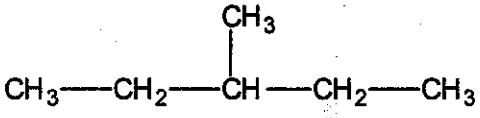
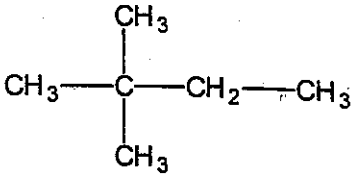
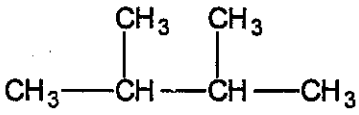
iii.



iv.



v.

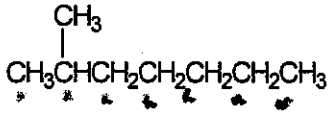


All other possibilities are identical to one of these five compounds.

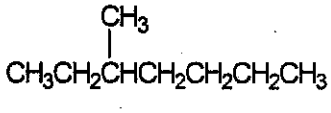
14. See Exercise 22.13 for the structures. The names of structure i - v respectively, are: hexane (or n-hexane), 2-methylpentane, 3-methylpentane, 2,2-dimethylbutane and 2,3-dimethylbutane.

15. A difficult task in this problem is recognizing different compounds from compounds that differ by rotations about one or more C–C bonds (called conformations). The best way to distinguish different compounds from conformations is to name them. Different name = different compound; same name = same compound so it is not an isomer, but instead, is a conformation.

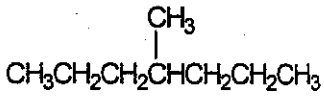
a.



2-methylheptane

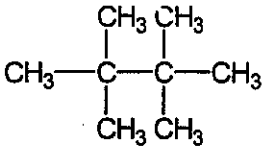


3-methylheptane



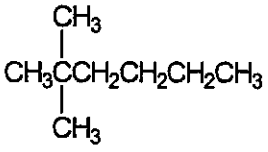
4-methylheptane

b.

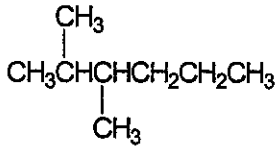


2,2,3,3-tetramethylbutane

16. a.

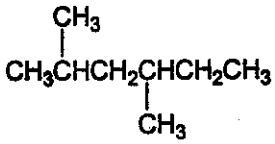


2,2-dimethylhexane

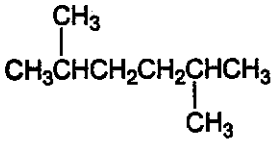


2,3-dimethylhexane

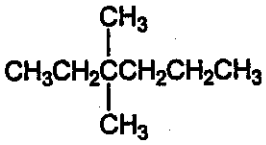
a. (continued)



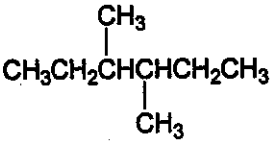
2,4-dimethylhexane



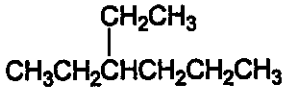
2,5-dimethylhexane



3,3-dimethylhexane

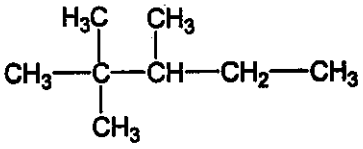


3,4-dimethylhexane

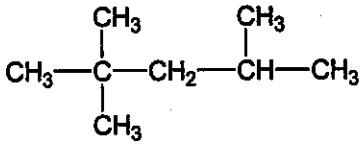


3-ethylhexane

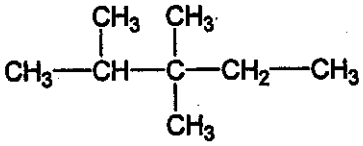
b.



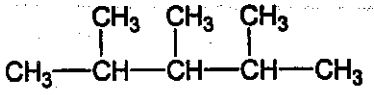
2,2,3-trimethylpentane



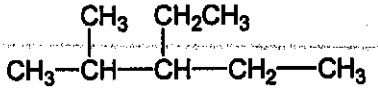
2,2,4-trimethylpentane



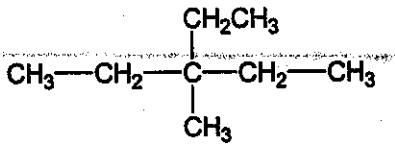
2,3,3-trimethylpentane



2,3,4-trimethylpentane

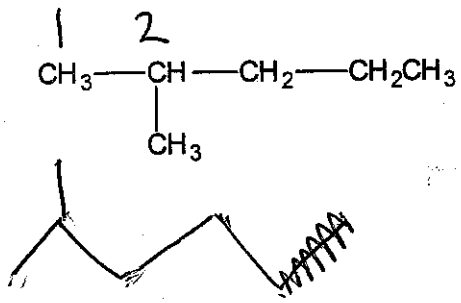


3-ethyl-2-methylpentane

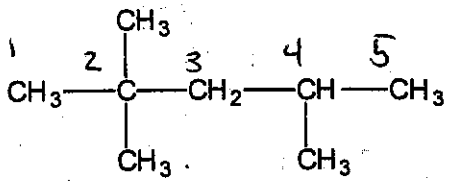


3-ethyl-3-methylpentane

17. a.

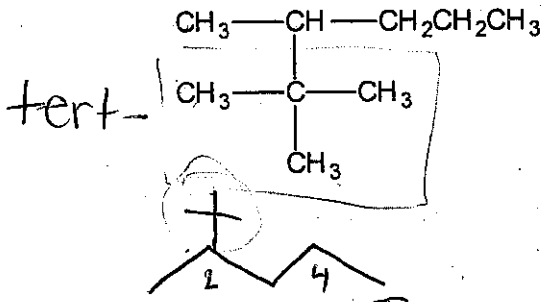


b.

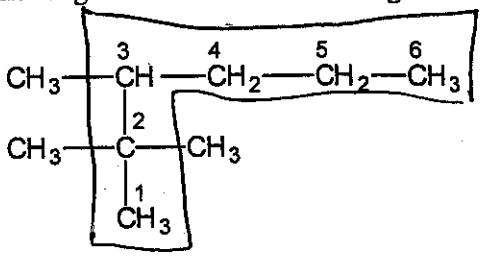


2,2,4 trimethyl pentane

c.

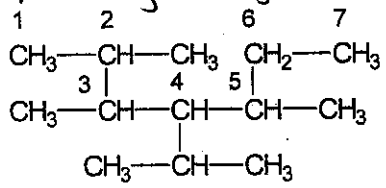


d. The longest chain is 6 carbons long.



2,2,3-trimethylhexane

18.



4-isopropyl-2,3,5-trimethylheptane

19. a. 2,2,4-trimethylhexane b. 5-methylnonane c. 2,2,4,4-tetramethylpentane

d. 3-ethyl-3-methyloctane

Note: For alkanes always identify the longest carbon chain for the base name first, then number the carbons to give the lowest overall numbers for the substituent groups.

20. The hydrogen atoms in ring compounds are commonly omitted. In organic compounds, carbon atoms satisfy the octet rule of electrons by forming four bonds to other atoms. Therefore, add C-H bonds to the carbon atoms in the ring in order to give each C atom four bonds. You can also determine the formula of these cycloalkanes by using the general formula C_nH_{2n}.

a. ethylcyclobutane: C_6H_{12} b. 1-methyl-3-propylcyclopentane; C_9H_{18}

c. 2-ethyl-1,3-dimethylcyclohexane; $C_{10}H_{20}$

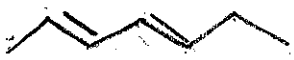
Note: For compound b, 3-methyl-1-propylcylopentane has the same lowest numbers for the substituent groups as 1-methyl-3-propylcyclopentane. When two different numbering systems each give the same lowest numbers, then number the carbons so the first substituent named has the lowest number. Hence, 1-methyl-3-propylcyclopentane is preferred.

21. a. 1-butene b. 2-methyl-2-butene c. 2,5-dimethyl-3-heptene

Note: The multiple bond is assigned the lowest number possible.

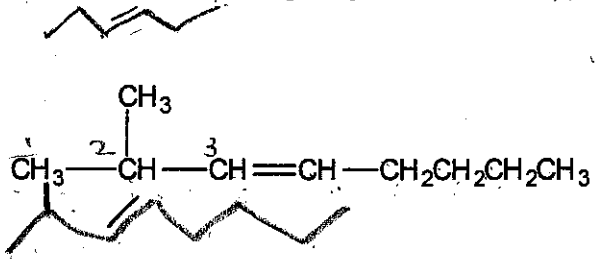
22. a. 2-butene b. 2-pentyne

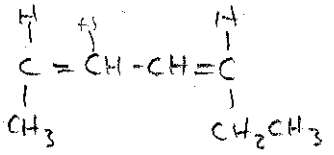
c. 2,3-dimethyl-1-pentene



23. a. $CH_3–CH_2–CH=CH–CH_2–CH_3$ b. $CH_3–CH=CH–CH=CH–CH_2CH_3$

c.

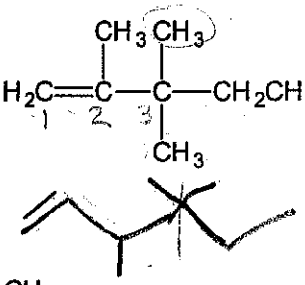




24.

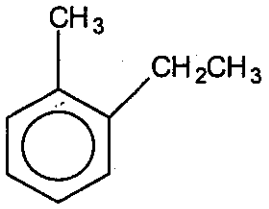
a. $HC\equiv C–CH_2–CH(CH_3)–CH_3$

b. $H_2C=C(CH_3)–C(CH_3)–CH_2CH_2CH_3$

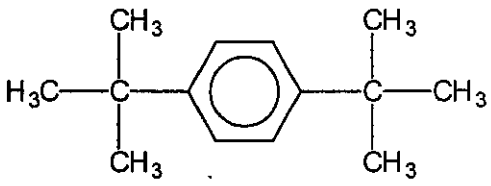


c. $CH_3CH_2–CH(CH_2CH_3)–CH=CH–CH_2CH_2CH_2CH_2CH_3$

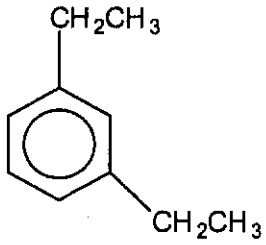
25. a.



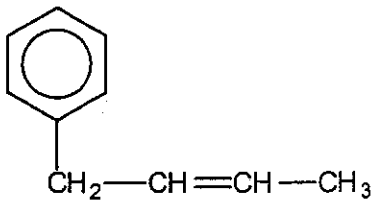
b.



c.



d.



26. isopropylbenzene or 2-phenylpropane

27. a. 1,3-dichlorobutane b. 1,1,1-trichlorobutane

c. 2,3-dichloro-2,4-dimethylhexane d. 1,2-difluoroethane

28. a. 3-chloro-l-butene b. 1-ethyl-3-methycyclopentene

c. 3-chloro-4-ethylcyclopentene d. 1,2,4-trimethylcyclohexane

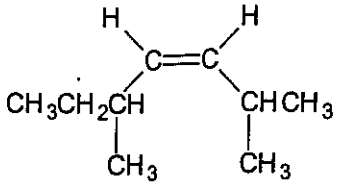
e. 2-bromotoluene (or 1-bromo-2-methylbenzene) f. 1-bromo-2-methylcyclohexane

g. 4-bromo-3-methylcyclohexene

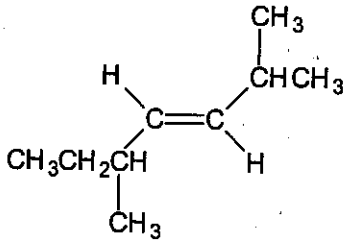
Note: If the location of double bond is not given in the name, then it is assumed to be located between C_1 and C_2. Also when the base name can be numbered in equivalent ways, then give the first substituent group the lowest number, e.g., for part f, 1-bromo-2-methylcyclohexane is preferred to 2-bromo-1-methycyclohexane.

Isomerism

29. To exhibit cis-trans isomerism, each carbon in the double bond must have two structurally different groups bonded to it. In Exercise 22.21, this only occurs for compound c. The cis and trans isomers for 21c are:



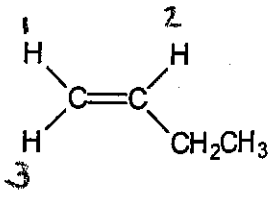
cis

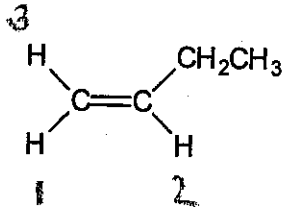


trans

Similarly, all the compounds in Exercise 22.23 can also exhibit cis-trans isomerism.

In the other compounds in Exercise 22.21, each carbon in the double bond does not contain two different groups. In 21a, the first carbon in the double bond contains two H atoms and in 21b, the first carbon in the double bond contains 2 CH_3 groups. To illustrate that these compounds do not exhibit cis-trans isomerism, lets look at the potential cis-trans isomers for the compound in Exercise 21a.

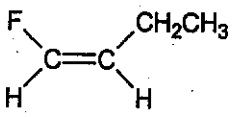
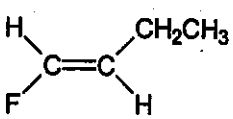
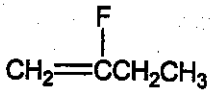
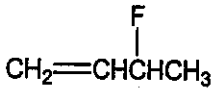
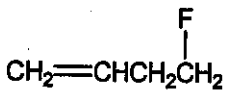
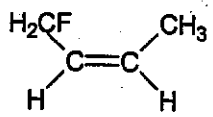
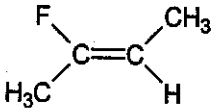
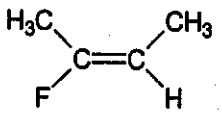
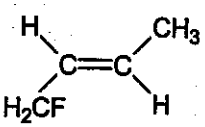
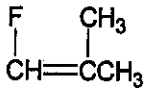
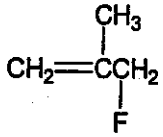




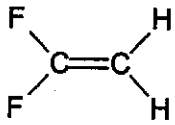
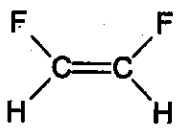
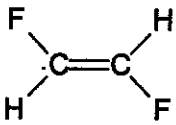
These are the same compounds; they only differ by a simple rotation of the molecule. Therefore, they are not isomers of each other.

30. In Exercise 22.22, only compounds a can exhibit cis-trans isomerism and in Exercise 22.24, only 3-ethyl-4-decene can exhibit cis-trans isomerism.

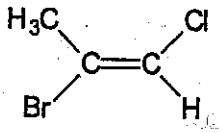
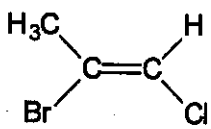
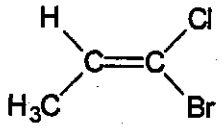
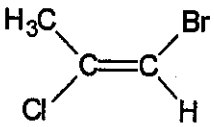
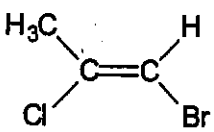
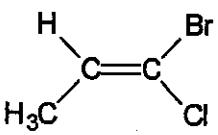
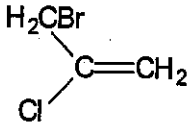
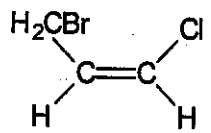
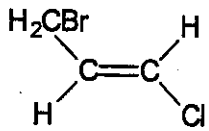
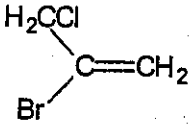
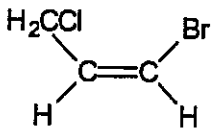
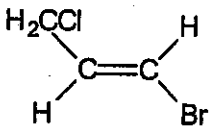
34.

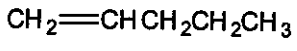
35.

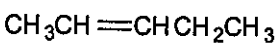
36. $HCBrCl–CH=CH_2$

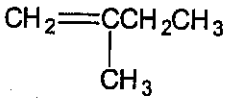
31. C_5H_{10} has the general formula for alkenes, C_nH_{2n}. To distinguish the different isomers from each other, we will name them. Each isomer must have a different name.



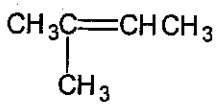
1-pentene



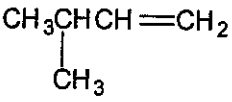
2-pentene



2-methyl-1-butene

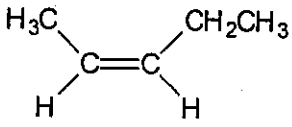


2-methyl-2-butene

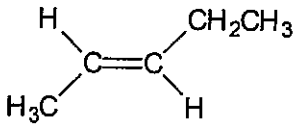


3-methyl-1-butene

32. Only 2-pentene exhibits cis-trans isomerism. The isomers are:



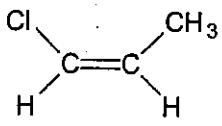
cis



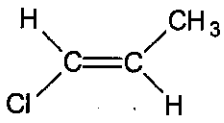
trans

The other isomers of C_5H_{10} do not contain carbons in the double bond that each contain two different groups attached.

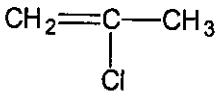
33. To help distinguish the different isomers, we will name them.



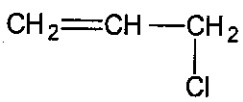
cis-1-chloro-1-propene



trans-1-chloro-1-propene



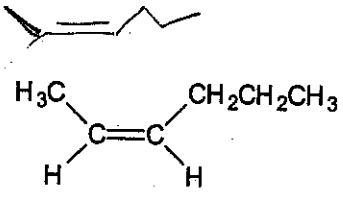
2-chloro-1-propene

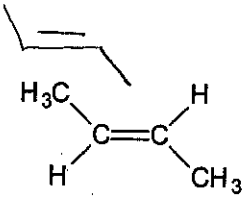


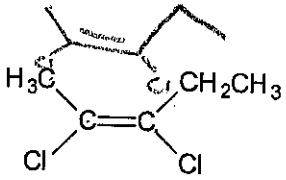
3-chloro-1-propene

Note: 1-bromo-1-chlorocyclopropane, cis-1-bromo-2-chlorocyclopropane and trans-1-bromo-2-chlorocyclopropane are the ring structures that are isomers of bromochloropropene. We did not include the ring structures in the answer since their base name is not bromochloropropene.

37.

a. 

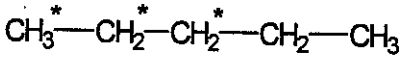
b. 

c. 

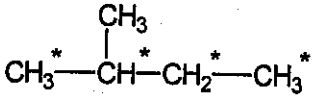
38. a. cis-1-bromo-1-propene b. cis-4-ethyl-3-methyl-3-heptene

c. trans-1,4-diiodo-2-propyl-1-pentene

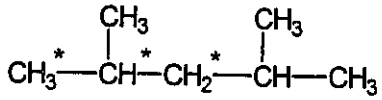
Note: In general, cis-trans designations refers to the relative positions of the largest groups. In compound b, the largest group off the first carbon in the double bond is CH_2CH_3 and the largest group off the second carbon in the double bond is $CH_2CH_2CH_3$. Since their relative placement is on the same side of the double bond, then this is the cis isomer.

39. a. 

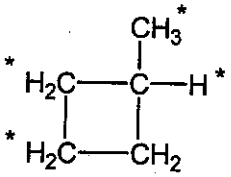
There are three different types of hydrogens in n-pentane (see asterisks). Thus there are three monochloro isomers of n-pentane (1-chloropentane, 2-chloropentane and 3-chloropentane).

b. 

There are four different types of hydrogens in 2-methylbutane, so four monochloro isomers of 2-methylbutane are possible.

c. 

There are three different types of hydrogens so three monochloro isomers are possible.

d. 

There are four different types of hydrogens so four monochloro isomers are possible.

b. The two nitrogens in the ring with double bonds are sp^2 hybridized. The other three N's are sp^3 hybridized.

c. The five carbon atoms in the ring with one nitrogen are all sp^3 hybridized. The four carbon atoms in the other ring with double bonds are all sp^2 hybridized.

d. Angles a and b ≈ 109.5°; Angles c, d, and e ≈ 120°

e. 31 sigma bonds

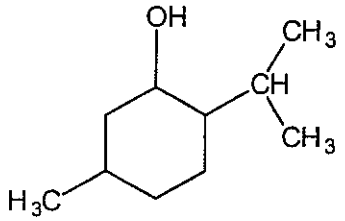
f. 3 pi bonds

45. a. 3-chloro-1-butanol: Since the carbon containing the OH group is bonded to just 1 other carbon (1 R group), then this is a primary alcohol.

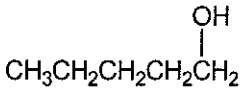
b. 3-methyl-3-hexanol; Since the carbon containing the OH group is bonded to three other carbons (3 R groups), then this is a tertrary alcohol

c. 2-methylcyclopentanol; Secondary alcohol (2 R groups bonded to carbon containing the OH group); Note: In ring compounds, the alcohol group is assumed to be bonded to C_1 so the number designation is commonly omitted for the alcohol group.

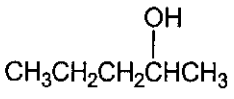
46. The C with the –OH group is number 1.



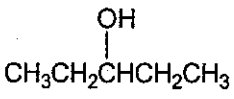
47.



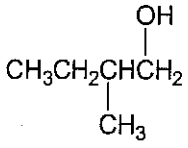
1-pentanol



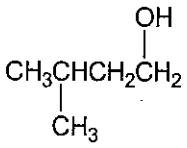
2-pentanol



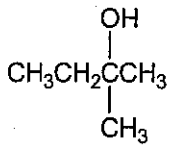
3-pentanol



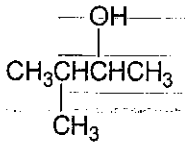
2-methyl-1-butanol



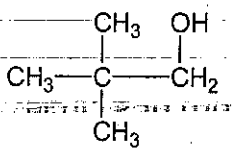
3-methyl-1-butanol



2-methyl-2-butanol

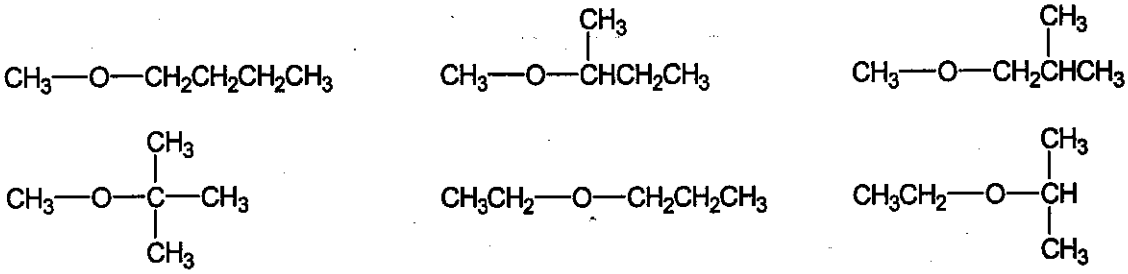


3-methyl-2-butanol

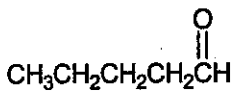


2,2-dimethyl-1-propanol

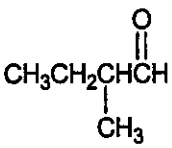
There are six isomeric ethers with formula $C_5H_{12}O$. The structures follow.



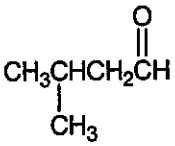
48. There are four aldehydes and three ketones with formula $C_5H_{10}O$. The structures follow.



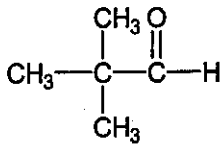
pentanal



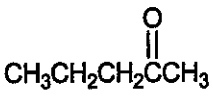
2-methylbutanal



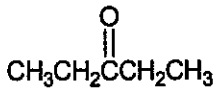
3-methylbutanal



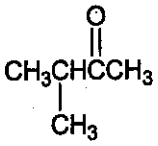
2,2-dimethylpropanal



2-pentanone



3-pentanone



3-methyl-2-butanone

49. a. 4,5-dichloro-3-hexanone b. 2,3-dimethylpentanal

c. 3-methylbenzaldehyde or m-methylbenzaldehyde

50. a. 4-chlorobenzoic acid or p-chlorobenzoic acid

b. 3-ethyl-2-methylhexanoic acid

c. methanoic acid (common name = formic acid)