

1. Which of these reactions has an enol intermediate?

B

- a. Anti-Markovnikov hydration of an alkene
- b. Anti-Markovnikov hydration of an alkyne
- c. Reduction of an alkyne using H<sub>2</sub> and Lindlar's catalyst
- d. Nucleophilic addition of an acetylide ion to formaldehyde
- e. Ozonolysis

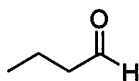
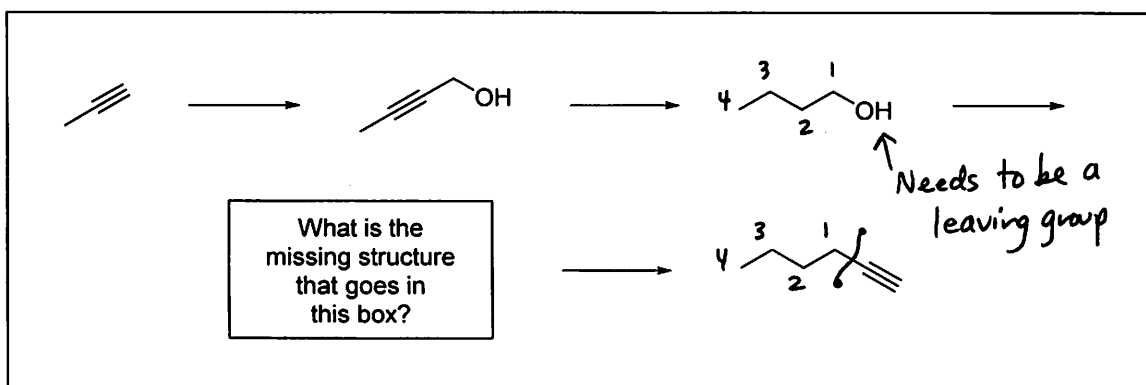
2. Which of these bases would not quantitatively deprotonate acetylene?

B

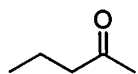
- a. NaH
- b. NaOH
- c. BuLi
- d. LDA
- e. Neither NaH nor NaOH would quantitatively deprotonate acetylene

3. In this multi-step synthesis, what is the most likely choice for the missing intermediate?

C



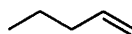
A



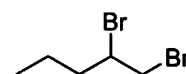
B



C

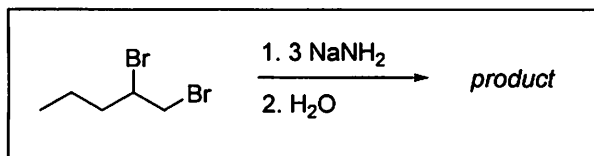


D

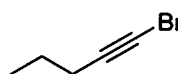
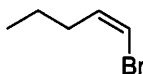
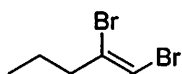
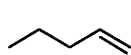


E

4. Which of these structures is an intermediate in the reaction described in the box?



C



None of these structures is an intermediate in the reaction

A

B

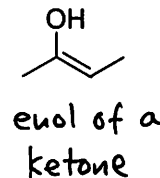
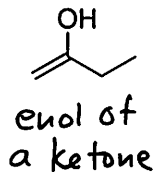
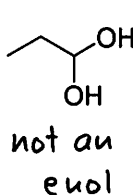
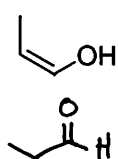
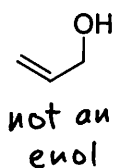
after one E2 occurs  
C

D

E

5. Select the structure that is the enol of an aldehyde.

B



A

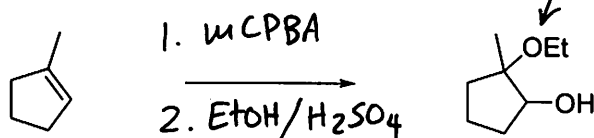
B

C

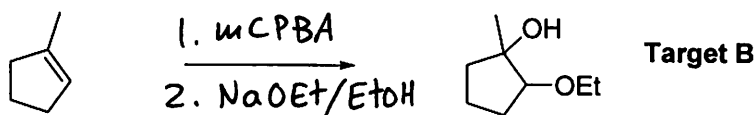
D

E

6. Here are two multi-step syntheses:



OEt on more substituted C suggests nucleophilic attack by EtOH on this: H

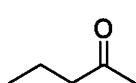
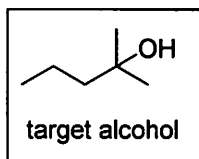


In which of these synthetic pathways is there a protonated epoxide?

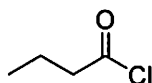
- a.  Synthesis of Target A  
 b.  Synthesis of Target B  
 c.  Both syntheses  
 d.  Neither synthesis

7. Which of the following structures is NOT a precursor to the target alcohol? ("Precursor" means you can make the alcohol in one synthetic step from the compound.)

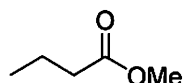
E



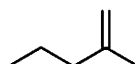
A  
+ MeLi  
then  $H_3O^+$



B  
+ 2 MeLi  
then  $H_3O^+$



C  
+ 2 MeLi  
then  $H_3O^+$



D  
+ 1.  $Hg(OAc)_2, H_2O$   
2.  $NaBH_4$

All of these compounds are precursors to the alcohol

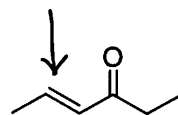
(E)

8. Which of these reagents is NOT used to make a carbonyl compound?

A

- a. mCPBA Epoxide formation from alkene  
b.  $HgSO_4, H_2SO_4, H_2O$   
c.  $(Sia)_2BH$ , then  $H_2O_2, HO^-, H_2O$   
d.  $O_3$ , then DMS  
e.  $O_3$ , then  $H_2O_2$

9. Consider this multi-step synthesis:



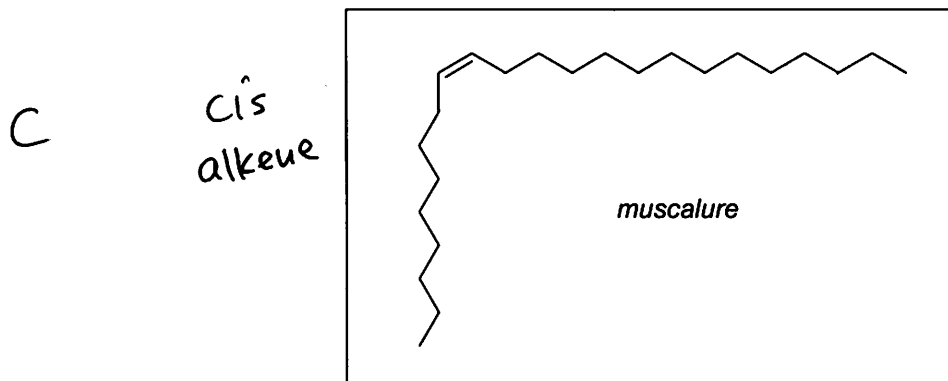
trans alkene: So far we have only one method to make this

Which of the following reagents, based on the chemistry you know so far, must be used at some point in this synthesis?

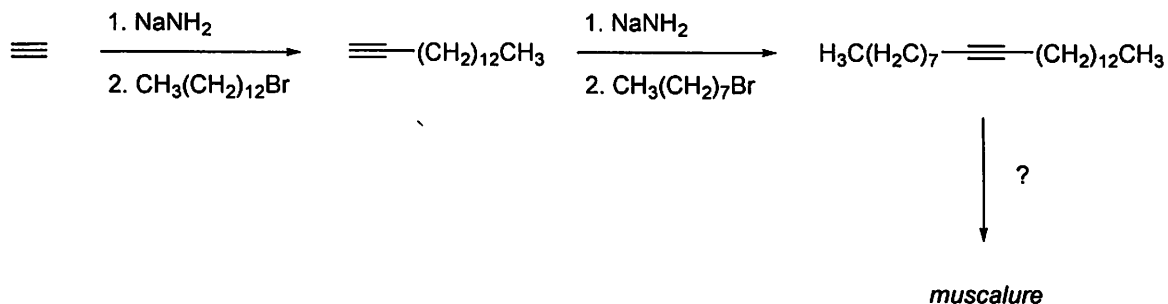
C

- a. Jones reagent ( $H_2CrO_4$ , acetone, water) — Can use PCC  
b.  $H_2$  and Pd — not needed in this synthesis  
c. Na,  $NH_3$   
d.  $NaNH_2$  — could use LDA, BuLi or NaH  
e. mCPBA — not needed in this synthesis

10. Bees use a form of motion called a "waggle dance" to communicate information to other bees about locations of pollen, water, or housing. The "waggle dance" involves flying in a particular pattern and direction. During the dance, a bee releases chemicals including the insect sex pheromone (9Z)-9-tricosene (muscalure). The structure of muscalure is shown here.



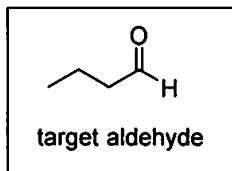
Muscalure can be synthesized according to the following scheme:



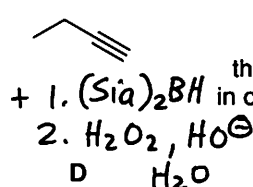
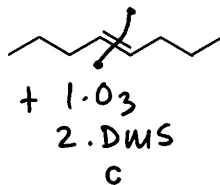
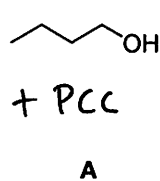
What is/are the missing reagent(s) in the last step?

- Na, NH<sub>3</sub>
- H<sub>2</sub>, Pd
- H<sub>2</sub>, Lindlar catalyst
- H<sub>2</sub>SO<sub>4</sub>, HgSO<sub>4</sub>, H<sub>2</sub>O
- None of the above

11. From which of these compounds can the target aldehyde NOT be made in one synthetic operation (including workup)?



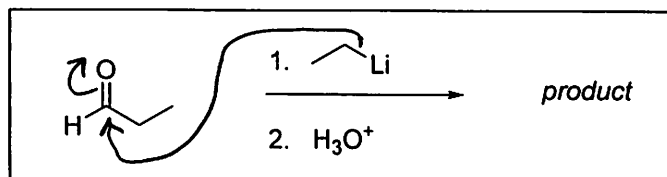
B



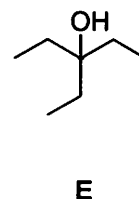
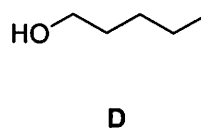
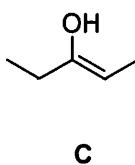
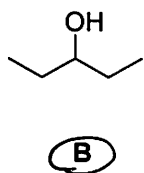
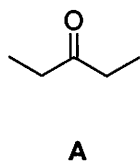
The aldehyde can be made from any of these compounds in one synthetic step

E

12. Select the structure that is the product of these reaction conditions.

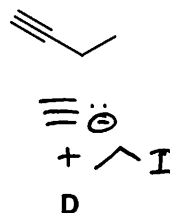
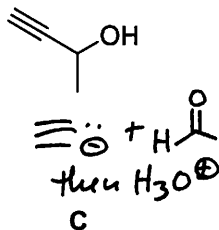
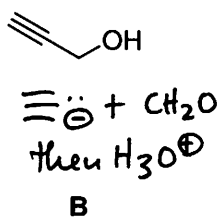
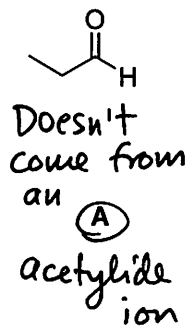


B



13. Which of these target molecules cannot be made in one step using an acetylide ion?

A



All of these compounds can be made from an acetylide ion

E

14. Which reagent would you use to convert 1-hexyne to hexanal?

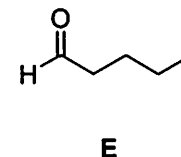
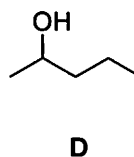
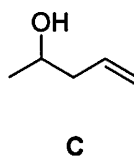
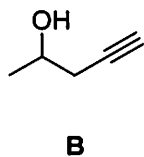
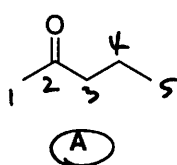
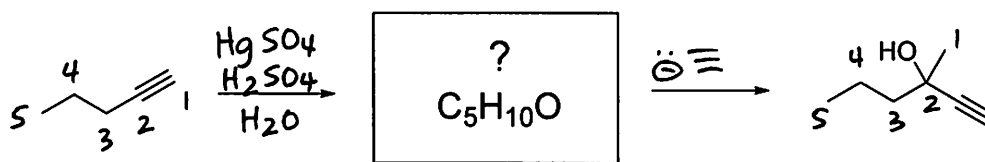


D

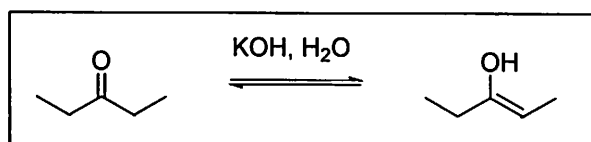
- a. Na, NH<sub>3</sub>
- b. H<sub>2</sub>, Pd, BaSO<sub>4</sub>, PbOAc, quinoline
- c. MMPP
- d.** (Sia)<sub>2</sub>BH, then H<sub>2</sub>O<sub>2</sub>, HO<sup>-</sup>, H<sub>2</sub>O
- e. H<sub>2</sub>CrO<sub>4</sub>, acetone, water

15. A compound with molecular formula C<sub>5</sub>H<sub>10</sub>O can be synthesized from the alkyne shown in one synthetic operation. This same compound can then be used to synthesize the alcohol at the right in one synthetic operation. What is the structure of the compound?

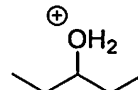
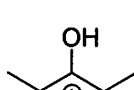
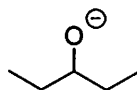
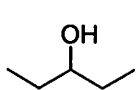
A



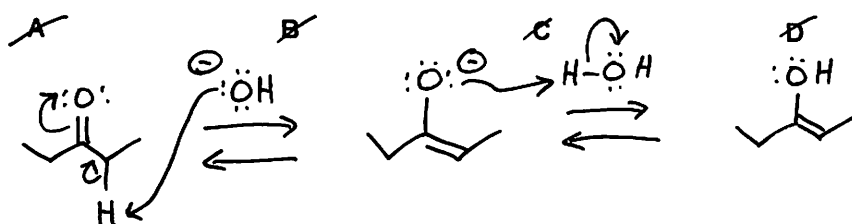
16. Select the structure that is a mechanistic intermediate in the tautomerization of this ketone in aqueous base.



E

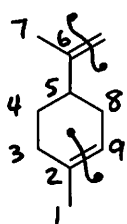
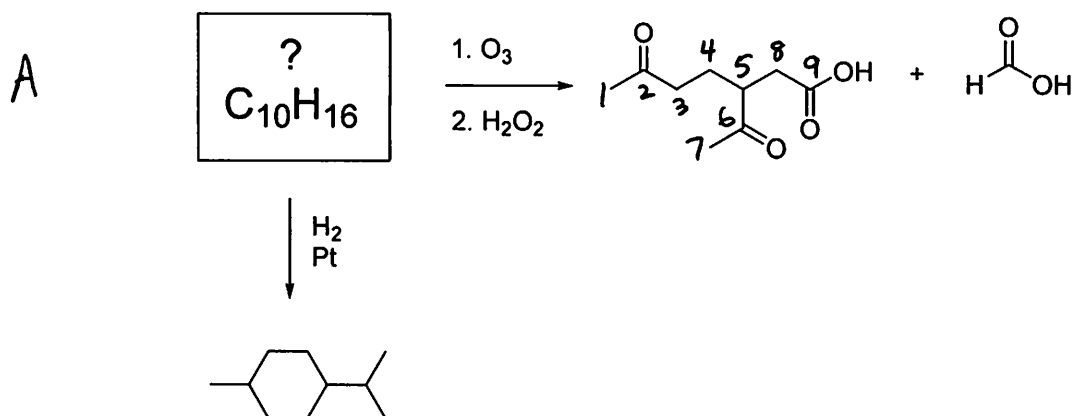


None of these structures are mechanistic intermediates

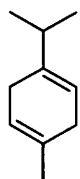


**E**

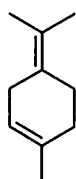
17. A compound with formula  $C_{10}H_{16}$  gives 1-isopropyl-4-methylcyclohexane when treated with hydrogen gas over platinum. The same compound produces the structure shown to the right, plus formic acid ( $HCOOH$ ), when treated with ozone followed by hydrogen peroxide workup. What is the structure of the compound?



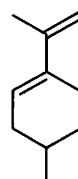
(A)



B



C



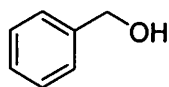
D

None of these

E

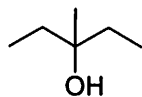
18. Which of these alcohols could be made from hydroboration-oxidation of an alkene?

C

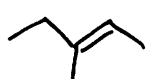


~~A~~

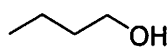
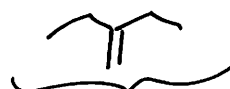
Could not have come from an alkene



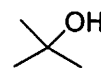
~~B~~



or



(C)



~~B~~

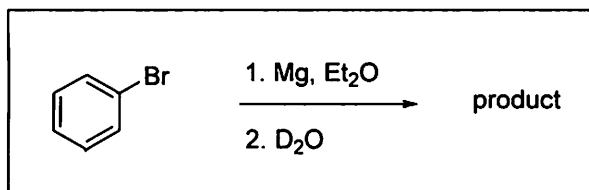


All of them

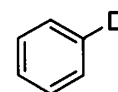
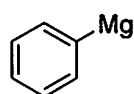
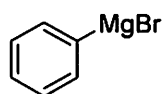
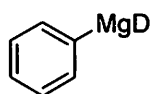
E

Hydroboration-oxidation of "B" or "D" precursors would not give "B" or "D"

19. What is the product of the following reaction sequence?



E



A

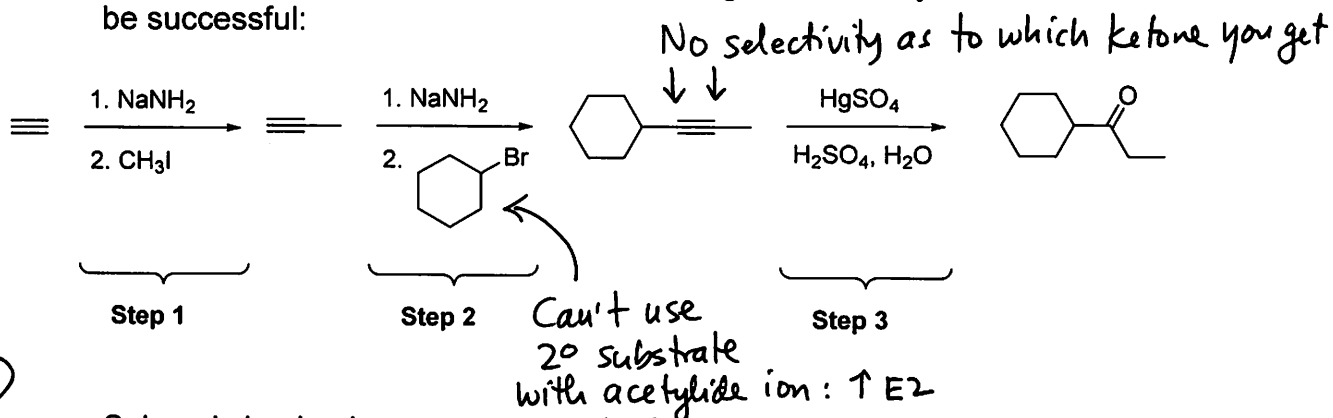
B

C

D

**E**

20. Selena Gomez has stated publicly that she dumped Justin Bieber because "that idiot doesn't know anything about the chemistry of alkynes". To prove her point, Selena points out that Justin thought that this synthesis would be successful:



D

Selena is basing her argument on the fact that at least one of the steps in the proposed synthesis would not give good yields of the product that Bieber is claiming, but in fact would give mixtures of products. Which steps have problems, according to Selena?

- a. Step 1
- b. Step 2
- c. Step 3
- d. Steps 2 and 3**
- e. All three steps



For questions 21 through 25, use the following list to identify the reagent(s) that you would use to accomplish each transformation. Choices may be used more than once, or not at all.

- a. 1)  $\text{Hg}(\text{OAc})_2, \text{H}_2\text{O}$   
2)  $\text{NaBH}_4$
- b. 1)  $\text{O}_3$   
2) DMS
- c.  $\text{HBr}/\text{CH}_3\text{OOCH}_3/\text{heat}$
- d. Na or Li,  $\text{NH}_3$
- e. Can't be accomplished using any of these choices

