-stick models below?



9. Objects that are _____ will produce a reflection that is indistinguishable from the original object.
10. Mirror images of a right hand and a left hand cannot be _____ .
11. What is an asymmetric carbon?

12. Is the following sentence true or false? The relationship of optical isomers is similar to that between right and left hands. _____
13. Look at Figure 22.9 on page 705. Why are these two molecules optical isomers?

14. Circle the two asymmetric carbons in the structure shown below.



CHAPTER 22, Hydrocarbon Compounds (continued)**SECTION 22.4 HYDROCARBON RINGS** (pages 709–711)

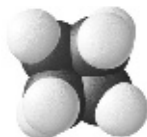
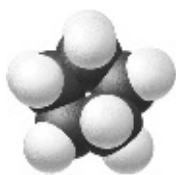
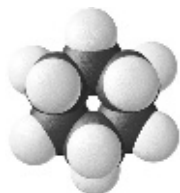
This section describes how to identify and classify cyclic hydrocarbons. It also explains the bonding in benzene.

► Cyclic Hydrocarbons (page 709)

1. What is a cyclic hydrocarbon?

2. The most abundant cyclic hydrocarbons contain _____ or _____ carbons.

3. What are the names of the cyclic hydrocarbons represented below?



- a. _____ b. _____ c. _____ d. _____

4. Is the following sentence true or false? Cyclic hydrocarbons that contain only single carbon–carbon bonds are called cycloalkanes. _____

► Aromatic Hydrocarbons (pages 710–711)

5. What is the origin of the name *aromatic compounds*?

6. Benzene has the chemical formula _____.

7. Is the following sentence true or false? Any substance that has carbon–carbon bonding like that of benzene is called an aromatic compound. _____

8. Another name for an aromatic compound is a(an) _____.

9. What does it mean to say that benzene exhibits resonance?

10. Molecules that exhibit resonance are more _____ than similar molecules that do not exhibit resonance.

11. The actual bonds in a benzene ring are identical _____ of single and double bonds.

12. When _____ is a substituent on an alkane, it is called a phenyl group.

CHAPTER 22, Hydrocarbon Compounds *(continued)*

6. Fill in the missing reactants and products in the equation for the combustion of methane.



7. Propane and butane are sold in _____ form to be used as _____ fuels.
8. _____ combustion of a hydrocarbon produces a blue flame; _____ combustion produces a yellow flame.
9. What toxic gas is formed during incomplete combustion of a hydrocarbon?

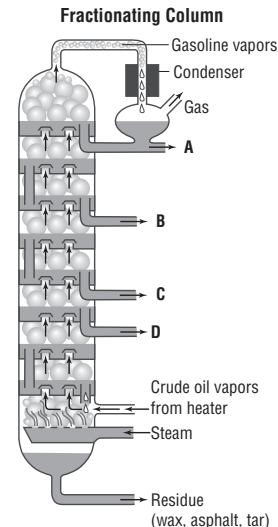
► Petroleum (page 713)

10. The first oil well was drilled in _____ in the late 1850s.
11. Is the following sentence true or false? Petroleum is commercially useful without refining. _____
12. How is petroleum refined?

13. Circle the letter of the distillation fraction that represents the highest percent of crude oil.
- a. natural gas
 - b. gasoline
 - c. kerosene
 - d. lubricating oil
14. Using a catalyst and heat to break hydrocarbons down into smaller molecules is called _____.

15. Complete the table below about four fractions obtained from crude oil. Indicate where each fraction will be collected from the fractionating column shown at the right.

Fraction	Composition of Carbon Chains	Where in Column?
Fuel oil		
Gasoline		
Lubricating oil		



► **Coal (pages 714–715)**

16. _____ is the intermediate material that is the first stage in coal formation.
17. Name the three types of coal and the carbon content of each.
- _____
 - _____
 - _____
18. Is the following sentence true or false? Coal mines in North America are usually at least a kilometer below Earth's surface. _____
19. Coal consists primarily of _____ compounds of extremely high molar mass.
20. Aromatic compounds produce more _____ when burned than do _____ fuels.
21. What major air pollutants are produced by burning coal that contains sulfur?

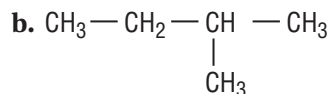
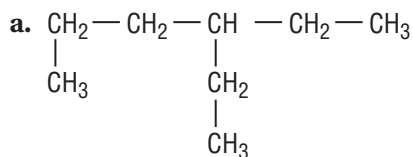
22. List four products that can be obtained by distilling coal.
- _____
 - _____
 - _____
 - _____
23. Which of these products can be distilled further?

CHAPTER 22, Hydrocarbon Compounds (continued)

GUIDED PRACTICE PROBLEM

GUIDED PRACTICE PROBLEM 3 (page 699)

3. Name these compounds according to the IUPAC system.



Use the steps on pages 698–699 to name each compound.

Step 1. How long is the longest string of carbon atoms? What is the name of the parent hydrocarbon structure?

a. _____ b. _____

Step 2. From which side will you number the carbon chain? Why?

a. _____

b. _____

Step 3. What are the names and positions of the substituents?

a. _____ b. _____

Step 4. Explain why neither name will contain a prefix.

a. _____

Step 5. Does the name contain any commas or hyphens?

a. _____

b. _____

Step 6. What is the complete name of each compound?

a. _____ b. _____

EXTRA PRACTICE PROBLEM (similar to Practice Problem 18, page 706)

18. Circle the symmetric carbon, if there is one, in each of these structures.

