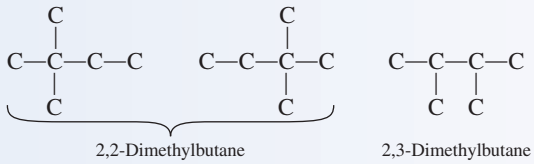
The fourth of the five structures is not a new isomer. Numbering its carbon chain from the right end shows that it is 2-methylpentane rather than 4-methylpentane. Thus the second and fourth structures are two representations of the same molecule.

Step 3: Decreasing the chain length to four carbon atoms is the next consideration. Two carbon atoms must now be added as attachments. This can be done in two ways—dimethyl and ethyl.

Examining dimethyl possibilities first, eliminating structures that have methyl groups on terminal carbon atoms gives the following possibilities.

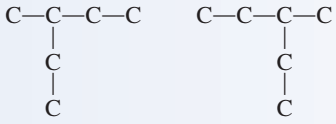


2,2-Dimethylbutane 2,3-Dimethylbutane

The first and second structures are the same; both represent the molecule 2,2-dimethylbutane, a fourth isomer.

The third structure, 2,3-dimethylbutane, is different from the other two. It is the fifth isomer.

What about ethyl butanes?



Neither of these structures is a new isomer because both have a five-carbon chain. Both structures are actually depictions of 3-methylpentane, one of the isomers previously identified.

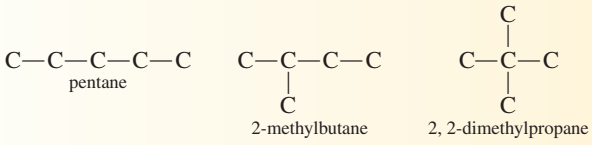
Step 4: A chain length of three does not generate any new isomers. A trimethyl structure is impossible, as the middle carbon atom, the only carbon to which substituents can be attached, would have five bonds. An ethyl methyl structure extends the carbon chain length, as does a single three-carbon attachment.

Thus, there are five constitutional isomers: *hexane, 2-methylpentane, 3-methylpentane, 2,2-dimethylbutane, and 2,3-dimethylbutane.*

Practice Exercise 12.4

Draw skeletal structural formulas for, and assign IUPAC names to, all C_5H_{12} alkane constitutional isomers.

Answer:



pentane 2-methylbutane 2, 2-dimethylpropane

12.9 LINE-ANGLE STRUCTURAL FORMULAS FOR ALKANES

Three two-dimensional methods for denoting alkane structures have been used in previous sections of this chapter. They are expanded structural formulas, condensed structural formulas, and skeletal structural formulas. An even more concise method for denoting molecular structure of alkanes (and other hydrocarbons and their derivatives) exists. This method, *line-angle structural formulas,* is particularly useful for molecules in which several carbon atoms are present.