(Student textbook page 36)

25. Cyclic hydrocarbons have higher boiling points and melting points than straight-chain hydrocarbons. There is a greater difference in terms of melting point.

26. Aromatic hydrocarbons contain a benzene ring; aliphatic hydrocarbons do not contain a benzene ring.

27. Benzene is more stable than cyclohexene (therefore, less reactive), and it has fewer hydrogen atoms.

28. All the bonds in benzene are identical and have an intermediate length compared with single and double bonds.

29. Electrons in the "double bonds" of a benzene ring are in fact shared by all six carbon atoms. They are not "localized" to a bond between two carbon atoms.

30.

Answers to Caption Questions

Figure 1.10 (Student textbook page 13): Triple bonds are linear and rigid and each carbon atom has only one atom attached.

Figure 1.13 (Student textbook page 15): They all contain only carbon and hydrogen atoms. All contain only single bonds. Except for methane, the carbon atoms are bonded to other carbon atoms. Each compound has one more CH_2 unit than the one before.

Figure 1.15 (Student textbook page 22): The compound on the left is unsaturated because the carbon atoms are not bonded to the maximum number of atoms possible, owing to the double bond. The compound on the right is saturated because the carbon atoms are bonded to the maximum number of atoms; all of the bonds are single bonds.

Figure 1.16 (Student textbook page 22): These two alkenes are isomers. The double bond can join an end carbon atom to another carbon atom, or the double bond can join the two middle carbon atoms.

Figure 1.25 (Student textbook page 46): Possible response: The CFCs act as catalysts and thus are not used up in the reactions. The CFCs take a long time to naturally degrade in the atmosphere. Also, older products, such as old refrigerators, may still emit CFCs.

Figure 1.36 (Student textbook page 70): The citric acid protonates the amines in the fish. That is, the acid adds a hydrogen ion to the amine, making it a soluble salt which is not volatile.

Figure 1.43 (Student textbook page 80): It is all three. Glucosamine contains hydroxyl side groups, an amino side group, and a formyl side group.

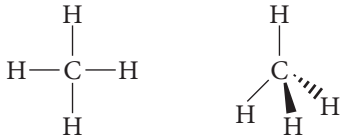
Answers to Section 1.1 Review Questions

(Student textbook page 14)

1. An organic compound is one in which carbon atoms are bonded to one another, to hydrogen and a few other non-metal elements (O, N, S P, halogens)

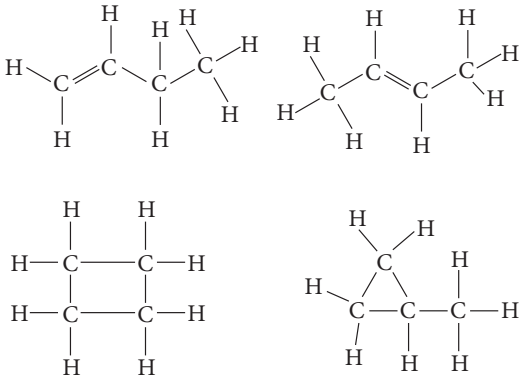
2. The carbon atom is bound only to oxygen atoms. There are no C–C or C–H bonds.

3. If the bond angle around carbon atoms was 90°, there would be fewer possible compounds because of greater repulsion between pairs of electrons. Also biological compounds would be restricted sheet or cubic shapes.

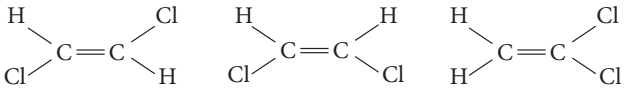


Lewis Structure

4. a.



b. $C_2H_2Cl_2$



5. a. Rotation occurs around a single bond and a *trans* "isomer" could easily rotate into a *cis* "isomer" for the same molecule

b. Each carbon atom in a triple bond is attached to only one other atom 180° to each other.

6. In the list of words, "trans" means across the nation, continent, or Atlantic respectively. The attached identical atoms or groups in the *trans* form are *across* the double bond from one another.

7. The wrist, the thumb side, the fingers and flat edge on the baby finger side.

8. Venn diagram should show:

Diastereomers only:
- carbon atoms joined by double bond
- non-mirror images, no free rotation about the double bond
- *cis* and *trans* forms have different physical properties

Diastereomers and enantiomers:
- carbon atoms

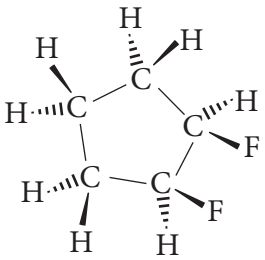
Enantiomers only:
- mirror images of one another
- single bonds
- four different atoms bonded to carbon
- same physical properties

9. The physical properties would be similar as their basic structure is the same except for the rotation of plane polarized light. Their chemical properties would also be similar. However, in living systems, the enzymes that catalyze chemical reactions recognize and bind to only one of the two enantiomers.

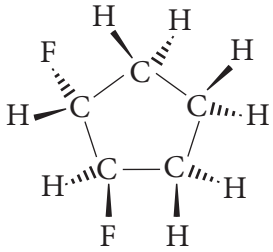
10. Looking at the two carbon atoms in the double bond, the one on the left is bonded to two identical CH_3 groups. The groups must differ in order to form *cis* or *trans* isomers.

11. **a.** The ring structure of the pentane causes the carbon atoms to form a rigid plane. Notice that, in the *cis* isomer, the two fluorine atoms are above the plane of the cyclic carbon atoms and in the *trans* isomer, the two fluorine atoms are on opposite sides of the plane.

cis- 1, 2 difluoropentane



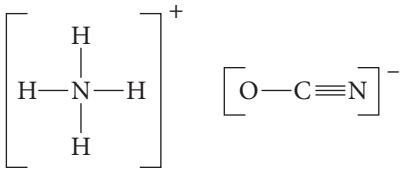
trans- 1, 2 difluoropentane



b. In the linear structures, a double bond prevents rotation around the bond, thus preventing the atoms attached to the carbons atoms of the bond. In the ring structure, the ring itself prevents rotation around the single bonds, preventing an attached atom from moving from one side of the ring to the other.

12. The boiling point depends upon the intermolecular attractions between molecules. This is affected by the surface area of each isomer. The more spherical the shape of the isomer, the less surface area is in contact between molecules and less energy is required to separate them. These isomers will have a lower boiling point than the more linear shaped isomers. The difference in chemical reactivity may be less notable for hydrocarbons since the bond strengths will be much the same regardless of their configuration. For constitutional isomers having functional groups attached, there can be a drastic difference in chemical reactivity.

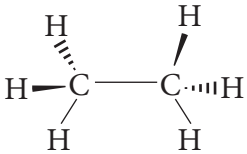
13.



Answers to Section 1.2 Review Questions (Student textbook page 41)

1. A homologous series is a specific series of compounds in which each member differs from the next by an additional specific structural unit. For example, C_2H_6 and C_3H_8 differ by CH_2

2. ethane C_2H_6



3. prefix: *2-methyl*; root: *hept*; suffix: *ane*

Each name has three parts, the prefix, the root, and the suffix. The root indicates the number of carbon atoms in the longest continuous chain of carbon atoms. The prefix indicates the position(s) and name(s) of any branches attached to the main chain. The suffix indicates the series to which the compound belongs.

4. **a.** C_nH_{2n+2}
   b. C_nH_{2n}
   c. C_nH_{2n-2}

5. Examples are:
- octane, major component of gasoline, $CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_3$
- butane, lighter fluid, $CH_3CH_2CH_2CH_3$
- nonane, component of camp stove fuel, $CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_3$
- toluene, used in paint thinner, $C_6H_5(CH_3)$