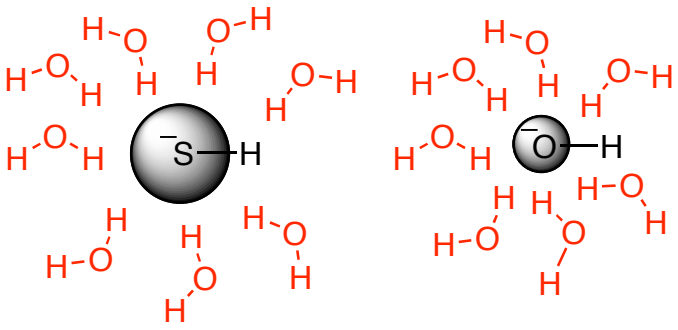
1. For each pair shown below, circle the structure that best fits the description and provide an explanation for your selection. *Note:* some explanations may require illustrations to receive full credit. (21 points)

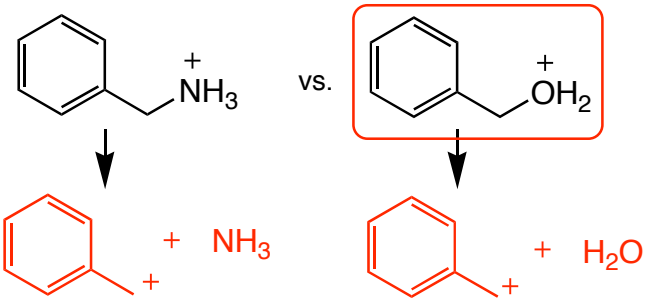
Gives the faster S_N2 reaction in a polar protic solvent

Na SH vs. Na OH



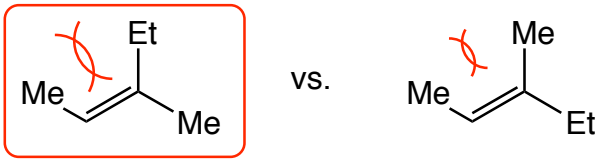
Hydroxide is more electronegative and will thus have a tighter sphere of hydration. The sulfur anion is less negative and more polarizable. It can more easily escape its sphere of hydration and act as a nucleophile. Since the rate of S_N2 reactions are dependent on the ability of the nucleophile to reach the substrate, HS^- will yield the faster reaction.

Gives the faster S_N1 reaction?



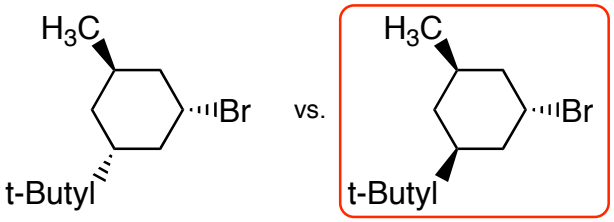
The faster reaction will come from the substrate with the better leaving group. The better leaving group is the less basic species (least reactive base). The pKa of H_2O is 15.7 while the pKa of NH_3 is 35. Therefore, H_2O is the weaker base and thus the better leaving group.

Releases more energy upon hydrogenation?

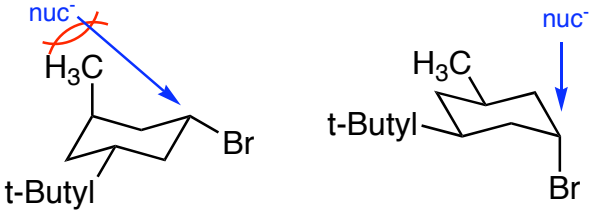


The ethyl group will cause more steric strain in the (Z) isomerbecause ehtyl is slightly larger than methyl. This makes the (Z) isomer less stable. It will thus release more energy upon hydrogenation, because it starts off higher in energy than the (E) isomer.

Gives the faster S_N2 reaction?

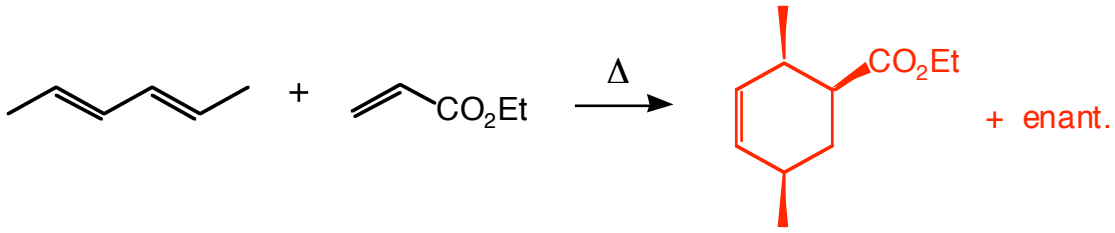


The first molecule presents more steric hindrance to the approaching nucleophile as shown in its most stable conformation. The second molecule does not present any steric hindrance to the nucleophile and therefore should react faster.

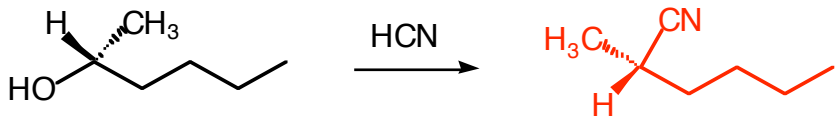


2. Predict the major organic product of each of the following reactions. (26 points)

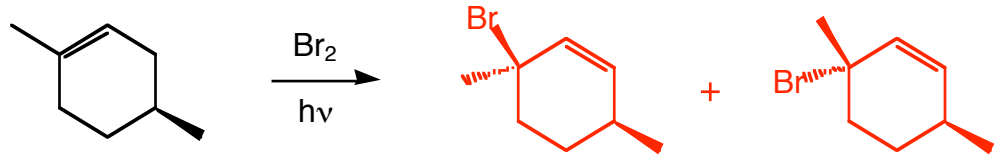
(a)



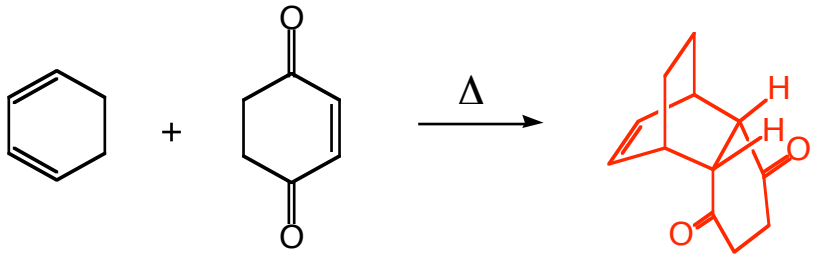
(b)



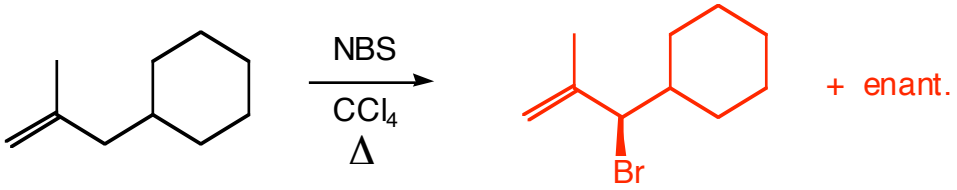
(c)



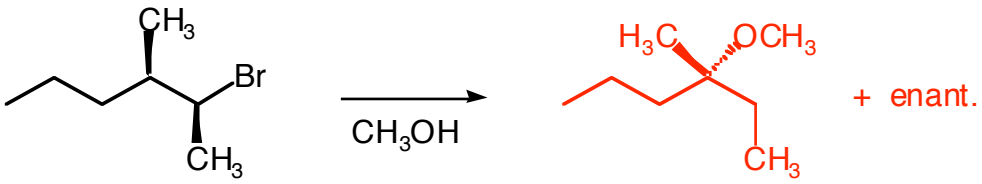
(d)



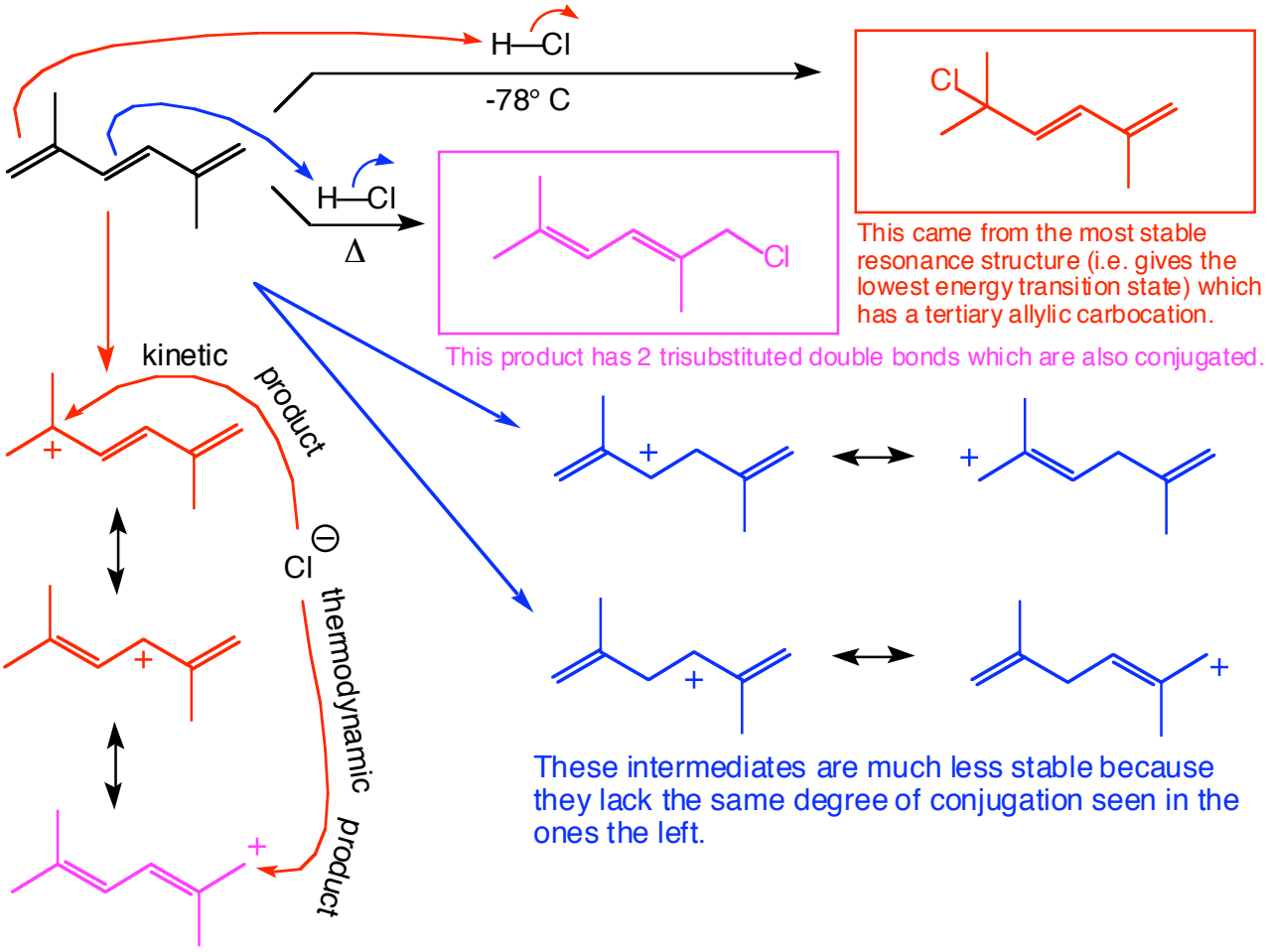
(e)



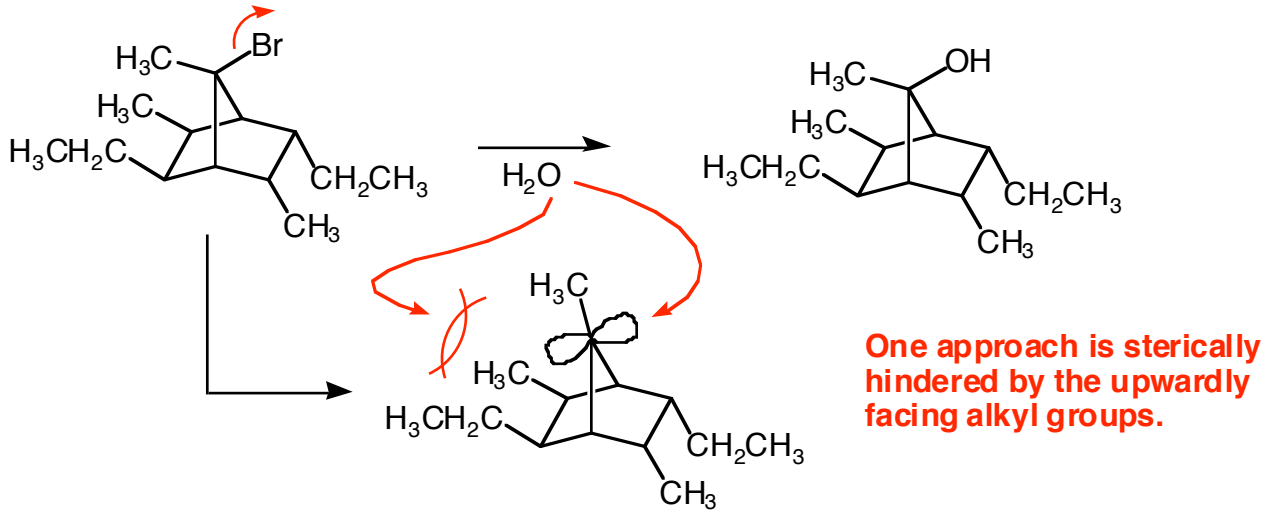
(f)



3. Determine the kinetic and thermodynamic products of the following reaction. Provide a mechanism that shows all *relevant* resonance structures and briefly explain why the products are favored. (12 pts)



4. The following substitution reaction occurs via an S_N1 pathway. However, unlike most S_N1 reactions, a racemic mixture is *not* formed. Instead, one enantiomer predominates. Predict this product and use pictures and words to explain this phenomenon. (8 points)



5. Provide a synthesis for each of the following transformations. You must show the products of each step for full credit. (20 points)