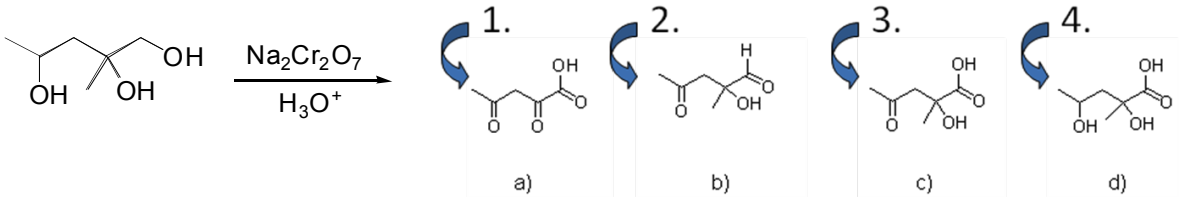
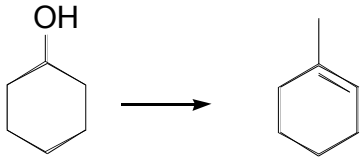
Part I. Alcohols and Phenols

1. What is the product of the following reaction?

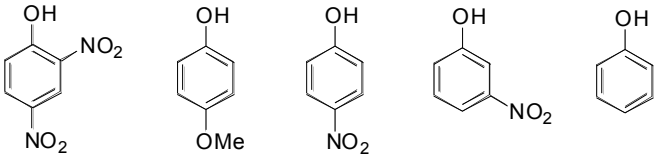


2. Which set of reagents is the best to perform the following transformation?

1. 1) tosyl chloride, 2) CH_3MgBr
2. 1) CrO_3, 2) CH_3MgBr, 3) $POCl_3$/pyridine
3. 1) HBr, 2) Mg^o, 3) CH_3I
4. 1) NaOH, 2) CH_3I
5. 1) CrO_3/H_3O^+, 2) $NaBH_4$, 3) CH_3MgBr



3. Rank the following groups of compounds from most acidic to least acidic.



1 2 3 4 5

$CF_3CH_2CH_2OH$ CF_3CH_2OH CF_3OH

1 2 3

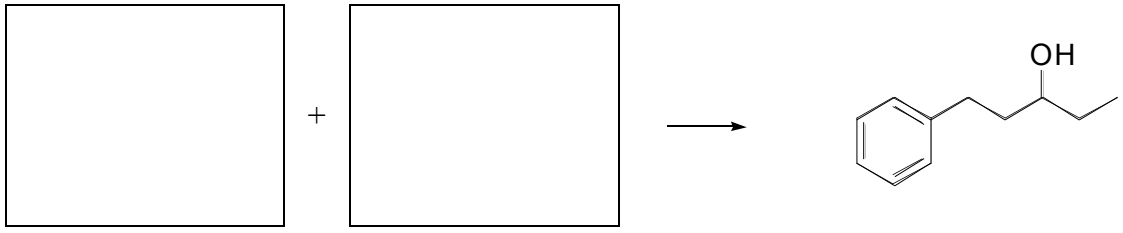
4. Choose the *best* reagent(s) for carrying out the following conversions from the list provided below. Place the letter of the best choice in the blank to the left of the conversion. Reagents may be used more than once.

a. 1. CH_3MgBr, ether
   2. H_3O^+
b. 1. PBr_3
   2. NaOH
c. 1. $LiAlH_4$, ether
   2. H_3O^+
d. Mg, ether
e. 1. ; 2. H_3O^+
f. PCC, CH_2Cl_2
g. $KMnO_4$, H_2O
h. Br_2, $FeBr_3$

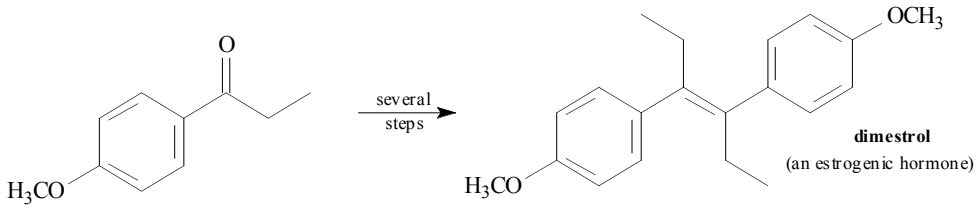
1-butanol $\xrightarrow{\text{step(s)}}$ 1-pentanol (one more carbon)

1-phenylethanol $\xrightarrow{\text{step(s)}}$ benzaldehyde (one less carbon)

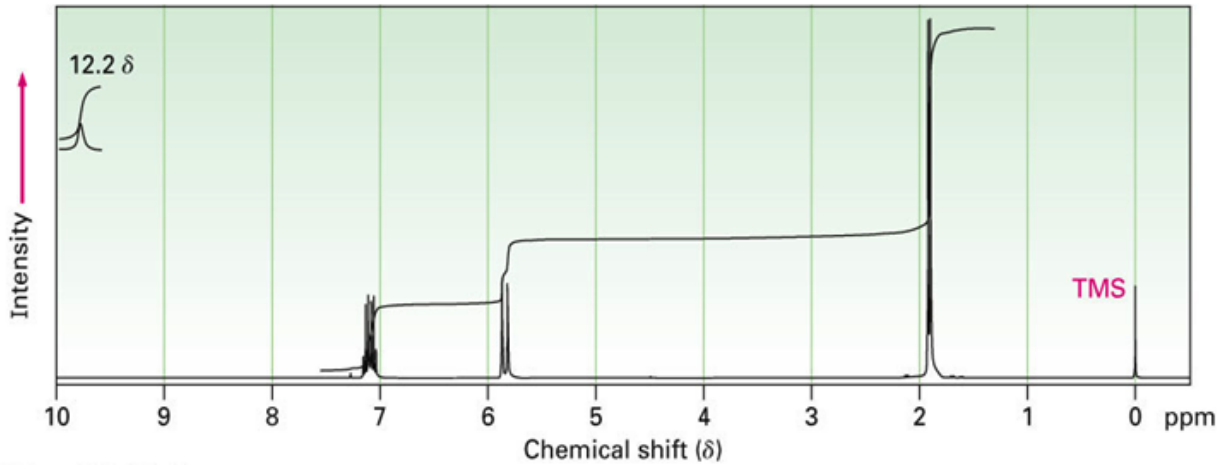
5. (1) Supply the missing starting material(s), product(s), or reagents (s). (2) Write the complete stepwise mechanism.



6. Propose a synthesis of Dimestrol starting from *p*-methoxypropiophenone as the only source of carbon.



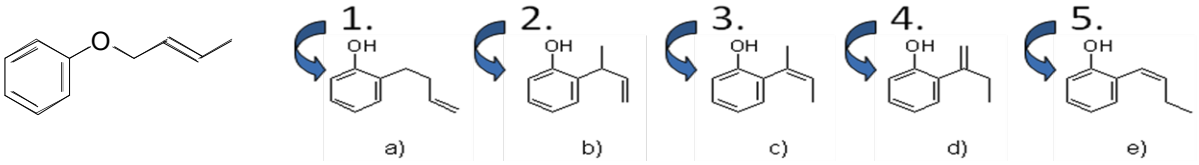
7. Propose a structure for a compound $C_4H_6O_2$ that exhibits infrared absorptions at 1700 and 2500-3300 cm^{-1} and the following ^1H NMR spectrum. The signal at 1.9 ppm is a doublet.



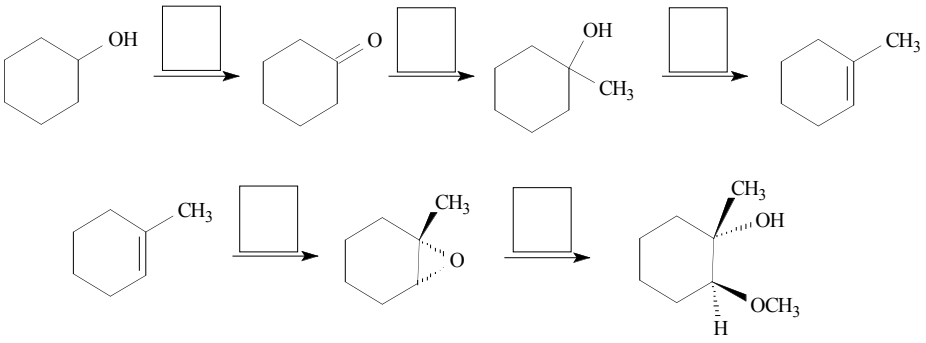
(1) Calculate the degree of unsaturation for this compound.
(2) What functional group is indicated by the IR data?
(3) Propose a structure that is consistent with the provided spectroscopic data.
(4) In your final structure label the non-equivalent hydrogens as a, b, c etc. and write those same letters above the corresponding peaks in the ^1H NMR spectrum.

Part II. Ethers

1. What is the product of Claisen rearrangement of the 2-butenyl phenyl ether shown below?



2. Choose the *best* reagent for carrying out the following reactions from the list below. Place the letter of the reagent(s) in the box over the reaction arrow. Use only one letter per box.



A. NaH, then CH_3I

B. $NaOCH_3$, CH_3OH

C. *m*-$ClC_6H_4CO_3H$

D. CH_3MgBr in ether, then H_3O^+

E. warm H_2SO_4/H_2O

F. $Hg(O_2CCF_3)_2$, CH_3OH

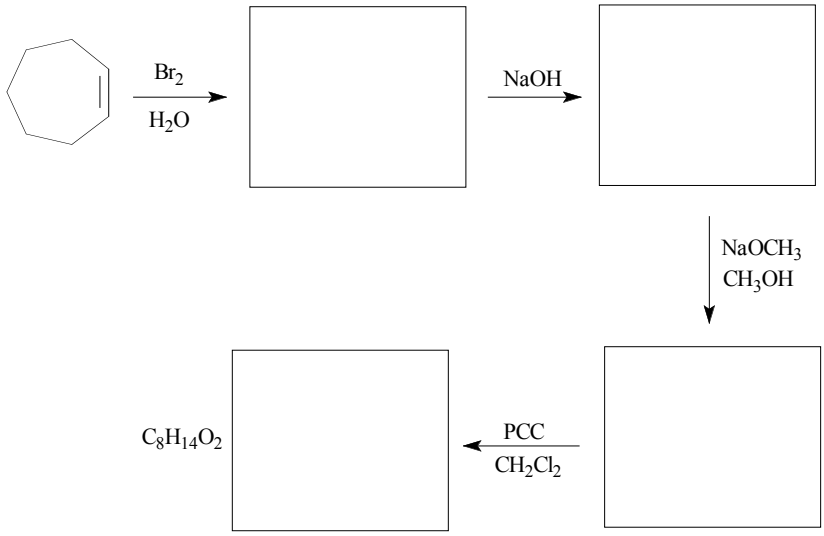
G. H_2/Pd

H. PCC, CH_2Cl_2

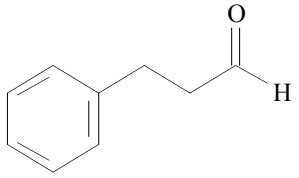
I. Cl_2, H_2O

J. $LiAlH_4$ in ether, then H_3O^+

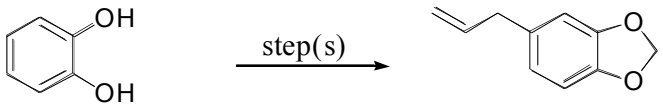
3. Complete the synthetic sequence below by drawing the structures of the reaction in the boxes provided. Pay attention to stereochemistry.



4. Propose a synthesis for the following compound using toluene and any other reagents necessary. Show all major intermediate compounds that would probably be isolated during the course of your synthesis.



5. Safrole, a substance isolated from oil of sassafras, is used as a perfumery agent.
(1) Propose a synthesis of safrole from catechol (1,2-benzenediol).
(2) A williamson ether synthesis is involved. Please write the mechanism its mechanism.



catechol
(1,2-benzene diol)

Safrole

6. Anethole, $C_{10}H_{12}O$, a major constituent of the oil of anise, has the ^1H NMR spectrum shown. On oxidation with $KMnO_4$, anethole yields p-methoxybenzoic acid.
Note: In 1H NMR, signal ***c*** is a doublet and signal ***d*** is a multiplet.
(1) Calculate the degree of unsaturation for this compound.
(2) Propose a structure that is consistent with the provided spectroscopic data.
(3) In your final structure label the non-equivalent hydrogens with ***a, b, c***… as indicated in the NMR spectrum.