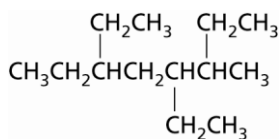


## CHAPTER 21 Hydrocarbons – Section 1 - Alkanes

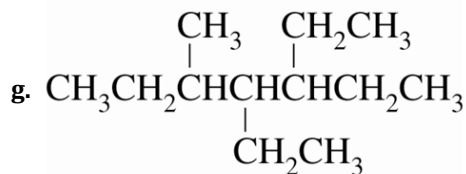
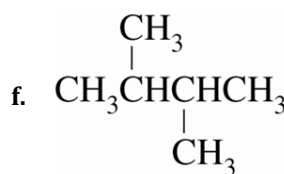
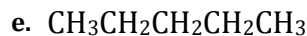
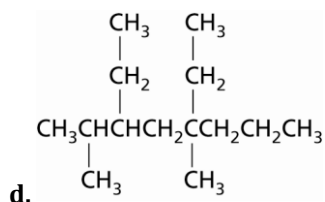
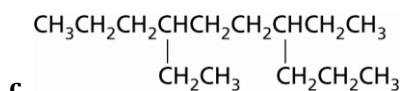
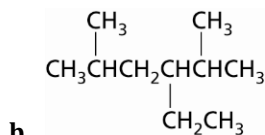
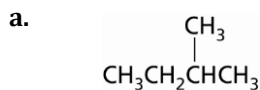
### Example Problem 1

#### Naming Branched-Chain Alkanes

Name the following alkane.



1. Name the compound represented by each of the following condensed structural formulas.



2. Write a condensed structural formula for each of these branched-chain alkanes.

a. 3-ethylpentane

b. 2,2-dimethyl-6-propylnonane

c. 2,3,3,5-tetramethylheptane

d. 4-ethyl-3,4,5-trimethyloctane

e. 4-propyloctane

f. 3,4-diethylhexane

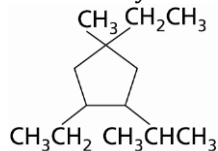
g. 2,2,4,4-tetramethylhexane

## Section 2 - Cycloalkanes

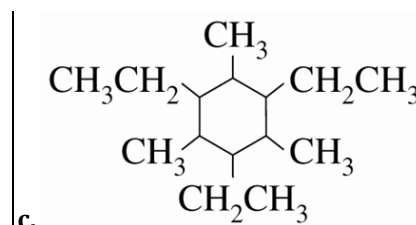
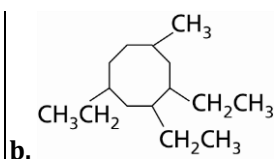
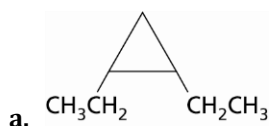
### Example Problem 2

#### Naming Substituted Cycloalkanes

Name the cycloalkane shown.



3. Name the compound represented by each structure.



4. Draw the structures of the following cycloalkanes.

a. propylcyclobutane

b. 1-ethyl-2,4-dimethylcyclopentane

c. 3-ethyl-5-isopropyl-1,1,2-trimethylcyclohexane

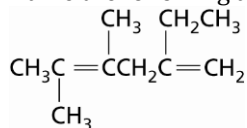
d. 1-ethyl-3-methyl-2-propylcyclopentane

## Section 3 - Alkenes and Alkynes

### Example Problem 3

#### Naming Branched-Chain Alkenes

Name the following alkene.



5. Name the compounds represented by these condensed structural formulas.

a.  $\text{CH}_3\text{CH}_2\text{CH}=\text{CHCH}_3$

b.   
CCCC(C=C)CCCC

c.   
CC(C)CCC#C

d.   
CC(C)=C(C)CC

e.   
CC1CCC(CC1)CC

6. Draw condensed structural formulas for these compounds.

a) 3,3,4,4-tetramethyl-1-hexyne

d) 7-methyl-2,5-nonadiene

b) 4-propyl-4-octene

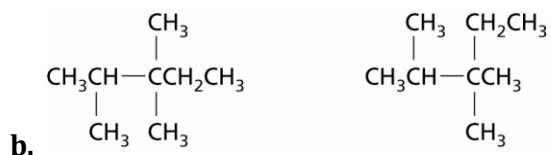
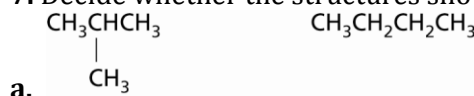
e) 4-ethyl-2-heptyne

c) 3-ethyl-2,6-dimethyl-2,5-heptadiene

f) 1,2-diethylcyclohexene

#### Section 4 - Hydrocarbon Isomers

7. Decide whether the structures shown in each of these pairs represent the same compound or pairs of isomers.



8. Which of the following is NOT a structural isomer of 2-heptene?

a. 2,3-dimethyl-1-pentene

b. methylcyclohexane

d. 3-ethyl-2-hexene

d. 3-heptene

9. Draw the structures of *cis*-4-octene and *trans*-4-octene.

#### Section 5 - Aromatic Compounds

10. Name the compounds represented in this condensed structural formula.



11. Draw the structural formula and determine the molecular formula for these aromatic hydrocarbons.

a. 1,2,4-trimethylbenzene

c. 1,3-diethyl-2,5-dimethylbenzene

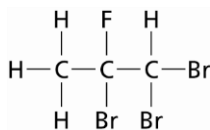
b. 1-ethyl-2-methyl-5-propylbenzene

## CHAPTER 22 Substituted Hydrocarbons – Section 1 - Halocarbons

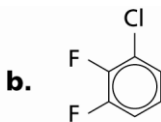
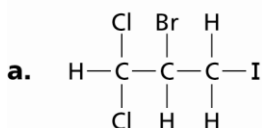
### Example Problem 1

#### Naming Halocarbons

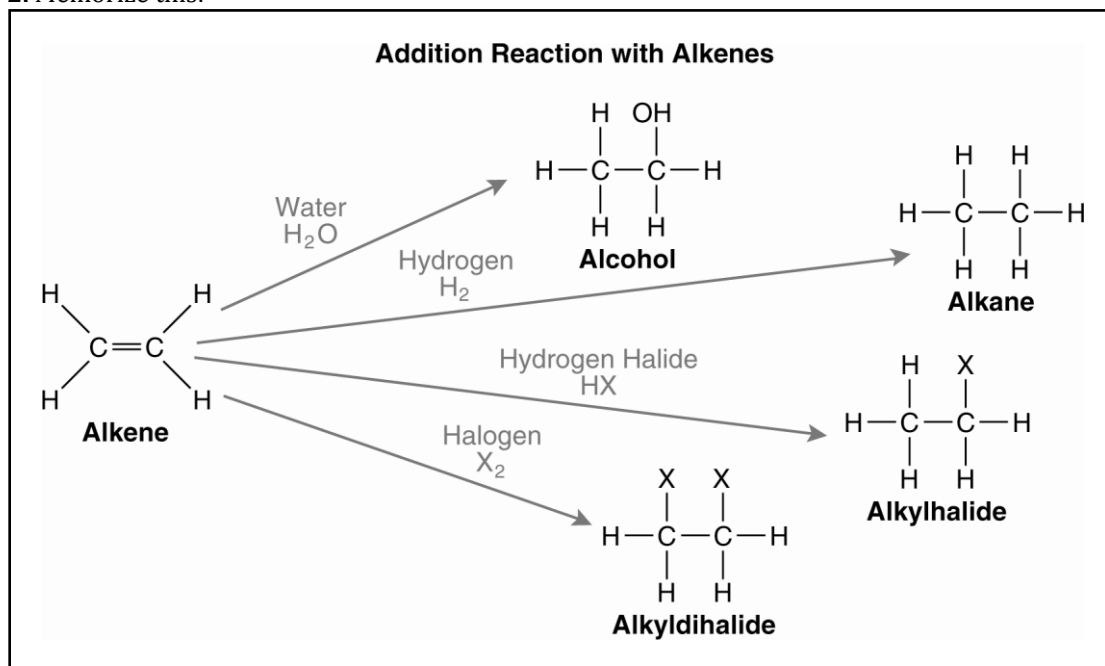
Name the halocarbon with the following structure.



1. Name the following halocarbons.

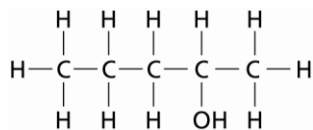


2. Memorize this:

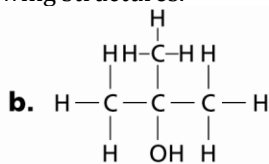
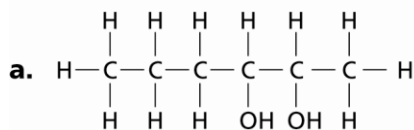


### Example Problem 2 Naming Alcohols

Name the alcohol with the following structure.



3. Name the alcohols with the following structures.



4. Draw structures for the alcohols that have the following names.

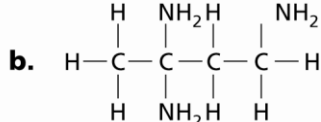
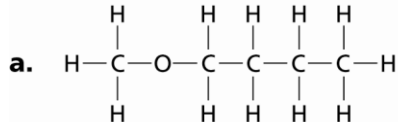
a. 2-butanol

b. 1,2-butanediol

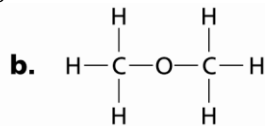
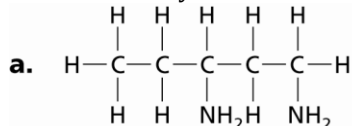
c. 2-methyl-1-butanol

### Example Problem 4 Naming Ethers and Amines

Classify each compound as an ether or an amine, and name the compound.



5. Classify each of the following as an ether or an amine, and name the compound.



6. Write the structure for each of the following.

a. butylpropyl ether

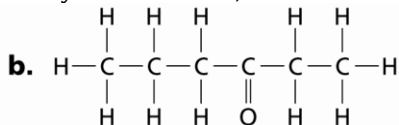
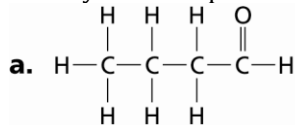
b. 1-propylamine

c. 1,1,2,4-butanetetraamine

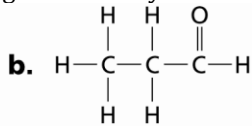
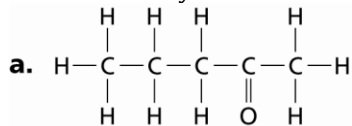
## Section 3 - Carbonyl Compounds

### Example Problem 5 Naming Aldehydes and Ketones

Classify each compound as an aldehyde or a ketone, and name the following compounds.



7. Classify each of the following as an aldehyde or a ketone, and name each compound.



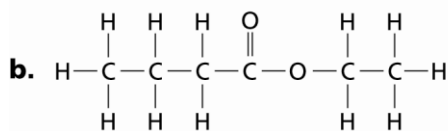
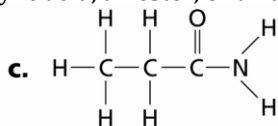
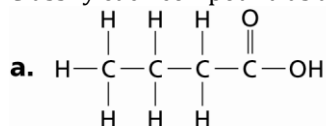
8. Write the structure for each of the following.

a. hexanal

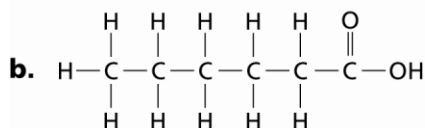
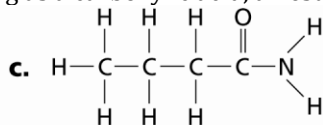
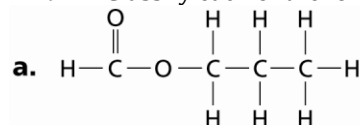
b. 4-octanone

### Example Problem 6 Naming Carboxylic Acids, Esters, and Amides

Classify each compound as a carboxylic acid, an ester, or an amide, and name the compound.



9. Classify each of the following as a carboxylic acid, an ester, or an amide, and name each compound.



11. Write the structure for each of the following.

a. heptanamide

b. methyl pentanoate

c. ethanoic acid

## CONCEPT REVIEW

12. Why is there no compound named 2-ethylheptane? Based on this incorrect name, write the structure of the compound and provide the correct name.

13. Classify each of these compounds as saturated or unsaturated. Explain your answers.

- 2,3,5-trimethylhexane
- 1,4-pentadiene
- 2-heptyne
- isopropylcyclooctane

14. Compare the physical and chemical properties of alkanes, alkenes, and alkynes.

15. Is 2-methylcyclobutene an isomer of 1-pentyne? Explain your answer.

16. Which of the following are aromatic compounds? Explain your answer.

- 2-ethylcyclopentene
- 1-methyl-4-propylbenzene
- anthracene
- 3-methyl-1-hexyne

17. Compare and contrast alcohols and ethers in terms of their structures and properties.

18. Define *carbonyl group*. Explain how aldehydes and ketones differ in terms of the placement of the carbonyl group.

19. Define *carboxylic acid*. Describe the typical properties of carboxylic acids, and explain how they are named.

20. Explain how esters and amides can be made from carboxylic acids.

21. Explain how halocarbons are named, including the way in which the presence of more than one kind of halogen is indicated.

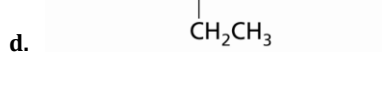
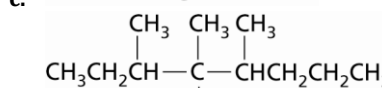
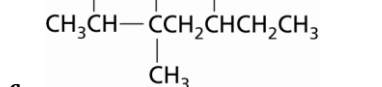
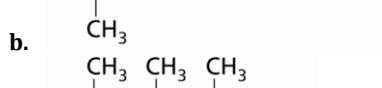
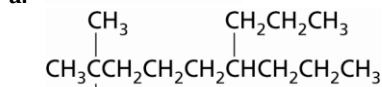
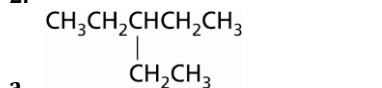
## CHAPTER 21 ANSWERS

1.

- a. 2-methylbutane
- b. 3-ethyl-2,5-dimethylhexane
- c. 4,7-diethyldecane
- d. 3,5-diethyl-2,5-dimethyloctane

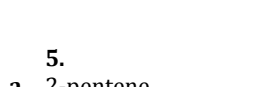
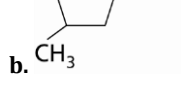
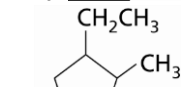
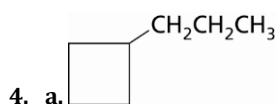
- e. pentane
- f. 2,3-dimethylbutane
- g. 3,4-diethyl-5-methylheptane

2.



3.

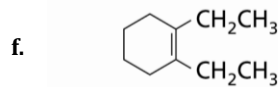
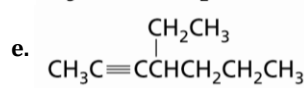
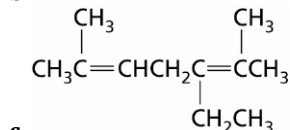
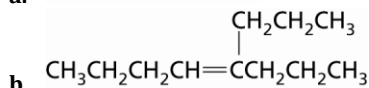
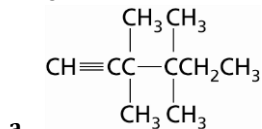
- a. 1,2-diethylcyclopropane
- b. 1,2,4-triethyl-7-methylcyclooctane
- c. 1,3,5-triethyl-2,4,6-trimethylcyclohexane



- a. 2-pentene
- b. 3-propyl-1-heptene
- c. 5-methyl-1-hexyne

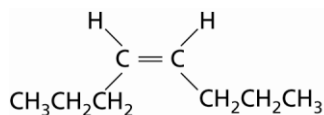
- d. 3,5,5-trimethyl-3-heptene
- e. 2,4-diethyl-1-methylcyclopentene

6.

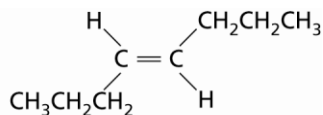


7. a. isomers  
 b. same compound  
 c. same compound

8. 3-ethyl-2-hexene; its molecular formula is  $C_8H_{16}$ , whereas the molecular formula of the other compounds is  $C_7H_{14}$ .



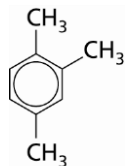
9. *cis*-4-octene



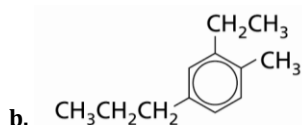
*trans*-4-octene

10. 1-ethyl-4-methylbenzene

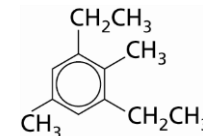
11.



a.  $C_9H_{12}$



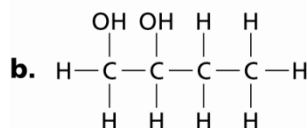
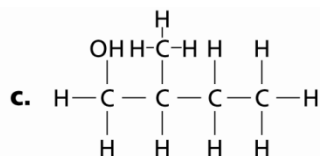
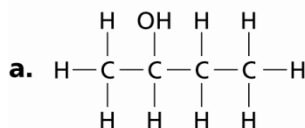
b.



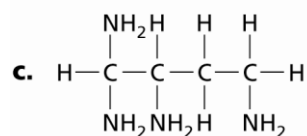
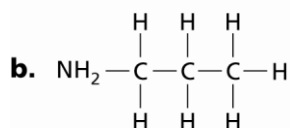
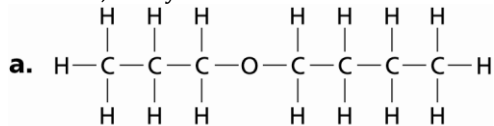
c.  $C_{12}H_{18}$

## CHAPTER 22 ANSWERS

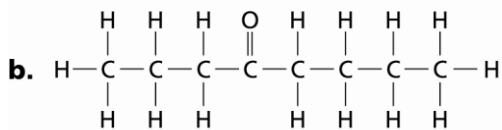
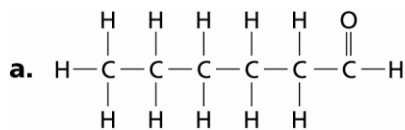
1. a. 2-bromo-1,1-dichloro-3-iodopropane  
 b. 1-chloro-2,3-difluorobenzene  
 3. a. 2,3-hexanediol  
 b. 2-methyl-2-propanol



4.  
 5. a. amine; 1,3-pentanediamine  
 b. ether; methyl ether



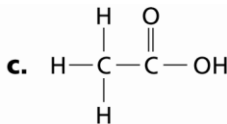
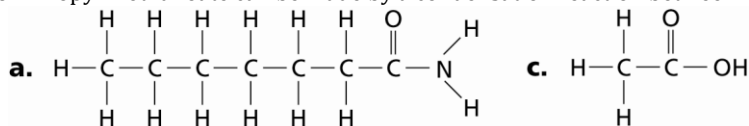
6.  
 7. a. ketone; 2-pentanone  
 b. aldehyde; propanal



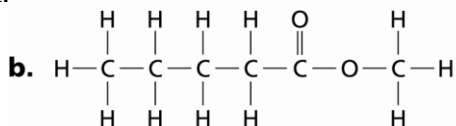
8.

9. a. ester; propyl methanoate  
b. carboxylic acid; hexanoic acid  
c. amide; butanamide

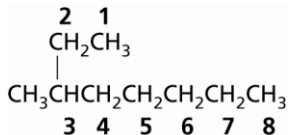
10. Propyl methanoate can be made by a condensation reaction between methanoic acid and propanol, with the loss of a water molecule.



11.



12. The name is incorrect because the longest carbon chain contains eight carbon atoms. The correct numbering is as follows.



The correct name is 3-methyloctane.

13. a. saturated; contains only single bonds  
b. unsaturated; contains two double bonds  
c. unsaturated; contains a triple bond  
d. saturated; contains only single bonds
14. Alkanes, alkenes, and alkynes are nonpolar compounds with relatively low melting and boiling points and low solubilities in water. The double bonds of alkenes cause them to be more reactive than alkanes. Alkynes are generally even more reactive than alkenes because of their triple bonds.
15. Yes; both compounds have the molecular formula  $\text{C}_5\text{H}_8$ , but they have different carbon chains.
16. The aromatic compounds are 1-methyl-4-propylbenzene and anthracene because these compounds contain benzene rings as part of their molecular structures.
17. Halocarbons are named by use of the prefixes *fluoro-*, *chloro-*, *bromo-*, and *iodo-* plus the alkane name. If there is more than one kind of halogen, the atoms are listed alphabetically. Numbers are used to identify the positions of the halogens. The lowest possible position number is given to the substituent that comes first alphabetically.
18. Both alcohols and ethers contain oxygen, carbon, and hydrogen. The oxygen atom in an alcohol is found in a hydroxyl group that has replaced a hydrogen of a hydrocarbon. In an ether, the oxygen atom is bonded to two carbon atoms, rather than to hydrogen. Alcohols are polar and can form hydrogen bonds. Ether molecules cannot form hydrogen bonds with each other and thus tend to have much lower boiling points than alcohols of similar size and mass.
19. A carbonyl group consists of an oxygen atom double-bonded to a carbon atom. In an aldehyde, the carbonyl group is located at the end of a carbon chain and is bonded to a carbon atom on one side and a hydrogen atom on the other. In a ketone, the carbon of the carbonyl group is bonded to two other carbon atoms.
20. A carboxylic acid is an organic compound that has a carboxyl group ( $-\text{COOH}$ ). Carboxylic acids are polar, reactive, and acidic. They are named by changing the *-ane* suffix of the parent alkane to *-anoic acid*.
21. Esters can be made through a condensation reaction between a carboxylic acid and an alcohol. Amides can be made by replacing the  $-\text{OH}$  group of a carboxylic acid with a nitrogen atom bonded to other atoms.