

# [Ch 18 – college essay](https://assignbuster.com/ch-18-college-essay/)

Chapter 18 Ethers & Epoxides; Thiols and Sulfides Assigned Reading from McMurry: Read Sections 18. 1 through 18. 9; not responsible for “ Focus on … Epoxy Resins & Adhesives, pp. 697-698). Recommended Problems from McMurry: 18. 1a-e; 18. 18. 2; 18. 3a-d; 18. 4; 18. 5a-d; 18. 6a-b; 18. 7a-b; 18. 8; 18. 9; 18. 10; 18. 11; 18. 12a, b; 18. 13a, b; 18. 14a-c; 18. 16a-f; 18. 17; 18. 18; 18. 19a-c; 18. 20; 18. 21; 18. 22; 18. 23a-e; 18. 24a-I; 18. 25a-f; 18. 26a-d; 18. 27; 18. 28; 18. 29ad; 18. 30a-e; 18. 31; 18. 32; 18. 33; 18. 34; 18. 35a-d; 18. 36; 18. 37; 18. 38; 18. 39; 18. 40a, b; 18. 41a-d; 18. 2; 18. 43; 18. 44; 18. 45; 18. 45; 18. 46; 18. 47; 18. 48; 18. 49; 18. 51; 18. 52; 18. 53; 18. 54; 18. 551-e; 18. 56; 18. 57; 18. 58a-b; 18. 59a-b; 18. 60; 18. 61. 18. 1 Names and Properties of Ethers Method A: Simple ethers; alphabetize if two organic substituents. CH3–CH2–O–CH2–CH3 Diethyl ether Methyl propyl ether O CH3–CH2–CH2–O–CH3 CH3 Methyl phenyl ether SP 18. 01 Provide systematic names for the following ethers. CH3–CH2–O–CH2–CH2–CH2–CH3 O SP 18. 02 Provide structures for the following systematic names. Systematic name: Isopropyl phenyl ether Systematic name: Cyclohexyl ethyl ether

Method B: Other functional groups present, ether component is an “ alkoxy” substituent. Alkoxy examples: methoxy -OCH3, ethoxy -OCH2CH3, propoxy -OCH2CH2CH3, etc. O C H3 O CH3 O C H3 para-Dimethoxybenzene 3-Methoxy-1-cyclopentene SP 18. 03 Provide systematic names for the following complex ethers. OCH3 O CH2CH3 Cl SP 18. 04 Provide structures for the following systematic names. Systematic name: meta-Bromopropoxybenzene Systematic name: 1-Isopropoxycyclopentene 18. 2 Synthesis of Ethers The Williamson Ether Synthesis R + O an alkoxide C X R SN2 an alkyl halide methyl & 1o best; X = Cl, Br, I, OTos O C ether product

Example: O Na + Sodium phenoxide CH3 Br O CH3 Phenyl methyl ether (anisole) + Na Br + X SP 18. 05 Complete the following reactions. CH3 CH3 C O Na + CH3 I + Na I CH3 CH3 CH3 C CH3 I + Na O CH3 + Na I SP 18. 06 Provide the suitable alkoxide and alkyl halide necessary to produce 2-ethoxy-2-methyl butane in good yield. CH3 CH3 CH2 C O CH3 CH2 CH3 + Na Br 8. 4 Oxymercuration Intermediates • For laboratory-scale hydration of an alkene • • Use mercuric acetate in THF followed by sodium borohydride Markovnikov orientation – via mercurinium ion Alkoxymercuration of Alkenes General Reaction: R C C 2) NaBH4 H C R Ether

Alkene RO Step #1 RO C 1) Hg(OAc)2, ROH H g OA c C C Step #2 R + HOAc Markovnikov addition SP 18. 07 Complete the following reactions by displaying the final major organic product. H C 1) Hg(OAc)2, CH3OH H C 2) NaBH4 H CH3 CH3 C C H CH3 1) Hg(OAc)2, CH3OH 2) NaBH4 SP 18. 08 Specify the alkene and alcohol needed to produce the following ether. Alcohol OCH2CH3 1) Hg(OAc)2, CH3 2) NaBH4 Alkene 18. 3 Reactions of Ethers: Acidic Ether Cleavage General Reaction: HX C O C C OH + X C (strong acid) Ether Alcohol Alkyl halide SP 18. 09 Predict the product for the following ether-cleavage reaction. CH3 CH3 C O CH3 HBr CH2CH3 8. 4 Reactions of Ethers: Claisen Rearrangement O OH 1, 3 O to C shift Thermodynamically more stable o 250 Allyl phenyl ether C9H10O ortho-Allyl phenol C9H10O Mechanism (involves six-membered transition state): 1 O TS 2 3 1 O 2 H keto-enol tautomerization 3 O H SP 18. 10 Predict the structure for the following Claisen rearrangement. O o 250 2-Butenyl phenyl ether C10H12O 18. 5 Cyclic Ethers: Epoxides (2 methods) General Reaction 1: O C C + R Alkene C O O O O C H A peracid C An epoxide R C O A carboxylic acid Specific Example 1: O Cl C O O H m-CPBA o H O O + CH2Cl2, 25 C H 1, 2-Epoxycycloheptane Cl H C O H 18. Cyclic Ethers: Epoxides (2 methods) General Reaction 2: C OH X2, H2O C C C X A halohydrin Alkene O NaOH H2O C + H2O + NaX C An epoxide Review Section 7. 3 Specific Example 2: H CH3 C C H CH3 cis-2-Butene Br2 H2O H CH3 Br C OH C H CH3 NaOH H2O O HC CH3 C H + H2O + NaBr CH3 meso-2, 3-Dimethyl-oxirane (or cis-2, 3-epoxybutane) SP 18. 11 Fill in the appropriate intermediates showing the correct stereochemistry. H CH3 C C CH3 Br2 NaOH H H2O H2O trans-2-Butene + H2O + NaBr 18. 6 Reactions of Epoxides: Ring-Opening General epoxide structure: O C Since each atom is sp3 there is considerable angle strain in the epoxide ring-system.

C Acidic Conditions: Epoxide opening under acidic conditions (aqueous acid) yields 1, 2-diols General Reaction: H H O O C H C HO C H2O An epoxide C OH A 1, 2-diol (glycol) H O C H C + O H H O C + C H O H H O H Specific Example (using symmetrical epoxide): H + H H3O OH H2O OH O H H trans-1, 2-Cyclohexanediol SP 18. 12 Predict the correct structure of the product diol showing the correct stereochemistry. O H CH3 C C CH3 H trans-2, 3-epoxybutane H3O+ H2O Note: Epoxide opening under anhydrous acidic conditions yields halohydrins. Specific Example (2° and 1° carbons): o 1 carbon o 2 carbon O CH3 H C C H H 1, 2-Epoxypropane

OH HCl Et2O CH3 C Cl CH2 Cl + CH3 H 1-Chloro-2-propanol (90%) C CH2 OH H 2-Chloro-1-propanol (10%) SP 18. 13 Using the above model predict the major halohydrin. O H C H C HCl H Et2O O H C C H H HCl OH C Et2O H Cl CH2 Cl + C CH2 OH H Explanation: In cases where a 2° carbon and a 1° carbon form the epoxide ring, the major halohydrin product will be the one where the incipient alcohol is 2° and the halide is 1°. Upon protonation of the epoxide oxygen the halide ion simple attacks the less-hindered 1° carbon with a greater frequency to give the major regioisomer. Specific Example (3° and 1° carbons): SP 18. 4 Using the above model predict the major halohydrin. Circle one. O C C H H HCl OH C Et2O + C H Cl Cl H C OH C H H Explanation: In cases where a 3° carbon and a 1° carbon form the epoxide ring, the major halohydrin product will be the one where the incipient alcohol is 1° and the halide is 3°. Upon protonation of the epoxide oxygen the halogen attacks the more-stabilized (same as moresubstituted) carbon atom to give the major regioisomer described. Basic Conditions: Note: Nucleophile will always attack least-hindered position. Specific Example: o 3 carbon 1o carbon O CH3 CH3 C C H H OH NaOH H2O, ? CH3 C CH2 OH CH3 -Methyl-1, 2-propanediol SP 18. 15 Predict the structure of the 1, 2-diol from the following reaction. O C C H H NaOH H2O, ? Reaction with Grignard Reagents: O CH3 CH3 C C H H OH 1) CH3CH2MgBr, Et2O 2) (aq) NH4Cl CH3 C CH2 CH3 CH2 CH3 SP 18. 16 Predict the structure of the organic product from the following Grignardepoxide reaction. O H C C H H 1) CH3MgBr, Et2O 2) (aq) NH4Cl Reaction with a 1° amine: O H C OH CH2 H H2NCH2CH2CH3 C CH2 N CH2 CH2 H Reaction with a 2° amine: O H C OH H H3C CH2 + N H3C H C CH2 N CH3 CH3 CH3 SP 18. 17 Predict the structure of the epoxide and amine needed to generate the amino alcohol shown to the right.

OH + CH3 C CH3 Epoxide Amine CH2 N H 18. 7 Crown Ethers • Large rings consisting of repeating (-OCH2CH2-) or similar units • Named as x-crown-y – x is the total number of atoms in the ring – y is the number of oxygen atoms – 18-crown-6 ether: 18-membered ring containing 6 oxygen atoms • Central cavity is electronegative and attracts cations 18. 8 Thiols and Sulfides • Thiols (RSH), are sulfur analogues of alcohols – Named with the suffix -thiol – SH group is called “ mercapto group” (“ capturer of mercury”) Thiols: Formation and Reaction • From alkyl halides by displacement with a sulfur nucleophile such as –SH The alkylthiol product can undergo further reaction with the alkyl halide to give a symmetrical sulfide, giving a poorer yield of the thiol Sulfides • Sulfides (RSR? ), are sulfur analogues of ethers – Named by rules used for ethers, with sulfide in place of ether for simple compounds and alkylthio in place of alkoxy Using Thiourea to Form Alkylthiols • Thiols can undergo further reaction with the alkyl halide to give dialkyl sulfides • For a pure alkylthiol use thiourea (NH2(C= S)NH2) as the nucleophile • This gives an intermediate alkylisothiourea salt, which is hydrolyzed cleanly to the alkyl thiourea Oxidation of Thiols to Disulfides Reaction of an alkyl thiol (RSH) with bromine or iodine gives a disulfide (RSSR) • The thiol is oxidized in the process and the halogen is reduced Sulfides • Thiolates (RS? ) are formed by the reaction of a thiol with a base • Thiolates react with primary or secondary alkyl halide to give sulfides (RSR’) • Thiolates are excellent nucleophiles and react with many electrophiles Sulfides as Nucleophiles • Sulfur compounds are more nucleophilic than their oxygen-compound analogues – 3p valence electrons (on S) are less tightly held than 2p electrons (on O) • Sulfides react with primary alkyl halides (SN2) to give rialkylsulfonium salts (R3S+) Oxidation of Sulfides • Sulfides are easily oxidized with H2O2 to the sulfoxide (R2SO) • Oxidation of a sulfoxide with a peroxyacid yields a sulfone (R2SO2) • Dimethyl sulfoxide (DMSO) is often used as a polar aprotic solvent 18. 9 Spectroscopy of Ethers • Infrared: C–O single-bond stretching 1050 to 1150 cm? 1 overlaps many other absorptions. • Proton NMR: H on a C next to ether O is shifted downfield to ? 3. 4 to ? 4. 5 – The 1H NMR spectrum of dipropyl ether shows this signal at ? 3. 4 – In epoxides, these H’s absorb at ? 2. 5 to ? 3. 5 in their 1H NMR spectra Carbon NMR: C’s in ethers exhibit a downfield shift to ? 50 to ? 80 Let’s Work a Problem When 2-methyl-2, 5-pentanediol is treated with sulfuric acid, dehydration occurs and 2, 2dimethyltetrahydrofuran is formed. Suggest a mechanism for this reaction. Which of the two oxygen atoms is most likely to be eliminated and why? Answer First, there is protonation of the 3? –OH group, then a 3? carbocation is formed via loss of H2O. Then there is a nucleophilic attack of the carbocation by the 2nd –OH group. The 3? OH group is the one eliminated in all likelihood because its removal involves the formation of the more stable 3? carbocation.