

Maharashtra State Board Class 12 Chemistry Solutions Chapter 11

Alcohols, Phenols and Ethers

1. Choose the correct option.

Question i.

Which of the following represents the increasing order of boiling points of (1), (2), and (3)?

(1) $\text{CH}_3 - \text{CH}_2 - \text{CH}_2 - \text{CH}_2 - \text{OH}$

(2) $(\text{CH}_3)_2\text{CH} - \text{O} - \text{CH}_3$

(3) $(\text{CH}_3)_3\text{COH}$

A. (1) < (2) < (3)

B. (2) < (1) < (3)

C. (3) < (2) < (1)

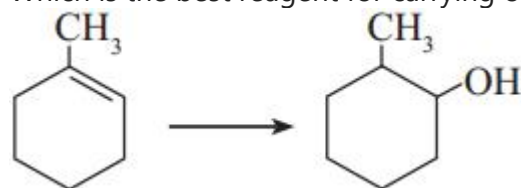
D. (2) < (3) < (1)

Answer:

(a) (1) < (2) < (3)

Question ii.

Which is the best reagent for carrying out following conversion ?



A. LiAlH_4

B. Conc. H_2SO_4 , H_2O

C. H_2/Pd

D. B_2H_6 , $\text{H}_2\text{O}_2 - \text{NaOH}$

Answer:

B. Conc. H_2SO_4 , H_2O

Question iii.

Which of the following reaction will give ionic organic product on reaction ?

A. $\text{CH}_3 - \text{CH}_2 - \text{OH} + \text{Na}$

B. $\text{CH}_3 - \text{CH}_2 - \text{OH} + \text{SOCl}_2$

C. $\text{CH}_3 - \text{CH}_2 - \text{OH} + \text{PCl}_5$

D. $\text{CH}_3 - \text{CH}_2 - \text{OH} + \text{H}_2\text{SO}_4$

Answer:

C. $\text{CH}_3 - \text{CH}_2 - \text{OH} + \text{PCl}_5$

Question iv.

Which is the most resistant alcohol towards oxidation reaction among the following ?

A. $\text{CH}_3 - \text{CH}_2 - \text{OH}$ B. $(\text{CH}_3)_2\text{CH} - \text{OH}$

C. $(\text{CH}_3)_3\text{C} - \text{OH}$ D. $\text{C}_2\text{H}_5 - \underset{\text{CH}_3}{\text{CH}} - \text{OH}$

Answer:

(c)

Question v.

Resorcinol on distillation with zinc dust gives

A. Cyclohexane

B. Benzene

C. Toluene

D. Benzene-1, 3-diol

Answer:

(b) Benzene

Question vi.

Anisole on heating with concentrated HI gives

A. Iodobenzene

B. Phenol + Methanol

C. Phenol + Iodomethane

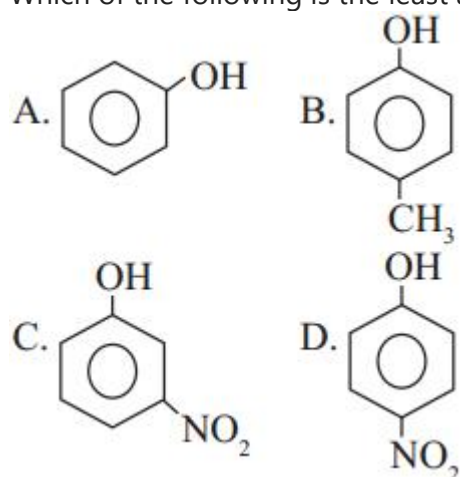
D. Iodobenzene + methanol

Answer:

B. Phenol + Methanol

Question vii.

Which of the following is the least acidic compound ?

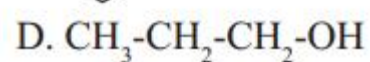
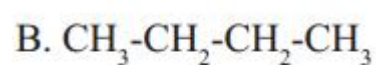


Answer:

(b)

Question viii.

The compound incapable of hydrogen bonding with water is



Answer:

(b)

Question ix.

Ethers are kept in air tight brown bottles because

- A. Ethers absorb moisture
- B. Ethers evaporate readily
- C. Ethers oxidise to explosive peroxide
- D. Ethers are inert

Answer:

C. Ethers oxidise to explosive peroxide

Question x.

Ethers reacts with cold and concentrated H_2SO_4 to form

- A. oxonium salt
- B. alkene
- C. alkoxides
- D. alcohols

Answer:

A. oxonium salt

2. Answer in one sentence/ word.

Question i.

Hydroboration-oxidation of propene gives.....

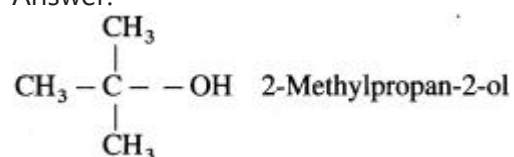
Answer:

n-propyl alcohol ($\text{CH}_3\text{-CH}_2\text{-CH}_2\text{-OH}$)

Question ii.

Write the IUPAC name of alcohol having molecular formula $\text{C}_4\text{H}_{10}\text{O}$ which is resistant towards oxidation.

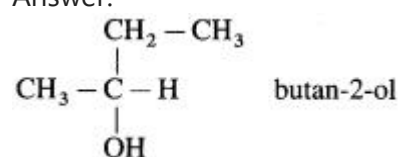
Answer:



Question iii.

Write the structure of optically active alcohol having molecular formula $\text{C}_4\text{H}_{10}\text{O}$

Answer:



Question iv.

Write name of the electrophile used in Kolbe's Reaction.

Answer:

Electrophile : Carbon dioxide ($\text{O} = \text{C} = \text{O}$)

3. Answer in brief.

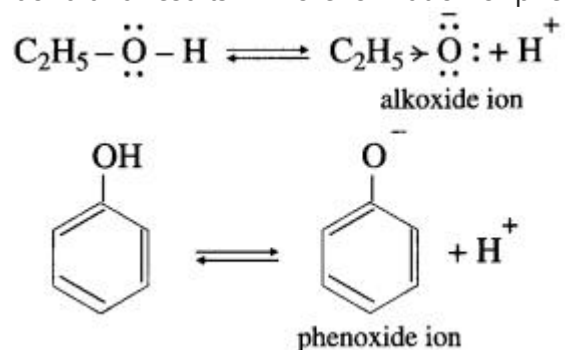
Question i.

Why phenol is more acidic than ethyl alcohol ?

Answer:

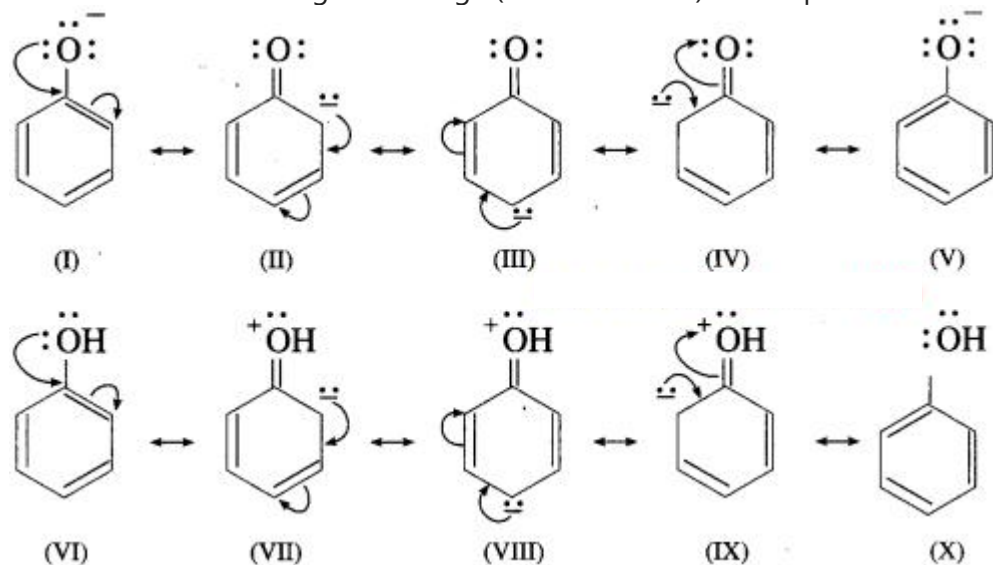
(1) In ethyl alcohol, the -OH group is attached to sp^3 – hybridised carbon while in phenols, it is attached to sp^2 – hybridised carbon.

(2) Due to higher electronegativity of sp^2 – hybridised carbon, electron density on oxygen decreases. This increases the polarity of O-H bond and results in more ionization of phenol than that of alcohols.



(3) Electron donating inductive effect (+I effect) of the alkyl group destabilizes alkoxide ion. As a result alcohol does not ionize much in water, therefore alcohol is neutral compound in aqueous medium.

(4) In alkoxide ion, the negative charge is localized on oxygen, while in phenoxide ion the negative charge is delocalized. The delocalization of the negative charge (structure I to V) makes phenoxide ion more stable than that of phenol.



The delocalization of charge in phenol (structures VI to X), the resonating structures have charge separation (where oxygen atom of OH group to be positive and delocalization of negative charge over the ortho and para positions of aromatic ring) due to which phenol molecule is less stable than phenoxide ion. This favours ionization of phenol. Thus phenols are more acidic than ethyl alcohol.

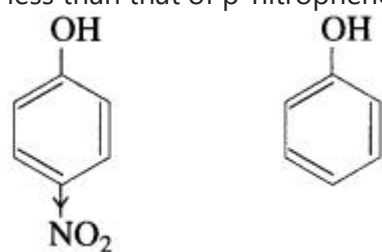
Question ii.

Why p-nitrophenol is a stronger acid than phenol ?

Answer:

(1) In p-nitrophenol, nitro group (NO_2) is an electron withdrawing group present at para position which enhances the acidic strength (-I effect). The O-H bond is under strain and release of proton (H^+) becomes easy. Further p-nitrophenoxide ion is more stabilised due to resonance.

(2) Since the absence of electron withdrawing group (like – NO₂) in phenol at ortho and para position, the acidic strength of phenol is less than that of p-nitrophenol.



Question iii.

Write two points of difference between properties of phenol and ethyl alcohol.

Answer:

Alcohol	Phenol
(1) Aqueous alcohol is a volatile liquid and neutral to litmus.	(1) Phenol is a low melting solid. Aqueous phenol turns blue litmus red. Therefore, phenol is acidic in nature.
(2) Alcohol does not react with aq. NaHCO ₃ or aq. NaOH.	(2) Phenol does not react with aq. NaHCO ₃ but reacts with NaOH $\text{Ar.OH} + \text{NaHCO}_3 \rightarrow \text{No reaction (aq)}$ $\text{Ar.OH} + \text{NaOH} \rightarrow \text{Ar} - \text{O}^-\text{Na}^+ + \text{H}_2\text{O(l)} \quad (\text{aq})$
(3) Alcohol does not react with neutral ferric chloride.	(3) Phenol reacts with neutral ferric chloride solution to give deep (purple/violet/green) colouration of ferric phenoxide. $3\text{Ar} - \text{OH} + \text{FeCl}_3 \rightarrow (\text{Ar} - \text{O})_3 - \text{Fe} + 3\text{HCl}$ <div style="display: flex; justify-content: space-around; width: 100%;"> neutral deep colour </div>
(4) It is non-corrosive.	(4) It is corrosive.

Question iv.

Give the reagents and conditions necessary to prepare phenol from

- Chlorobenzene
- Benzene sulfonic acid.

Answer:

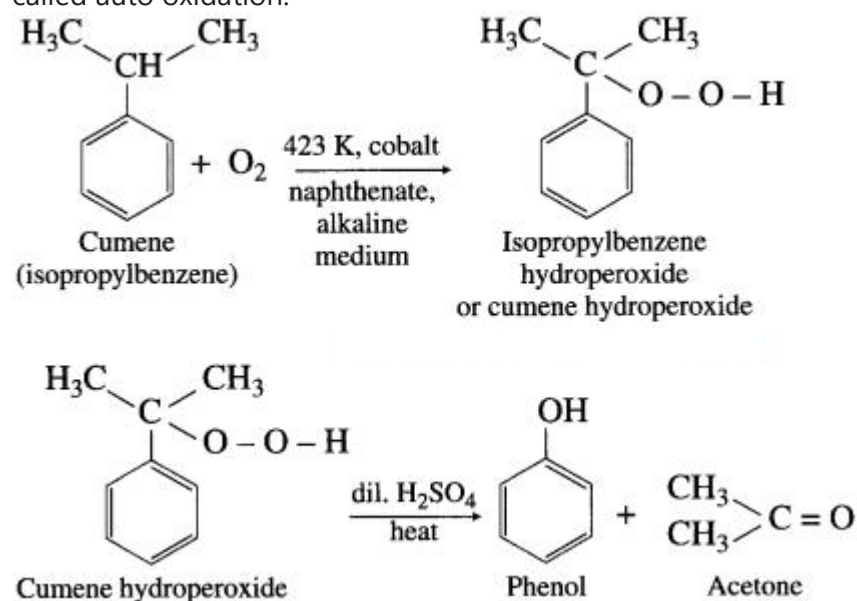
- From chlorobenzene : Reagents required : NaOH and dil. HCl Temperature : 623 K, Pressure : 150 atm
- From Benzene sulphonic acid : Reagents required : aq NaOH, caustic soda, dil. HCl Temperature : 573 K

Question v.

Give the equations of the reactions for the preparation of phenol from isopropyl benzene.

Answer:

Preparation of phenol from cumene (isopropylbenzene) : This is the commercial method of preparation of phenol. When a stream of air is passed through cumene (isopropylbenzene) suspended in aqueous Na₂CO₃ solution in the presence of cobalt naphthenate catalyst, isopropyl benzene hydroperoxide or cumene hydroperoxide is formed. Isopropylbenzene hydroperoxide on warming with dil. H₂SO₄ gives phenol and acetone. Acetone is an important by-product of the reaction and is separated by distillation. The reaction is called auto oxidation.

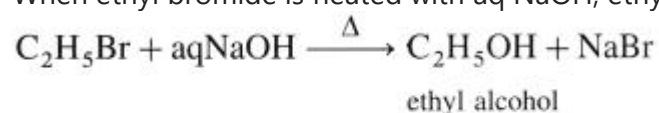


Question vi.

Give a simple chemical test to distinguish between ethanol and ethyl bromide.

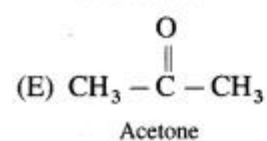
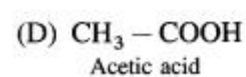
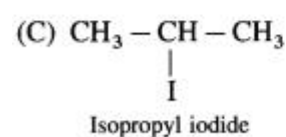
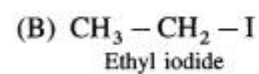
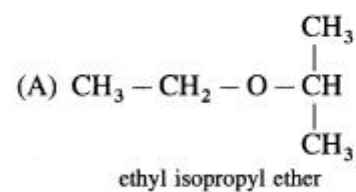
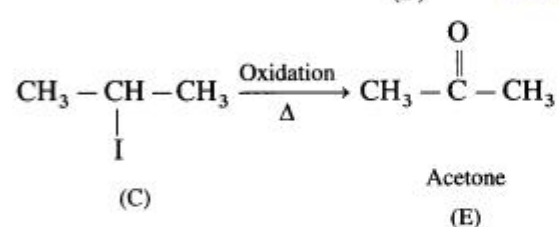
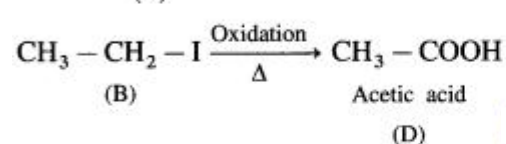
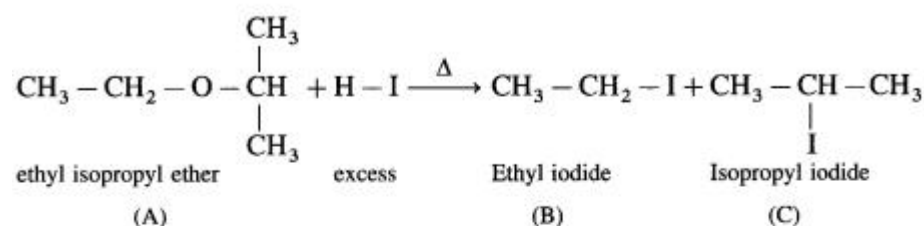
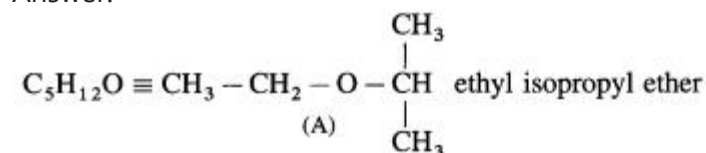
Answer:

When ethyl bromide is heated with aq NaOH; ethyl alcohol is formed whereas ethanol does not react with aq NaOH



4. An ether (A), $\text{C}_5\text{H}_{12}\text{O}$, when heated with excess of hot HI produce two alkyl halides which on hydrolysis form compound (B) and (C), oxidation of (B) gave an acid (D), whereas oxidation of (C) gave a ketone (E). Deduce the structural formula of (A), (B), (C), (D) and (E).

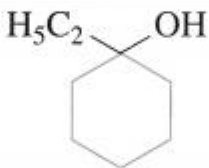

Answer:



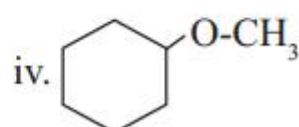
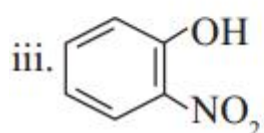
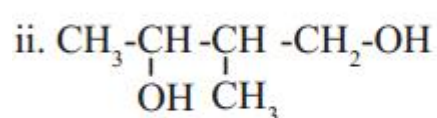
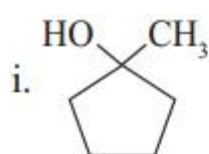
5. Write structural formulae for

- 3-Methoxyhexane
- Methyl vinyl ether
- 1-Ethylcyclohexanol
- Pentane-1,4-diol
- Cyclohex-2-en-1-ol

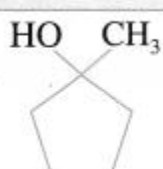
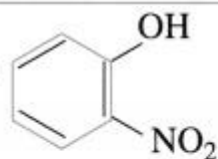
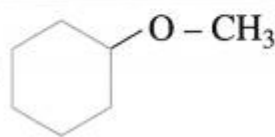
Answer:

IUPAC name	Ans.	Structural formula
1. 3-Methoxyhexane		$\begin{array}{c} \text{CH}_3 - \text{CH}_2 - \text{CH} - \text{CH}_2 - \text{CH}_2 - \text{CH}_3 \\ \\ \text{O} - \text{CH}_3 \end{array}$
2. Methyl vinyl ether		$\text{CH}_2 = \text{CH} - \text{OCH}_3$
3. 1-Ethylcyclohexanol		
4. Pentane-1, 4-diol		$\begin{array}{c} \text{H}_2\text{C} - \text{CH}_2 - \text{CH}_2 - \text{CH} - \text{CH}_3 \\ \qquad \qquad \qquad \\ \text{OH} \qquad \qquad \qquad \text{OH} \end{array}$
5. Cyclohex-2-en-1-ol		

6. Write IUPAC names of the following



Answer:

Compound	Ans.	IUPAC name
1. 		1-Methyl cyclopentanol
2. $\begin{array}{c} \text{CH}_3 - \text{CH} - \text{CH} - \text{CH}_2 - \text{OH} \\ \qquad \\ \text{OH} \quad \text{CH}_3 \end{array}$		2-Methyl butane-1, 3-diol
3. 		2-Nitrophenol (o-nitrophenol)
4. 		Methoxy cyclohexane

Activity :

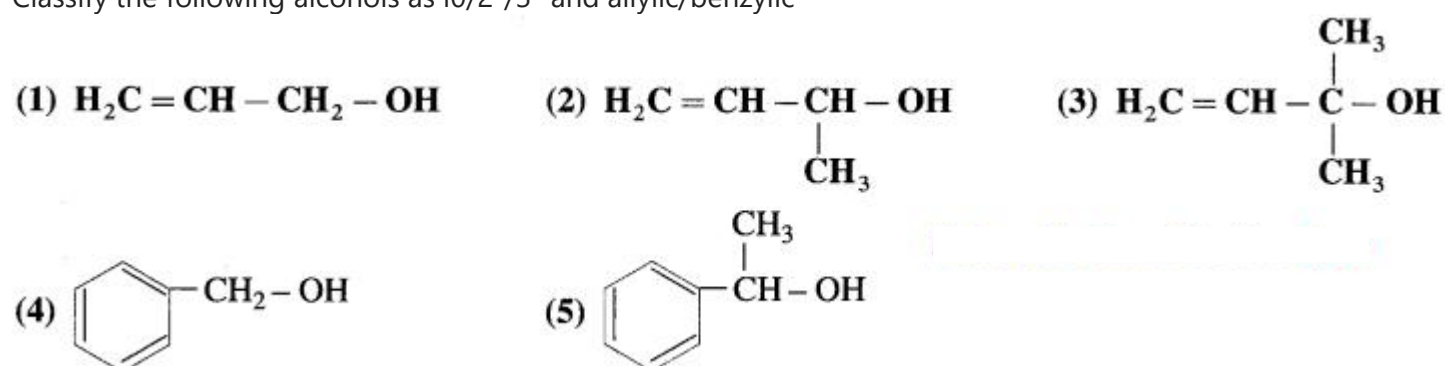
- Collect information about production of ethanol as byproduct in sugar industry and its importance in fuel economy.
- Collect information about phenols used as antiseptics and polyphenols having antioxidant activity.

12th Chemistry Digest Chapter 11 Alcohols, Phenols and Ethers Intext Questions and Answers

Use your brain power! (Textbook Page No 235)

Question 1.

Classify the following alcohols as 1°/2°/3° and allylic/benzylic



Answer:

- (1) Allylic alcohol (primary)
- (2) Allylic alcohol (secondary)
- (3) Allylic alcohol (tertiary)
- (4) Benzylic alcohol (primary)
- (5) Benzylic alcohol (secondary)

Use your brain power (Textbook Page No 236)

Question 1.

Name t-butyl alcohol using carbinol system of nomenclature.

Answer:

Trimethyl carbinol.

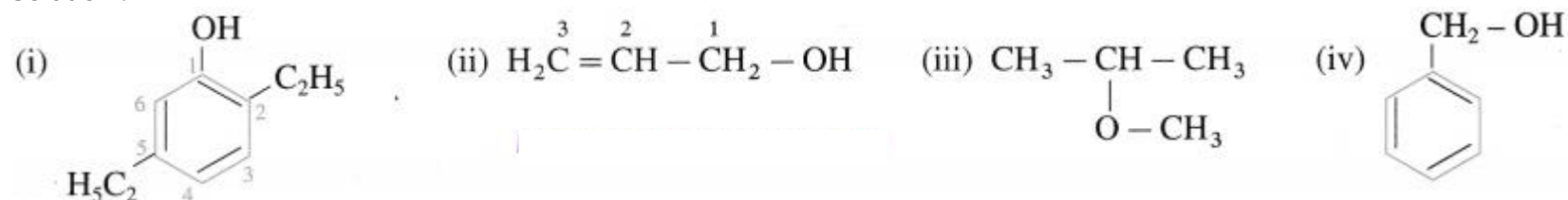
Problem 11.1 (Textbook Page No 238)

Question 1.

Draw structures of following compounds:

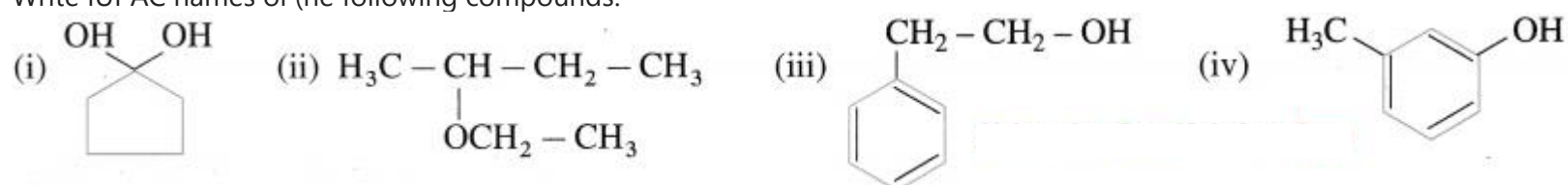
- (i) 2,5-Diethylphenol
- (ii) Prop-2-en-1-ol
- (iii) 2-methoxypropane
- (iv) Phenylmethanol

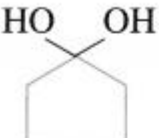
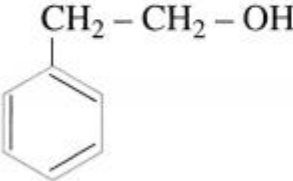
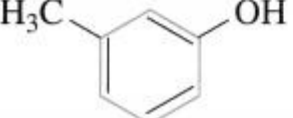
Solution :



Try this (Textbook Page No 238)

Write IUPAC names of the following compounds.



Compound	Ans.	IUPAC name
(i) 		Cyclobutane-1, 1-diol
(ii) $\text{H}_3\text{C}-\underset{\text{OCH}_2-\text{CH}_3}{\text{CH}}-\text{CH}_2-\text{CH}_3$		2-Ethoxybutane
(iii) 		2-Phenylethan-1-ol
(iv) 		3-Methylphenol (m-cresol)

Do you know (Textbook Page No 238)

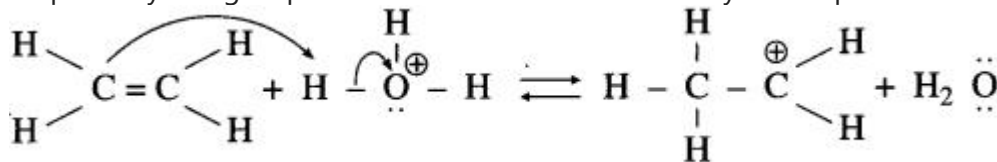
Question 1.

The mechanism of hydration of ethylene to ethyl alcohol.

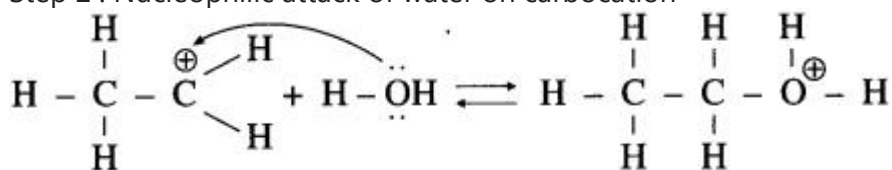
Answer:

The mechanism of hydration of ethylene involves three steps:

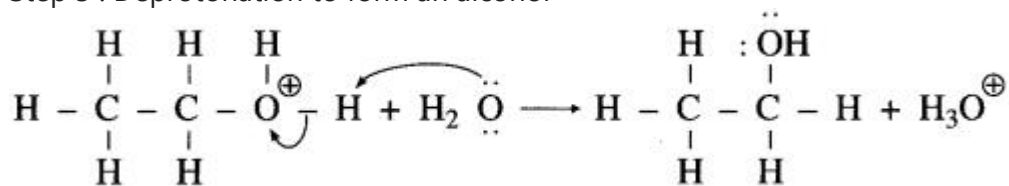
Step 1: Ethylene gets protonated to form carbocation by electrophilic attack of H_3O^+ (Formation of carbocation intermediate).



Step 2 : Nucleophilic attack of water on carbocation



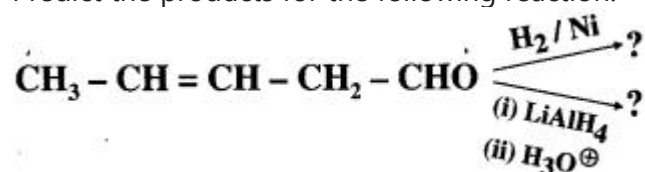
Step 3 : Deprotonation to form an alcohol



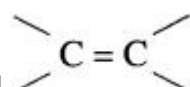
Problem 11.2 : (Textbook Page No 239)

Question 1.

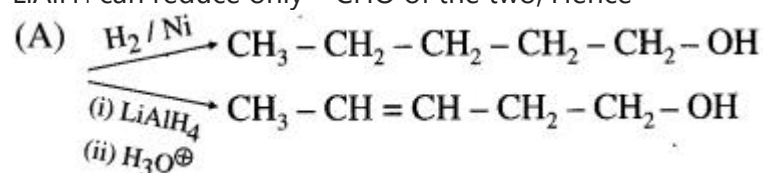
Predict the products for the following reaction.



Solution:



The substrate (A) contains an isolated $\text{C}=\text{C}$ and an aldehyde group. H_2/Ni can reduce both these functional groups while LiAlH_4 can reduce only $-\text{CHO}$ of the two, Hence



[Try this \(Textbook page 240\)](#)

Question 1.

Arrange O – H, C – H and N – H bonds in increasing order of their bond polarity.

Answer:

Increasing order of polarity :C – H, N – H, O – H

[Problem 11.3 : \(Textbook Page No 241\)](#)

Question 1.

The boiling point of n-butyl alcohol, isobutyl alcohol, sec-butyl alcohol and tert-butyl alcohol are 118 °C, 108 °C, 99 °C and 82 °C respectively. Explain.

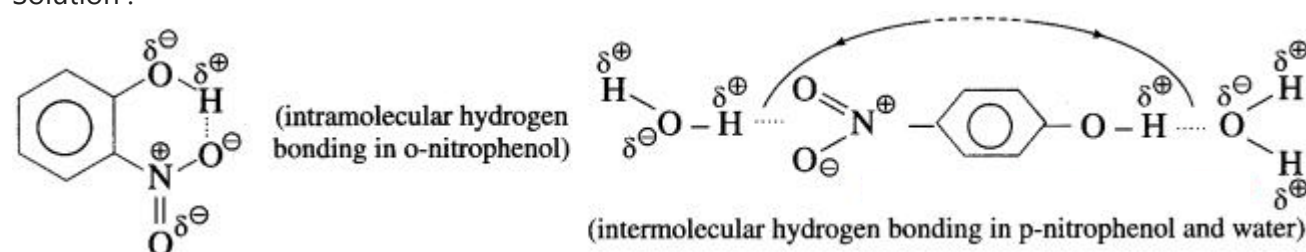
Solution:

As branching increases, intermolecular van der Waal's force become weaker and the boiling point decreases. Therefore, n-butyl alcohol has highest boiling point 118 °C and tert-butyl alcohol has lowest boiling point 83 °C. Isobutyl alcohol is a primary alcohol and hence its boiling point is higher than that of sec-butyl alcohol.

[Problem 11.4 : \(Textbook Page No 242\)](#)

The solubility of o-nitrophenol and p-nitrophenol is 0.2 g and 1.7 g/100 g of H₂O respectively. Explain the difference.

Solution :



p-Nitrophenol has strong intermolecular hydrogen bonding with solvent water. On the other hand, o-nitrophenol has strong intramolecular hydrogen bonding and therefore the intermolecular attraction towards solvent water is weak. The stronger the intermolecular attraction between solute and solvent higher is the solubility. Hence p-nitrophenol has higher solubility in water than that of o-nitrophenol.

[Problem 11.5 : \(Textbook Page No 243 & 244\)](#)

Question 1.

Arrange the following compounds in decreasing order of acid strength and justify.

(1) CH₃ – CH₂ – OH

(2) (CH₃)₃ C – OH

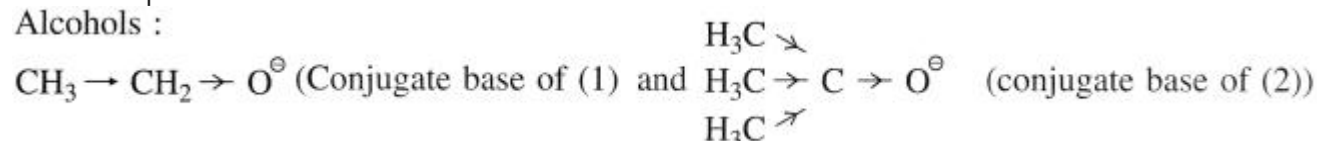
(3) C₆H₅ – OH

(4) p-NO₂ – C₆H₄ – OH

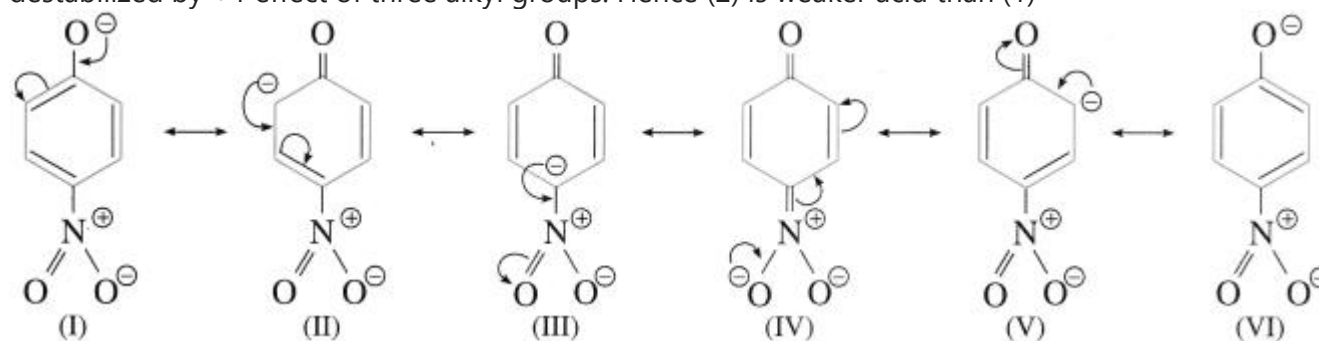
Solution :

Compounds (3) and (4) are phenols and therefore are more acidic than the alcohols (1) and (2). The acidic strengths of compounds depend upon stabilization of the corresponding conjugate bases. Hence let us compare electronic effects in the conjugate bases of these compounds :

Alcohols :



The conjugate base of the alcohol (1) is destabilized by + I effect of one alkyl group, whereas conjugate base of the alcohol (2) is destabilized by +I effect of three alkyl groups. Hence (2) is weaker acid than (1)

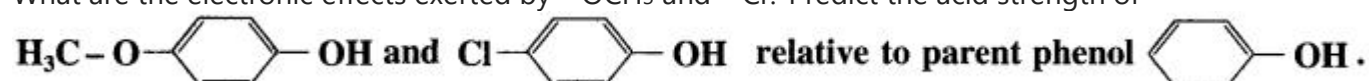


Phenols : The conjugate base of p-nitrophenol (4) is better resonance stabilized due to six resonance structures compared to the five resonance structure of conjugate base of phenol (3). The resonance structure VI has – ve charge on only electronegative oxygens. Hence the phenol (4) is stronger acid than (3). Thus the decreasing order of acid strength is (4), (3), (1), (2).

[Use your brain power \(Textbook Page No 244\)](#)

Question 1.

What are the electronic effects exerted by $-\text{OCH}_3$ and $-\text{Cl}$? Predict the acid strength of

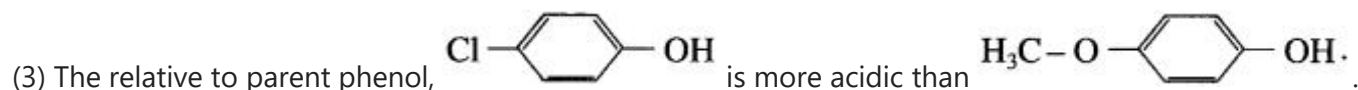


Answer:

The electronic effects exerted by $-\text{Cl}$ and $-\text{OCH}_3$ are as follows :

(1) Cl being more electronegative atom it pulls the bonding electrons towards itself. This is known as negative inductive effect ($-\text{I}$).

(2) $-\text{OCH}_3$ is less electronegative group which repels the bonding electrons away from it. This is known as positive inductive effect ($+\text{I}$).



[Problem 11.6 : \(Textbook Page No 245\)](#)

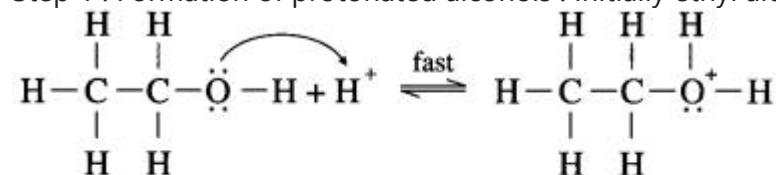
Question 1.

Mechanism of acid catalyzed dehydration of ethanol to give ethene.

Answer:

The mechanism of dehydration of ethanol involves the following order :

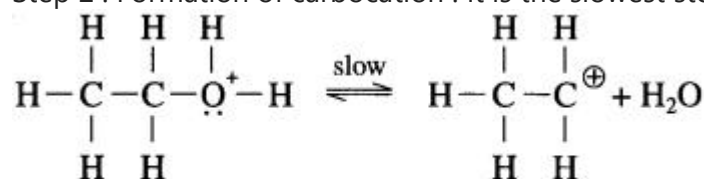
Step 1 : Formation of protonated alcohols : Initially ethyl alcohol gets protonated to form ethyl oxonium ion.



Ethanol

protonated alcohol
(ethyl oxonium ion)

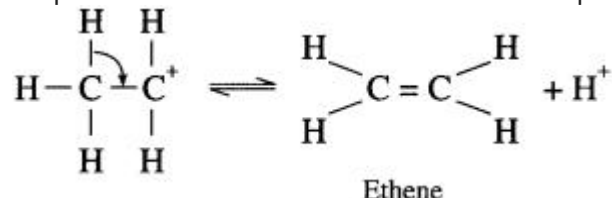
Step 2 : Formation of carbocation : It is the slowest step and hence, the rate determining step of the reaction.



Oxonium ion

Carbocation

Steps 3: Formation of ethene: Removal of a proton (H^+) from carbocation.



Ethene

The acid used in step 1 is released in step 3, the equilibrium is shifted to the right, ethene is removed as it is formed.

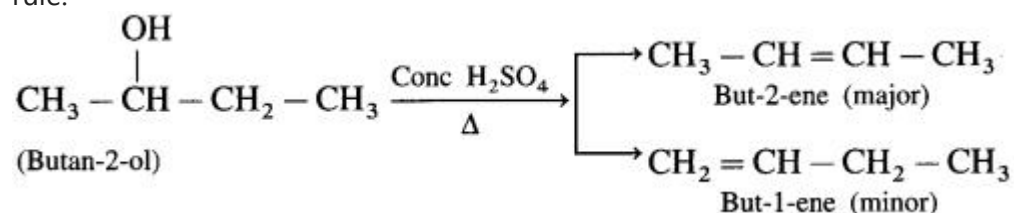
[Problem 11.6 : \(Textbook Page No 245\)](#)

Question 1.

Write the reaction showing major and minor products formed on heating butan-2-ol with concentrated sulphuric acid.

Solution :

In the reaction described butan-2-ol undergoes dehydration to give but-2-ene (major) and but-1-ene (minor) in accordance with Saytzeff rule.



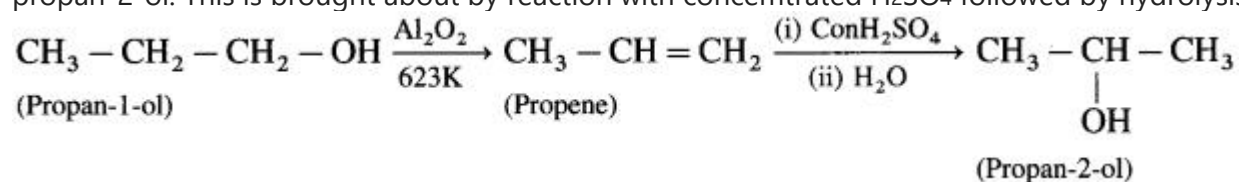
[Problem 11.7 : \(Textbook Page No 246\)](#)

Question 1.

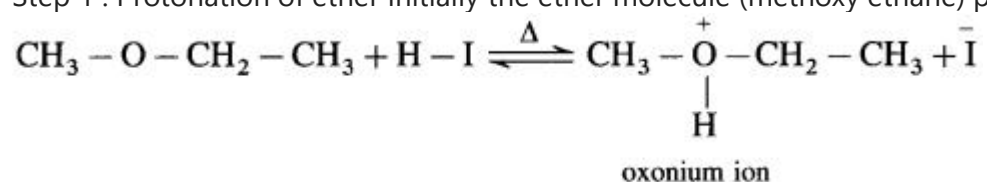
Write and explain reactions to convert propan-1-ol into propan-2-ol.

Solution :

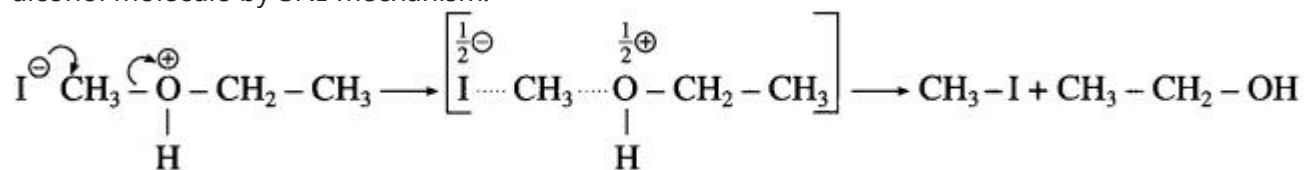
The dehydration of propan-1-ol to propene is the first step. Markownikoff hydration of propene is the second step to get the product propan-2-ol. This is brought about by reaction with concentrated H_2SO_4 followed by hydrolysis.



Step 1 : Protonation of ether Initially the ether molecule (methoxy ethane) protonated by conc. HI to form oxonium ion.



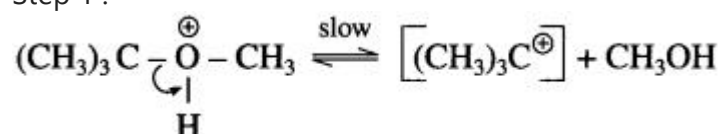
Step 2 : Iodide is a good nucleophile. It attacks the least substituted carbon of the oxonium ion formed in step 1 and displaces an alcohol molecule by $\text{S}_\text{N}2$ mechanism.



For example :

- Use of excess HI converts the alcohol into alkyl iodide.
- In case of ether having one tertiary alkyl group the reaction with hot HI follows $\text{S}_\text{N}1$ mechanism, and tertiary iodide is formed rather than tertiary alcohol.

Step 1 :



Step 2 :

