Chapter 13
The Chemistry of Hydrocarbons

Solutions for Practice Problems
Student Textbook page 545

1. Problem
Heptane has 7 carbon atoms. What is the chemical formula of heptane?

What Is Required?
You need to establish the chemical formula of heptane.

What Is Given?
Heptane has 7 carbon atoms.

Plan Your Strategy
Heptane is an alkane, meaning it is a saturated hydrocarbon. In these, there are 2 hydrogen atoms for every middle C, and 3 H atoms for the two outer C atoms. Multiply the number of middle carbon atoms by 2H and the outer carbons by 3H and add the results for the total number of H atoms in the formula.

Act on Your Strategy
\((5 \times 2 \text{ H atoms}) + (2 \times 3 \text{ H atoms}) = 16 \text{ H atoms}\). Therefore, the formula should be \(\text{C}_7\text{H}_{16}\).

Check Your Solution
The formula of heptane can be found in most chemistry books and on the Internet. Make a search to verify your answer.

2. Problem
Nonane has 9 carbon atoms. What is the chemical formula?

What Is Required?
You need to establish the chemical formula of nonane.

What Is Given?
Nonane has 9 carbon atoms.

Plan Your Strategy
Nonane is an alkane, meaning it is a saturated hydrocarbon. In these, there are 2 hydrogen atoms for every middle C, and 3 H atoms for the two outer C atoms. Multiply the number of middle carbon atoms by 2H and the outer carbons by 3H and add the results for the total number of H atoms in the formula.

Act on Your Strategy
\((7 \times 2 \text{ H atoms}) + (2 \times 3 \text{ H atoms}) = 20 \text{ H atoms}\). Therefore, the formula should be \(\text{C}_9\text{H}_{20}\).

Check Your Solution
The formula of nonane can be found in most chemistry books and on the Internet. Make a search to verify your answer.
3. Problem
An alkane has 4 carbon atoms. How many hydrogen atoms does it have?

What Is Required?
You need to find the number of hydrogen atoms in the alkane.

What Is Given?
The alkane has 4 carbon atoms.

Plan Your Strategy
An alkane is a saturated hydrocarbon. In these, there are 2 hydrogen atoms for every middle C, and 3 H atoms for the two outer C atoms. Multiply the number of middle carbon atoms by 2H and the outer carbons by 3H and add the results for the total number of H atoms in the formula.

Act on Your Strategy
\[(2 \times 2 \text{ H atoms}) + (2 \times 3 \text{ H atoms}) = 10 \text{ H atoms}.\]

Check Your Solution
You can check by searching in books or on the Internet if the alkane \( \text{C}_4\text{H}_{10} \) really does exist. It does, and is in fact butane.

4. Problem
Candle wax contains an alkane with 52 hydrogen atoms. How many carbon atoms does this alkane have?

What Is Required?
You need to find the number of carbon atoms in the candle wax alkane.

What Is Given?
The number of hydrogen atoms is 52.

Plan Your Strategy
An alkane is a saturated hydrocarbon. In these, there are 2 hydrogen atoms for every middle C, and 3 H atoms for the two outer C atoms. Subtract 6 H atoms from the total number given, and reserve these 6 for the 2 outer carbons. Divide the difference by 2 to get the number of middle carbons.

Act on Your Strategy
Subtracting from the 2 outer C atoms: \( 52 \text{ H atoms} - 6 \text{ H atoms} = 46 \text{ H atoms} \)

Middle C atoms: \( 46 \text{ H atoms} / 2 \text{ H atoms per C atom} = 23 \text{ C atoms} \).

23 middle C atoms + 2 outer C atoms = 25 C atoms

Check Your Solution
You can check by searching in books or on the Internet if the candle wax alkane \( \text{C}_{25}\text{H}_{52} \) really does exist. It does, and the unbranched alkane is called pentacosane.

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5. Problem
Name each compound.

(a) \[
\begin{array}{c}
\text{CH}_3 \\
\text{CH}_3 - \text{CH} - \text{CH}_2 - \text{CH}_3
\end{array}
\]
What Is Required?
You have to name the compounds listed.

What Is Given?
The structural formula for each compound is given.

Plan Your Strategy
For each structure, follow the following steps.

Step 1 Find the parent chain, or the longest continuous chain. The number of carbons in the parent chain forms the root of the main alkane name.

Step 2 Identify any branches present. The end closest to the branch is the lower-numbered end of the main parent chain. Number the parent from this end across.

Step 3 If there are more than one type of branch, remember that the numbering of the branch must reflect its lowest possible number in the chain.

Step 4 Identify the location of the branch relative to the main chain. Number the branch by the number of main chain C it is attached to. Change the -ane suffix of the branch to -yl.

Step 5 If more than one of the same type of branch alkane is present, name them once using the appropriate number prefixes (di- for two, tri- for 3, tetra- for 4, and so on).

Step 6 Put the prefix + suffix + root name together for the name of the compound, in alphabetical order of branches.

Act on Your Strategy

(a) The main chain has 4 carbons, so it will be butane.

(b) The methane branch is attached to C2 of the main root, so it is a 2-methyl branch.
The name of the structure is 2-methylbutane.

(b) The main branch has 3 carbons, so it will be propane. The two methane branches are both on the C2 of the main chain, so they will be 2, 2-dimethyl branches (di- because there is two of them). The name of the structure is 2, 2-dimethylpropane.

(c) The longest main branch has 6 carbons, so it will be hexane. There are 2 ethane groups attached to the root and one methane group. Since the ethane groups must have the lowest numbering possible, numbering of the chain will go from left to right, so that they are at C2 and C4 (if numbering was right to left, they would be at positions C3 and C5 which are not the lowest possible numbers). The methane is at C5. The name is therefore 2,4-diethyl-5-methylhexane.

(d) The main branch has 6 carbons, so it is a hexane. Two methane groups are attached to the C2 of the main branch as well as C4, so these will be 2,2,4,4-tetramethyl branches (tetra- because there are 4 of them). The name is 2,2,4,4-tetramethylhexane.

(e) There are 8 main carbons in the root so it is an octane. There are 3 methane parts, so in order to give it their lowest number, numbering of the chain will proceed from right to left. The methane groups are thus two at C2 and one at C4, so they will be names 2,2,4-trimethyl branches. A propyl branch is attached to the C4 main carbon, so it will be called 4-propyl. The name, taken together in alphabetical order, is 2,2,4-trimethyl-4-propyloctane.

Check Your Solution
Try searching for these names on the Internet and in chemistry books and see if the structures and names match.

6. Problem
Draw a condensed structural diagram for each alkane.

(a) 3-ethyl-3,4-dimethylhexane
(b) 2,3,4-trimethylpentane
(c) 5-ethyl-3,3-dimethyloctane
(d) 4-butyl-6-ethyl-2,5-dimethylnonane

What Is Required?
You have to draw the structural diagrams of the listed alkanes.

What Is Given?
The name of the branched-chain alkane is given.

Plan Your Strategy
For each compound, follow the following steps.
Step 1 Identify the root chain, which is usually the last name with the suffix -ane.
Step 2 Draw the main chain first, preferably as a straight chain, of linked C atoms only.
Step 3 Choose either end to be C1. Add the branches accordingly to the main chain. The number in front of the -yl branch alkane identifies the main chain C it must be attached to. Add the branch alkane to the main branch first.
Step 4 Finish off the diagram by adding the H atoms to the main branch C. Remember that each main branch carbon should be attached to 4 other atoms, be it C or H or both.
Act on Your Strategy

(a) 3-ethyl-3,4-dimethylhexane

(b) 2,3,4-trimethylpentane

(c) 5-ethyl-3,3-dimethylheptane

(d) 4-butyl-6-ethyl-2,5-dimethylnonane

Check Your Solution

Try searching for these names on the Internet and in chemistry books and see if the structures and names match. Also work backward by renaming your drawn structure according to the naming rules for alkanes.

7. Problem

One way to assess how well you have learned a new skill is to identify mistakes. Examine the following compounds and their names. Identify any mistakes, and correct the names.

(a) 4-ethyl-2-methypentane

(b) 4,5-methylhexane
What Is Required?
You have to verify if the names for the given structural diagrams are correct.

What Is Given?
The structural diagram is given with a chemical name.

Plan Your Strategy
For each diagram, use the rules for naming alkanes from structural diagrams.

Step 1 Find the parent chain, or the longest continuous chain. The number of carbons in the parent chain forms the root of the main alkane name.

Step 2 Identify any branches present. The end closest to the branch, or which has the most branches, is the lower-numbered end of the main parent chain. Number the parent from this end across.

Step 3 Identify the location of the branch relative to the main chain. Number the branch by the number of main chain C it is attached to. Change the -ane suffix of the branch to -yl.

Step 4 If more than one of the same type of branch alkane is present, name them once using the appropriate number prefixes (di- for two, tri- for 3, tetra- for 4, and so on)

Act on Your Strategy
(a) 2,4-dimethylhexane → the longest chain should be 6 carbons, not 5, and two methyl branches therefore occur at C2 and C4.

(b) 2,3-dimethylhexane → numbering on the main chain should occur at the end closest to substitution, or the end with the most branches.

(c) 3-ethyl-3-methylhexane → the longest chain is 6 carbons, not 5.

Check Your Solution
Try searching for these names on the Internet and in chemistry books and see if the structures and names match. Also, try drawing the structures for the incorrect names given, using the drawing rules for alkanes, and see how the structures differ.

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8. Problem
Name each hydrocarbon.

(a) CH₃—CH₂—CH＝CH—CH₂—CH₃
(b) CH₃—CH₂—CH₂—CH₂—C＝CH—CH₃
What is Required?
You have to name the alkenes given.

What Is Given?
The full structural diagrams of the alkenes are given.

Plan Your Strategy
Follow the following steps for all the structures.

Step 1
Find the chain that contains the double bond. This is the main root chain, and it need not be the longest chain possible. The number of C atoms in the main chain will determine the main alkene name.

Step 2
Number the main chain, starting from the end closest to the double bond. Identify the C number at the double bond; this will be the alkene number.

Step 3
Identify the branches on the main chain and number there position relative to the main chain C atom it is attached to. The suffix of the branch should be changed to -yl.

Step 4
If more than one of the same type of branch is present, name them once using the appropriate number prefixes (di- for two, tri- for 3, tetra- for 4, and so on).

Step 5
Put the prefix + suffix + root name together for the name of the compound, in alphabetical order of branches.

Act on Your Strategy
(a) The main double-bonded chain has 6 C atoms. The double-bond is on C3, so it is simply 3-hexene.

(b) The main double-bonded chain has 7 C atoms, with the double bond at C2. It will be a 2-heptene. The propane branch is on C3, so it will be the 3-propyl branch. The final name is 3-propyl-2-heptene.

(c) The main double-bonded chain has 8 C atoms, with the double bond on C4. It will be 4-octene. Numbering will start from left to right. On the C2 and C3, there is one methane on each; these will be 2,3-dimethyl branches. An ethane group is on C4, so it will be the 4-ethyl branch. Putting these together alphabetically, we get 4-ethyl-2,3-dimethyl-4-octene.

Check Your Solution
Try searching for these names on the Internet and in chemistry books and see if the structures and names match.

9. Problem
Draw a condensed structural diagram for each compound.

(a) 2-methyl-1-butene
(b) 5-ethyl-3,4,6-trimethyl-2-octene

What Is Required?
You need to draw the structural diagrams of the given alkenes.

What Is Given?
The branched name of the alkene is given.

Plan Your Strategy
For each of the alkenes, follow the following steps.
**Step 1** Identify the root chain in the name, which is usually the last name with the suffix -ene.

**Step 2** Draw the main chain first, preferably as a straight chain, of linked C atoms only. The number before the root chain name is the number of the C with the double bond.

**Step 3** Number the rest of the main chain carbons according to the position of the double bond.

**Step 4** Add the branches to the main chain. The number in front of the -yl branch alkane identifies the main chain C it must be attached to. Add the branches to the main branch first.

**Step 5** Finish off the diagram by adding the H atoms to the main branch C. Remember that each main branch carbon should be attached to 4 other atoms, be it C or H or both. In the case of the double-bonded carbons, they only have 2 other atom attachments available each, one being a C atom and one a H atom.

**Act on Your Strategy**

(a) 2-methyl-1-butene

```
   CH3
   CH2=C-CH2-CH3
```

(b) 5-ethyl-3,4,5-trimethyl-2-octene

```
   CH3 CH3
  CH3-CH=C-CH-CH2-CH2-CH3
       |     |     |
       CH2  CH3
```

**Check Your Solution**

Try searching for these names on the Internet and in chemistry books and see if the structures and names match. Work backward and try to rename the structures you have drawn using the naming rules for alkenes.

10. **Problem**

You have seen that alkenes, such as C₆H₁₂, can have isomers. Draw condensed structural formulas for the isomers of C₄H₈. Then name the isomers.

**What Is Required?**

You need to draw the isomers of the alkene C₄H₈.

**What Is Given?**

You are given the formula of C₄H₈.

**Plan Your Strategy**

Isomers have the same number of C and H atoms, but in a completely different attachment to one another. Set out the four C atoms and add the double bond in different areas of the links. You can even create branches along the root chain. the important facts to remember are:

1. Each C atom in the double bond is only allowed to form 2 more bonds with another atom, be it a C or H atom.
2. Those C atoms not part of the double bond can form 4 bonds with other atoms.
3. Any “free-end” C atom is usually a methyl group, unless it is double (or triple) bonded to the C2 atom.
4. The total number of C atoms must be 4, and the total number of H atoms must be 8 for C₄H₈.

**Act on Your Strategy**

(a) 2-methyl-1-propene

\[
\text{CH}_3 \\
\uparrow \\
\text{CH}_2=\text{C}−\text{CH}_3
\]

(b) 1-butene

\[
\text{CH}_2=\text{CH}−\text{CH}_2−\text{CH}_3
\]

**Check Your Solution**

Check other chemistry textbooks or the Internet to see if your answers are correct. See also Student Textbook page 558 for the geometric isomers of 2-butene, as well as the Electronic Learning Partner for more about geometric isomers.

11. Draw and name the cis-trans isomers for C₅H₁₀.

**What Is Required?**

You have to draw the geometric isomers of C₅H₁₀.

**What Is Given?**

The formula of C₅H₁₀ is given.

**Plan Your Strategy**

Step 1 First draw the five C atoms as a straight chain. You will see that there are 4 links in which a double bond can be placed. Repeat this drawing 3 more times.

Step 2 Draw a double bond into each of the 4 diagrams of the chain, one for each main chain position of the link.

Step 3 Add the H atoms to the C atoms. Remember that each double-bonded C atom can only have two other atom attachments.

Step 4 For the double bond being at the centre links; you can actually have two geometric isomers depending on how the H atoms are positioned relative to the C atoms.

**Act on Your Strategy**

(a) cis-2-pentene

\[
\begin{array}{c}
\text{CH=CH} \\
\text{CH}_3 \\
\text{CH}_2 \\
\text{CH}_3
\end{array}
\]

(b) trans-2-pentene

\[
\begin{array}{c}
\text{CH}=	ext{CH} \\
\text{CH}_3 \\
\text{CH}_2 \\
\text{CH}_3
\end{array}
\]

**Check Your Solution**

Try searching for pentene geometric isomers on the Internet and in other chemistry books and see if the structures and names match.

12. **Problem**

Why can 1-butene not have cis-trans isomers? Use a structural diagram to explain.
What Is Required?
You need to explain why 1-butene will not generate geometric isomers.

What Is Given?
The double bond position of the butene is given.

Plan Your Strategy
Repeat the steps given in Problem 10 above. It was noted that two of the 3 drawn structures would be identical. These are the 1-butene structures.

Act on Your Strategy
\[
\begin{align*}
&\text{H} & \text{H} & \text{H} & \text{H} \\
&\text{C} & \text{C} & \text{C} & \text{C} & \text{H} \\
&\text{H} & \text{H} & \text{H} \\
\end{align*}
\]

Therefore, no matter from which end of the chain you had started the double bond, the result is identical.

Check Your Solution
If available, use ball and stick models to check the results. Wine gums and toothpicks can be used if model kits are not available. You will see that no matter how you twist the C atoms around the double bond, the configuration is the same. there are no true isomers of 1-butene.

13. Problem
Like other isomers, two cis-trans isomers have the same atomic weight. They also yield the same elements when decomposed. How might you distinguish between two such isomers in the lab?

What Is Required?
You need to explain how two isomers can be distinguished in a lab.

What Is Given?
The isomers are geometric only.

Plan Your Strategy
All isomers have different physical and chemical properties, including cis-trans isomers. These can be investigated in the laboratory.

Act on Your Strategy
The simplest way to determine between cis and trans isomers in the lab is to evaluate their boiling points and compare to reference data.

Check Your Strategy
Review some organic chemistry reference books or Internet sources for laboratory data on cis-trans isomers, particularly for boiling points. Also see the Electronic Learning Partner for more on cis-trans isomers.

14. Problem
\( \text{C}_6\text{H}_{12} \) has four possible pairs of cis-trans isomer. Draw and name all four pairs.

What Is Required?
You have to draw the 4 geometric isomers of \( \text{C}_6\text{H}_{12} \).

What Is Given?
The formula of \( \text{C}_6\text{H}_{12} \) is given.
Plan Your Strategy

**Step 1** First draw the six C atoms as a straight chain. You will see that there are 5 links in which a double bond can be placed. Repeat this drawing 4 more times.

**Step 2** Draw a double bond into each of the 5 diagrams of the chain, one for each main chain position of the link.

**Step 3** Add the H atoms to the C atoms. Remember that each double-bonded C atom can only have two other atom attachments.

**Step 4** For the double bond at the centre links; you can actually have two geometric isomers depending on how the H atoms are positioned relative to the C atoms.

Act on Your Strategy

(a) cis-3-hexene

\[
\begin{align*}
 & \text{CH} = \text{CH} \\
 & \text{CH}_2 \quad \text{CH}_2 \\
 & \text{CH}_3 \quad \text{CH}_3
\end{align*}
\]

(b) trans-3-hexene

\[
\begin{align*}
 & \text{CH}_3 \\
 & \text{CH}_2 \\
 & \text{CH} = \text{CH} \\
 & \text{CH}_2 \\
 & \text{CH}_3
\end{align*}
\]

(c) cis-2-hexene

\[
\begin{align*}
 & \text{CH} = \text{CH} \\
 & \text{CH}_3 \quad \text{CH}_2 \\
 & \text{CH}_2 \quad \text{CH}_3
\end{align*}
\]

(d) trans-2-hexene

\[
\begin{align*}
 & \text{CH}_3 \\
 & \text{CH}_2 \\
 & \text{CH} = \text{CH} \\
 & \text{CH}_2 \\
 & \text{CH}_3
\end{align*}
\]

Check Your Strategy

Review some organic chemistry reference books or Internet sources on cis-trans isomers of \( \text{C}_6\text{H}_{12} \). Also see the Electronic Learning Partner for more on cis-trans isomers.

Solutions for Practice Problems

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15. Problem

Name each alkyne.
What Is Required?
You have to name the unsaturated hydrocarbons listed.

What Is Given?
The structural diagrams of the alkynes are given.

Plan Your Strategy
Alkynes are named in the same way as alkenes.

Step 1
Find the chain that contains the triple bond. This is the main root chain, and it need not be the longest chain possible. The number of C atoms in the main chain will determine the main alkyne name.

Step 2
Number the main chain, starting from the end closest to the triple bond. Identify the C number at the triple bond; this will be the alkyne number.

Step 3
Identify the branches on the main chain and number there position relative to the main chain C atom it is attached to. The suffix of the branch should be changed to -yl.

Step 4
If more than one of the same type of branch is present, name them once using the appropriate number prefixes (di- for two, tri- for 3, tetra- for 4, and so on).

Step 5
Put the prefix + suffix + root name together for the name of the compound, in alphabetical order of branches.

Act on Your Strategy
(a) The main chain has 5 carbons so it is a pentyne; the triple bond is at C2, so it is a 2-pentyne. There are 2 methane branches at the C4 position; these will be 4,4-dimethyl branches. The final name is 4,4-dimethyl-2-pentyne.

(b) The main chain with the triple bond has 6 C atoms, with the bond being at position C1, so it is 1-hexyne. There is an ethane group and a propane group attached to C3, so these will be 3-ethyl and 3-propyl branches, respectively. A methane branch is attached to C5, so it is a 5-methyl branch. Taken together, the name of the alkyne is 3-ethyl-5-methyl-3-propyl-1-hexyne.

Check Your Solutions
Look up other organic chemistry books or Internet sources to find these structures and see if the names and structures match.

16. Problem
Draw a condensed structural diagram for each compound.
(a) 2-pentyne
(b) 4,5-dimethyl-2-heptyne  
(c) 3-ethyl-4-methyl-1-hexyne  
(d) 2,5,7-trimethyl-3-octyne

What Is Required?
You have to draw the condensed structural diagram of the alkynes listed.

What Is Given?
The branched names of the alkynes are given.

Plan Your Strategy
For each of the alkynes, follow the following steps.

Step 1 Identify the root chain in the name, which is usually the last name with the suffix \(-yne\).

Step 2 Draw the main chain first, preferably as a straight chain, of linked C atoms only. The number before the root chain name is the number of the C with the triple bond.

Step 3 Number the rest of the main chain carbons according to the position of the triple bond.

Step 4 Add the branches to the main chain. The number in front of the \(-yl\) branch alkane identifies the main chain C it must be attached to. Add the branches to the main branch first.

Step 5 Finish off the diagram by adding the H atoms to the main branch C. Remember that each main branch carbon should be attached to 4 other atoms, be it C or H or both. In the case of the triple-bonded carbons, they only have 1 other atom attachment available each.

Act on Your Strategy
(a) 2-pentyne
\[
\text{CH}_3 \quad \text{C} \equiv \text{C} \quad \text{CH}_2 \quad \text{CH}_3
\]

(b) 4,5-dimethyl-2-heptyne
\[
\text{CH}_3 \quad \text{CH}_3 \\
\text{CH}_3 \quad \text{C} \equiv \text{C} \quad \text{CH} \quad \text{CH} \quad \text{CH}_2 \quad \text{CH}_3
\]

(c) 3-ethyl-4-methyl-1-hexyne
\[
\text{CH}_3 \\
\text{CH}_2 \\
\text{C} \equiv \text{C} \quad \text{CH} \quad \text{CH} \quad \text{CH}_2 \quad \text{CH}_3
\]

(d) 2,5,7-trimethyl-3-octyne
\[
\text{CH}_3 \\
\text{CH}_3 \quad \text{CH}_3 \\
\text{CH}_3 \quad \text{CH} \quad \text{C} \equiv \text{C} \quad \text{CH} \quad \text{CH}_2 \quad \text{CH} \quad \text{CH}_3
\]

Check Your Solutions
Look up other organic chemistry books or Internet sources to find these names and see if the names and structures match.
17. Problem
Name each compound.
(a) \( \text{CH}_3 - \text{CH}_2 - \text{CH}_2 - \text{CH}_3 \)
(b) \( \text{H}_3\text{C} - \text{CH}_3 \)
(c) \( \text{CH}_3 \)
(d) \( \text{CH}_3 - \text{CH}_2 - \text{CH}_2 - \text{CH}_3 \)
(e) \( \text{CH}_3 \)
(f) \( \text{CH}_2\text{CH}_3 \)
(g) \( \text{CH}_3\text{CH}_2 - \text{CH}_2\text{CH}_3 \)
(h) \( \text{CH}_3 - \text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3 \)

What Is Required?
You have to name each compound drawn.

What Is Given?
The condensed structural diagram for each cyclic hydrocarbon is given.

Plan Your Strategy
The following rules can be applied to naming cyclic compounds.

**Rule 1**
When naming cyclic compounds, all the C in the ring are treated as equal, so any carbon can be used as C1.

**Rule 2**
When there are branches attached, the C atom with the branch is assigned the lowest number.

**Rule 3**
If there are more than two branches attached, number in one direction (clockwise or counterclockwise) according to alphabetical listing of the branches; that is, an ethyl group will usually start first, followed by methyl, and so on.

**Rule 4**
Wherever a double bond occurs in the ring, it must be assign the lowest 2 C numbers (that is C1 and C2 on either side of the bond). Then number either clockwise or counterclockwise to the nearest branch, in such a way that the branches have the lowest possible number in the ring.
Act on Your Strategy

(a) The ring has 5 C atoms so it is a cyclopentane. There is an ethane branch and a methane branch attached to the ring. Name the ethane first, so positioning it as C1. It will be the 1-ethyl branch. The methane group is clockwise to the ethane group, so number the rest of the C atoms in a clockwise direction. Methane is thus the 3-methyl branch. Taken together, the name is 1-ethyl-3-methylcyclopentane.

(b) The ring has 6 C atoms, so it is a cyclohexane. There are methane branches attached consecutively to 4 of its C atoms. Choose as C1 either one of the 2 carbon atoms with methane attached, but which does not have both C neighbours with branches. Count towards the neighbouring branched carbons in the ring (you can see that no matter which C1 you choose, the clockwise or counterclockwise counting makes not difference to the numbering of other branches). This structure is therefore 1,2,3,4-tetramethylcyclohexane.

(c) The ring has 4 C atoms so it is a cyclobutane. There is only one methane branch so this will be position C1. The name is 1-methylcyclobutane.

(d) The ring has 5 C atoms, but one double bond, so it is a cyclopentene. A propane branch and a methane branch is attached to it. Choose the carbon at the double bond, which is closer to methane as C2 since it should count alphabetically. Counting counterclockwise, the structure is therefore named 3-methyl-5-propyl-1-cyclopentene.

(e) The ring has 8 carbons with a double bond, so it is a 1-cyclooctene. Counting clockwise from C1 to the methane branch at C4, the final name is 4-methyl-1-cyclooctene.

(f) The ring has 9 C atoms and one double bond, so it is a 1-nonene. Counting counterclockwise from the double bond to the nearest branch, we find a methane at C3 and C4 and an ethane branch at C5. Considered alphabetically, the final name is 5-ethyl-3,4-dimethyl-1-nonene.

(g) The ring has 6 carbon atoms with a double bond so it is a 1-cyclohexene. There are two ethane groups attached, and the lowest numbering of these is achieved if the counting is done counterclockwise from the double bond, giving the branches at C3 and C5. The name is 3,5-diethyl-1-cyclohexene.

(h) The ring has 5 C atoms so it is a cyclopentane. There is a methane branch and a pentane branch attached, so by alphabetical default, the methane branch will be assigned as the C1 position. Counting clockwise, the name is 1-methyl-2-pentylcyclopentane.

Check Your Solutions

Look up other organic chemistry books or Internet sources to find these names and see if the names and structures match.

18. Problem

Draw a condensed structural diagram for each compound.

(a) 1,2,4-trimethylcycloheptane
(b) 2-ethyl-3-propyl-1-cyclobutene
(c) 3-methyl-2-cyclopentene
(d) cyclopentene
(e) 1,3-ethyl-2-methylcyclopentane
(f) 4-butyl-3-methyl-1-cyclohexene
(g) 1-1-dimethylcyclopentane
(h) 1,2,3,4,5,6-hexamethylcyclohexane

What Is Required?

You need to draw the condensed structural formula of the compounds given.
What Is Given?
The branched names of the cyclic hydrocarbons are given.

Plan Your Strategy
The following rules can be applied to drawing cyclic hydrocarbons.

**Rule 1** The ring structure and number of carbons is given by the last cyclo-prefixed word in the name. The presence of a double bond is indicated by the suffix -ene and the number in front of cyclo-.

**Rule 2** Where there is a double bond, its C atoms always have the lowest numbers. This can be placed first in any position in the ring.

**Rule 3** The numbers and -yl groups in the front of the root name are the positions and names of the branches. They always have the lowest possible number position around the ring, and so place relative to any double bonds in this way.

Act on Your Strategy
(a) 1,2,4-trimethylcycloheptane

(b) 2-ethyl-3-propyl-1-cyclobutene

(c) 3-methyl-2-cyclopentene

(d) cyclopentene

(e) 1,3-ethyl-2-methylcyclopentane

(f) 4-butyl-3-methyl-1-cyclohexene

(g) 1-1-dimethylcyclopentane
(h) 1,2,3,4,5,6-hexamethylcyclohexane

Check Your Solutions
Look up other organic chemistry books or Internet sources to find these names and see if the names and structures match.