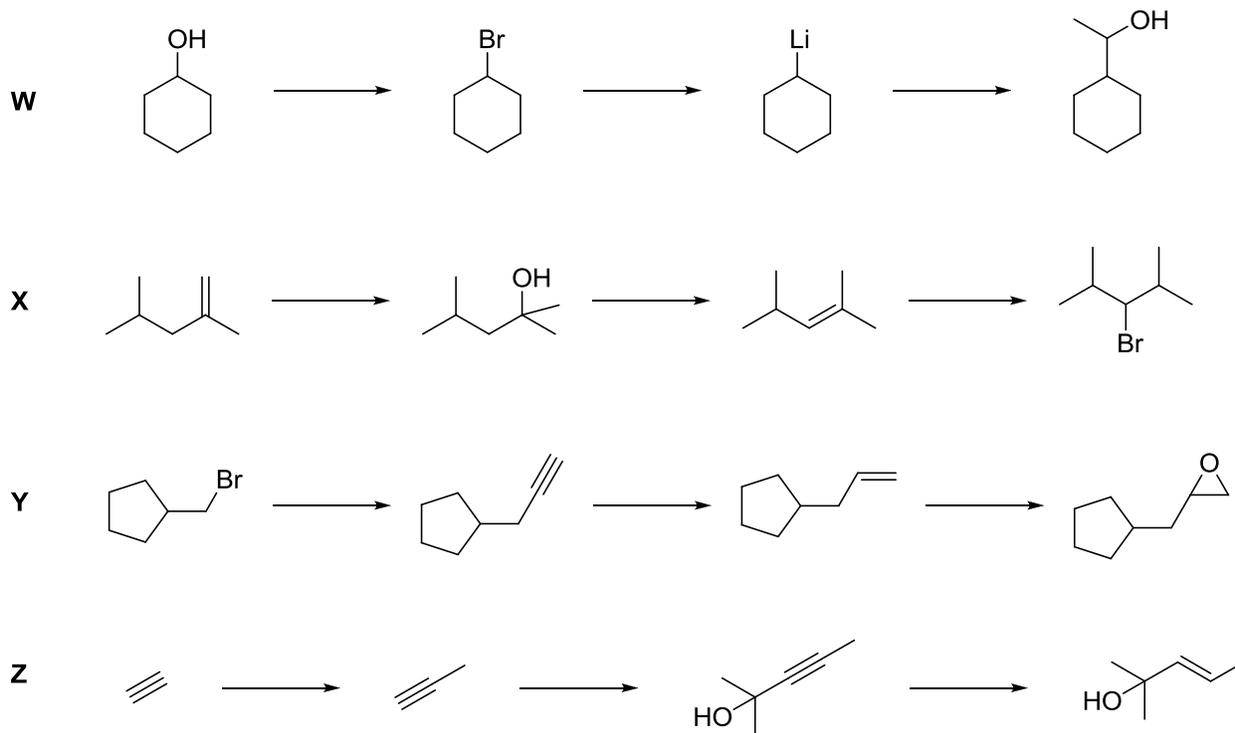


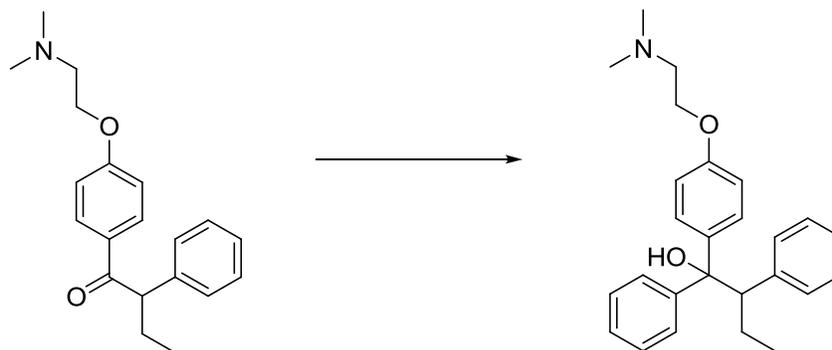
For questions 1-5, consider these four multi-step syntheses, then use the answer choices below.



- Synthesis W
- Synthesis X
- Synthesis Y
- Synthesis Z
- None of these syntheses

- Which synthesis involves the use of a ketone as a reagent?
- Which synthesis includes an addition reaction with anti-Markovnikov regioselectivity?
- Which synthesis can only be accomplished using a dissolving metal reduction?
- Which synthesis could involve the use of hydroboration-oxidation?
- Which synthesis has a final product that can either be oxidized to a ketone OR dehydrated?

6. Tamoxifen is a drug used in the treatment of a certain type of breast cancer. One of the steps in the synthesis of Tamoxifen is this transformation:



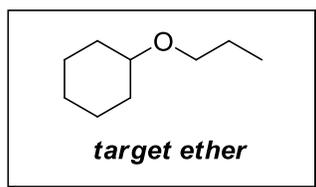
Which of the following reaction types is involved in this step?

- a. Nucleophilic substitution
 - b. Alkylation
 - c. Nucleophilic addition
 - d. Electrophilic addition
 - e. Oxidation
7. Which of the following is a necessary step in this two-step synthesis?

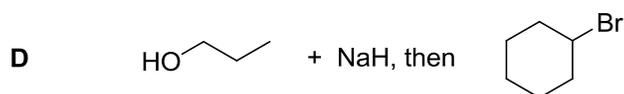
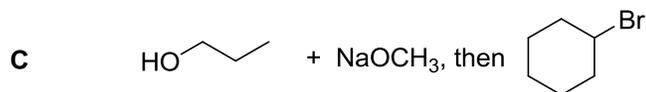
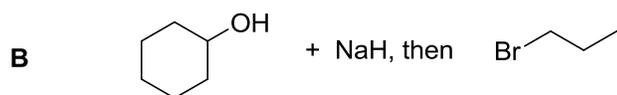
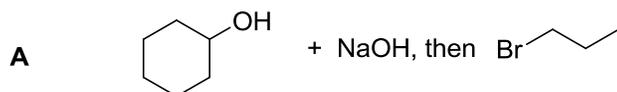


- a. Reduction of an alkyne
 - b. Oxidation of an alcohol
 - c. Dehydration of an alcohol
 - d. Ozonolysis of an alkene
 - e. Epoxide formation
8. Which of these bases should be used to quantitatively deprotonate a terminal alkyne?
- a. Hydroxide, OH^-
 - b. Methoxide, CH_3O^-
 - c. Ethoxide, $\text{CH}_3\text{CH}_2\text{O}^-$
 - d. *tert*-Butoxide, $(\text{CH}_3)_3\text{CO}^-$
 - e. None of these

9. You want to make this ether using a Williamson ether synthesis:



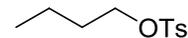
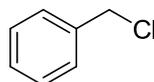
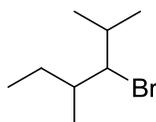
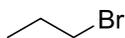
Given that a Williamson ether synthesis involves the reaction of an alkoxide ion with an electrophile, select the best set of reagents and compounds that you would need to use to make the ether in the highest yields possible.



E None of these approaches would produce the desired ether in good yield

10. Which of these compounds should NOT be used to alkylate an acetylide ion?

CH₃I



A

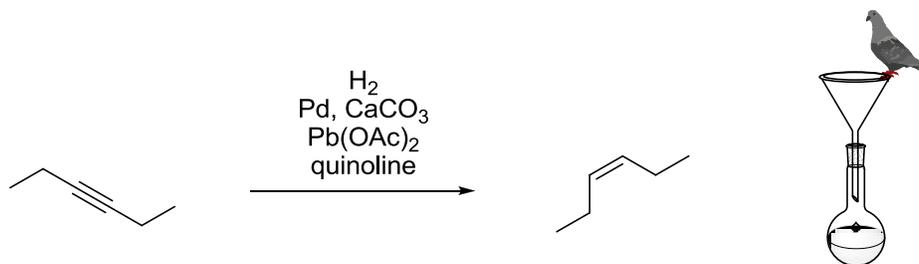
B

C

D

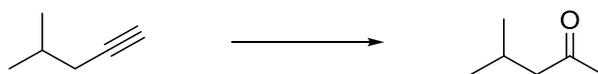
E

11. A famous pigeon chemist, Professor Burblecoo, needed to prepare an alkene from an alkyne using hydrogen gas and the Lindlar catalyst.

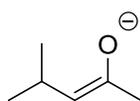


As Professor Burblecoo was busily working at his lab bench, he was momentarily distracted by one of his grad students dropping some breadcrumbs on the floor. After the professor gobbled up all the breadcrumbs and flew back to his bench, he failed to notice that he neglected to add Pb(OAc)_2 to the reaction mixture. Given that this is the reagent that “poisons” the catalyst, what effect will this have on the reaction?

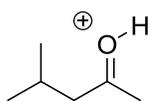
- The alkyne will be reduced to an alkane.
 - The alkyne will be reduced to a trans alkene rather than a cis alkene.
 - No reaction will occur.
 - The alkyne will become hydrated instead of being reduced.
 - Leaving the Pb(OAc)_2 out of the reaction will not change the desired outcome.
12. An alkyne is hydrated to produce a ketone:



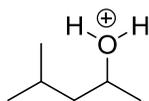
In the reaction, an enol intermediate forms which then tautomerizes to the final ketone product. Which of the following is a mechanistic intermediate in the tautomerization in this reaction?



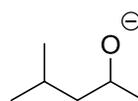
A



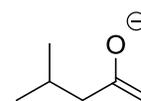
B



C



D

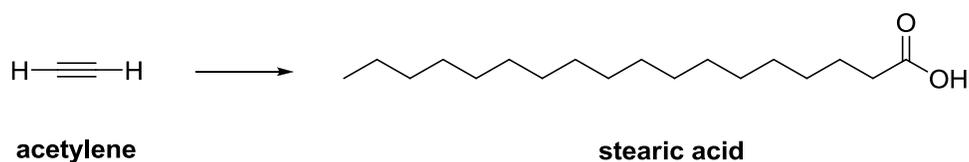


E

13. Pheromones are chemical compounds produced by organisms for a variety of purposes, e.g. to establish territory, attract mates, or repel predators. The ocellated lizard (*Timon lepidus*) secretes a mixture of chemicals, some of which serve as pheromones. One of these is stearic acid, $C_{18}H_{36}O_2$. The lizard in the photo decided to synthesize stearic acid in very large quantities because it wants to claim the entire state of Colorado as its territory.

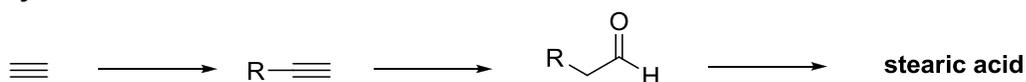


Stearic acid can be synthesized from acetylene:

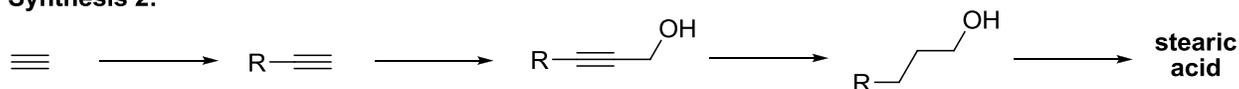


The lizard is considering these two approaches:

Synthesis 1:



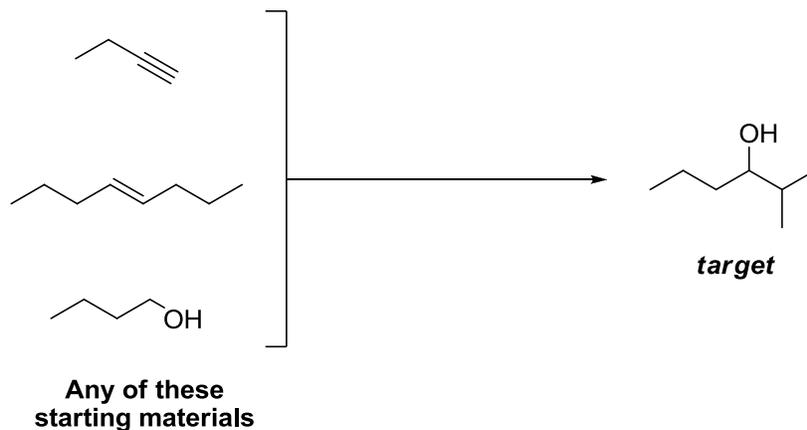
Synthesis 2:



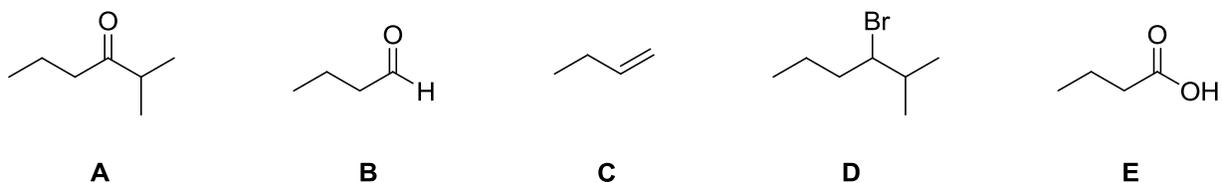
Which of the following statements is FALSE?

- The "R" group in the product of the first step of each synthesis is the same.
- The lizard will alkylate an acetylide ion at some point in its synthesis.
- One of the steps shown above requires the lizard to use disiamylborane, Si_2BH .
- One approach used by the lizard could involve the use of formaldehyde, CH_2O .
- The lizard is unlikely to be successful in its efforts to claim the entire state of Colorado as its territory, but it might try a smaller state like Rhode Island and see how that goes first.

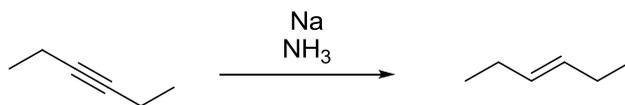
14. This target alcohol can be made in a two-step synthesis from any of the starting materials shown:



All three syntheses involve the same precursor to the alcohol. Which of these compounds is that precursor?



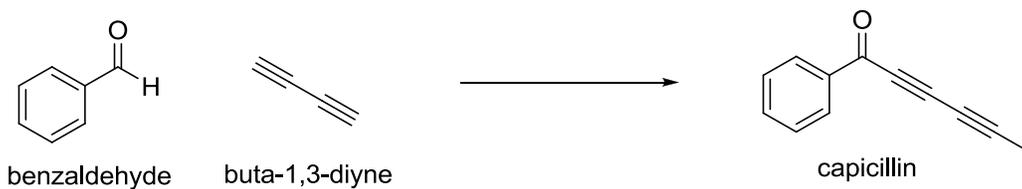
15. An alkyne is reduced to a trans alkene as shown:



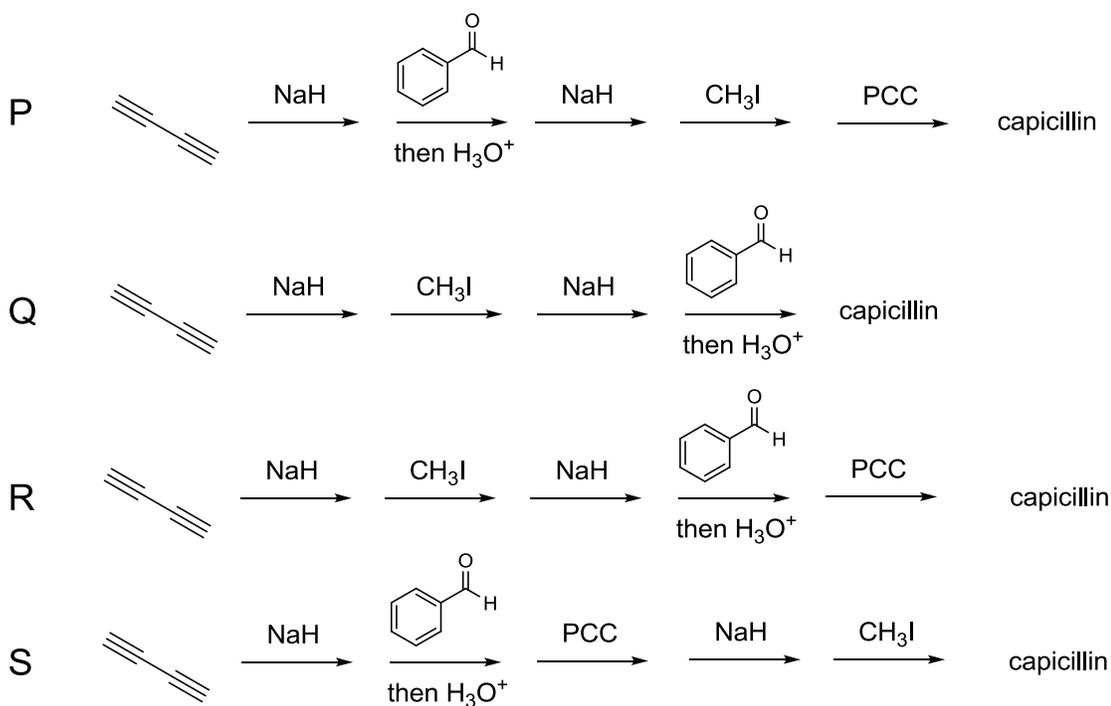
Which of these answer choices describes the correct sequence of steps in the mechanism for this transformation?

- Proton transfer, electron transfer, electron transfer, proton transfer
- Proton transfer, electron transfer, proton transfer, electron transfer
- Electron transfer, proton transfer, electron transfer, proton transfer
- Electron transfer, electron transfer, protonation, protonation
- Protonation, protonation, electron transfer, electron transfer

16. Capicillin is a fungicidal oil isolated from chrysanthemums. Capicillin can be prepared from benzaldehyde and buta-1,3-diyne in a multi-step synthesis:



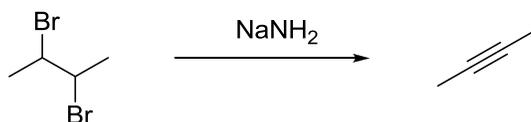
Here are four proposals for a multi-step synthesis of capicillin. Each forward arrow/reagent combination represents one step, but the product of each step is not shown:



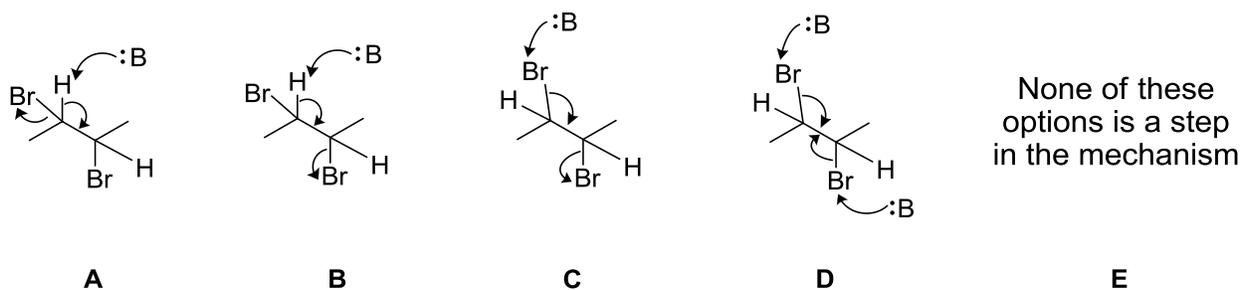
Which of these proposed syntheses would NOT be successful?

- P
- Q
- P, Q
- P, Q, S
- P, Q, R, S

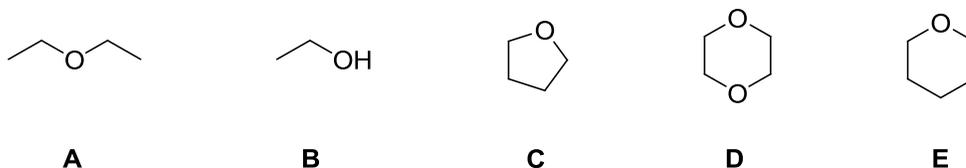
17. Alkynes can be prepared from vicinal dihalides using a base such as sodium amide. (Notice in this example we do not need three equivalents of the base because we are making an internal alkyne.)



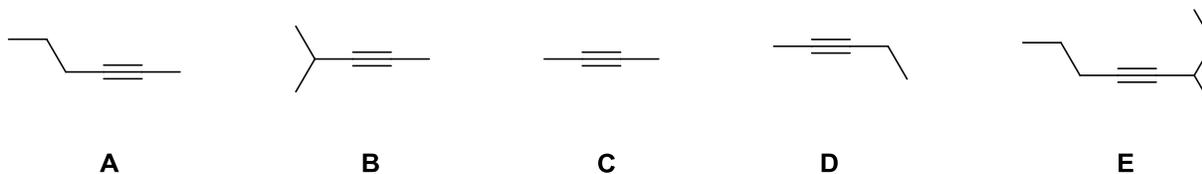
Which of these options shows one of the mechanistic steps involved in this transformation? :B represents the base.



18. Which of the following solvents would you NOT use to prepare a Grignard or organolithium reagent?



19. Each of these alkynes was treated with HgSO_4 , H_2SO_4 and H_2O . Which of these reactions resulted in the formation of a single product?

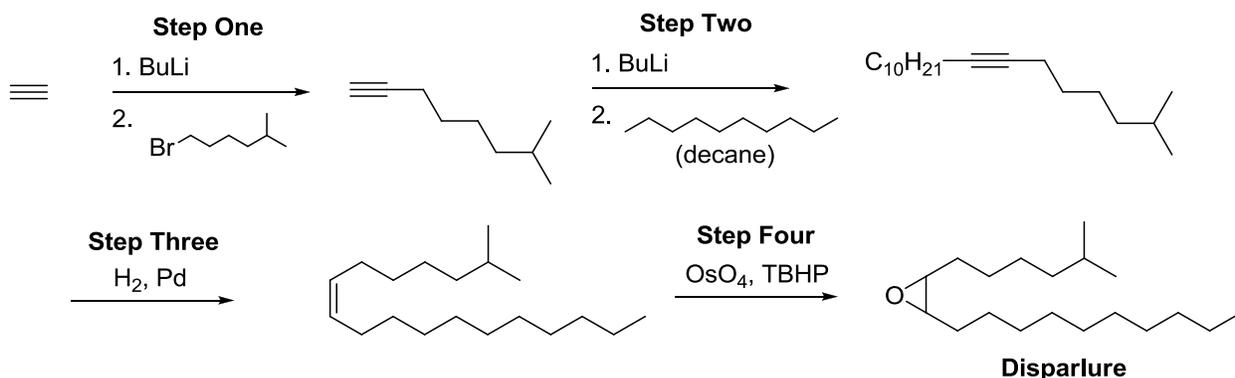


20. Despite being smashed to a pulp in last year's Synthesis Showdown, Justin Bieber has challenged the Chemistry Cat to a rematch!



In this contest, Bieber and the Cat must each design a multi-step synthesis of disparlure, the sex pheromone of the gypsy moth, starting from acetylene. The winner of the Showdown makes the target molecule in the least number of successful steps. Syntheses that have steps with mixtures of products or that incorrectly predict products are not acceptable.

Justin Bieber designed the following synthesis:



Identify any and all steps in Justin Bieber's synthesis that involve reactions that will NOT go to completion or that will NOT provide the indicated product of a particular step.

- Step 1
- Step 2
- Steps 1 and 4
- Steps 3 and 4
- Steps 2, 3 and 4