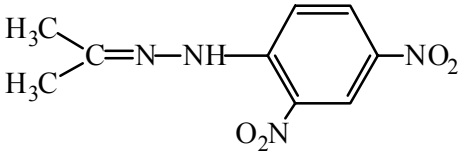
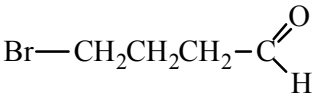
1. (12 marks) Structure and Nomenclature

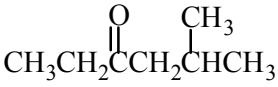
Draw structures for which names are given and name the given structures by any accepted system

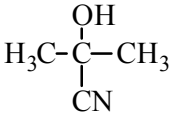
(2 points each)

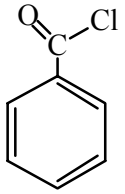
a)  ethylene oxide, oxirane or oxycyclopropane

b)  acetone 2,4-dinitrophenylhydrazone

c) 4-bromobutanal 

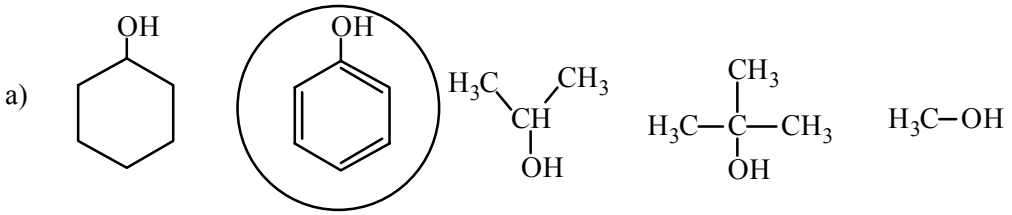
d)  5-methyl-3-hexanone

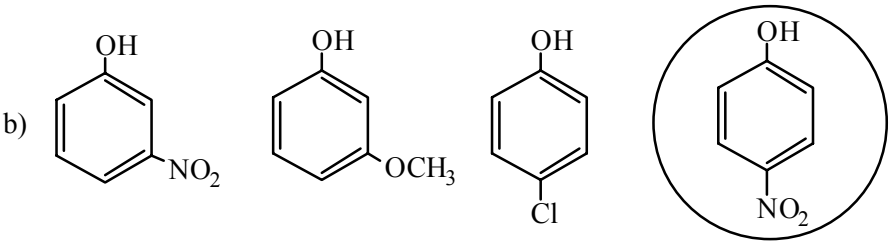
e) acetone cyanohydrin 

f) benzoyl chloride 

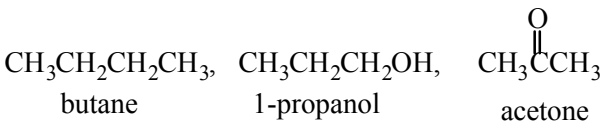
2. (10 points) Physical Properties

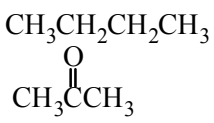
A. (3 points each) In each group of compounds, circle the most acidic one.

a) 

b) 

B, (4 points) List the following compounds in order of <u>increasing</u> boiling point. Briefly explain the reasoning behind your answer.





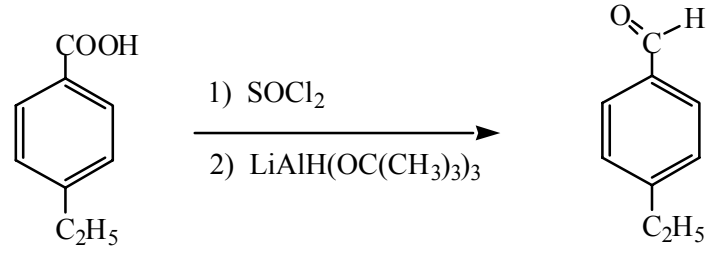
lowest boiling point

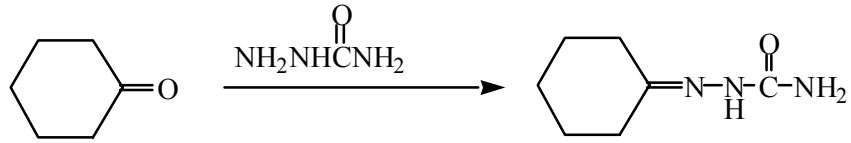
$CH_3CH_2CH_2CH_2OH$ highest boiling point

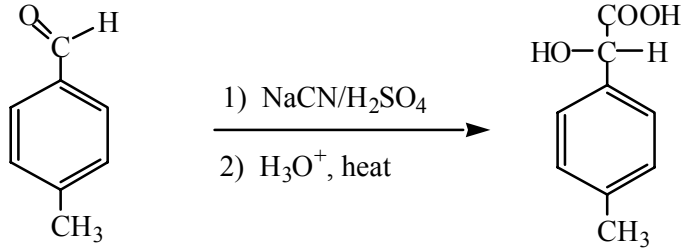
Propanol has the highest boiling point due to hydrogen bonding.
Acetone is polar so has a higher boiling point than non-polar butane.

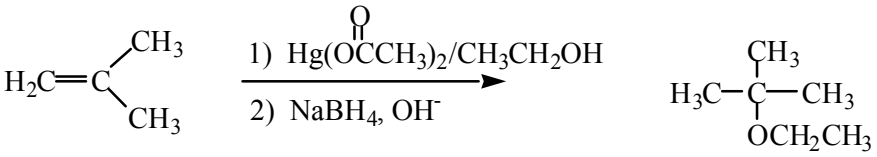
3. (34 points) Reactions

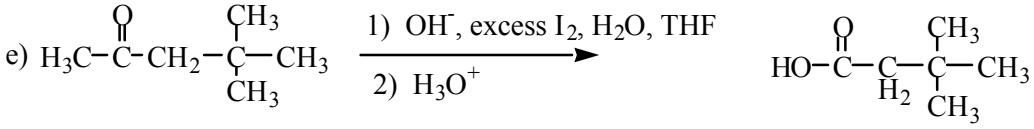
A. (3 points each) Draw the structures of the major organic product(s) of the following reactions.

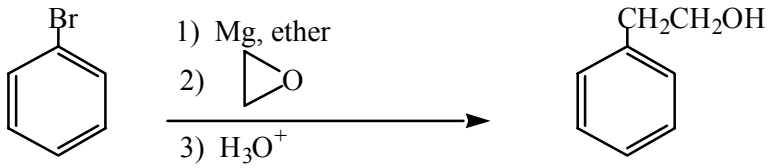
a) 

b) 

c) 

d) 

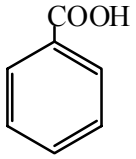
e) 

f) 

B. (16 points) List the reagents which will accomplish the following transformations. More than one step may be required.

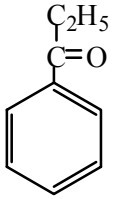
(4 points each)

a)

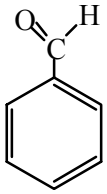


1) $SOCl_2$

2) $(C_2H_5)_2CuLi$, -80°C

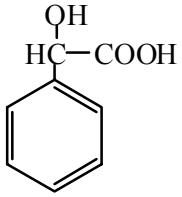


b)

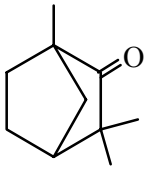


1) $NaCN, H_3O^+$

2) H_3O^+



c)



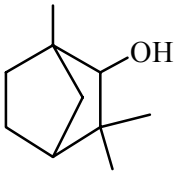
fenchone

1) $LiAlH_4$, ether

2) H_2O

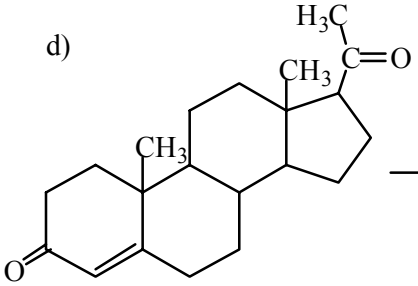
or 1) $NaBH_4$, CH_3OH

2) H_3O^+



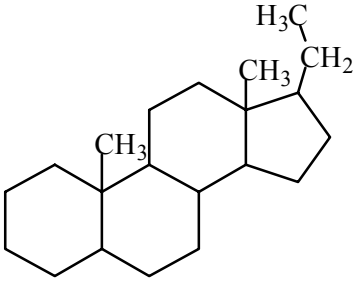
fenchol

d)



1) NH_2NH_2, OH^-

2) H_2, Pd

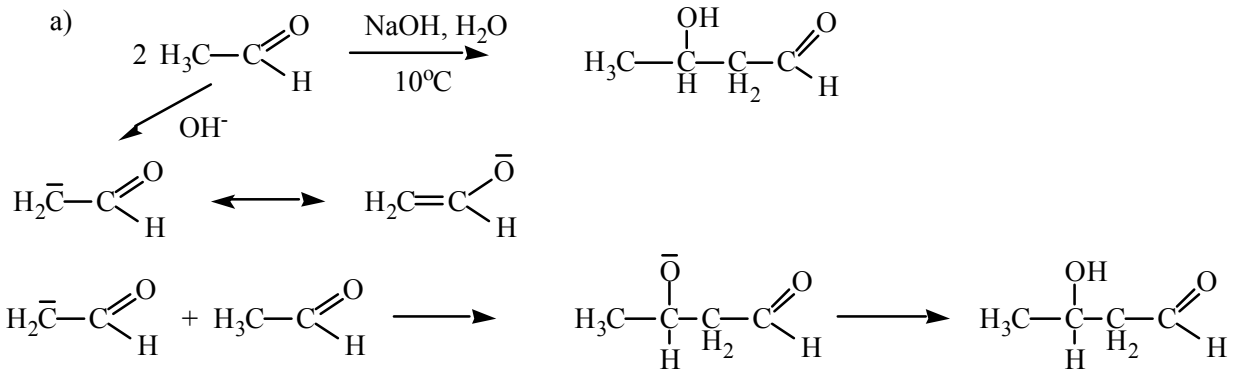


4. (10 points) Reaction Mechanisms

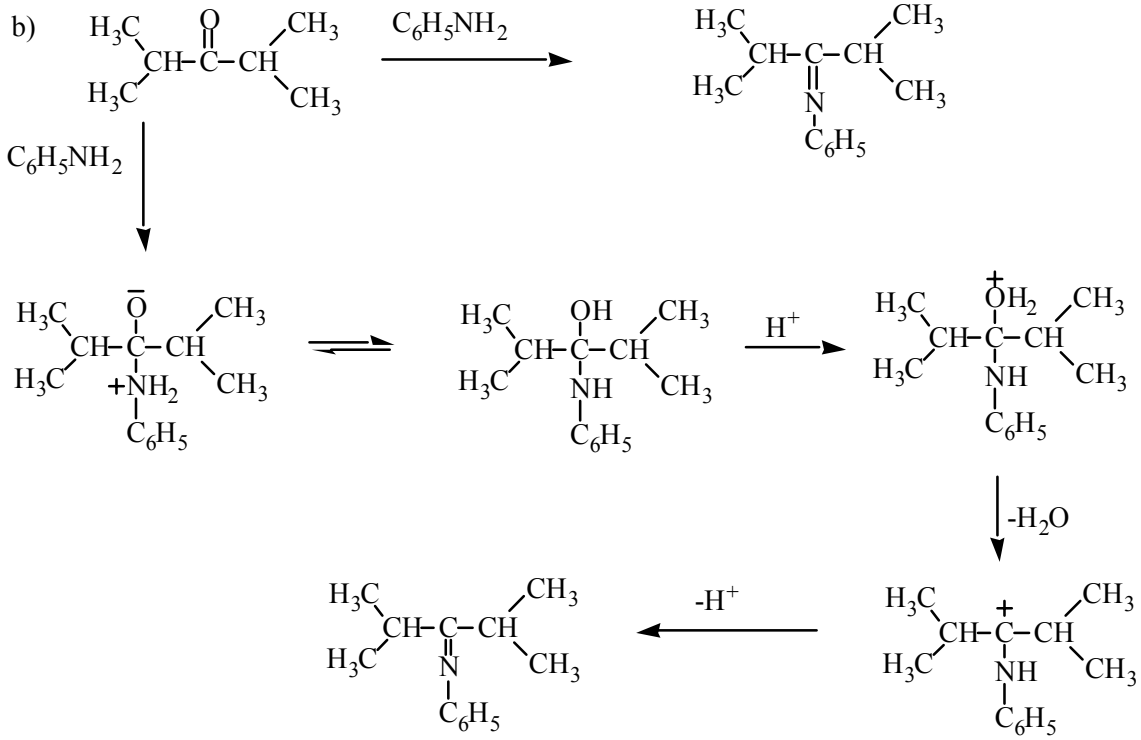
(5 points each)

Draw all intermediates formed between the starting material and the product in the following reactions

a)



b)

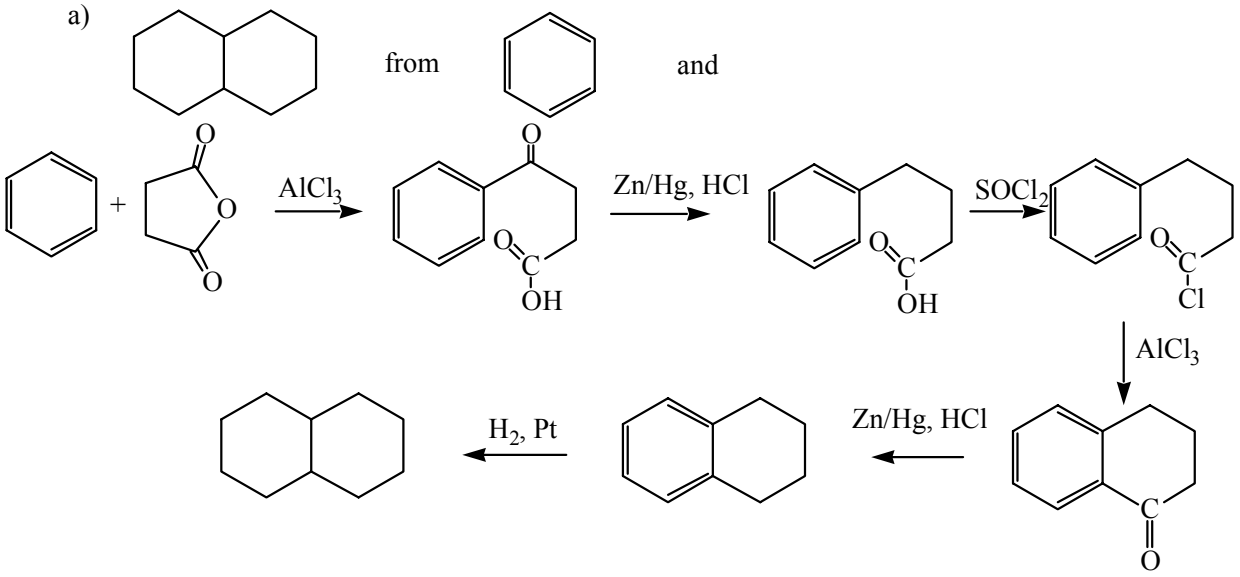


5. (12 points) Synthesis

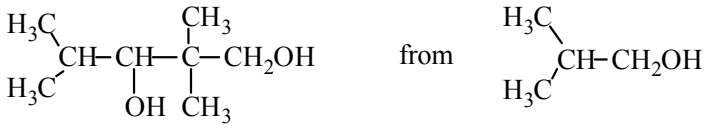
6 points each)

Show reactions for the synthesis of the following compounds from the indicated starting materials and any inorganic reagents required

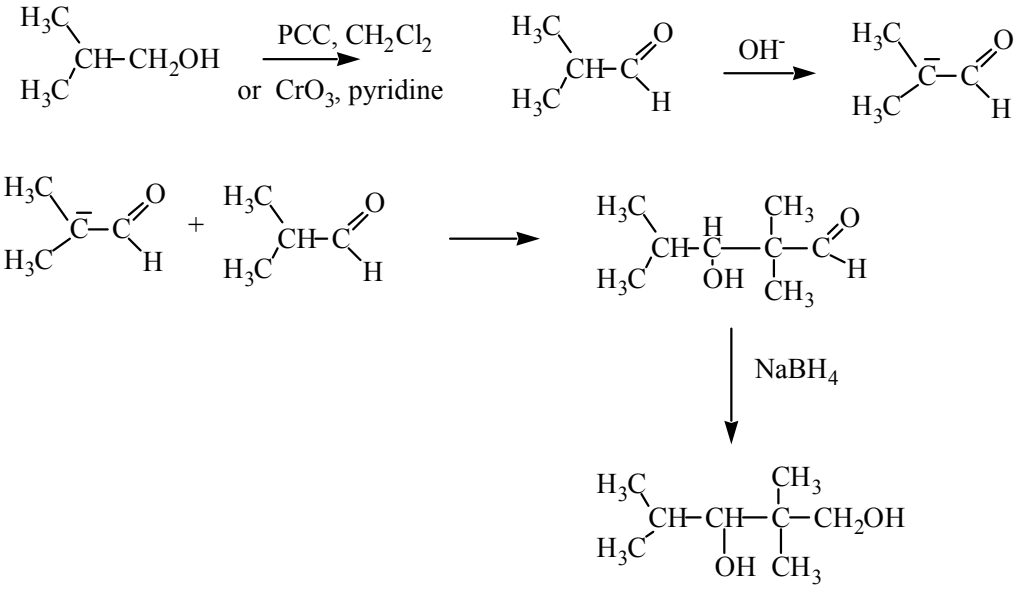
a)



b)



Hint: aldehydes can readily be reduced to alcohols

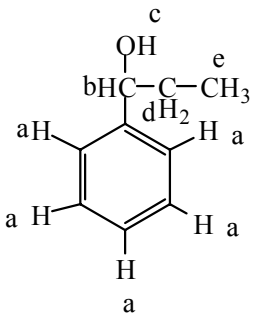


6. (12 points) Spectroscopic Identification

Draw the structure of compound Y whose IR and NMR spectra are given. The molecular formual of Y is $C_9H_{12}O$. Assign the protons in your structure to the signals in the NMR spectrum and indicate what information you used from the IR spectrum.

Note that the chemical shfts of protons influenced by <u>two</u> functional groups will be further downfield than the values given in the table. (IR and NMR tables are appended)

IR shows that there is an OH present and no carbonyl



a protons: signal at δ 7.2 - singlet
b proton: signal at δ 4.4 - triplet
c proton: signal at δ 2.6 - singlet
d protons: signal at δ 1.6 - quintet
e protons: signal at δ 0.8 - triplet

7. (10 points) Vitamin E is a mixture of substances known as tocopherols which act as biological antioxidants and are abundant in vagetable oils, cereals and eggs. Show how you would synthesize α-tocopherol in several steps from the indicated starting materials. Use any inorganic reagents you need.

Hint: this ether linkage can be formed using a tertiary halide because it is intramolecular.