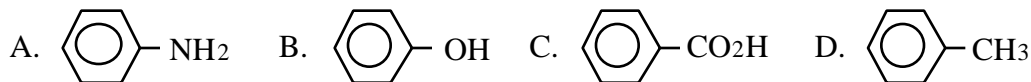
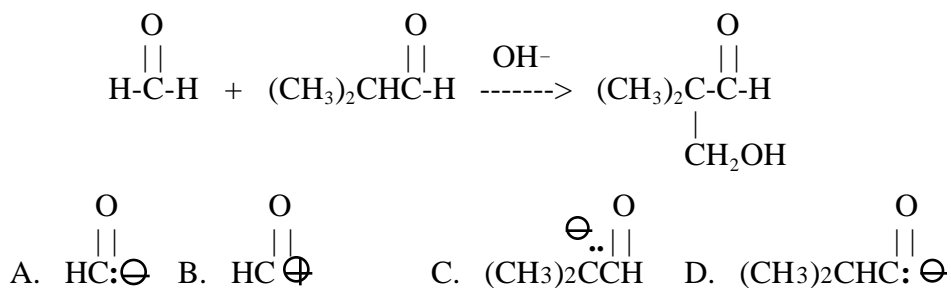


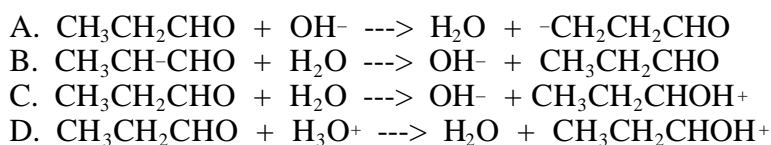
1. Which of the following compounds is insoluble in both water and 5% HCl, and soluble in both 5% NaOH and 5% NaHCO<sub>3</sub>?



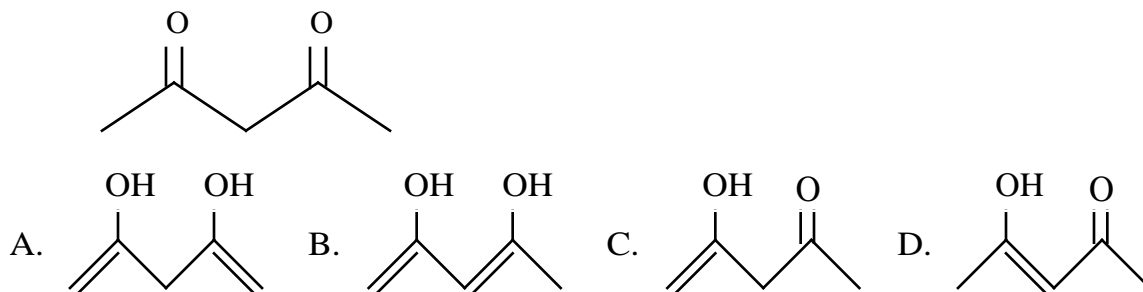
2. Which of the following species is formed during the mechanism of the reaction shown?



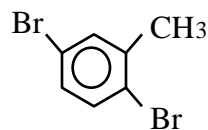
3. Which of the following is a step in the mechanism of the acid-catalyzed enolization of propanal, CH<sub>3</sub>CH<sub>2</sub>CHO?



4. What is the structure of the most stable enol form of the compound shown?

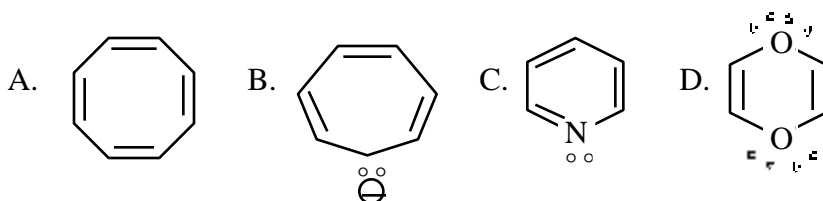


5. What is the name of the compound shown?

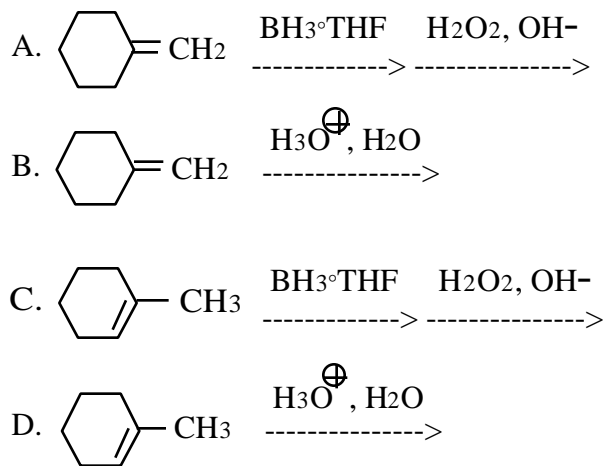


- A. 3,6-Dibromo-2-methylbenzene  
 B. 2,6-Dibromo-1-methylbenzene  
 C. 3,6-Dibromotoluene  
 D. 2,5-Dibromotoluene

6. Which of the species shown is aromatic?



7. Which of the following reactions gives *trans*-2-methylcyclohexanol as the major product?



8. Which of the compounds shown has the lowest boiling point?

- A.  $(\text{CH}_3)_3\text{COH}$   
 B.  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$   
 C.  $\text{CH}_3\text{CH}_2\text{OCH}_2\text{CH}_3$   
 D.  $(\text{CH}_3)_2\text{CHOCH}_3$

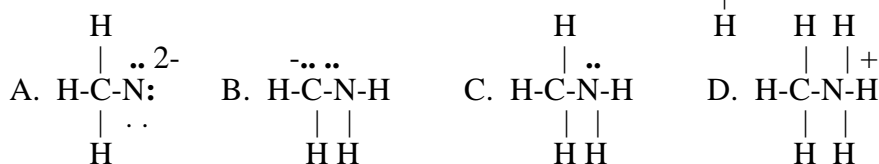
9. Consider the reaction  $(\text{CH}_3)_2\text{CHI} + \text{CH}_3\text{OH} \rightarrow (\text{CH}_3)_2\text{CHOCH}_3 + \text{HI}$ . What is the mechanism of the reaction? Use the data table at right.

	$[(\text{CH}_3)_2\text{CHI}]$	$[\text{CH}_3\text{OH}]$	rel. rate
A. SN1			
B. SN2	0.02	0.02	1
C. E1	0.04	0.02	2
D. E2	0.04	0.04	2

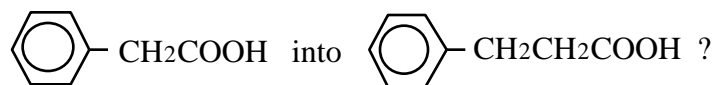
10. Which of the following compounds is an ester?



11. What is the structure of the conjugate base of the ion  $\text{H}-\overset{\text{H}}{\underset{\cdot\cdot}{\text{C}}}-\overset{\cdot\cdot}{\text{N}}-\text{H}$ ?

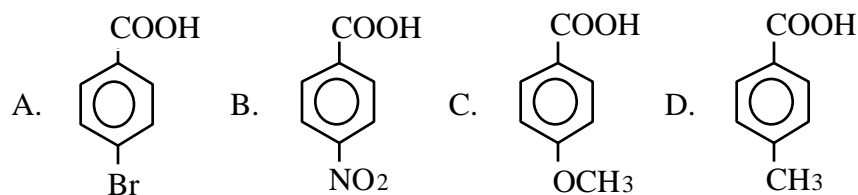


12. Which of the following reaction sequences can be used to convert



- A.  $\text{LiAlH}_4$ , then  $\text{H}_3\text{O}^+$ ;  $\text{PBr}_3$ ;  $\text{Mg/ether}$ ,  $\text{CO}_2$ , then  $\text{H}_3\text{O}^+$   
 B.  $\text{SOCl}_2$ ;  $(\text{CH}_3)_2\text{CuLi}$ ;  $\text{LiAlH}_4$ , then  $\text{H}_3\text{O}^+$   
 C.  $\text{SOCl}_2$ ; then  $\text{NaCN}$ , then  $\text{H}_3\text{O}^+/\text{heat}$   
 D.  $\text{LiAlH}_4$ , then  $\text{H}_3\text{O}^+$ ;  $\text{H}_2\text{CrO}_4$
13. Which of the following acid-base reactions occurs as written?
- A.  $\text{CH}_3\text{CO}_2\text{Na} + \text{CH}_3\text{CH}_2\text{OH} \rightarrow \text{CH}_3\text{CO}_2\text{H} + \text{CH}_3\text{CH}_2\text{ONa}$   
 B.  $\text{HOMgBr} + \text{CH}_3\text{CH}_2\text{OH} \rightarrow \text{H}_2\text{O} + \text{CH}_3\text{CH}_2\text{OMgBr}$   
 C.  $\text{CH}_3\text{OH} + \text{CH}_3\text{CH}_2\text{MgBr} \rightarrow \text{CH}_3\text{CH}_3 + \text{CH}_3\text{OMgBr}$   
 D.  $\text{CH}_3\text{CH}_2\text{ONa} + \text{CH}_3\text{C}\equiv\text{CH} \rightarrow \text{CH}_3\text{CH}_2\text{OH} + \text{CH}_3\text{C}\equiv\text{CNa}$

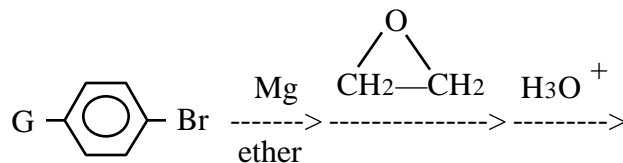
14. Which of the following compounds is the strongest acid?

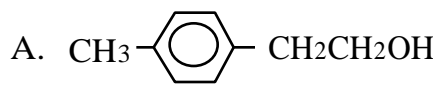
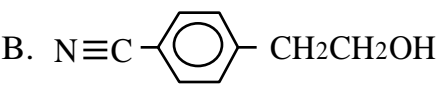
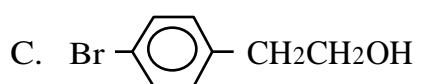
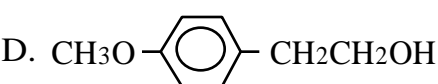


15. Which of the following gives benzaldehyde from benzoic acid?

- A.  $\text{LiAlH}_4$   
 B. PCC (pyridinium chlorochromate)  
 C.  $\text{NaBH}_4$ , followed by  $\text{Na}_2\text{Cr}_2\text{O}_7/\text{H}_2\text{SO}_4$   
 D.  $\text{SOCl}_2$ , followed by  $\text{H}_2/\text{Ni}_2\text{B}$

16. Which of the following alcohols cannot be synthesized using the reaction sequence shown?

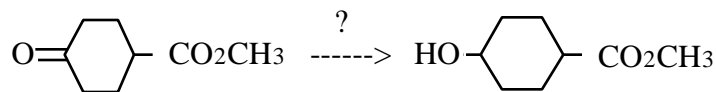


- A.  B.   
 C.  D. 

17. Which of the following reagents can be used to distinguish between 1-pentanol and 2-pentanol?

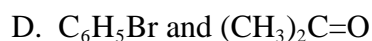
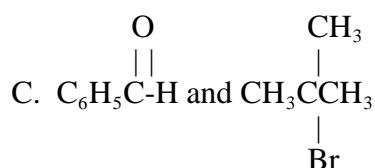
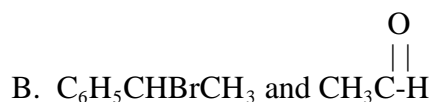
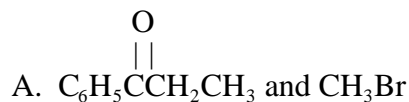
- A.  $\text{I}_2/\text{NaOH}$  B.  $\text{CrO}_3/\text{H}_2\text{SO}_4$  C.  $\text{Br}_2/\text{CCl}_4$  D.  $\text{Br}_2/\text{H}_2\text{O}$

18. Which of the following reagents is used to carry out the transformation shown?

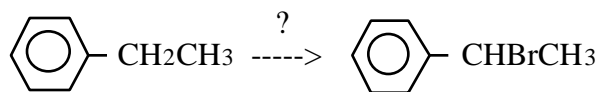


- A.  $\text{LiAlH}_4$  B.  $\text{NaBH}_4$  C.  $\text{CrO}_3/\text{H}_2\text{SO}_4$  D. PCC

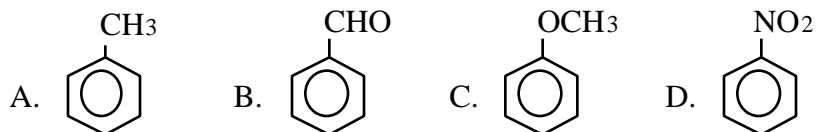
19. In the Grignard synthesis of  $\text{C}_6\text{H}_5\text{C}(\text{OH})(\text{CH}_3)\text{CH}_2\text{CH}_3$ , which of the following pairs of compounds can be used as starting materials?



20. Which of the following reagents is used to give the transformation shown?



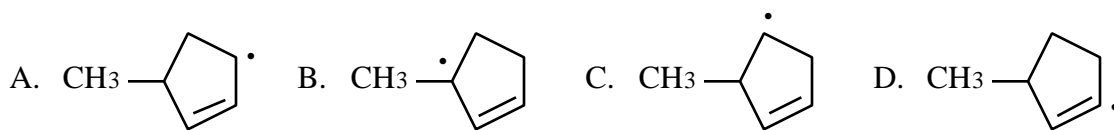
- A.  $\text{Br}_2/\text{FeBr}_3$  B.  $\text{Br}_2/\text{light}$  C.  $\text{Br}_2/\text{P}$  D.  $\text{Br}_2/\text{H}_2\text{O}$
21. Which of the following compounds is the most reactive toward  $\text{Br}_2/\text{FeBr}_3$ ?



22. The nitration of benzaldehyde yields predominantly:

- A. *o*-Nitrobenzaldehyde.  
 B. *m*-Nitrobenzaldehyde.  
 C. *p*-Nitrobenzaldehyde.  
 D. a mixture of the *ortho* and *para* isomers.

23. Which of the following free radicals is the most stable?



24. What alkene is the major organic product of the dehydration of  $(\text{CH}_3)_2\text{CHCH}_2\text{CH}_2\text{OH}$  with concentrated sulfuric acid?

A. 3-methyl-1-butene B. 2-Pentene C. 2-methyl-1-butene D. 2-methyl-2-butene

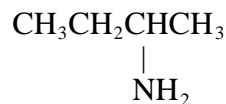
25. Which of the following reagents can be used to distinguish between 1-pentene and 1-pentyne?

A.  $\text{Br}_2$  in  $\text{CCl}_4$   
 B. Cold aqueous  $\text{KMnO}_4$   
 C. Chromic acid  
 D. Silver nitrate in aqueous ammonia

26. What is the most stable conformation of *cis*-3-*tert*-butyl-1-methylcyclohexane?

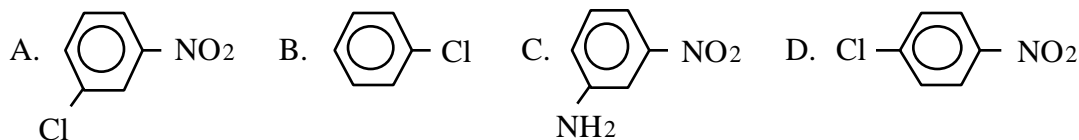
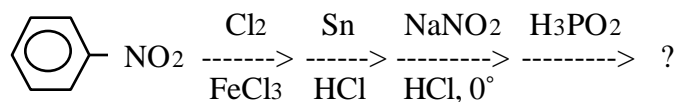
A. The methyl group is axial and the *tert*-butyl group is equatorial.  
 B. The *tert*-butyl group is axial and the methyl group is equatorial.  
 C. Both groups are axial.  
 D. Both groups are equatorial.

27. What is the name of the compound at right?

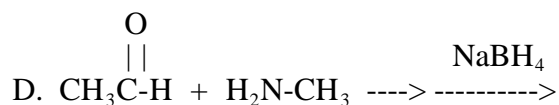
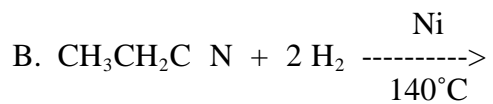
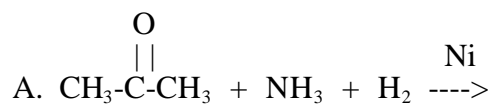


A. *n*-Butylamine B. Isobutylamine C. *sec*-Butylamine D. *tert*-Butylamine

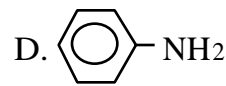
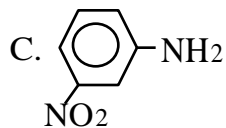
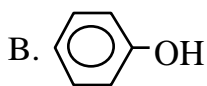
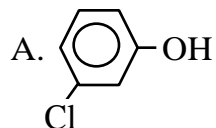
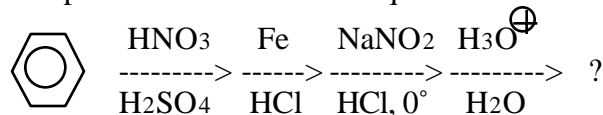
28. What is the product of the reaction sequence shown?



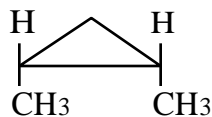
29. Which of the following processes does not yield a primary amine?



30. What is the product of the reaction sequence shown?

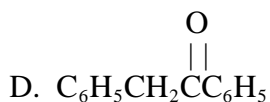
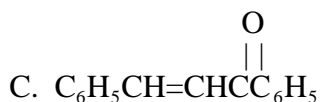
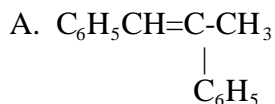
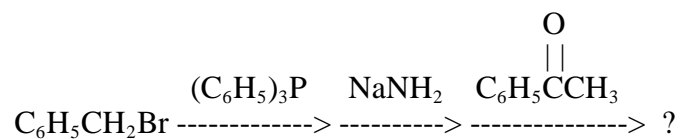


31. How many signals are present in the proton nmr spectrum of the compound shown? (Neglect signal splitting).



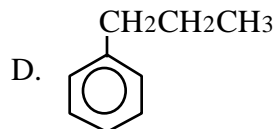
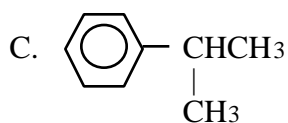
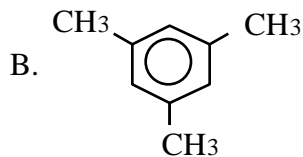
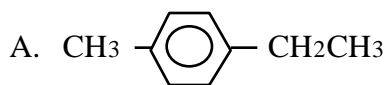
A. 1 B. 2 C. 3 D. 4

32. What is the major organic product of the following reaction sequence?

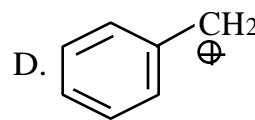
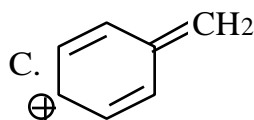
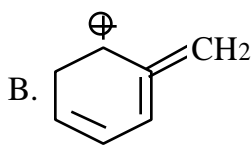
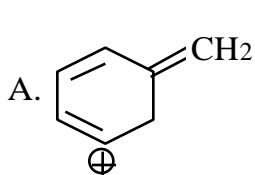


33. An unknown compound having the formula  $\text{C}_9\text{H}_{12}$  gave the following proton nmr spectrum. What is the structure of this unknown?

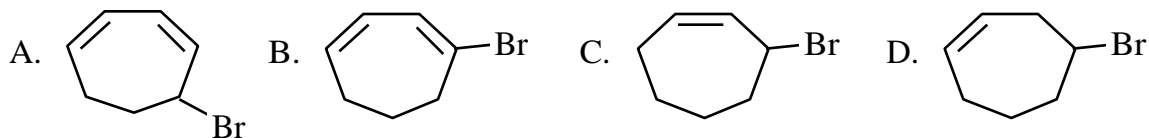
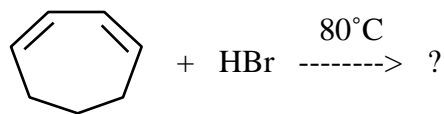
doublet at 1.25  
septet at 2.90  
multiplet at 7.25



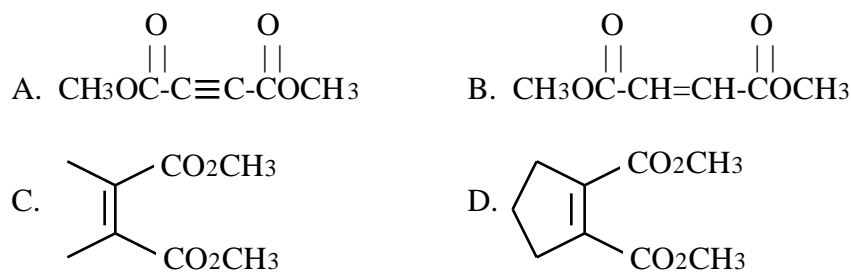
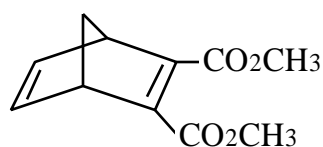
34. Which of the following is the most important contributor to the resonance hybrid of the benzyl carbocation?



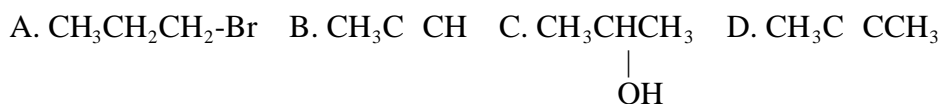
35. What is the major organic product of the reaction shown?



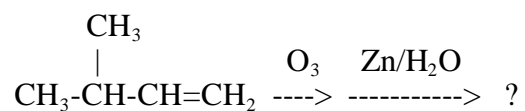
36. What dienophile is used to synthesize the compound shown?



37. Which of the following compounds is soluble in concentrated  $\text{H}_2\text{SO}_4$ , gives no reaction with either  $\text{AgNO}_3/\text{alcohol}$  or  $\text{Ag}(\text{NH}_3)_2^+$ , and rapidly decolorizes  $\text{Br}_2/\text{CCl}_4$ ?



38. Which of the following compounds is a product of the reaction shown?



A.  $\text{CH}_2=\text{CH-OH}$

B.  $\begin{array}{c} \text{CH}_3 \quad \text{OH} \\ | \quad | \\ \text{CH}_3\text{-CH-CH-CH}_2\text{OH} \end{array}$

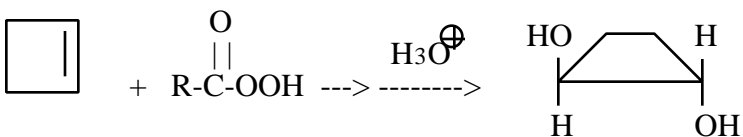
C.  $\begin{array}{c} \text{O} \\ || \\ \text{H-C-OH} \end{array}$

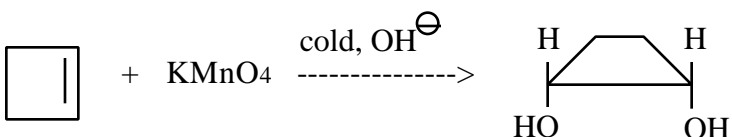
D.  $\begin{array}{c} \text{O} \\ || \\ \text{H-C-H} \end{array}$

39. Which of the following reactions does not occur as shown?

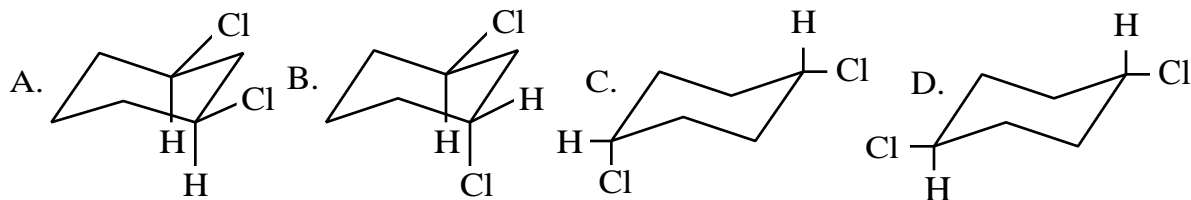
A.  $\text{CH}_3\text{-CH=CH}_2 + \text{HBr} \rightarrow \text{CH}_3\text{CHBrCH}_3$

B.  $\text{CH}_3\text{-CH=CH}_2 + 2 \text{H}_2\text{O} \rightarrow \text{CH}_3\text{CHOHCH}_2\text{OH}$

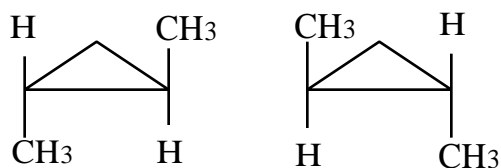
C. 
 $\text{Cyclobutene} + \text{R-C(=O)-OOH} \xrightarrow{\text{H}_3\text{O}^+} \text{trans-1,2-cyclobutane-1,2-diol}$

D. 
 $\text{Cyclobutene} + \text{KMnO}_4 \xrightarrow{\text{cold, OH}^-} \text{cis-1,2-cyclobutane-1,2-diol}$

40. Which of the compounds shown does not have a plane of symmetry?

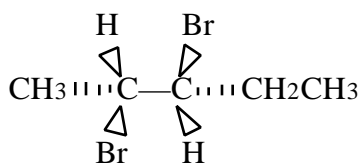


41. What is the relationship between the structures shown?



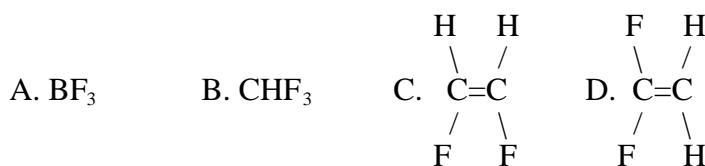
- A. Same compound
- B. Enantiomers
- C. Diastereomers
- D. Structural isomers

42. What is the configuration of the compound shown?



- A. 2R, 3R
- B. 2R, 3S
- C. 2S, 3R
- D. 2S, 3S

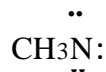
43. Which of the following compounds has the smallest dipole moment?



44. What is the shape of the ion  $\text{:CH}_3^-$ ?

- A. Trigonal planar
- B. Tetrahedral
- C. Trigonal pyramidal
- D. Angular (bent)

45. What is the total charge of the species shown?



- A. 0
- B. -1
- C. +1
- D. -2