Substances consisting entirely of single-bonded carbon and hydrogen atoms and lacking functional groups are called alkanes. There are three basic types of structures that classify the alkanes: (1) linear straight-chain alkanes, (2) branched alkanes, and (3) cycloalkanes.

**Linear Straight-Chain Alkanes**

In the straight-chain alkanes, each carbon is bound to its two neighbors and to two hydrogen atoms. (In red) Exceptions are the two terminal carbon nuclei, which are bound to only one carbon atom and three hydrogen atoms. (In blue)

\[ \text{CH}_3 - \text{CH}_2 - \text{CH}_2 - \text{CH}_3 \]

(Propane)

Alkanes belong to a homologous series (homo, Greeks, same as) of organic compounds in which the members differ by a constant relative atomic mass of 14 (one carbon atom and two hydrogen atoms); one following another can be distinguished by the addition of a methylene group. The general formula for the straight-chain alkanes is \( \text{H} \cdot (\text{CH}_2)_n \cdot \text{H} \). Methane \((n=1)\) is the first member of the homologous series of the alkanes, followed by ethane \((n=2)\) and so forth.

\[ \text{H} \cdot (\text{CH}_2)_1 \cdot \text{H} \cdot (\text{CH}_2)_2 \cdot \text{H} \]

(Methane) (Ethane)

**Branched Alkanes**

Branched alkanes are derived from the straight-chain alkanes system by removing one of the hydrogen atoms from a methylene group (-CH\(_2\)-) and replacing it with an alkyl group.

\[
\begin{align*}
\text{CH}_3 & \quad \text{methyl} \\
\text{CH}_3\text{CH}_2 & \quad \text{ethyl} \\
\text{CH}_3\text{CH}_2\text{CH}_2 & \quad \text{propyl} \\
\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2 & \quad \text{butyl} \\
\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2 & \quad \text{pentyl}
\end{align*}
\]

Straight-chain and branched alkanes follow the same general formula: \( \text{C}_n\text{H}_{2n+2} \). The smallest branched alkane is 2-methylpropane or isobutane (Pictures shown above). 2-methylpropane has the same molecular formula as butane \((\text{C}_4\text{H}_{10})\) but with a different connectivity, resulting in a different structure. These 2 compounds form a pair of isomers (isos, Greeks, equal). Isomers are compounds with the same molecular formula but different structural formulae.
For higher alkane homologs (n > 4), more than two isomers are possible. For example, pentane has three possible isomers in which one is a linear straight-chain alkane and two are branched alkanes. When branched, the nomenclature can be different because of common and IUPAC names.

References


Problems

1. Draw linear straight-chain hexane.
2. Using the formula, calculate for the number of hydrogen in a alkane with 25 carbons.
3. How many forms of linear straight-chain can be produced with a seven-carbon alkane.
4. How many forms of branched alkane can be produced with a six-carbon alkane.

Problem Answers

1. CH$_3$ - CH$_2$ - CH$_2$ - CH$_2$ - CH$_2$ - CH$_3$
2. 52 Hydrogens
3. Only 1 form for the straight-chain alkane.
4. There are 5 other forms of the branched alkane.

Contributors

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