

## 15.1: PHYSICAL PROPERTIES OF ETHERS

### COMPARISONS OF PHYSICAL PROPERTIES OF ALCOHOLS AND ETHERS

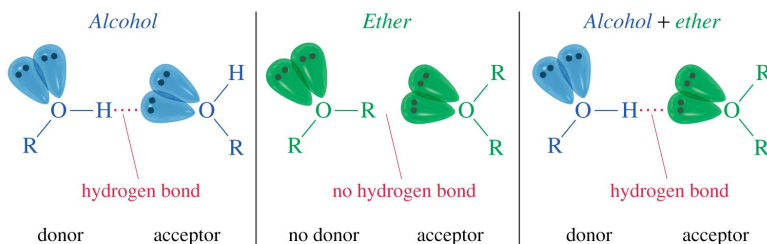
Ether molecules have no hydrogen atom on the oxygen atom (that is, no OH group). Therefore there is no intermolecular hydrogen bonding between ether molecules, and ethers therefore have quite low boiling points for a given molar mass. Ether molecules do have an oxygen atom, however, and engage in hydrogen bonding with water molecules. Consequently, an ether has about the same solubility in water as the alcohol that is isomeric with it. For example, dimethyl ether and ethanol (both having the molecular formula  $C_2H_6O$ ) are completely soluble in water, whereas diethyl ether and 1-butanol (both  $C_4H_{10}O$ ) are barely soluble in water (8 g/100 mL of water). Indeed, ethers have boiling points about the same as those of alkanes of comparable molar mass and much lower than those of the corresponding alcohols as shown in the table below.

Table. Comparison of Boiling Points of Alkanes, Alcohols, and Ethers

| Condensed Structural Formula | Name           | Molar Mass | Boiling Point (°C) | Intermolecular Hydrogen Bonding in Pure Liquid? |
|------------------------------|----------------|------------|--------------------|---|
| $CH_3CH_2CH_3$               | propane        | 44         | -42                | no  |
| $CH_3OCH_3$                  | dimethyl ether | 46         | -25                | no  |
| $CH_3CH_2OH$                 | ethyl alcohol  | 46         | 78                 | yes   |
| $CH_3CH_2CH_2CH_2CH_3$       | pentane        | 72         | 36                 | no  |
| $CH_3CH_2OCH_2CH_3$          | diethyl ether  | 74         | 35                 | no  |
| $CH_3CH_2CH_2CH_2OH$         | butyl alcohol  | 74         | 117                | yes   |

### ETHERS ARE GOOD SOLVENTS FOR MANY ORGANIC REACTIONS

Ethers can only accept H-bonds, while alcohols are both H-bond donors and acceptors. The ability of ethers to accept H-bonds combined with the London forces of the alkyl groups bonded to the oxygen allows ethers to be excellent solvents for a wide range of organic compounds. The low chemical reactivity of ethers also makes ethers a preferred solvent for many organic reactions. Additionally, the high volatility of ethers allows for their evaporation when isolating reaction products.

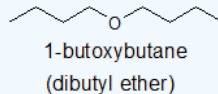
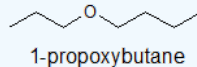
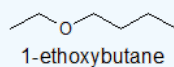
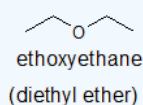


#### Exercise

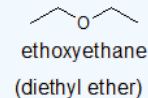
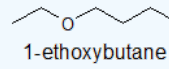
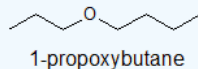
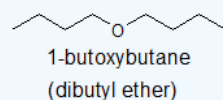
- Draw the bond-line structures and arrange the following ethers in order of increasing boiling point: 1-propoxybutane, diethyl ether, 1-ethoxybutane, dibutyl ether.
- Arrange the following ethers in order of increasing water solubility: 1-propoxybutane, diethyl ether, 1-ethoxybutane, dibutyl ether.

#### Answer

1.



2.



## CONTRIBUTORS AND ATTRIBUTIONS

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- Prof. Steven Farmer ([Sonoma State University](#))
- William Reusch, Professor Emeritus ([Michigan State U.](#)), [Virtual Textbook of Organic Chemistry](#)
- Jim Clark ([Chemguide.co.uk](#))

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