

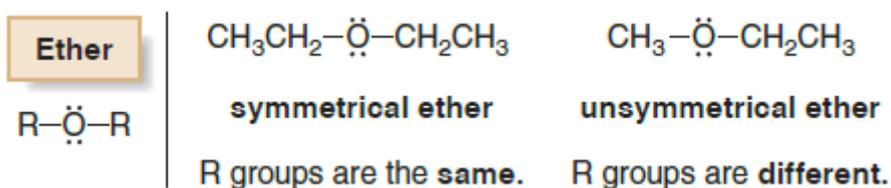
كلية التربية للعلوم الصرفة	الكلية
قسم الكيمياء	القسم
Organic chemistry	المادة باللغة الانجليزية
الكيمياء العضوية	المادة باللغة العربية
المرحلة الثانية	المرحلة الدراسية
د. عمر جمال مهدي العسافي	اسم التدريسي
Ether	عنوان المحاضرة باللغة الانجليزية
الايثر	عنوان المحاضرة باللغة العربية
الثالثة	رقم المحاضرة
<i>Organic Chemistry</i> 6 ^{ed} , William H. Brown, Christopher S. Foote, Brent L. Iverson, Eric V. Anslyn, Bruce M. Novak, 2012	المصادر والمراجع
<i>Organic Chemistry</i> 3 ^{ed} , Janice Gorzynski Smith, 2011	
<i>Organic Chemistry</i> '' by Jonathan Clayden, Nick Greeves, and Stuart Warren	



Ethers is a functional group that contain carbon–oxygen σ bonds.

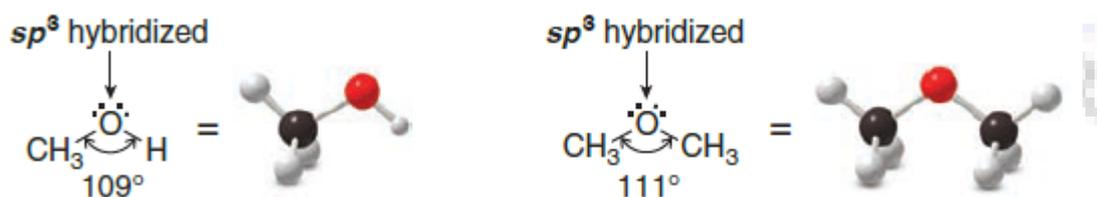


Ethers have two alkyl groups bonded to an oxygen atom. An ether is **symmetrical** if the two alkyl groups are the same, and **unsymmetrical** if they are different. Both alcohols and ethers are organic derivatives of H_2O , formed by replacing one or both of the hydrogens on the oxygen atom by R groups, respectively.



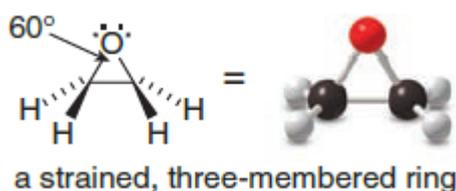
Problem -: Draw all constitutional isomers having molecular formula $\text{C}_4\text{H}_{10}\text{O}$. Classify each compound as a 1° , 2° , or 3° alcohol, or a symmetrical or unsymmetrical ether.

2- Structure and Bonding



The bond angle around the O atom in an ether is similar to the tetrahedral bond angle of 109.5° . In contrast, the C –O– C bond angle of an epoxide must

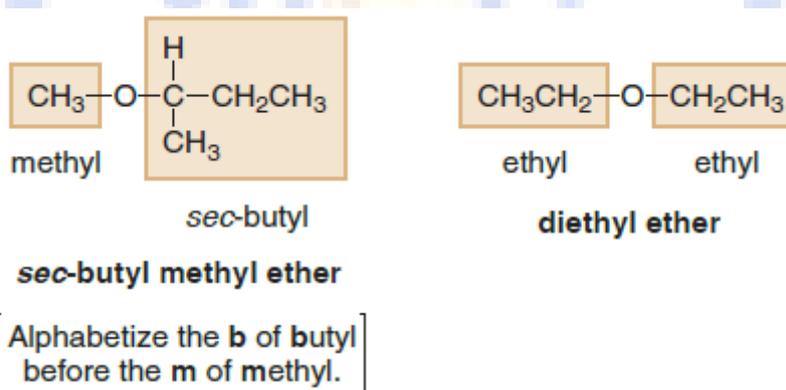
be 60° , a considerable deviation from the tetrahedral bond angle. For this reason, epoxides have angle strain, making them much more reactive than other ethers.



Because oxygen is much more electronegative than carbon or hydrogen, the C – O and O – H bonds are all polar, with the O atom electron rich and the C and H atoms electron poor.

3. Naming Ethers

Simple ethers are usually assigned common names. To do so, **name both alkyl groups** bonded to the oxygen, arrange these names alphabetically, and add the word **ether**. For symmetrical ethers, name the alkyl group and add the prefix **di-**.



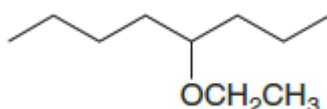
More complex ethers are named using the IUPAC system. One alkyl group is named as a hydrocarbon chain, and the other is named as part of a substituent bonded to that chain.

- Name the simpler alkyl group + O atom as an **alkoxy** substituent by changing the **-yl** ending of the alkyl group to **-oxy**.



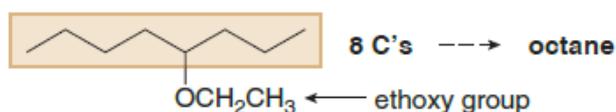
Name the remaining alkyl group as an alkane, with the alkoxy group as a substituent bonded to this chain.

Sample Problem Give the IUPAC name for the following ether.

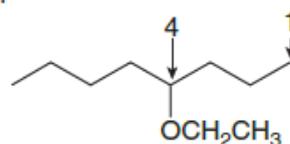


Solution

[1] Name the longer chain as an alkane and the shorter chain as an alkoxy group.

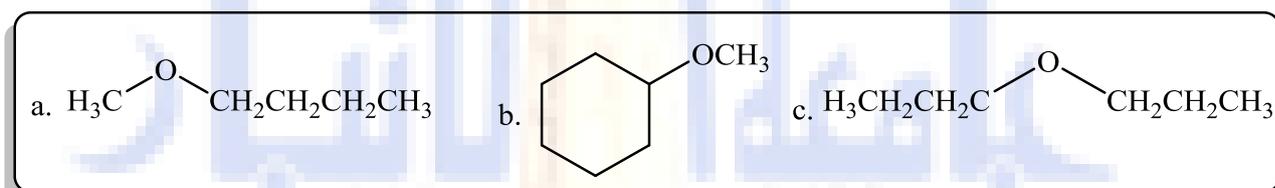


[2] Apply the other nomenclature rules to complete the name.



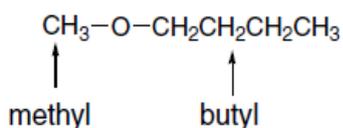
Answer: 4-ethoxyoctane

Problem :- Name each of the following ethers.



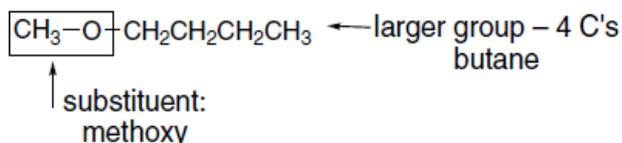
Solution:-

a. common name:



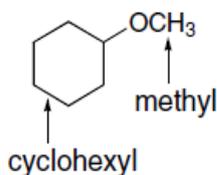
butyl methyl ether

IUPAC name:



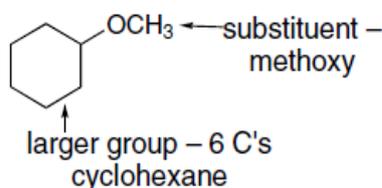
1-methoxybutane

b. common name:



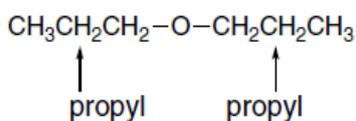
cyclohexyl methyl ether

IUPAC name:



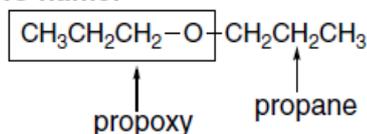
methoxycyclohexane

c. common name:



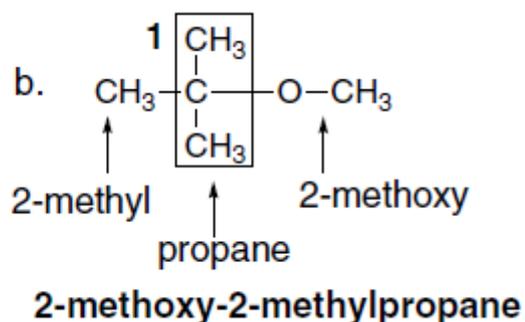
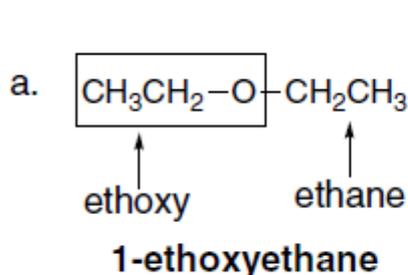
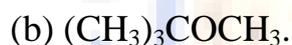
dipropyl ether

IUPAC name:



1-propoxypropane

Problem :- Name each simple ether as an alkoxy alkane:

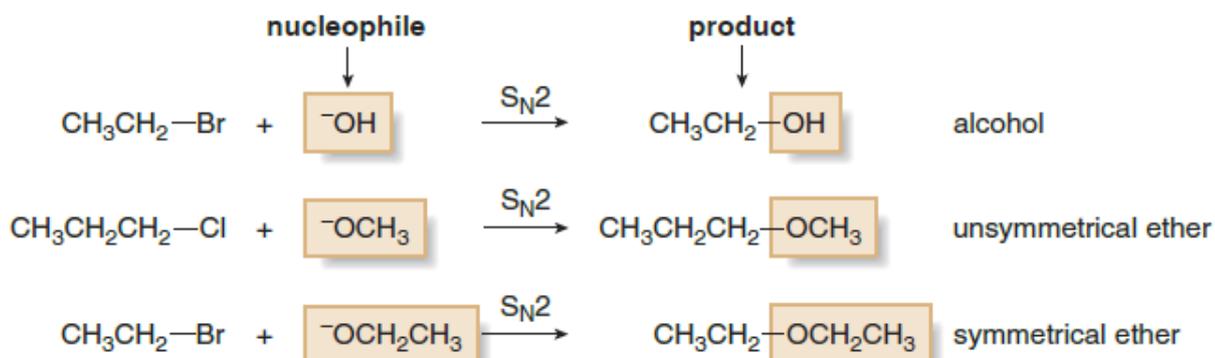


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4. Preparation of Ethers

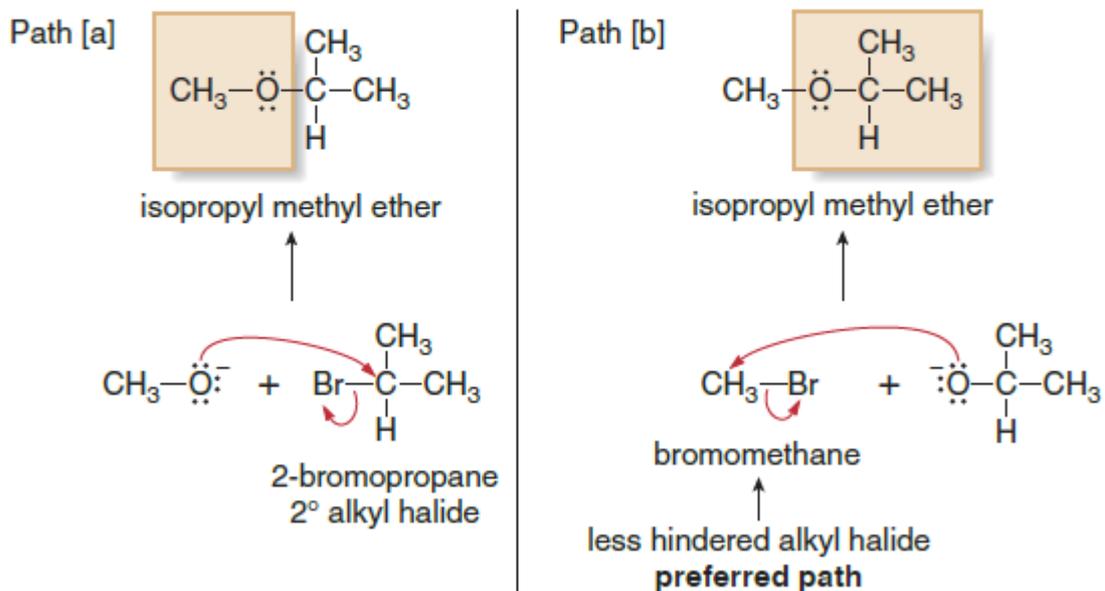
Ethers is common products of nucleophilic substitution. They are synthesized from alkyl halides by $\text{S}_{\text{N}}2$ reactions using strong nucleophiles. As

in all S_N2 reactions, highest yields of products are obtained with unhindered methyl and 1° alkyl halides.

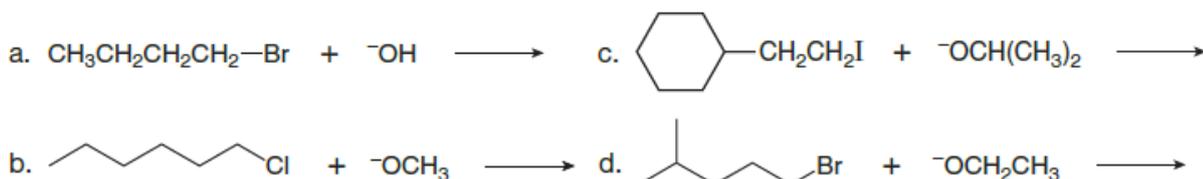


The preparation of ethers by this method is called the **Williamson ether synthesis**, and, although it was first reported in the 1800s, it is still the most general method to prepare an ether. Unsymmetrical ethers can be synthesized in two different ways, but often one path is preferred. For example, isopropyl methyl ether can be prepared from CH_3O^- and 2-bromopropane (Path [a]), or from $(\text{CH}_3)_2\text{CHO}^-$ and bromomethane (Path [b]). Because the mechanism is S_N2 , the preferred path uses the less sterically hindered halide, CH_3Br —Path [b].

Two possible routes to isopropyl methyl ether



Problem Draw the organic product of each reaction and classify the product as an alcohol, symmetrical ether, or unsymmetrical ether.



5. Reactions of Ethers

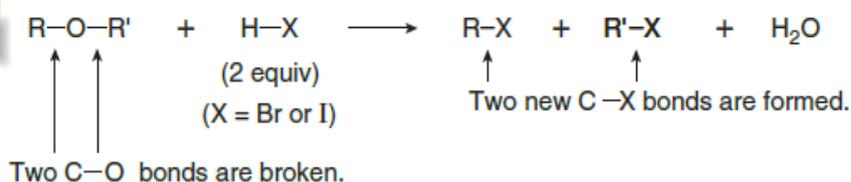
Like alcohols, ethers do not contain a good leaving group, which means that nucleophilic substitution and β elimination do not occur directly. Ethers undergo fewer useful reactions than alcohols.



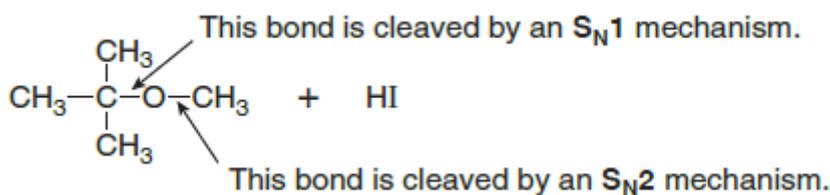
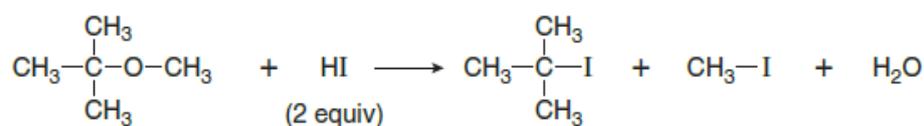
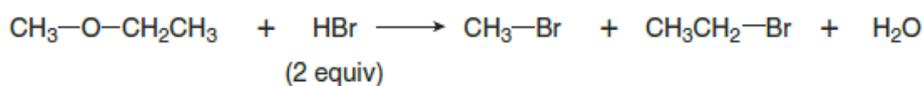
Reaction of Ethers with Strong Acid

That ethers have a poor leaving group, so they cannot undergo nucleophilic substitution or β elimination reactions directly. Instead, they must first be converted to a good leaving group by reaction with strong acids. Only **HBr** and **HI** can be used, though, because they are strong acids that are also sources of good nucleophiles (Br^- and I^- , respectively). **When ethers react with HBr or HI, both C – O bonds are cleaved and two alkyl halides are formed as products.**

General reaction



Examples

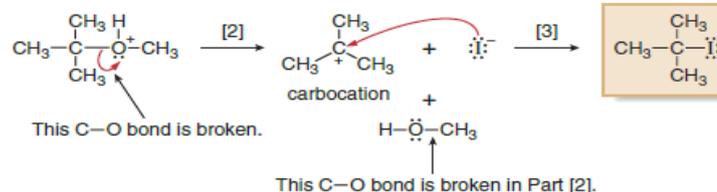
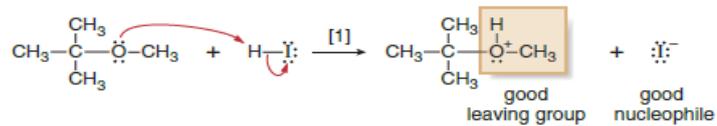


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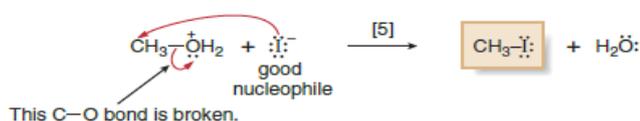
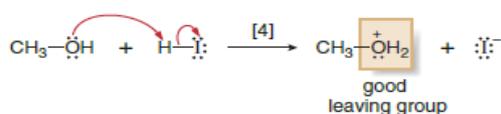
Mechanism Mechanism of Ether Cleavage in Strong Acid— $(\text{CH}_3)_3\text{COCH}_3 + \text{HI} \rightarrow (\text{CH}_3)_3\text{CI} + \text{CH}_3\text{I} + \text{H}_2\text{O}$

Part [1] Cleavage of the 3° C–O bond by an $\text{S}_\text{N}1$ mechanism



- **Protonation** of the O atom forms a good leaving group in Step [1]. Cleavage of the C–O bond then occurs in two steps: the bond to the leaving group is broken to form a **carbocation**, and then the bond to the nucleophile (I^-) is formed. This generates one of the alkyl iodides, $(\text{CH}_3)_3\text{CI}$.

Part [2] Cleavage of the CH_3 –O bond by an $\text{S}_\text{N}2$ mechanism



- **Protonation of the OH group** forms a good leaving group (H_2O), and then nucleophilic attack by I^- forms the second alkyl iodide, CH_3I , and H_2O .

Problem What alkyl halides are formed when each ether is treated with HBr ?

