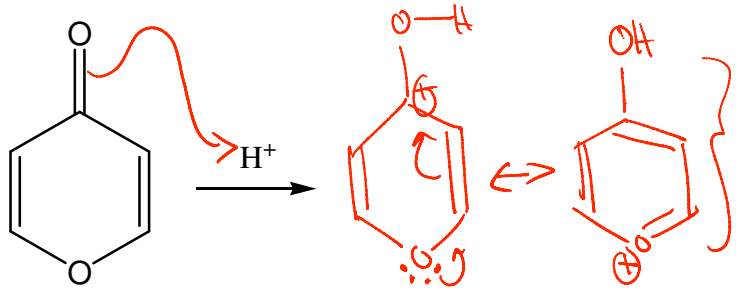
Question 1 (6 marks)

a) 4-Pyrone (below) is protonated by acid to give a stable cationic product. Propose a structure for this product and **explain why** it is relatively stable.

either structure 1 mark — must be protonated at C=O



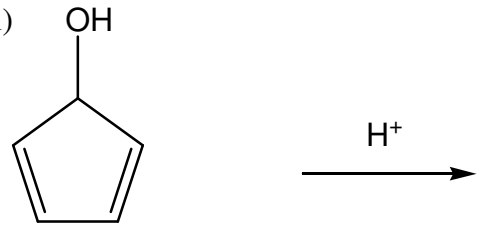
aromatic

The protonated product is stabilized by aromaticity and delocalization of the positive charge around the ring. (2)

1 → aromaticity
1 → logic of explanation
If only mention delocalization max 1/2

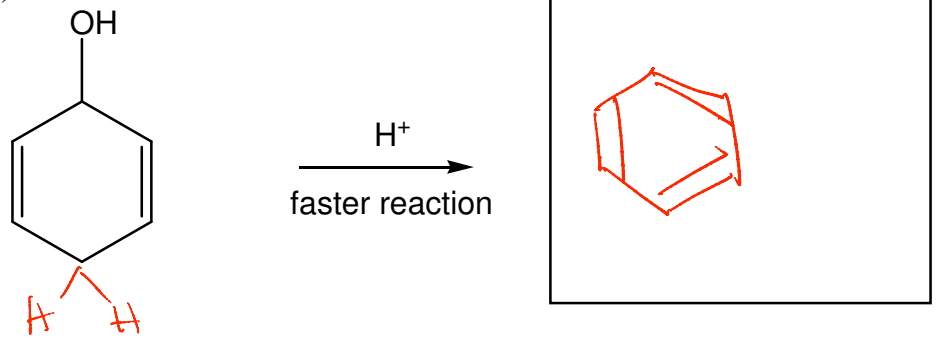
b) Draw the product of the reaction in (ii).

(i)



no reaction

(ii)



1 mark for benzene
(no other structure accepted)

c) Why does reaction (ii) proceed but not reaction (i)? 2 marks for description

1 mark for i
1 mark for ii

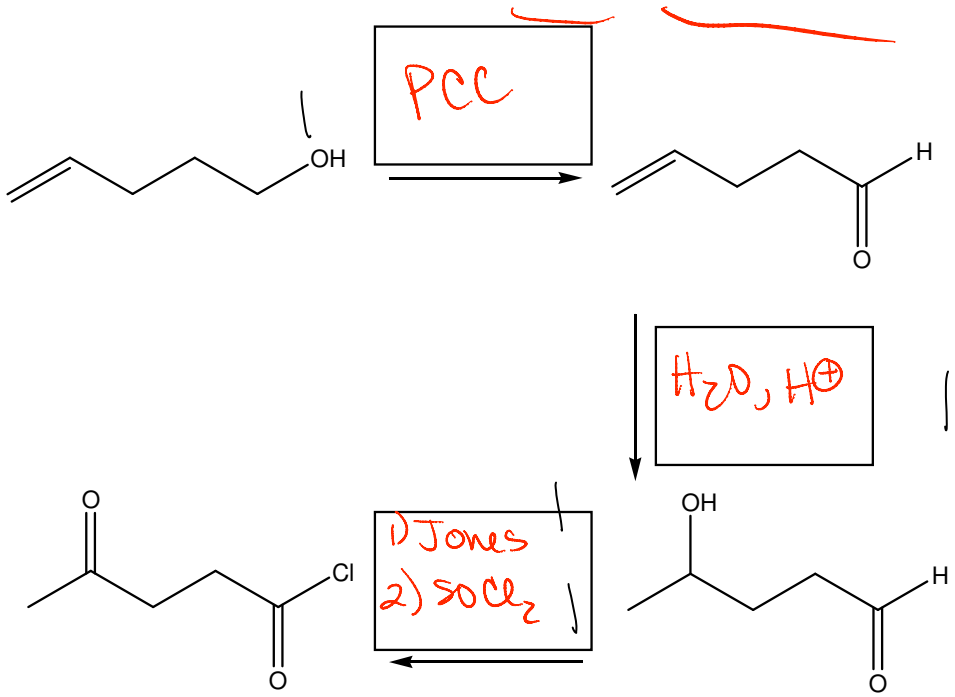
Protonation of the hydroxyl group in (ii) allows the water molecule to be eliminated with loss of a proton from the sp^3-hybridized carbon on the opposite side of the ring to generate the aromatic benzene product. Similar protonation of the alcohol in (i) would not lead to elimination since the carbocation that would be formed is anti-aromatic ($4\pi e^-$) and since there is no sp^3-hybridized proton to lose.

If they only mention i being antiaromatic but not ii being aromatic 1 out of 2

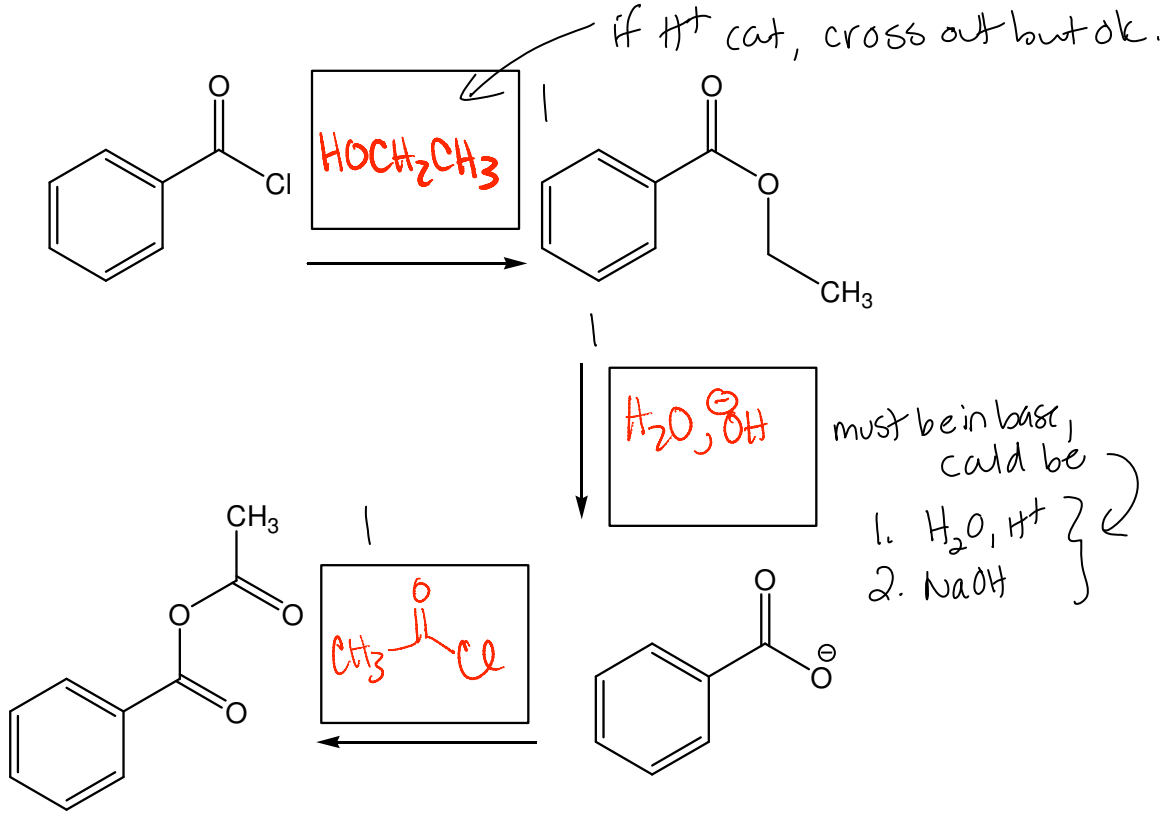
Question 2 (7 marks)

Write the reagents required to perform the following transformations in the boxes below. There may be more than one reaction in each box. Where necessary, separate these with reaction numbers 1,2, etc. Pay attention to the direction of the reaction arrows!

a)

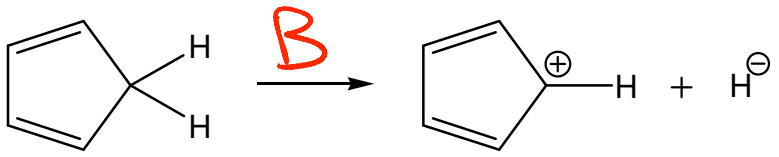


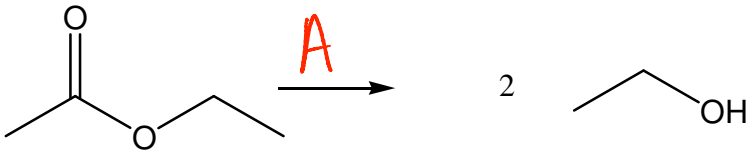
b)

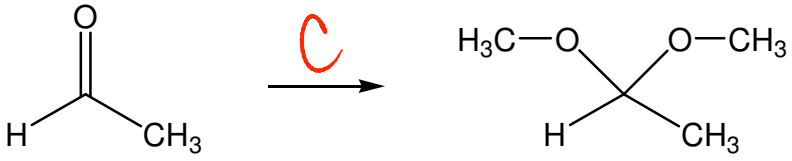


Question 3 (8 marks) 1 mark each

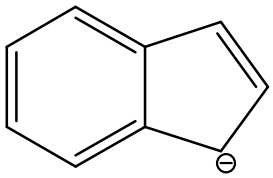
a) Label the following reactions by writing (**A**) reduction (**B**) oxidation or (**C**) neither above the reaction arrows.



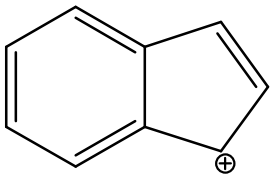




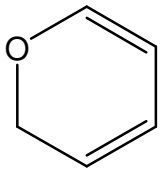
b) Label the following molecules as (**A**) aromatic (**B**) anti-aromatic or (**C**) non-aromatic.



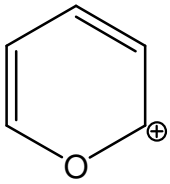
A



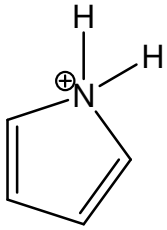
B



C



A

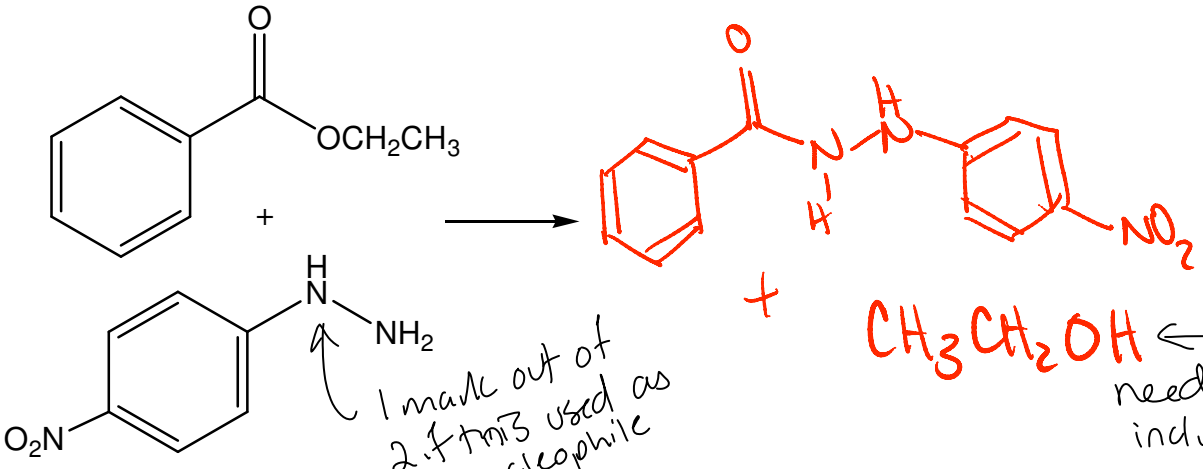


C

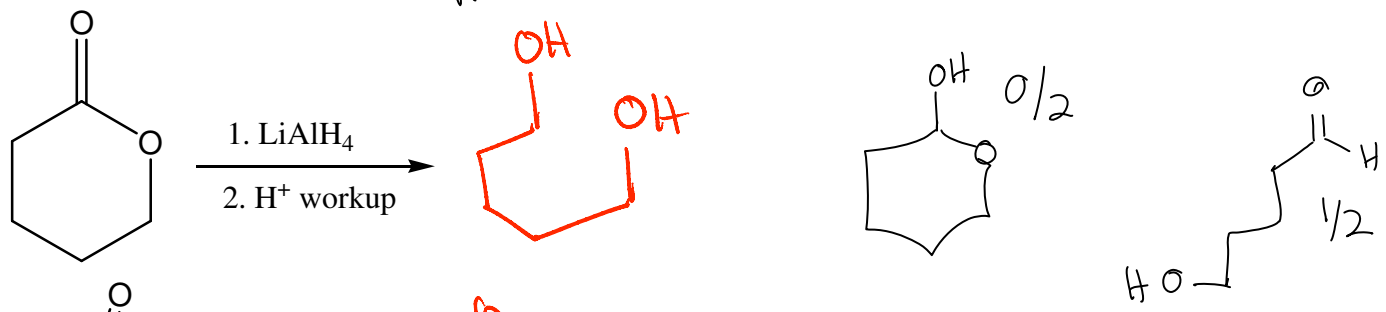
Question 4 (10 marks) 2 marks each

Predict the major product(s) of the following reactions.

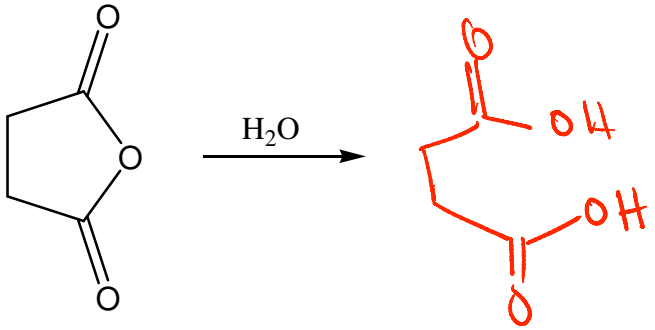
a)



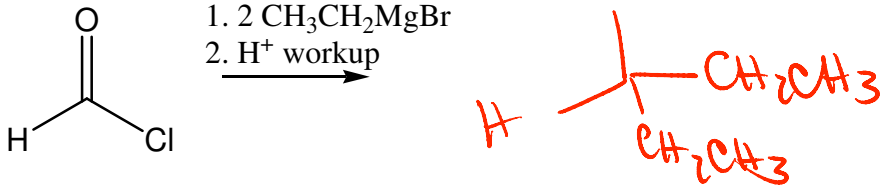
b)



c)

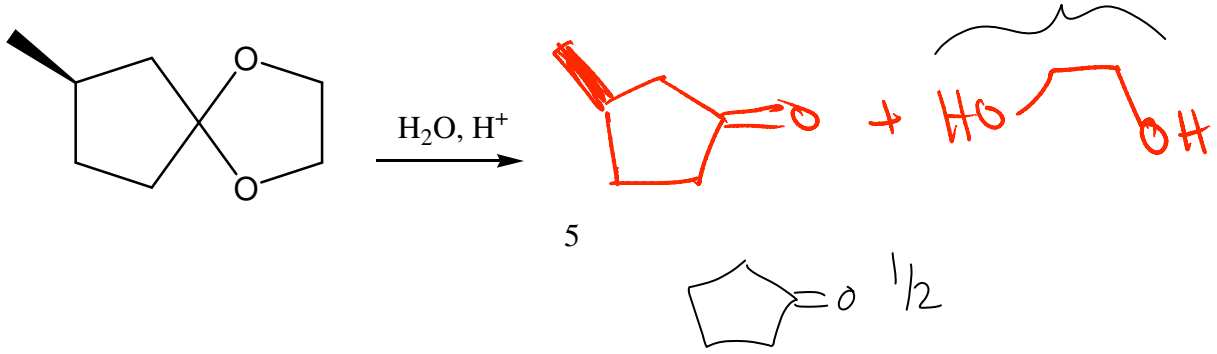


d)



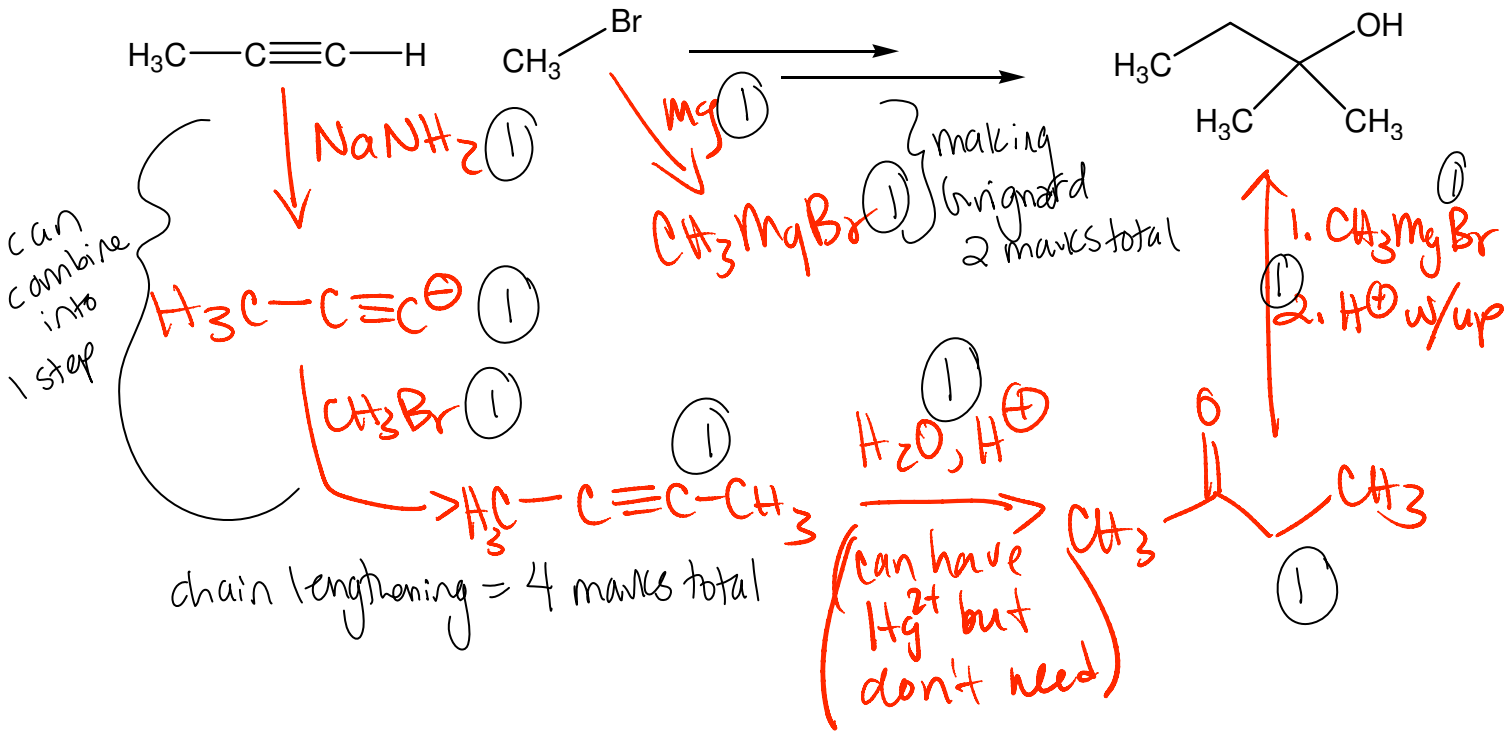
do not need to include.

e)



Question 5 (8 marks)

a) Using methylbromide as your only other carbon source, show how you would carry out the following multi-step synthesis. Show all reagents and products for each step. You DO NOT need to show a detailed mechanism or stereochemistry.



If no #s CH_3MgBr } 1/2
H+ workup

Question 6 (11 marks)

Propose a detailed step-by-step mechanism for the following reaction. Draw the hemi-acetal intermediate in the box below, and show all electron movement arrows, formal charges, and intermediates.