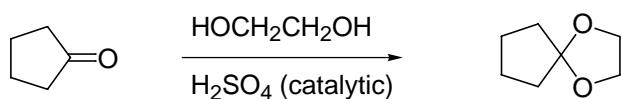
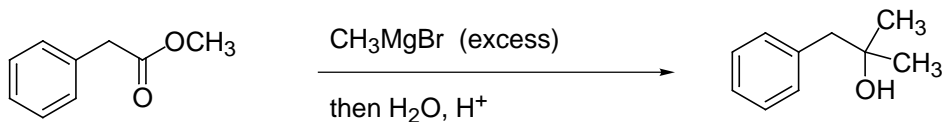


Predict the major organic product of the following reactions. Be sure to indicate stereochemistry where appropriate. 3 points each

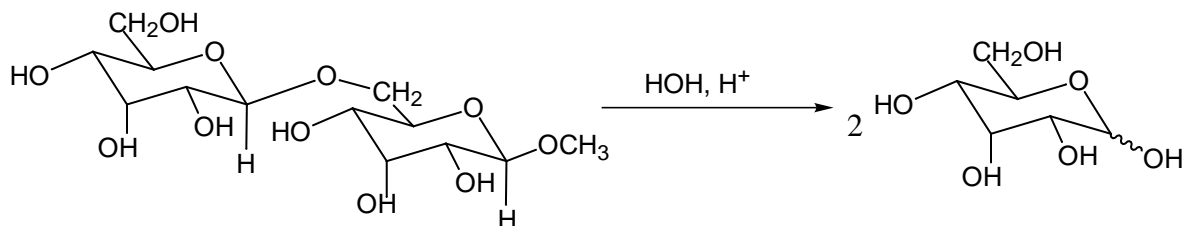
1.



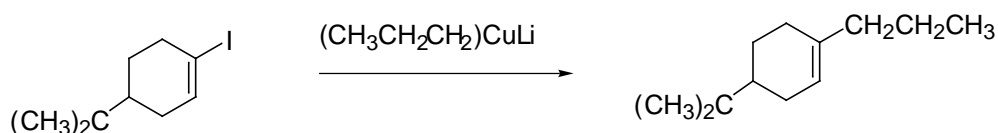
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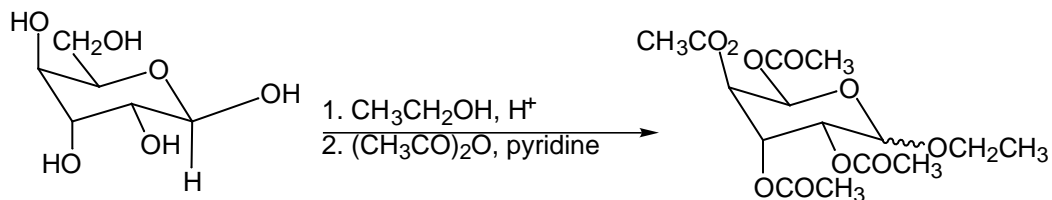
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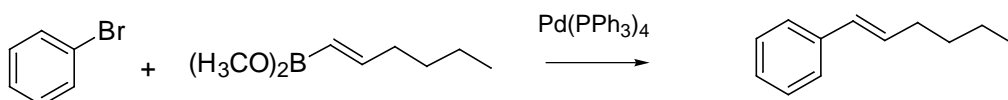
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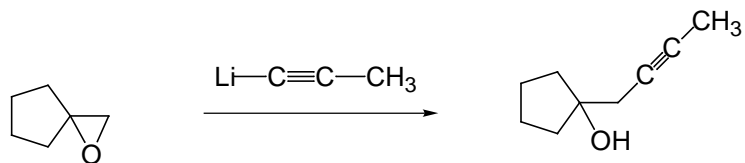
5.



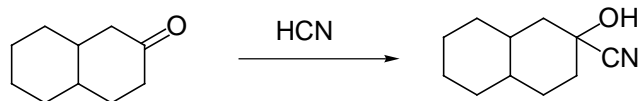
6.



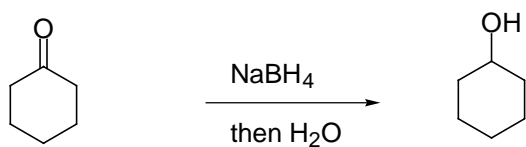
7.



8.

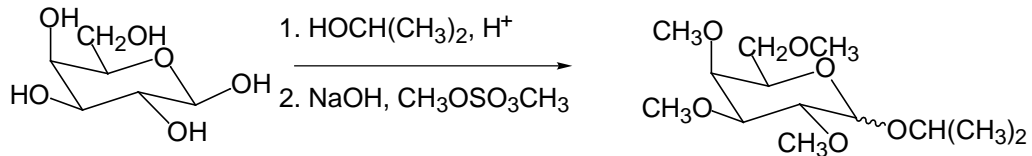


9.

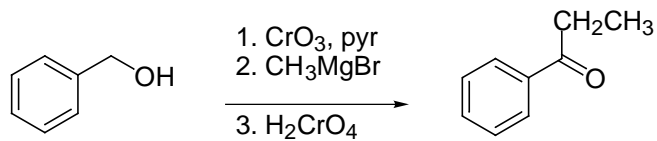


Give reagents to carry out the following transformations. Some may require more than one step. 3 points each

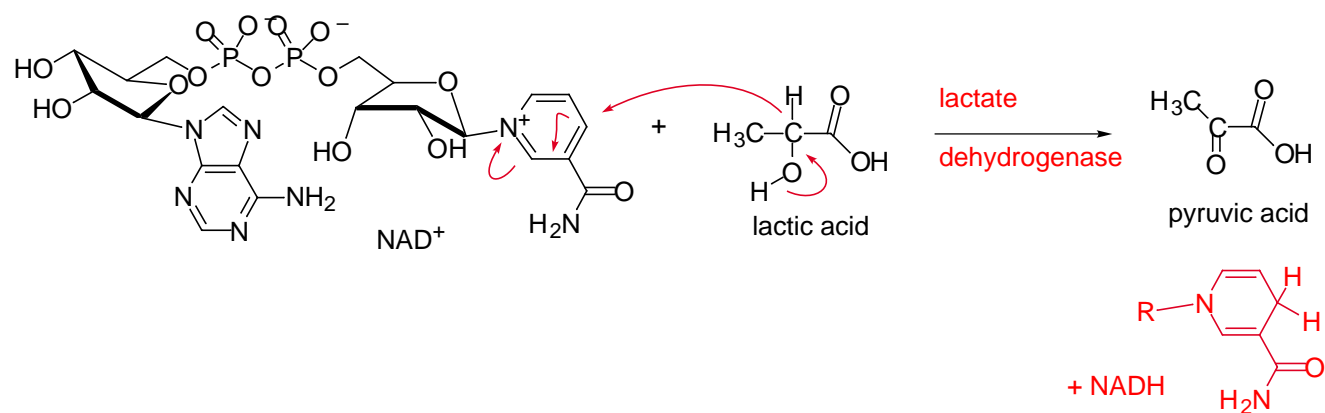
10.



11.

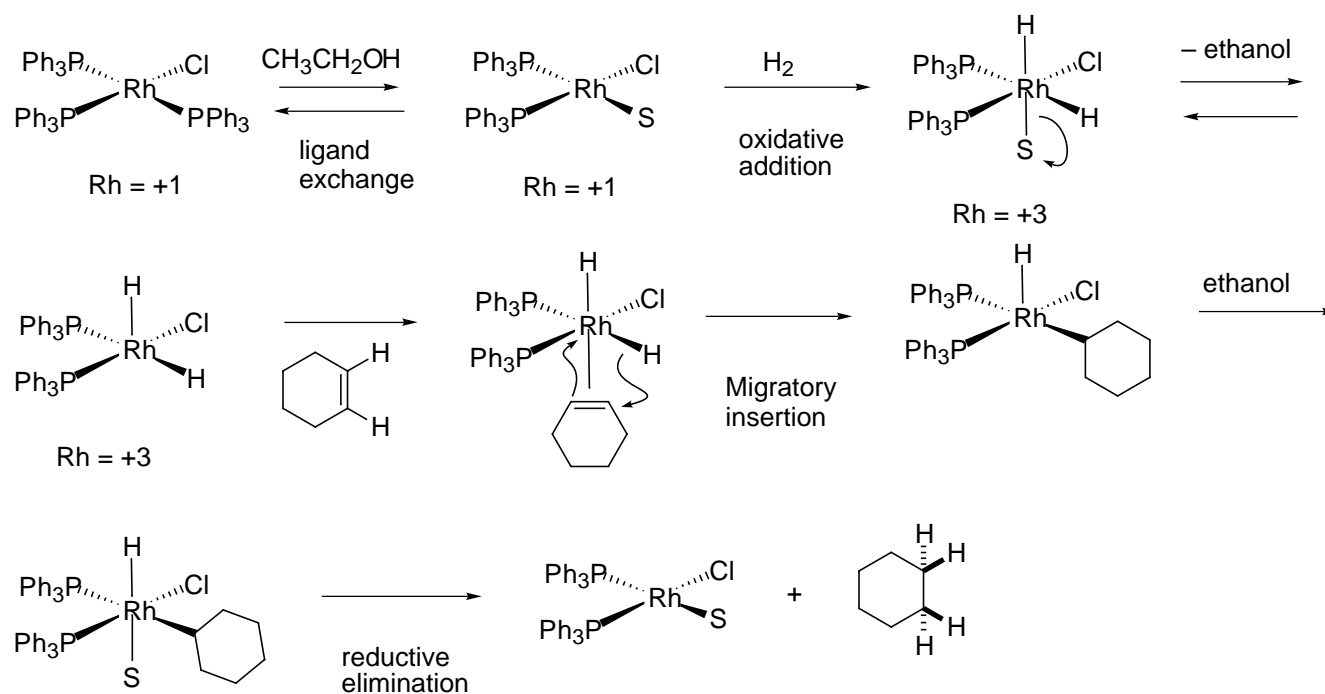


12. Give a mechanism to explain how NAD⁺ acts to convert lactic acid to pyruvic acid. 5 points.

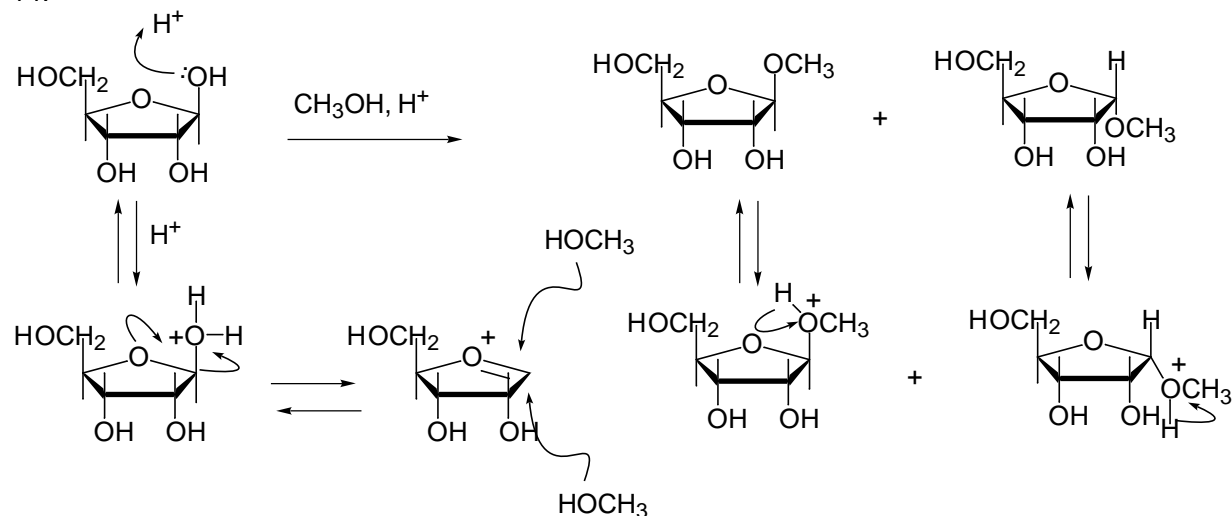


Give a stepwise, detailed mechanism with arrows and intermediates for each of the following reactions. 5 points each).

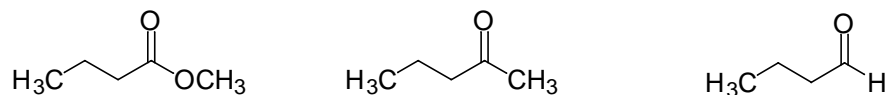
13.



14.



15. Rank the following in order of decreasing reactivity toward nucleophilic attack. (1 = most, 2 = next, 3 = least reactive) and briefly explain. (5 points).



rate of attack depends on the positive charge on the carbonyl carbon and the steric hindrance at the carbonyl carbon. aldehyde is the most positive and the least hindered, ketone is slightly less positive because of inductive donation of the additional methyl group and is also more hindered, the ester is the least positive of the three carbonyl carbons because of inductive donation of the lone pairs on the methoxy oxygen.

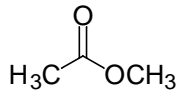
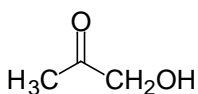
16. Consider the reactions below. In each case, circle the species which will predominate at equilibrium and briefly explain. (5 points).



The more highly positive the carbonyl carbon, the more the hydrate is favored since the carbonyl is destabilized. Also, the more sterically hindered the carbonyl, the less favored is the hydrate due to steric interactions. So, in trifluoroacetone, the hydrate is more favored because of a very electrophilic carbonyl. Conversely, in acetone, the ketone is favored since the two methyl groups donate electron density to reduce the positive charge on the carbonyl carbon and the hydrate is sterically disfavored.

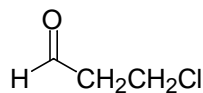
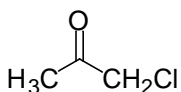
Consider each of the following pairs of structures. What differences in the spectroscopic data (IR, MS, NMR) would you expect to see to allow you to differentiate the two structures and what would you look for? 2 points each

17.



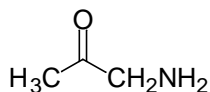
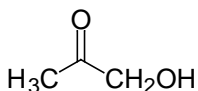
molecule on left would show an OH stretch at about 3500 cm^{-1} in IR, molecule on right would not

18.



molecule on left would show two singlets in the NMR, molecule on right would show triplet at about 9 ppm for the aldehyde proton and two triplets for the CH_2CH_2

19.



amine would have an odd mass in the mass spec and the two molecules would have different masses

Give a one sentence definition/description of each of the following (2 points each):

20. oxidative addition:

reaction of a transition metal in which the coordination number and the oxidation state of the metal are increased by 2.

21. base peak:

the largest peak in the mass spec which corresponds to the most abundant ion.

22. mutarotation

process by which a carbohydrate which is a single anomer undergoes conversion to a mixture of anomers by ring opening and ring closing through equilibrium of the cyclic hemiacetal with the open chain aldehyde