

## NCERT Solutions for Class 11 Chemistry Chapter 13 Hydrocarbons

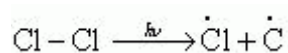
**Q 13.1** How do you account for the formation of ethane during chlorination of methane ?

**Answer:**

Chlorination of methane is by free radical mechanism and it takes place in three steps-

**(i) Initiation-**

First, homolytic cleavage of the  $Cl - Cl$  bond as

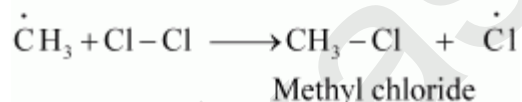


**(ii) Propagation-**

Chlorine-free radicals attack methane molecule and generate methyl-free radical as



This methyl radical reacts with other molecules of chlorine ( $Cl - Cl$ ) and form methyl chloride and liberate chlorine-free radicals.

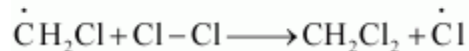
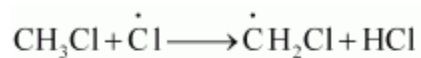


Then chlorine free radical reacts with methyl chloride and this way propagation occurs.

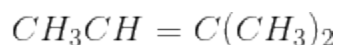


**(iii) Termination-**

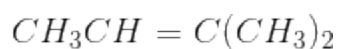
Ethane will be produced as a final product in this step. When two methyl free radicals react with each other ethane will be formed.



**Q13.2(a)** Write IUPAC names of the following compounds

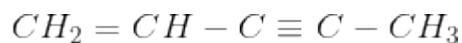


**Answer:**

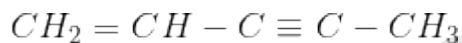


The IUPAC name of the given compound is 2-Methylbut-2-ene

**Q 13.2(b)** Write IUPAC names of the following compounds

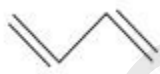


**Answer:**



The IUPAC name of the compound is Pent-1-ene-3-yne

**Q 13.2(c)** Write IUPAC names of the following compounds

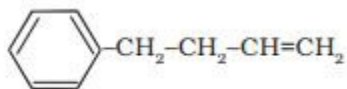


**Answer:**

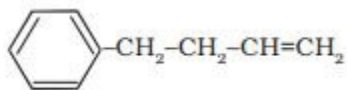


The IUPAC name of the compound is 1,3-Butadiene or Buta-1,3-diene

**Q 13.2(d)** Write IUPAC names of the following compounds :

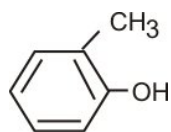


**Answer:**

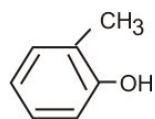


The IUPAC name of the compound is 4-phenylbut-1-ene

**Q 13.2(e)** Write IUPAC names of the following compounds :

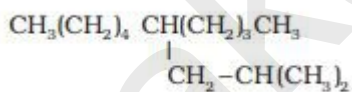


**Answer:**

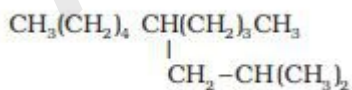


The IUPAC name of the compound is 2-methylphenol

**Q 13.2 (f)** Write IUPAC names of the following compounds :

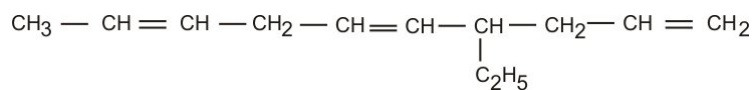


**Answer:**

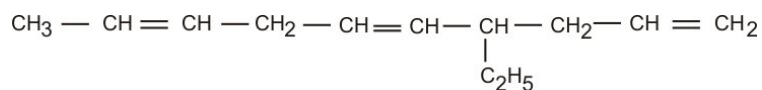


The IUPAC name of the compound is- 5-(2-methyl propyl)-decane

**Q 13.2(g)** Write IUPAC names of the following compounds :



**Answer:**



The IUPAC name of the compound is- 4-ethylDeca-1, 4, 8-triene

**Q 13.3** For the following compounds, write structural formulas and IUPAC names for all possible isomers having the number of the double or triple bond as indicated :

$C_4H_8$  ( one double bond)

**Answer:**

$C_4H_8$  the following isomers are possible with one double bond ;

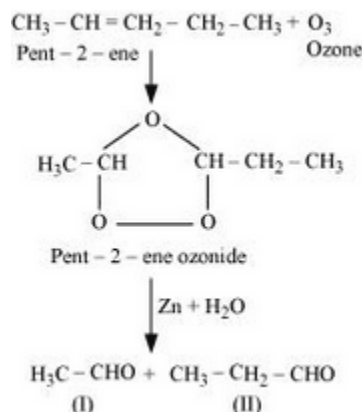
$\begin{array}{c} \text{H}_2\overset{1}{\text{C}} = \overset{2}{\text{C}}\text{H} - \overset{3}{\text{C}}\text{H}_2 - \overset{4}{\text{C}}\text{H}_3 \\ \text{(I)} \end{array}$	But-1-ene
$\begin{array}{c} \overset{1}{\text{C}}\text{H}_3 - \overset{2}{\text{C}}\text{H} = \overset{3}{\text{C}}\text{H} - \overset{4}{\text{C}}\text{H}_3 \\ \text{(II)} \end{array}$	But-2-ene
$\begin{array}{c} \overset{1}{\text{C}}\text{H}_2 = \overset{2}{\text{C}} - \overset{3}{\text{C}}\text{H}_3 \\   \\ \text{CH}_3 \\ \text{(III)} \end{array}$	2-Methylprop-1-ene

**Q 13.4(i)** Write IUPAC names of the products obtained by the ozonolysis of the following compounds :

Pent-2-ene

**Answer:**

Ozonolysis of Pent-2-ene gives two products both are aldehyde compounds. In this process, the ozone molecules attach at double bond of the molecule and break it into two products



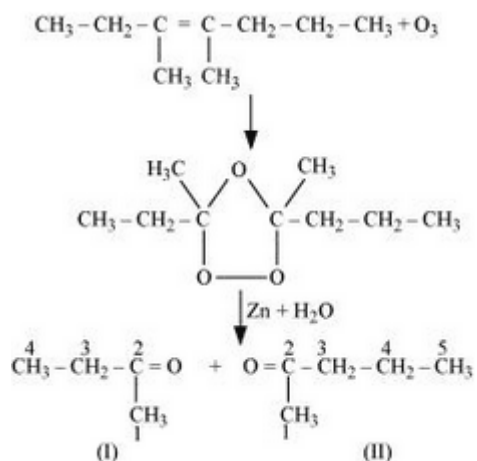
The IUPAC name of the compounds-(i) ethanal (ii) propanal

**Q 13.4 (ii)** Write IUPAC names of the products obtained by the ozonolysis of the following compounds :

3,4-Dimethylhept-3-ene

**Answer:**

Ozonolysis of 3,4-Dimethylhept-3-ene , gives two products of keto-compounds. The ozone molecules attach at the double bond.



The IUPAC name of the compound is -(i) Butan-2-one (ii) Pentan-2-one

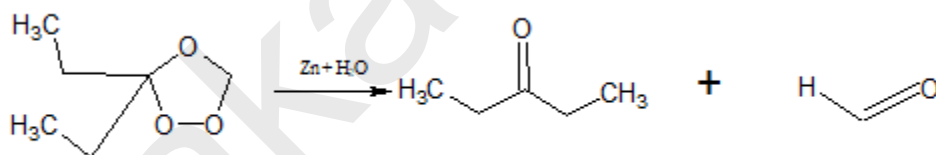
**Q 13.4(iii)** Write IUPAC names of the products obtained by the ozonolysis of the following compounds:

2-Ethylbut-1-ene

**Answer:**

Ozonolysis of 2-Ethylbut-1-ene gives two products one is keto compound and another is aldehyde.

2-Ethylbut-1-ene +  $\text{O}_3 \rightarrow$



(i)

(ii)

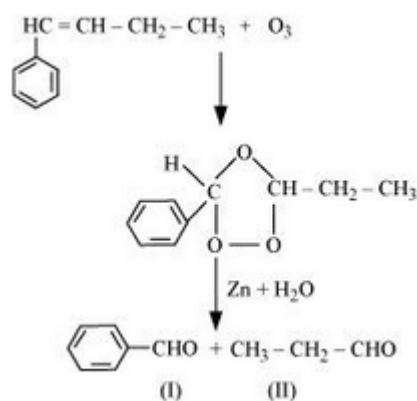
aldehyde The IUPAC name of the compound (i) is Pentan-3-one and the name of the (ii) compound is methanal.

**Q 13.4 (iv)** Write IUPAC names of the products obtained by the ozonolysis of the following compounds :

1-Phenylbut-1-ene

**Answer:**

On ozonolysis of 1-Phenylbut-1-ene gives two product of aldehyde compound. one is aromatic in nature and other is aliphatic aldehyde.

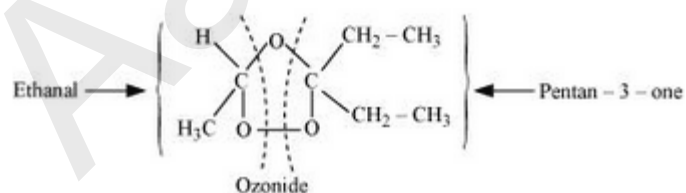


The IUPAC name of the compound is-(i) Benzaldehyde (ii)propanal

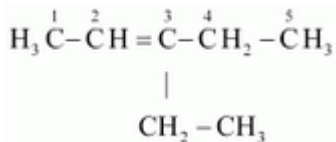
**Q 13.5** An alkene 'A' on ozonolysis gives a mixture of ethanal and pentan-3- one. Write structure and IUPAC name of 'A'.

**Answer:**

In the process of ozonolysis, an ozonide, cyclic ring structure intermediate is formed, which undergoes cleavage to give the product. The compound A produce pentan-3-one and ethanal. So, the possible structure of A should be-



Thus, by removing the ozone from ozonide we can get the parent alkene structure.



**Q 13.6** An alkene 'A' contains three C – C, eight C – H  $\sigma$  bonds and one C – C  $\pi$  bond. 'A' on ozonolysis gives two moles of an aldehyde of molar mass 44 u. Write IUPAC name of 'A'.

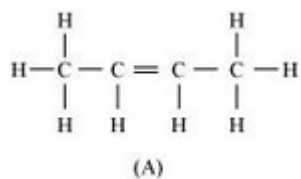
**Answer:**

As per the given data, compound A on ozonolysis give two moles of aldehyde, having molar mass 44u. It indicates that the compound has an identical structure around (both sides) a double bond.

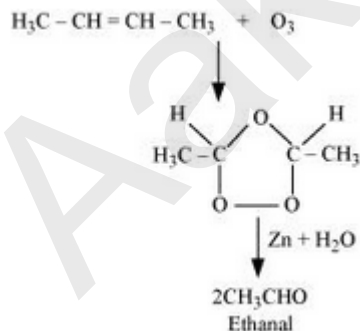
So, the possible general structure of A = YC = CY

There are eight C – H sigma bonds, it means eight Hydrogen atoms in the structure A. Also, three C – C bonds, it indicates the presence of four Carbon atom in A.

Now, by combining all the observation, the structure of the A would be-



Ozonolysis reaction is shown below-



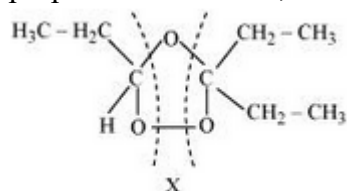
The atomic mass of ethanal is 44 u.



**Q 13.7** Propanal and pentan-3-one are the ozonolysis products of an alkene? What is the structural formula of the alkene?

**Answer:**

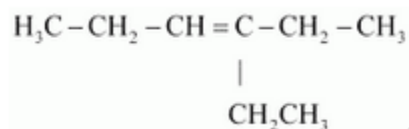
In the process of ozonolysis, an ozonide, cyclic ring structure intermediate is formed, which undergoes cleavage to give the product. The parent compound produces pentan-3-one and propanal. So, the possible structure should be-



Here in this above structure, right side Pent-3-one and the left-hand side propanal structure.

Thus, by removing the ozone from ozonide we can get the parent alkene structure.

Therefore the structure of the parent alkene is



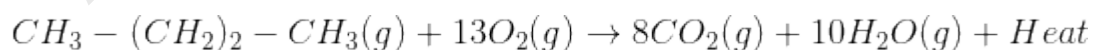
(3-ethyl-3-hexene)

**Q 13.8(i)** Write chemical equations for combustion reaction of the following hydrocarbons:

Butane

**Answer:**

Combustion means the reaction of a compound with the dioxygen ( $O_2$ )

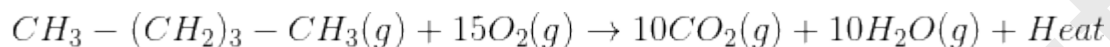


**Q 13.8(ii)** Write chemical equations for combustion reaction of the following hydrocarbons:

Pentene

**Answer:**

Combustion means the reaction of a compound with the dioxygen( $O_2$ ). Combustion reaction of the Pentene-

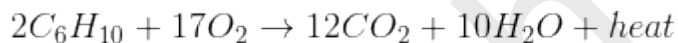


**Q 13.8 (iii)** Write chemical equations for combustion reaction of the following hydrocarbons:

Hexyne

**Answer:**

Combustion means the reaction of the given compound with the dioxygen( $O_2$ ) gives carbon dioxide, water molecule and produce some amount of heat.

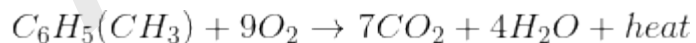


**Q 13.8(iv)** Write chemical equations for combustion reaction of the following hydrocarbons:

Toluene

**Answer:**

Combustion means the reaction of the given compound with the dioxygen( $O_2$ ) gives carbon dioxide, water molecule and produce some amount of heat.

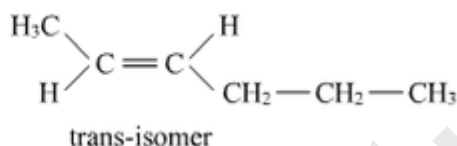
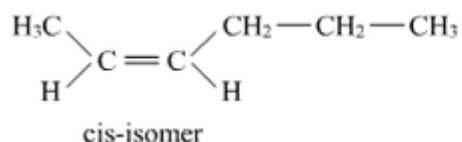


**Q 13.9** Draw the cis and trans structures of hex-2-ene. Which isomer will have higher b.p. and why?

**Answer:**

The structure of the hex-2-ene is shown here-  
 $\text{CH}_3-\text{CH}=\text{CH}-\text{CH}_2-\text{CH}_2-\text{CH}_3$

Now, the Geometrical, cis and trans isomers -

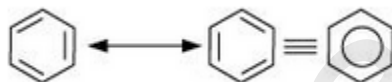


Cis-isomer has a higher boiling point than trans-isomers due to more dipole-dipole interaction between the molecules. The cis-form is more polar than trans-form because it has a high dipole moment than trans-form. Trans-form is almost non-polar in nature.

**Q 13.10** Why is benzene extra ordinarily stable though it contains three double bonds?

**Answer:**

Benzene is a hybrid of various resonating structure.



Each carbon of benzene is in  $sp^2$  hybridisation. Two  $sp^2$  hybrid orbitals of each carbon is overlapping with adjacent carbon atoms orbital resulting in six C-C sigma bonds all are in a hexagonal plane and remaining  $sp^2$  orbital overlap with s-orbitals of hydrogen and form C-H sigma bonds. In benzene six C-H sigma bond presents. And the remaining unhybridised  $p$ -orbital (which are perpendicular to the plane), they formed  $\pi$ -bond by lateral overlapping. The possibility of forming  $\pi$ -bond is six ( $C_1 - C_2, C_3 - C_4, C_6 - C_1, C_2 - C_3, C_4 - C_6, C_6 - C_1$ ).

There are 6-  $\pi$  electron, which delocalised and moves freely about the six carbon nuclei and the presence of these delocalised  $\pi$ -electrons in benzene makes it more stable

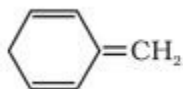
**Q 13.11** What are the necessary conditions for any system to be aromatic?

**Answer:**

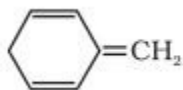
The necessary conditions for any system to be aromatic are -

1. The cyclic compound should be a planar
2. The complete(continuous) delocalisation of  $\pi$  -electrons in the ring
3. Follow the **Huckel rule**- it states that, the ring has  $(4n+2)$   $\pi$  -electrons, where  $n = \text{integer}(n = 0, 1, 2, 3, \dots)$

**Q 13.12 (i)** Explain why the following systems are not aromatic?



**Answer:**

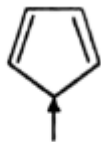


Not an aromatic compound because the  $\pi$  -electrons in the ring are not in a complete conjugation. And it is a non-planar structure.

**Q 13.12(ii)** Explain why the following systems are not aromatic?



**Answer:**



$sp^3$  hybridised

There is no complete conjugation of a  $\pi$  electron in the ring. And also it does not obey huckle rule  $[(4n+2) \pi]$  electron.

**Q 13.12(iii)** Explain why the following systems are not aromatic?



**Answer:**



It disobeys the Huckle rule of  $(4n+2) \pi$  electron. According to this rule, it has 2, 6, 10 .... number of  $\pi$  electron but it has 8  $\pi$  electrons.

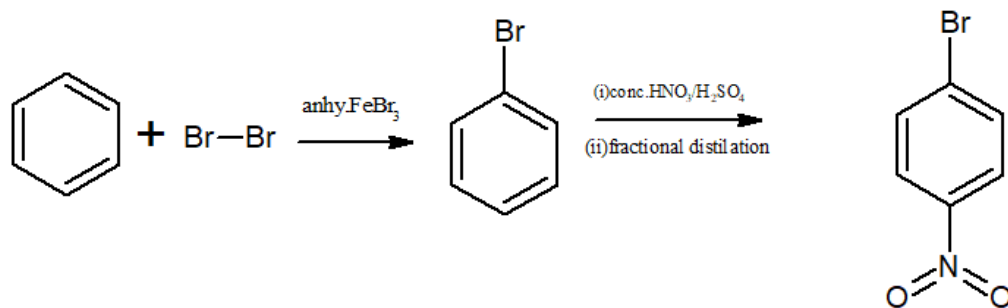
**Q 13.13(i)** How will you convert benzene into

p-nitrobromobenzene

**Answer:**

Bromination of a benzene ring in the presence of anhydrous  $FeCl_3$  and  $Br_2$  gives bromobenzene and after that treating bromobenzene with conc. nitric acid in the presence of sulphuric acid

followed by fractional distillation gives p-nitrobenzene.

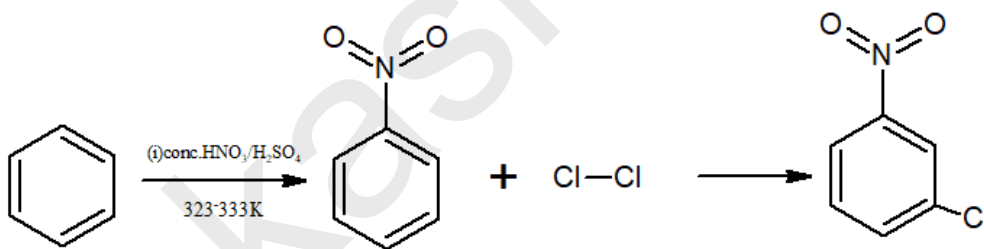


**Q 13.14 (ii)** How will you convert benzene into

m- nitrochlorobenzene

**Answer:**

Benzene on treatment with conc. nitric acid and sulphuric acid gives nitrobenzene which on further treatment with chlorine in the presence of anhydrous aluminium chloride ( $AlCl_3$ ) gives m-nitrochlorobenzene.

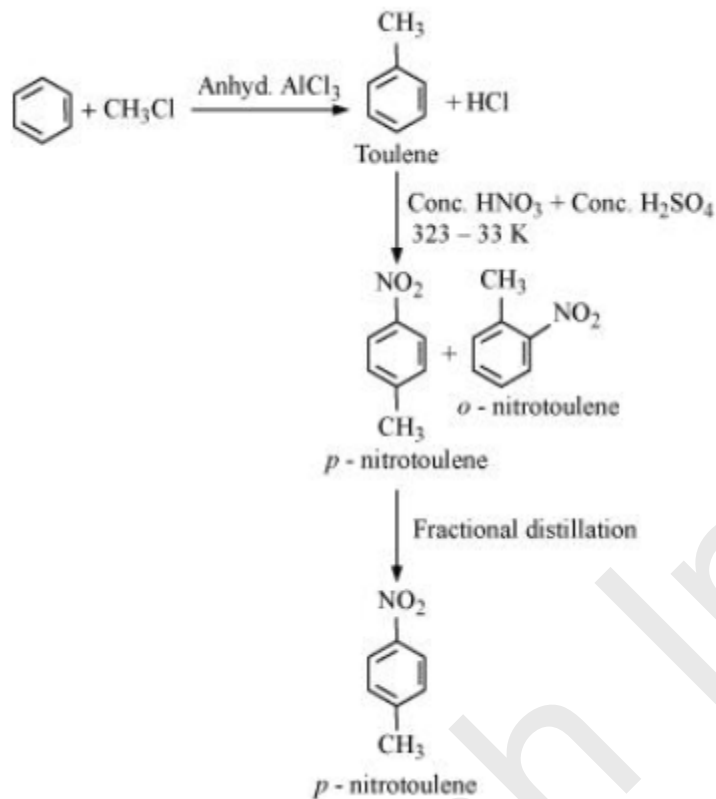


**Q 13.13(iii)** How will you convert benzene into

p - nitrotoluene

**Answer:**

Alkylation of benzene gives in the presence of anhydrous aluminium chloride give methylbenzene and  $HCl$ . When methylbenzene reacts with conc. nitric acid and sulphuric acid gives a mixture of para and ortho product of nitrotoluene, which on distillation gives *P*-nitrotoluene.

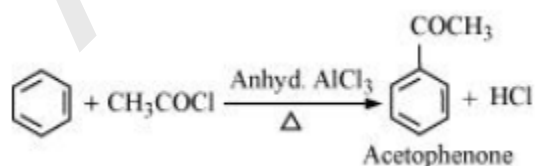


Q 13.13 (iv) How will you convert benzene into

acetophenone

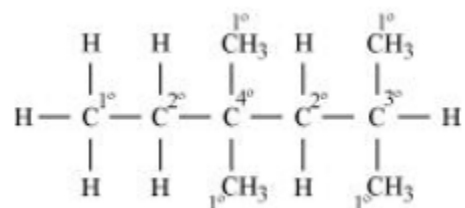
**Answer:**

Benzene on reacting with an acyl chloride in the presence of anhydrous aluminium chloride gives acetophenone and hydrochloric acid as a by-product.



**Q 13.14** In the alkane  $\text{H}_3\text{C}-\text{CH}_2-\text{C}(\text{CH}_3)_2-\text{CH}_2-\text{CH}(\text{CH}_3)_2$ , identify  $1^\circ, 2^\circ, 3^\circ$  carbon atoms and give the number of H atoms bonded to each one of these.

**Answer:**



$1^\circ$  Carbon are those which are directly bonded with only one carbon atoms, the given structure has five  $1^\circ$  carbon atom and 15 hydrogens attached to it.

$2^\circ$  carbon are those which are connected with only two carbon atoms. In the above structure, there is two  $2^\circ$  carbon present, and four hydrogens attached to it.

$3^\circ$  are those which connect with three carbon atom. In the above structure, 1 carbon atom is  $3^\circ$  carbon atom and only one hydrogen is attached to it.

**Q 13.15** What effect does branching of an alkane chain has on its boiling point?

**Answer:**

On an increase in the branching of the alkane, the boiling point of the alkane is decreased. Alkane experience inter-molecular van der Waals forces. The strong is the force, strong will be the boiling point. When we increase the branching, the surface area of the molecule decreases, as a result, of the van der Waals force also decreases.

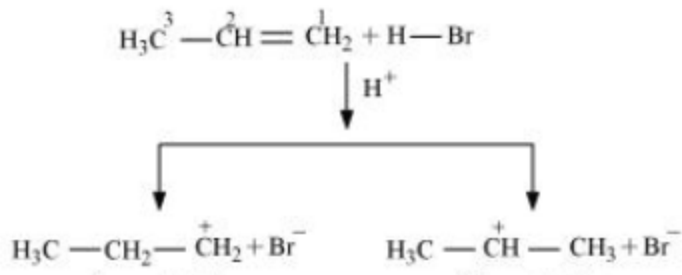
**Q 13.16** Addition of HBr to propene yields 2-bromopropane, while in the presence of benzoyl peroxide, the same reaction yields 1-bromopropane. Explain and give mechanism.

**Answer:**

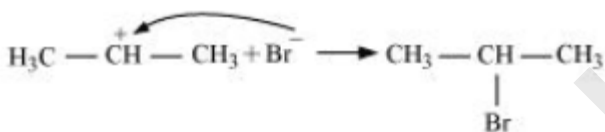


Addition of  $HBr$  to propene-

In this addition, an electrophile  $H^+$  attacks the double bond of the alkene to form  $1^\circ$  and  $2^\circ$  carbocations-



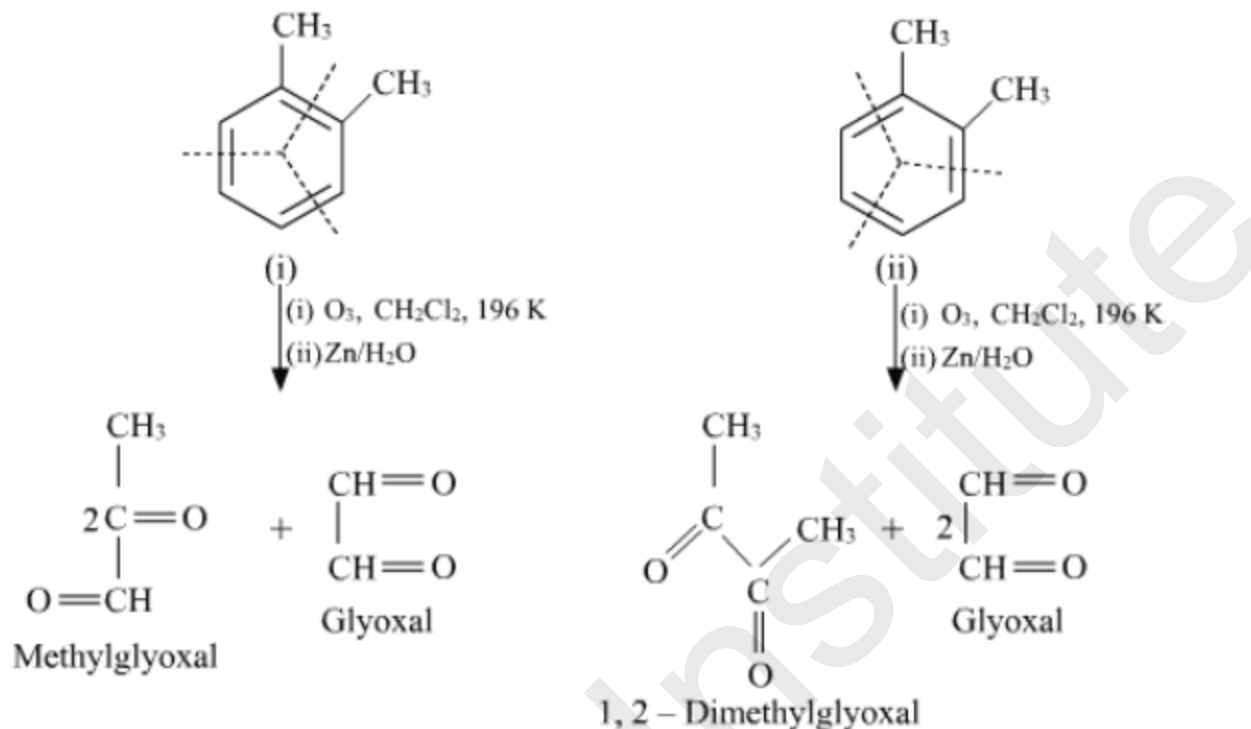
a secondary carbocation is more stable than the primary carbocation. Thus bromide ion attacks the carbocation to form 2-bromopropane as a major product. (This mechanism is followed by Markovnikov's rule)



**Q 13.17** Write down the products of ozonolysis of 1,2-dimethylbenzene (o-xylene). How does the result support Kekulé structure for benzene?

**Answer:**

Ortho-xylene has two resonant structures so,



Since all three products, methylglyoxal, 1, 2-methylglyoxal and glyoxal are cannot be obtained from any one of the two structure (i and ii). Hence we can say that o-xylene is a resonant hybrid of two Kekule structure (I and II)

**Q 13.19** Why does benzene undergo electrophilic substitution reactions easily and nucleophilic substitutions with difficulty?

**Answer:**

In benzene, the  $\pi$ -electrons are delocalised above and below of the ring. Thus it is an electron rich species. In nucleophilic substitution, the attacking species is an electron-rich in nature, so it becomes challenging to attack benzene because they are repelled by benzene. On the other hand, when the attacking agent is electrophile, which is electron deficient, are easily attracted by the benzene.

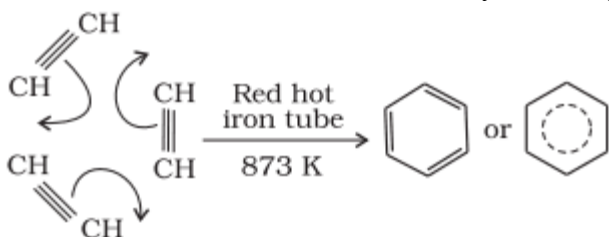
**Q 13.20 (i)** How would you convert the following compounds into benzene?

Ethyne

**Answer:**

By cyclic polymerisation of ethyne, Ethyne on passing by red hot tube(made of iron) at 873K.

Three molecules of ethyne polymerises to form benzene.



**Q 13.20(ii)** How would you convert the following compounds into benzene?

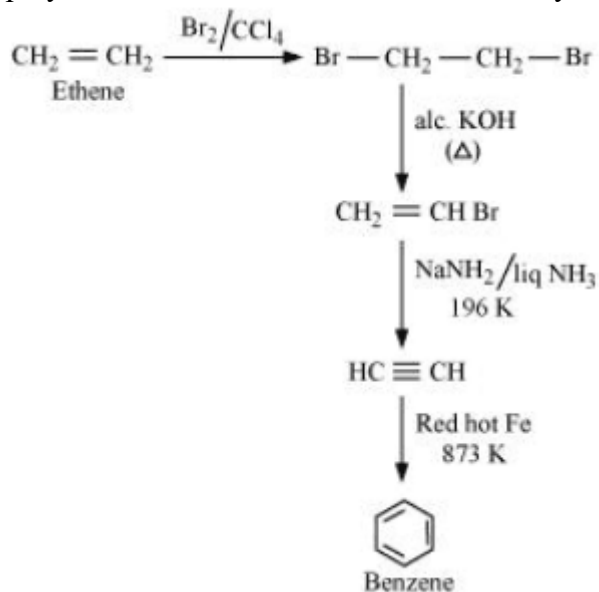
Ethene

**Answer:**

By converting ethene to ethyne by reacting with bromine in the presence of carbon tetrachloride.

And then heating in presence of alc. KOH followed by  $NaNH_2/liq. NH_3$ . Cyclic

polymerisation of ethyne gives us benzene.

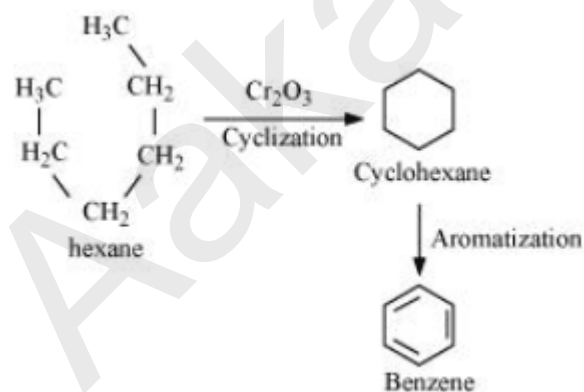


Q 13.20(iii) How would you convert the following compounds into benzene?

Hexane

**Answer:**

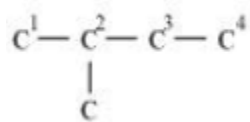
The cyclisation of hexane in the presence of  $\text{Cr}_2\text{O}_3$  produce cyclohexane, which on aromatisation gives benzene.



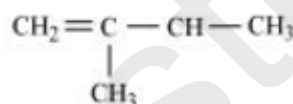
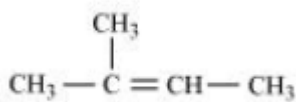
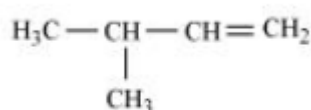
Q 13.21 Write structures of all the alkenes which on hydrogenation give 2-methylbutane.

**Answer:**

Structures of all the alkenes which on hydrogenation give 2-methylbutane. the general structure of the 2-methylbutane is shown here;



As per the above structure, the following alkene compounds produces 2-methylbutane by hydrogenation.



**Q 13.22(a)** Arrange the following set of compounds in order of their decreasing relative reactivity with an electrophile,  $E^+$

Chlorobenzene, 2,4-dinitrochlorobenzene, p-nitrochlorobenzene

**Answer:**

Electrophiles are electron deficient species, so they want a nucleophile which donates electrons to them. The higher the electron density on a benzene ring, the higher is the reactivity towards electrophile.

$\text{NO}_2$  is an electron withdrawing group, it deactivates the benzene ring towards electrophile by decreasing the electron density from the ring.

Decreasing order of their reactivity with an electrophile ( $E^+$ )

Chlorobenzene > p-nitrochlorobenzene > 2, 4-dinitrochlorobenzene

**Q 13.22 (b)** Arrange the following set of compounds in order of their decreasing relative reactivity with an electrophile,  $E^+$

Toluene,  $p - H_3C - C_6H_4 - NO_2$ ,  $p - O_2N - C_6H_4 - NO_2$ .

**Answer:**

Electrophiles are electron deficient species, so they want a nucleophile which donates electrons to them. The higher the electron density on a benzene ring, the higher is the reactivity towards electrophile.

since the methyl group is electron donating group it increases the electron density on the benzene ring. And more the number of EWG lesser reactive towards electrophile.

therefore, the decreasing order of reactivity towards electrophile -  
toluene  $> p - CH_3C_6H_4 - NHO_2 > p - O_2NC_6H_4 - NO_2$

**Q 13.23** Out of benzene, m-dinitrobenzene and toluene which will undergo nitration most easily and why?

**Answer:**

Nitration is occurred by an electrophilic substitution reaction, in which an electron rich species is attacked by an electron deficient molecule known as an electrophile. In nitration  $NO_2^+$  is used as an electrophile. Here methyl group is electron donating group and the nitro group is electron withdrawing group. So, benzene ring attached with the  $-CH_3$  group has high electron density and the ring which is attached with the nitro group has least electron density. Hence toluene undergoes nitration most easily.

**Q 13.24** Suggest the name of a Lewis acid other than anhydrous aluminium chloride which can be used during ethylation of benzene.

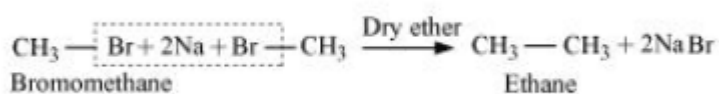
**Answer:**

Lewis acid like anhydrous ferric chloride ( $FeCl_3$ ), stannic chloride ( $SnCl_4$ ),  $BF_3$  etc. can be used instead of aluminium chloride.

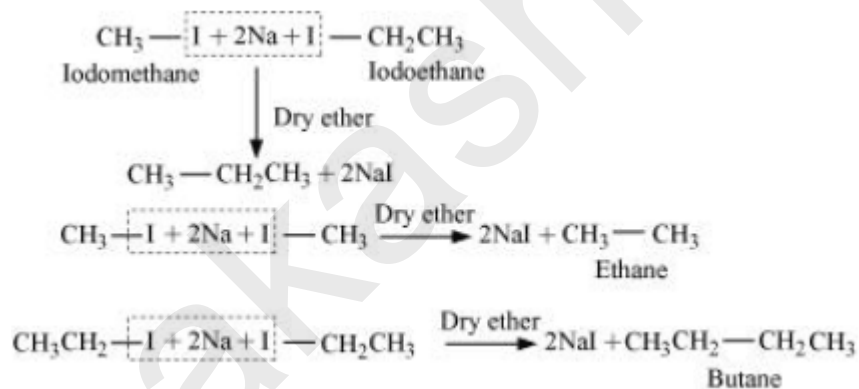
**Q 13.25** Why is Wurtz reaction not preferred for the preparation of alkanes containing an odd number of carbon atoms? Illustrate your answer by taking one example.

**Answer:**

Wurtz reaction-



Wurtz reaction not preferred for the preparation of alkanes containing an odd number of carbon atoms because if we take two dissimilar alkyl halide as a reactant, the product will be a mixture of alkane but the reaction is by a free radical mechanism it will produce an alkene also. example- bromomethane and iodoethane.



all the products in the mixture have nearly close boiling point. So, the separation will be difficult.