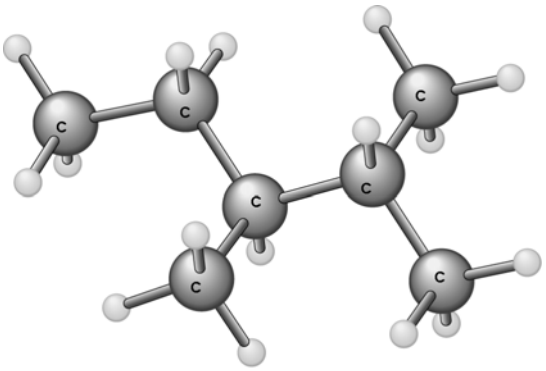
Chapter 24

Organic Chemistry

Concept Check 24.1

Given the model below where C atoms are labeled and H atoms are the small white balls:



a. Write the molecular formula.
b. Write the condensed structural formula.

Solution

a. C_7H_{16}

b. $CH_3CHCHCH_2CH_3$ (with a CH_3 branch on the second carbon)

Concept Check 24.2

For a gasoline to function properly in an engine, it should not begin to burn before it is ignited by the spark plug. If it does, it makes the noise we think of as engine "knock." The octane-number scale rates the anti-knock characteristics of a gasoline. This linear scale is

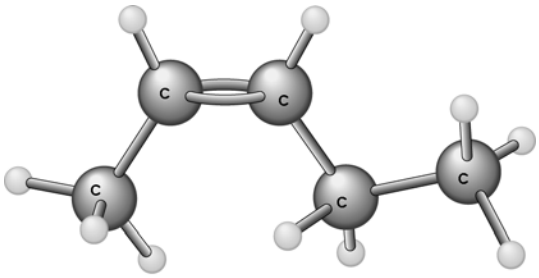
based on heptane, given an octane number of 0, and on 2,2,4-trimethylpentane (an octane constitutional isomer), given an octane number of 100. The higher the octane number, the better the anti-knock characteristics. If you had a barrel of heptane and a barrel of 2,2,4-trimethylpentane, how would you blend these compounds to come up with a 90 octane mixture?

Solution

Since, by definition, heptane is zero octane and 2,2,4-trimethylpentane is 100 octane, a mixture of 10% heptane and 90% 2,2,4-trimethylpentane would produce a 90 octane mixture.

Concept Check 24.3

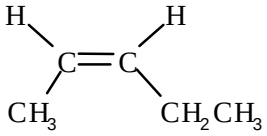
Given the model below where C atoms are labeled and H atoms are the small white balls:



a. Write the molecular formula.
b. Write the condensed structural formula.
c. Write the IUPAC name.

Solution

a. C_5H_{10}

b. 

c. *cis*-2-pentene

Conceptual Problem 24.15

You are distilling a barrel of oil that contains the hydrocarbons listed in Table 24.4. You heat the contents of the barrel to 200°C.

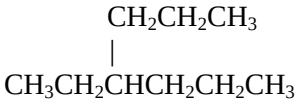
a. What molecules will no longer be present in your sample of oil?
b. What molecules will be left in the barrel?
c. Provide an explanation for your answers in parts a. and b.
d. Which molecule would boil off at a lower temperature, hexane or 2,3-dimethylbutane?

Solution

a. The molecules with carbon chains in the C_5-C_{11} range will no longer be present because they have all boiled off. Additionally, some of the heavily branched C_{12} chains will boil off.
b. The molecules with carbon chains greater than C_{11} will be left in the barrel because they boil at temperatures above 200°C (Keep in mind that the heavily branched C_{12} chains will have boiled off at or slightly below 200°C.)
c. Low molecular weight hydrocarbons have fewer polarizable electrons; therefore, they have weaker London forces than the longer chains and, as a result, boil at a lower temperature.
d. The more compact 2,3-dimethylbutane would boil at a lower temperature.

Conceptual Problem 24.16

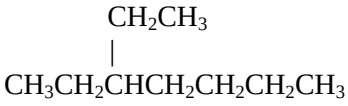
A classmate tells you that the following compound has the name 3-propylhexane.



a. Is he right? If not, what error did he make and what is the correct name?
b. How could you redraw the condensed formula to better illustrate the name?

Solution

a. He is incorrect because he didn't use the longest chain of carbon atoms for the root name (it is seven, not six). The name should be 4-ethylheptane.
b. Writing the longest carbon atom chain on a line sometimes is helpful when naming compounds:



Conceptual Problem 24.17

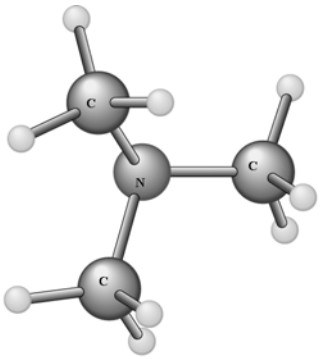
Explain why you wouldn't expect to find a compound with the formula CH_5.

Solution

Since carbon would have more than four bonds in this case, CH_5 would be in violation of the octet rule.

Conceptual Problem 24.18

Catalytic cracking is an industrial process used to convert high-molecular-weight hydrocarbons to low-molecular-weight hydrocarbons. A petroleum company has a huge supply of heating oil stored as straight chain $C_{17}H_{36}$ and demand has picked up for shorter chain hydrocarbons to be used in formulating gasoline. The company uses catalytic cracking to create the shorter chains necessary for gasoline. If they produce two molecules in the cracking, and 1-octene is one of them, what is the formula of the other molecule produced? As part of your answer, draw the condensed structural formula of the 1-octene.

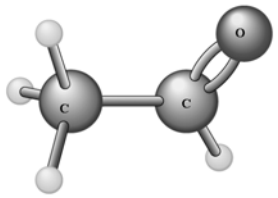


Solution

$CH_2CHCH_2CH_2CH_2CH_2CH_2CH_3$ The other product formula is C_9H_{20}.

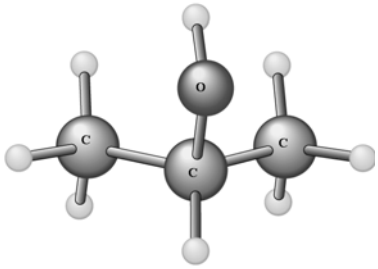
1-octene

Conceptual Problem 24.19



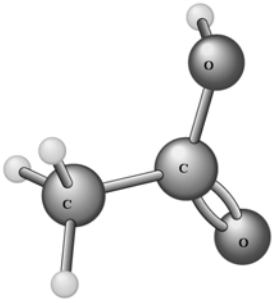
Given the models shown here where C, N, and O atoms are labeled and H atoms are the small white balls:

a. Write the molecular formula of each molecule.
b. Write the condensed structural formula for each molecule.
c. Identify the functional group for each molecule.



Solution

a. The molecular formulas are: trimethylamine – C_3H_9N, acetaldehyde – C_2H_4O, 2-propanol – C_3H_8O, and acetic acid – $C_2H_4O_2$.
b. The condensed structural formulas are:



trimethylamine: $N(CH_3)_3$

acetaldehyde: $CH_3CH{=}O$

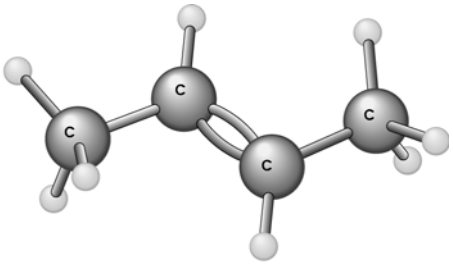
2-propanol: $CH_3CH(OH)CH_3$

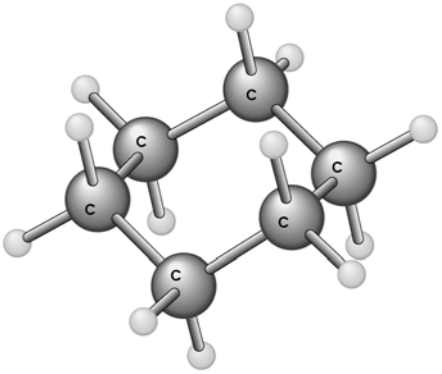
acetic acid: CH_3COOH

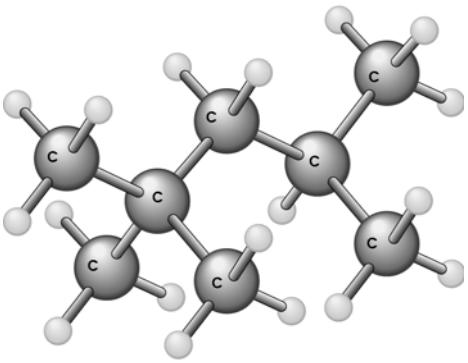
c. The functional groups in the molecules are trimethylamine – amine (tertiary), acetaldehyde – aldehyde, 2-propanol – alcohol, and acetic acid – carboxylic acid.

Conceptual Problem 24.20

Given the models shown where C atoms are labeled and H atoms are the small white balls:
a. Write the molecular formula of each molecule.
b. Write the condensed structural formula for each molecule.
c. Give the IUPAC name of each molecule.





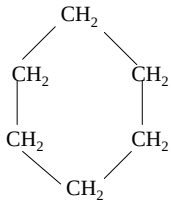


Solution

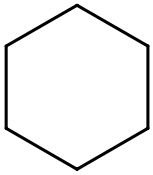
a. The molecular formulas are *trans*-2-butene – C_4H_8, cyclohexane – C_6H_{12}, and 2,2,4-trimethylpentane – C_8H_{18}.
b. The condensed structural formulas are:

trans-2-butene:
$CH_3CH{=}CHCH_3$

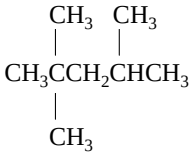
cyclohexane:



or



2,2,4-trimethyl pentane:



c. The IUPAC names are *trans*-2-butene, cyclohexane, and 2,2,4-trimethylpentane.

Conceptual Problem 24.21

Why would you expect the melting point of the alkanes to increase in the series methane, ethane, propane, and so on?

Solution

The molecules increase regularly in molecular weight. Therefore, you expect their intermolecular forces and thus their melting points to increase.

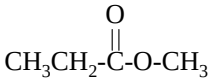
Conceptual Problem 24.22

Consider the following formulas of two esters:

One of these is ethyl ethanoate (ethyl acetate) and one is methyl propanoate (methyl propionate). Which is which?

Solution

Ethyl ethanoate (acetate) is:



Methyl propanoate is: