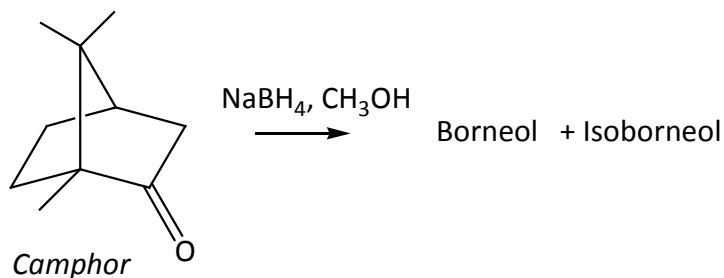


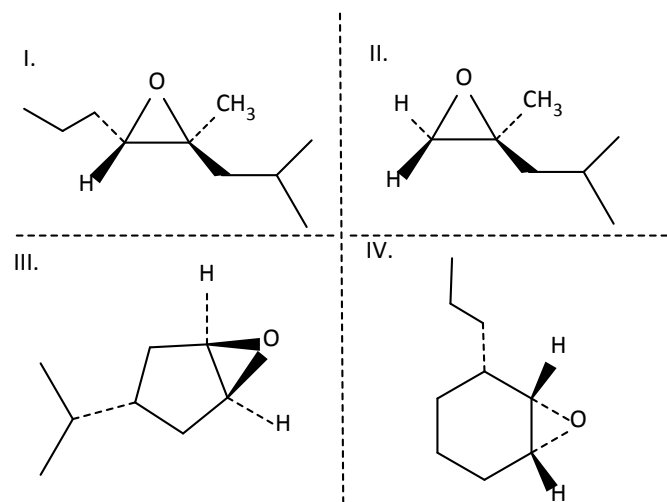
1. Reaction of camphor with NaBH_4 , CH_3OH provides a mixture of borneol and isoborneol. Which of the following statements is true regarding this reaction? **B**



- a) I & III
b) II & III
c) IV
d) II & IV
e) II, III & IV

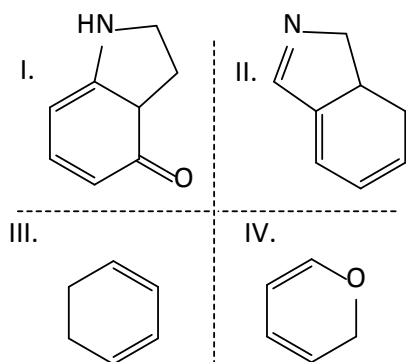
- I. Borneol and Isoborneol are enantiomers
II. Borneol and isoborneol are diastereomers
III. Both borneol and isoborneol contain a secondary alcohol
IV. Camphor cannot form an enol

2. Which of the following epoxides provide a mixture of positional isomers as major products upon reaction with 1. LiAlH_4 2. H_2O ? **D**



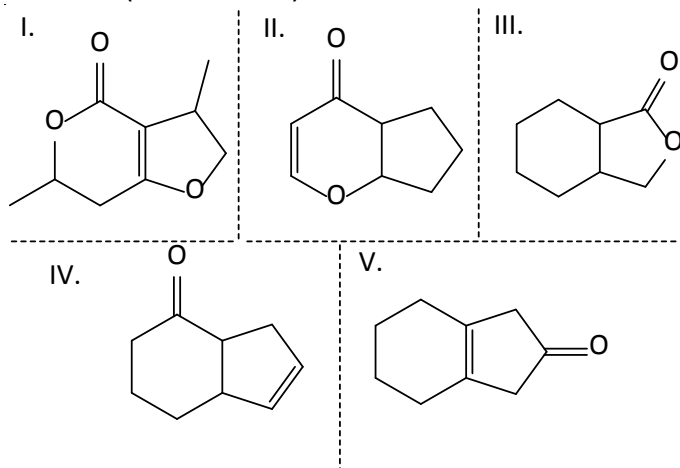
- a) I & II
b) III
c) II & IV
d) IV
e) III & IV

3. Rank the dienes below from most reactive to least reactive in a Diels-Alder reaction. **C**



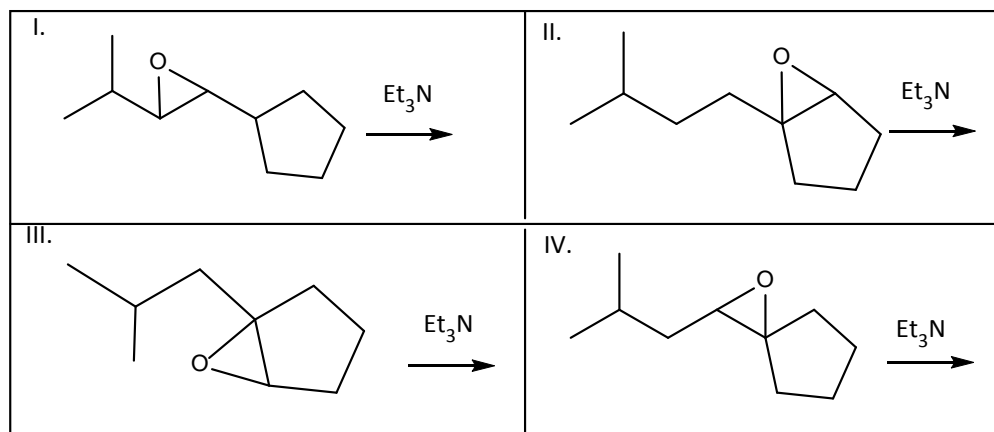
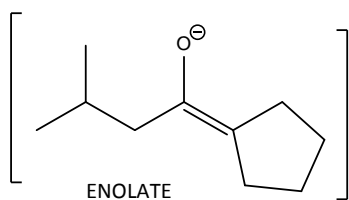
- a) I = III > IV > II
b) IV = II > I > III
c) IV > III = I > I
d) IV > II > III = I
e) II > III = I > IV

4. Rank the reactivity of the following carbonyl-containing compounds with a nucleophile from most reactive to least reactive (most > least). **E**



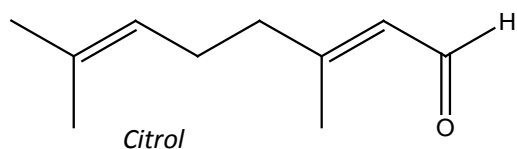
- a) V > II > III > IV > I
 b) IV > V > II > III > I
 c) V > IV > III > I > II
 d) V > IV > III > II > I
 e) V > IV > II > III > I

5. The enolate below will form in which of the following reactions? **E**



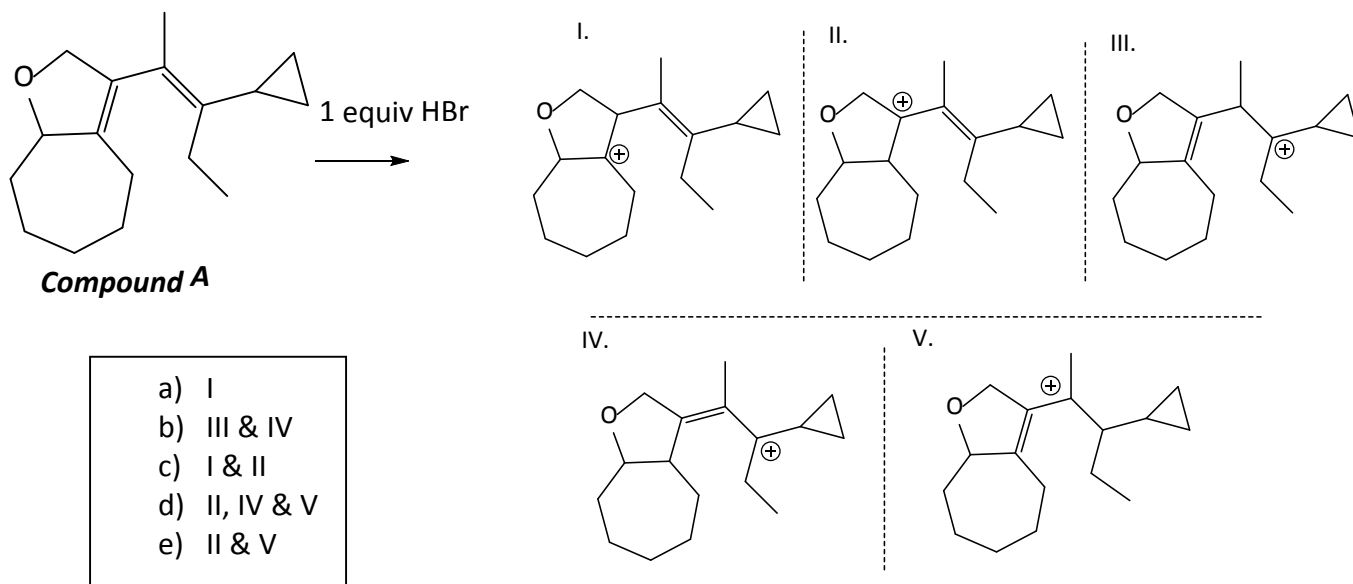
- a) I
 b) I & IV
 c) II
 d) III
 e) IV

6. Treatment of citrol with isopropylmagnesium bromide followed by treatment with acid will provide: **B**

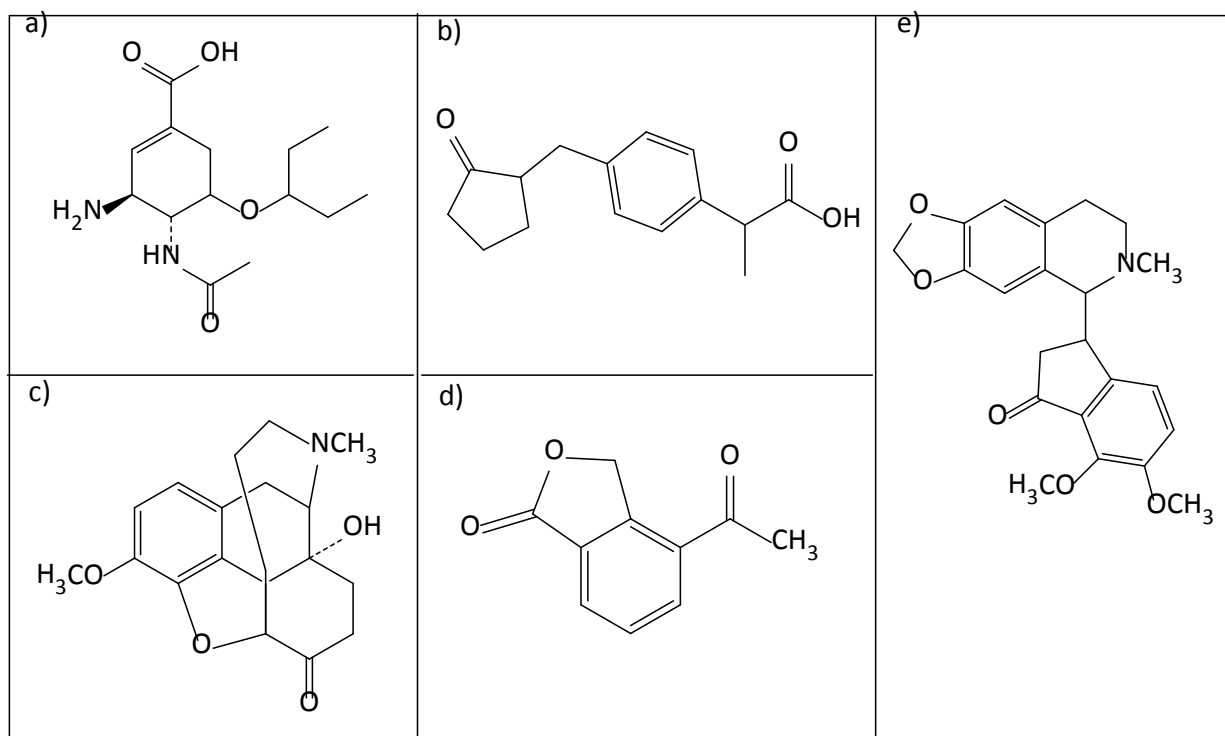


- a) citrol
 b) 2,5,9-trimethyl-4,8-decadiene-3-ol
 c) 1-isopropyl-3,7-dimethyl-2,6-octadiene-1-ol
 d) 1-isopropyl-3,5-dimethyl-2,4-octadiene-1-ol
 e) 2,6,9-trimethyl-2,6-decadiene-8-ol

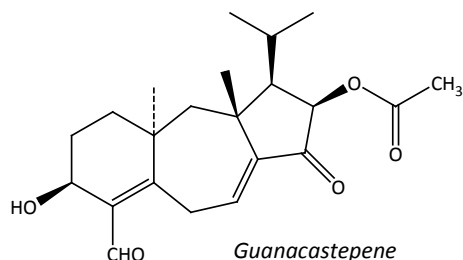
7. Which of the following reaction intermediates, derived from Compound A (below) and 1 equivalent of HBr, leads to the major kinetic product? **D**



8. Loxoprofen is a non-steroidal anti-inflammatory agent (NSAID). Reaction of loxoprofen with 1. LiAlH_4 2. H_2O provides a product containing both 1° and 2° alcohols. When loxoprofen is treated with NaBH_4 , CH_3OH the product contains a 2° alcohol, but no 1° alcohol. Reaction with excess n-butyllithium, followed by treatment with excess water generates a product with only a 3° alcohol (no other alcohols). Which of the following compounds is loxoprofen? **B**

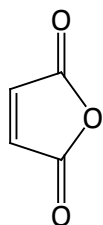


9. Treatment of guanacastepene with NaBH_4 , CH_3OH will provide a product that contains: **D**

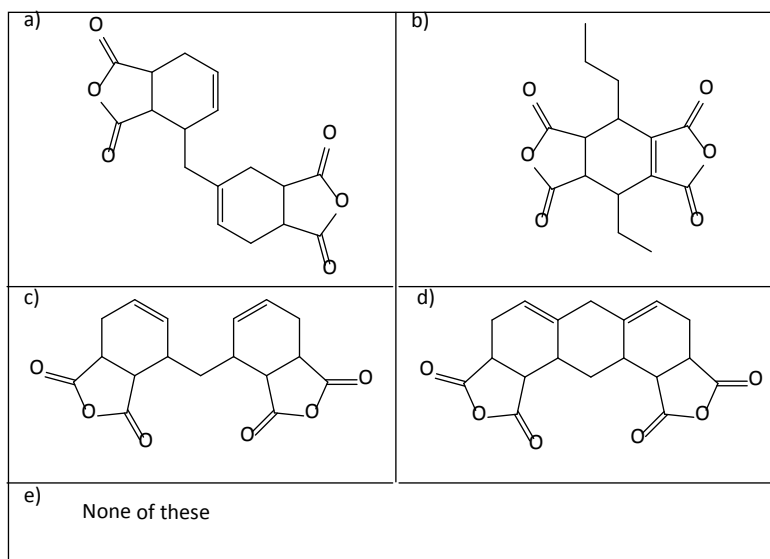


- a) Two 2° allylic alcohols, one 1° allylic alcohol, one 2° alcohol and one 1° alcohol
- b) Two 2° allylic alcohols, one 2° alcohol and two 1° allylic alcohols
- c) Three 2° alcohols and two 1° alcohols
- d) Two 2° allylic alcohols, one 1° allylic alcohol and one ester
- e) One 1° alcohol, one 2° alcohol and an ester

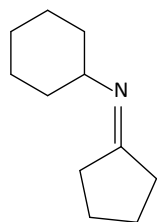
10. In the lab, 2,4-hexadien-1-ol was reacted with maleic anhydride (see structure below) to give a Diels-Alder adduct. The molar ratio of the diene:dienophile in this reaction is 1:1. If the diene in this reaction were replaced with 1,3,6,8-nonatetraene and the molar ratio of the diene and dienophile were changed to 1:2 (diene:dienophile), which of the following compounds would be generated as the major Diels-Alder adduct in this modified Diels-Alder reaction? (The dienophile is still maleic anhydride) **C**



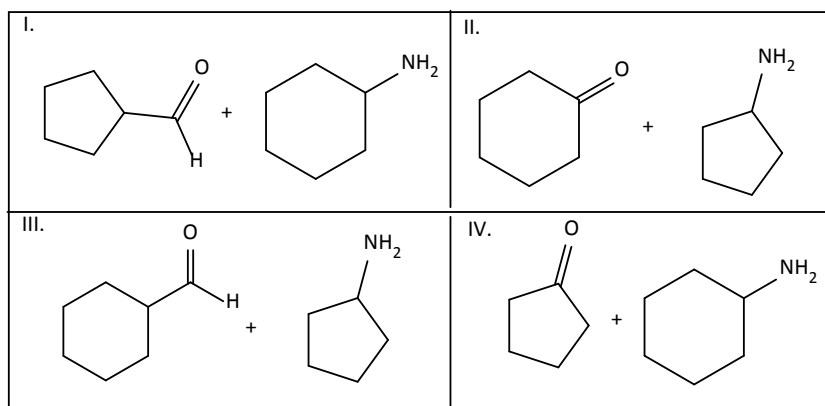
maleic anhydride



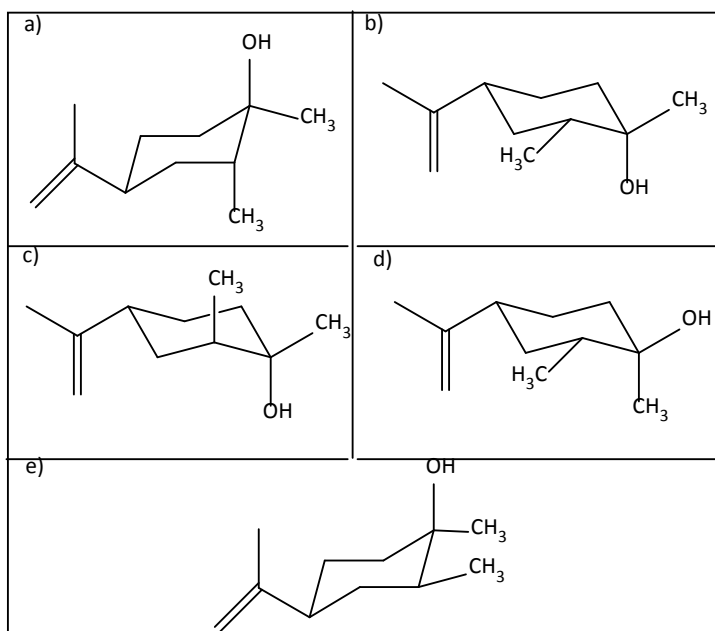
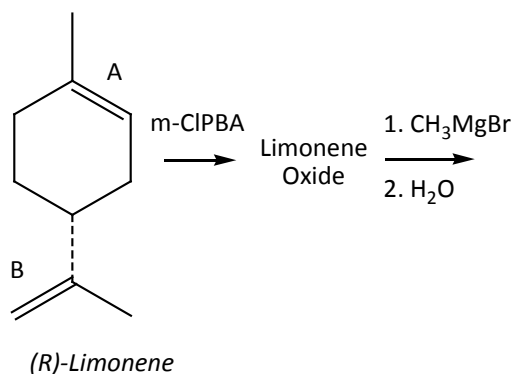
11. The imine below could be derived from which carbonyl/amine combination? **A**



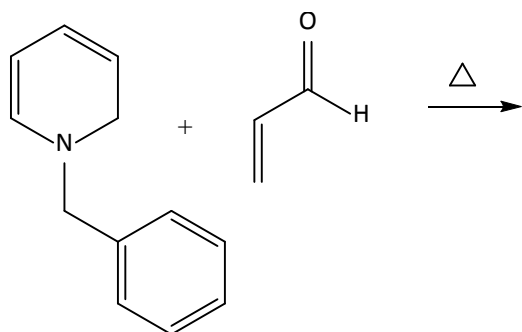
- | |
|------------|
| a) IV |
| b) III |
| c) II |
| d) II & IV |
| e) I & III |



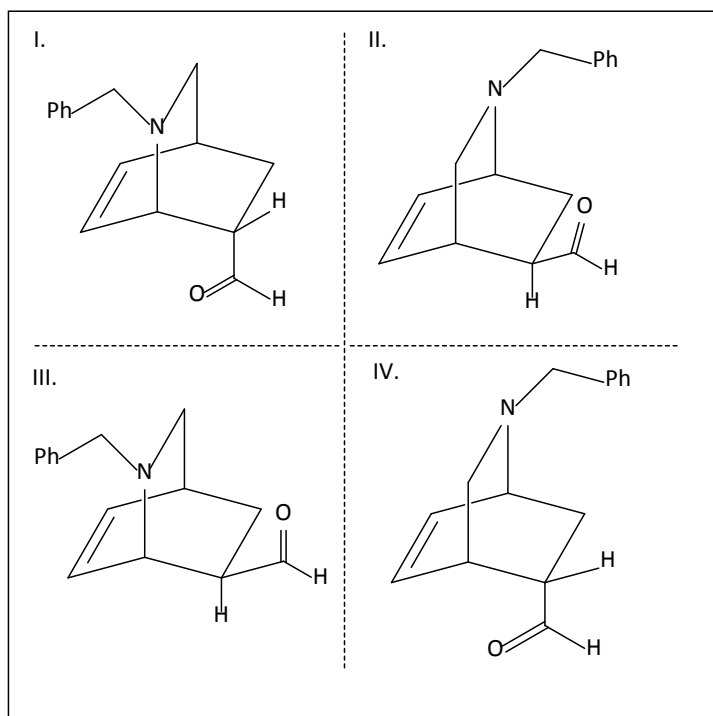
12. Reaction of (R)-limonene with m-CPBA occurs on the "A" alkene to generate limonene oxide. Limonene oxide then reacts with 1. CH_3MgBr 2. H_2O to give an alcohol product. Which of the following structures represents the chair conformation of the *final major thermodynamic product* in this reaction sequence? **D**



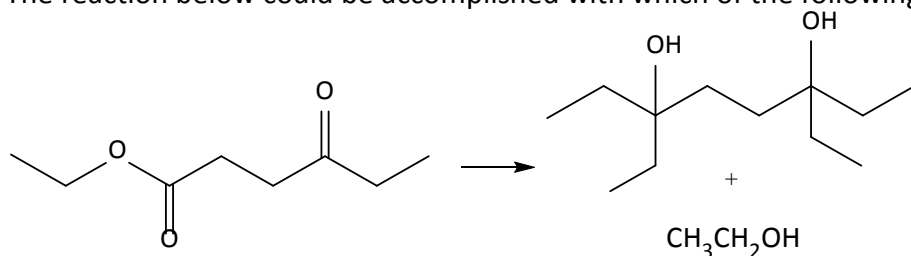
13. The major product(s) of the Diels-Alder reaction below is (are): (Ph represents benzene ring.) **A**



- a) I
b) II
c) I & II
d) IV
e) III & IV



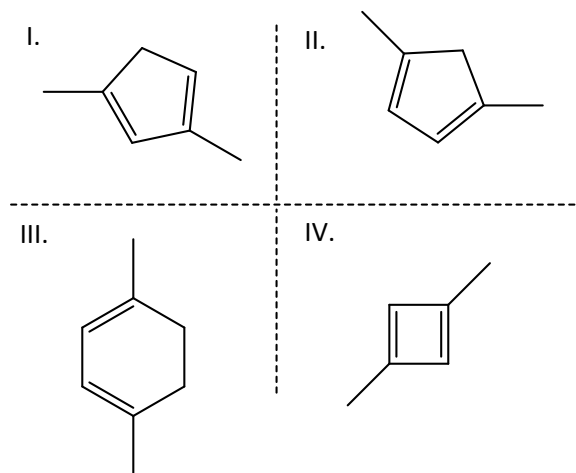
14. The reaction below could be accomplished with which of the following reagents? **A**



- I. NaBH_4 , CH_3OH
- II. 1) LiAlH_4 2) H_2O
- III. 1) $\text{CH}_3\text{CH}_2\text{Br}$, Mg 2) H_2O
- IV. 1) NaOH 2) $\text{CH}_3\text{CH}_2\text{Br}$

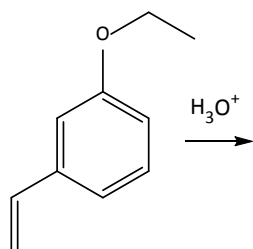
- | |
|---|
| <ul style="list-style-type: none"> a) III b) I & II c) II & III d) IV e) I, II & III |
|---|

15. In the reaction with one equivalent of HCl , which of the following dienes has a kinetic product(s) that is (are) ALSO a thermodynamic product(s)? **A**

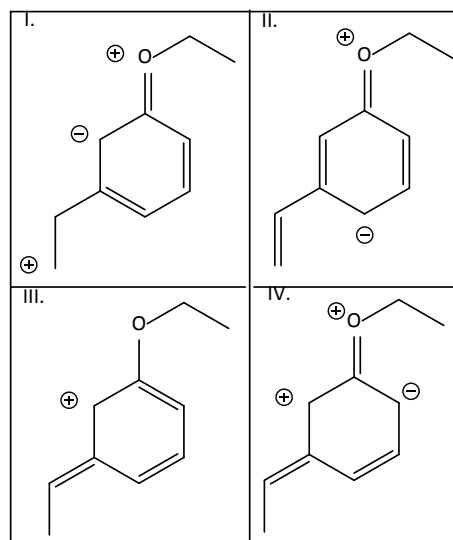


- | |
|---|
| <ul style="list-style-type: none"> a) I & IV b) I c) II & III d) IV e) I, II, III & IV |
|---|

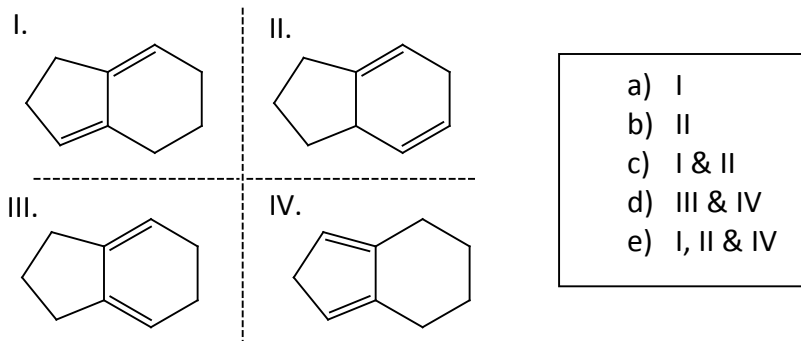
16. A resonance form of the most stable reaction intermediate that forms upon reaction of the compound below with H_3O^+ is: **A**



- a) III & IV
- b) I & II
- c) I, II, III & IV
- d) III
- e) I, III & IV

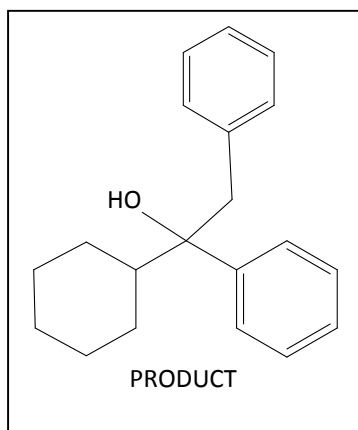


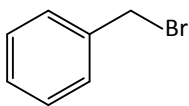
17. Which of the following dienes cannot undergo the Diels-Alder reaction? **C**

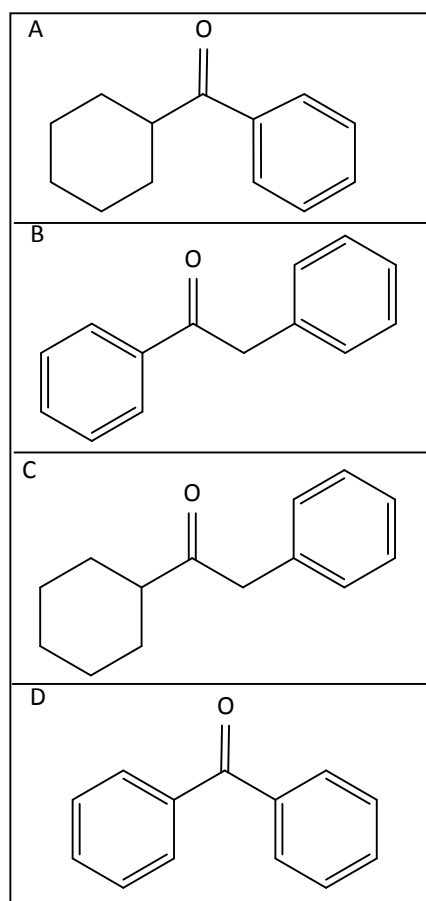


18. Which combination of reagents could be used to prepare the product given below? **B**

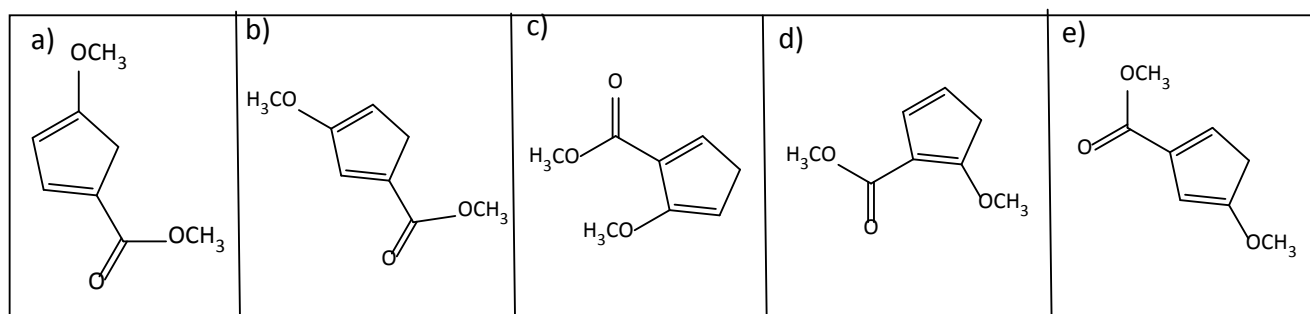
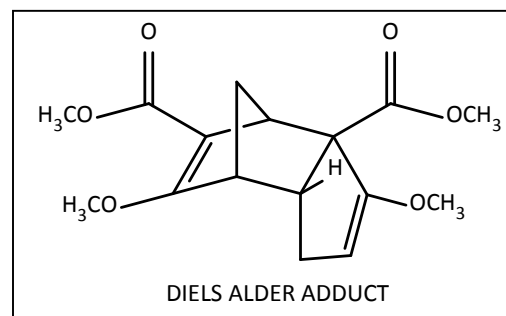
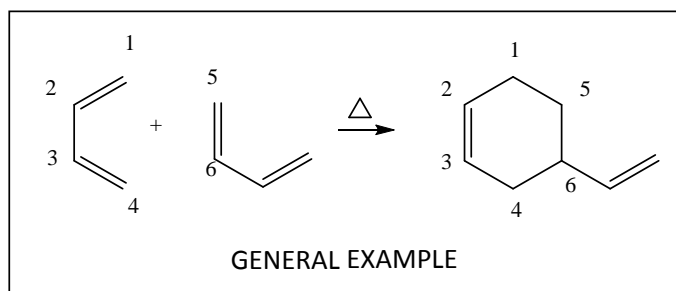
- a) A + III
b) B + IV
c) C + I
d) D + II
e) C + V



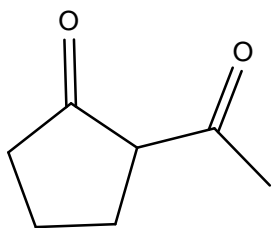
- I. NaBH_4 , CH_3OH
 II. 1. LiAlH_4 2. H_2O
 III. 1. Mg, bromobenzene 2. H_2O
 IV. 1. Mg, chlorocyclohexane 2. H_2O
 V. 1. 2 equivalents of Li,  2. H_2O



19. In some Diels-Alder reactions, the one of the alkenes of the conjugated diene behaves as a dienophile and reacts with a second equivalent of the conjugated diene to give a Diels-Alder adduct. (See general example below). Identify the starting conjugated diene that reacts this way to give the Diels-Alder adduct below. **C**

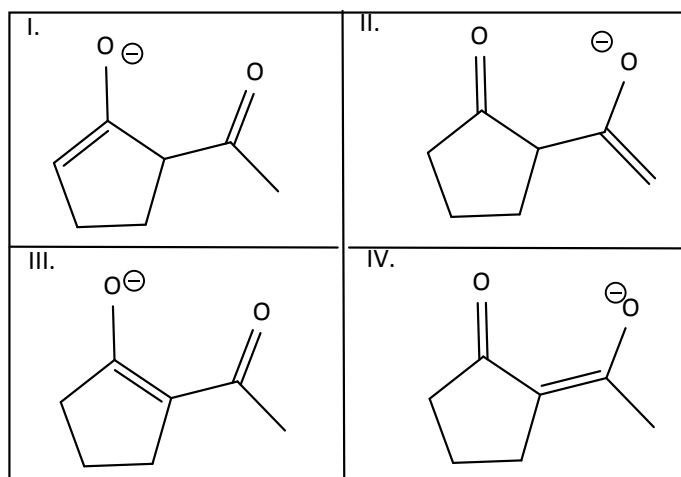


20. 2-Acetylcyclopentanone (2-ACP) is a compound that has been shown to protect against liver toxicity associated with excess use of acetaminophen (APAP). The mechanism associated with the protective activity of 2-ACP involves formation of an enolate that is generated from reaction of its most acidic hydrogen with base. Which of the following structures represents the enolate of 2-ACP that provide protection against liver toxicity caused by APAP? **C**

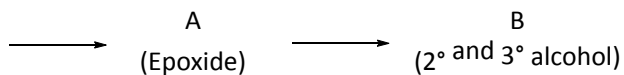
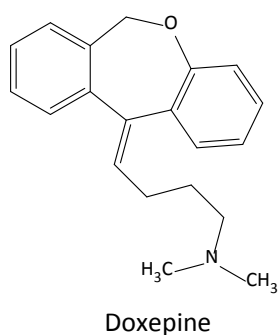


2-acetylcyclopentanone (2-ACP)

- a) I
b) I & II
c) III & IV
d) IV
e) II



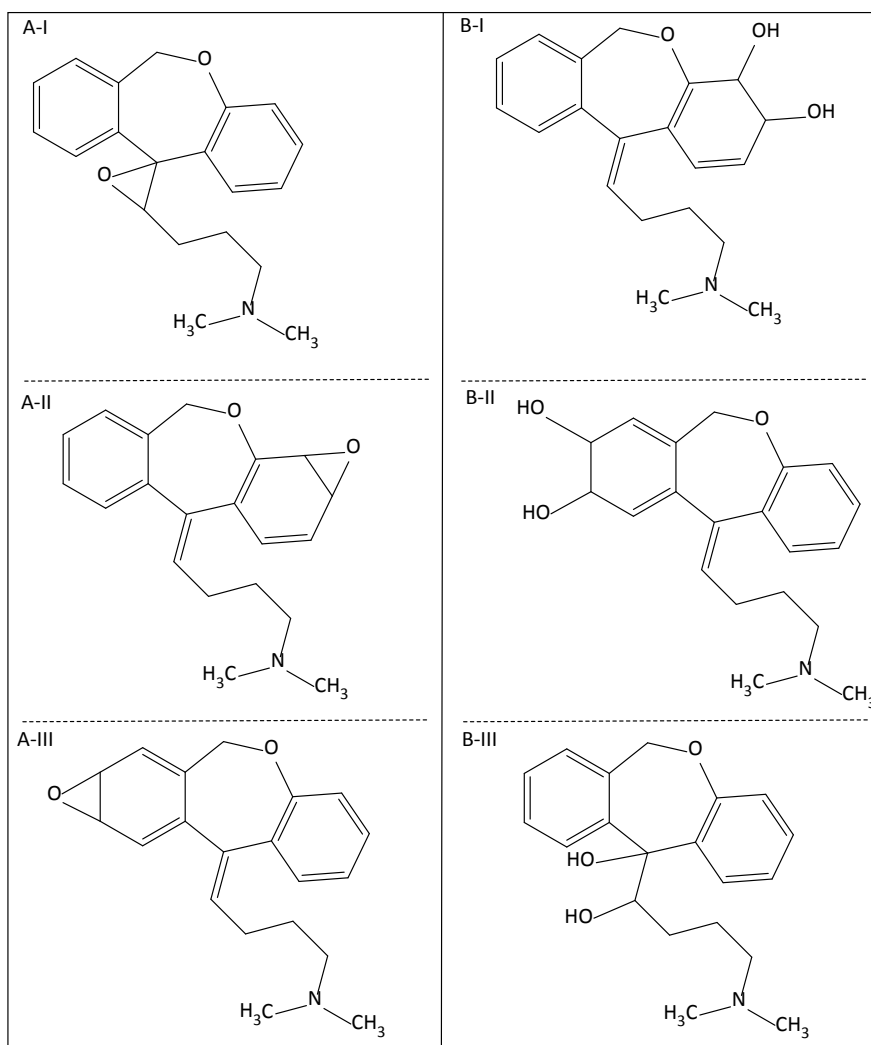
21. Doxepin is a tricyclic antidepressant. Doxepin undergoes epoxidation through a mechanism that mimics its reaction with m-CBPA as one of its metabolic pathways. This epoxide metabolite (A) reacts with water under acidic conditions to give a product (B) that contains a tertiary and secondary alcohol. Identify the epoxide (A) and product (B) generated from doxepin during its metabolism. **B**



- a) A-I & B-I
- b) A-I & B-III
- c) A-II & B-I
- d) A-III & B-II
- e) b, c & d

A
(Epoxide)

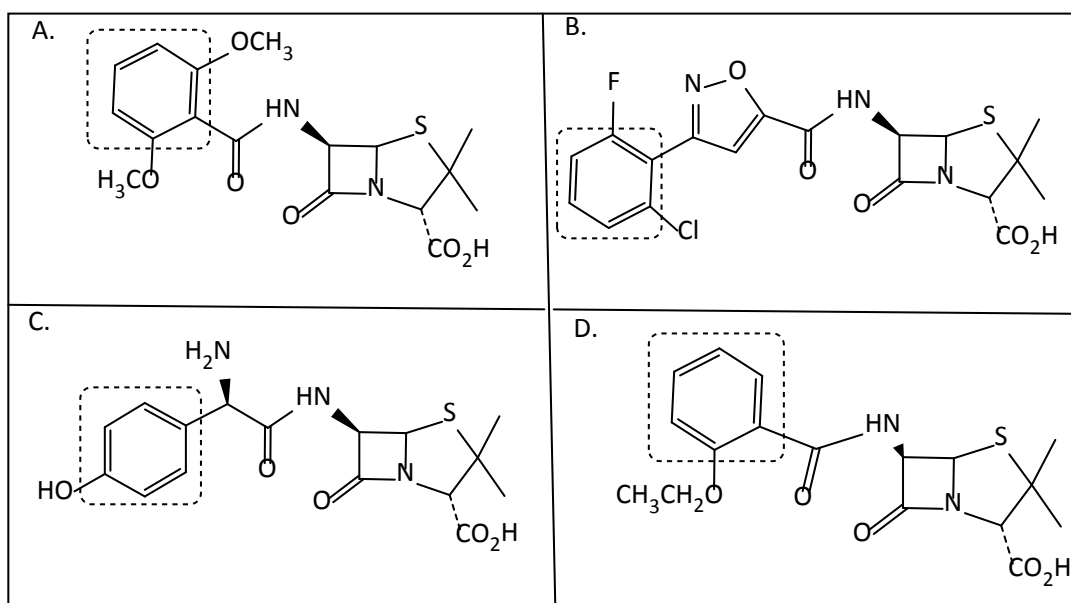
B
(2° and 3° alcohol)



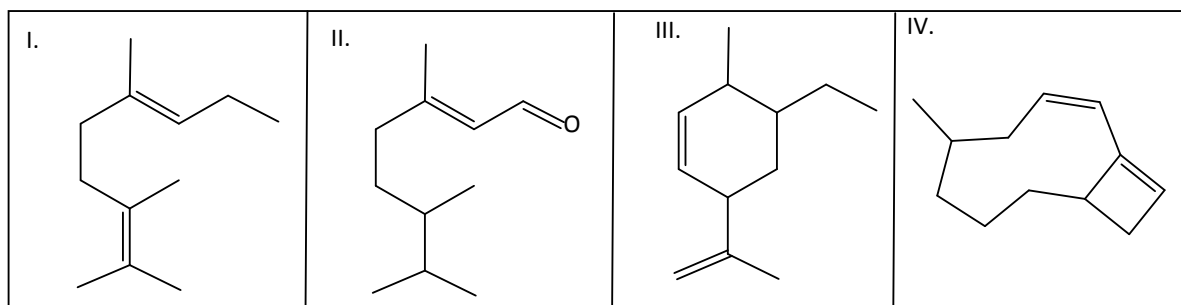
22. The structures of three penicillins are shown below. A benzene ring is highlighted in each structure. Which of the following statements is true related to the substituents that are bonded to each benzene ring. (Note: Consider the benzene ring a "parent" structure and classify substituents on each ring as electron-donating by resonance (EDG by resonance), electron-withdrawing by resonance (EWG by resonance) or electron-withdrawing by induction (EWG by induction). **D**

- I. A ring contains two EDG by resonance and one EWG by resonance.
 II. B ring contains three EWG
 III. C ring is more negative than the B ring
 IV. D ring contains one EDG by induction and one EWG by resonance

- a) I
 b) I & II
 c) IV
 d) I, II & III
 e) III

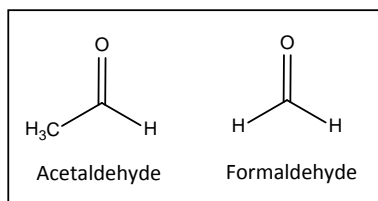
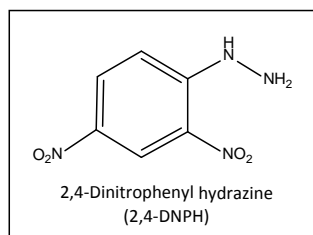


23. Which of the following compounds contains a conjugated diene? **E**

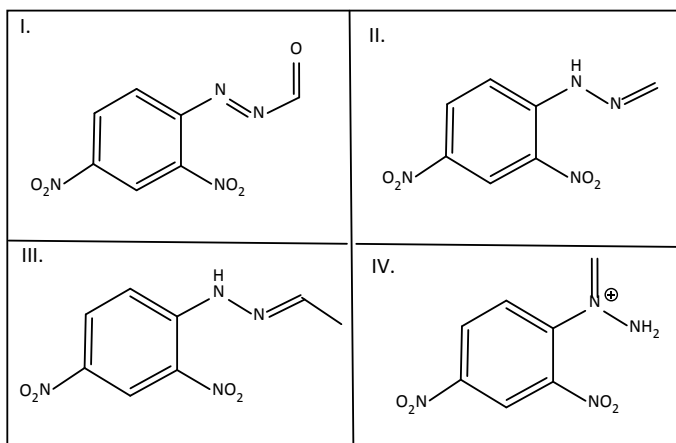


- a) I & II
 b) II & IV
 c) III
 d) III & IV
 e) IV

24. 2, 4-Dinitrophenylhydrazine is a reagent used to detect the airborne environmental toxins, acetaldehyde and formaldehyde. Reaction of 2,4-DNPH with these toxins results in formation of hydrazones that are then easily detected and quantified by visible spectroscopy. Which of the following structures represents the hydrazone that is formed upon reaction of 2,4-DNPH with formaldehyde? **B**



- a) I
- b) II
- c) II & IV
- d) III
- e) I, II & III



25. The R-enantiomer of thalidomide is a drug that was first marketed in 1957 as a sedative and later was used to treat nausea associated with morning sickness in pregnant women. It was soon discovered that the drug caused birth defects due to tautomerization of the R-enantiomer to the S-enantiomer. Which of the following structures represents the enol involved in conversion of the R-enantiomer of thalidomide to the S-enantiomer? **C**

