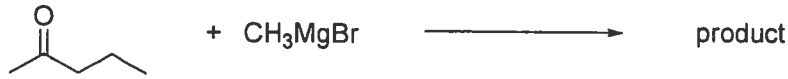


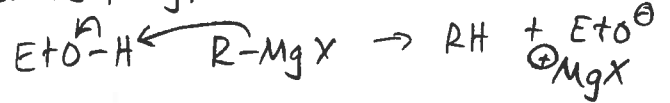
1. Which of the following solvents could you not use to run the reaction shown? (Assume any appropriate aqueous workup also occurs.)

C



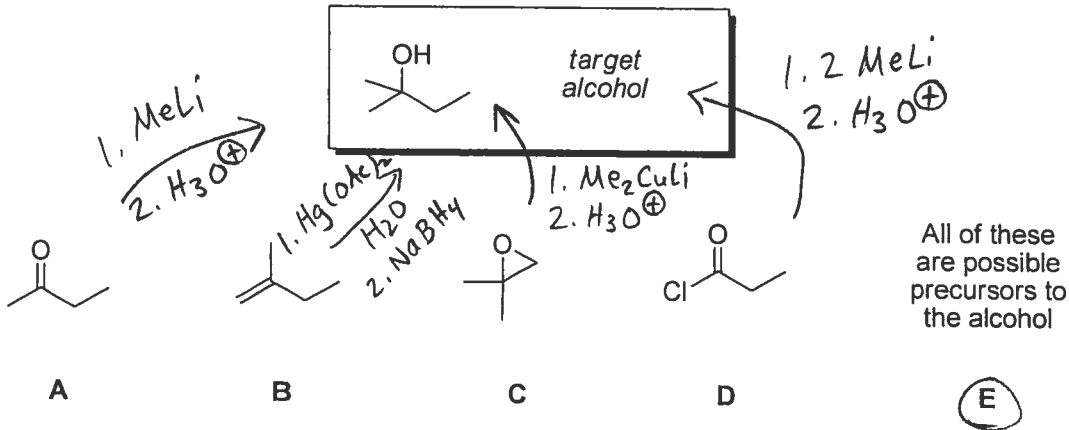
- a. THF
 b. Et₂O
 c. EtOH
 d. Any of these could be used
 e. None of these could be used

protic solvents protonate RMgX/RLi:



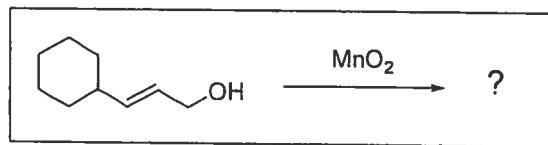
2. Which of the following is a possible precursor to this alcohol? (Another way to think of this question is, From which of these compounds can the alcohol be made in one step, including workup?) You can use any reagents you like.

E



3. Select the correct product of the following reaction.

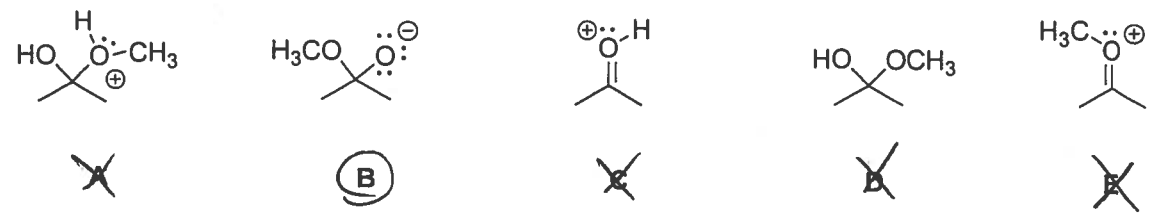
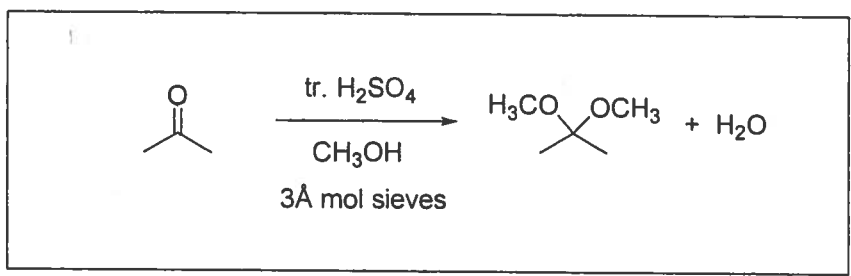
C



- A: C1CCCCC1C(O)C(O)CO
 B: C1CCCCC1CCCCO
 C: C1CCCCC1/C=C/C=O
 D: C1CCCCC1/C=C/C(=O)O
 E: None of these is the product
- (C)

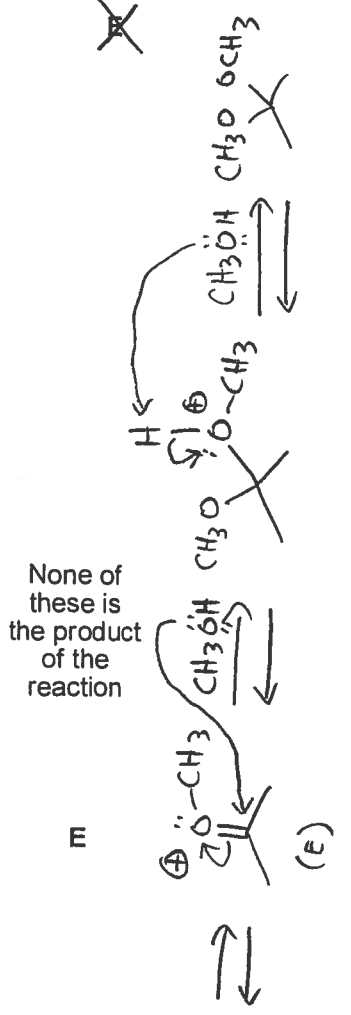
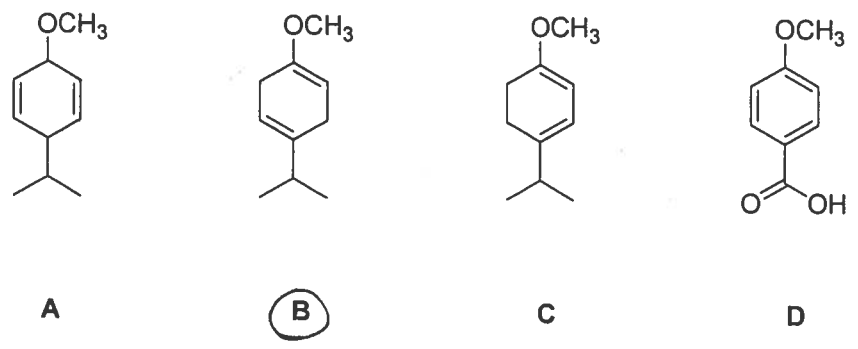
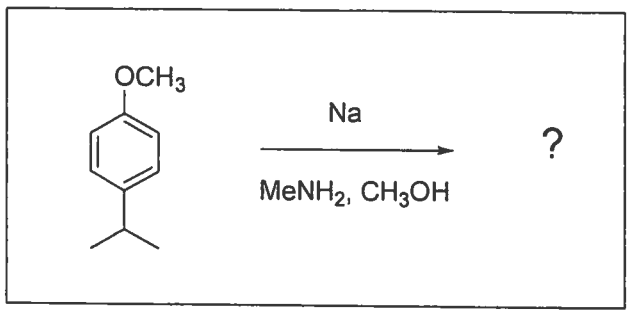
4. Which of these structures is not a mechanistic intermediate in acetal formation? (The overall reaction is shown in the box.)

B
see below

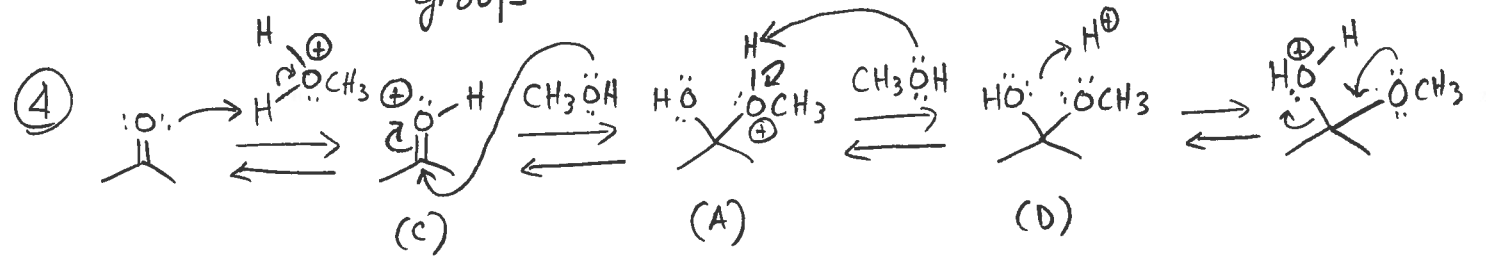


5. What is the product of this reaction?

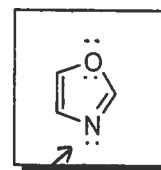
B



Both are e⁻ donating groups



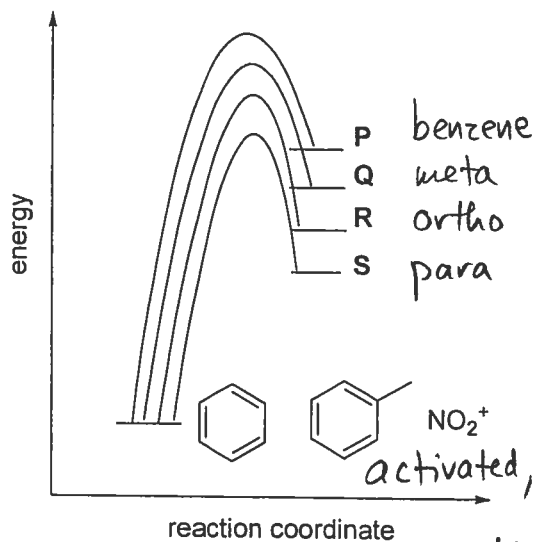
6. This compound is called oxazole. What type of orbital contains the nitrogen lone pair in oxazole?



not involved in aromaticity

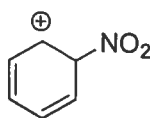
- a. sp
 b. sp^2
 c. sp^3
 d. p
 e. None of these

7. Equal amounts of benzene and toluene are mixed and allowed to react with the nitronium ion, NO_2^+ , in an electrophilic aromatic substitution (nitration). An energy vs. reaction coordinate diagram for the rate-limiting step of the reaction is shown. Which structure corresponds to the intermediate marked "Q" on this diagram? (Notice that each of your answer choices also has several resonance structures that are not shown.)



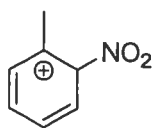
activated, so all pathways are faster than benzene
 o,p director, so o,p pathways faster than meta

benzene



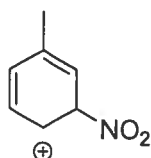
A

ortho



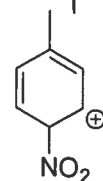
B

meta



C

para



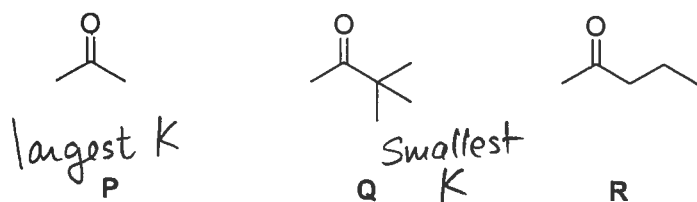
D

None of these structures is Q

E

8. Place these compounds in *increasing* order of $K_{\text{hydration}}$ (smallest K to largest K).

D

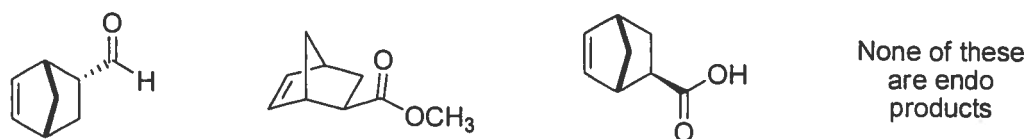


- a. P, Q, R
 b. P, R, Q
 c. R, Q, P
 d. Q, R, P
 e. Q, P, R

$$K_{\text{hydration}} = \frac{[\text{hydrate}]}{[\text{C}=\text{O}]}$$

9. Which of these is an *endo* Diels Alder product?

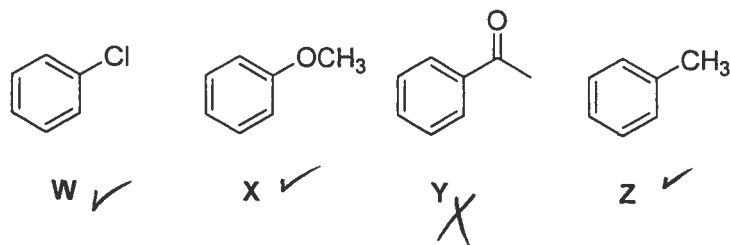
A



(A)
 aldehyde *trans* to bridge

10. Which of these compounds contains an *ortho*, *para* director?

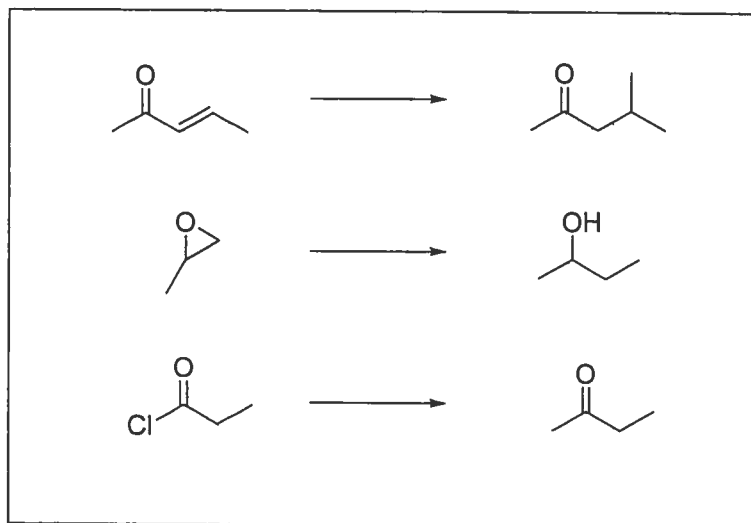
C



- a. W, X
 b. X, Z
 c. W, X, Z
 d. W, X, Y, Z
 e. X, Z

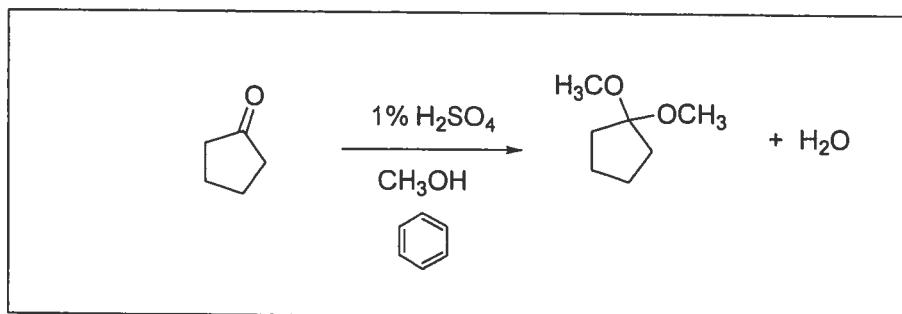
11. Which of the reagents listed (followed by aqueous workup) will accomplish each of the transformations shown?

C



- CH₃Li
 - CH₃MgBr
 - (CH₃)₂CuLi
 - either "a" or "b"
 - "a", "b" or "c" would all work
12. A dimethyl acetal can be formed in the following conditions:

B

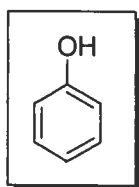


What is the purpose of the benzene in this reaction?

- It is a catalyst
- To allow the water formed in the reaction to be removed through an azeotropic distillation
- To facilitate the reaction by lowering the energies of the transition states for several of the steps
- To prevent a Friedel Crafts reaction from happening
- There was a little left in the bottle and we wanted to use it up

13. Which of the following statements about phenol and electrophilic aromatic substitution is true?

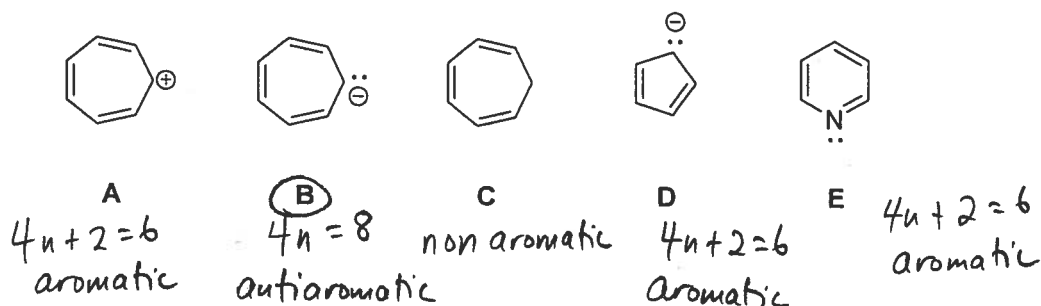
A



- T a. Donation of electron density to the ring is a more important factor than inductive withdrawal of electron density.
 F b. Donation of electron density to the ring is a less important factor than inductive withdrawal of electron density.
 F c. Both donation and withdrawal of electron density are equally important.
 F d. The rate of electrophilic aromatic substitution is not affected by whether or not electron density is donated to the ring or withdrawn from it.
 F e. The ring in phenol is deactivated.

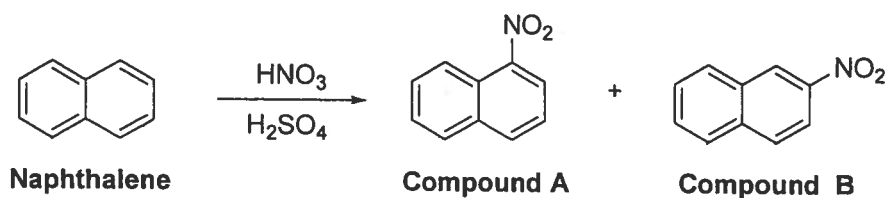
14. Which of the following compounds is anti-aromatic? For this question, assume that all compounds are planar. All lone pairs are shown.

B

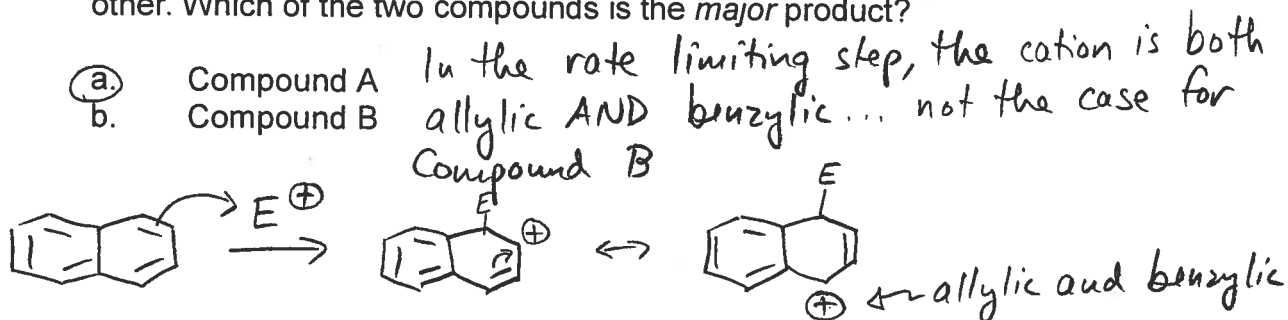


15. Naphthalene can undergo a nitration reaction:

A

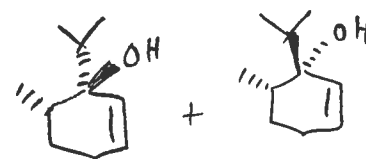
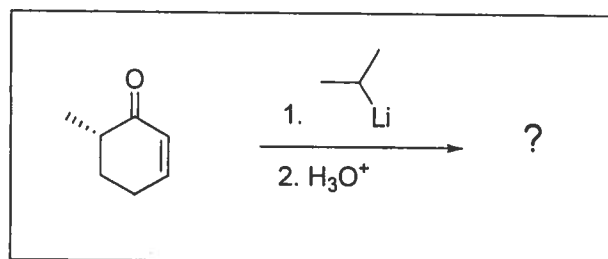


One of the two possible products forms in significant preference to the other. Which of the two compounds is the *major* product?



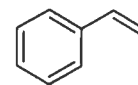
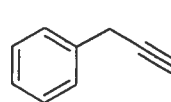
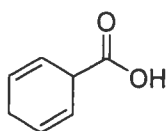
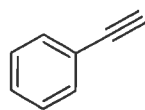
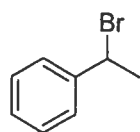
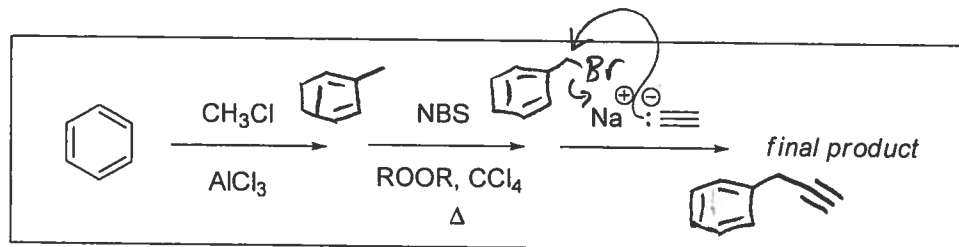
16. Which of the following statements is the best description of the product(s) of this reaction?

E



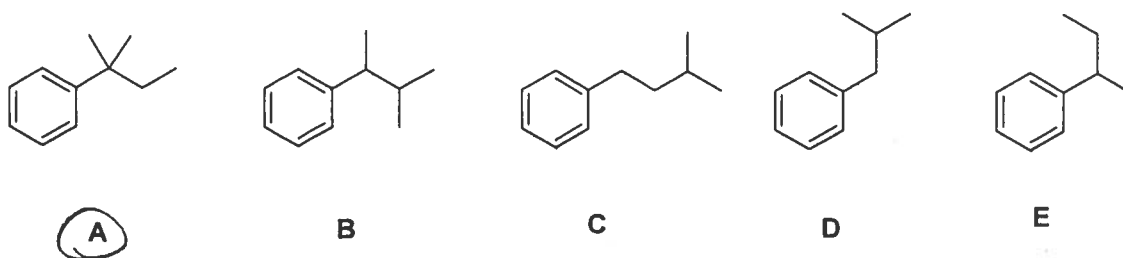
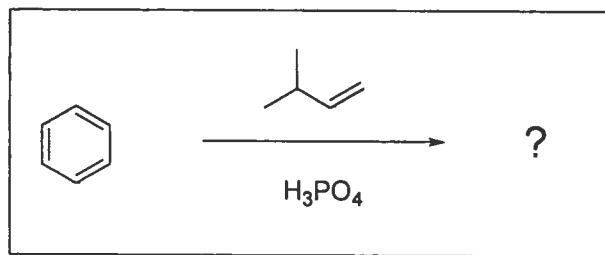
- a. A racemic mixture of alcohols
 b. A racemic mixture of ketones
 c. A single achiral alcohol
 d. A mixture of ketones that are diastereomers
 e. A mixture of alcohols that are diastereomers
17. Predict the final product of this sequence of reactions.

D



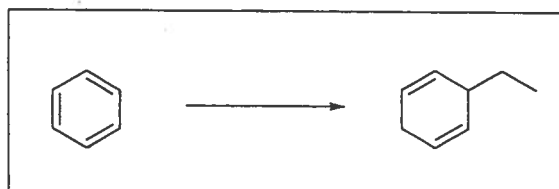
18. What is the final product of these conditions?

A See below

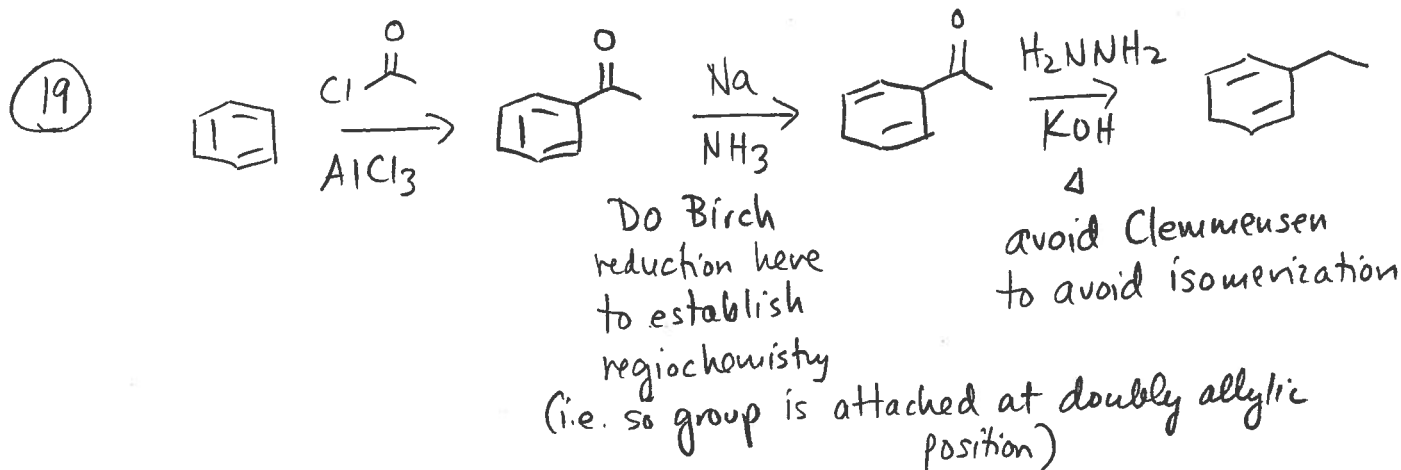
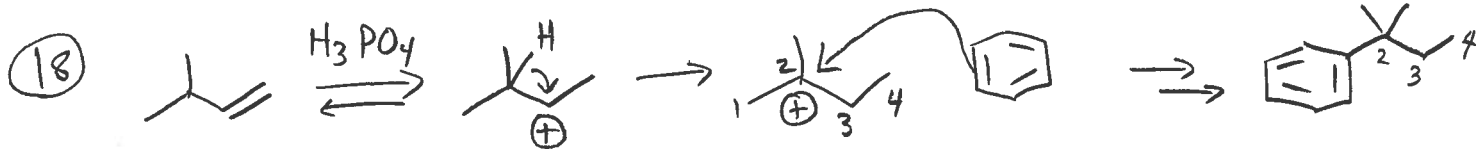


19. In this multistep synthesis, what reagent(s) would you use in the *last* step of the sequence?

E

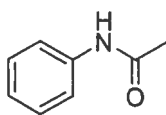
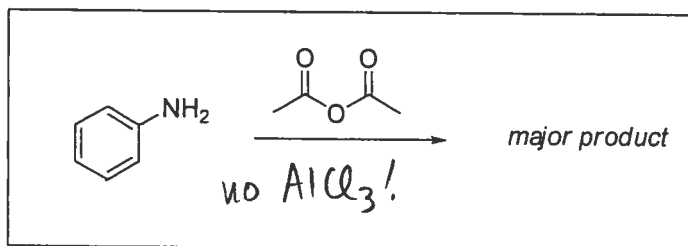


- a. Na, NH₃
- b. H₂, Pd/C
- c. H₂, Lindlar catalyst
- d. HCl(aq), Hg/Zn
- e. H₂NNH₂, KOH, heat

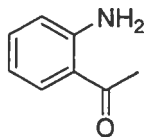


20. What is the major product of this reaction?

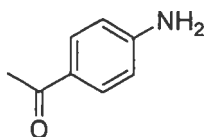
A



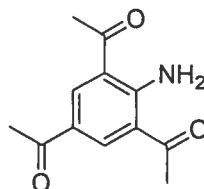
(A)



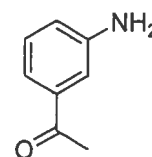
B



C



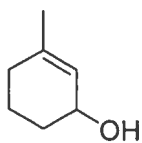
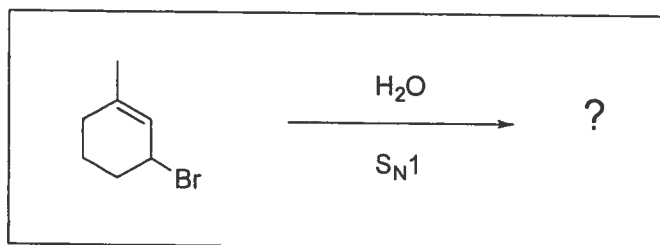
D



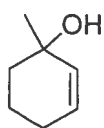
E

21. What is the outcome of these conditions?

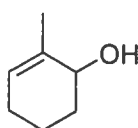
E



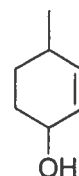
A ✓



B ✓



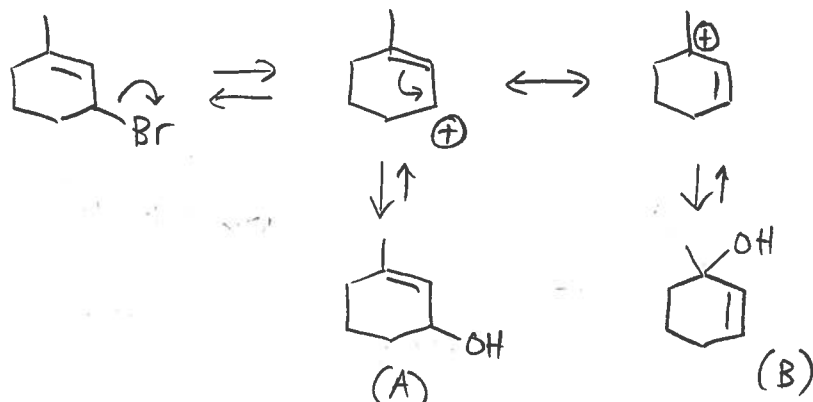
C X



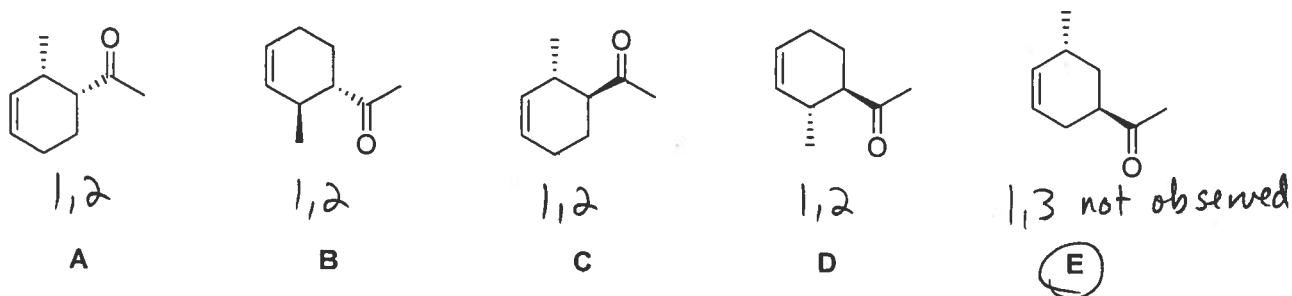
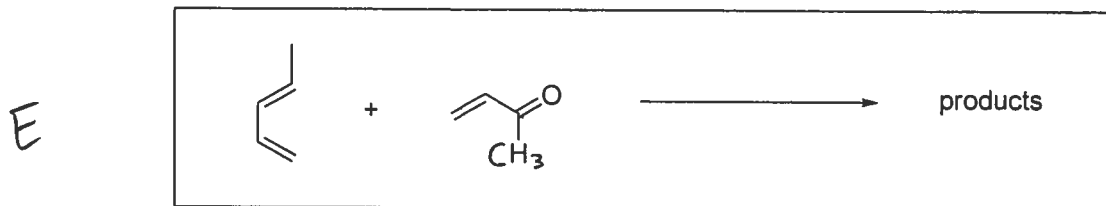
D X

A mixture of A and B

(E)

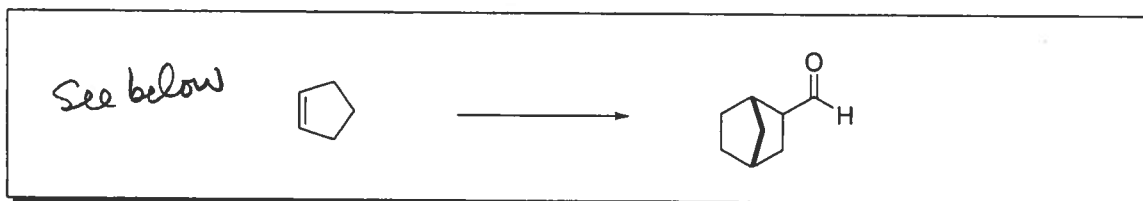


22. Which structure is the least likely product of this reaction?



23. You wish to accomplish the following multistep synthesis. The reagents available to you are listed below. Can you successfully complete this synthesis? (All necessary solvents and solutions for aqueous workups are also available, though not necessarily listed.)

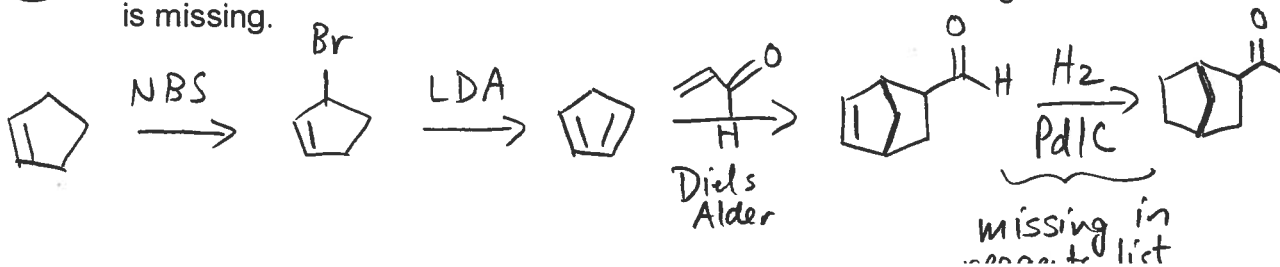
B



Available reagents:

LAH	Sia ₂ BH			CH ₃ Li
OsO ₄	Aqueous acid (H ₃ O ⁺)	AlCl ₃		(CH ₃) ₂ CuLi
H ₂ O ₂	Aqueous base (HO ⁻)	KMnO ₄		CO
O ₃	LDA	NaBH ₄		HCl
DMS	Na metal	Jones reagent		CuCl
NBS	NH ₃	SOCl ₂		PCC
				MCPBA

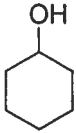

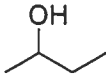
- a. Yes, I can complete the synthesis with the reagents provided.
 b. No, I cannot complete the synthesis because at least one reagent is missing.



24. Which of these alcohols could not be made in one step (including workup) from an epoxide?

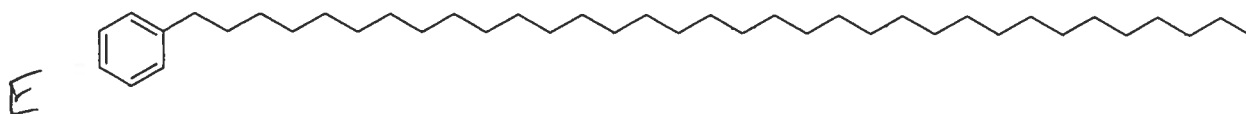
D

See below

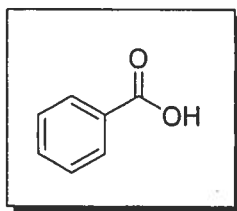
A  B  C  All could be made from epoxides None could be made from epoxides

A B C **D** E

25. Kim Kardashian somehow managed to synthesize this molecule, which cures cancer, reverses the aging process, improves personality, and increases the IQ of whoever ingests it by at least 50 points.



Unfortunately, as Kim was rushing to the phone to call Khloe, she accidentally dropped the only sample of the molecule into a large beaker of boiling purple liquid. After this unfortunate accident, Kim recovered the following compound from the beaker:



What was in the beaker of boiling purple liquid?

- Kim's third husband (aq)
- HIO_4
- H_3O^+
- O_3
- KMnO_4**

24

