Ethers
Nomenclature, Properties, Synthesis and Reactions

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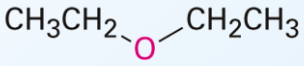
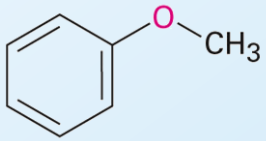
Ether Functional Group

- An **ether** has two organic groups (alkyl, aryl, or vinyl) bonded to the same oxygen atom, R–O–R′

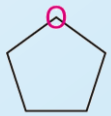
- *Thiols* (R–S–H) and *sulfides* (R–S–R′) are sulfur (for oxygen) analogues of alcohols and ethers



Diethyl ether



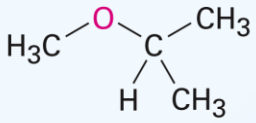
Anisole
(methyl phenyl ether)



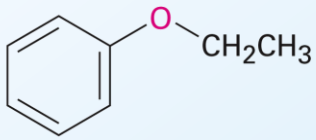
Tetrahydrofuran

Nomenclature: Ethers

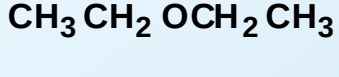
- IUPAC: the longest carbon chain is the parent.
  - Name the OR group as an alkoxy substituent.
- Common names: name the groups bonded on either side of oxygen in alphabetical order followed by the word ether.



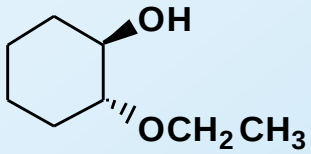
Isopropyl methyl ether



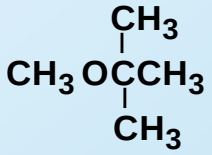
Ethyl phenyl ether



Ethoxyethane
(Diethyl ether)

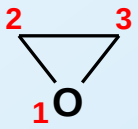


trans- 2-Ethoxy-cyclohexanol



2-Methoxy-2-methylpropane
(*tert*- Butyl methyl ether)

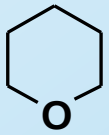
- Although cyclic ethers have IUPAC names, their common names are more widely used.
- IUPAC: prefix ox- shows oxygen in the ring. The suffixes -irane, -etane, -olane, and -ane show three, four, five, and six atoms in a saturated ring.



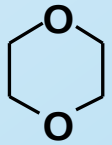
Oxirane
(Ethylene oxide)

Oxetane

Oxolane
(Tetrahydrofuran)



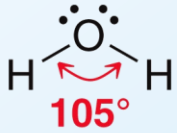
Oxane
(Tetrahydropyran)



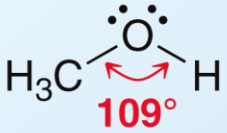
1,4-Dioxane

Physical Properties of Ethers

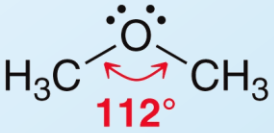
- Low boiling points due to lack of H-Bonding
- Low solubility in water.
- Have a sweet odor.



Water



Methanol



Dimethyl ether

Boiling Points

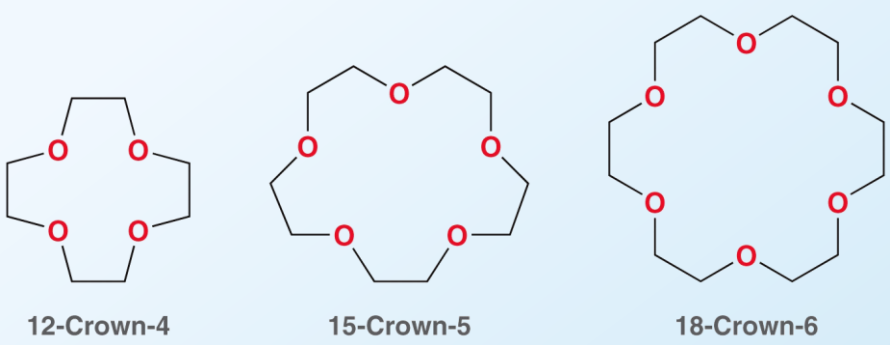
TABLE 14-1 Comparison of the Boiling Points of Ethers, Alkanes, and Alcohols of Similar Molecular Weights

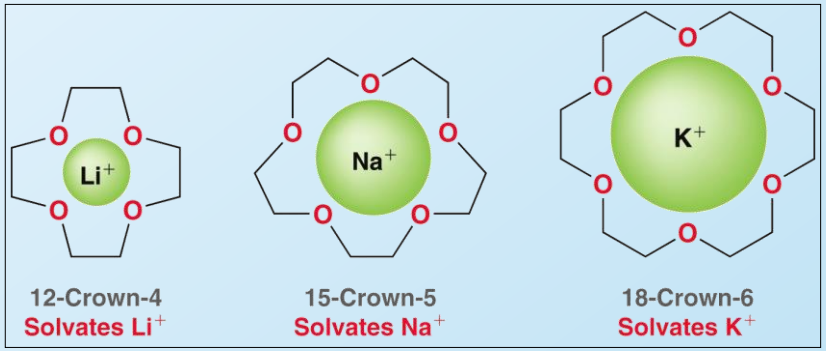
Compound	Formula	MW	bp (°C)	Dipole Moment (D)
water	H_2O	18	100	1.9
ethanol	$CH_3CH_2—OH$	46	78	1.7
dimethyl ether	$CH_3—O—CH_3$	46	−25	1.3
propane	$CH_3CH_2CH_3$	44	−42	0.1
n-butanol	$CH_3CH_2CH_2CH_2—OH$	74	118	1.7
tetrahydrofuran		72	66	1.6
diethyl ether	$CH_3CH_2—O—CH_2CH_3$	74	35	1.2
pentane	$CH_3CH_2CH_2CH_2CH_3$	72	36	0.1

Note: The alcohols are hydrogen bonded, giving them much higher boiling points. The ethers have boiling points that are closer to those of alkanes with similar molecular weights.

Applications of Ethers

- **Solvent**: this is by far the most common use of ethers. They are more non polar than alcohols and can dissolve more non polar compounds. Tetrahydrofuran is a very common lab solvent – it has a higher boiling point so reactions can be carried out at higher temperatures.
- **Crown Ethers**: used to trap metals (chelating agents). Can also be used as phase transfer catalyst.

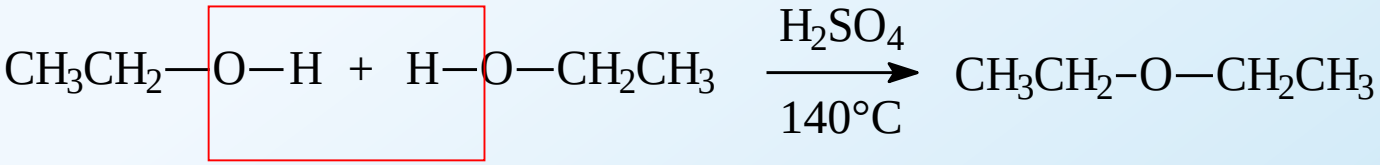


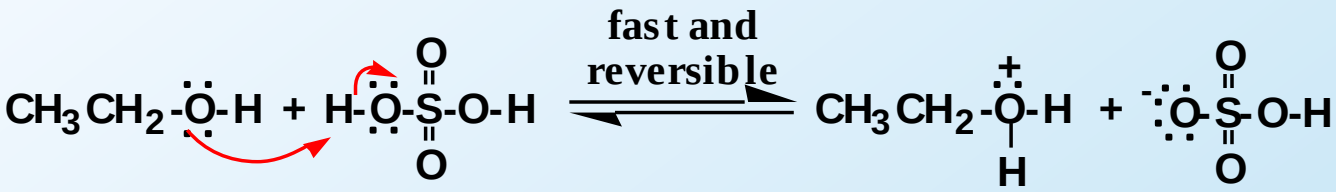


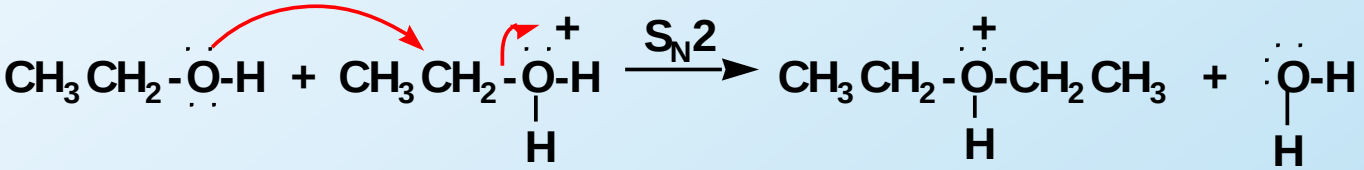
- **Anesthetic Agents**: used first as an anesthetic agent in the 1840s. It is still used presently, but it does cause side effects.

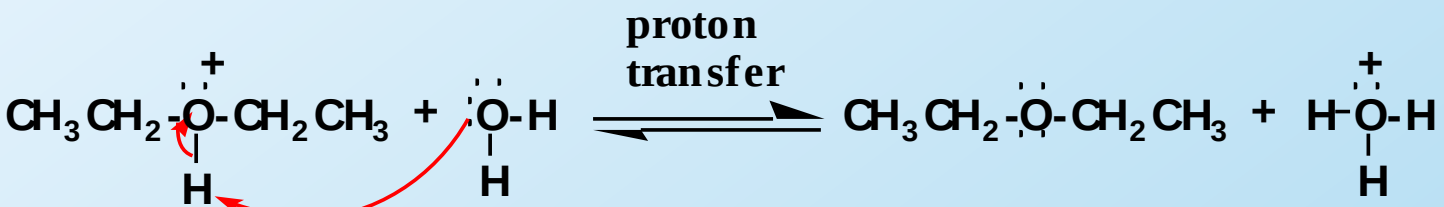
Ether Synthesis

1) Bimolecular Dehydration: Industrial method, not good lab synthesis. If temperature is too high, alkene forms.



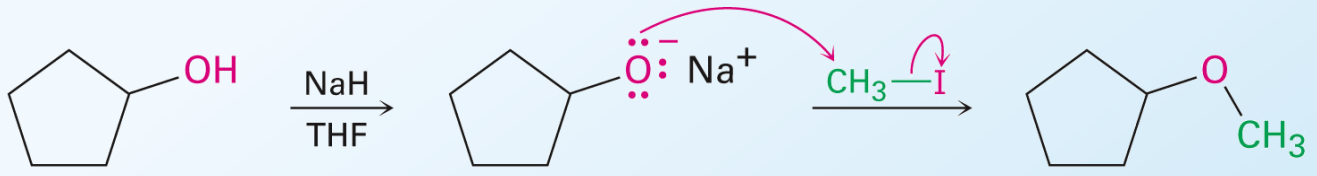






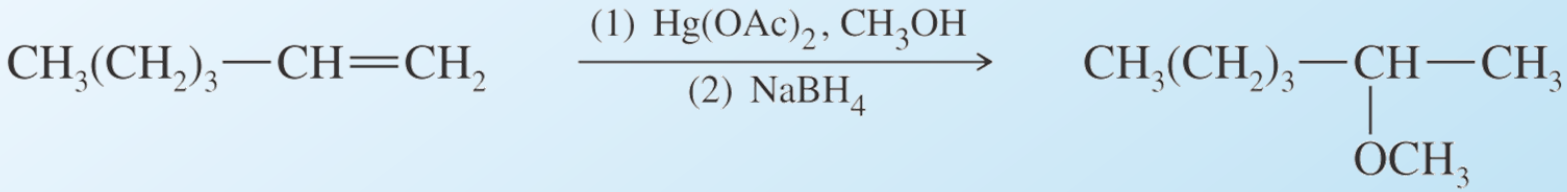
Ether Synthesis, contd….

2) Williamson Synthesis: this synthesis is more efficient in making unsymmetric ethers. An alkoxide ion is added to a 1° alkyl bromide (or tosylate) and reaction occurs via S_N2 mechanism.



Cyclopentanol **Alkoxide ion** **Cyclopentyl methyl ether (74%)**

3) Alkoxymercuration-Demercuration

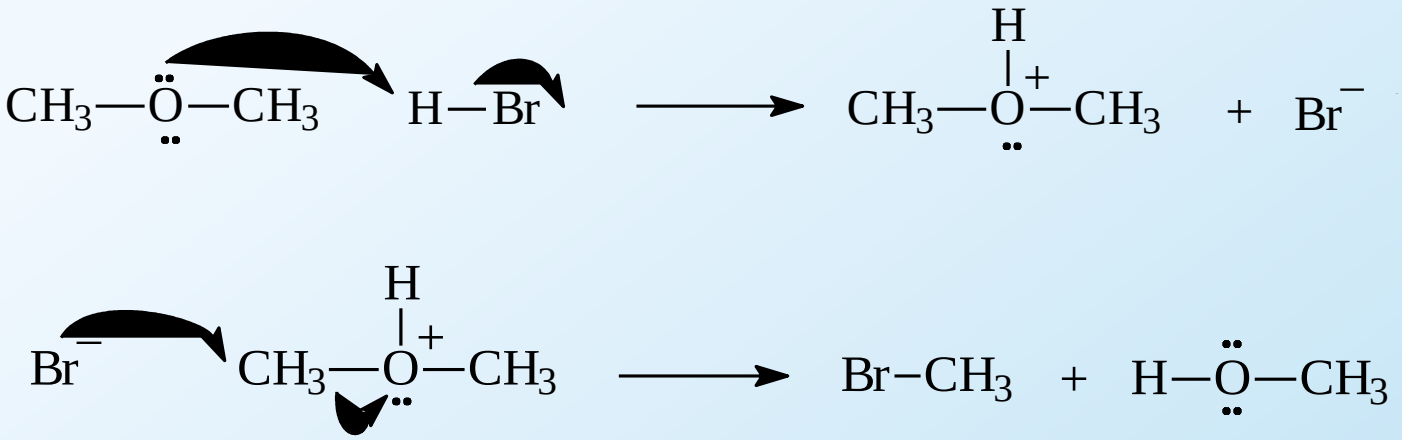


1-hexene

2-methoxyhexane, 80%
(Markovnikov product)

Cleavage of Ethers

- Ethers are unreactive toward base, but protonated ethers can undergo substitution reactions with strong acids.
- Alcohol leaving group is replaced by a halide.
- Reactivity: HI > HBr >> HCl



Key Concepts

- Ethers – Nomenclature
- Physical properties
- Williamson synthesis
- Reactions (Cleavage)