It is important to note that expanded structural formulas show all bonds within a molecule and that condensed structural formulas show only certain bonds—the bonds between carbon atoms. Specifically, the bond line in the condensed structural formula

$$CH_3—CH_3$$

denotes the bond between the first carbon atom and the second carbon atom; it is not a bond between hydrogen atoms and the second carbon atom.

In situations where the focus is solely on the arrangement of carbon atoms in an alkane, *skeletal structural formulas* that omit the hydrogen atoms are often used. A **skeletal structural formula** *is a structural formula that shows the arrangement and bonding of carbon atoms present in an organic molecule but does not show the hydrogen atoms attached to the carbon atoms.*

C—C—C—C—C means the same as $CH_3—CH_2—CH_2—CH_2—CH_3$

Skeletal structural formula — Condensed structural formula

The skeletal structural formula still represents a unique alkane because we know that each carbon atom shown must have enough hydrogen atoms attached to it to give the carbon four bonds.

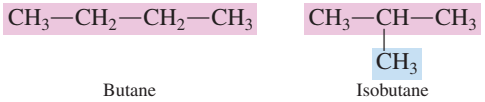
12.6 ALKANE ISOMERISM

The molecular formulas CH_4, C_2H_6, and C_3H_8 represent the alkanes methane, ethane, and propane, respectively. Next in the alkane molecular formula sequence (C_nH_{2n+2}) is C_4H_{10}, which would be expected to be the molecular formula of the four-carbon alkane. A new phenomenon arises, however, when an alkane has four or more carbon atoms. There is more than one structural formula that is consistent with the molecular formula. Consequently, more than one compound exists with that molecular formula. This situation brings us to the topic of *isomerism.*

The word *isomer* comes from the Greek *isos,* which means "the same," and *meros,* which means "parts." Isomers have the same parts put together in different ways.

Isomers *are compounds that have the same molecular formula (that is, the same numbers and kinds of atoms) but that differ in the way the atoms are arranged.* Isomers, even though they have the same molecular formula, are always different compounds with different properties.

There are two four-carbon alkane isomers, the compounds *butane* and *isobutane.* Both have the molecular formula C_4H_{10}.



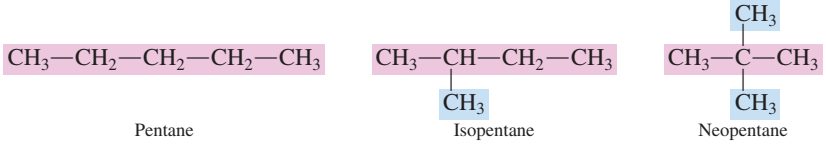
Butane — Isobutane

Butane and isobutane are different compounds with different properties. Butane has a boiling point of −1°C and a melting point of −138°C, whereas the corresponding values for isobutane are −12°C and −159°C.

The existence of isomers necessitates the use of structural formulas in organic chemistry. Isomers always have the same molecular formula and different structural formulas.

Contrasting the two C_4H_{10} isomers structurally, note that butane has a chain of four carbon atoms. It is an example of a continuous-chain alkane. A **continuous-chain alkane** *is an alkane in which all carbon atoms are connected in a continuous nonbranching chain.* The other C_4H_{10} isomer, isobutane, has a chain of three carbon atoms with the fourth carbon attached as a branch on the middle carbon of the three-carbon chain. It is an example of a branched-chain alkane. A **branched-chain alkane** *is an alkane in which one or more branches (of carbon atoms) are attached to a continuous chain of carbon atoms.*

There are three isomers for alkanes with five carbon atoms (C_5H_{12}):



Pentane — Isopentane — Neopentane