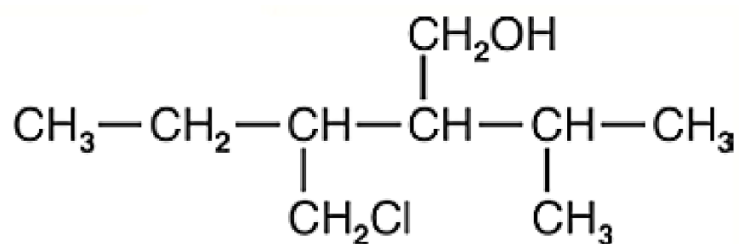


Chapter – Alcohols, phenols and Ethers

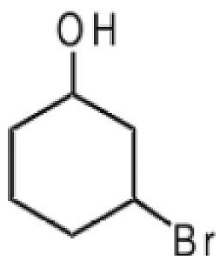
1. Write IUPAC names of the following compounds:

(i)



Ans: 3-chloromethyl-2-isopropyl pentan-1-ol

(ii)

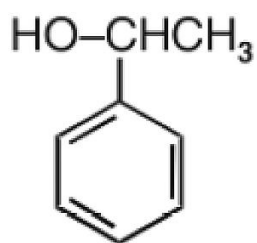


Ans: 3-bromo cyclohexan-1-ol

(iii) $\text{CH} \equiv \text{C} - \text{CH}_2\text{OH}$

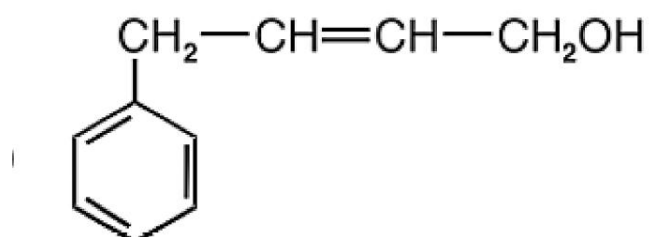
Ans: Prop-2-yn-1-ol

(iv)



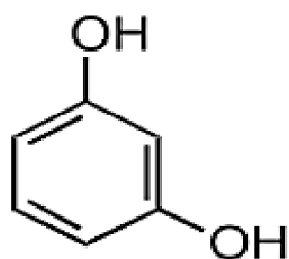
Ans: 1-phenyl Ethanol

(v)



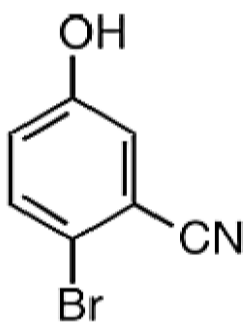
Ans: 3-phenyl prop-2-en-1-ol

(vi)



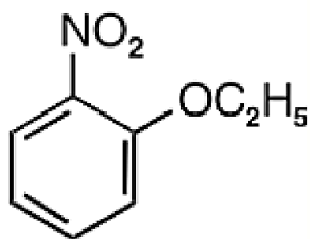
Ans: Benzene-1,3-diol

(vii)



Ans: 4-bromo-3-cyano phenol

(viii)



Ans: 2-nitro ethoxybenzene

(ix) $\text{C}_6\text{H}_5\text{OC}_3\text{H}_7$

Ans: Propoxybenzene

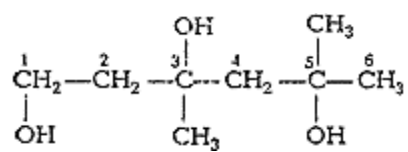
(x) $\text{CH}_3\text{CH}_2\text{OCH}_2\text{CH}_2\text{CH}_2\text{Cl}$

Ans: 3-ethoxy chloropropane

2. Write the structures of the compounds whose names are given below:

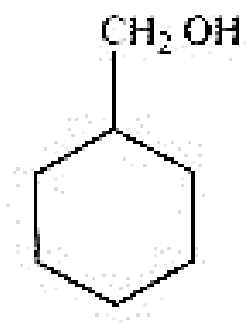
(i) 3,5 -dimethoxyhexane-1,3,5-triol

Ans:



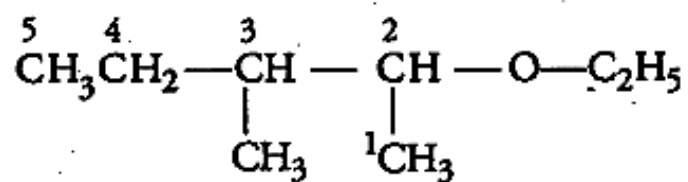
(ii) cyclohexylmethanol

Ans.



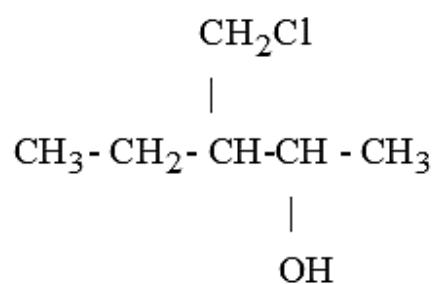
(iii) 2-ethoxy-3-methylpentane

Ans:



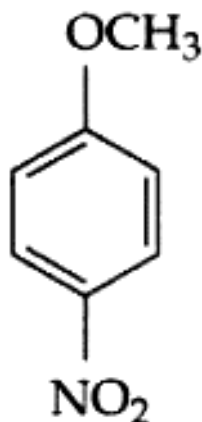
(iv) 3-chloromethylpentan-2-ol

Ans:



(v) p-nitroanisole

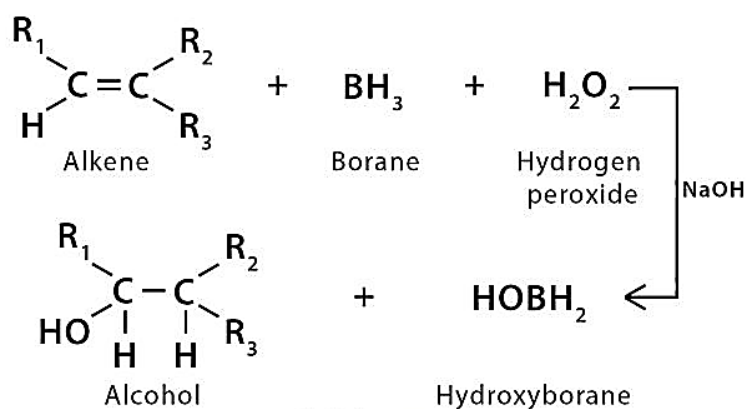
Ans:



3. Describe the following reactions with example:

(i) Hydroboration oxidation of alkenes

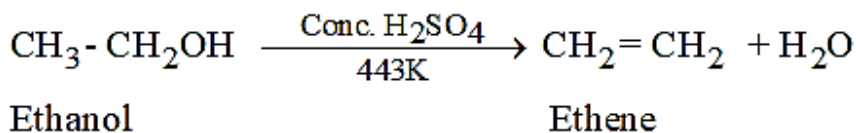
Ans: The hydroboration-oxidation route is a two-step process for producing alcohols. The reaction proceeds in an Anti-Markovnikov fashion, with the hydrogen (from BH₃ or BHR₂) attaching to the most substituted carbon in the alkene double bond and the boron attaching to the least substituted carbon.



(ii) Acid catalysed dehydration of alcohols at 443 K.

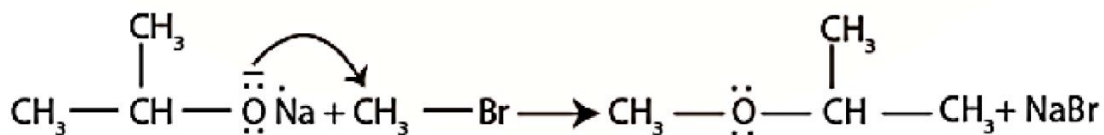
Ans: The following reaction shows the acid dehydration of ethanol to produce ethene.

The protonation of the oxygen atom in the OH group is the first step. The second step is the loss of a water molecule, which results in the formation of the carbonium ion. The final step is deprotonation, which results in the formation of a carbon-carbon double bond.



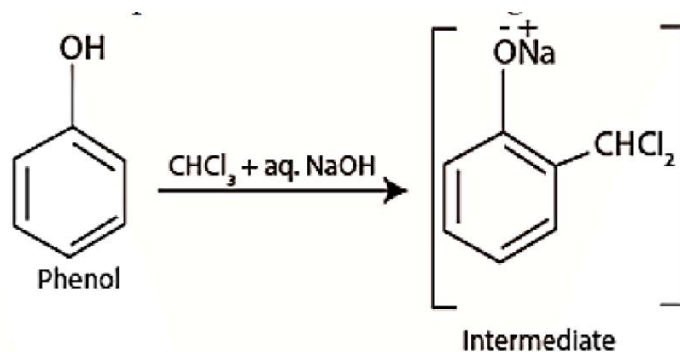
(iii) Williamson synthesis

Ans: The Williamson ether synthesis method involves permitting alkyl group halides to react with sodium alkoxides within the workplace to yield symmetrical and unsymmetrical ethers. This reaction includes the alkoxide particle offensive the organic compound via S_N^2 mechanism. within the case of primary alkyl group halides, higher results are obtained. If the organic compound is secondary or tertiary, substitution prioritises over elimination.

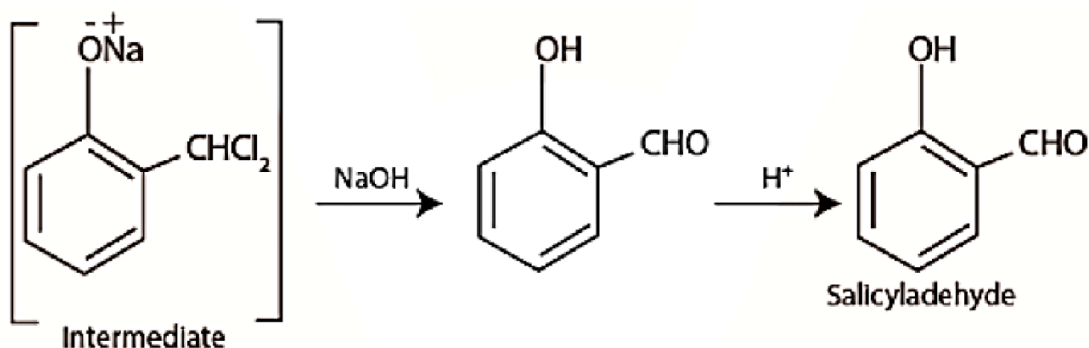


(iv) Reimer-Tiemann reaction.

Ans: The -CHO group is introduced at the ortho position of the benzene ring when phenol is treated with chloroform in the presence of sodium hydroxide.

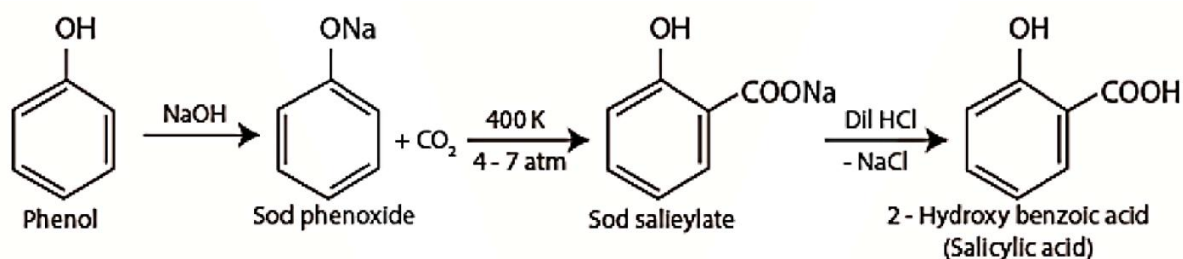


The Reimer-Tiemann reaction is the name for this reaction. In the presence of alkalis, the intermediate is hydrolyzed to create salicylaldehyde.



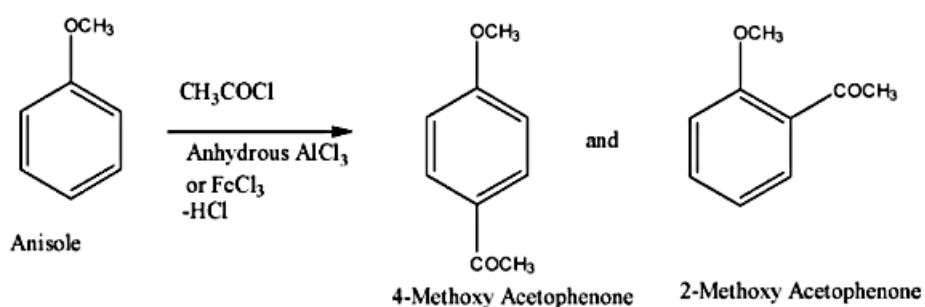
(v) Kolbe's reaction

Ans: Kolbe's reaction: Salicylic acid is made by boiling a combination of sodium phenoxide and carbon dioxide at 180 - 200°C under pressure.

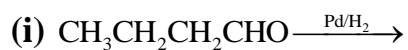


(vi) Friedel-Crafts acylation of Anisole.

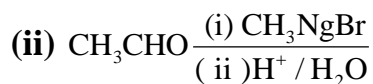
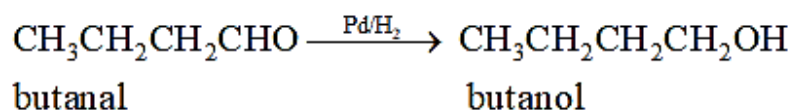
Ans: The aromatic ring is converted into an aryl ketone via a Friedel-Crafts acylation process. Anisole interacts with acetyl chloride; it transforms into ketone.



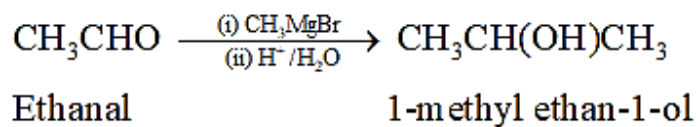
4. Complete the following reactions:



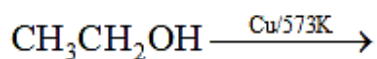
Ans:



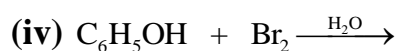
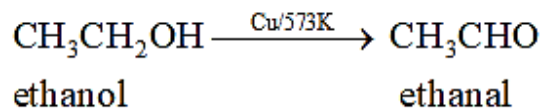
Ans:



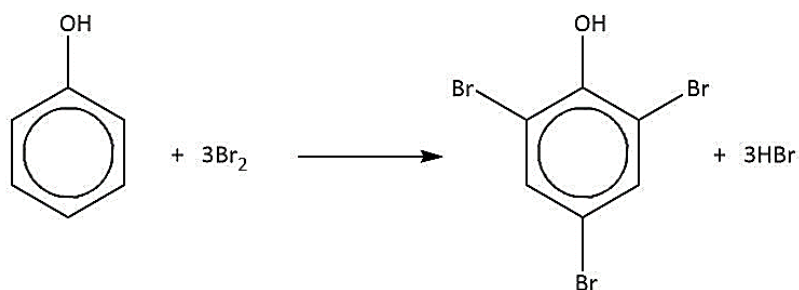
(iii)



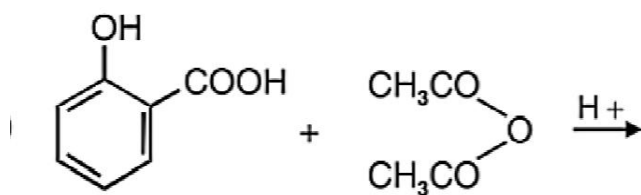
Ans:



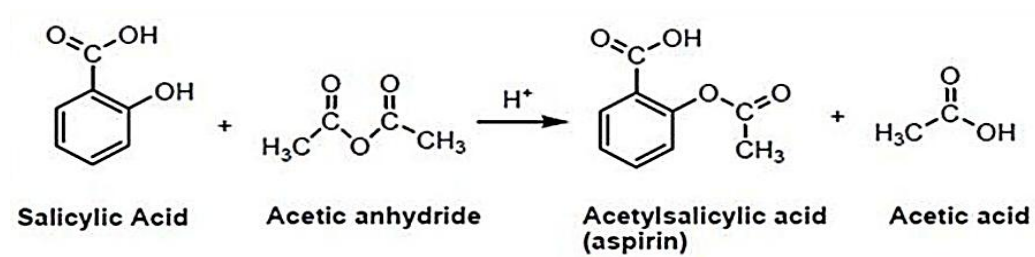
Ans:



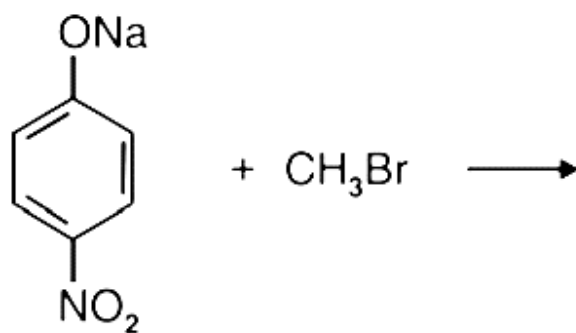
(v)



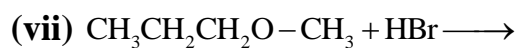
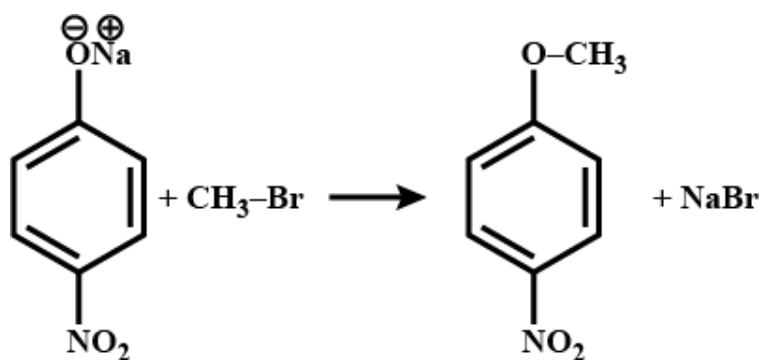
Ans:



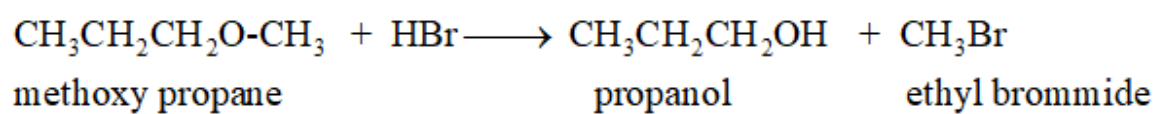
(vi)



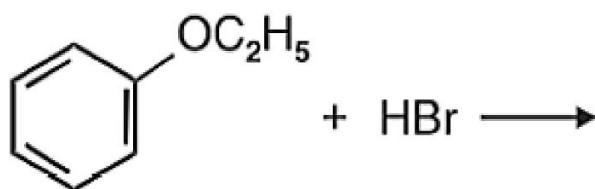
Ans:



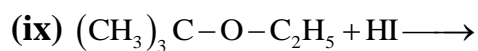
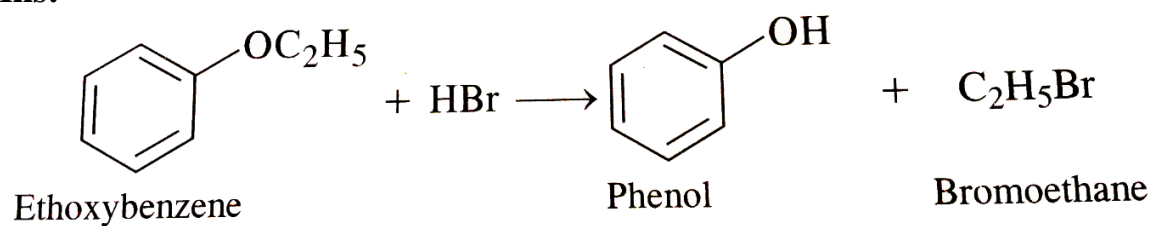
Ans:



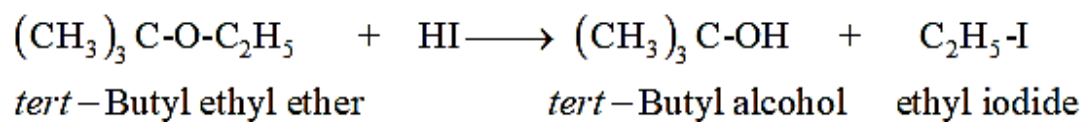
(viii)



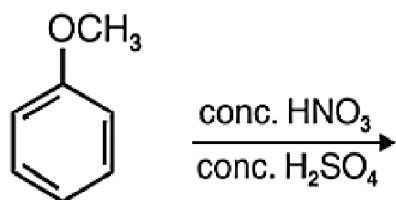
Ans:



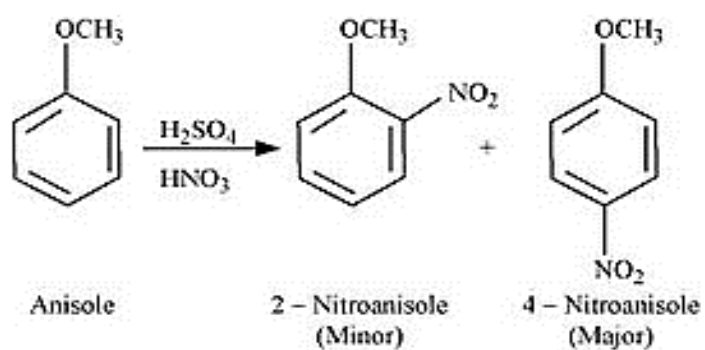
Ans:



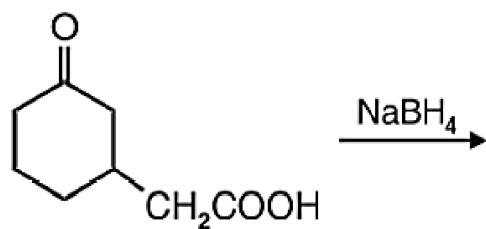
(x)



Ans:

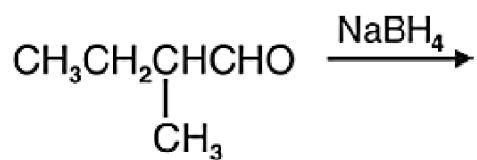


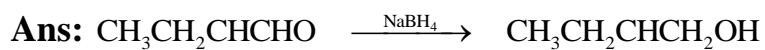
(xi)



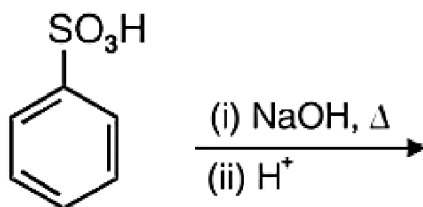
Ans:

(xii)

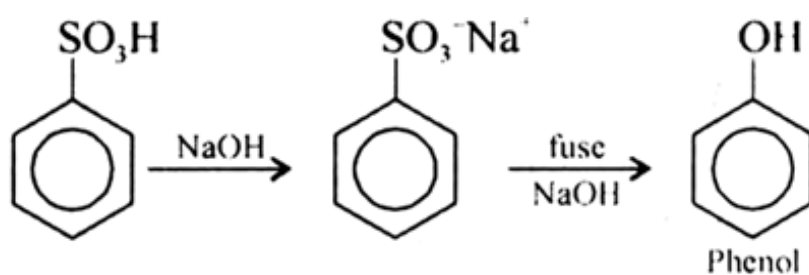




(xiii)



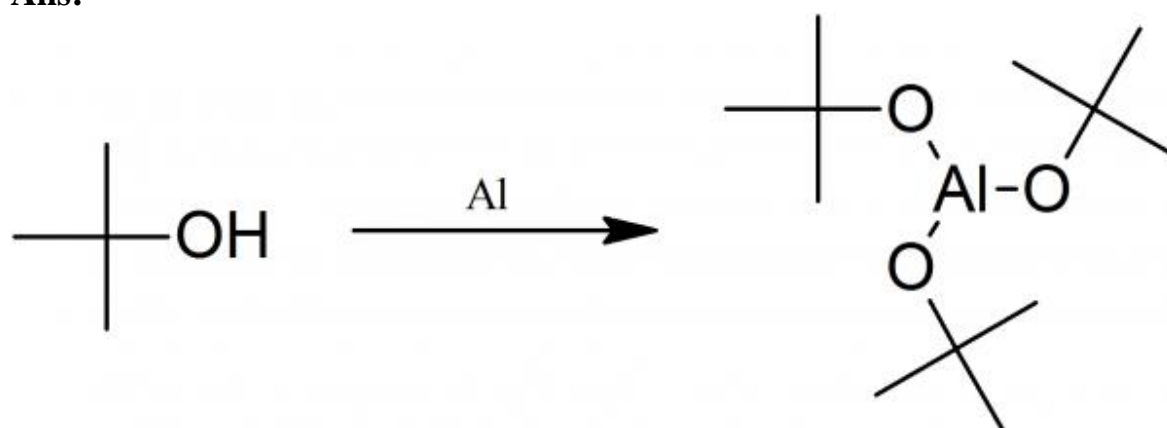
Ans:



5. What happens when:

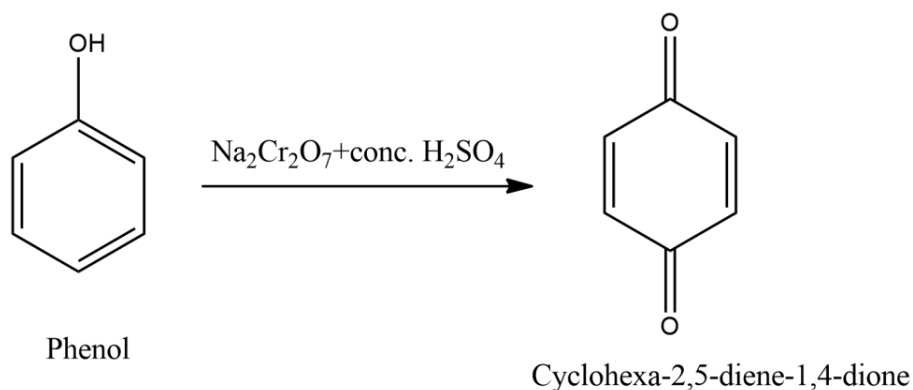
(i) aluminium reacts with tert-butyl alcohol

Ans:



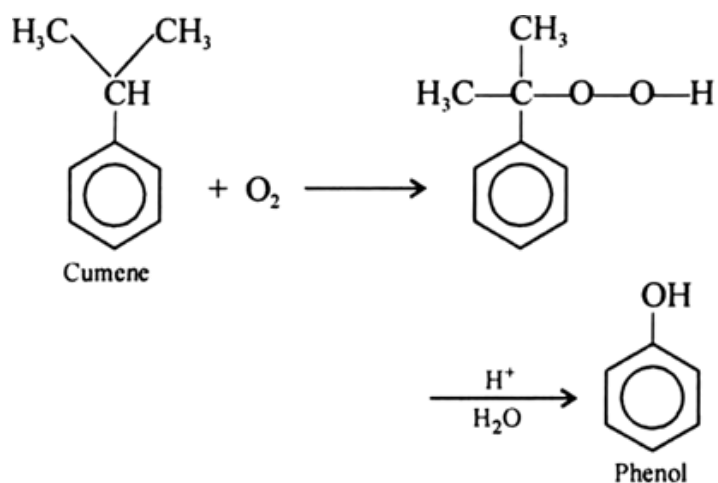
(ii) phenol is oxidised with chromic acid

Ans:



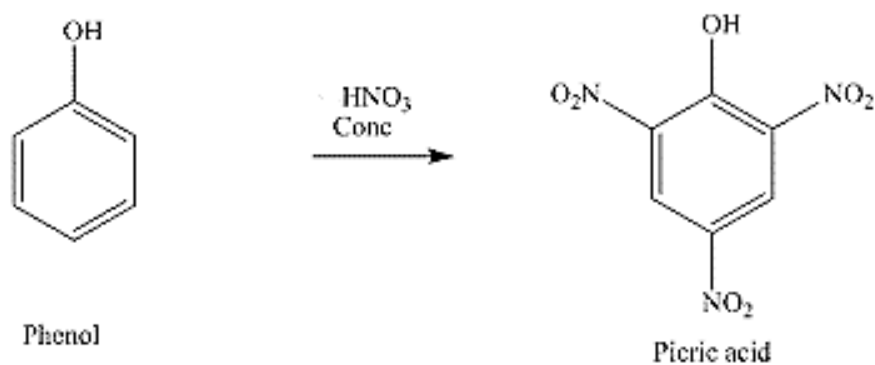
(iii) cumene is oxidised in the presence of air and the product formed is treated with dilute acid.

Ans:



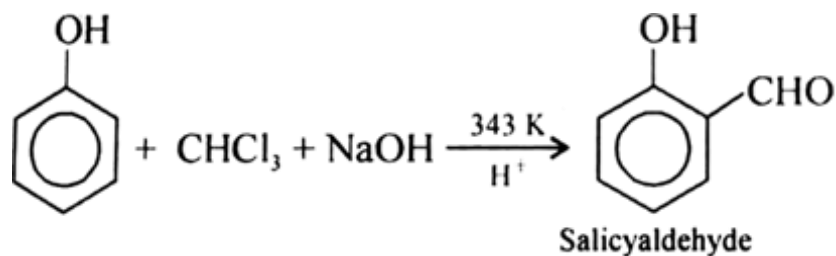
(iv) phenol is treated with conc. HNO_3 .

Ans:



(v) phenol is treated with chloroform in presence of dilute NaOH.

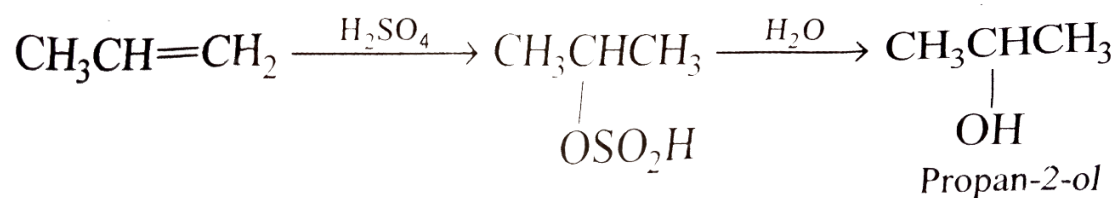
Ans:



6. How will you convert

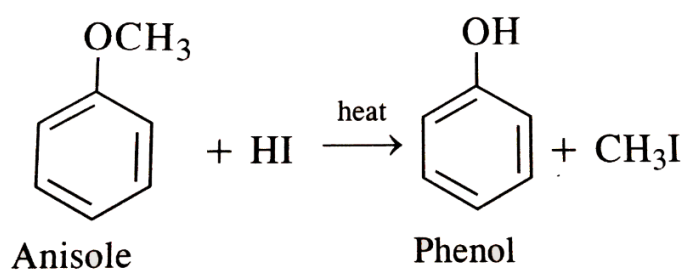
(i) propene to propan-1-ol.

Ans:



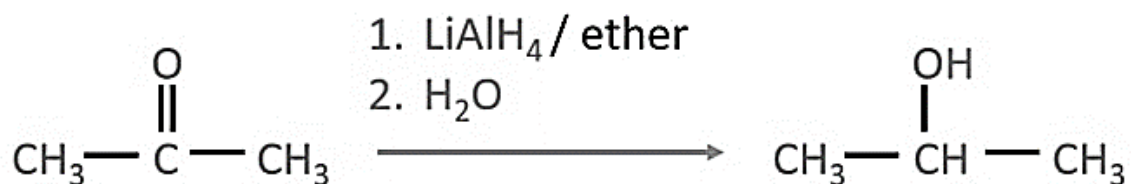
(ii) anisole to phenol

Ans:



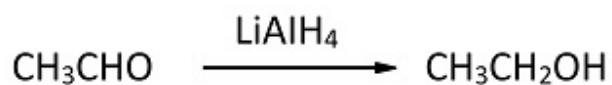
(iii) butan-2-one to butan-2-ol

Ans:



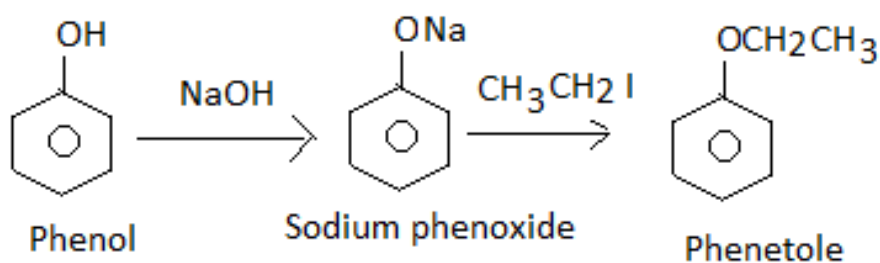
(iv) ethanal to ethanol

Ans:



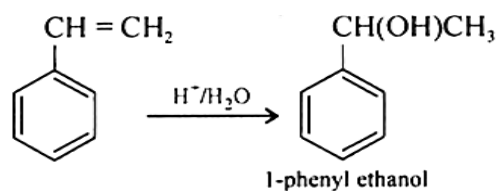
(v) phenol to ethoxybenzene

Ans:



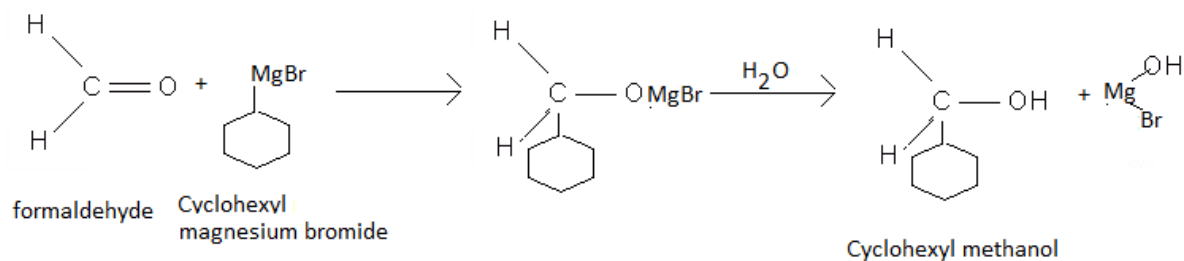
(vi) 1-phenylethene to 1-phenylethanol

Ans:



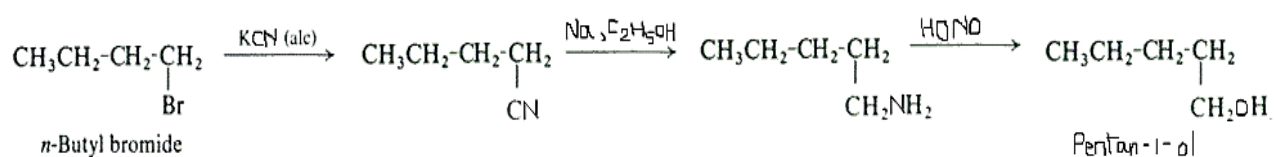
(vii) formaldehyde to cyclohexylmethanol

Ans:



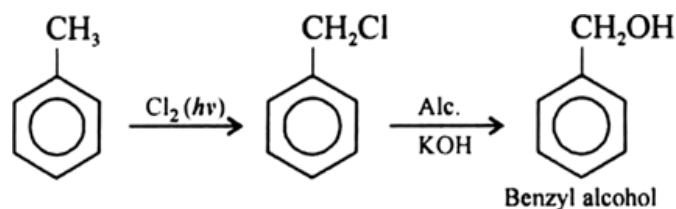
(viii) butyl bromide to pentan-1-ol.

Ans:



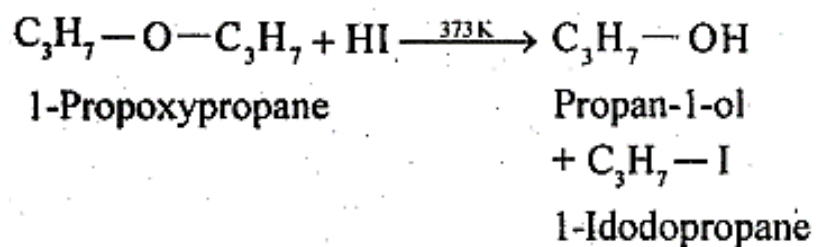
(ix) toluene to benzyl alcohol

Ans:

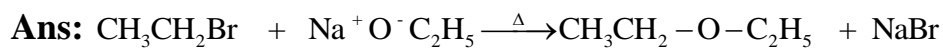


(x) 1-propoxypropane to propyl iodide

Ans:

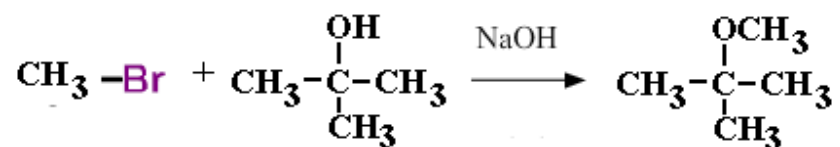


(xi) ethyl bromide to 1-ethoxyethane



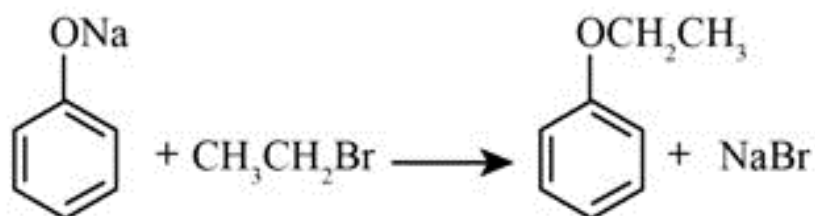
(xii) methyl bromide to 2-methoxy-2-methylpropane

Ans:



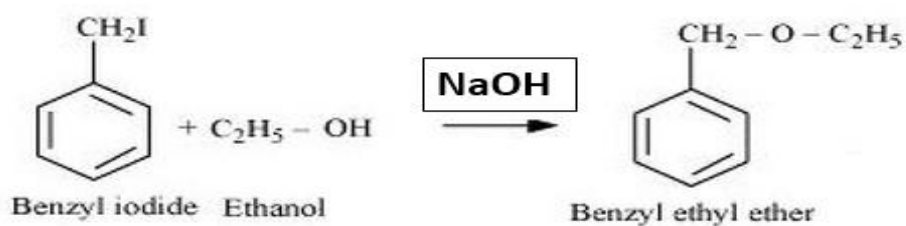
(xiii) ethyl bromide to ethoxybenzene

Ans:



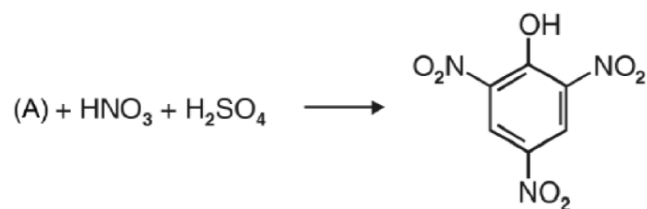
(xiv) ethanol to benzyl ethyl ether.

Ans:

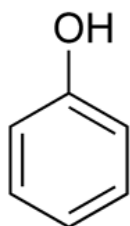


7. Identify the missing reactant or product A to D in the following equations:

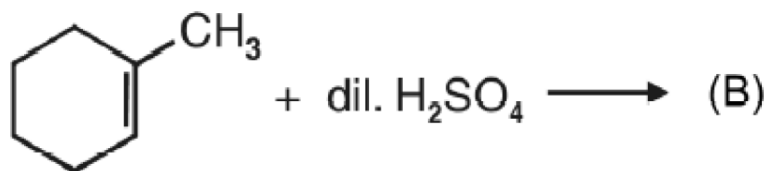
(i)



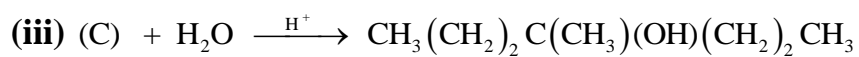
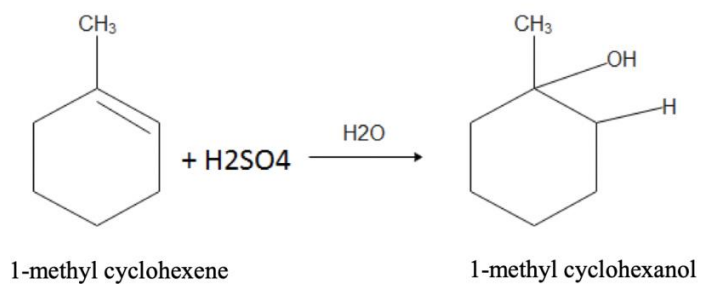
Ans: The compound A is phenol.



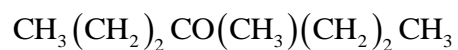
(ii)

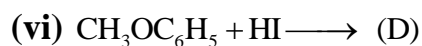


Ans: The compound B is 1-methyl cyclohexanol.

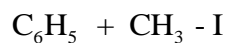


The compound C is 2-propyl propan-2-one.

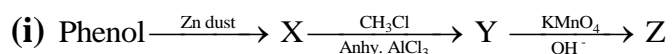




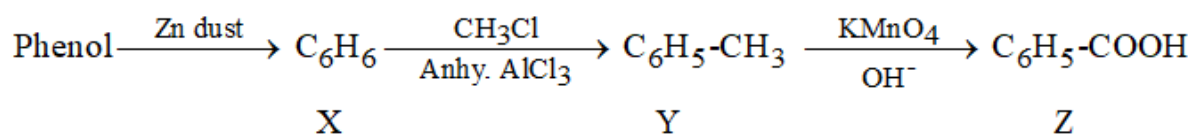
Ans: The compound D are phenol and methyl iodide.



8. Identify X, Y and Z in the following sequence of reactions:



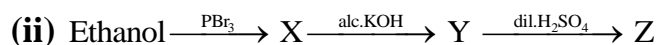
Ans:



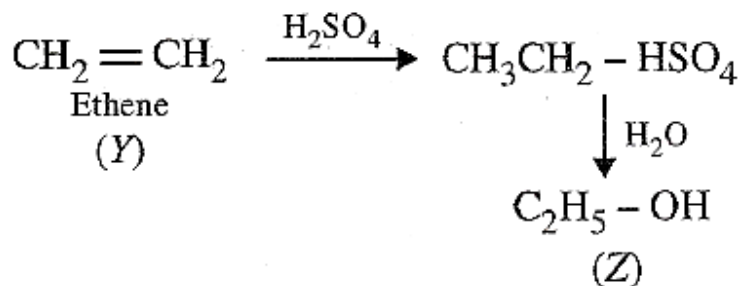
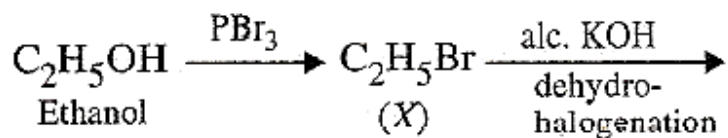
X is Benzene.

Y is Toluene.

Z is benzoic acid.



Ans:

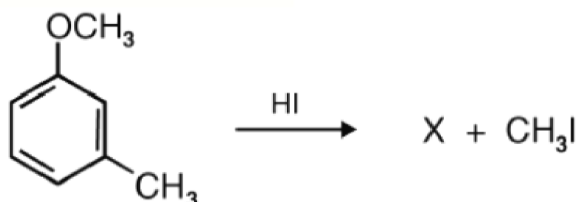


X is Ethyl bromide.

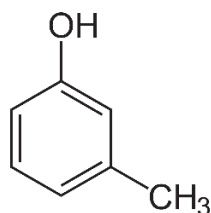
Y is Ethene.

Z is Ethanol.

(iii)

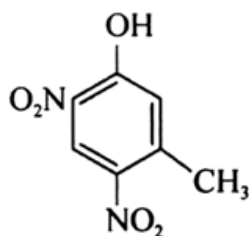


Ans: The compound X is 3-methyl phenol.



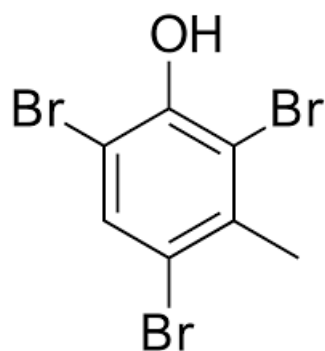
(iv). $X + \text{conc. HNO}_3 \longrightarrow Y$ (a dinitro compound)

Ans: The compound Y is 2,4-Dinitro-5-methylphenol.

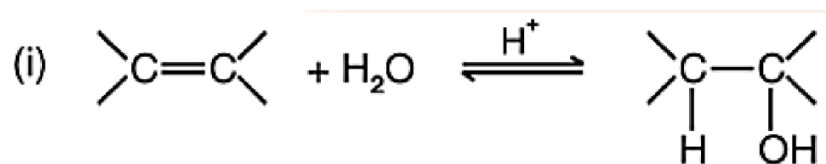


$X + \text{Br}_2(\text{aq}) \longrightarrow Z$ (a tribromo product)

Ans. The compound Z is 2,4,6-Tribromo-3-methylphenol.



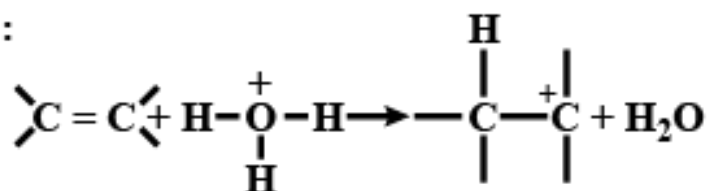
10. write the mechanism for the following reactions:



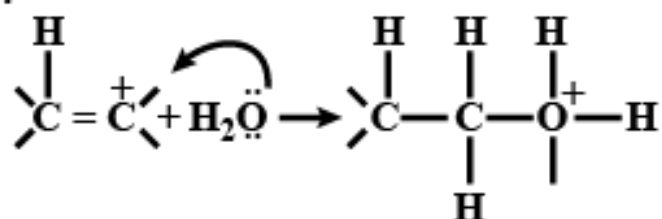
(acid catalysed hydration of alkenes)

Ans:

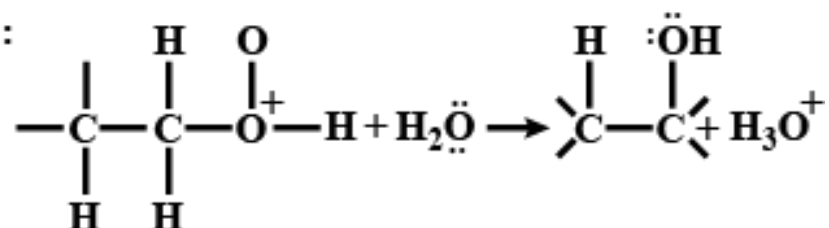
Step 1 :



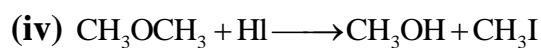
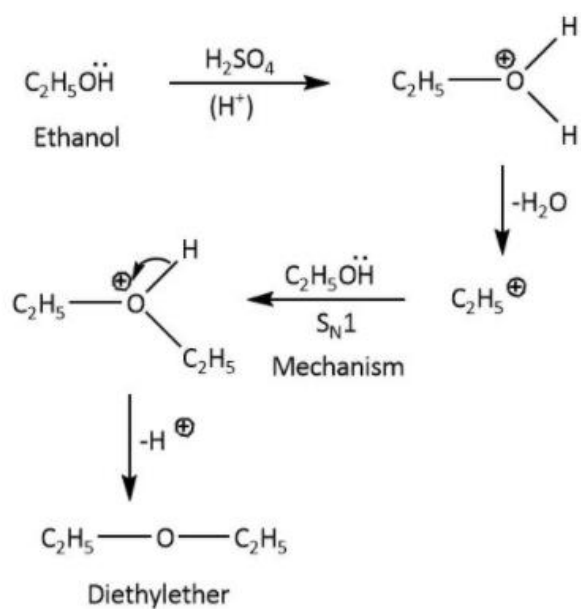
Step 2 :



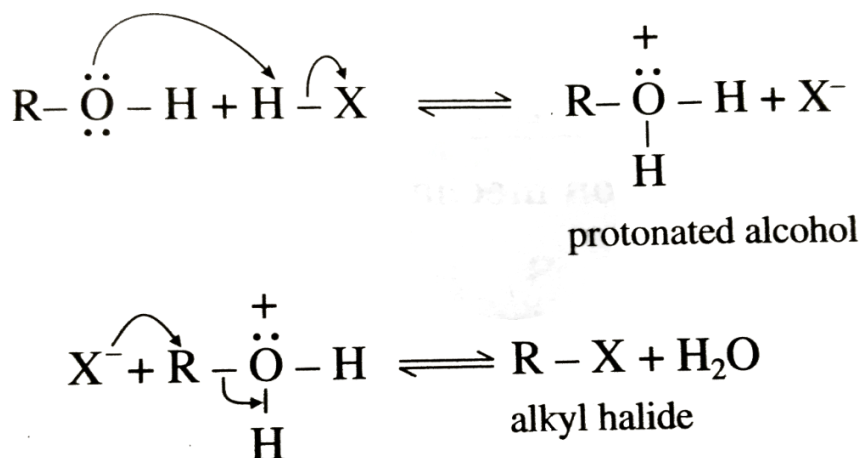
Step 3 :



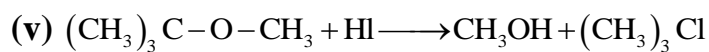
Ans:



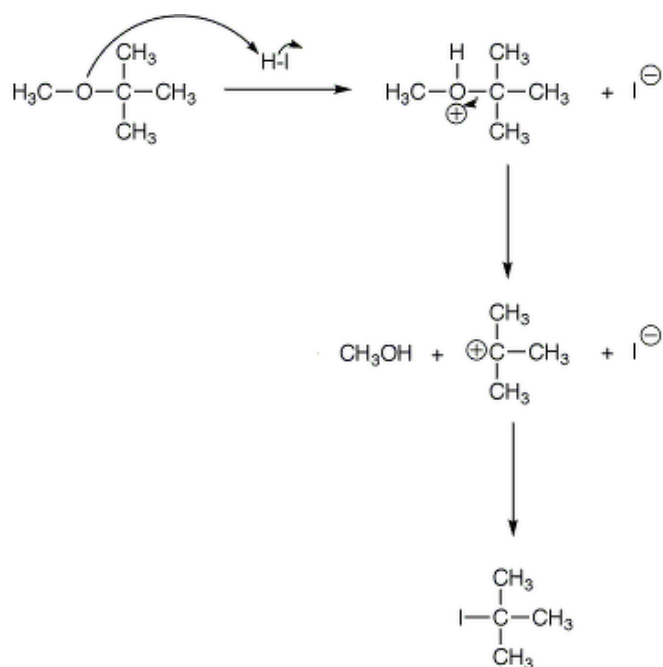
Ans:



Where R is the methyl group and HI is the halogen acid.



Ans:



11. Give reason for the following:

(i) The C - O - C bond angle in dimethyl ether is 111.7°

Ans: The two lone pairs of electrons in oxygen try to get closer to the oxygen atom in this molecule. The repulsion of lone pairs of electrons cannot compress the side groups, however, since they are hefty. As a result, the bond angle will be 111.7° .

(ii) Alcohols have higher boiling points than ethers of comparable molecular masses.

Ans: Because the OH group permits alcohol molecules to form hydrogen bonds, they have higher boiling temperatures than ethers and alkanes with similar molar weights.

(iii) Phenols are more acidic than alcohols.

Ans: Although phenols are more powerful than alcohols, they are still rather weak acids. Because the phenoxide ion is more persistent than the alkoxide ion, phenol is more acidic than cyclohexanol and acyclic alcohols. The negative charge of an alkoxide ion, such as the one formed from cyclohexanol, is concentrated near the oxygen atom.

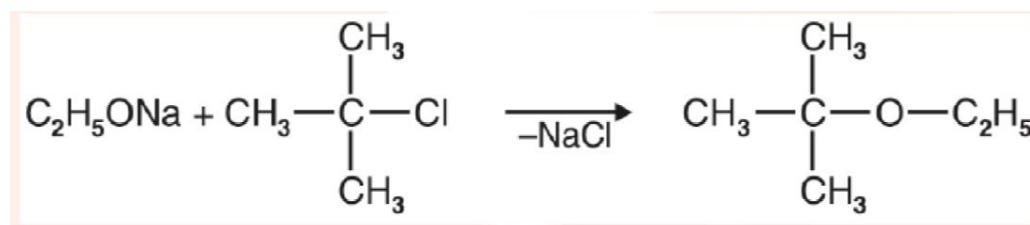
(iv) Nitrophenol is more acidic than o-methoxyphenol.

Ans: The acidity of ortho-nitrophenol is higher than that of ortho-methoxyphenol. The presence of the nitro group in the ortho position, which is an electron withdrawing group, reduces the electron density in the O-H bond. Due to resonance, the o-nitrophenoxide ion produced following the loss of protons is also stable.

(v) Phenol is more reactive towards electrophilic substitution reaction than benzene.

Ans: When it comes to electrophilic substitution reactions, phenol is more reactive than benzene. The electron density around the ring system is increased by the donation of the oxygen's lone pair into the ring system. In comparison to benzene, this makes the ring significantly more reactive. The intermediate carbocation is more stable in terms of resonance.

(vii) The following is not an appropriate method for the preparation of t-butyl ethyl ether:

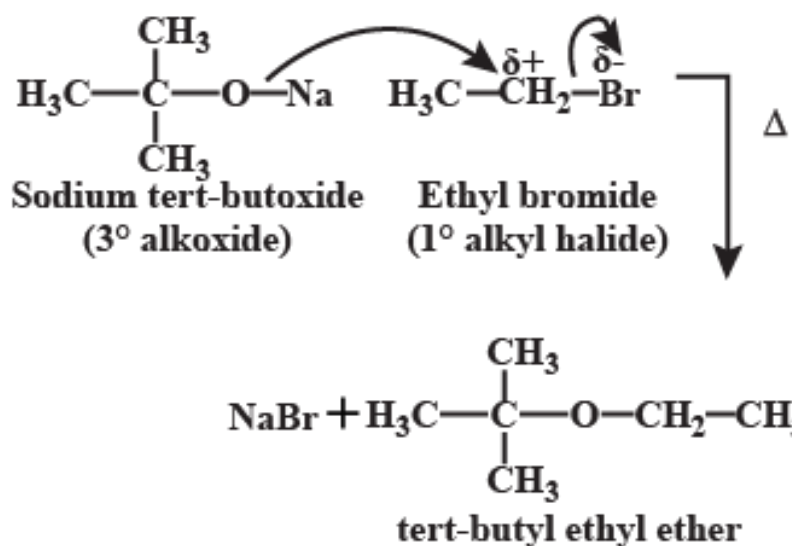


(a) What would be the major product of this reaction?

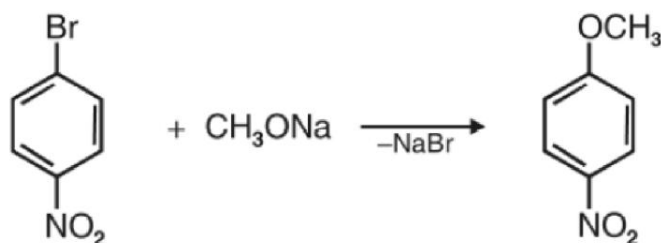
Ans: The major product in the above reaction is t-butyl ethyl ether

(b) Write suitable reaction for the preparation of t-butyl ethyl ether.

Ans: t-butyl ethyl ether can be prepared as follows:

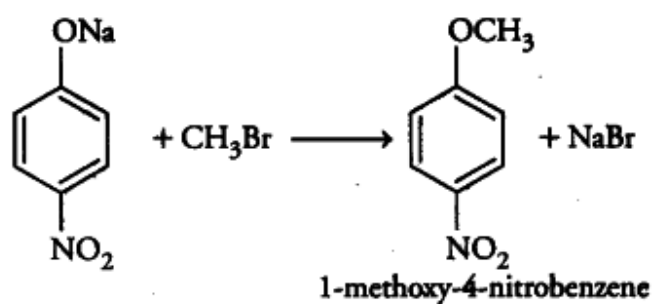


(viii) The following is not an appropriate method for the preparation of 1-methoxy-4-nitrobenzene;



(x) Write the suitable reaction for the preparation of 1-methoxy-4-nitrobenzene

Ans:



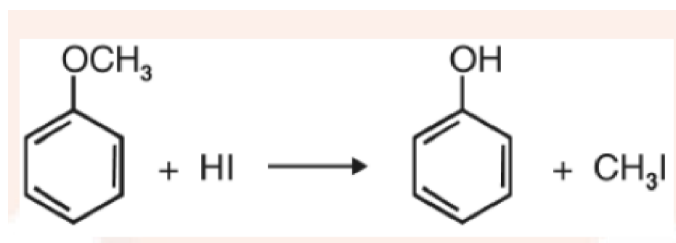
(ix) o-nitrophenol is steam volatile but p-nitrophenol is not.

Ans: In the case of p-nitrophenol molecules, energy is necessary to overcome attractive forces, while in the case of o-nitrophenol molecules, no such energy is required. This indicates that o-nitrophenol has a lower boiling point and is thus steam volatile, whereas p-nitrophenol has a higher boiling point and is thus steam non-volatile.

(x) phenol is less polar than ethanol.

Ans: The polarity of phenol is higher than that of ethanol. The phenol O - H bond is more polar than the ethanol O - H bond. The electron pair at O in phenol travels towards the conjugated benzene ring and demonstrates resonance. The polarity of the O - H bond rises as a result of this resonance.

(xi) The phenyl methyl ether reacts with HI to form phenol and iodomethane and not iodobenzene and methanol.



Ans: Because HI is a powerful acid; hydrogen ions are easily produced. As oxygen contains lone pairs, this produced hydrogen ion attacks the oxygen atom of phenyl methyl ether. When oxygen makes three bonds and has a positive charge, it becomes unstable. As a result, nucleophilic addition occurs. Because the charge on the methyl group is unstable, and there is a resonance between oxygen and the benzene ring, it undergoes the $\text{S}_\text{N}2$ process. There will be a transition state when the methyl group's carbon atom has 5 bonds when it is attacked by a nucleophile. As iodine ions are big, and the benzene ring is even bigger than the methyl group. There will be a lot of steric repulsions if the iodine and benzene groups approach each other. Phenol and methyl iodide are produced as a result.

(xii) methanol is less acidic than water.

Ans: Water is significantly less acidic in the gas phase than methanol, which is consistent with the polarizability differential between a proton and a methyl group. Water is more acidic than methanol because the solvation energy of hydroxide is even higher than that of methoxide.

(xiii) alcohols can act as weak base as well as weak acids.

Ans: Alcohol is amphoteric, meaning it can function as both an acid and a base. Alcohol is a base because it can receive H^+ from both mineral acids and water. Due to the existence of the strong conjugate base RO^- , it functions as a weak acid. The acid becomes weaker as the conjugate base becomes stronger.

(xiv) phenols do not give protonation reaction readily.

Ans: Protonation is difficult to achieve using phenol. Through resonance, the lone pair on oxygen $O-H$ in phenol is shared with the benzene ring. As a result, phenols do not undergo protonation reactions because a lone pair is not entirely present on oxygen.

(xvi) absolute ethanol cannot be obtained by fractional distillation of ethanol and water mixture.

Ans: Fractional distillation cannot separate absolute alcohol. The process of fractional distillation is when a liquid mixture is vaporised, resulting in a mixture of components from which the desired component is separated into pure form.

12. Arrange the following in the increasing order of property shown:

(i) methanol, ethanol, diethylether, ethyleneglycol. (Boiling points)

Ans: diethylether < methanol < ethanol < ethyleneglycol

(ii) phenol, o-nitrophenol, m-nitrophenol, p-nitrophenol. (Acid strength)

Ans: phenol < m-nitrophenol < o-nitrophenol < p-nitrophenol

(iii) dimethylether, ethanol, phenol. (Solubility in water)

Ans: dimethylether < phenol < ethanol

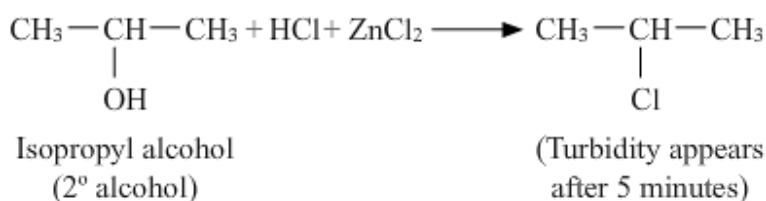
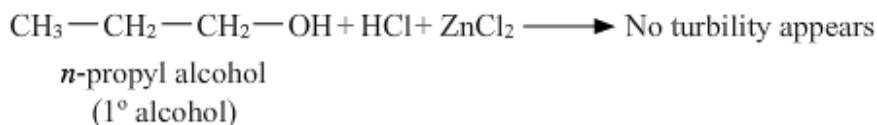
(iv) n-butanol, 2-methylpropan-1-ol, 2-methylpropan-2-ol. (Acid strength)

Ans: n-butanol < 2-methylpropan-1-ol < 2-methylpropan-2-ol

13. Give a chemical test to distinguish between the following pair of compounds.

(i) n-propyl alcohol and isopropylalcohol

Ans: Lucas test can be used to distinguish n-propyl alcohol and isopropylalcohol.



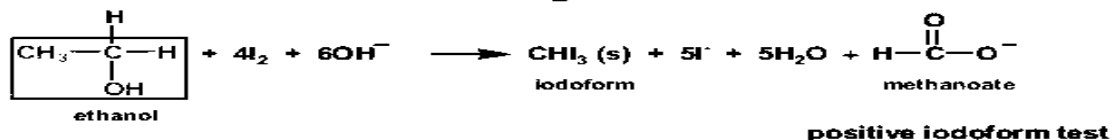
(ii) methanol and ethanol

Ans: Iodoform test can be done to distinguish between methanol and ethanol.



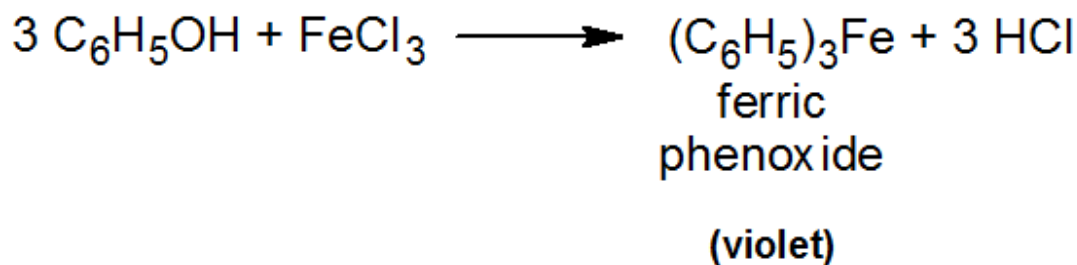
where R = hydrogen, alkyl or aryl group

• The iodoform test can distinguish ethanol from methanol



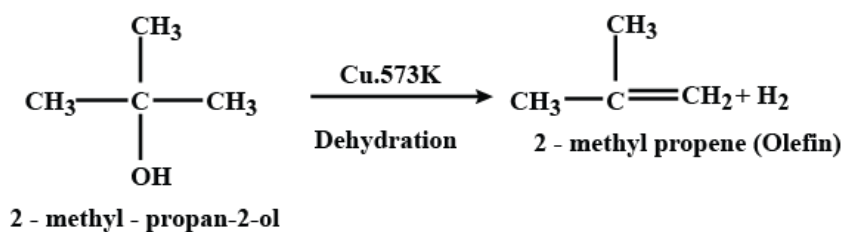
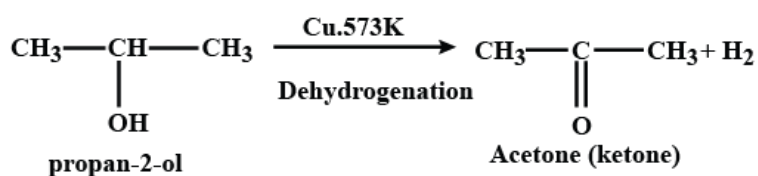
(iii) cyclohexanol and phenol.

Ans: With a neutral FeCl₃ solution, phenol becomes violet, but Cyclohexanol does not.



(iv) propan-2-ol and 2-methylpropan-2-ol.

Ans: propan-2-ol and 2-methylpropan-2-ol can be distinguished with process of copper metal which is as follows:

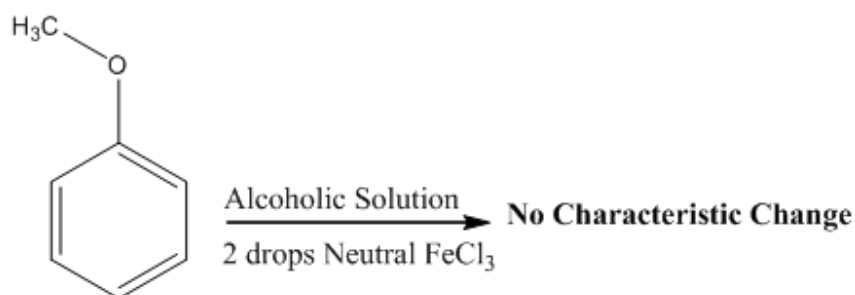


(v) phenol and anisole

Ans: FeCl_3 test can be used to distinguish between phenol and anisole.



The ferric phenoxide formed is violet in color.



(vi) ethanol and diethyl ether

Ans: ethanol and diethyl ether can be distinguished by iodoform test.



where R = hydrogen, alkyl or aryl group

• The iodoform test can distinguish ethanol from methanol

Diethyl ether does not give iodoform test (No Reaction)

14. Which of the following compounds gives fastest reaction with HBr and why?

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

(ii) $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$

(iii)

$$\begin{array}{c} \text{OH} \\ | \\ \text{CH}_3 - \text{CH} - \text{CH}_3 \end{array}$$

(iv)

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

Ans: Out of all the given compounds (i) i.e. tertiary alcohol will give fastest reaction with HBr .

The increased number of alkyl groups in tertiary alcohols increases the +I effect, making them more reactive. As a result, the charge density on carbon atoms increases, as does the charge density around oxygen atoms. The lone pairs on oxygen atoms are being pushed away by this negative charge density. Therefore, compound (i) t-butyl alcohol is most reactive towards HBr .

15. What is the function of ZnCl_2 (anhydrous) in Lucas test for distinction between 1° , 2° and 3° alcohols.

Ans: Lucas Reagent is ($\text{ZnCl}_2 + \text{HCl}$) because of Zn has vacant d orbitals, ZnCl_2 is a Lewis acid. The oxygen in -OH forms a coordination connection with Zinc, or compounds with it. Oxygen takes on a positive charge, whereas Zn takes on a negative charge. So, because oxygen now has a positive charge, a poor leaving group -OH has been transformed into a good leaving group (increased electronegativity).

16. An alcohol A ($\text{C}_4\text{H}_{10}\text{O}$) on oxidation with acidified potassium dichromate gives carboxylic acid B ($\text{C}_4\text{H}_8\text{O}_2$). Compound A when dehydrated with conc. H_2SO_4 at 443 K gives compound C. Treatment of C with aqueous H_2SO_4 gives compound D ($\text{C}_4\text{H}_{10}\text{O}$) which is an isomer of A. Compound D is resistant to oxidation but compound A can be easily oxidised. Identify A, B, C and D and write their structures.

Ans: The compound A i.e. $\text{C}_4\text{H}_{10}\text{O}$ corresponds to 2-methyl propan-1-ol, which is a primary alcohol. When A undergoes oxidation, the alcohol gets converted to corresponding carboxylic acid. The carboxylic acid B formed is 2-methyl propan-1-oic acid. On further dehydration, B forms double bonded compound C i.e. 2-methyl prop-1-ene. The alkene formed reacts with aqueous H_2SO_4 to again form an alcohol compound called, 2-methyl propan-2-ol which is D and is an isomer of A.

$A \rightarrow (\text{CH}_3)_2\text{CHCH}_2\text{OH}$, 2-methyl propan-1-ol

$B \rightarrow \text{CH}_3\text{CH}(\text{CH}_3)\text{COOH}$, 2-methyl propan-1-oic acid

$C \rightarrow (\text{CH}_3)_2\text{C}=\text{CH}_2$, 2-methyl prop-1-ene

$D \rightarrow (\text{CH}_3)_3\text{C}-\text{OH}$, 2-methyl propan-2-ol

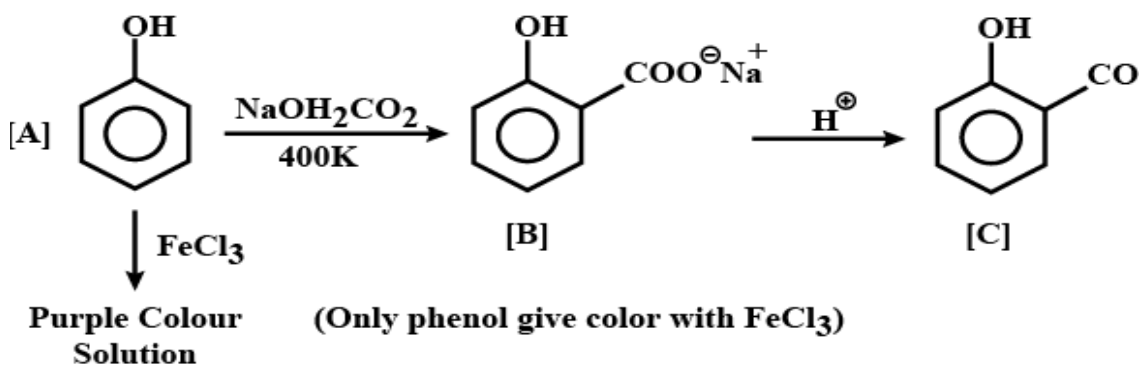
17. An organic compound A having molecular formula $\text{C}_6\text{H}_6\text{O}$ gives a characteristic colour with aqueous FeCl_3 . When A is treated with NaOH and CO_2 at 400 K under pressure, compound B is obtained. Compound B on acidification gives compound C which reacts with acetyl chloride to form D which is a popular pain killer. Deduce the structure of A, B, C and D. What is the common name of Drug D?

Ans: A is phenol

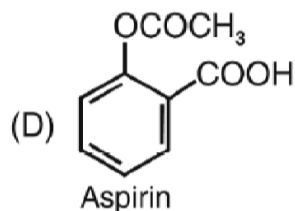
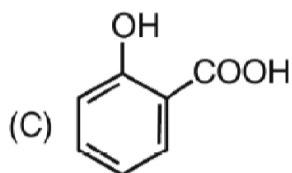
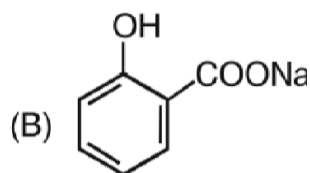
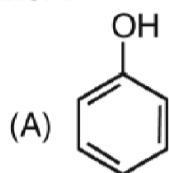
B is sodium salicylate

C is salicylic acid

D is 2-acetoxy benzoic acid, commonly known as aspirin.

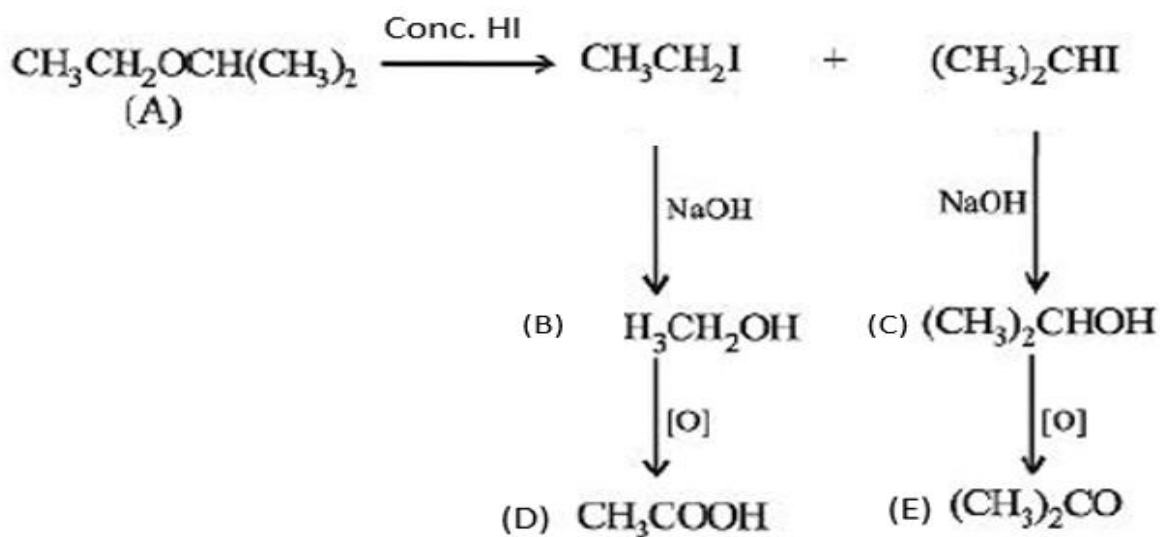


The structure of compound A, B, C & D are as follows:



19. An ether A ($C_5H_{12}O$) when heated with excess of hot concentrated HI produced two alkyl halides which on hydrolysis form compounds B and C. Oxidation of B gives an acid D whereas oxidation of C gave a ketone E. Deduce the structures of A, B, C, D and E.

Ans:



(A) $\text{CH}_3\text{CH}_2 - \text{O} - \text{CH}(\text{CH}_3)_2$, 2-ethoxy isopropane

(B) $\text{CH}_3\text{CH}_2\text{OH}$, ethanol

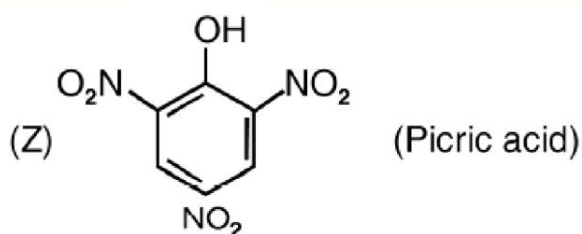
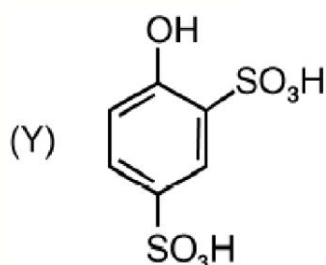
(C) $\text{CH}_3\text{CHOHCH}_3$, iso-propyl alcohol

(D) CH_3COOH , ethanoic acid

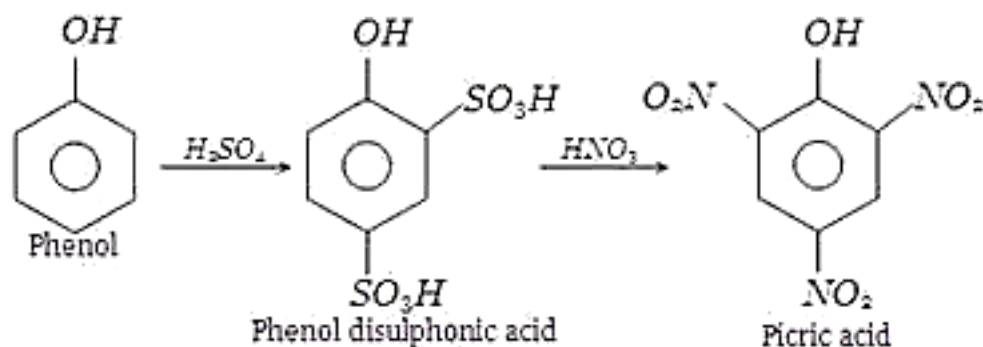
(E) CH_3COCH_3 , acetone

20. Phenol, $\text{C}_6\text{H}_5\text{OH}$ when it first reacts with concentrated sulphuric acid, forms Y. Y is reacted with concentrated nitric acid to form Z. Identify Y and Z and explain why phenol is not converted commercially to Z by reacting it with conc. HNO_3 .

Ans: When phenol; $\text{C}_6\text{H}_5\text{OH}$ reacts with concentrated H_2SO_4 , it produces phenol disulphonic acid, which on reaction with concentrated nitric acid yields 2,4,6,-trinitro phenol or picric acid.



The above reaction can be represented as:

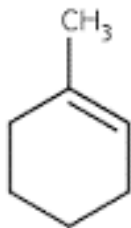


Also, Phenol is not reacted directly with conc. HNO_3 because the yield of picric acid is very poor, that's why it is not converted commercially to picric acid.

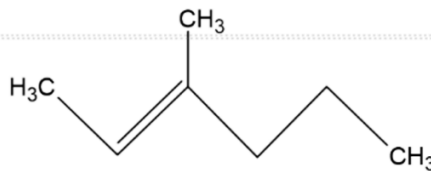
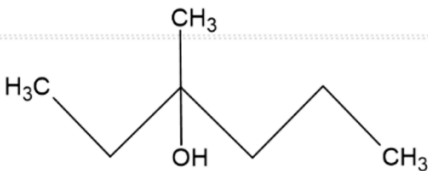
21. Synthesise the following alcohols from suitable alkenes.



Ans: 1-methyl cyclohexan-1-ol can be prepared by hydrolysis of methylene cyclohexane.



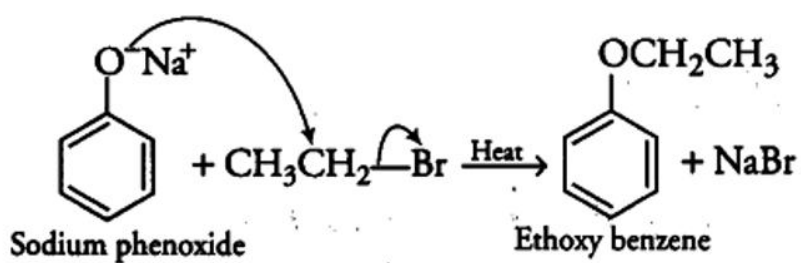
Ans: 3-methyl hexan-3-ol can be prepared as follows:



22. How are the following ethers prepared by Williamson synthesis?

(a) Ethoxybenzene

Ans:



(b) 2-methoxy-2-methyl propane

Ans:

