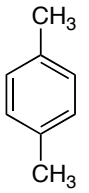
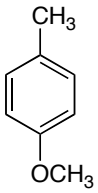
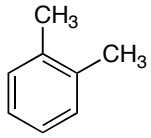
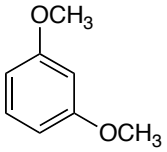
Multiple choice: Select the best answer for the follow questions. (10 questions, 30 points)

1. Select the structure that is consistent with the following ^{13}C NMR data:
   δ= 137, 129, 125, 18

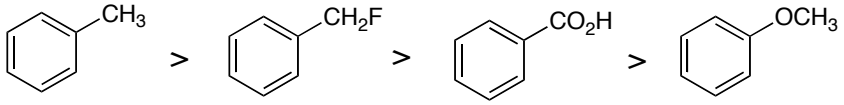
a. 

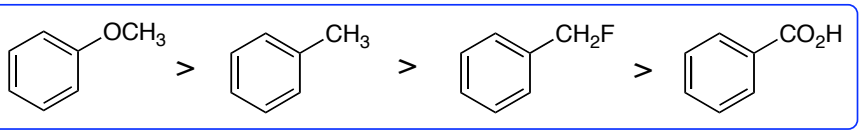
b. 

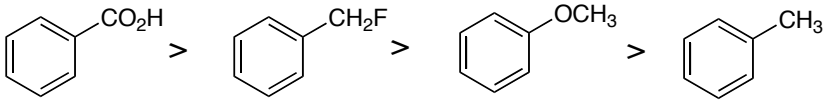
c. 

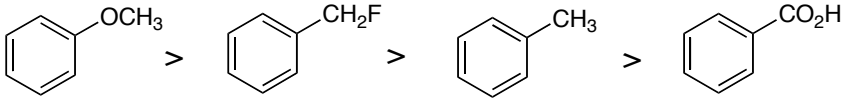
d. 

2. Which is the correct order of reactivity (most reactive to least reactive) toward electrophilic aromatic substitution?

a. 

b. 

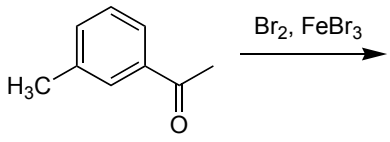
c. 

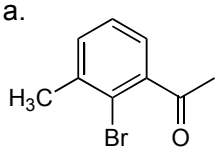
d. 

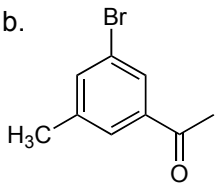
3. Which of the following is the weakest acid?

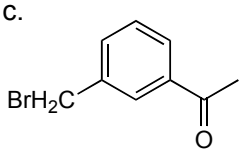
   a. phenol
   b. 3,4-dimethylphenol
   c. *m*-chlorophenol
   d. *p*-nitrophenol

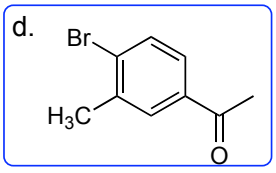
4. Which is expected to be the major product for the following reaction:



a. 

b. 

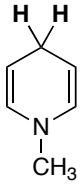
c. 

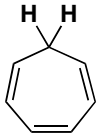
d. 

5. Consider the highlighted protons. Which compound is predicted to have the lowest pK_a?

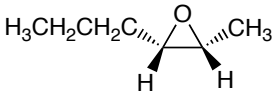
a. 

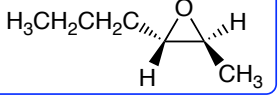
b. 

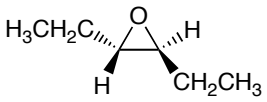
c. 

d. 

6. Which of the following will be the product from the reaction of (*E*)-2-hexene with *m*-chloroperbenzoic acid?

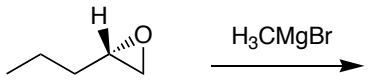
a. 

b. 

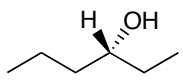
c. 

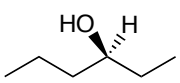
d. a, b and c are all products of the reaction

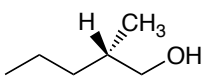
7. Predict the major product from the following reaction.

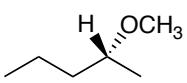


(*S*)-2-propyloxirane

a. 

b. 

c. 

d. 

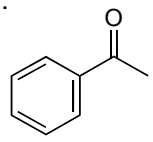
8. Which of the following can be used to convert benzyl alcohol to benzoic acid?

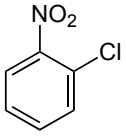
a. $LiAlH_4$, ether
b. CrO_3, H_3O^+ (Jones' Reagent)
c. pyridinium chlorochromate (PCC), CH_2Cl_2
d. $Hg(O_2CCH_3)_2$

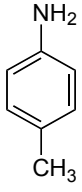
9. Which of the following reagents will react with (*S*)-3-methyl-3-octanol to give an optically active product.

a. $POCl_3$, pyridine
b. HBr
c. NaH, THF, CH_3I
d. all of the above

10. Which of the following is compatible with a Friedel-Crafts reaction.

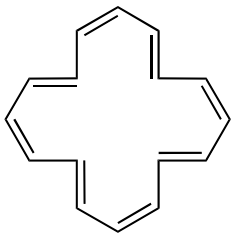
a. 

b. 

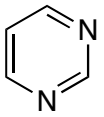
c. 

d. None; a, b, and c are all incompatible witht he Friedel-Crafts reaction

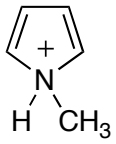
11. Describe the following as aromatic, anti-aromatic or non-aromatic (neither aromatic nor anti-aromatic). Assume each is planar. (10 points)



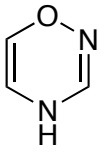
Anti-aromatic



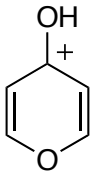
Aromatic



Non-aromatic



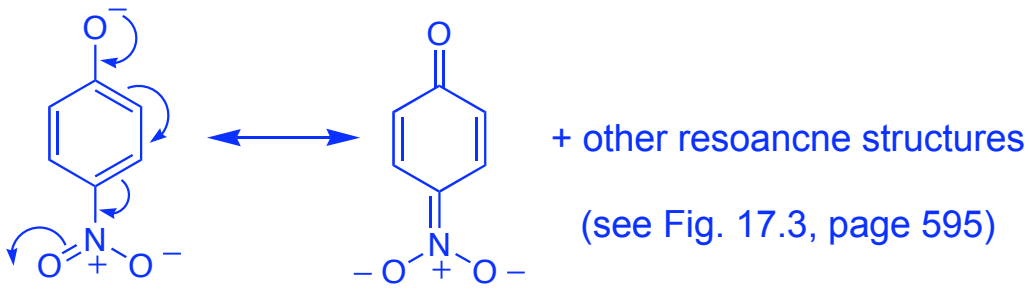
Anti-aromatic



Aromatic

12. Explain why *p*-nitrophenol is much more acidic than a normal alcohol. Your answer should include a mechanism that is consistent with the increased acidity. Be brief; a picture is worth a thousand words. (12 pts)

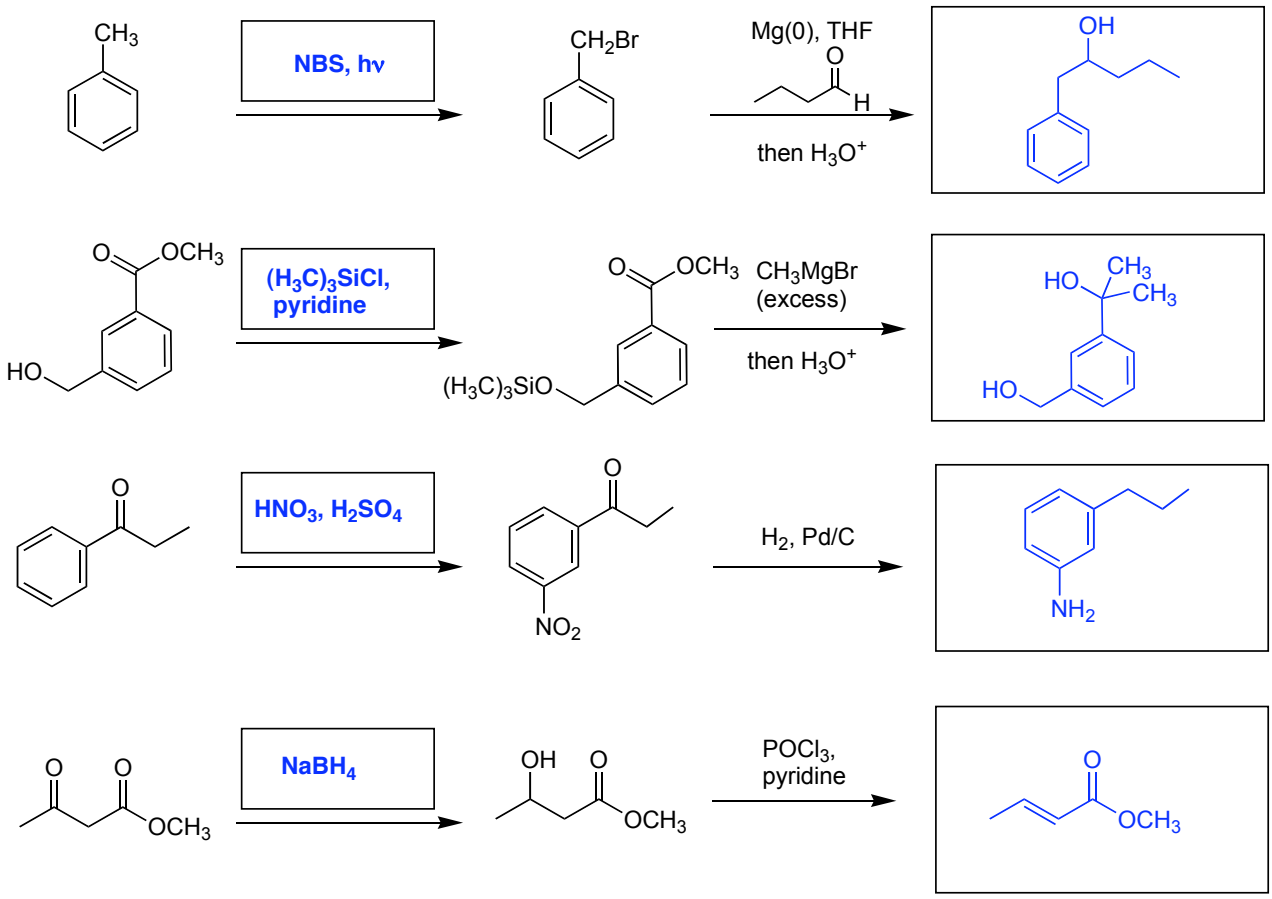
The negative charge of the p-nitrophenoxide ion, the conjugate base of p-nitrophenol, is stabilized by resonance delocalization into the p-nitro group (resonance effect). The nitro group is a strong electron-withdrawing group. The electron withdrawing nature polarizes the pi-electrons of the benzene ring resulting is partial positive charge near the OH (inductive effect). This can also stabilize the negative charge of the p-nitrophenoxide ion. Stabilizing the conjugate base through resonance and inductive effects makes p-nitrophenol more acidic than a normal alchohol.



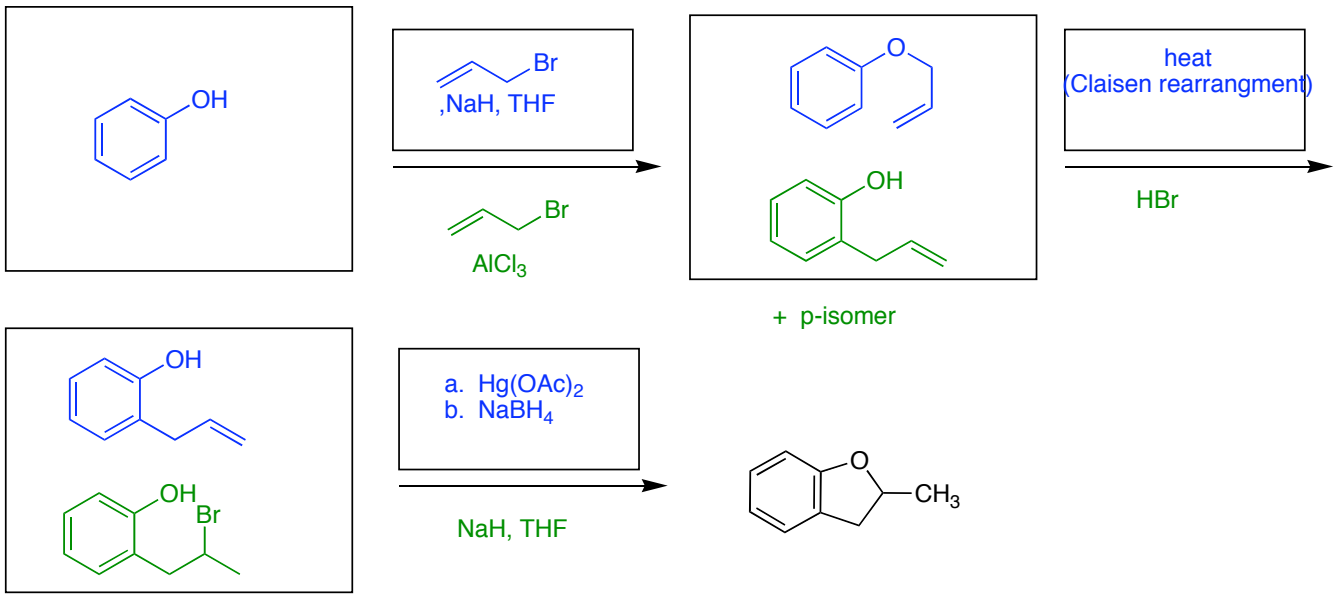
+ other resoancne structures

(see Fig. 17.3, page 595)

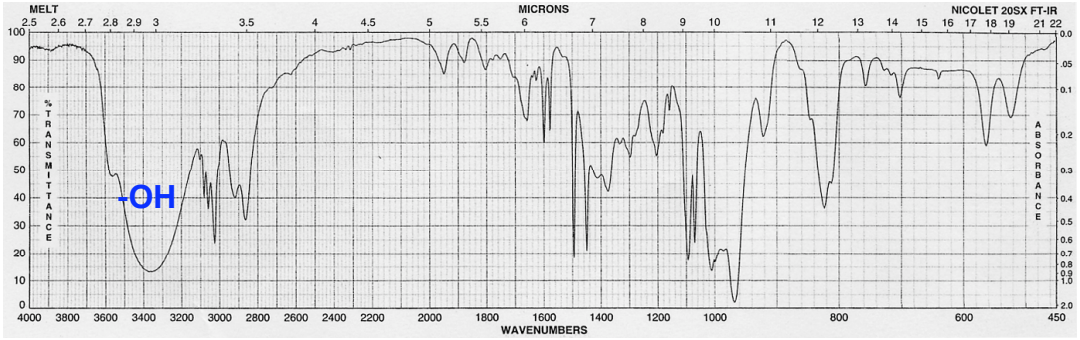
13. Provide the necessary reagents and give the products for the following reactions: (24 pts)

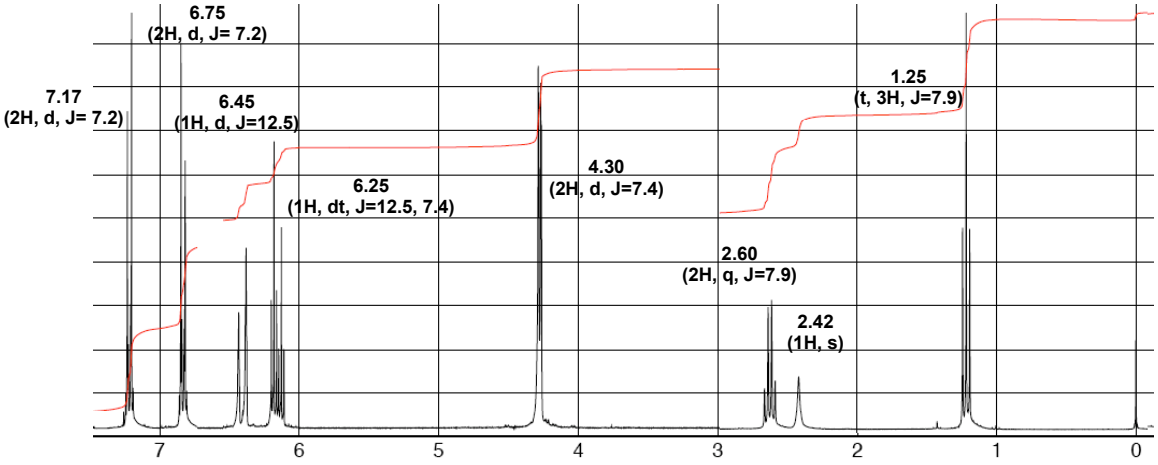


14. Complete the following synthesis. You may start with any mono-substituted benzene and use any alkyl halide, any acid chloride and any other necessary reagents. For full credit, complete the synthesis in the number of steps shown, while minimizing the number of reactions that give mixtures of products. (12 pts)



15. Provide a structure that is consistent with the following data. Please show your reasoning. (12 pts)
Formula: **$C_{11}H_{14}O$**





^{13}C NMR: 140, 132, 128, 125, 122, 119, 65, 32, 14

5 units of unsaturation IR: hydroxyl stretch; alcohol

1H NMR: δ 7.17 and 6.75, aromatic protons, integrates to 4H's, two doublets p-disubstituted aromatic

δ 6.75 and 6.25 are couple to each other, vinyl region, 1H each

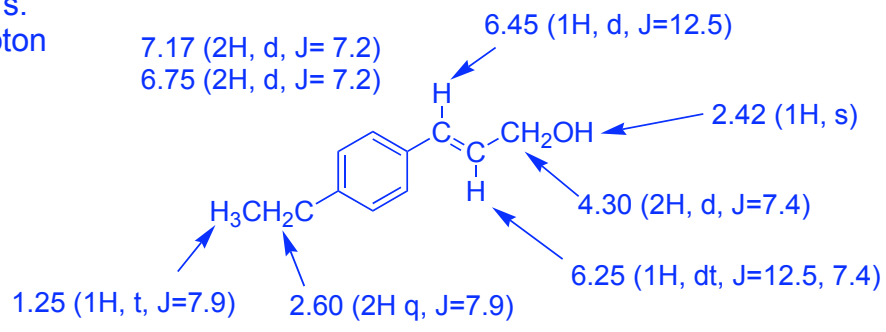
δ 6.75 is a doublet, coupled to the other vinyl proton, but no other proton

δ 6.25 is a doublet or triplets, coupled to the other vinyl proton and the CH_2 group at δ 4.30 (both have a 7.4 Hz coupling constant)

δ 4.30 is a doublet and integrates to 2H's; a CH_2 that is coupled to the vinyl proton at δ 6.25 but no other proton. Chemical shift indicates that it is attached to at least one deshielding group.

δ 2.60 and 1.25 are coupled to each other (they have the same coupling constant). 2.60 is a quartet that integrates to 2H's while 1.25 is a triplet that integrates to 3H's. This is a -CH_2-CH_3 group. The CH_2 is attached to a carbon with no H's.

δ 2.60 is the -OH proton



Problem	1-10:_____(30 pts)	13:_____ (24 pts)
	11:_____ (10 pts)	14:_____ (12 pts)
	12:_____ (12 pts)	15:_____ (12 pts)

Total out of 100: _____