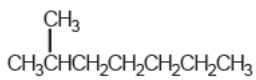
Homework #5

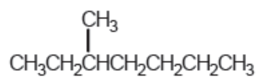
Chapter 21

Organic and Biochemical Molecules

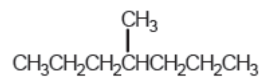
5. a)



2-methylheptane

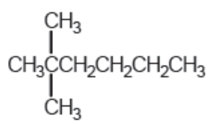


3-methylheptane

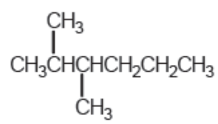


4-methylheptane

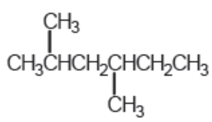
b)



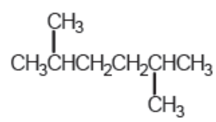
2,2-dimethylhexane



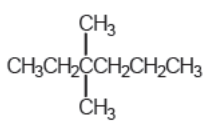
2,3-dimethylhexane



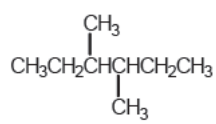
2,4-dimethylhexane



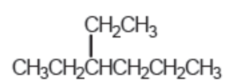
2,5-dimethylhexane



3,3-dimethylhexane

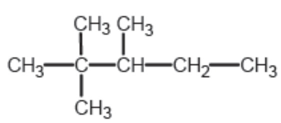


3,4-dimethylhexane

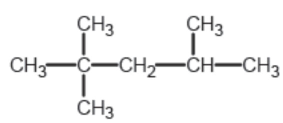


3-ethylhexane

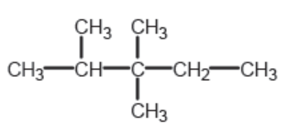
c)



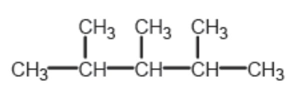
2,2,3-trimethylpentane



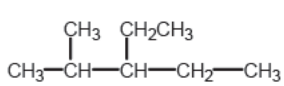
2,2,4-trimethylpentane



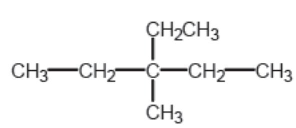
2,3,3-trimethylpentane



2,3,4-trimethylpentane

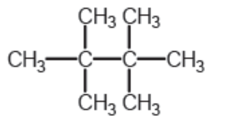


3-ethyl-2-methylpentane



3-ethyl-3-methylpentane

d)

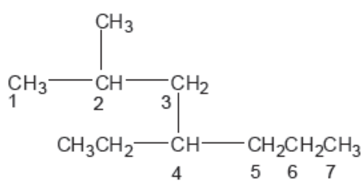


2,2,3,3-tetramethylbutane

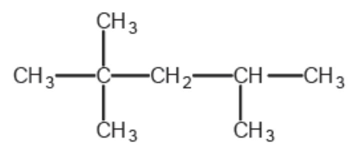
7. As the branching increases the intermolecular forces decrease due to the fact that the molecules cannot get as close to each other, therefore, cannot as easily set up instantaneous dipole moments (dipole moments resulting from uneven electron distribution with in a molecule). These interactions are referred to as London forces. Since the London interactions are smaller for branching molecules, the intermolecular forces are weaker, and the boiling point decreases.

8. hexane
   2-methylpentane
   3-methypentane
   2,2-dimethylbutane
   2,3-dimethylbutane

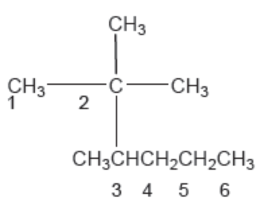
9. a)



b)



c)



d) a should be named 4-ethyl-2-methylheptane
   c should be named 2,2,3-trimethylhexane

11. a) 2,2,4-trimethylhexane
    b) 5-methylnonane
    c) 2,2,4,4-tetramethylpentane
    d) 3-ethyl-3-methyloctane

12. a) isopropylcyclobutane C_7H_{14}
    b) 1-*tert*-butyl-3-methylcyclopentane $C_{10}H_{20}$
    c) 1,3-dimethyl-2-propylcyclohexane $C_{11}H_{22}$

13. a) 1-butene
b) 2-methyl-2-butene
c) 2,5-dimethyl-3-heptene
d) 2,3-dimethyl-1-pentene
e) 1-ethyl-3-methylcyclopentene (double bond is assumed to be in location 1)
f) 4-ethyl-3-methylcyclopentene (double bond is assumed to be in location 1)
g) 4-methyl-2-pentyne

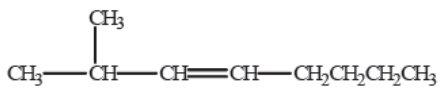
14. a)

$CH_3-CH_2-CH=CH-CH_2-CH_3$

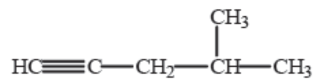
b)

$CH_3-CH=CH-CH=CH-CH_2CH_3$

c)



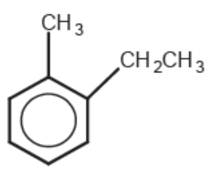
d)



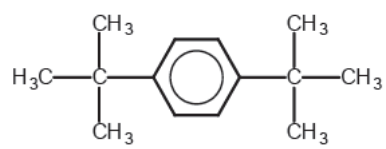
15. a) 1,3-dichlorobutane
b) 1,1,1-trichlorobutane
c) 2,3-dichloro-2,4-dimethylhexane
d) 1,2-difluoroethane
e) 3-iodo-1-butene
f) 1-bromo-2-methylbenzene or o-bromomethylbenzene or o-bromotoluene or 2-bromotoluene
g) 1-bromo-2-methylcyclohexane
h) 4-bromo-3-methylcylcohexene

16.

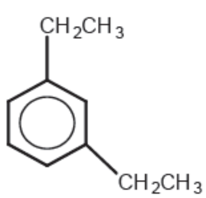
a)



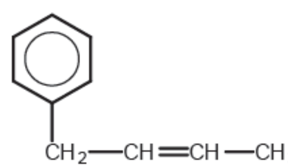
b)



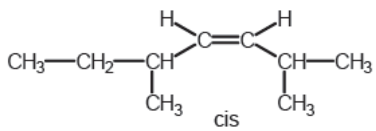
c)



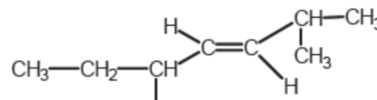
d)



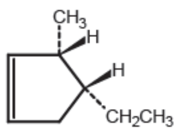
21. In order to form *cis-trans* isomers there needs to be restricted motion about a bond. This can be achieved in two ways; either there can be a double bond or there can be a ring. If a triple bond is present then there is only 1 placement and no *cis-trans* isomers can form (*cis-trans* isomers not possible for g). On each side of the non-rotatable bond there must be two different groups. For instance $H_2C=CHCH_3$ could not have *cis-trans* isomers because the two groups on the left hand side are both hydrogens. This eliminates a, b, and d from having *cis-trans* isomers. Structure e cannot have *cis-trans* isomers because the ethyl group is bonded to a carbon that has a double bond. This causes the ethyl group to only be able to have one position. This leaves c and f having *cis-trans* isomers, which are shown below.



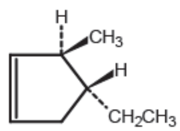
cis



trans



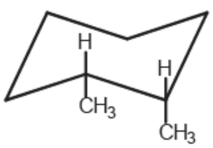
cis



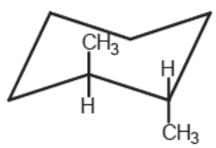
trans

= out of plane of paper; ----- = into plane of paper

25.

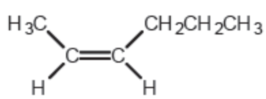


cis

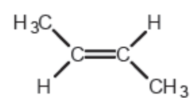


trans

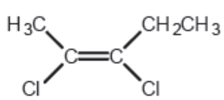
26. a)



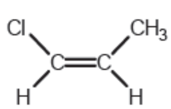
b)



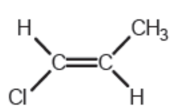
c)



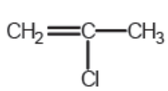
27.



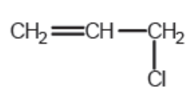
cis-1-chloro-1-propene



trans-1-chloro-1-propene



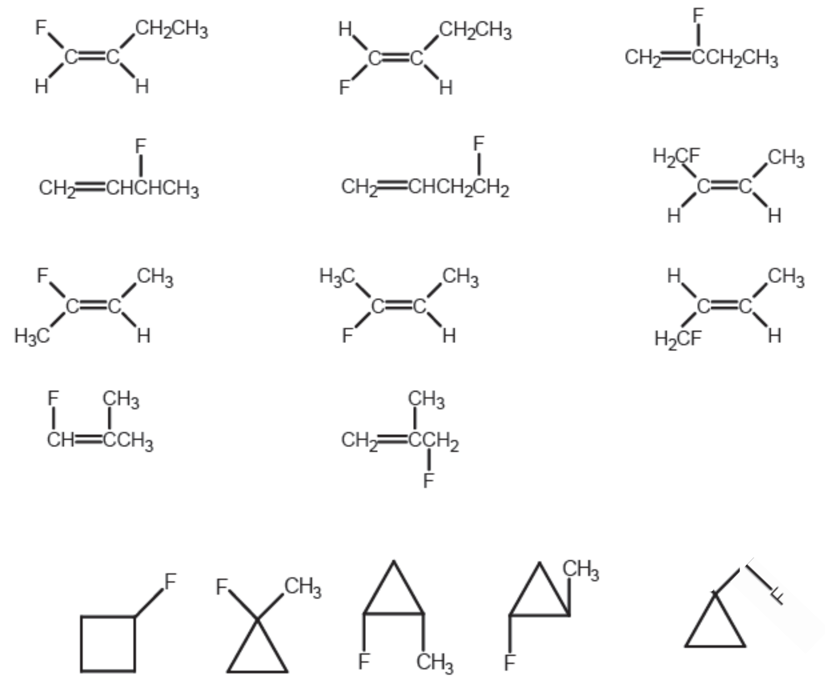
2-chloro-1-propene



3-chloro-1-propene

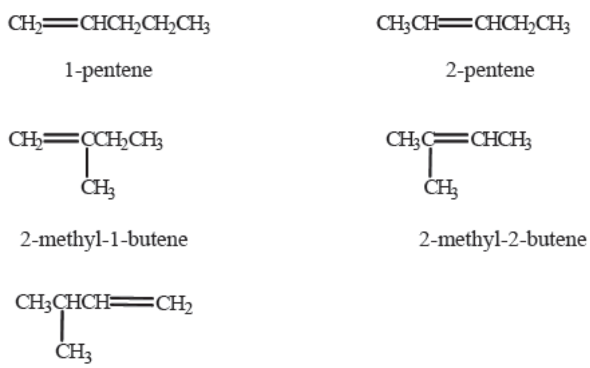
chlorocyclopropane

28.



cis trans

29.

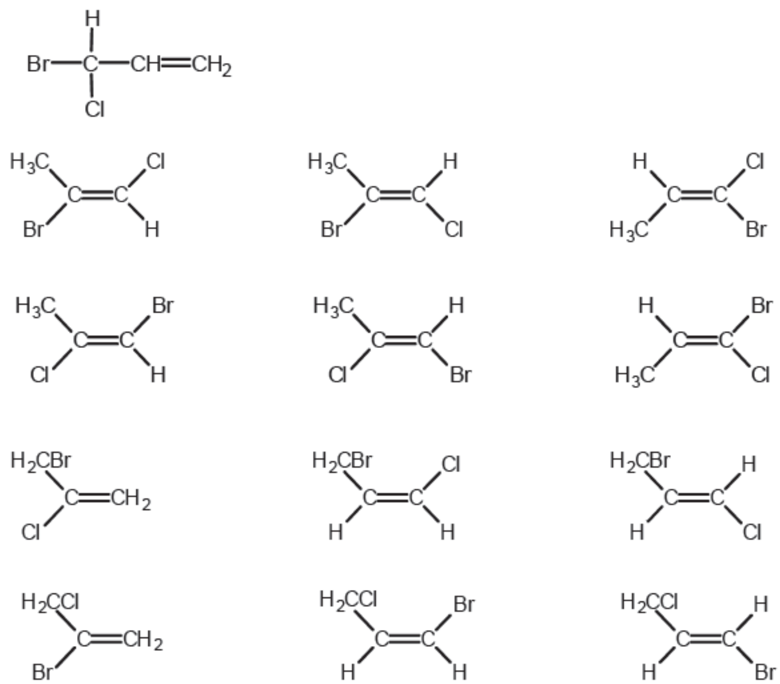


1-pentene 2-pentene 2-methyl-1-butene 2-methyl-2-butene 3-methyl-1-butene

Only 2-pentene has *cis-trans* isomers.

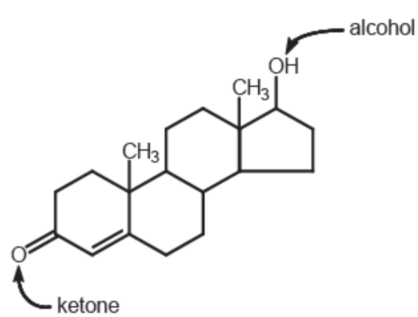
cis trans

30.

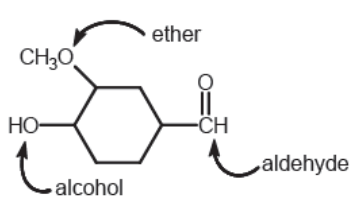


37. a) ketone
b) aldehyde
c) carboxylic acid
d) amine

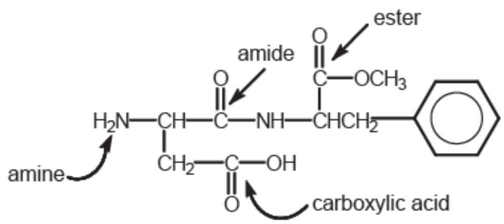
38. a)



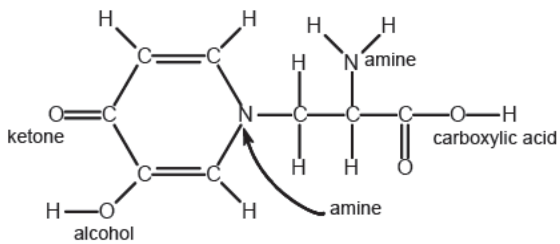
b)



c)



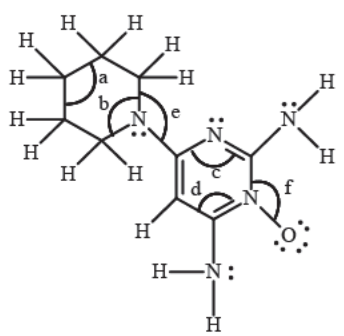
39. a)



b) The carbon atoms in the ring are sp^2 hybridized along with the carbon atom in the carboxylic acid. The other two carbons are sp^3 hybridized.

c) There are 24 σ bonds and 4 π bonds.

40.



a) Each of the amine groups can act as a proton acceptor (base). Therefore, the compound is more soluble in acidic solutions.

b) The two nitrogen atoms in the central ring (with double bonds) are sp^2 hybridized and the other three nitrogen atoms are sp^3 hybridized.

c) The five carbons in the ring with one nitrogen atom are sp^3 hybridized and the four carbon atoms in the ring, with two nitrogen atoms, are sp^2 hybridized.

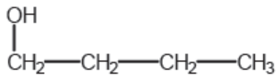
d) a=109.5˚ b=<109.5˚ c=<120˚ d=120˚ e=<109.5˚ f=120˚

e) 31 σ bonds

f) 3 π bonds

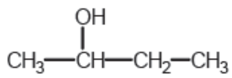
41.	a) 3-chloro-1-butanol	primary alcohol
	b) 3-methyl-3-hexanol	tertiary alcohol
	c) 2-methylcyclopentanol	secondary alcohol

42. a)



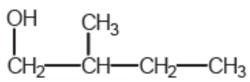
Primary alcohol

c)



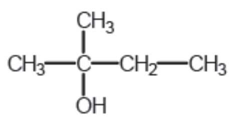
Secondary alcohol

d)



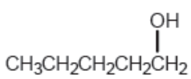
Primary alcohol

e)

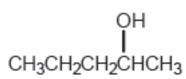


Tertiary alcohol

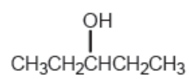
43.



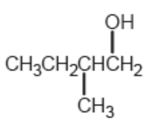
1-pentanol



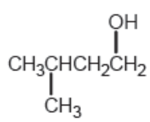
2-pentanol



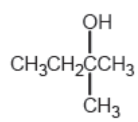
3-pentanol



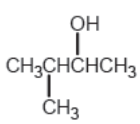
2-methyl-1-butanol



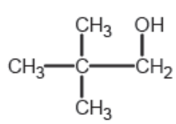
3-methyl-1-butanol



2-methyl-2-butanol

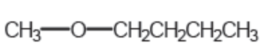


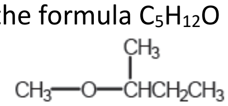
3-methyl-2-butanol

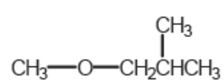


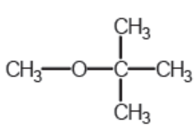
2,2-dimethyl-1-propanol

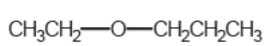
There are 6 ethers that have the formula $C_5H_{12}O$

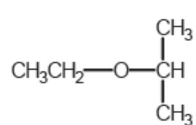




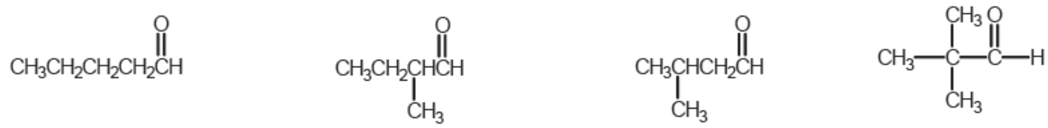






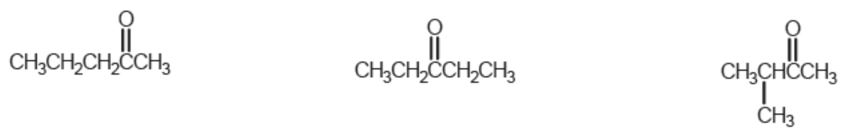


44. There are four aldehydes with the formula $C_5H_{10}O$



pentanal 2-methylbutanal 3-methylbutanal 2,2-dimethylpropanal

There are three ketones with the formula $C_5H_{10}O$

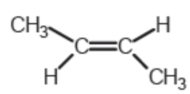


2-pentanone 3-pentanone 3-methyl-2-butanone

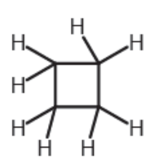
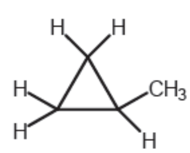
45. a) 4,5, dichloro-3-hexanone
b) 2,3-dimethylpentanal
c) 3-methylbenzaldehyde or m-methylbenzaldehyde

46. a) 4-chlorobenzoic acid or p-chlorobenzoic acid
b) 3-ethyl-2-methylhexanoic acid
c) methanoic acid

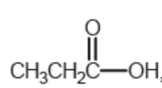
49. a)

trans-2-butene:  , formula = C_4H_8

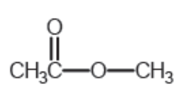
Isotopes

 or 

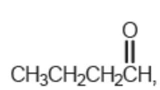
b)

propanoic acid:  formula = $C_3H_6O_2$

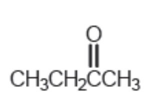
Isotope



c)

butanal:  formula = C_4H_8O

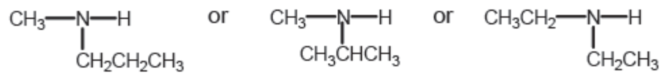
Isotope



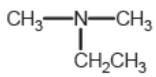
d)

butylamine: $CH_3CH_2CH_2CH_2NH_2$, formula = $C_4H_{11}N$:

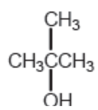
Isotopes



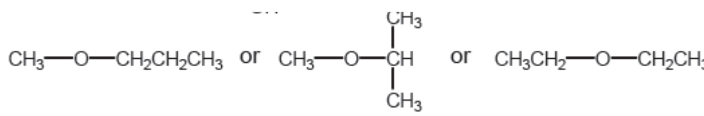
e)



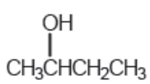
f)

2-methyl-2-propanol:  , formula = $C_4H_{10}O$

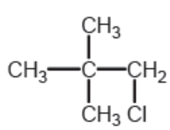
Isotopes



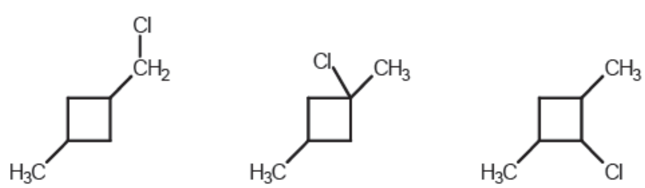
g)



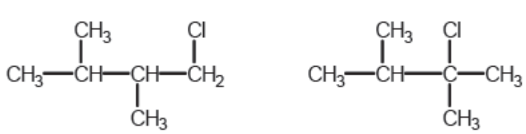
56. a)



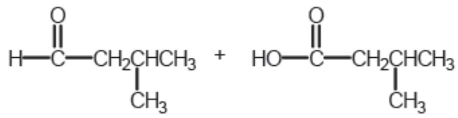
b)



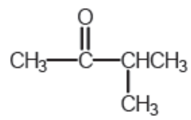
c)



61. a)

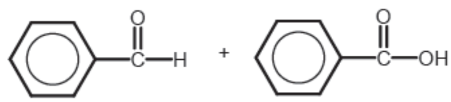


b)

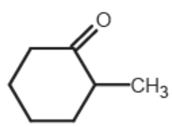


c) No Reaction

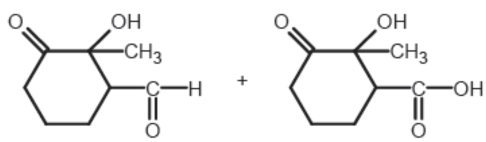
d)



e)

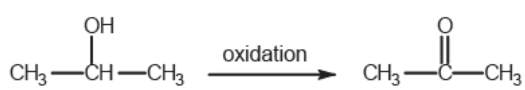


f)

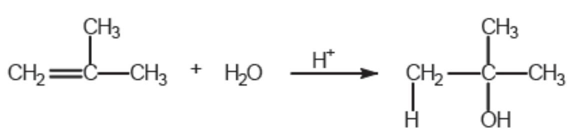


65. a) $CH_3CH_2{=}CH_2 + Br_2 \rightarrow CH_3CHBrCH_2Br$

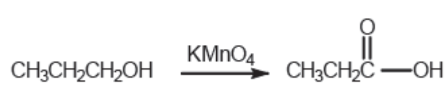
b)



c)



d)



$KMnO_4$ is a strong oxidizing agent

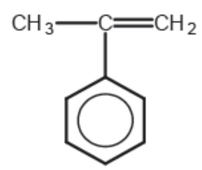
69. a) Addition Polymer: A polymer formed by adding monomer units together (usually by reacting at double bonds) while losing no atoms/molecules. (Example: polyethylene)

b) Condensation Polymer: A polymer that forms when two monomers combine by eliminating a small molecule (usually H_2O or HCl). (Example: Nylon)

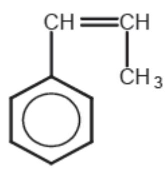
c) Copolymer: A polymer formed from a mixture of different monomers. (Example: Nylon)

d) Homopolymer: A polymer formed from a single monomer. (Example: polyethylene)
e) Polyester: A polymer in which the monomers are linked by ester groups formed by condensation. (Example: Dacron)
f) Polyamide: A polymer in which the monomers are linked by amide bonds formed by condensation. (Example: Nylon)

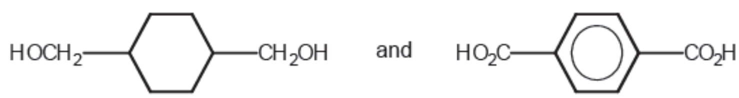
72. a) $CHF{=}CH_2$
b) $HOCH_2CH_2COOH$
c) $NH_2CH_2CH_2NH_2$ and $HOOCCH_2CH_2COOH$
d)



e)

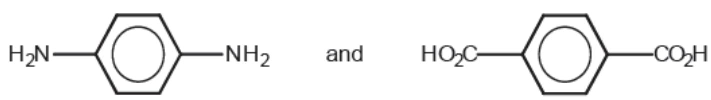


f)

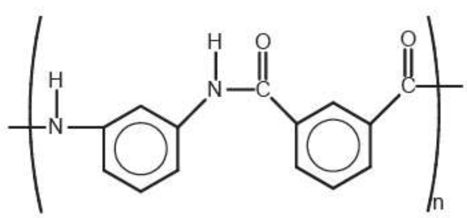


Polymers a, d, and e are addition polymers. Polymers b, c, and f are condensation polymers. Polymers c and f are copolymers.

75. a)

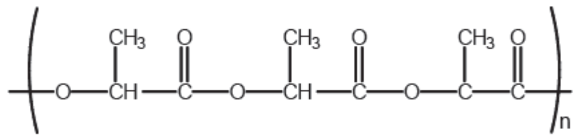


b)

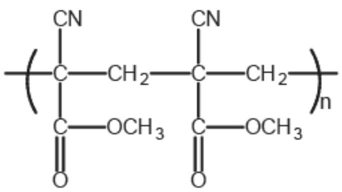


The bonding sites are in the para position for Kevlar and in the meta position for Nomex, making the Kevlar a straighter polymer than Nomex.

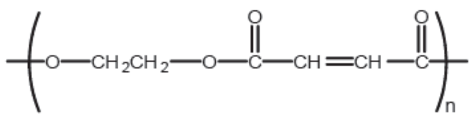
76.



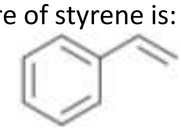
77.

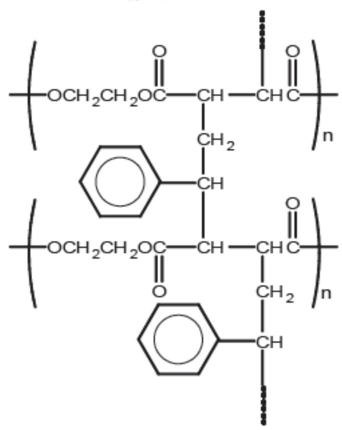


84. a)



b) The structure of styrene is:

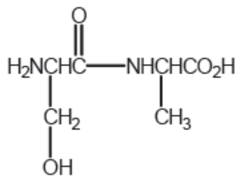




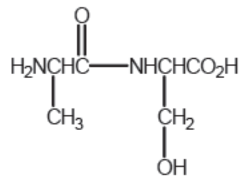
88. The primary structure of proteins is the order in which the amino acids are sequenced. Amino acids are mainly held together by covalent bonds.
The secondary structure of proteins is the arrangement of the chain of the larger molecules to each other (ex. α-helix or pleated sheet). The chains are mainly held together with hydrogen bonding.
The tertiary structure of proteins is the overall shape of the protein (long and narrow or globular). The tertiary structure is maintained through a variety of interactions including hydrogen bonding, covalent bonding, London dispersion forces, and dipole-dipole forces.

89. The three dimensional structure of a protein is important to its function. When a protein is denatured it loses its three dimensional structure and can no longer perform its function.

95.

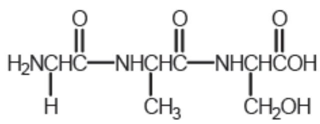


ser - ala

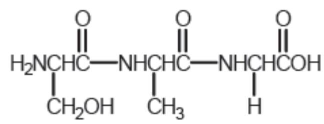


ala - ser

96.



gly ala ser



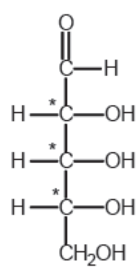
ser ala gly

There are 6 tripeptides that are possible with gly, ala, and ser. Two of them where already given (in bold), therefore, four remain.

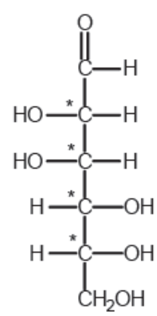
gly-ala-ser	ser-gly-ala	ala-gly-ser
gly-ser-ala	**ser-ala-gly**	ala-ser-gly

99. a) Covalent (S – S disulfide linkages)
b) H-bonding (needs R groups that are both capable of H-bonding)
c) Ionic (needs R groups that both contain either NH_2 or COOH)
d) London dispersion (need amino acids with nonpolar R groups)

106. In order to be a chiral carbon the carbon atom must have a mirror image that is not identical to itself; for this to occur the carbon atom must be bonded to 4 different atoms/groups of atoms.



D-Ribose



D-Mannose

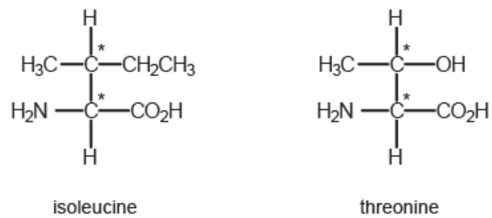
Starred carbons are chiral.

111. The difference between α and β glucose is the orientation of the hydroxyl group which results in different location of the oxygen linkage. α-glucose is the building block for starch and β-glucose is the building block for cellulose.

112. Optical isomers are compounds that have the same formula and the atoms in each complex are in the same bonding environment, however, the two compounds are not superimposable. In an organic compound, if a carbon is sp^3 hybridized and it has four different atoms/groups of atoms

bonded to it, then it will have an optical isomer. Therefore, 1-bromo-chloroethane has an optical isomer while 1-brome-2chloroethane does not.

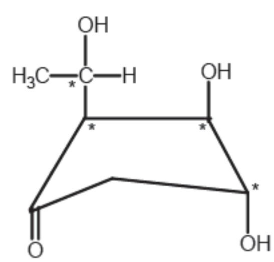
113. In order to be a chiral carbon the carbon atom must have a mirror image that is not identical to itself; for this to occur the carbon must be bonded to 4 different atoms/groups of atoms. Therefore, there are only 2 amino acids in table 21.18 that meet these requirements.



The starred atoms are the chiral carbons.

114. In order to be optically active the molecule must have a non-superimposable mirror image. This results when a carbon atom is bonded to four different atoms/groups of atoms. The central carbon atom in glycine is bonded to two hydrogen atoms. Therefore, its mirror image is superimposable and it is not optically active.

116. In order to be a chiral the carbon atom must have a mirror image that is not identical to it; for this to occur the carbon must be bonded to 4 different atoms/groups of atoms. Therefore, there are 4 chiral carbons.



117. They all contain nitrogen atoms with lone pairs of electrons.

119. C-C-A-G-A-T-A-T-G

132. Typically as temperature rises the viscosity of the solution decreases. This decrease in viscosity arises from the additional energy the molecules have, allowing them to overcome intermolecular forces and pass by one another. The flatter a molecules is, the closer the molecules can get to each other, resulting in greater London forces. As poly(lauryl methacrylate) is heated it uncoils. This uncoiling increase the London forces which counteracts

the additional energy that the molecules have from the added heat. Therefore, the viscosity remains the same instead of decreasing.