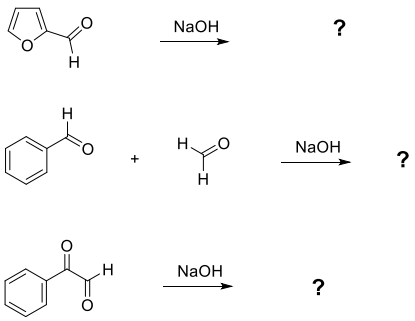
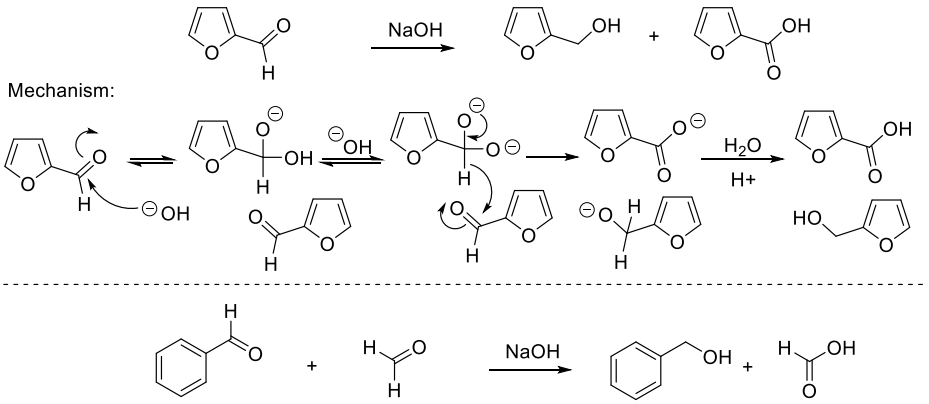
Solutions to Problems - Set 7: Carbonyl compounds (part II)

Problem 1

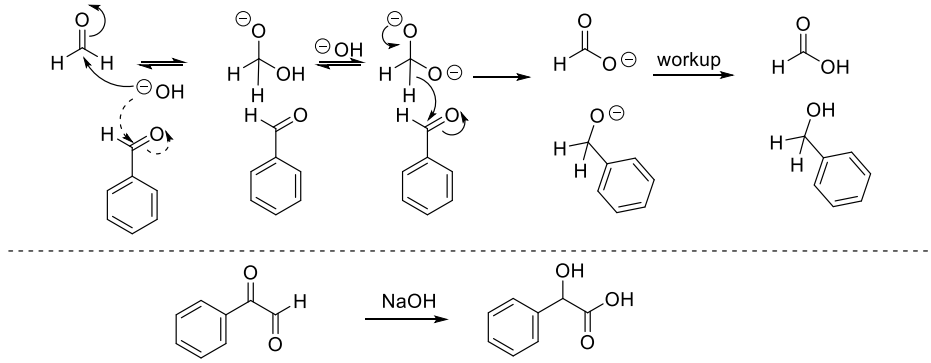
Predict the product structures of the following Cannizzaro reactions and suggest the mechanism for each.



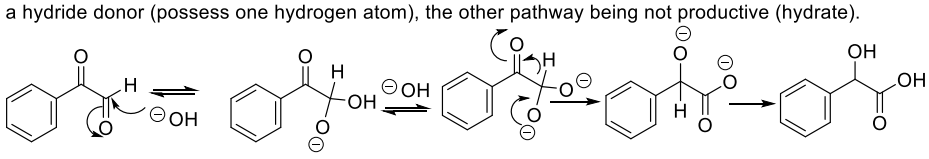
Solution



Mechanism: This is a Canizzaro reaction between different aldehydes. Statistically, 4 products could be formed. However, hydroxide anion favorably attacks on carbonyl of formaldehyde which is more activated and less crowded (therefore less destabilized during the transition state). As a result, 2 expected products are benzylic alcohol and formic acid.



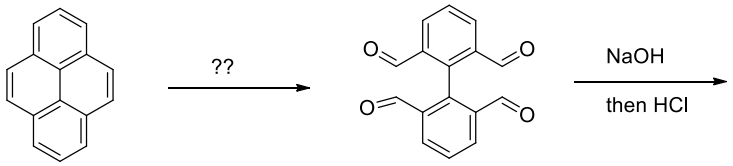
Mechanism: This is an intramolecular Canizzaro reaction. As discussed before, aldehyde is more activated for the attack of the hydroxide anion than the ketone. Moreover, only the aldehyde can act as a hydride donor (possess one hydrogen atom), the other pathway being not productive (hydrate).

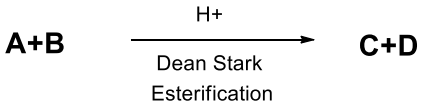


Note: Only aldehydes without α-hydrogen can undergo Canizzaro reaction. Otherwise : aldol reaction !

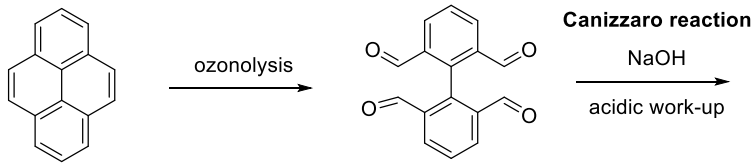
Problem 2

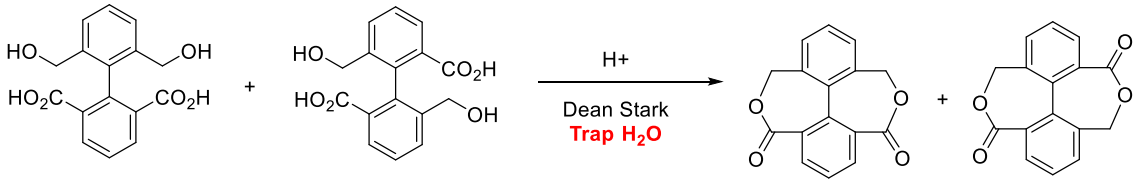
Give the structure of compounds **A, B, C, D** and the reaction conditions for first transformation as well the detailed mechanism of each transformation.





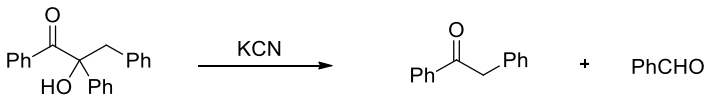
Solution





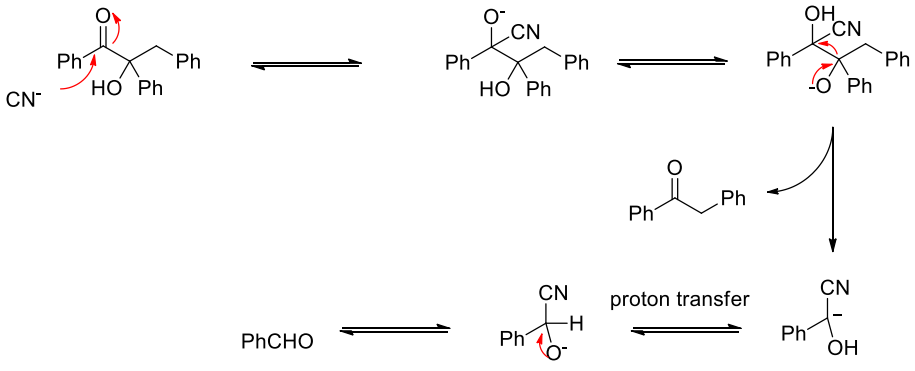
Problem 3

Give the mechanism of following transformation (think about Benzoin reaction):



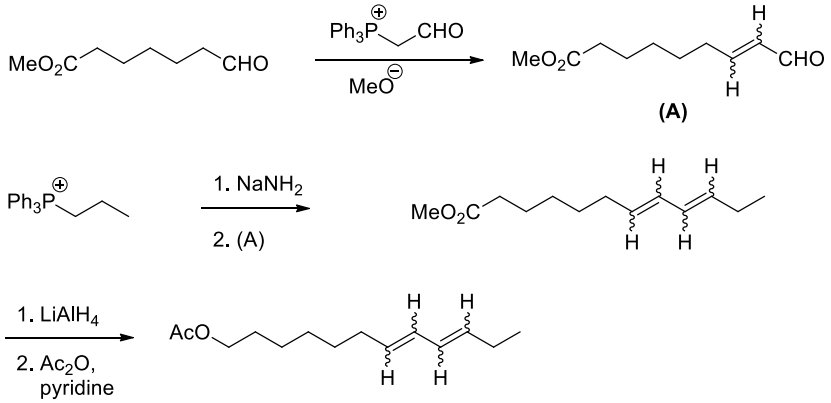
Solution

This reaction is retro-benzoin reaction



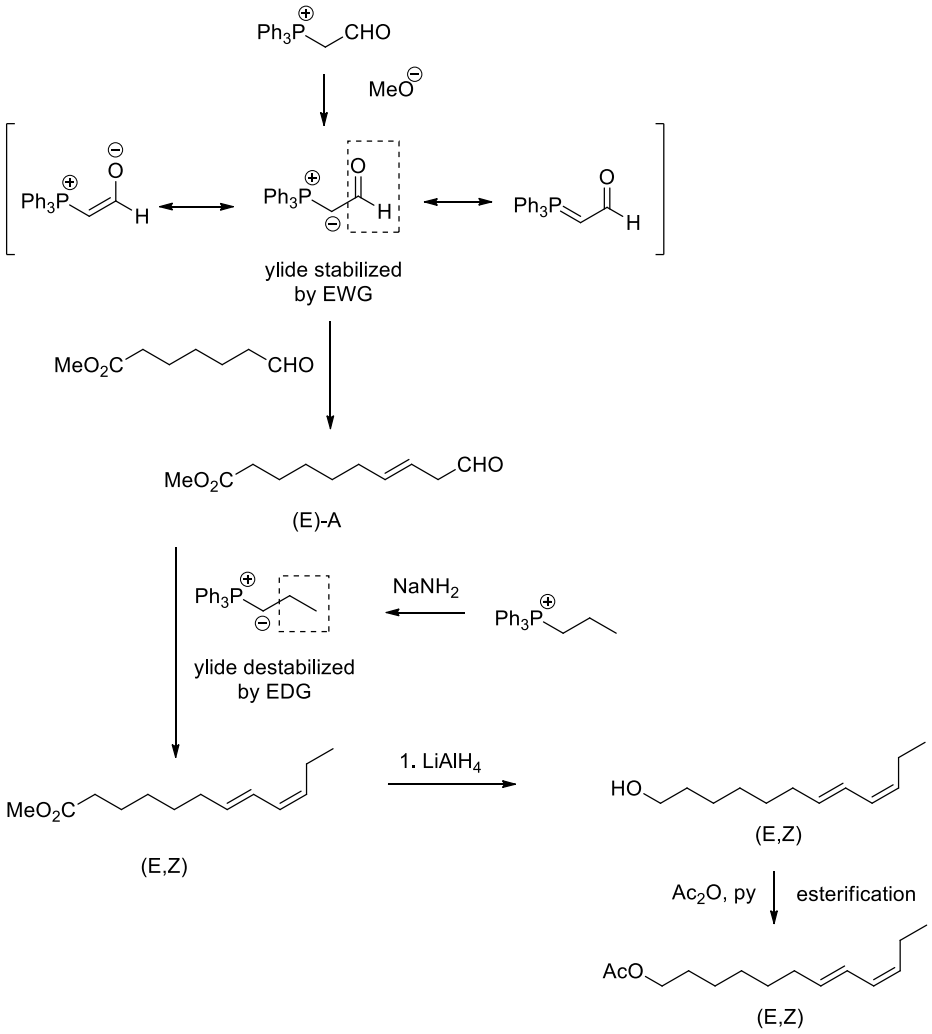
Problem 4

A single diastereoisomer of an insect pheromone was prepared in the following way. Which isomer is formed and why? Outline a synthesis of one other isomer.

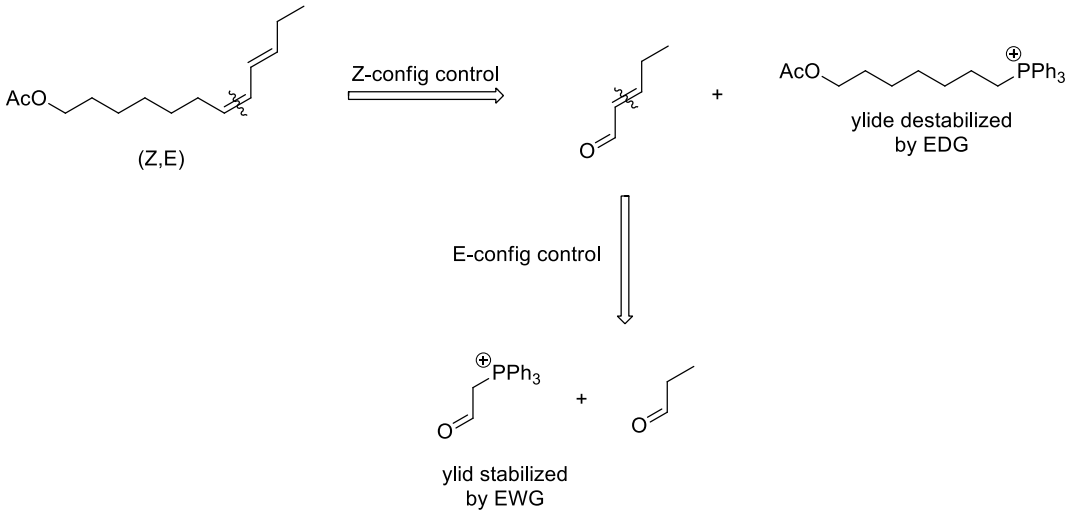


Solution

The first reaction, with a stabilized ylide and a milder base, gives the *E*-enal (A). The second, with an unstabilized ylide and strong base, gives a *Z*-alkene, and the final product is an *E,Z*-diene.

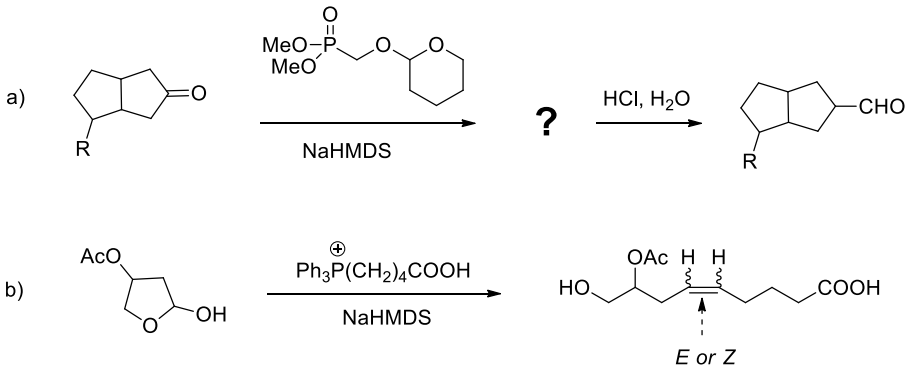


To make another isomer, for example, by using other starting materials we can prepare the *(Z,E)*-isomer:



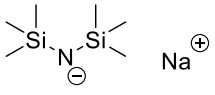
Problem 5

Find the missing compound; give the mechanism of following reactions. Define the double bond geometry (if available) and explain.

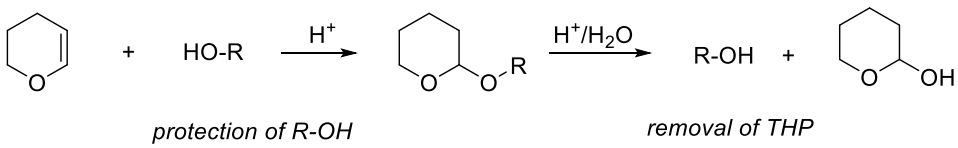


Notes

NaHMDS - Sodium bis(trimethylsilyl)amide
or sodium hexamethyldisilazide is a very strong base



THP - tetrahydropyranyl is a protecting group for alcohol
which can be removed easily by acids

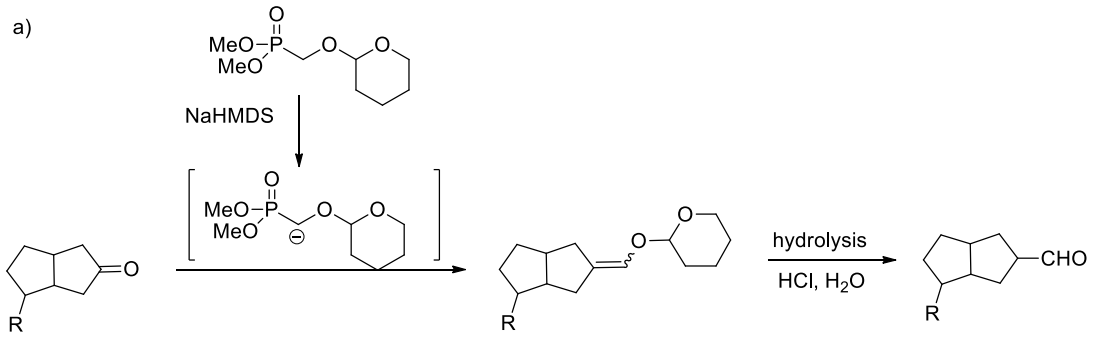


protection of R-OH

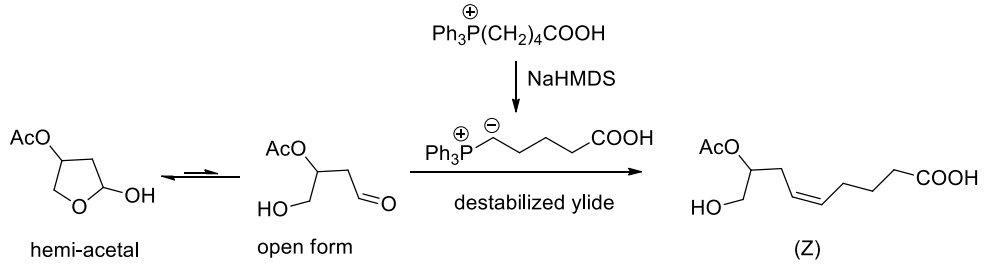
removal of THP

Solution

a)


MeO–P
MeO
O
NaHMDS
R
hydrolysis
HCl, H2O
CHO

b)


Ph3P(CH2)4COOH
NaHMDS
AcO
OH
HO
COOH
destabilized ylide
hemi-acetal
open form
(Z)