

3. methanol, ethylene, propylene, styrene, butadiene, butylenes, toluene, and xylene
How each has affected students' lives depends on individual experience, circumstance, and opinion.

Chapter 13 Review Answers

Student Textbook pages 573–575

Answers to Knowledge/Understanding Questions

- (a) decomposition of once-living organisms deep below Earth's surface
(b) three of the following: wood, coal, oil, or natural gas
(c) petroleum (crude oil)
- heat, pressure, and time
- Carbon has four bonding electrons, which allow it to form strong covalent bonds with a variety of different elements (primarily H, N, P, and S). Carbon can form single, double, and triple bonds. It can also form long, stable chains. Carbon compounds can have different structural shapes, such as chains and rings.
- Fractional distillation is a process used to separate petroleum into its hydrocarbon components. Petrochemicals are basic hydrocarbons that are converted into plastics and other synthetic materials.
- Isomers are compounds having the same formula but different structural arrangements. One example of a set of isomers is:



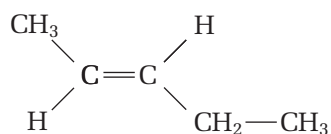
pentene



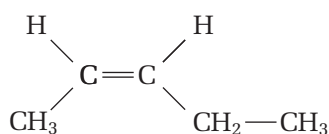
2-pentene



cyclopentane



cis-1-methylbutene

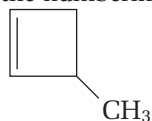


trans-1-methylbutene

- Aliphatic compounds are non-polar molecules. The only intermolecular forces exhibited by such molecules are London (dispersion) forces. Therefore, the boiling point of an aliphatic compound such as an alkane increases as the chain length increases.

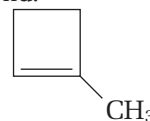
	alkanes	alkenes	alkynes
polarity	non-polar	non-polar	non-polar
boiling point	lower than similar-sized alkenes and alkynes	usually slightly higher than similar-sized alkanes but lower than similar-sized alkynes	higher than similar-sized alkanes and alkenes
degree of saturation	saturated	unsaturated	unsaturated
reactivity	less reactive than alkenes and alkynes	more reactive than alkanes but less reactive than alkynes	more reactive than alkanes and alkenes

8. Structural isomers have the same formula but different structural arrangements. Cis-trans isomers have different groups of atoms arranged around a double bond. The formula and basic structural arrangement (i.e., which atoms are bonded to each other) is the same for a cis isomer and a trans isomer; however, the spatial arrangement of atoms is different for each isomer.
9. (a) butane
(c) 2,3,4-trimethylpentane
10. (a) 2-methyl-1-propene (alkene)
(c) 3-methyl-1-pentyne (alkyne)
(e) 3-ethyl-3,4-dimethylhexane
11. trans-2-heptene
cis-2-heptene
12. (a) D;
(c) C;
(e) none;
- (b) ethane
(d) 3-ethyl-4-methylhexane
(b) 1-ethyl-2-methylcyclohexane (cycloalkane)
(d) trans-3-methyl-2-pentene (alkane)
- (b) none;
(d) A;
(f) B
13. No, the numbering must begin at the double bond.



3-methyl-1-cyclobutene

or

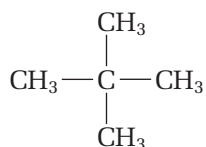
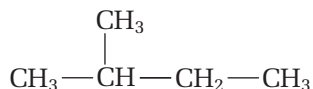
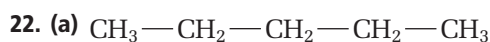


1-methyl-1-cyclobutene

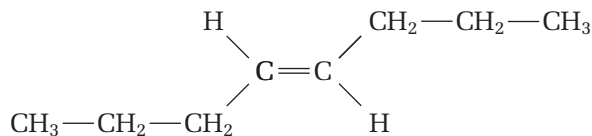
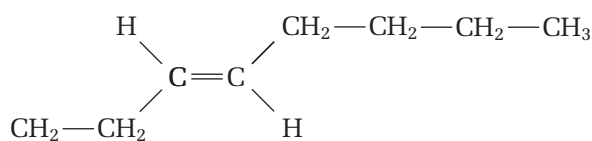
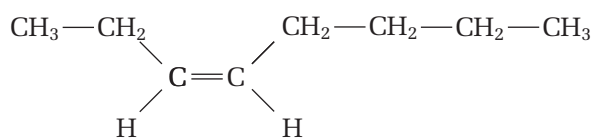
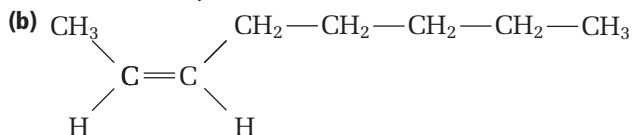
14. Oil molecules are non-polar; they do not dissolve in water molecules, which are polar. Oil floats on the surface of water.
15. The “1” position at the end of an alkane chain is always a methyl group that is part of the main chain.
16. True isomers of C_6H_{14} are diagrams (a), (b), and (e). Diagrams (a), (c) and (b), (d) represent the same isomer.

Answers to Inquiry Questions

17. Add potassium permanganate to each beaker. A change in colour will occur in the beaker that contains the alkene.
18. First, determine the possible structural formulae for the isomers of C_6H_{12} . Only structural diagrams of cycloalkanes and alkenes fit the criteria. Next, determine the boiling points of the two compounds and compare them to the literature value. Another test is the addition of $KMnO_4$, which turns brown in the presence of an alkene.
19. (a) Springs were required to accommodate the orientation of the carbon atoms in this configuration. Carbon allows covalent bonds to occur in a tetrahedral arrangement around its nucleus but does not allow a perfect cube to form from four carbon atoms. For this reason, a straight connection cannot be made in a model and springs must be used.
(b) Cyclobutane is a relatively unstable molecule.



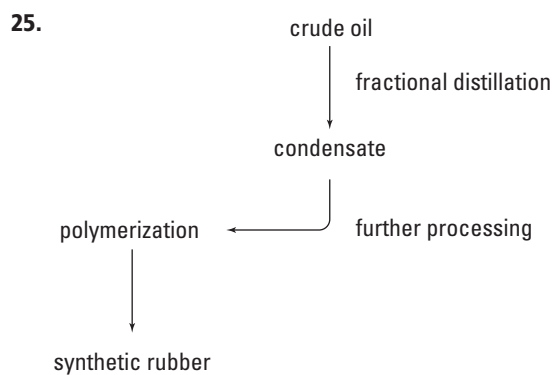
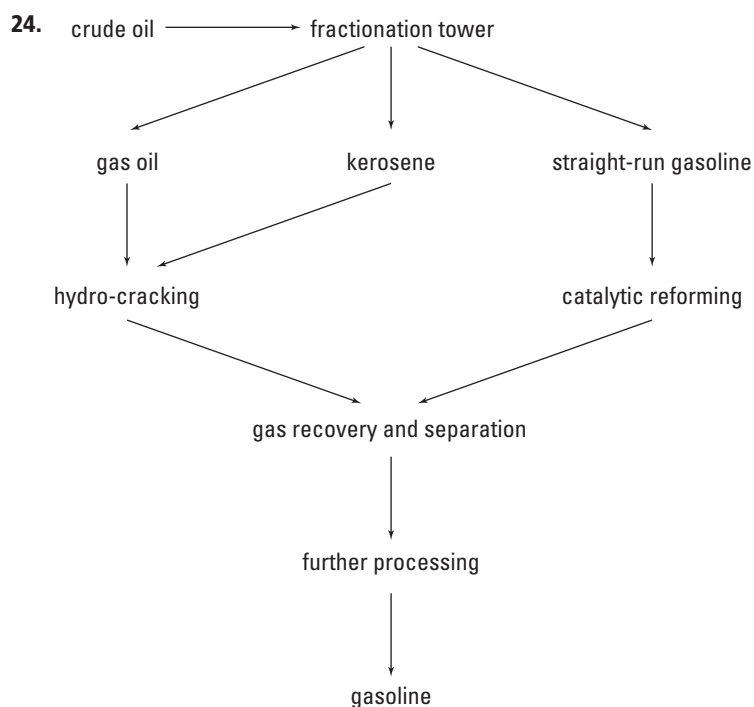
There are only three isomers of C_5H_{12} .



23. (a) Each hydrocarbon component has its own range of boiling points. Hydrocarbons with lower boiling points vaporize first and rise to the top of the tower.

Hydrocarbons with higher boiling points remain in the solid state and stay at the bottom of the tower.

(b) A chain that is 15 carbon atoms in length would most likely be removed from the “gas oil” section of the fractionation tower, which is close to the base. As the number of carbon atoms in a chain increases, so does the compound’s boiling point, so this particular compound would fractionate out close to the bottom of the tower.

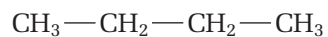


26. The cracking process must be employed.

27. Alkanes containing the fewest carbon atoms in the main chain have the lowest boiling point.



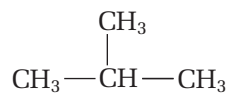
propane



butane



pentane

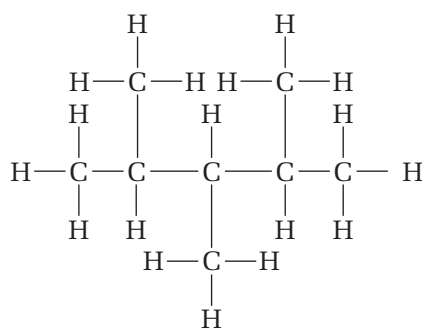


2-methylpropane

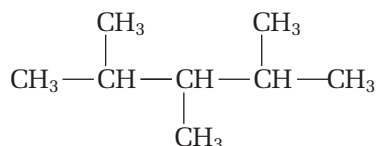
lowest BP

highest BP

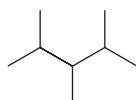
28.



complete structural diagram



condensed structural diagram



line structural diagram

Complete structural diagrams provide a strong visual representation of the arrangement of atoms in a molecule but are difficult to produce for large hydrocarbon molecules. Condensed structural diagrams are easy to produce and can be used to represent virtually any organic compound. Line structural diagrams are very easy to draw but some confusion can exist when trying to determine the number of carbon and hydrogen atoms found within a particular molecule.

Answers to Making Connections Questions

29. Ethene is used to increase the ripening of fruit and to manufacture plastics.
30. Two Internet sites containing information on oil drilling are:
- <http://www.hibernia.ca/index.html> (information about the Hibernia oil drilling platform off the coast of Newfoundland)
 - <http://www.capp.ca/> (official site of the Canadian Association of Petroleum Producers)
31. Responses will vary based on students' opinions on the use of natural resources. It appears there are plenty of resources for the current generation but what might not be realized is that it took billions of years to build up these resources and, at the current rate of use, we will run out of petroleum resources before more can be created.