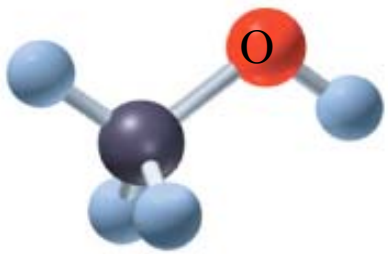
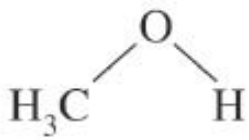
Chapter 13 **Alcohols, Phenols, and Thiols**





Methanol

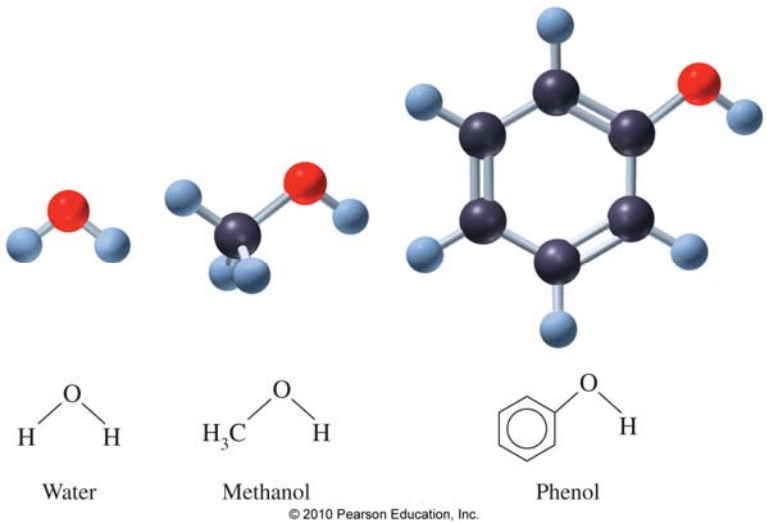
Wood alcohol

An **alcohol** contains

a hydroxyl group (—OH) attached to a carbon chain

A **phenol** contains

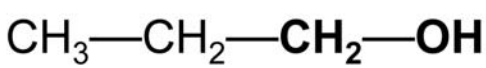
a hydroxyl group (—OH) attached to a benzene ring



Naming alcohols

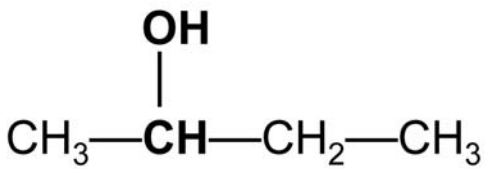
1. Identify the longest carbon chain
2. Name the OH using the suffix: –ol and locate its position with the lowest number or name the –OH group as a hydroxy group
3. Identify and locate the remaining groups

1-hydroxypropane



1-Propan**ol**

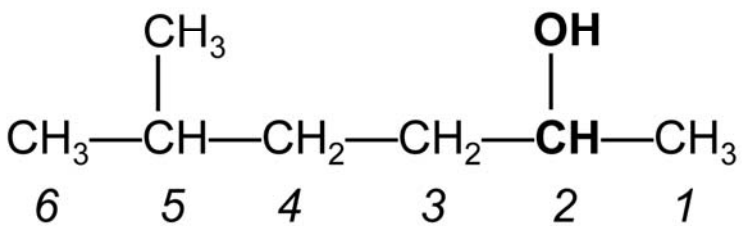
2-hydroxybutane



2-Butan**ol**

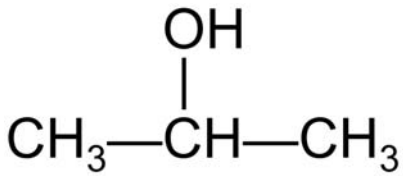
hexane

5-methyl-2-hydroxyhexane



5-Methyl-**2**-hexan**ol**

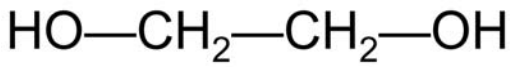
"Rubbing alcohol":



2-Propanol (isopropyl alcohol)

2-hydroxypropane

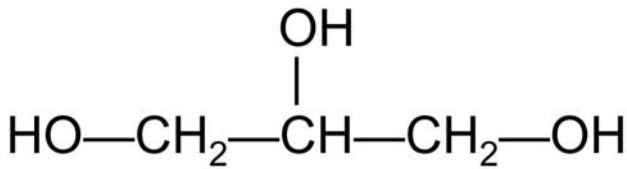
Antifreeze:



1,2-Ethanediol (ethylene glycol)

1,2-dihydroxyethane

Glycerol:



1,2,3-Propanetriol

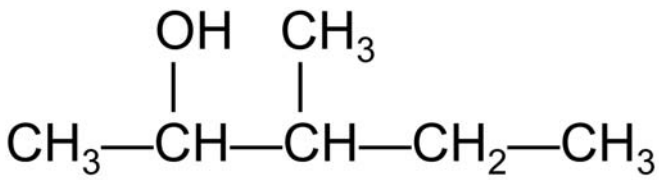
1,2,3-trihydroxypropane

Name for each of the following:

A. $CH_3—CH_2—CH_2—CH_2—OH$

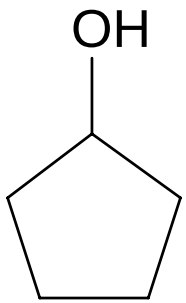
1-butanol

1-hydroxybutane

B. 

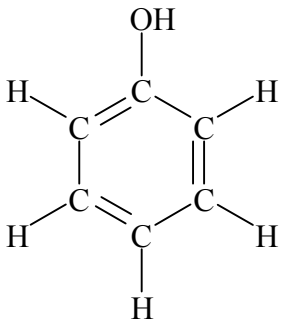
3-methyl-2-pentanol

3-methyl-2-hydroxypentane

C. 

1-cyclopentanol

1-hydroxycyclopentane



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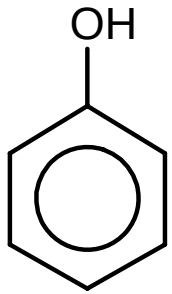
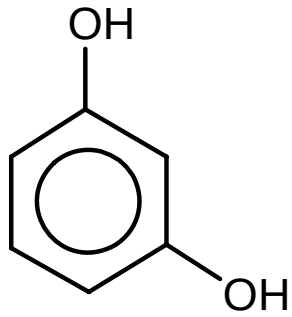
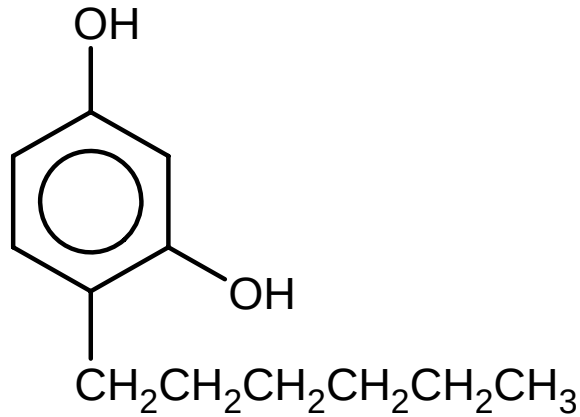






Hydroxybenzene

phenol

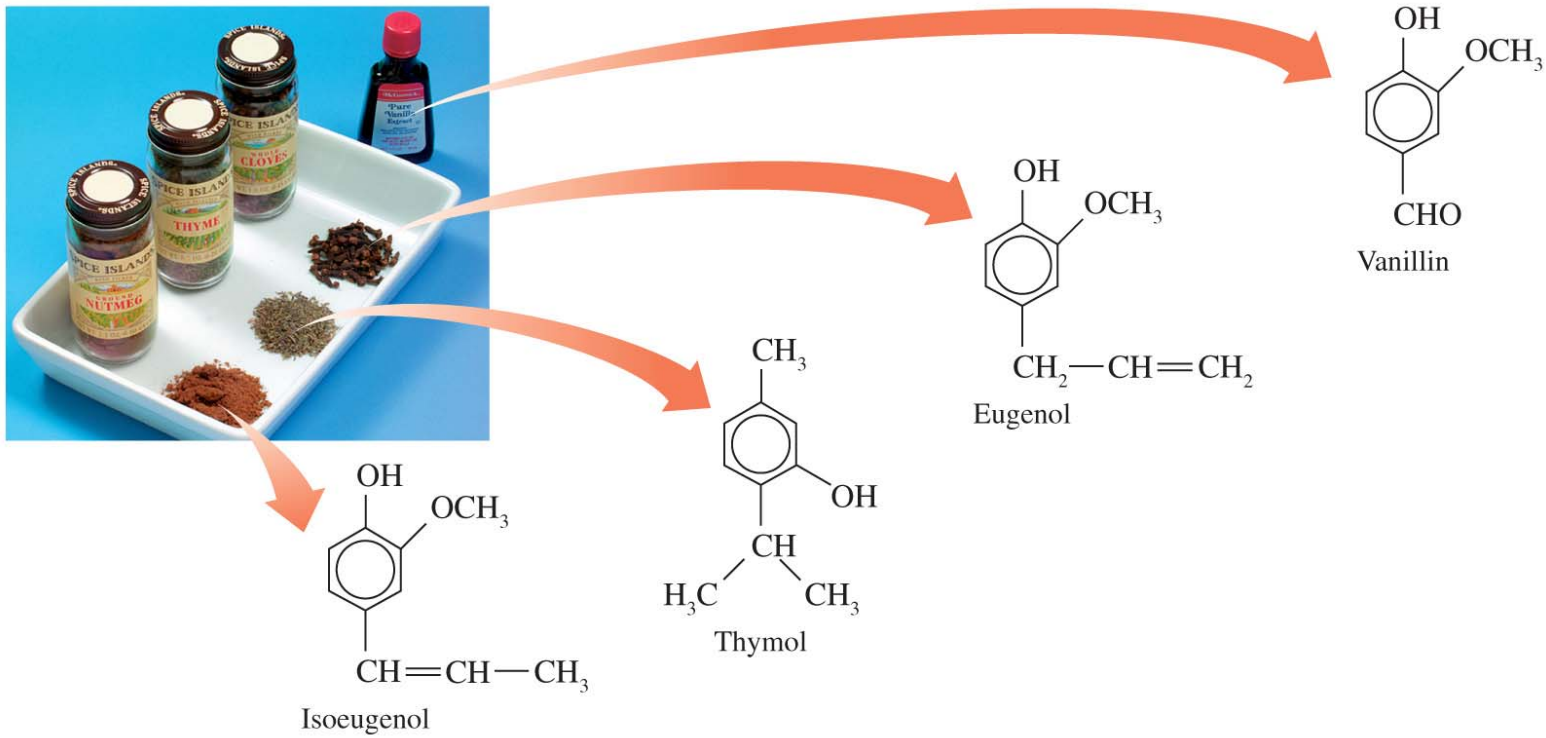
1,3-dihydroxybenzene

4-hexyl-1,3-dihydroxybenzene

Urushiol is a substance in poison ivy and poison oak that causes itching and blistering of the skin.

The hydrogen on the hydroxyl group is very mildly acidic. Washing you skin with an alkaline soap is a good way of removing much of the uruhiol before much of it penetrates your skin. The salt form from urushiol is much more soluble in water and less in the organic component of your skin.

- Compounds of hydroxybenzene (phenol) are the active ingredients in the essential oils
- of cloves, vanilla, nutmeg, and mint.



Thiols are organic compounds that contain a –SH group

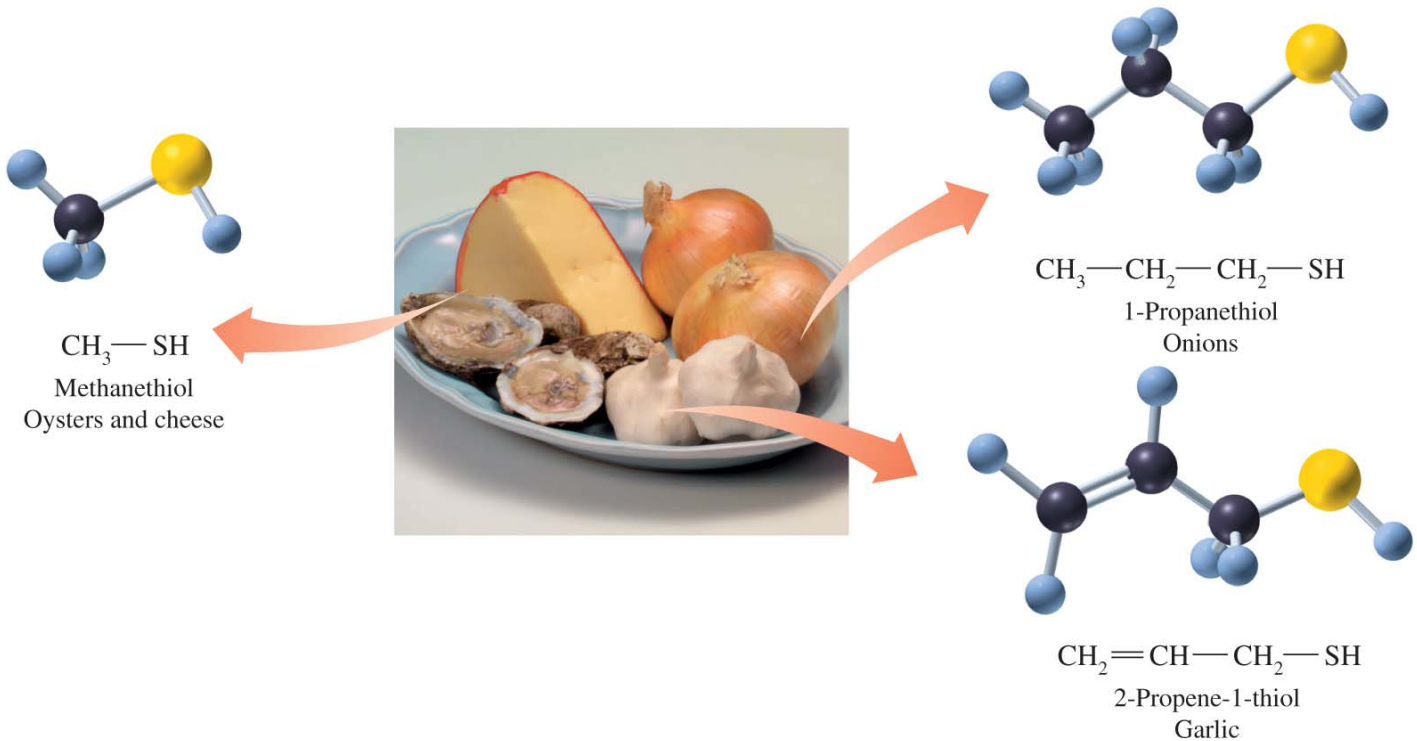
they are named by adding *thiol* to the alkane name of the longest carbon chain

Thiols often have strong odors
- are used to detect gas leaks
- are found in onions, oysters, and garlic

H_2S

hydrogen sulfide

highly toxic



Ethers

Anesthetics

inhibit pain signals to the brain;

such as diethyl ether, $CH_3{-}CH_2{-}O{-}CH_2{-}CH_3$, were used for over a century but caused nausea and were flammable;

those developed by the1960s were nonflammable

$CH_3OCH_2CH_3$

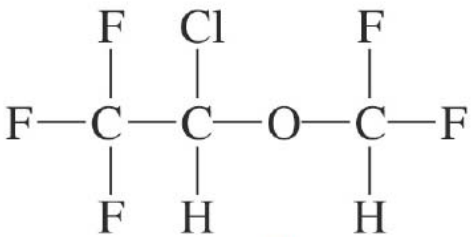
methyl ethyl ether
or methoxyethane
the methoxy group:

$-OCH_3$

Naming ethers: alkyl alkyl ether or as an alkoxyalkane

Name: $-OCH_2CH_3$ ethoxy

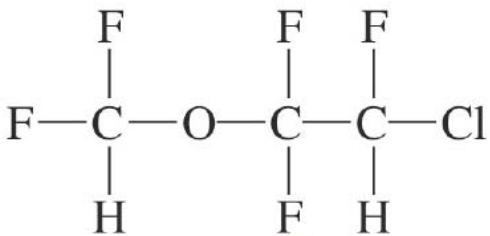
Name: $-OCH(CH_3)_2$ isopropoxy



Forane® (isoflurane)

difluoromethyl 1-chloro-2,2,2-trifluoroethyl ether

1,1-difluoromethoxy-1chloro-2,2,2-trifluoroethane

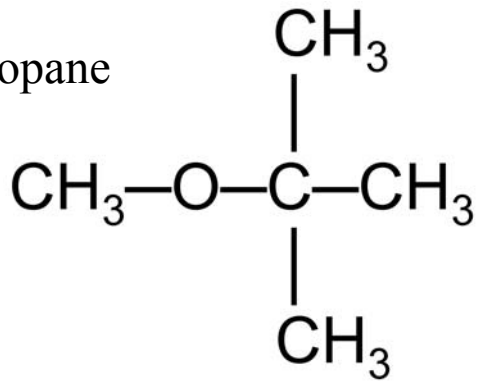


Ethrane® (enflurane)

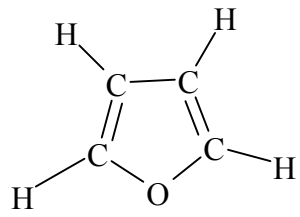
difluoromethyl 2-chloro-1,1,2-trifluoroethyl ether

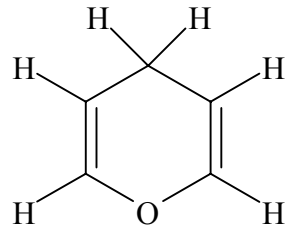
1-difluoromethoxy-1,1,2-trifluoro-2-chloroethane

Methyl *tert*-butyl ether
2-methoxy-2-methylpropane



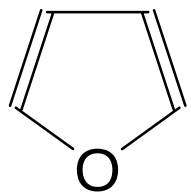
is one of the most produced organic chemicals;
is a fuel additive, replacing tetraethyllead;
is used to improve gasoline combustion;
use is questioned since the discovery that
MTBE has contaminated water supplies

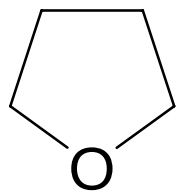


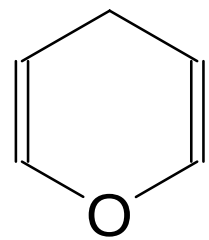


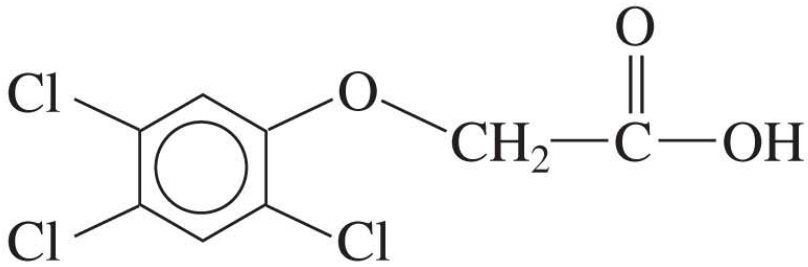
Cyclic ethers

contains an O atom in a carbon ring;
are called a *heterocyclic* compound;
typically haves 5 (furan) or 6 atoms (pyran)
in the ring

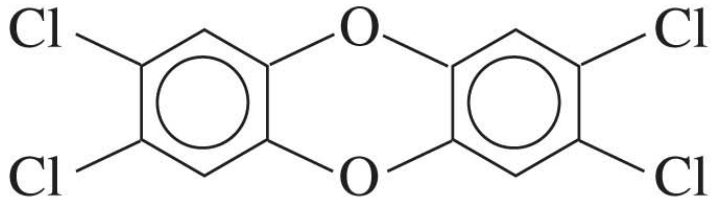






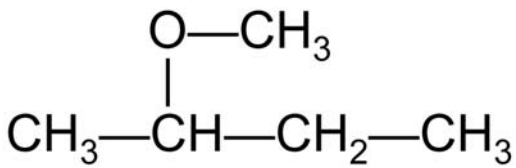


2,4,5-Trichlorophenoxyacetic acid
(2,4,5-T; Agent Orange)



2,3,7,8-Tetrachlorodibenzo-*p*-dioxin
(TCDD, "dioxin")

Name the following:



2-methoxybutane

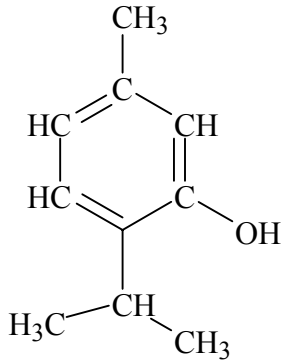
$CH_3—CH_2—O—CH_2—CH_2—CH_3$

ethyl propyl ether

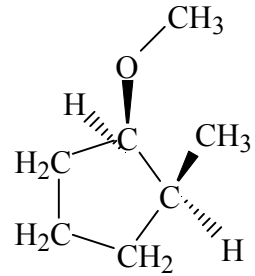
or 1-ethoxypropane

Draw structures for the following compounds:

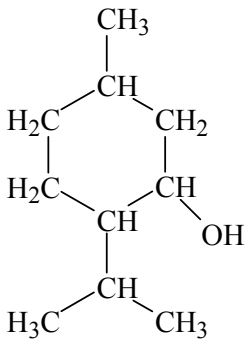
1. 1-hydroxy-2-isopropyl-5-methylbenzene



2. cis 1-methoxy-2-methylcyclopentane

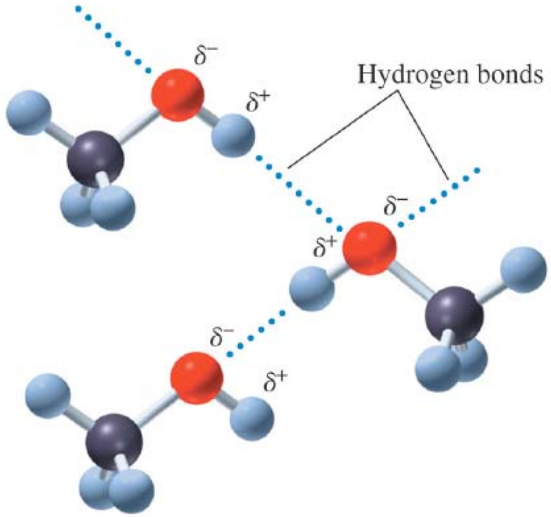


3. 1-hydroxy-2 isopropyl-5 methylcyclohexane



Menthol gives a peppermint taste and odor used in candy and throat lozenges..

Physical Properties of Alcohols, Phenols, and Ethers



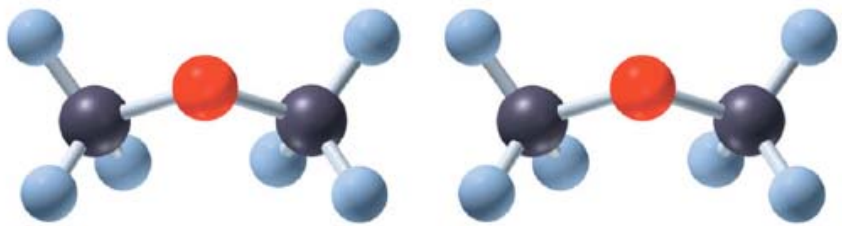
Methyl alcohol

Alcohols form hydrogen bonds between the oxygen of one molecule and the hydrogen of another
Consequently, have higher boiling points and vaporization enthalpies than alkanes and ethers of similar size

Ethers have an O atom, but no H is attached;
they cannot form hydrogen bonds between ether molecules
therefore they have boiling points similar to alkanes of similar size

Boiling point or boiling temperature is the temperature at which the vapor pressure of a liquid is equal to 1 atm. Vapor pressure is a measure of the tendency of a molecule to escape the liquid phase

No hydrogen bonds



Dimethyl ether

Alcohols and ethers are more soluble in water than are alkanes because the oxygen atom hydrogen bonds with water. Alcohols are more soluble in water than ethers. Alcohols with 1–4 C atoms are soluble, but alcohols with 5 or more C atoms are not very and the solubility decreases with increasing number of carbon atoms.

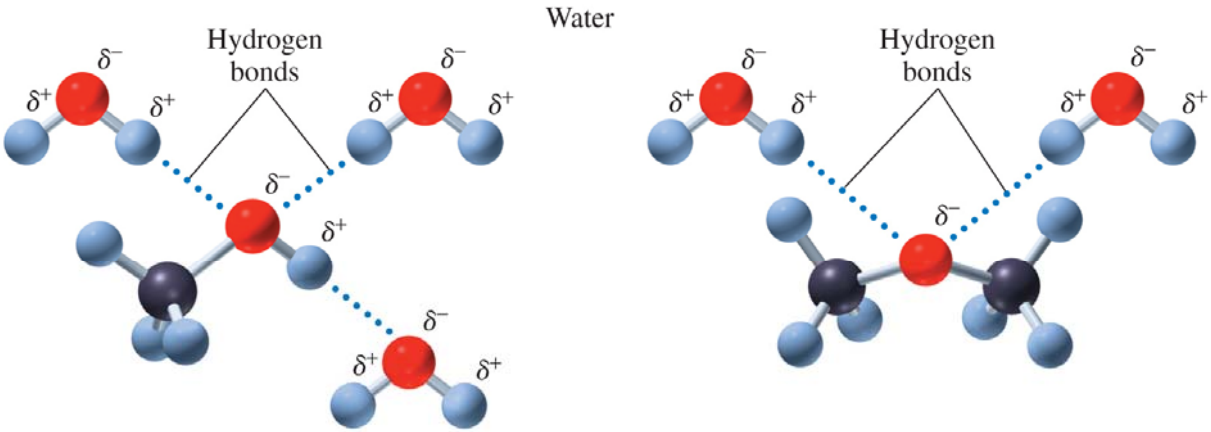


TABLE 13.1 Solubility and Boiling Points of Some Typical Alkanes, Alcohols, and Ethers of Similar Molar Mass

Compound	Condensed Structural Formula	Molar Mass (g/mole)	Boiling Point (°C)	Soluble in Water?
Propane	$CH_3—CH_2—CH_3$	44	−42	No
Dimethyl ether	$CH_3—O—CH_3$	46	−23	Yes
Ethanol	$CH_3—CH_2—OH$	46	78	Yes
Butane	$CH_3—CH_2—CH_2—CH_3$	58	0	No
Ethyl methyl ether	$CH_3—O—CH_2—CH_3$	60	8	Yes
1-Propanol	$CH_3—CH_2—CH_2—OH$	60	97	Yes

Combustion is the reaction of an alcohol or phenol with O_2 to produce CO_2 and H_2O.

$$CH_3{-}CH_2{-}OH(g) + 3O_2(g) \longrightarrow 2CO_2(g) + 3H_2O(g) + \text{heat}$$

An oxidation reaction of thiols is to lose a H atom from two –SH groups to form a disulfide

$$CH_3{-}\mathbf{S}\mathbf{H} + \mathbf{H}\mathbf{S}{-}CH_3 \xrightarrow{[O]} CH_3{-}S{-}S{-}CH_3 + \mathbf{H_2O}$$