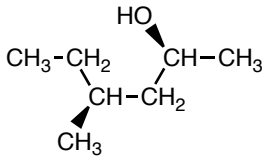
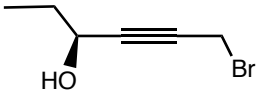
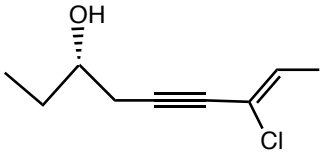
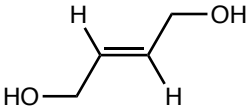
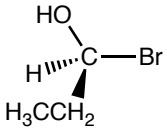
Provide a IUPAC name for the following compounds. Be sure to use cis/trans, E/Z or R/S *as appropriate (non-bonding electrons are not shown)*

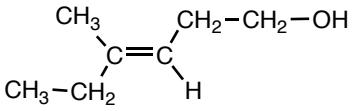
a) 

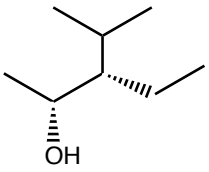
b) 

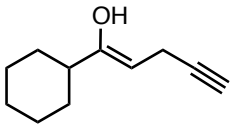
c) 

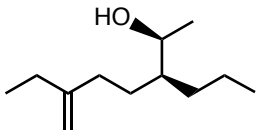
d) 

e) 

f) 

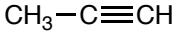
g) 

h) 

i) 

Rank the following in order as requested. Give a BRIEF explanation.

a) increasing Bronsted acidity



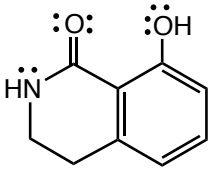
A

B

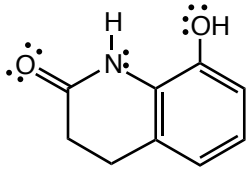
C

___ < ___ < ___

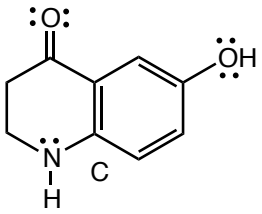
b) increasing Bronsted acidity of the -OH group



A



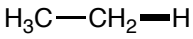
B



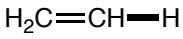
C

___ < ___ < ___

c) increasing bond dissociation energy of the bond in **BOLD**

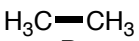


A



B

C

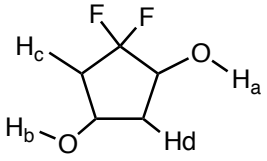


D

___ < ___ < ___ < ___

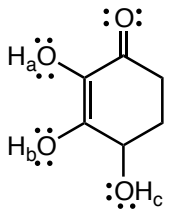
Rank the order requested, give a BRIEF explanation

a) Increasing Bronsted acidity of the hydrogens Ha, Hb, Hc and Hd



___ < ___ < ___ < ___

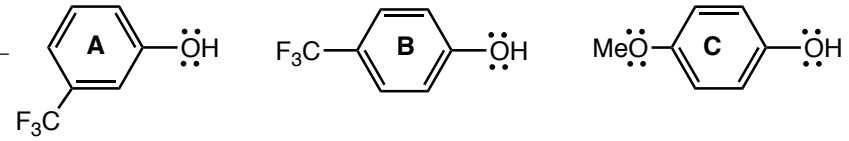
b) Use resonance arguments to rank the following hydrogens Ha, Hb and Hc in order of increasing Bronsted acidity



___ < ___ < ___

c) Use resonance arguments to rank the following in order of increasing Bronsted acidity

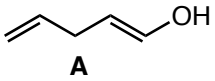
___ < ___ < ___



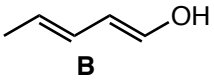
rank in order of increasing Bronsted acidity, give a BRIEF explanation

a) (ignore keto tautomers)

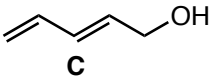
___ < ___ < ___



A



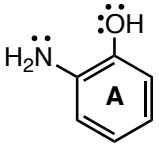
B



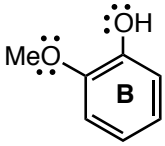
C

b)

___ < ___ < ___



A



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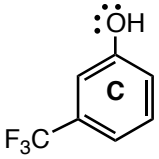
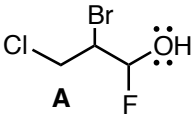


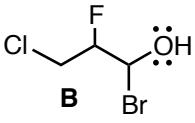
C

c)

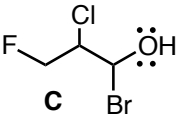
___ < ___ < ___



A

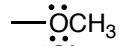
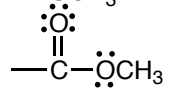
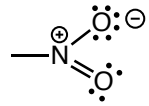
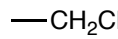
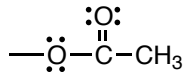
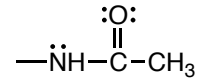


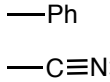
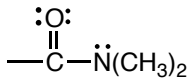
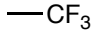
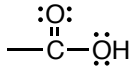
B



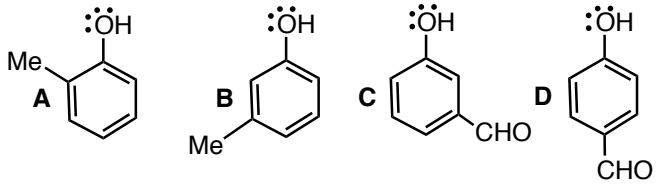
C

a) Classify the following, when as substituents on a benzene ring, as electron donating or withdrawing

	donating	withdrawing
	donating	withdrawing
	donating	withdrawing
	donating	withdrawing
	donating	withdrawing
	donating	withdrawing

	donating	withdrawing
	donating	withdrawing
	donating	withdrawing
	donating	withdrawing
	donating	withdrawing

b) Rank the following in order of increasing Bronsted acidity and give a BRIEF explanation (hint, convert the condensed -CHO into a full Lewis structure)



__ < __ < __ < __

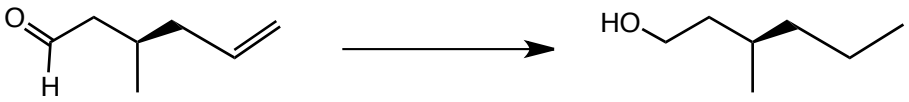
lowest acidity highest acidity

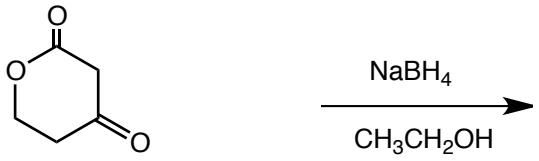
In each case, fill in the missing product, reagents or reactants. Note that non-bonding electrons are generally not shown in these structures.

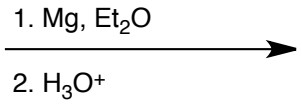
UNLESS INDICATED, pay attention to relative and absolute stereochemistry as appropriate. If several (more than 2) chiral centers are involved you will usually NOT be asked to indicate stereochemistry since such reactions often form mixtures of enantiomers of diastereomers.

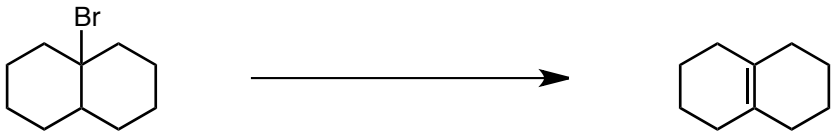
When the REACTANT structure is missing, there may be more than one possible correct answer, but there will always be a reaction

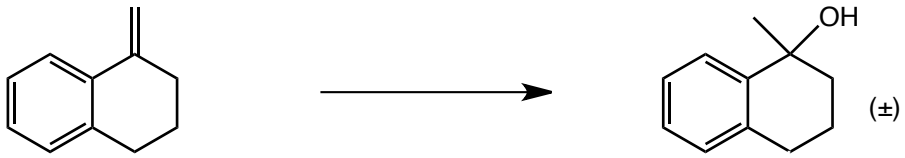
State whether EACH reaction is an **oxidation, reduction** or **neither**
State whether EACH reaction is an addition, elimination, substitution or rearrangement

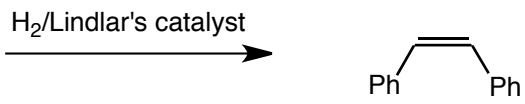
a) 

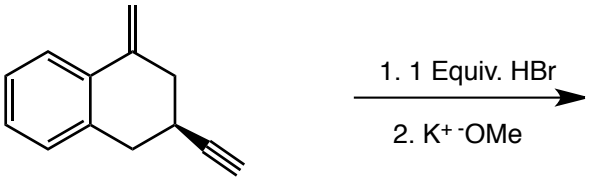
b) 

c) $CH_3\text{-}CH_2\text{-}CH_2\text{-}CH_2\text{-}Br$ 

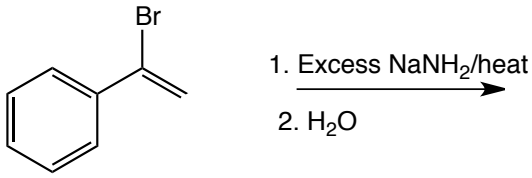
d) 

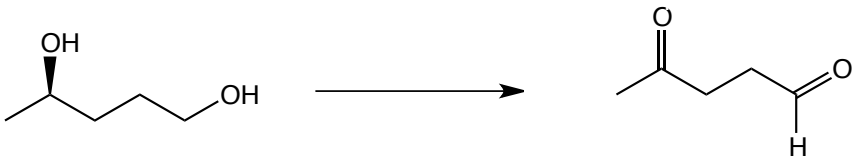
e) 

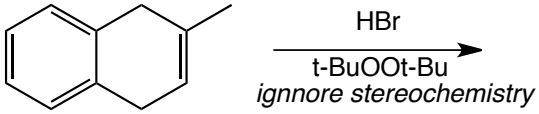
f) 

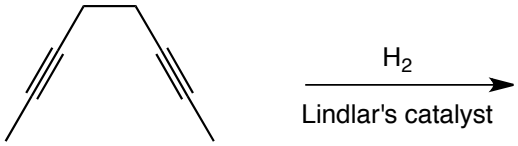
g) 

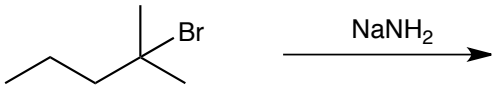
same instructions as previous page

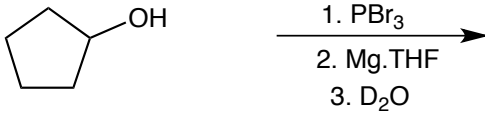
a) 

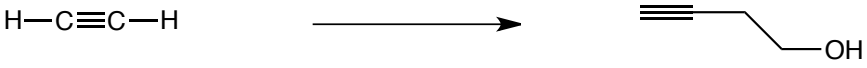
b) 

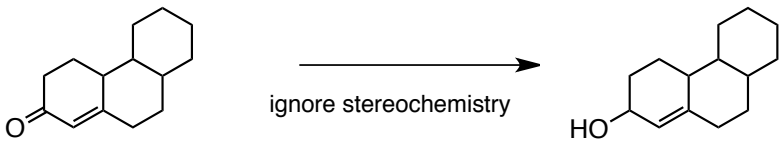
c) 

d) 

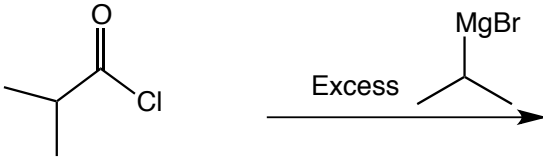
e) 

f) 

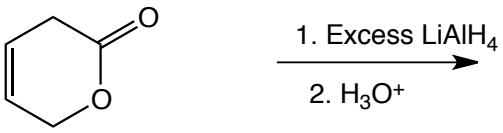
g) 

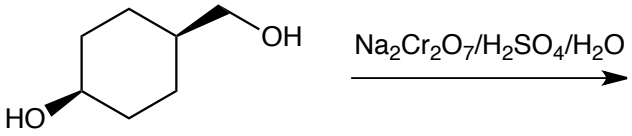
h) 

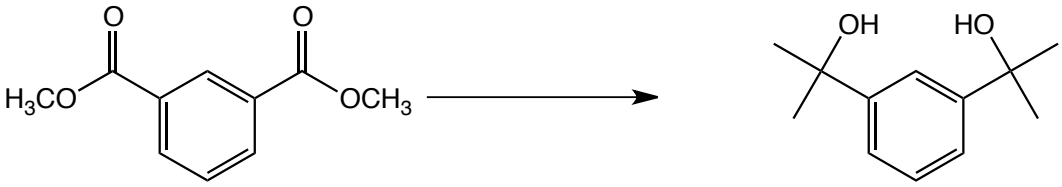
same instructions as previous pages
EXCEPT DO NOT INDICATE REACTION TYPE OR OX/RED for the problems on this page!!

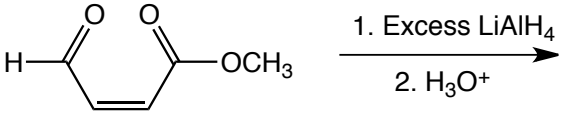
a) 

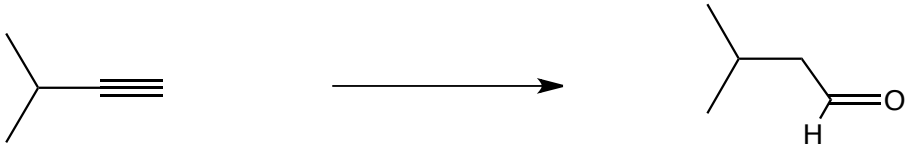
b) $CH_3CH_2C{\equiv}CH \longrightarrow CH_3CH_2\overset{O}{\overset{\|}{C}}CH_3$

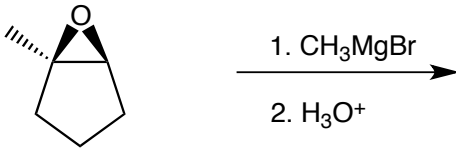
c) 

d) 

e) 

f) 

g) 

h) 

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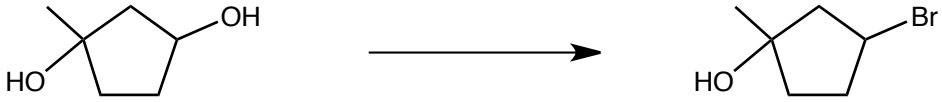
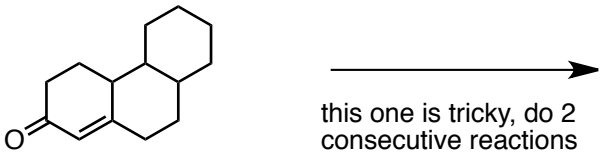
a) 

b) 

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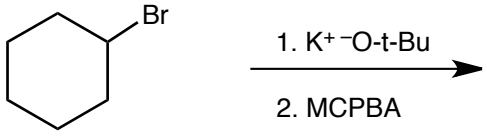
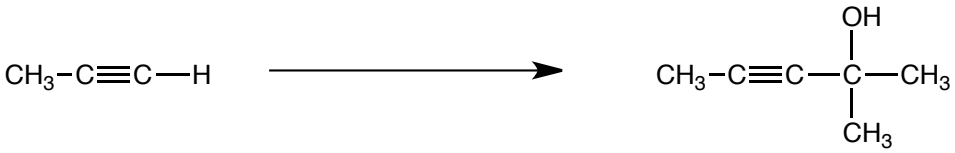
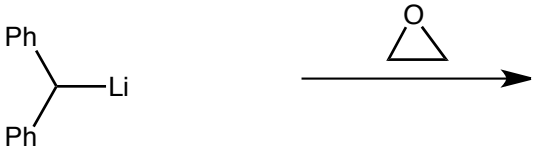
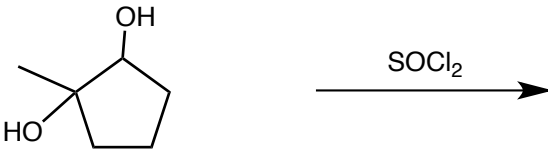
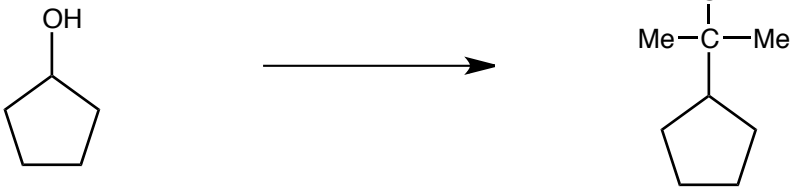
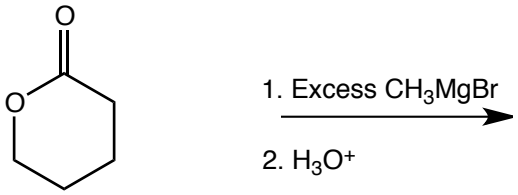
c) 

d) 

e) 

f) 

g) 

h) 

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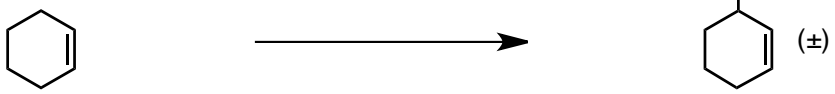
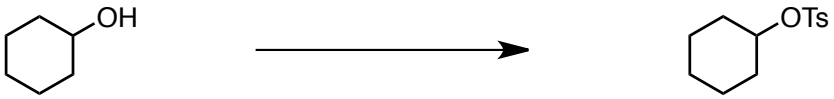
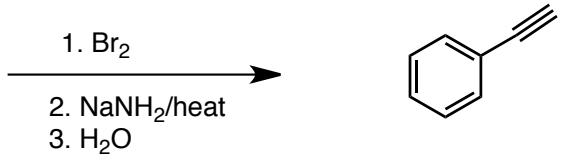
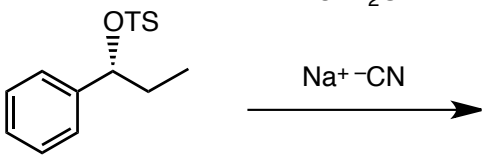
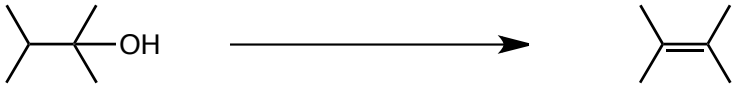
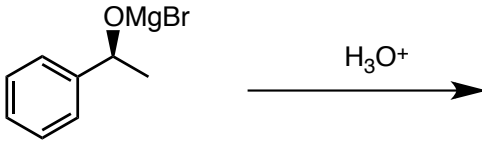
a) 

b) 

c) 

d) 

e) 

f) 

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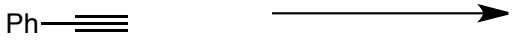
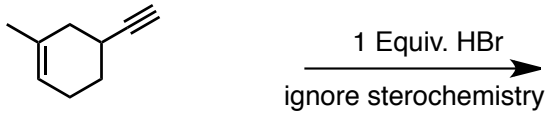
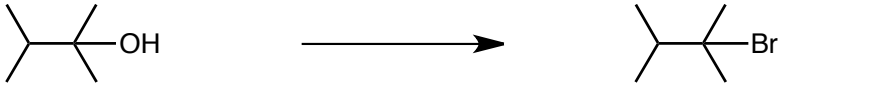
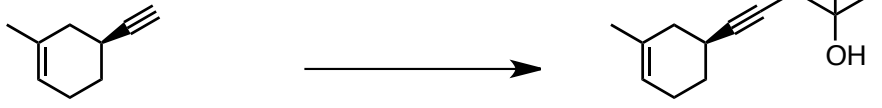
h) 

i) 

j) 

k) 

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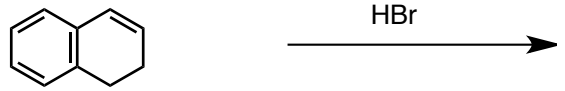
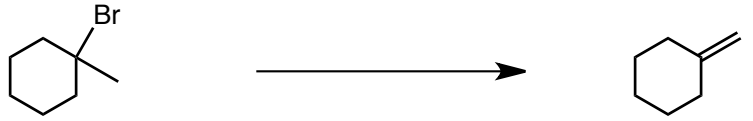
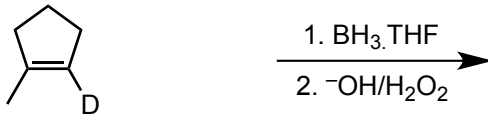
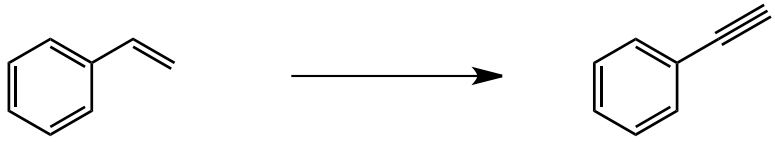
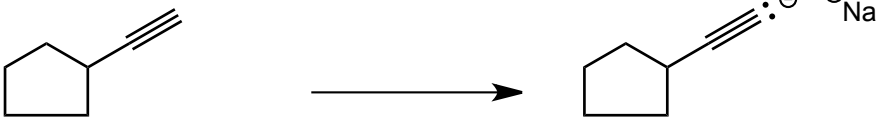
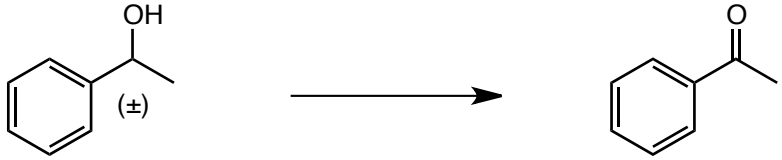
a) 

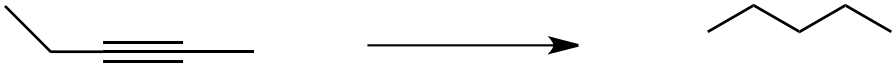
b) 

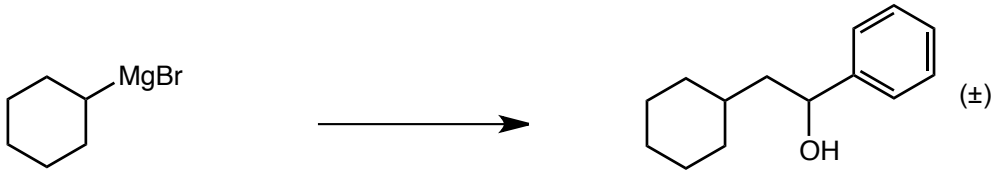
c) 

d) 

e) 

e) 

f) 

g) 

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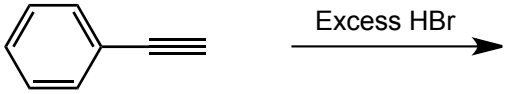
i) 

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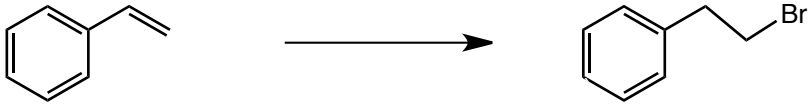
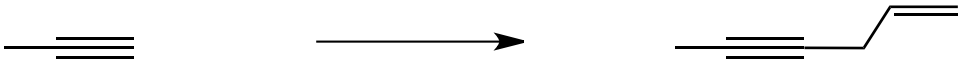
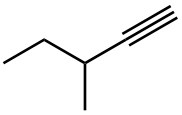
a) 

b) 

c) 

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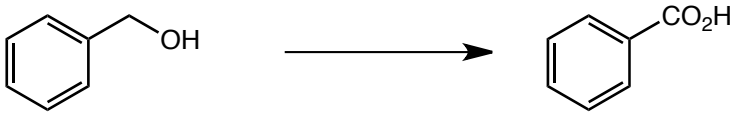
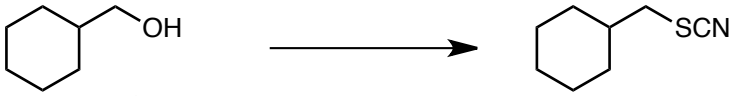
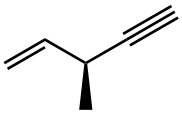
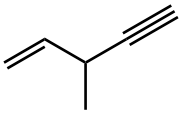
e) 

f) 

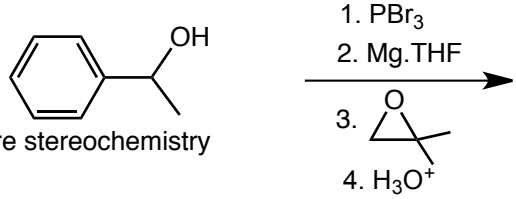
hint, use tosylate

g) 

h) 

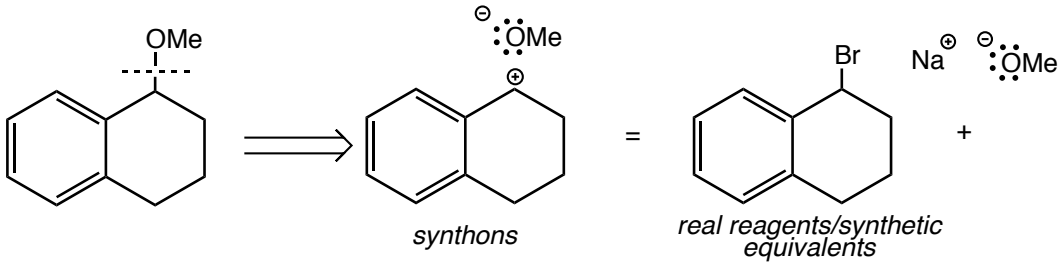
ignore stereochemistry

i) 

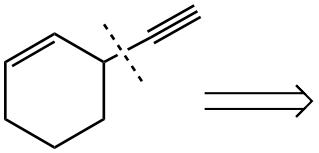
j) 

ignore stereochemistry

disconnect the indicated bond according to the method of retrosynthetic analysis, generate the synthons and convert these into "real reagents", or "synthetic equivalents". The first one is done for you so that you can see what to do.



a)



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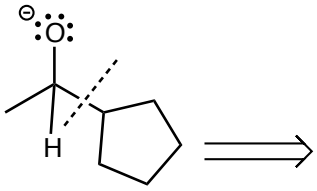

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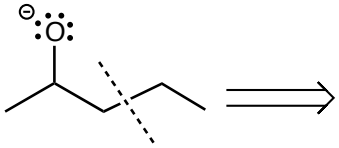

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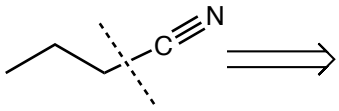

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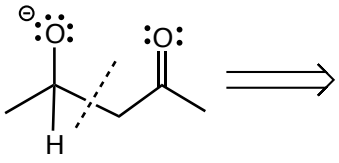
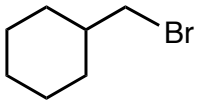
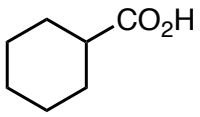
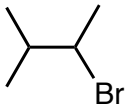
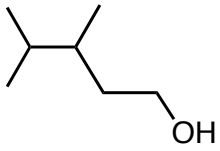


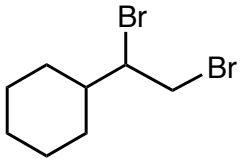
The following retrosynthesis problems can be done in only two steps, they are simpler than you will find on the midterms, they are to build confidence (ignore sterochemistry)

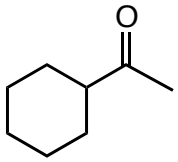
a) 

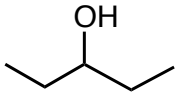


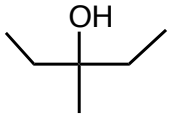
b) 

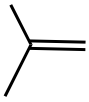
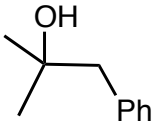


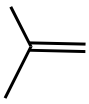
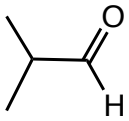
c) 



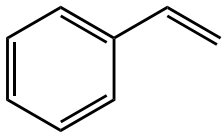
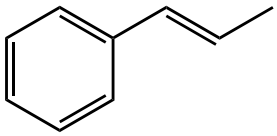
d) 

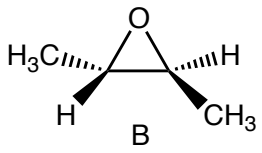


e) 


f) 


Synthesize the (target) molecule on the right from the starting molecule the left. this can not be done in one reaction. Give reagents and conditions and the intermediate molecules at each step. Do not show any mechanisms or transient intermediates.

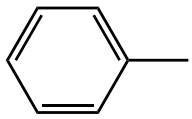
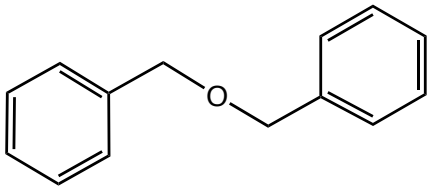
a)  

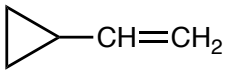
b) HC≡CH A do NOT ignore stereochemistry 

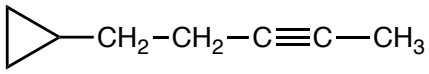
B

Synthesize the (target) molecule on the right from the starting molecule the left. this can not be done in one reaction. Give reagents and conditions and the intermediate molecules at each step. Do not show any mechanisms or transient intermediates.

a) CH_3-CH_2OH $CH_3-CH_2-CH_2-CH_2OH$

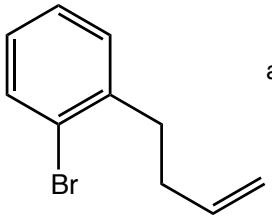
b)  

c) 

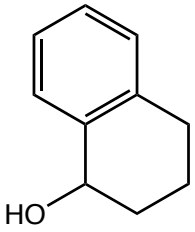


Synthesize the (target) molecule on the right from the starting molecule the left. this can not be done in one reaction. Give reagents and conditions and the intermediate molecules at each step. Do not show any mechanisms or transient intermediates.

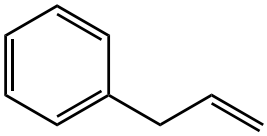
a)

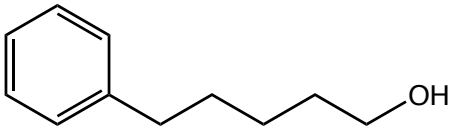


this one is tricky, the last step is an intramolecular Grignard, do the Grignard backwards at the last step to see how to solve this one (ignore stereochemistry)

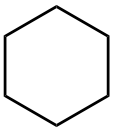


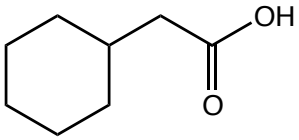
b)





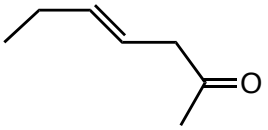
c)

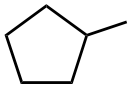
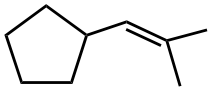


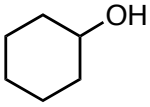


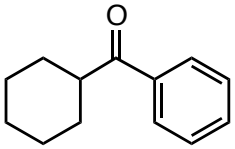
Synthesize the (target) molecule on the right from the starting molecule the left. this can not be done in one reaction. Give reagents and conditions and the intermediate molecules at each step. Do not show any mechanisms or transient intermediates.

These problems are considered difficult

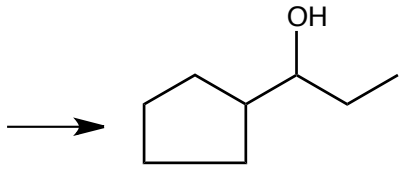
a)  do NOT ignore stereochemistry 

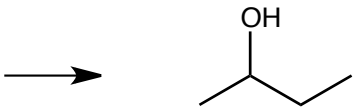
b)  

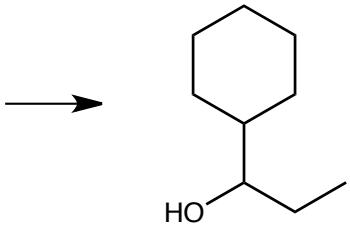
c) 



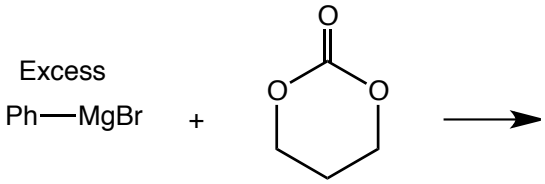
In each case, provide TWO DIFFERENT SETS of reactants that when they undergo a Grignard reaction give the provided structure as the product (after acid workup). In each case there are more than two possible answers, but only 2 answers will be provided in the answer key



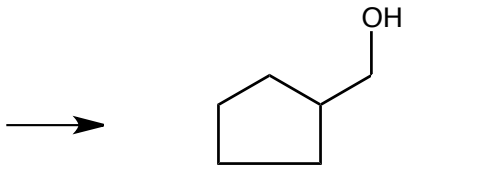


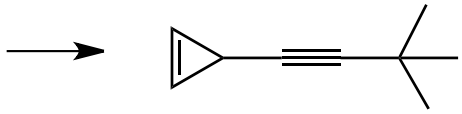


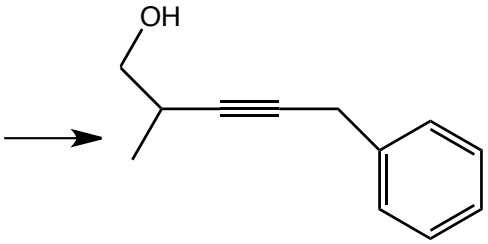
Give the product of addition of this Grignard reagent to this cyclic compound, after workup with dilute aqueous acid (addition of H_3O^+.

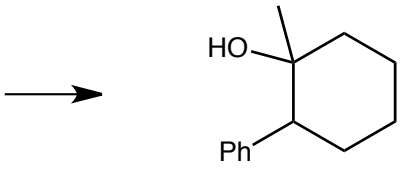


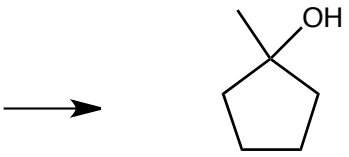
In each case, provide ONE SET of reactants/reagents/conditions that can react to make a new C-C bond for each provided structure (an acid workup step can be assumned, if necessary, you do not need to include it). In each case there may be more than two possible answers, but only 1 is shown here





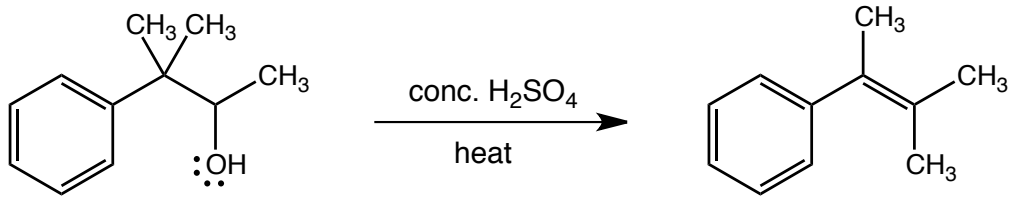




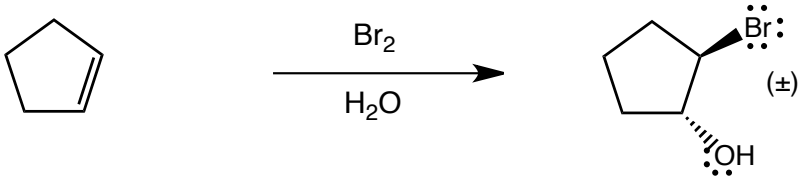


Provide detailed (arrow pushing) mechanisms for the following transformations. Where appropriate, indicate the Lewis acids and bases for each step, and whether they are also Brønsted acids and bases (LB/BA, LA/BA etc.)
Add non-bonding electron pairs and C-H bonds as necessary

a)



b)



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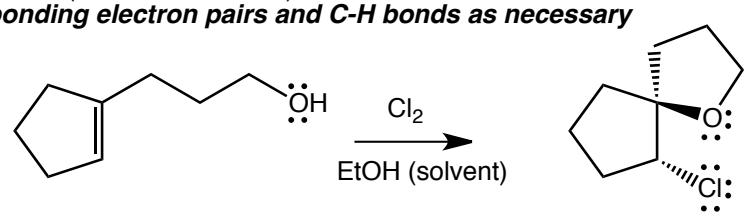
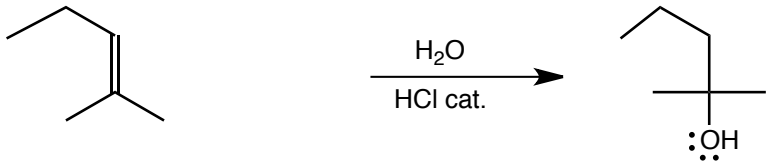
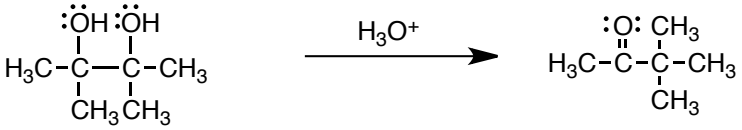


b)



In this case, draw important resonance structures for all intermediates

c)



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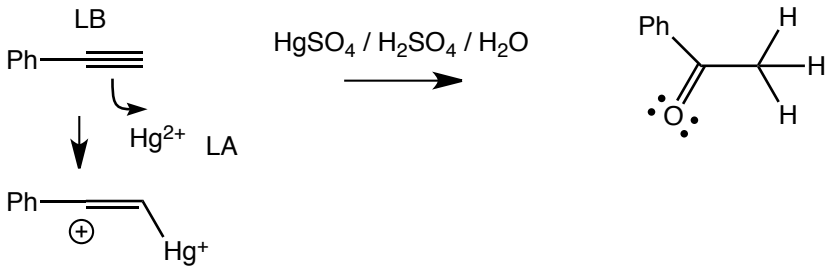
Add non-bonding electron pairs and C-H bonds as necessary

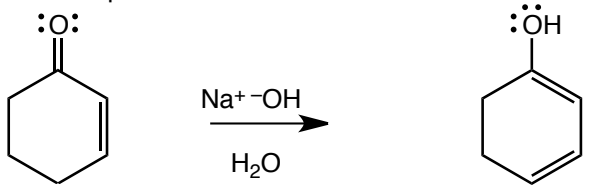
In this case draw all important resonance structures for the intermediates, this mechanism has been started fo ryou

a)



In this case draw all important resonance structures for the intermediates

b)



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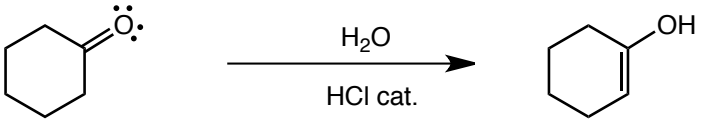
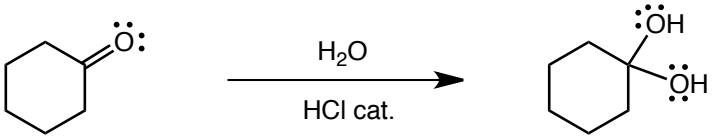
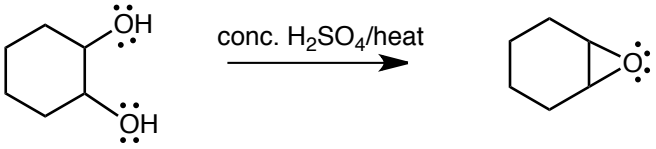
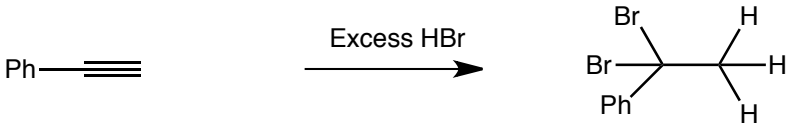
a) 

b) 

c) 

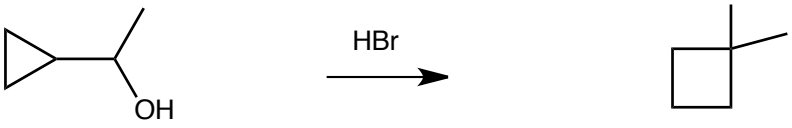
Give the curved-arrow pushing mechanism for the following reaction, at each step identify the Lewis acid/Lewis Base (LA/LB), indicate whether any reaction is also a Brønsted acid/base reaction(BA/BB). Draw a reaction energy diagram for the mechanism, clearly indicating the relative energies of all the intermediates, starting material, product. Do not draw any transition states BUT INDICATE THEIR POSITIONS ON THE DIAGRAM. Do not draw resonance contributors for the intermdiates.



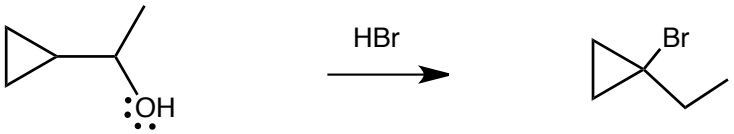
Provide detailed (arrow pushing) mechanisms for the following transformations. Where appropriate, indicate the Lewis acids and bases for each step, and whether they are also Brønsted acids and bases (LB/BA, LA/BA etc.)
Add non-bonding electron pairs and C-H bonds as necessary

these are a little bit tricky, but use what you know about LA/LB reactions and cation rearrangements to solve them

a)

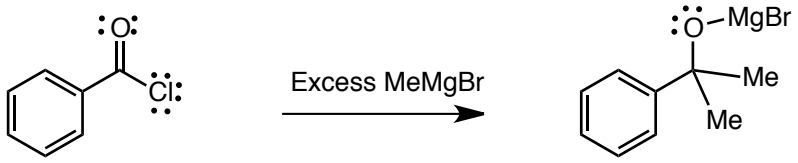


b)

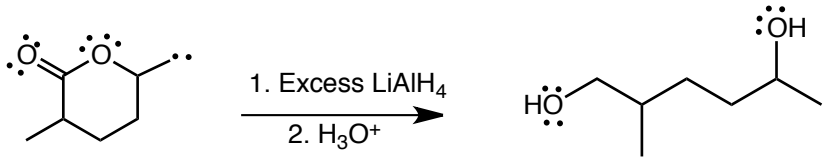


Provide detailed (arrow pushing) mechanisms for the following transformations. Where appropriate, indicate the Lewis acids and bases for each step, and whether they are also Brønsted acids and bases (LB/BA, LA/BA etc.)
Add non-bonding electron pairs and C-H bonds as necessary

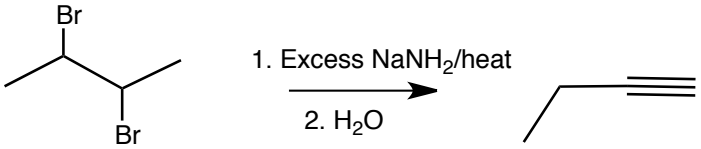
a)



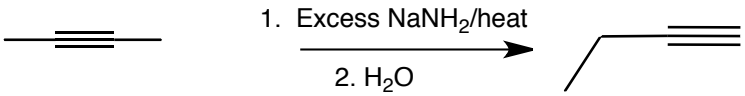
b)



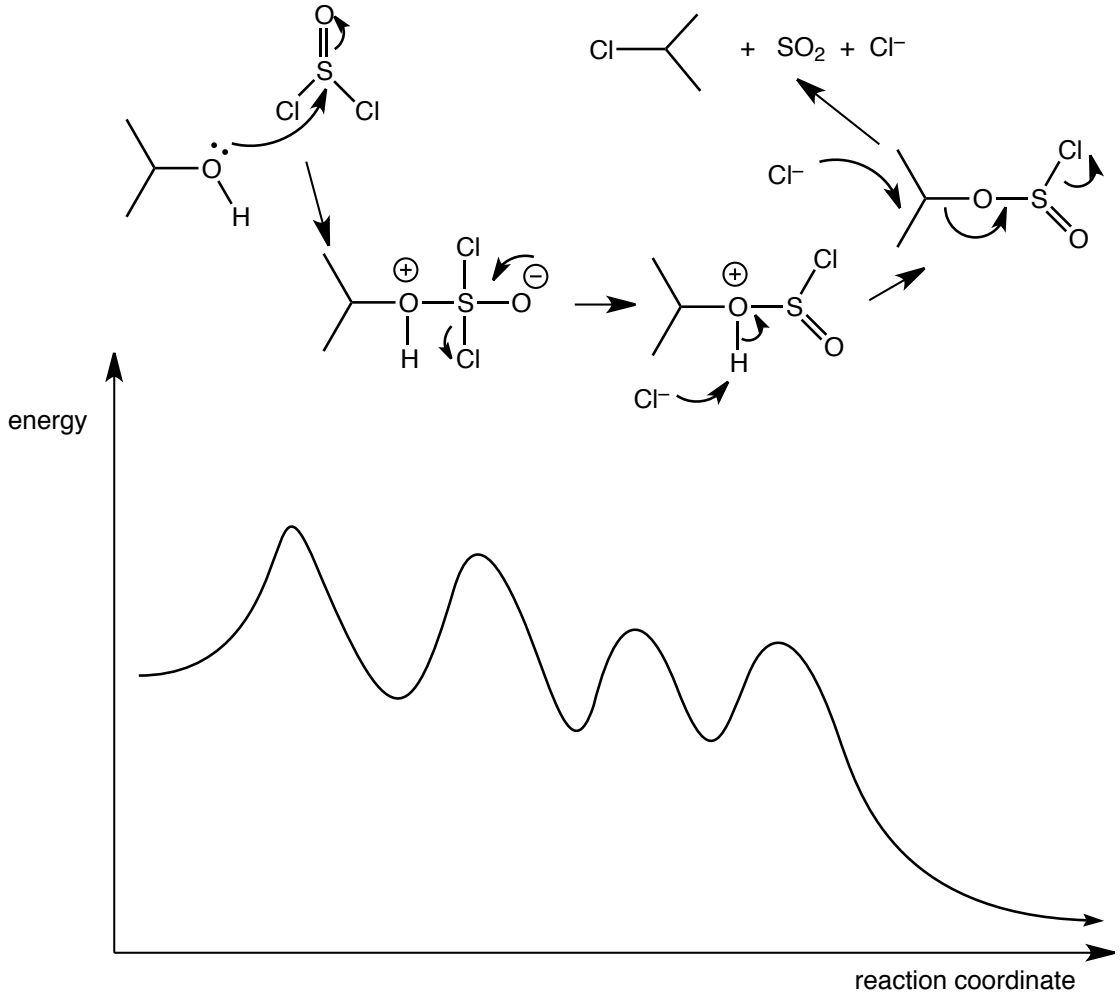
In class we learned that dehydrohalogenation of a dibromide is only useful for preparation of a terminal alkyne, in fact the following reaction occurs.....



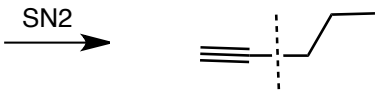
the internal alkyne is formed initially, but it isomerizes to the terminal alkyne, as shown below. Give a mechanism for this isomerization. Solve the problem using the strategy we talked about in class, look at what C-H bonds you have to break and which you have to make, and simply do them in the correct order! It will be helpful to use the common trick of adding the hydrogens to the line-angle formula before you start. Remember that you are in the presence of a strong base, so you should do a DEprotonation first. In the presence of a base, you are unlikely to have any positively charged intermediates. Draw the important resonance contributors for any intermediates. Finally, it will be helpful to note that the amide anion catalyzes the reaction, it is not consumed overall.

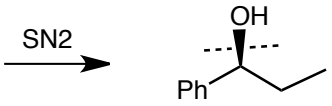


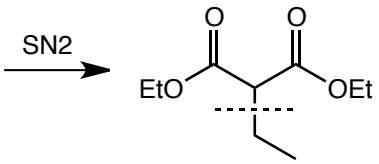
For each step in the following mechanism as appropriate, identify the Lewis acid/Lewis Base (LA/LB) and indicate whether each is also a Brønsted acid/base reaction(BA/BB). Identify each step as either an S_N1, S_N2, E1, E2, addition, elimination, protonation or deprotonation. Draw a reaction energy diagram for the overall process. Identify the locations of the starting structures, the products and the intermediates on the provided energy diagram and provide a drawing of each transition state and indicate their locations on the diagram.

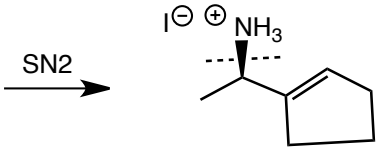


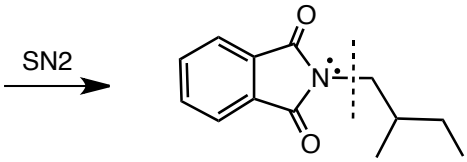
Provide detailed reactants that can be used to make the indicated bonds (dashed line) in an SN2 reaction. Unless the leaving group is implied in the product, the leaving group can be either bromide, iodide or tosylate, your choice (my answers will interchange among these randomly to remind you that you can use more than just bromide), you do not have to specify the solvent, it doesn't matter which counterion you use, but if you need one you must specify an example one

a) 

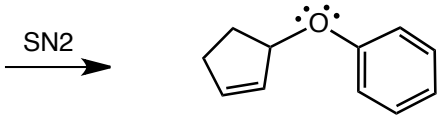
b) 

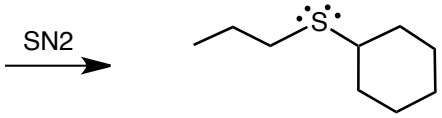
c) 

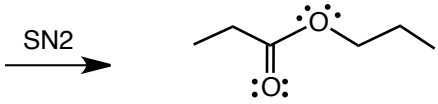
d) 

e) 

Give the reactants to synthesize the provided structures in an SN2 reaction. One of the bonds in each structure is the obvious one to make in an SN2 reaction, in these problems you will have to decide which it is

f) 

g) 

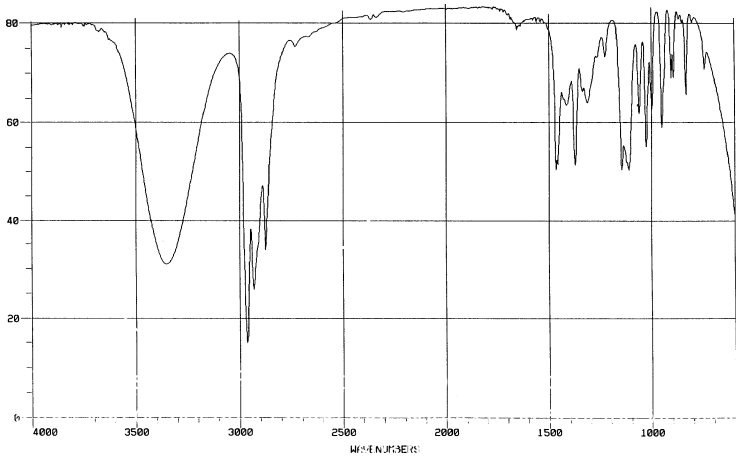
h) 

THIS IS THE FORMAT OF THE SPECTRUM QUESTION YOU WILL SEE ON AN EXAM

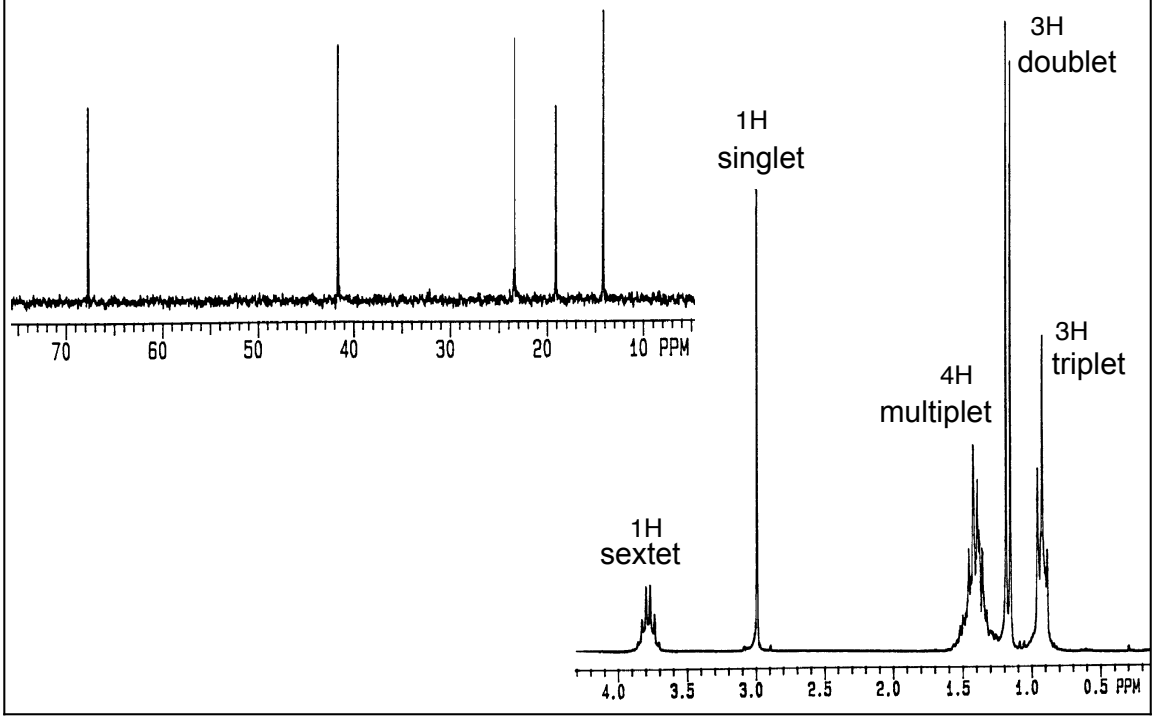
Provided are spectra for a compound with molecular formula **$C_5H_{12}O$**

a) Give the degrees of unsaturation _____

b) On the infrared spectrum, indicate the peaks that identify the functional groups in the molecule (including C(sp^3)-H). Indicate **BOTH the functional group**, and where appropriate, **the specific BOND** in the functional that corresponds to the peak**.**



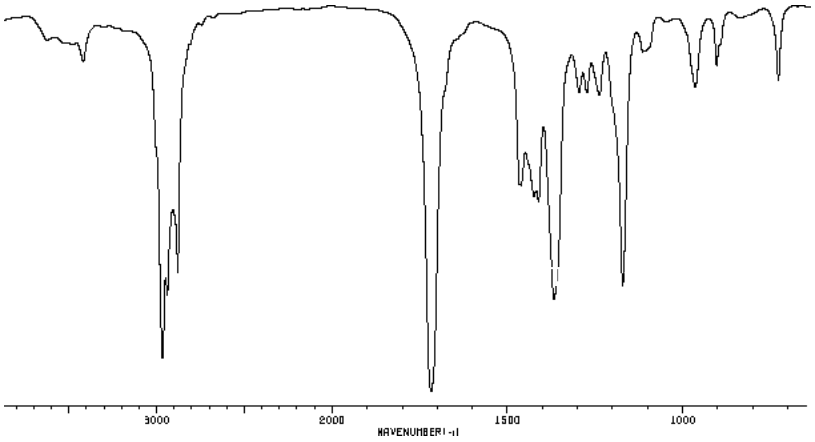
c) draw the structure and clearly indicate which hydrogens correspond to which signals **in the proton nmr spectrum ONLY**



Provided are spectra for a compound with molecular formula **$C_5H_{10}O$**

a) Give the degrees of unsaturation _____

b) On the infrared spectrum, indicate the peaks that identify the functional groups in the molecule (including C(sp^3)-H). Indicate **BOTH the functional group**, and where appropriate, **the specific BOND** in the functional that corresponds to the peak**.**



c) draw the structure and clearly indicate which hydrogens correspond to which signals **in the proton nmr spectrum ONLY**