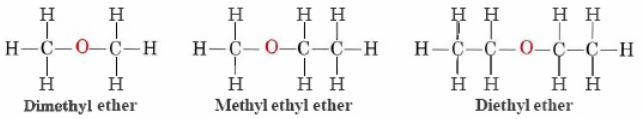
8.15: Ethers

In alcohols, one of the two bonds to the oxygen atom involves hydrogen and one involves carbon. When two or more carbon atoms are present, however, isomeric structures in which oxygen is bonded to two different carbons become possible. Such compounds are called ethers. For example, dimethyl ether is isomeric with ethanol, and methyl ethyl ether is isomeric with propanol:



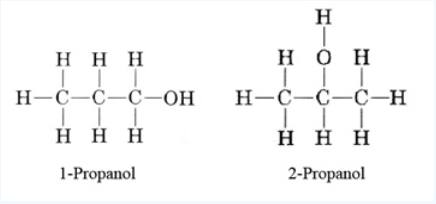
Structures for dimethyl ether, methyl ethyl ether, and diethyl ether with the "O" highlighted in red.

The general formula for an ether is R—O—R′, where R′ signifies that both R groups need not be the same.

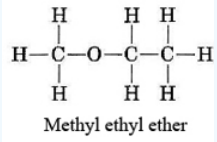
Example 8.15.1: Projection Formulas

Draw projection formulas and name all the isomers which correspond to the molecular formula C_3H_8O.

Solution The formula C_3H_8 would correspond to an alkane. The extra oxygen atom might be added between two carbons, giving ether, or it might be added between a carbon and a hydrogen, giving an alcohol. The alcohol molecules might have the hydroxyl group at the end of the three-carbon chain or on the second carbon atom:



Only one ether structure is possible—that in which one methyl and one ethyl group are attached to oxygen:



In an ether there are no hydrogen atoms connected to a highly electronegative neighbor, and so, unlike alcohols, ether molecules cannot hydrogen bond among themselves. Each C—O bond is polar, but the bonds are at approximately the tetrahedral angle. The polarity of one partially cancels the polarity of the other. Consequently the forces between two ether molecules are not much greater than the London forces between alkane molecules of comparable size. The boiling point of dimethyl ether, for example, is –23°C, slightly above that of propane (–42°C), but well below that of ethanol (78.5°C). All three molecules contain 26 electrons and are about the same size. In the table of the boiling points of comparable organic compounds we see this trend again, this time with compounds containing 32 or 34 electrons.

The chemical reactivity of ethers is also closer to that of the alkanes than that of the alcohols. Ethers undergo few characteristic reactions other than combustion, and so they are commonly used as solvents. Diethyl ether is also used as an anesthetic, although the flammability of its vapor requires that precautions be taken to prevent fires.