Chapter: HYDROCARBONS

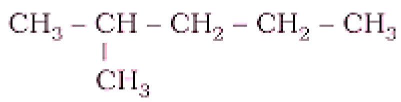
Examples

Example 13.1 Write structures of different chain isomers of alkanes corresponding to the molecular formula. Also write their IUPAC names.

Answer: (i) IUPAC NAME: $n-$Hexane

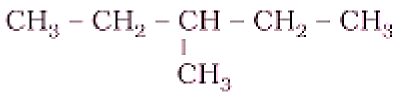
$$CH_3-CH_2-CH_2-CH_2-CH_2-CH_3$$

(ii) IUPAC NAME: $2-$Methylpentane



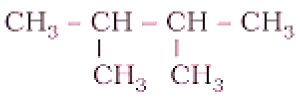
$$CH_3-\underset{\substack{|\\CH_3}}{CH}-CH_2-CH_2-CH_3$$

(iii) IUPAC NAME: $3-$Methylpentane



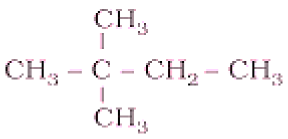
$$CH_3-CH_2-\underset{\substack{|\\CH_3}}{CH}-CH_2-CH_3$$

(iv) IUPAC NAME: $2,3$-Dimethylbutane



$$CH_3-\underset{\substack{|\\CH_3}}{CH}-\underset{\substack{|\\CH_3}}{CH}-CH_3$$

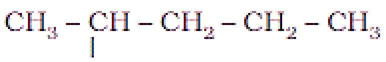
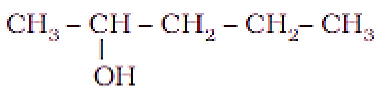
(v) IUPAC NAME : $2,2-$Dimethylbutane

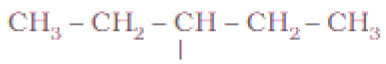
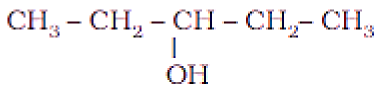
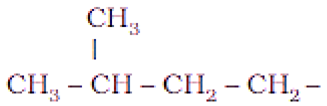
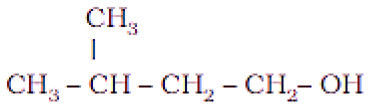
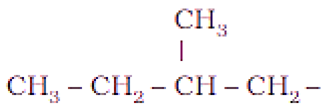
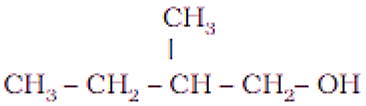
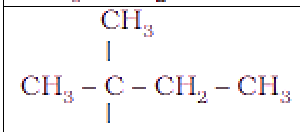
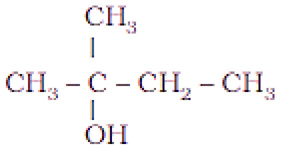
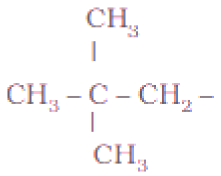
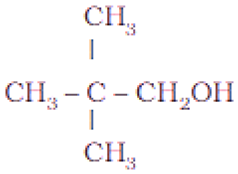
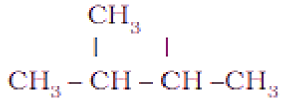
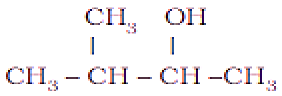


$$CH_3-\overset{\substack{CH_3\\|}}{\underset{\substack{|\\CH_3}}{C}}-CH_2-CH_3$$

Example 13.2 Write structures of different isomeric alkyl groups corresponding to the molecular formula C_5H_{11}. Write IUPAC names of alcohols obtained by attachment of $-OH$ groups at different carbons of the chain.

Answer:

Structures of C_5H_{11} group	Corresponding alcohols	Name of alcohol
$CH_3-CH_2-CH_2-CH_2-CH_2-$	$CH_3-CH_2-CH_2-CH_2-CH_2-OH$	Pentan-1-ol
 $CH_3-\underset{\mid}{CH}-CH_2-CH_2-CH_3$	 $CH_3-\underset{\substack{\mid\\OH}}{CH}-CH_2-CH_2-CH_3$	Pentan-2-ol

 $CH_3-CH_2-\underset{\vert}{CH}-CH_2-CH_3$	 $CH_3-CH_2-\underset{OH}{\underset{\vert}{CH}}-CH_2-CH_3$	Pentan-3-ol
 $CH_3-\overset{CH_3}{\overset{\vert}{CH}}-CH_2-CH_2-$	 $CH_3-\overset{CH_3}{\overset{\vert}{CH}}-CH_2-CH_2-OH$	3-Methyl-butan-1-ol
 $CH_3-CH_2-\overset{CH_3}{\overset{\vert}{CH}}-CH_2-$	 $CH_3-CH_2-\overset{CH_3}{\overset{\vert}{CH}}-CH_2-OH$	2-Methyl-butan-1-ol
 $CH_3-\underset{\vert}{\overset{CH_3}{\overset{\vert}{C}}}-CH_2-CH_3$	 $CH_3-\underset{OH}{\underset{\vert}{\overset{CH_3}{\overset{\vert}{C}}}}-CH_2-CH_3$	2-Methyl-butan-2-ol
 $CH_3-\underset{CH_3}{\underset{\vert}{\overset{CH_3}{\overset{\vert}{C}}}}-CH_2-$	 $CH_3-\underset{CH_3}{\underset{\vert}{\overset{CH_3}{\overset{\vert}{C}}}}-CH_2OH$	2, 2 – Dimethylpropan -1-ol
 $CH_3-\overset{CH_3}{\overset{\vert}{CH}}-\overset{\vert}{CH}-CH_3$	 $CH_3-\overset{CH_3}{\overset{\vert}{CH}}-\overset{OH}{\overset{\vert}{CH}}-CH_3$	3-Methylbutan-2-ol

Example 13.3 Write IUPAC names of the following compounds:

(i) $(CH_3)_3CCH_2C(CH_3)_3$

Answer: 2, 2, 4, 4 – Tetramethylpentane

(ii) $(CH_3)_2C(C_2H_5)_2$

Answer: 3, 3 – Dimethylpentane

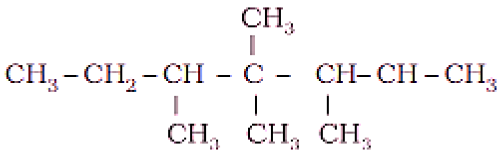
(iii) tetra - tert-butylmethane

Answer: 3, 3-Di-tert-butyl - 2, 2, 4, 4 tetramethylpentane

Example 13.4 Write structural formulas of the following compounds:

(i) 3, 4, 4, 5-Tetramethylheptane

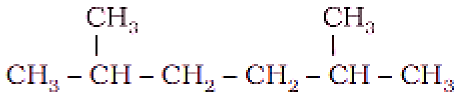
Answer:



$$CH_3-CH_2-\underset{CH_3}{\underset{|}{CH}}-\overset{CH_3}{\overset{|}{\underset{CH_3}{\underset{|}{C}}}}-\underset{CH_3}{\underset{|}{CH}}-CH-CH_3$$

(ii) **2, 5**-Dimethyhexane

Answer:

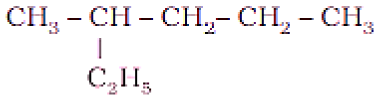


$$CH_3-\overset{\overset{\displaystyle CH_3}{|}}{CH}-CH_2-CH_2-\overset{\overset{\displaystyle CH_3}{|}}{CH}-CH_3$$

Example 13.5 Write structures for each of the following compounds. Why are the given names incorrect? Write correct IUPAC names.

(i) **2** -Ethylpentane

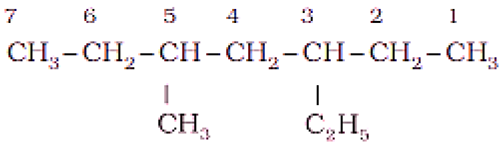
Answer: The given name is incorrect because chain has six carbon atoms . As a result, correct name is 3-Methylhexane.



$$CH_3-\underset{\underset{\displaystyle C_2H_5}{|}}{CH}-CH_2-CH_2-CH_3$$

(ii) 5-Ethyl-3-methylheptane

Answer: The given name is incorrect because the numbering should be started from the end, giving the ethyl group a lower number. As a result, correct name is 3 -ethyl-5-methylheptane.



$$\overset{7}{CH_3}-\overset{6}{CH_2}-\underset{\underset{\displaystyle CH_3}{|}}{\overset{5}{CH}}-\overset{4}{CH_2}-\underset{\underset{\displaystyle C_2H_5}{|}}{\overset{3}{CH}}-\overset{2}{CH_2}-\overset{1}{CH_3}$$

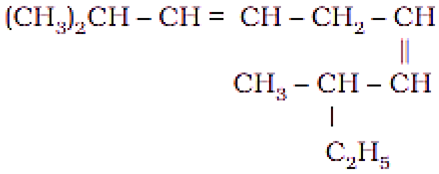
Example 13.6 Sodium salt of which acid will be needed for the preparation of propane? Write chemical equation for the reaction.

Answer: Butanoic acid,

$$CH_3CH_2CH_2COO^-Na^+ + NaOH \xrightarrow{CaO} CH_3CH_2CH_3 + Na_2CO_3$$

Example 13.7 Write IUPAC names of the following compounds:

(i)



$$\begin{array}{l}(CH_3)_2CH-CH=CH-CH_2-CH\\ \qquad\qquad\qquad\qquad\qquad\qquad\qquad\quad \|\\ \qquad\qquad\qquad\qquad\quad CH_3-\underset{\underset{\displaystyle C_2H_5}{|}}{CH}-CH\end{array}$$

Answer: 2,8-Dimethyl-3, 6-decadiene

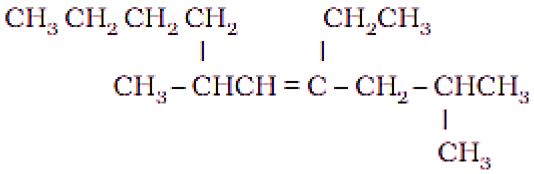
(ii) 

Answer: 1,3,5,7 Octatetraene

(iii) $CH_2 = C\,(CH_2CH_2CH_3)_2$

Answer: 2 -n-Propylpent-1-ene

(iv)



$$\begin{array}{l} CH_3CH_2CH_2CH_2 \qquad\quad CH_2CH_3 \\ \qquad\qquad\qquad\quad | \qquad\qquad\quad | \\ \qquad\quad CH_3-CHCH=C-CH_2-CHCH_3 \\ \qquad\qquad\qquad\qquad\qquad\qquad\qquad\quad | \\ \qquad\qquad\qquad\qquad\qquad\qquad\qquad CH_3 \end{array}$$

Answer: 4 -Ethyl- 2,6 -dimethyl-dec- 4 -ene;

Example 13.8 Calculate number of sigma (σ) and pi(π) bonds in the above structures (i-iv).

Answer:

(i) σ bonds: 33, π bonds: 2

(ii) σ bonds: 17 , π bonds: 4

(iii) σ bonds: 23, π bond: 1

(iv) σ bonds: 41, π bond: 1

Example 13.9 Write structures and IUPAC names of different structural isomers of alkenes corresponding to C_5H_{10}.

Answer:

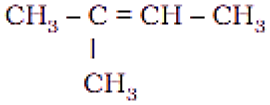
(a) $CH_2=CH-CH_2-CH_2-CH_3$

Pent-1-ene

(b) $CH_3-CH=CH-CH_2-CH_3$

Pent-2-ene

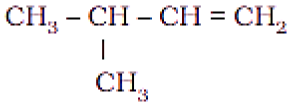
(c)



$CH_3-C(CH_3)=CH-CH_3$

2-Methylbut-2-ene

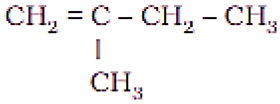
(d)



$CH_3-CH(CH_3)-CH=CH_2$

3-Methylbut-1-ene

(e)



$CH_2=C(CH_3)-CH_2-CH_3$

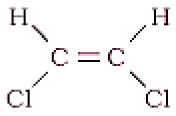
2-Methylbut-1-ene

Example 13.10 Draw cis and trans isomers of the following compounds. Also write their IUPAC names :

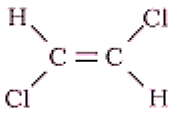
(i) $CHCl=CHCl$

Answer:

(i)



cis-1, 2-Dichloroethene

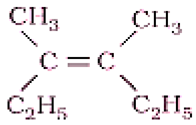


trans-1, 2-Dichloroethene

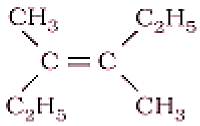
(ii) $C_2H_5CCH_3=CCH_3C_2H_5$

Answer:

(ii)



cis-3, 4-Dimethylhex-3-ene



trans-3, 4-Dimethylhex-3-ene

Example 13.11 Which of the following compounds will show cis-trans isomerism?

(i) $(CH_3)_2C=CH-C_2H_5$

Answer: These compounds will not show cis-trans isomerism as

One of the doubly linked carbon atoms is coupled to two identical groups.

(ii) $CH_2 = CBr_2$

Answer: These compounds will not show cis-trans isomerism as

One of the doubly linked carbon atoms is coupled to two identical groups.

(iii) $C_6H_5CH = CH - CH_3$

Answer: These compounds will show cis-trans isomerism.

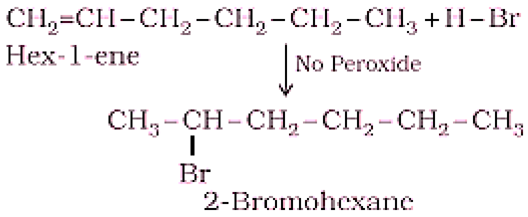
(iv) $CH_3CH = CClCH_3$

Answer: These compounds will show cis-trans isomerism.

Example 13.12 Write IUPAC names of the products obtained by addition reactions of HBr to hex-1-ene

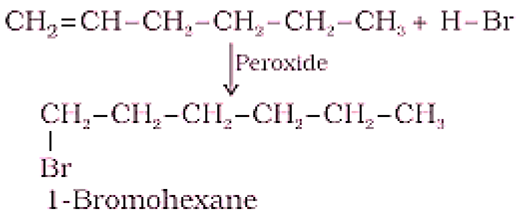
(i) in the absence of peroxide and

Answer:



(ii) in the presence of peroxide.

Answer:



Example 13.13 Write structures of different isomers corresponding to the 5^{th} member of alkyne series. Also write IUPAC names of all the isomers. What type of isomerism is exhibited by different pairs of isomers?

Answer: 5^{th} member of alkyne is having molecular formula C_6H_{10}. The isomers are as follows:

(a) $HC\equiv C-CH_2-CH_2-CH_2-CH_3$

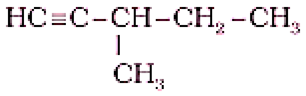
Hex-1-yne

(b) $CH_3-C\equiv C-CH_2-CH_2-CH_3$

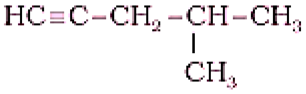
Hex-2-yne

(c) $CH_3-CH_2-C\equiv C-CH_2-CH_3$

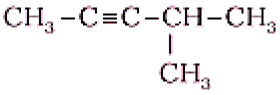
Hex-3-yne

(d) 
$HC\equiv C-\underset{\substack{|\\ CH_3}}{CH}-CH_2-CH_3$

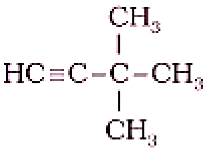
3-Methylpent-1-yne

(e) 
$HC\equiv C-CH_2-\underset{\substack{|\\ CH_3}}{CH}-CH_3$

4-Methylpent-1-yne

(f) 
$CH_3-C\equiv C-\underset{\substack{|\\ CH_3}}{CH}-CH_3$

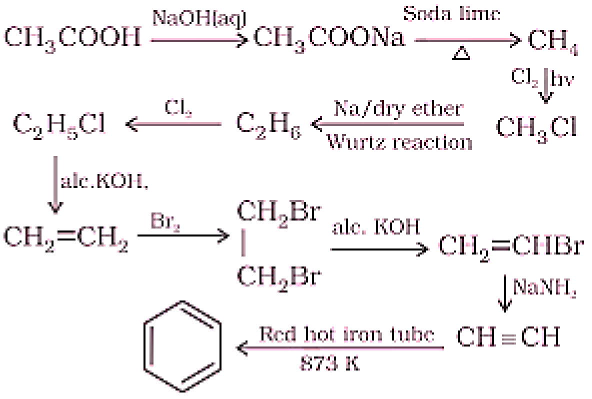
4-Methylpent-2-yne

(g) 
$HC\equiv C-\overset{\substack{CH_3\\ |}}{\underset{\substack{|\\ CH_3}}{C}}-CH_3$

3,3-Dimethylbut-1-yne

Example 13.14 How will you convert ethanoic acid into benzene?

Answer:



EXERCISES

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

Ans: The chlorination of methane is accomplished using a free radical chain process.

The whole reaction occurs in the three steps listed.

Step I: Initiation

$$\text{Cl}-\text{Cl}\xrightarrow{h\nu}\dot{\text{C}}\text{l}+\dot{\text{C}}$$

Chlorine free radicals

Step II: Propagation

$$\underset{\text{Methane}}{\text{CH}_4}+\dot{\text{C}}\text{l}\xrightarrow{h\nu}\dot{\text{C}}\text{H}_3+\text{H}-\text{Cl}$$

$$\dot{\text{C}}\text{H}_3+\text{Cl}-\text{Cl}\longrightarrow\underset{\text{Methyl chloride}}{\text{CH}_3-\text{Cl}}+\dot{\text{C}}\text{l}$$

$$\text{CH}_3\text{Cl}+\dot{\text{C}}\text{l}\longrightarrow\dot{\text{C}}\text{H}_2\text{Cl}+\text{HCl}$$

$$\dot{\text{C}}\text{H}_2\text{Cl}+\text{Cl}-\text{Cl}\longrightarrow\text{CH}_2\text{Cl}_2+\dot{\text{C}}\text{l}$$

Step III: Termination

$$\dot{\text{C}}\text{l}+\dot{\text{C}}\text{l}\longrightarrow\text{Cl}-\text{Cl}$$

$$\text{H}_3\dot{\text{C}}+\dot{\text{C}}\text{H}_3\longrightarrow\underset{(\text{Ethane})}{\text{H}_3\text{C}-\text{CH}_3}$$

So, ethane is formed.

13.2 Write IUPAC names of the following compounds:

(i) $CH_3CH=C(CH_3)_2$

Ans: IUPAC name: 2-Methylbut-2-ene

(ii) $CH_2=CH-C\equiv C-CH_3$

Ans: IUPAC name: Pen-1-ene-3-yne

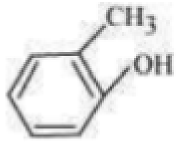
(iii)

Ans: IUPAC name: 1,3-Butadiene or Buta-1,3-diene }

(iv) 

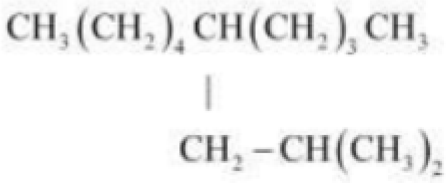
Ans: IUPAC name: 4-Phenyl but-1-ene

(v)



Ans: IUPAC name: 2 -Methyl phenol

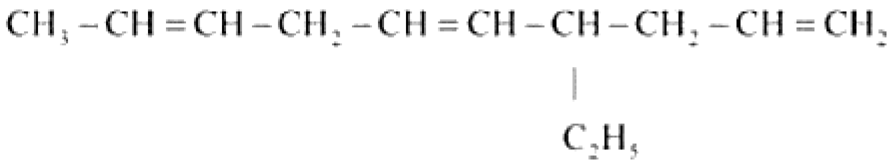
(vi)



$$\begin{array}{l} CH_3(CH_2)_4CH(CH_2)_3CH_3 \\ \qquad\qquad\quad | \\ \qquad\qquad\quad CH_2-CH(CH_3)_2 \end{array}$$

Ans: IUPAC name: 5-(2-Methylpropyl)-decane

(vii)



$$\begin{array}{l} CH_3-CH=CH-CH_2-CH=CH-\underset{\displaystyle C_2H_5}{\underset{|}{CH}}-CH_2-CH=CH_2 \end{array}$$

Ans: IUPAC name: 4 -Ethyldeca-1,5,8 -triene

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

(a) C_4H_8 (one double bond)

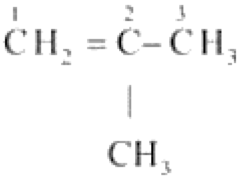
Ans:

$$H_2\overset{1}{C}=\overset{2}{C}H-\overset{3}{C}H_2-\overset{4}{C}H_3$$

(I)

$$\overset{1}{C}H_3-\overset{2}{C}H=\overset{3}{C}H-\overset{4}{C}H_3$$

(II)



$$\overset{1}{C}H_2=\underset{\displaystyle CH_3}{\underset{|}{\overset{2}{C}}}-\overset{3}{C}H_3$$

(III)

The IUPAC name of

Compound (I) is But-1-ene,

Compound (II) is But-2-ene, and

Compound (III) is 3-Methylprop-1-ene.

(b) C_5H_8 (one triple bond)

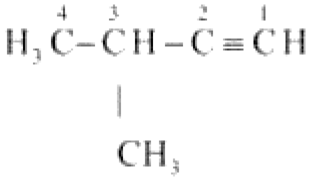
Ans:

$\overset{1}{HC} \equiv \overset{2}{C} - \overset{3}{C}H_2 - \overset{4}{C}H_2 - \overset{5}{C}H_3$

(I)

$H_3\overset{1}{C} - \overset{2}{C} \equiv \overset{3}{C} - \overset{4}{C}H_2 - \overset{5}{C}H_3$

(II)



$H_3\overset{4}{C} - \underset{CH_3}{\overset{3}{C}H} - \overset{2}{C} \equiv \overset{1}{C}H$

(III)

The IUPAC name of

Compound (I) is Pent-1-yne, Compound

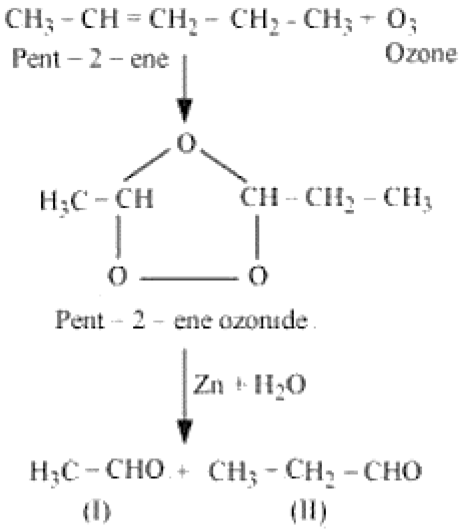
(II) is Pent-2-yne, and

Compound (III) is 3-Methylbut-1-ene.

13.4 Write IUPAC names of the products obtained by the ozonolysis of the following compounds :

(i) Pent-2-ene

Ans:



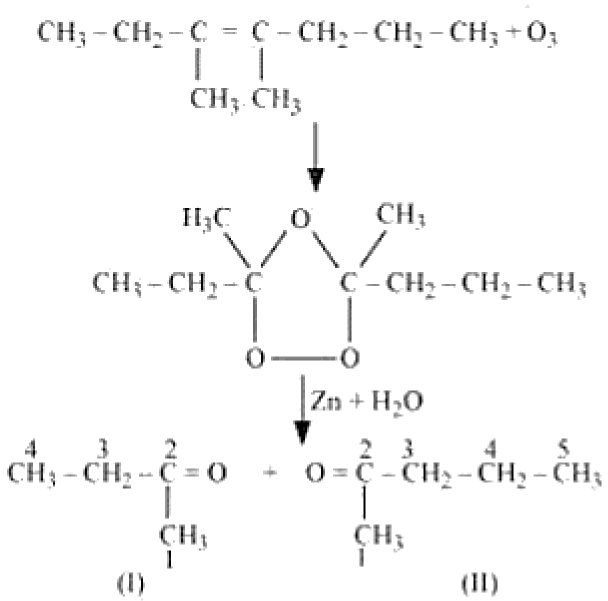
IUPAC names of the products are:

(i) ethanol

(ii) propanal

(ii) $3,4$ -Dimethylhept-3-ene

Ans:



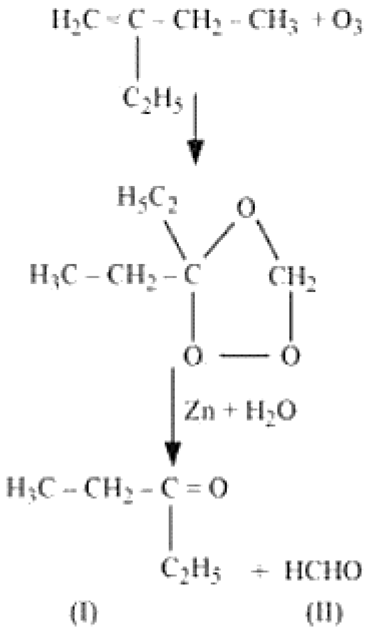
IUPAC names of the products are:

(i) butan-2 -one

(ii) Pentan-2 -one

(iii) 2 -Ethylbut-1-ene

Ans:



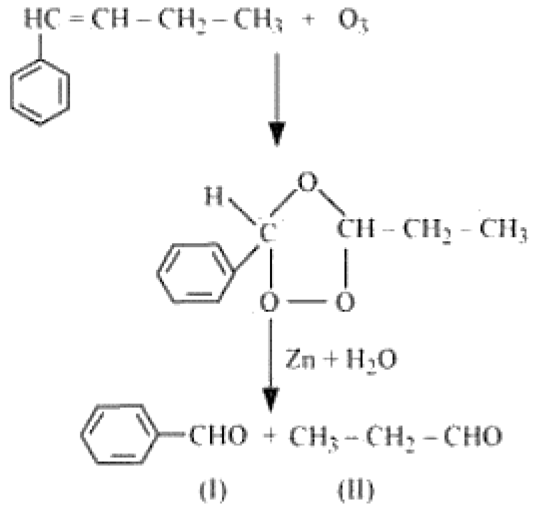
IUPAC names of the products are:

(i) pentan-3-one

(ii) methanal

(iv) 1 -Phenylbut-1-ene

Ans:



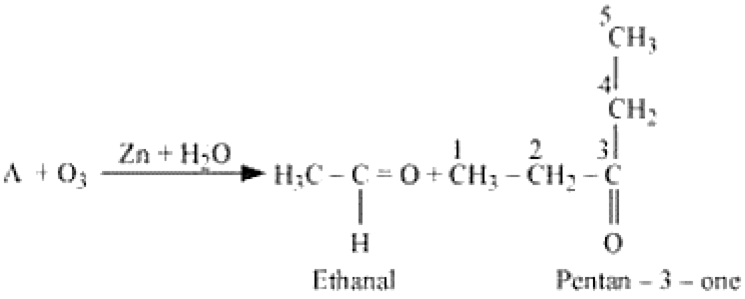
IUPAC names of the products are:

(i) benzaldehyde

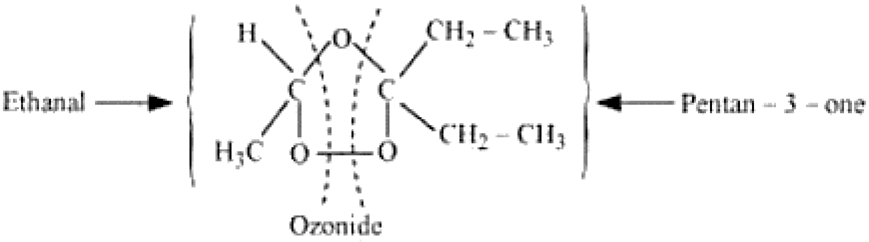
(ii) propanal

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

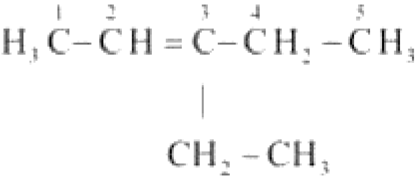
Ans:



During ozonolysis, an ozonide with a cyclic structure is generated as an intermediate that is cleaved to provide the end products.
The intermediate ozonide yields ethanal and pentan-3-one.
As a result, the ozonide's predicted structure is:



This ozonide is generated by adding ozone to 'A'.
By removing ozone from the ozonide, the required structure of 'A' can be achieved.
As a result, the structural formula for 'A' is:



$$H_3\overset{1}{C}-\overset{2}{C}H=\underset{\displaystyle |\atop CH_2-CH_3}{\overset{3}{C}}-\overset{4}{C}H_2-\overset{5}{C}H_3$$

IUPAC name of 'A' is 3-Ethylpent-2-ene.

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

Ans: According to the information provided, ozonolysis of 'A' yields two moles of an aldehyde with a molar mass of $44u$.

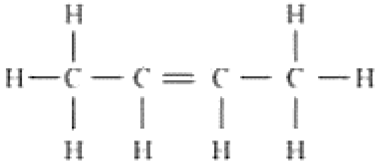
Structural units on each side has carbon atoms implies the creation of two moles of an aldehyde.
As a result, the structure of 'A' may be expressed as follows:

X C=C X

There are a total of eight $C-H$ sigma bonds. As a result, $'A'$ has 8 hydrogen atoms.

There are also three $C-C$ bonds. As a result, the structure of $'A'$ has four carbon atoms.

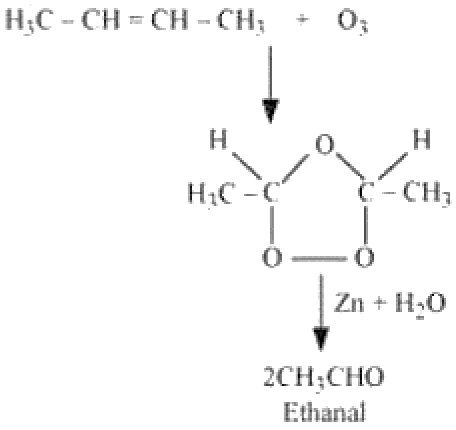
The structure of $'A'$ may be described by combining the inferences as follows:



(A)

IUPAC name of $'A'$ is But-2-ene.

Ozonolysis of $'A'$,

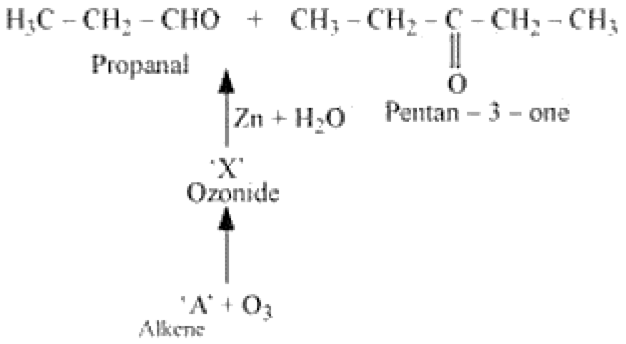


Ethanol’s Molecular mass,

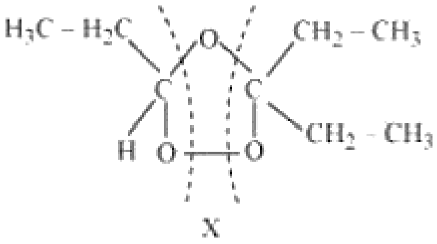
$$=[(2\times12)+(4\times1)+(1\times16)]$$
$$=44\text{u}$$

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

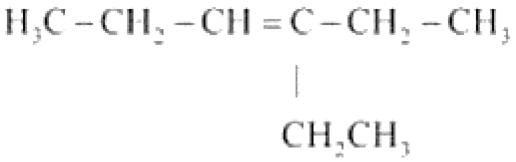
Ans: The reverse of the ozonolysis reaction,



The possible structure of ozonide,



As a result, Alkene's structure is,



$$H_3C-CH_2-CH=\underset{CH_2CH_3}{\underset{|}{C}}-CH_2-CH_3$$

13.8 Write chemical equations for combustion reaction of the following hydrocarbons:

(i) Butane

Ans: $2C_4H_{10(g)}+13O_{2(g)}\rightarrow 8CO_{2(g)}+10H_2O_{(g)}+\text{ Heat}$

(ii) Pentene

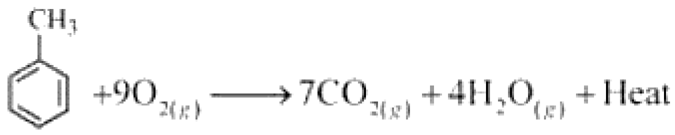
Ans: $2C_5H_{10(g)}+15O_{2(g)}\rightarrow 10CO_{2(g)}+10H_2O_{(g)}+\text{ Heat}$

(iii) Hexyne

Ans: $2C_6H_{10(g)}+17O_{2(g)}\rightarrow 12CO_{2(g)}+10H_2O_{(g)}+\text{ Heat}$

(iv) Toluene

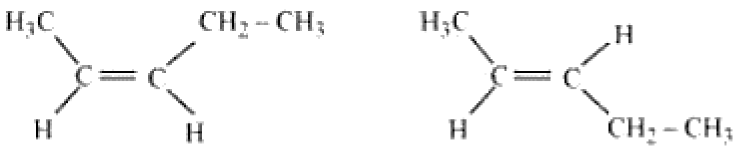
Ans:



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

Ans: Hex- 2 -ene, $H_3C-HC=CH-CH_2-CH_3$

Hex- 2 -ene Geometrical isomers's are:

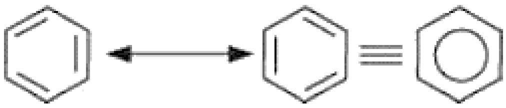


Cis – isomer   Trans – isomer

The cis-compound dipole moment is the sum of the dipole moments of $C-CH_3$ and $C-CH_2CH_3$ bonds operating in the same direction.
The trans-compound dipole moment is achieved when we put together
dipole moments of the $C-CH_3$ and $C-CH_2CH_3$ bonds acting in opposing directions.
As a result, the cis-isomer is more polar than the trans-isomer.
The stronger the polarity, the greater the intermolecular
dipole-dipole interaction and, consequently, the higher the boiling point.
As a result, the cis-isomer will have a greater boiling point than the trans-isomer.

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

Ans:

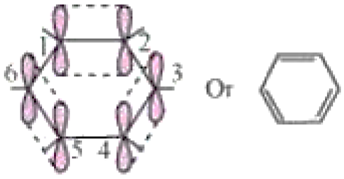


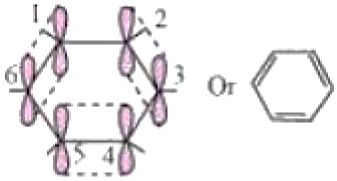
In benzene, all six carbon atoms are sp^2 hybridized.

Each carbon atom's two sp^2 hybrid orbitals overlap with the sp^2
hybrid orbitals of nearby carbon atoms to produce six sigma bonds in the hexagonal plane.

Each carbon atom's remaining sp^2 hybrid orbital overlaps with the $s-$
orbital of hydrogen to produce six sigma $C-H$ bonds.
The lateral overlap of the remaining unhybridized $p-$
orbital of carbon atoms has the potential to generate three n bonds.

$$C_1-C_2, C_3-C_4, C_3-C_6, \quad \text{or } C_2-C_3, C_4-C_5, C_6-C_1$$





The six n's have been delocalized and can freely wander about the six carbon nuclei.
These delocalized n-electrons stabilise benzene even in the presence of three double bonds.

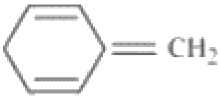
13.11 What are the necessary conditions for any system to be aromatic?

Ans: If a chemical has the following three criteria, it is considered to be aromatic:

(i) Its structure should be flat.
(ii) The compound's n-electrons are totally delocalized in the ring.
(iii) The total number of n-electrons in the ring should be $(4n+2)$, where $n=0,1,2\ldots$, and so on.
This is referred to as Huckel's rule.

13.12 Explain why the following systems are not aromatic?

(i)



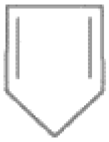
Ans: The number of n-electrons is 6.

Using Huckel's rule,

$$4\ n+2=6$$
$$4\ n=4\ n=1$$

As the value of n is an integer, the given compound is aromatic in nature.

(ii)



Ans: The number of n-electrons is 4.

Using Huckel's rule,

$$4n+2=4$$
$$4n=2$$
$$n=\frac{1}{2}$$

As the value of n is not an integer, the given compound is not aromatic in nature.

(iii)

Ans: The number of π-electrons is 4.

Using Huckel's rule,

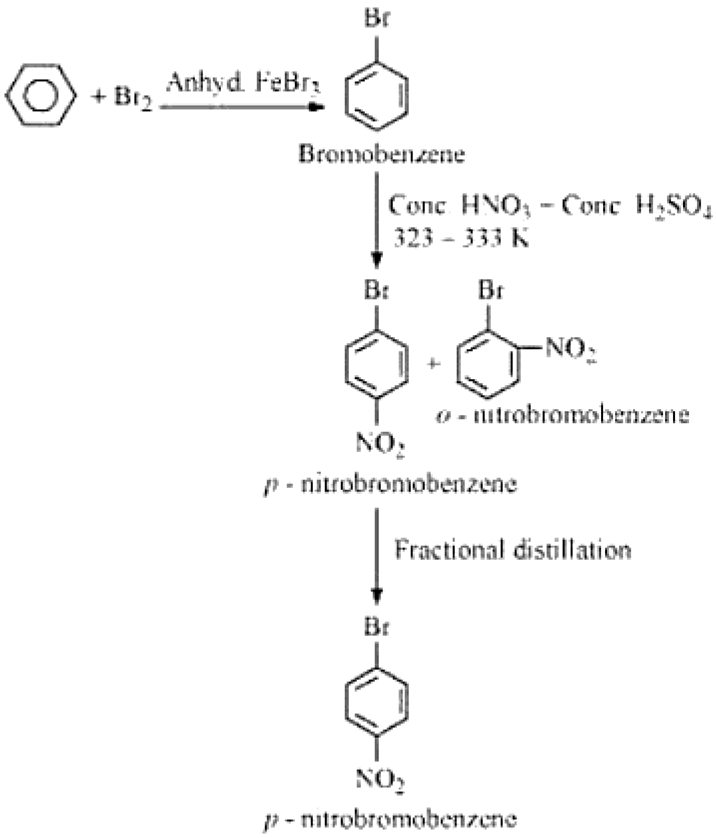
$$4n+2=8$$
$$4n=6$$
$$n=\frac{3}{2}$$

As the value of n is not an integer, the given compound is not aromatic in nature.

13. 13 How will you convert benzene into

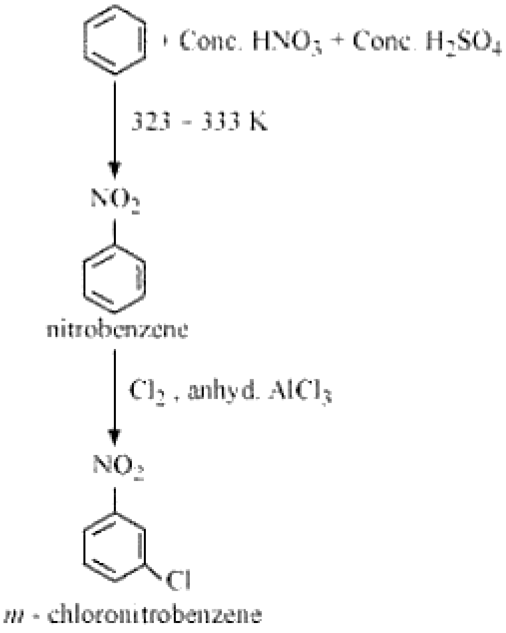
(i) p-nitrobromobenzene

Ans:



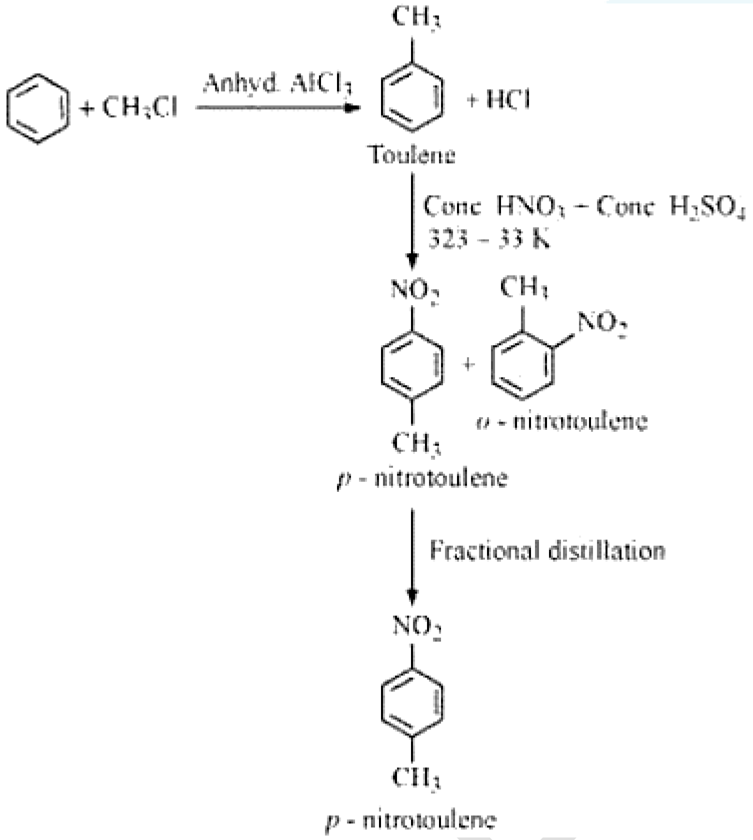
(ii) *m* - nitrochlorobenzene

Ans:



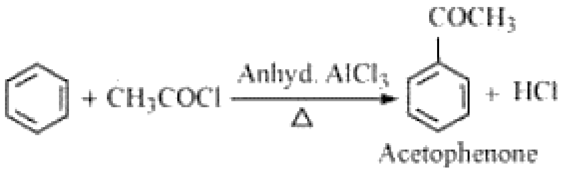
(iii) *p* – nitrotoluene

Ans:



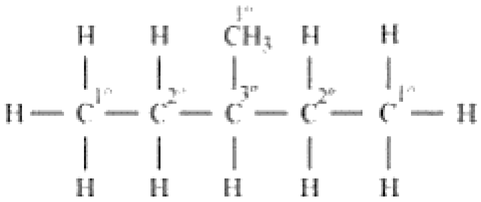
(iv) acetophenone?

Ans:



13.14 In the alkane $H_3C-CH_2-C(CH_3)_2-CH_2-CH(CH_3)_2$, identify $1^\circ, 2^\circ, 3^\circ$ carbon atoms and give the number of H atoms bonded to each one of these.

Ans:



1° carbon atoms are those that are bonded to only one other carbon atom, i.e., they only have one carbon atom as a neighbour.

The provided structure is made up of five 1° carbon atoms and fifteen hydrogen atoms.
2° carbon atoms are those that are bound to two carbon atoms,
implying that they have two carbon atoms as neighbors.
Two 2° carbon atoms and four hydrogen atoms are attached to the given structure.
3° carbon atoms are those that are bound to three carbon atoms, implying that they have three carbon atoms as neighbours.
The suggested structure has one 3° carbon atom and just one hydrogen atom.

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

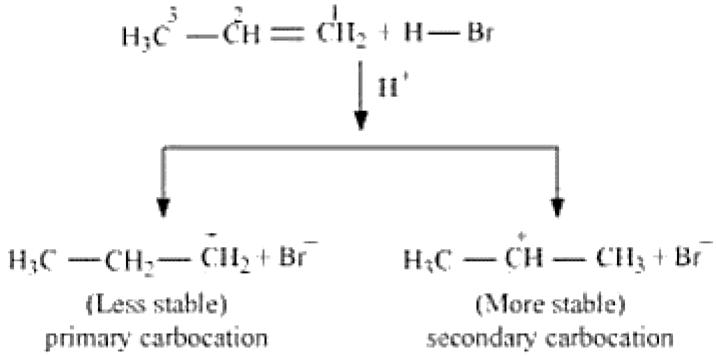
Ans: Intermolecular interactions occur in alkanes.

Forces of Van der Waals, The higher the force, the higher the boiling point of the alkane.
As branching grows, the molecule's surface area reduces, resulting in a limited region of contact.
As a result, the Van der Waals force reduces, allowing it to be overcome at a lower temperature.
As a result, the boiling point of an alkane chain drops as branching increases.

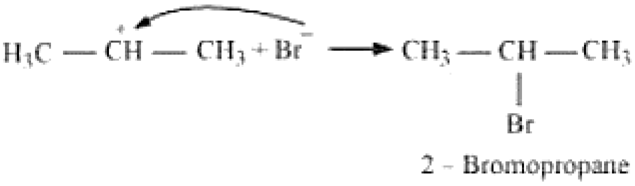
13. 16 Addition of HBr to propene yields 2-bromopropane, while in the presence of benzoyl peroxide, the same reaction yields 1-bromopropane. Explain and give mechanism.

Ans: An electrophilic substitution reaction is the addition of HBr to propene.

An electrophile, H^+, is provided by hydrogen bromide.
As illustrated, this electrophile attacks the double bond to generate 1° and 2° carbocations:

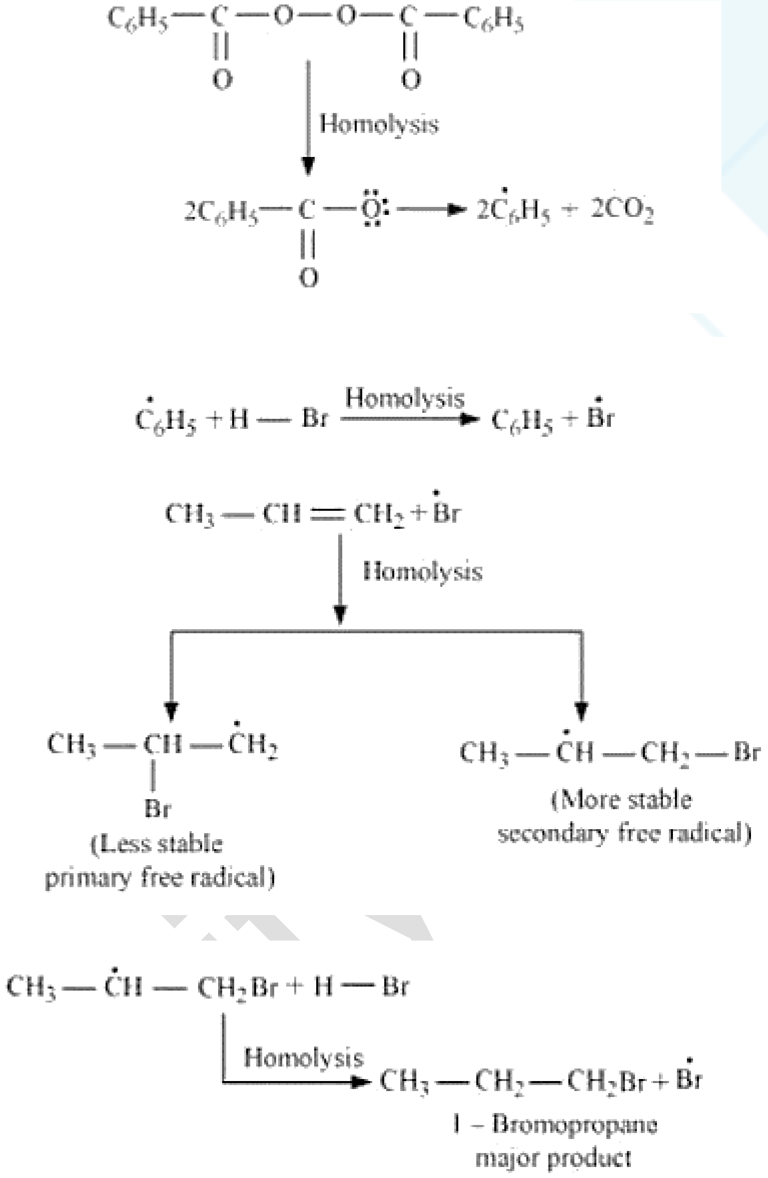


As a result, the former takes precedence since it forms at a quicker rate.
As a result, in the following step, Br-attacks the carbocation to produce 2 - bromopropane as the primary product.



This reaction adheres to Markovnikov's rule, in which the negative component of the addendum is connected to the carbon atom with the fewest hydrogen atoms.

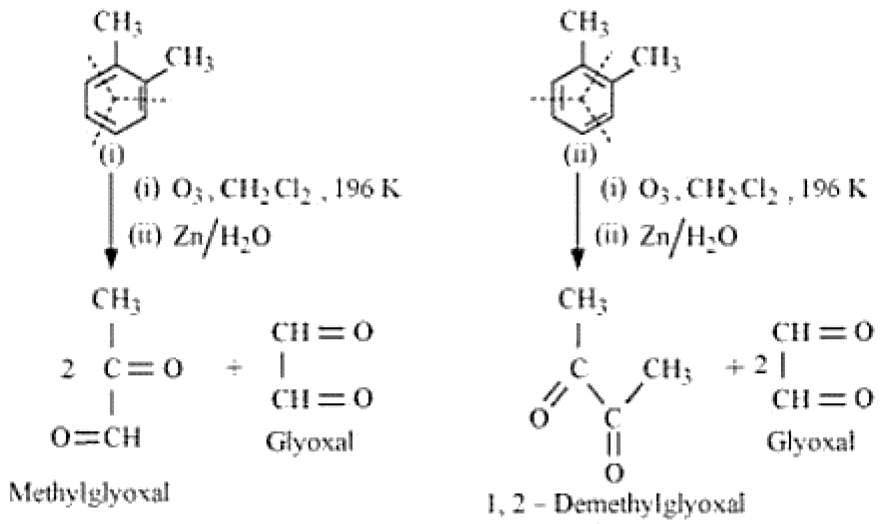
In the presence of benzoyl peroxide, an addition reaction occurs in the opposite direction to Markovnikov's rule. The reaction is governed by a free radical chain mechanism, which is as follows:



Br free radical behaves as an electrophile in the presence of peroxide.
As a result, the addition of HBr to propene in the absence and presence of peroxide yields two distinct compounds.

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

Ans:

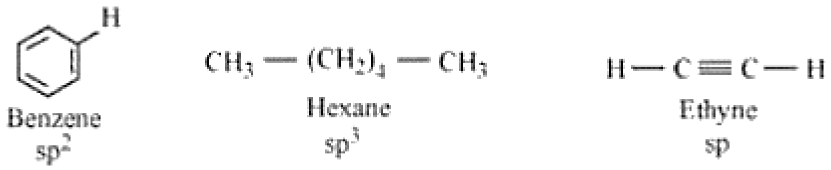


Two Kekule structures provide all three products, namely methyl glyoxal, $1,2$ -demethylglyoxal, and glyoxal.
Because none of the three products can be derived from any of the two structures, $o-xylene$ is a resonance hybrid of two Kekule structures (I and II).

13.18 Arrange benzene, n -hexane and ethyne in decreasing order of acidic behaviour. Also give reason for this behaviour.

Ans: The ease with which a species can lose its H atoms define its acidic nature.

Carbon's hybridization state in the given chemical is:



As the s -character grows, so does carbon's electronegativity, and the electrons of the $C-H$ bond pair move closer to the carbon atom.
As a result, the partial positive charge of the H - atom rises, and H^+ ions are liberated.
The s -character rises in the following order:
$sp^3 < sp^2 < sp$

As a result, $\text{Ethyne} > \text{Benzene} > \text{Hexane}$.

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

Ans: Benzene is a planar molecule with electrons delocalized above and below the plane of

the ring. As a result, it is electron rich. As a result, it is very appealing to electron-deficient species, such as electrophiles.
As a result, it readily conducts electrophilic substitution reactions. Electrons abound in

nucleophiles. As a result, benzene repels them. As a result, benzene has a tough time undergoing nucleophilic replacements.

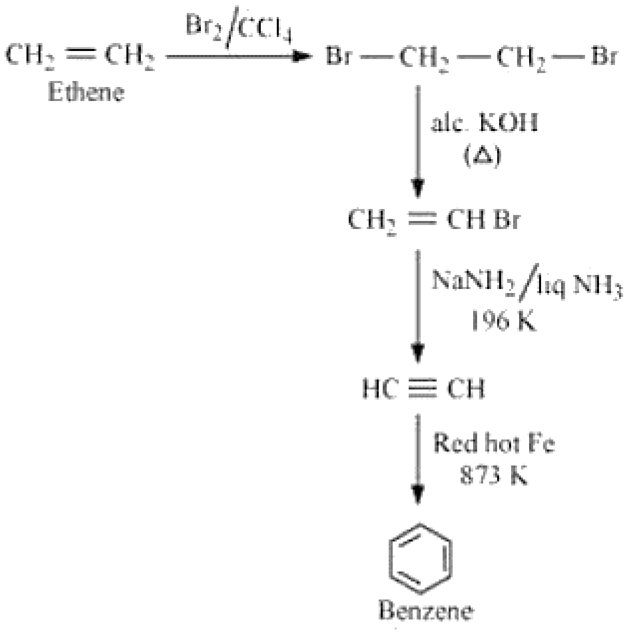
13.20 How would you convert the following compounds into benzene?

(i) Ethyne

Ans:

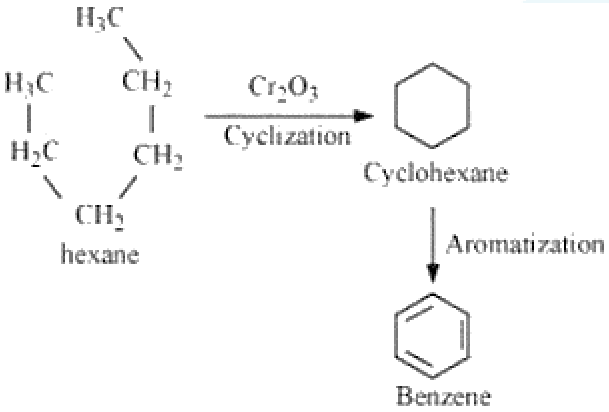
(ii) Ethene

Ans:



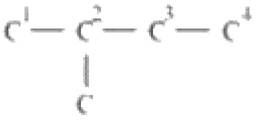
(iii) Hexane

Ans:



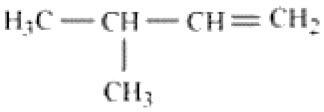
13.21 Write structures of all the alkenes which on hydrogenation give 2 -methylbutane.

Ans:

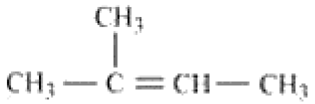


$$\overset{1}{C}-\underset{\displaystyle C}{\overset{2}{C}}-\overset{3}{C}-\overset{4}{C}$$

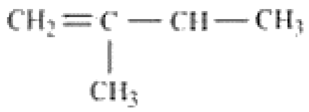
Based on this structure, the following alkenes will yield 2 -methylbutane when hydrogenated:



$$H_3C-\underset{\displaystyle CH_3}{CH}-CH=CH_2$$



$$CH_3-\overset{\displaystyle CH_3}{C}=CH-CH_3$$



$$CH_2=\underset{\displaystyle CH_3}{C}-CH-CH_3$$

13.22 Arrange the following set of compounds in order of their decreasing relative reactivity with an electrophile, E^+

(a) Chlorobenzene, 2,4 -dinitrochlorobenzene, *p* -nitrochlorobenzene

Ans: The presence of an electron withdrawing group such as NO_2 and

Cl^- deactivates the aromatic ring by lowering the electron density.

Because the NO_2^- group withdraws more electrons (because to the resonance effect) than the Cl group (due to the inductive effect), the decreasing order of reactivity is as follows:
$\text{Chlorobenzene} > p-\text{ nitrochlorobenzene} > 2,4\text{ - dinitrochlorobenzene}$

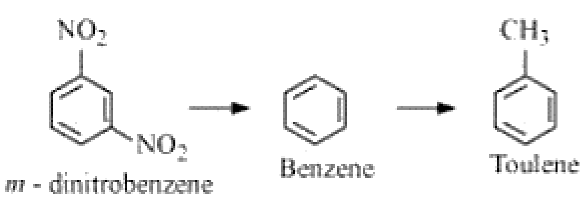
(b) Toluene, $p-H_3C-C_6H_4-NO_2 \cdot p-O_2N-C_6H_4-NO_2$.

Ans: $\text{Toluene} > p-CH_3-C_6H_4-NO_2, p-O_2N-C_6H_4-NO_2$

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

Ans:
The ease with which a chemical may be nitrated is determined by the existence of electron density on the substance to produce nitrates. Nitration reactions are electrophilic substitution reactions in which a n electron-rich molecule is attacked by a nitronium ion $\left(NO_2^-\right)$.

Now, the CH_3 group is donating electrons, while the NO_2 group is taking electrons.
As a result, toluene will have the highest electron density of the three chemicals, followed by benzene.
As a result, increasing order of nitration is,



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

Ans: The benzene ethylation reaction includes the addition of an ethyl group to the benzene ring.

This type of reaction is known as a Friedel-Craft alkylation reaction.

In the presence of a Lewis acid, this reaction occurs. Any Lewis acid, such as anhydrous $FeCl_3$, $SnCl_4$, BF_3 can be employed during the ethylation of benzene.

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

Ans: The Wurtz reaction can only be used to synthesize symmetrical alkanes.

Two identical alkyl halides are used as reactants in the reaction, and an alkane with double the number of carbon atoms is generated.

Example:

$$\underset{\text{Bromomethane}}{CH_3 - \boxed{Br + 2Na + Br} - CH_3} \xrightarrow{\text{Dry ether}} \underset{\text{Ethane}}{CH_3 - CH_3} + 2NaBr$$

The Wurtz reaction cannot be utilised to generate unsymmetrical alkanes because if two different alky l halides are employed as reactants, the results are a mixture of alkanes.

Because the reaction includes free radical species, an alkene is produced as a byproduct.

For example, the reaction between bromomethane with iodoethane produces an alkane combination.

$$\underset{\text{Iodomethane}}{CH_3 - \boxed{I + 2Na + I}} - \underset{\text{Iodoethane}}{CH_2CH_3}$$

$$\Big\downarrow \text{Dry ether}$$

$$CH_3 - CH_2CH_3 + 2NaI$$

$$CH_3 - \boxed{I + 2Na + I} - CH_3 \xrightarrow{\text{Dry ether}} 2NaI + \underset{\text{Ethane}}{CH_3 - CH_3}$$

$$CH_3CH_2 - \boxed{I + 2Na + I} - CH_2CH_3 \xrightarrow{\text{Dry ether}} 2NaI + \underset{\text{Butane}}{CH_3CH_2 - CH_2CH_3}$$

The boiling points of the alkanes (obtained from the combination) are extremely near.

As a result, they cannot be aparted.