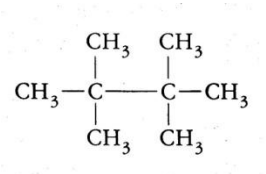


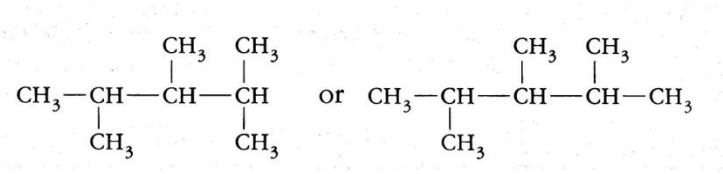
Chapter 15

Answers to Questions

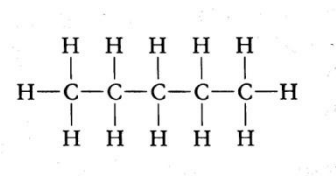
1. Structural formulas show all the covalent bonds between atoms. In condensed formulas, the lines depicting carbon-hydrogen bonds are removed.
2. Space-filling models provide a better image of how a molecule might look like, however, it is impossible to see the angles of the bonds or whether they are single, double, or triple. Ball-and-stick representations enable the bond angles and number of bonds to be seen, but there are no 'sticks' between atoms in reality.
3. $109\frac{1}{2}^\circ$
4. 120°
5. Alkenes
6. C_nH_{2n+2}
7. (a)



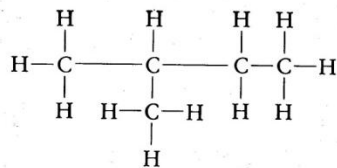
(b)



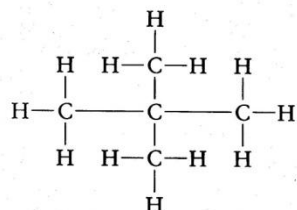
8. (a)



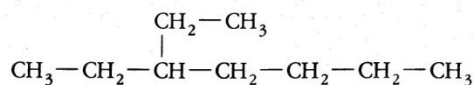
(b)



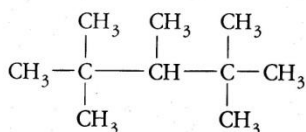
(c)



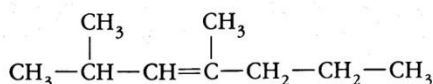
9. All of these formulas have five carbon atoms in the longest chain and a CH_3- group on the second carbon atom from one end. Thus they are all the same isomer. The first representation is the way in which the structure would normally be depicted.
10. The structures depicted in (a), (b), and (c) are all the same with a five-carbon longest chain and one CH_3- group on the second carbon and one CH_3- on the third carbon from one end. The only different structure is (d), which also has a five-carbon chain but with both CH_3- groups on the third carbon of the chain.
11. The longest chain contains six carbon atoms, thus the root-name will be hexane. There is a CH_3-CH_2- group (ethyl) on the third carbon atom from one end. The name will be 3-ethylhexane.
12. The longest chain contains four carbon atoms thus the root-name will be butane. There are two CH_3- groups on the second carbon atom of the chain and two CH_3- groups on the third carbon atom of the chain. To indicate the presence of four methyl groups, the prefix "tetra" is used. The name will be 2,2,3,3-tetramethylbutane
13. The longest chain (or "backbone") of the molecule contains seven carbon atoms. There is a CH_3-CH_2- group on the third carbon atom. The structure will be that shown below. Note that one hydrogen atom must be removed from the third carbon atom so that there are only four covalent bonds to that carbon atom. Also, that to take up less space, the ethyl group is bent at a 90° angle. It would be equally correct to show the ethyl group vertical from the main chain.



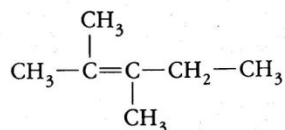
14. The longest chain contains five carbon atoms. There are two CH_3- groups on the second carbon atom, one CH_3- group on the third carbon atom, and two CH_3- groups on the fourth carbon atom. Making sure there are four bonds to each carbon atom gives a structure of:



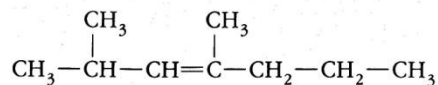
15. The ring contains five carbon atoms, thus the ring name will be *cyclopentane*. There is one CH_3- group attached to the ring. The name will be *methylcyclopentane* (the prefix 1- can be omitted as there is no need for a locator number).
16. The ring contains six carbon atoms, thus the ring name will be *cyclohexane*. There are three CH_3- groups, giving the name *trimethylcyclohexane*. Finally, the lowest set of numerical locators are 1,2, and 4 on the carbon ring. The complete name will be *1,2,4-trimethylcyclohexane*.
17. The longest chain contains seven carbon atoms with a double bond between carbon atoms 3 and 4. There are two CH_3- groups, one on carbon atom 2 and one on carbon atom 4. Ensuring only four bonds to each carbon atom gives the structure of:



18. The longest chain contains five carbon atoms with a double bond between carbon atoms 2 and 3. There are two CH_3- groups, one on carbon atom 2 and one on carbon atom 3. Ensuring only four bonds to each carbon atom gives the structure of:

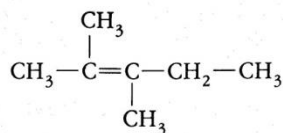


19. The longest chain contains seven carbon atoms with a double bond between carbon atoms 3 and 4. There are two CH_3 - groups, one on carbon atom 2 and one on carbon atom 4. Ensuring only four bonds to each carbon atom gives the structure of:



There are four different groups attached to the $\text{C}=\text{C}$ double bond and these could be arranged with the H - and the CH_3 - groups on the same side of the double bond or on opposite sides. Thus there would be geometric isomers.

20. The longest chain contains five carbon atoms with a double bond between carbon atoms 2 and 3. There are two CH_3 - groups, one on carbon atom 2 and one on carbon atom 3. Ensuring only four bonds to each carbon atom gives the structure of:

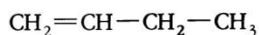


There are two CH_3 - groups on the carbon 2 of the double bond. As these are the same groups, there will not be geometric isomers.

21. (a) The longest chain (or “backbone”) of the molecule contains five carbon atoms and there is a double carbon-carbon bond starting on carbon atom 2. The root name will be 2-pentene. There is a CH_3 - CH_2 - group on the third carbon atom. The name is 3-ethyl-2-pentene.
- (b) The longest chain of the molecule contains five carbon atoms and there is a double carbon-carbon bond starting on carbon atom 2. The root name will be 2-pentene. There is a CH_3 - group on the second carbon atom. The name is 2-methyl-2-pentene
- (c) The longest chain of the molecule contains seven carbon atoms and there is a double carbon-carbon bond starting on carbon atom 2 (counting from the right end). The root name will be 2-heptene. There are two CH_3 - groups, one is on carbon 2 (counting from the right end) and the other is on carbon 6. The name is 2,6-dimethyl-2-heptene.
- (d) The longest chain of the molecule contains eight carbon atoms and there is a double carbon-carbon bond starting on carbon atom 2 (counting from the right end). The root name will be 2-octene. There are three CH_3 - groups, one on carbon 5 (counting from the right end), and two on carbon 7. The name is 5,7,7-trimethyl-2-octene.

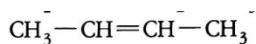
22. (a) The longest chain (or “backbone”) of the molecule contains four carbon atoms and there is a double carbon-carbon bond starting on carbon atom 2. The root name will be 2-butene. There is a CH_3 - group on the second carbon atom. The name is 2-methyl-2-butene.
- (b) The longest chain of the molecule contains seven carbon atoms and there is a double carbon-carbon bond starting on carbon atom 2 (counting from the right end). The name is 2-heptene.
- (c) The longest chain of the molecule contains four carbon atoms and there is a double carbon-carbon bond starting on carbon atom 2. The root name will be 2-butene. There are two CH_3 - groups, one of carbon atom 2 and the other on carbon atom 3. The name is 2,3-dimethyl-2-butene.
- (d) The longest chain of the molecule contains seven carbon atoms and there is a double carbon-carbon bond starting on carbon atom 3. The root name will be 3-heptene. There are two $\text{CH}_3\text{-CH}_2$ - groups, one on carbon atom 3 and the other on carbon atom 4. The name is 3,4-diethyl-3-heptene.

23. (a) One possibility is four carbon atoms in a chain with the double bond on the first carbon atom.



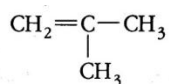
The four carbon chain with a carbon-carbon double bond starting on the first carbon atom is named 1-butene.

- (b) A second possibility is four carbon atoms in a chain with the double bond on the second carbon atom.



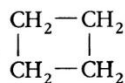
The four carbon chain with a carbon-carbon double bond starting on the second carbon atom is named 2-butene.

- (c) A third possibility is three carbon atoms in a chain with a CH_3 - group.



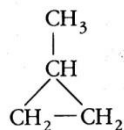
The four carbon chain with a carbon-carbon double bond starting on the second carbon atom is named 2-methyl-1-propene.

24. (a) An alternative to a double bond is a ring structure. So there can be four carbon atoms in a ring.



This molecule would be named *cyclobutane*.

(b) There can also be three carbon atoms in a ring with the fourth carbon atom as a CH_3 - group.



This molecule has the three-carbon ring so the stem name will be cyclopropane. The CH_3 - group would give the name of methylcyclopropane (this is unambiguous and there is no need to use the “1-“ locator).

25. (a) The longest chain (or “backbone”) of the molecule contains five carbon atoms and there is a triple carbon-carbon bond starting on carbon atom 1. The name is 1-pentyne.
- (b) The longest chain of the molecule contains five carbon atoms and there is a triple carbon-carbon bond starting on carbon atom 2. The root name will be 2-pentyne. There is one CH_3 - group on the fourth carbon atom. The name is 4-methyl-2-pentyne.
- (c) The longest chain of the molecule contains six carbon atoms and there is a triple carbon-carbon bond starting on carbon atom 2. The root name will be 2-hexyne. There are two CH_3 - groups on the fourth carbon atom. The name is 4,4-dimethyl-2-hexyne.
- (d) The longest chain of the molecule contains eight carbon atoms and there is a triple carbon-carbon bond starting on carbon atom 3. The root name will be 3-octyne. There are two CH_3 - groups, one on the fifth carbon atom, and the other on the seventh carbon atom. The name is 5,7-dimethyl-3-octyne.
- (e) The longest chain of the molecule contains eight carbon atoms and there is a triple carbon-carbon bond starting on carbon atom 2. The root name will be 2-octyne. There is a CH_3 - group on the seventh carbon atom. The name is 7-methyl-2-octyne.
26. (a) The longest chain (or “backbone”) of the molecule contains four carbon atoms and there is a triple carbon-carbon bond starting on carbon atom 2. The name is 2-butyne.

- (b) The longest chain of the molecule contains five carbon atoms and there is a triple carbon-carbon bond starting on carbon atom 2. The root name will be 2-pentyne. There are two CH_3 - groups on the fourth carbon atom. The name is 4,4-dimethyl-2-pentyne.
- (c) The longest chain of the molecule contains six carbon atoms and there is a triple carbon-carbon bond starting on carbon atom 2 (counting from the right). The root name will be 2-hexyne. There is one CH_3 - group on the fourth carbon atom. The name is 4-methyl-2-hexyne.
- (d) The longest chain of the molecule contains five carbon atoms and there is a triple carbon-carbon bond starting on carbon atom 1. The root name will be 1-pentyne. There is one CH_3 - group on the fourth carbon atom. The name is 4-methyl-1-pentyne.
- (e) The longest chain of the molecule contains six carbon atoms and there is a triple carbon-carbon bond starting on carbon atom 3. The root name will be 3-hexyne. There are four CH_3 - groups, two on the second carbon atom, and two on the fifth carbon atom. The name is 2,2,5,5-tetramethyl-3-hexyne.