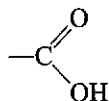


Section 22.7

thermoset polymer
 thermoplastic polymer
 crosslinking
 vulcanization
 polyethylene
 isotactic chain
 syndiotactic chain
 atactic chain
 polystyrene
 polyvinyl chloride (PVC)
 elastomers
 solid-phase inhibition
 vapor-phase inhibition
 free-radical inhibitors



They can react with alcohols to form esters. Amines can be thought of as derivatives of ammonia in which one or more N—H bonds have been replaced by an N—C bond.

Polymers can be formed by addition polymerization in which monomers add together via a free radical mechanism. Polymers also can be formed by condensation polymerization, which involves the splitting out of a small molecule (often water) between two monomers to form a dimer, which then undergoes further condensation.

A blue question or exercise number indicates that the answer to that question or exercise appears at the back of this book and a solution appears in the *Solutions Guide*.

Questions

- The normal (unbranched) hydrocarbons are often referred to as the *straight-chain hydrocarbons*. What does this name refer to? Does this mean that the carbon atoms in a straight-chain hydrocarbon really have a linear arrangement? Explain.
- Distinguish between structural and geometrical isomerism.
- Distinguish between substitution and addition reactions. Give an example of each type.
- Define and give an example of each of the following.
 - addition polymer
 - condensation polymer
 - copolymer
- Distinguish between a thermoset polymer and a thermoplastic polymer.
- How do the physical properties of polymers depend on chain length and extent of chain branching?
- Explain how plasticizers and crosslinking agents are used to change the physical properties of polymers.
- Isotactic polypropylene is harder than atactic polypropylene. Explain.
- Explain why each of the following changes in a polymer will lead to decreased flammability.
 - replacing hydrogen atoms with halogen atoms
 - replacing carbon atoms singly bonded to each other in the polymer chain with aromatic rings
 - highly crosslinking a polymer
- Nylon is named according to the number of C atoms between the N atoms in the chain. Nylon-46 has 4 C atoms then 6 C atoms, and this pattern repeats. Nylon-6 always has 6 atoms

in a row. Speculate as to why nylon-46 is stronger than nylon-6. (*Hint*: Consider the strengths of interchain forces.)

- In which polymer, polyethylene or polyvinyl chloride, would you expect to find the stronger intermolecular forces (assuming the average chain lengths are equal)?
- Define the following processes used by the petrochemical industry to improve the quality and/or quantity of gasoline.
 - cracking
 - alkylation
 - isomerization
 - catalytic reforming (sometimes known as *aromatization*)

Exercises

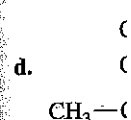
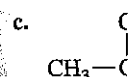
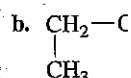
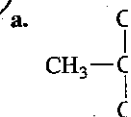
In this section similar exercises are paired.

Hydrocarbons

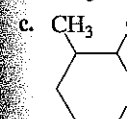
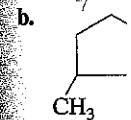
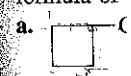
- Draw the five structural isomers of hexane (C₆H₁₄).
- Name the structural isomers in Exercise 13.
- Draw all the structural isomers for C₈H₁₈ that have the following root name (longest carbon chain). Name the structural isomers.
 - heptane
 - butane
- Draw all the structural isomers for C₈H₁₈ that have the following root name (longest carbon chain). Name the structural isomers.
 - hexane
 - pentane
- Draw the structural formula for each of the following.
 - 2-methylpentane
 - 2,2,4-trimethylpentane, also called *isooctane*. This substance is the reference (100 level) for octane ratings.

- 2-*tert*-butyl
 - The name for this hydrocarbon is
8. Draw the structural formula for this hydrocarbon. The name is incorrect.

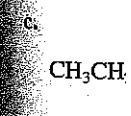
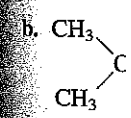
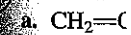
9. Name each hydrocarbon.



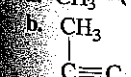
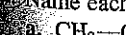
10. Name each hydrocarbon from the formula of the structural formula.

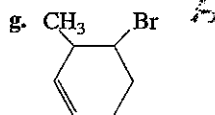
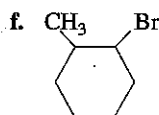


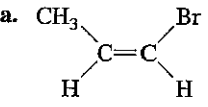
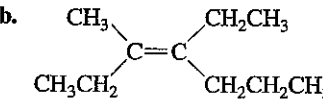
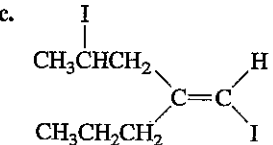
11. Name each hydrocarbon.



12. Name each hydrocarbon.



**Isomerism**

29. Which of the compounds in Exercises 21 and 23 exhibit *cis-trans* isomerism?
30. Which of the compounds in Exercises 22 and 24 exhibit *cis-trans* isomerism?
31. Draw all the structural isomers of C_5H_{10} . Ignore any cyclic isomers.
32. Which of the structural isomers in Exercise 31 exhibit *cis-trans* isomerism?
33. Draw all the structural and geometrical (*cis-trans*) isomers of C_3H_5Cl . Ignore any cyclic isomers.
34. Draw all the structural and geometrical (*cis-trans*) isomers of C_4H_7F . Ignore any cyclic isomers.
35. Draw all the isomers of difluoroethene.
36. Draw all the structural and geometrical (*cis-trans*) isomers of bromochloropropene.
37. Draw the following.
- cis*-2-hexene
 - trans*-2-butene
 - cis*-2,3-dichloro-2-pentene
38. Name the following compounds.
- 
 - 
 - 

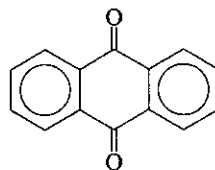
39. If one hydrogen in a hydrocarbon is replaced by a halogen atom, the number of isomers that exist for the substituted compound depends on the number of types of hydrogen in the original hydrocarbon. Thus there is only one form of chloroethane (all hydrogens in ethane are equivalent), but there are two isomers of propane that arise from the substitution of a methyl hydrogen or a methylene hydrogen. How many isomers can

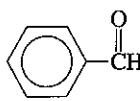
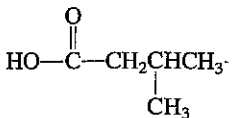
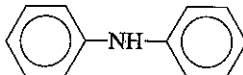
be obtained when one hydrogen in each of the compounds named below is replaced by a chlorine atom?

- n*-pentane
 - 2-methylbutane
 - 2,4-dimethylpentane
 - methylcyclobutane
40. There are three isomers of dichlorobenzene, one of which has now replaced naphthalene as the main constituent of mothballs.
- Identify the *ortho*, the *meta*, and the *para* isomers of dichlorobenzene.
 - Predict the number of isomers for trichlorobenzene.
 - It turns out that the presence of one chlorine atom on a benzene ring will cause the next substituent to add *ortho* or *para* to the first chlorine atom on the benzene ring. What does this tell you about the synthesis of *m*-dichlorobenzene?
 - Which of the isomers of trichlorobenzene will be the hardest to prepare?

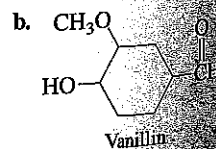
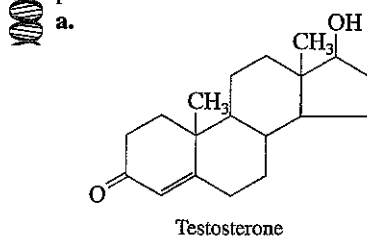
Functional Groups

41. Identify each of the following compounds as a carboxylic acid, ester, ketone, aldehyde, or amine.
- Anthraquinone, an important starting material in the manufacture of dyes:



- 
- 
- 

42. Identify the functional groups present in the following compounds.



c.



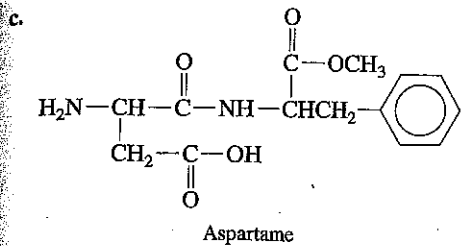
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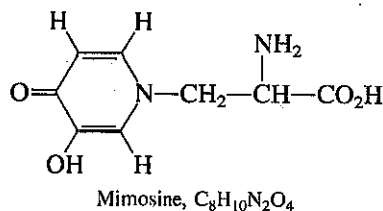
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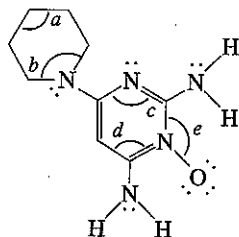


Mimosine is a natural product found in large quantities in the seeds and foliage of some legume plants and has been shown to cause inhibition of hair growth and hair loss in mice.



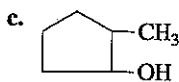
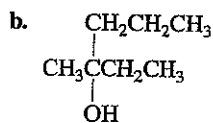
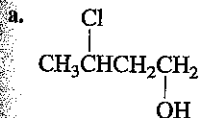
- What functional groups are present in mimosine?
- Give the hybridization of the eight carbon atoms in mimosine.
- How many σ and π bonds are found in mimosine?

Minoxidil ($C_9H_{15}N_5O$) is a compound produced by the Pharmacia & Upjohn Company that has been approved as a treatment of some types of male pattern baldness.



- Would minoxidil be more soluble in acidic or basic aqueous solution? Explain.
- Give the hybridization of the five nitrogen atoms in minoxidil.
- Give the hybridization of each of the nine carbon atoms in minoxidil.
- Give approximate values of the bond angles marked a , b , c , d , and e .
- Including all the hydrogen atoms, how many σ bonds exist in minoxidil?
- How many π bonds exist in minoxidil?

For each of the following alcohols, give the systematic name and specify whether the alcohol is primary, secondary, or tertiary.

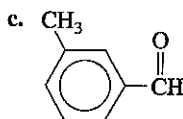
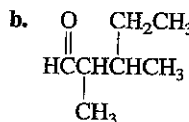
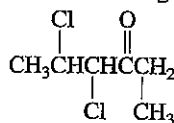


46. Menthol has the systematic name 2-isopropyl-5-methylcyclohexanol. Draw the structure of menthol.

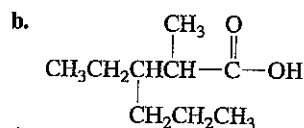
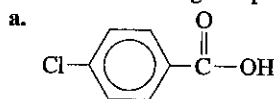
47. Name all the alcohols that have the formula $C_5H_{12}O$. How many ethers have the formula $C_5H_{12}O$?

48. Name all the aldehydes and ketones that have the formula $C_5H_{10}O$.

49. Name the following compounds.



50. Name the following compounds.



c. $HCOOH$

Reactions of Organic Compounds

51. Complete the following reactions.

