

Chapter - 9

Hydrocarbons

FAST TRACK : QUICK REVISION

Hydrocarbons are the organic compounds containing carbon and hydrogen only. Depending upon the types of carbon-carbon bonds present, hydrocarbons can be classified into three categories- (i) Saturated (ii) Unsaturated (iii) Aromatic hydrocarbons.

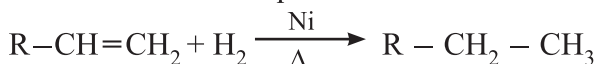
Saturated hydrocarbons contain carbon-carbon multiple bonds—double bonds, triple bonds or both.

ALKANES : Saturated open chain hydrocarbons containing carbon-carbon single bonds. These are inert under normal conditions i.e. do not react with acids, bases and other reagents. Alkanes exhibit Chain isomerism, Position isomerism and conformational isomerism.

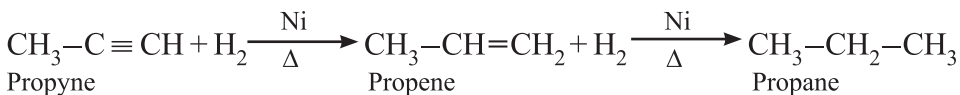
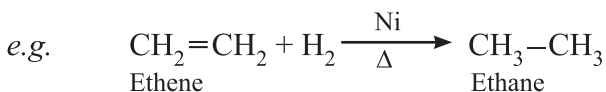
General methods of preparation of alkanes :

- From Unsaturated hydrocarbons** : By hydrogenation in the presence of platinum, palladium or nickel as catalyst.

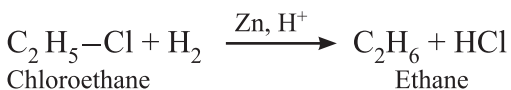
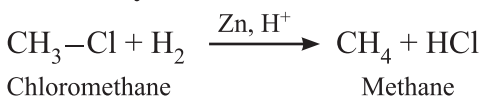
General Chemical Equation :

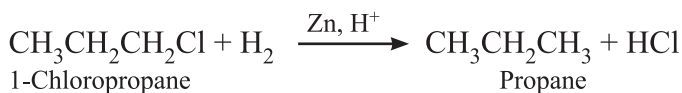


[Where R is H or Alkyl group]

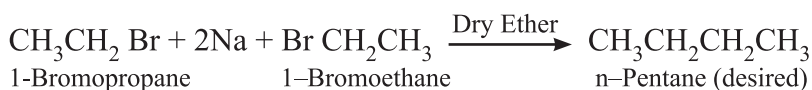
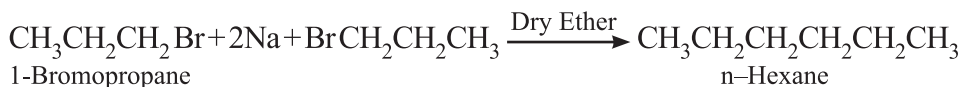
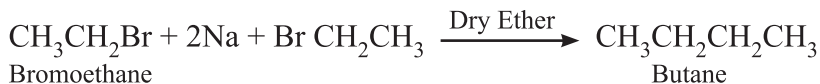


- From alkyl halides** : on reduction with Zinc and dilute hydrochloric acid

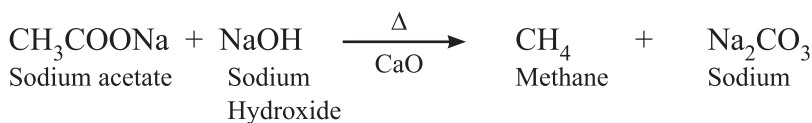




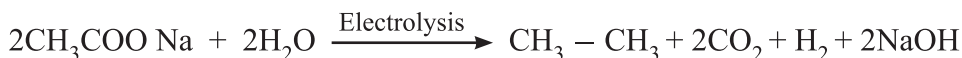
3. **From alkyl halides by Wurtz reaction :** Reaction of alkyl halide with sodium in dry ether, useful only for the preparation of symmetrical alkanes.



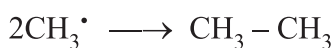
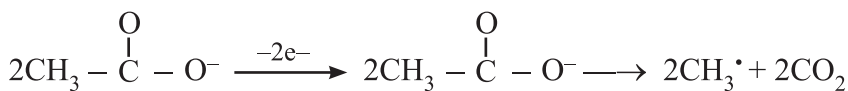
4. **From Carboxylic acids :** By decarboxylation with soda lime



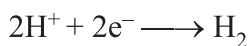
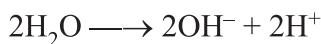
5. **By Kolbe's electrolytic method :** Electrolysis of an aqueous solution sodium or potassium salt of carboxylic acid. Alkane containing even number of carbon atoms is formed at anode.



At Anode : (Oxidation)



At Cathode : (Reduction)



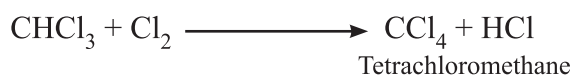
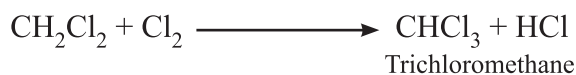
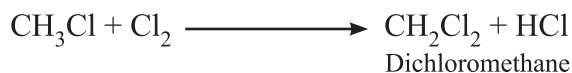
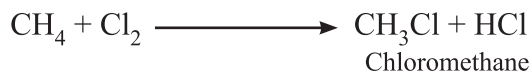
Physical Properties of alkanes :

- Boiling point of alkanes decreases on branching due to decrease in surface area of molecule with branching which decreases magnitude of van der Waal's forces of attraction.
- Alkanes being non-polar in nature are soluble in non-polar solvents.

Chemical properties of Alkanes :

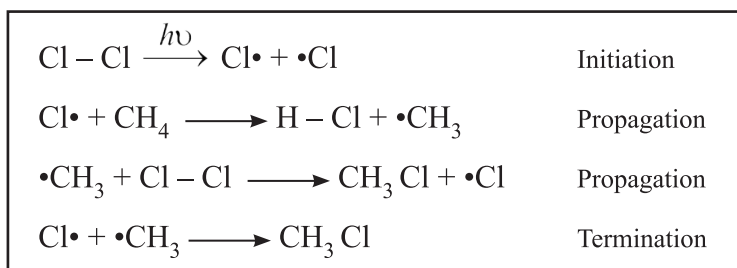
- Alkanes undergo substitution reactions.
e.g., Halogenation, Nitration, Sulphonation.

Halogenation : For example Chlorination of methane



Rate of reaction of alkanes with halogens is $\text{F}_2 > \text{Cl}_2 > \text{Br}_2 > \text{I}_2$. Rate of replacement of hydrogen in alkanes is $3^\circ > 2^\circ > 1^\circ$. Fluorination is too violent to be controlled. Iodination is reversible and it is therefore carried out in the presence of oxidising agent like HNO_3 .

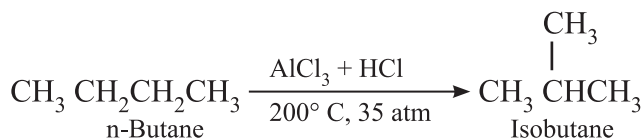
Mechanism of halogenation : Free radical mechanism



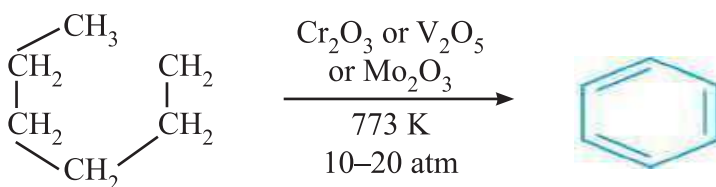
Combustion : Complete combustion gives carbon dioxide and water.



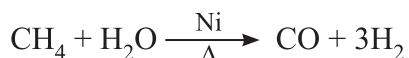
Isomerisation :



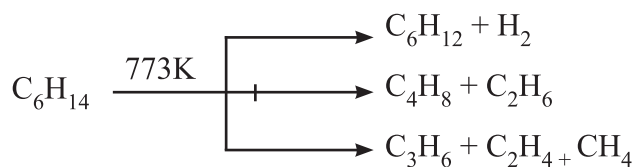
Aromatisation :



(vi) Reaction with steam



Pyrolysis : Decomposition of higher alkanes to lower alkanes on heating.



Conformations :

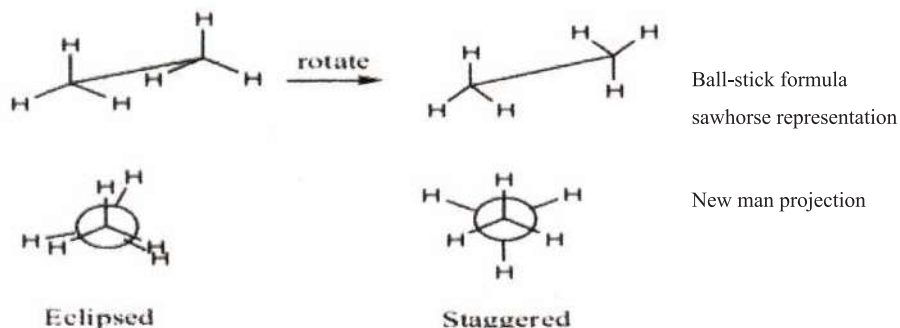
Different spatial arrangement of atoms arising due to rotation around C-C single bond.

Conformation of ethane, CH₃CH₃

Two conformational isomers or conformers.

Eclipsed form = all hydrogen atoms nearest to each other.

Staggered form = all hydrogen atoms are farthest apart.



Stability of eclipsed conformation is least while staggered conformation is most stable. The energy difference between two extreme forms is 12.5kJmol^{-1} . Due to this small energy difference the two forms are easily inter-convertible at ordinary temperature and cannot be separated and isolated.

ALKENES

These are unsaturated non-cyclic hydrocarbons which have sp^2 -hybridisation with 120° bond angle.

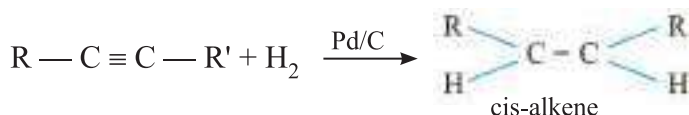
Alkenes are also called olefins [oil-forming] which indicates their high reactive nature.

Alkenes have general formula $C_n H_{2n}$, where $n = 2, 3, 4, \dots$

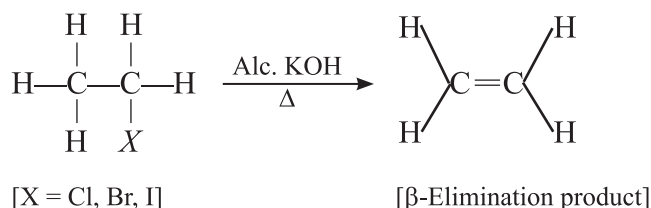
C_2H_4 (ethene), C_3H_6 (propene), etc.

• Methods of Preparation of Alkenes

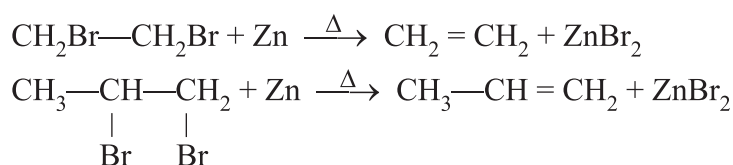
(i) From alkynes



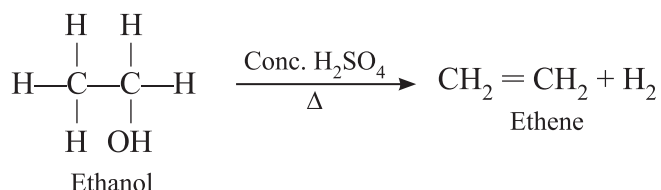
(ii) From alkyl halide [Dehydrohalogenation]



(iii) From vicinal dihalides

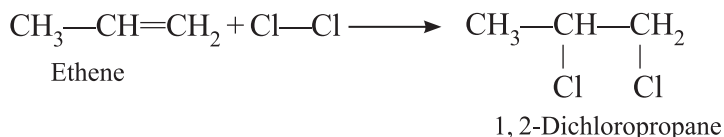
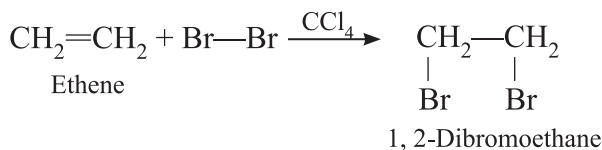


(iv) From alcohols by acidic dehydrogenation



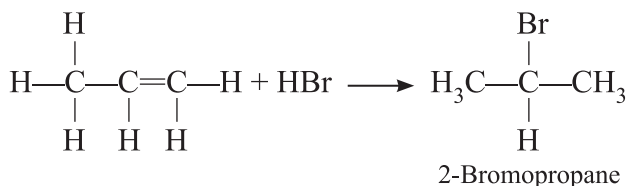
● **Chemical Properties of Alkenes :**

1. Addition of Halogens :

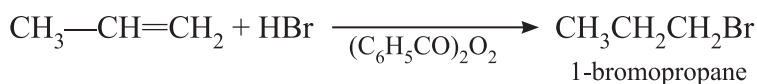


2. Addition of hydrogen halides HCl, HBr, HI : Add up to alkenes to form alkyl halides as per their reactivity order in $\text{HI} > \text{HBr} > \text{HCl}$.

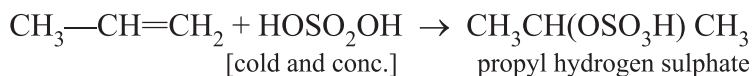
Addition reaction of HBr to unsymmetrical alkenes (Markownikov's rule) According to Markownikov's rule, the negative part of the addendum (adding molecule) gets attached to that carbon atom which possesses lesser number of hydrogen atoms.



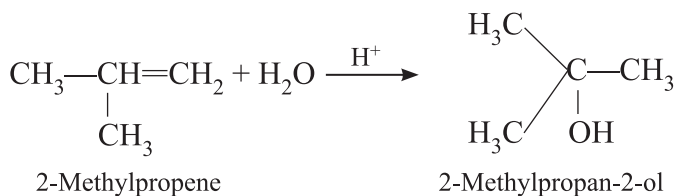
Anti Markownikov addition or peroxide effect or Kharasch effect in the presence of organic peroxide, addition of only HBr molecule on unsymmetrical alkene takes place contrary to the Markownikov's rule. Peroxide effect is not observed in case of HF, HCl and HI.



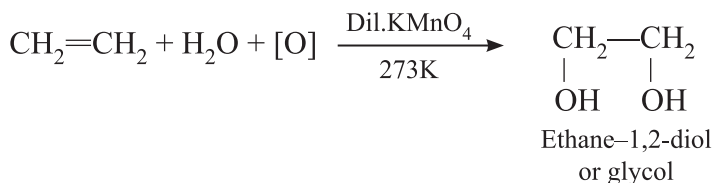
3. Addition of sulphuric acid



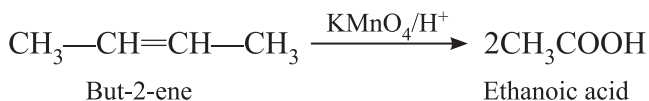
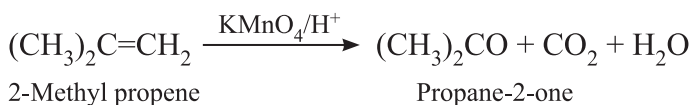
4. Addition of water



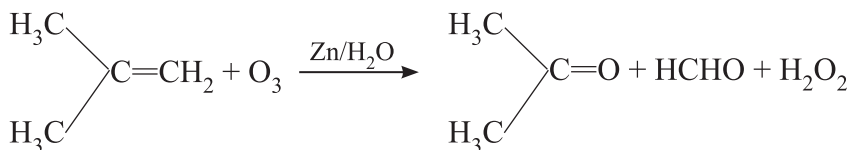
5. **Oxidation** : Alkenes decolourise cold dilute aqueous solution potassium permanganate (Baeyer's reagent). It is used as a test for unsaturation.



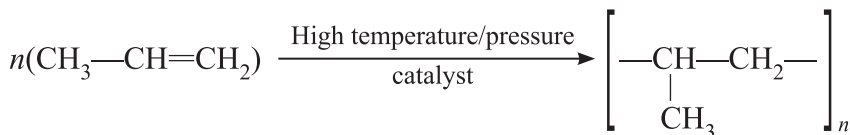
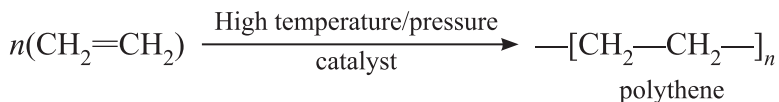
Acidic KMnO_4 or acidic $\text{K}_2\text{Cr}_2\text{O}_7$ oxidises alkenes to ketones and/or acids depending upon the nature of alkene and the experimental conditions.



6. **Ozonolysis** : Reaction of ozone with alkene to form ozonide which on subsequent reductive cleavage with zinc dust and water give carbonyl compounds (aldehydes & ketones).



7. **Polymerization**



ALKYNES

These are unsaturated hydrocarbons with general formula C_nH_{2n-2} e.g., C_2H_2 (ethyne), C_3H_4 (propyne).

Alkynes also exhibit electrophilic addition reaction but less reactive than alkenes because the dissociation of π -electron cloud requires more energy.

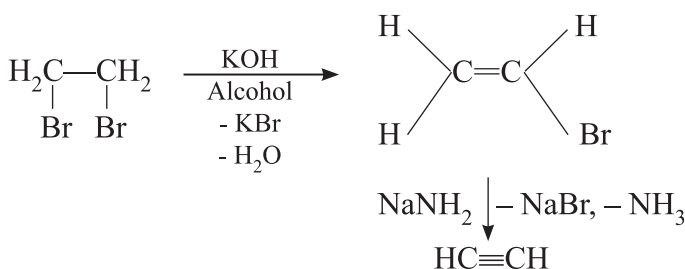
$H-C\equiv C-H$ contains 3σ and 2π -bonds and bond length is 120 pm. In acetylene. $H-C-C$ bond angle is 180° .

• Methods of Preparation of Alkynes

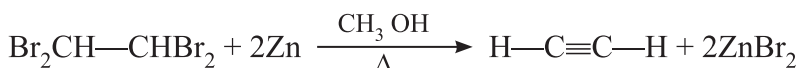
1. From calcium carbide



2. From vicinal dihalides



3. From tetrahalides



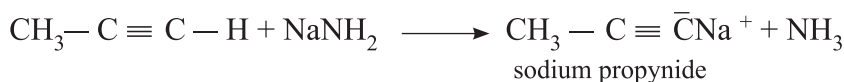
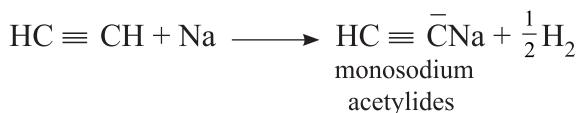
Physical Properties of Alkynes :

1. The first two members are gases next eight members ($C_5 - C_{12}$) are liquids and higher members are solids.
2. They are all colourless and odourless with the exception of acetylene which has slightly garlic odour due to the presence of PH_3 and H_2S as impurities.
3. Alkynes are insoluble in water but soluble in organic solvents like ethers, carbon tetrachloride and benzene.
4. Melting point, boiling point and density increase with increase in molar mass.

- **Chemical properties of Alkynes**

Alkynes show electrophilic as well as nucleophilic addition reactions.

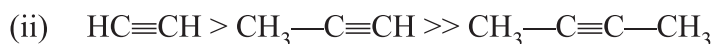
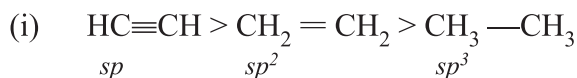
(i) Acidic character of alkyne



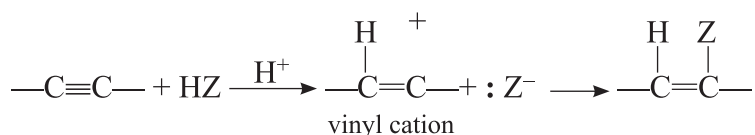
These reactions are not shown by alkenes, alkanes and non-terminal alkynes, hence used for distinction between alkane, alkene and alkyne.

Acetylenic hydrogens are acidic in nature due to 50% s-character in sp-hybridised orbitals. Acidity of alkynes is lesser than water.

Acidic behaviour order



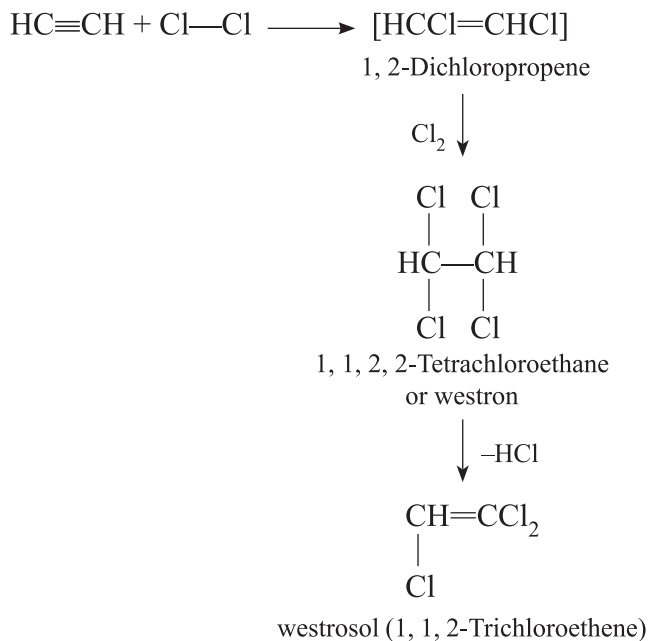
(ii) Electrophilic addition reactions



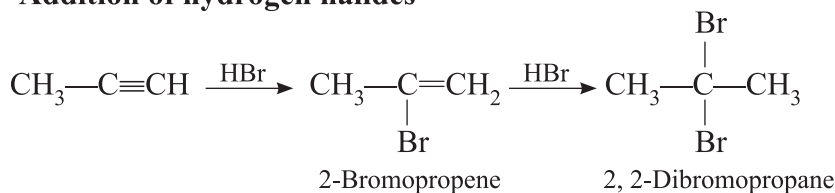
The addition product formed depends upon the stability of vinylic cation. Addition on unsymmetrical alkynes takes place according to Markovnikov's rule.



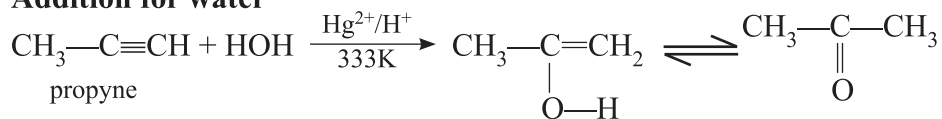
Addition of halogens



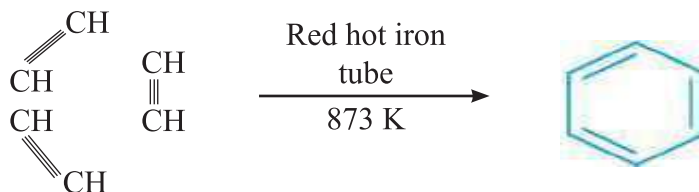
Addition of hydrogen halides



Addition for water



(iii) Cyclic polymerisation of ethyne

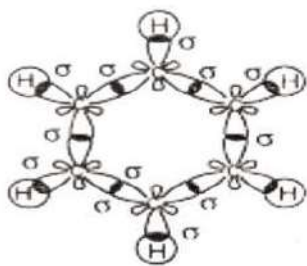


AROMATIC HYDROCARBONS

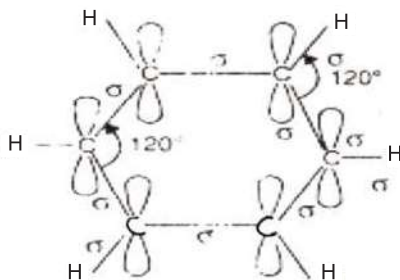
These hydrocarbon are also known as arenes. The parent member of the family aromatic hydrocarbons is benzene.

Aromatic compounds containing benzene ring are known as benzenoids.

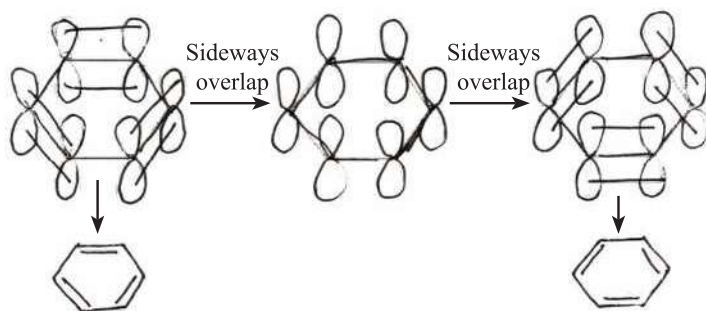
Structure of benzene : Hexagonal ring of carbon atoms with alternate single and double bonds. Each carbon atom is sp^2 hybridised. Planar ring, bond angle 120° . All C-C bond lengths are equal due to complete delocalisation of π electrons.



Formation of C-C and C-H sigma bonds



Sigma skeleton of benzene molecule



HUCKEL'S RULE

- **Huckel's rule, (based on calculations) :** a planar cyclic molecule with alternating double and single bonds has aromatic stability if it has $(4n + 2)\pi$ electrons (n is 0, 1, 2, 3, 4)
- For $n = 1 : 4n + 2 = 6$; benzene is stable and electrons are delocalized.

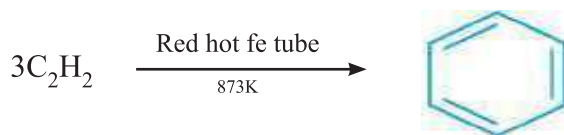
Benzene



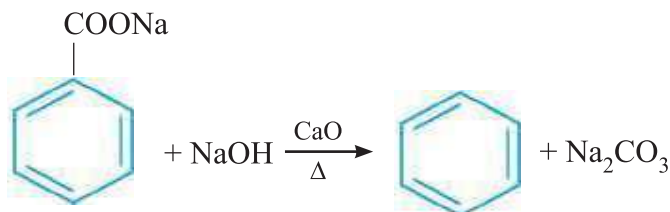
Three double bonds;
six π electrons

● METHODS OF PREPARATION

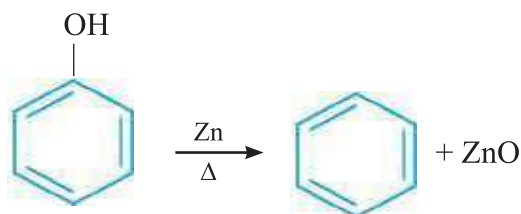
1. Cyclic polymerisation of ethyne



2. Decarboxylation of aromatic acids



3. Reduction of phenol



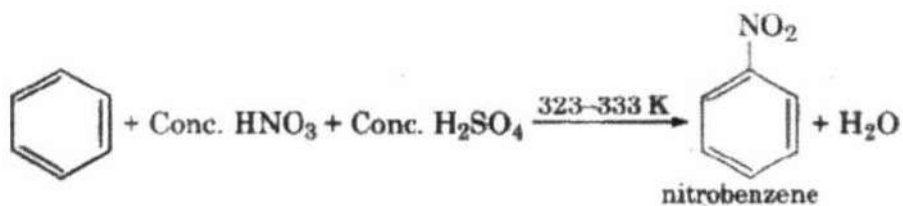
Physical Properties of Benzene :

- (i) Aromatic hydrocarbons are non-polar molecules and are usually colourless liquids or solids with a characteristic aroma.
- (ii) Aromatic hydrocarbons are immiscible with water but readily miscible with organic solvents.
- (iii) Aromatic compounds burn with sooty flame.

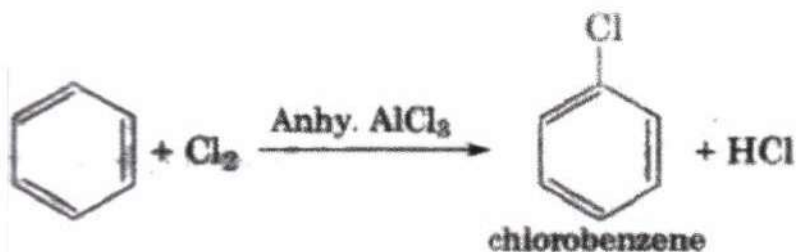
Chemical Reactions of Benzene :

- (i) Benzene gives electrophile substitution reactions.
- (ii) According to experimental evidences, electrophile substitution reaction involve following three steps :
 - Generation of electrophile
 - Formation of carbocation intermediate.
 - Removal of proton from the carbocation intermediate.

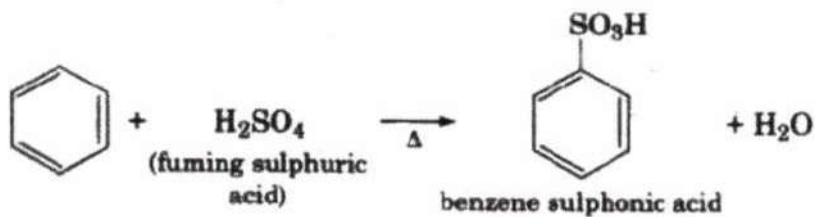
(i) Nitration



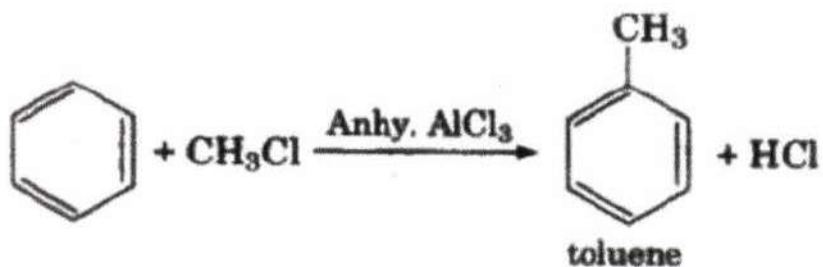
(ii) Halogenation



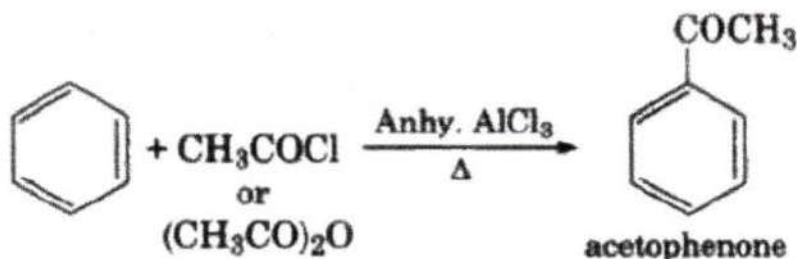
(iii) Sulphonation



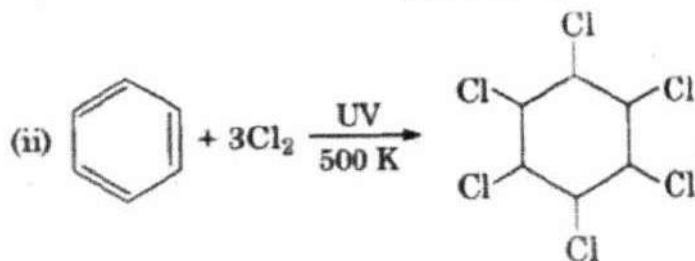
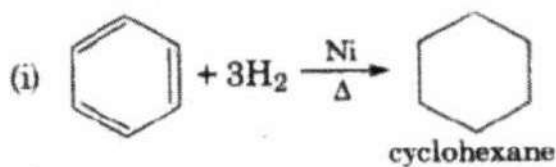
(iv) Friedel-Craft's alkylation reaction



(v) Friedel-Crafts acylation reaction



Benzene also undergoes addition reactions e.g.



benzene hexachloride or 666
(BHC or Gammexane or lindane)

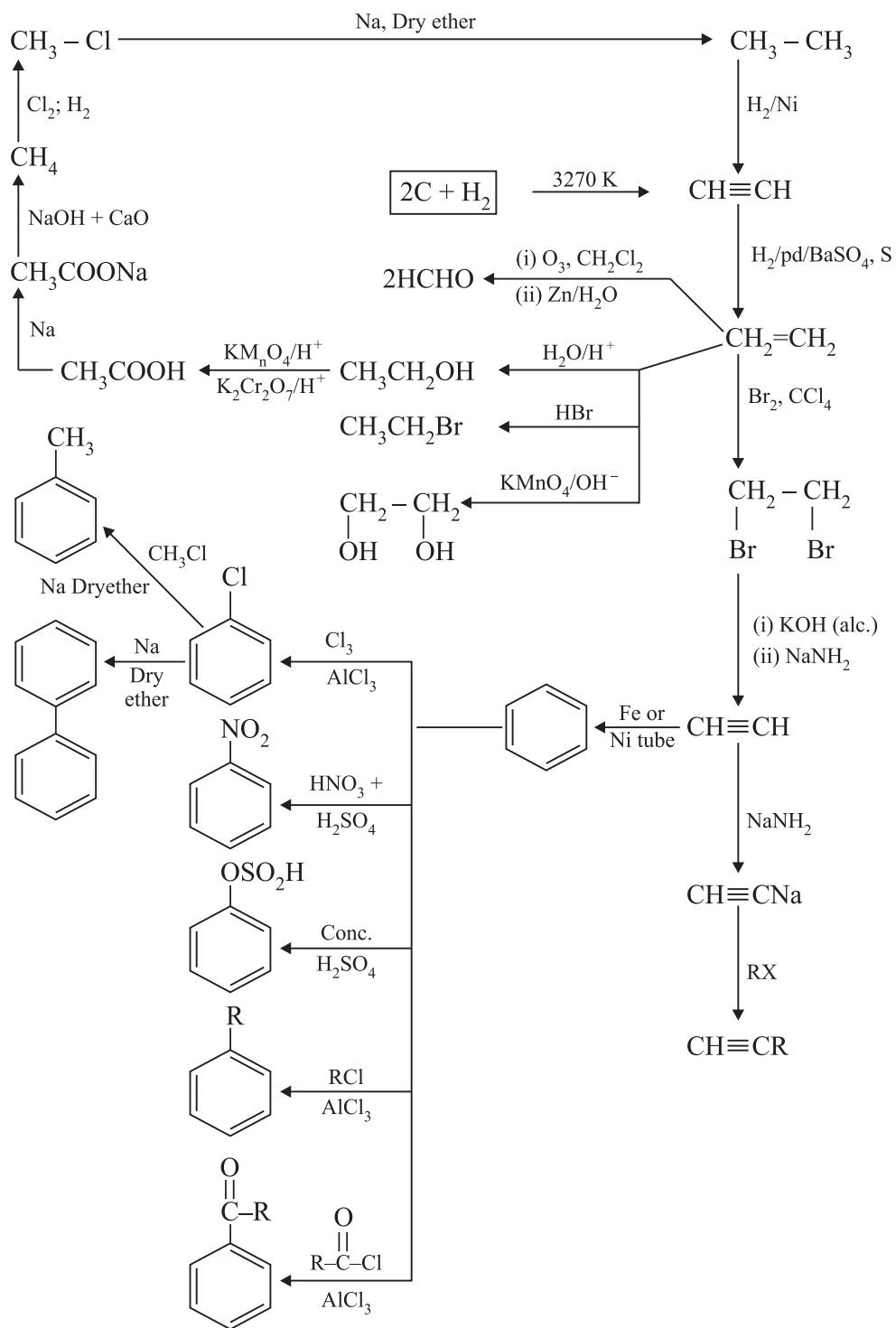
• COMBUSTION



Directing influence of substituents in monosubstituted benzene

- (i) **Ortho and para directing groups** : Ring activating groups
e.g., NH_2 , $-\text{CH}_3$, $-\text{C}_2\text{H}_5$, $-\text{OCH}_3$ etc. (+ R effect)
- (ii) **Meta directing groups** : Ring deactivating groups
e.g. $-\text{NO}_2$, $-\text{CN}$, $-\text{CHO}$, $-\text{COOH}$, $-\text{SO}_3\text{H}$ (– R effect).

MIND MAP : HYDROCARBON

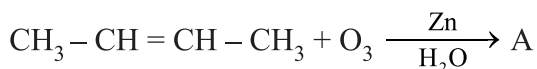


CASE BASED STUDY - QUESTIONS

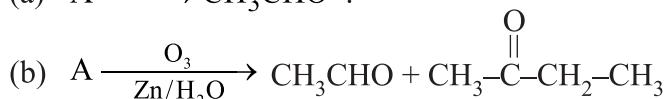
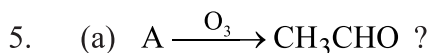
PASSAGE-I

Presence of double bond in an alkene is tested by reacting with either water or with dilute solution of Bayer's reagent. The position of double bond is located with the help of ozonolysis. It is done by joining together the product of ozonolysis which are carbonyl compounds at their carbonyl carbon atoms by double bond. One mole of ozone is used in the ozonolysis reaction per mole of double bond in a particular alkene.

1. An alkene upon ozonolysis will give $\text{CH}_3\text{CH}_2\text{CHO}$ and CH_3COCH_3 . Give IUPAC name and structure of the given alkene.
2. Complete the given chemical equation.



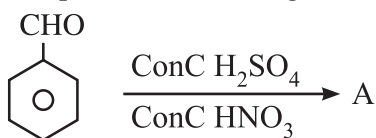
3. On ozonolysis one molecule of a hydrocarbon produces two molecules of ethanal and one molecule of ethanedial. Give the structure on ozonolysis of hydrocarbon.
4. An alkene give 5-keto-2-methyl hexanal. Give IUPAC name of the given alkene.



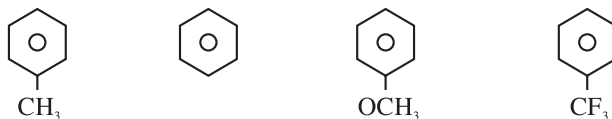
PASSAGE-II

Benzene responds to electrophilic substitution reactions. However some reagents are needed in these reactions in order to generate the attaching electrophiles. The directive influence in disubstitution taking place in the ring depends upon the nature of the group already present. An activating group increases the electron density at the ortho and para positions. The deactivating group decreases the same at these positions thereby making the meta position comparatively a point of high electron density.

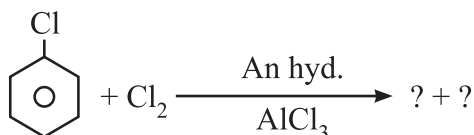
1. Complete the following chemical equation



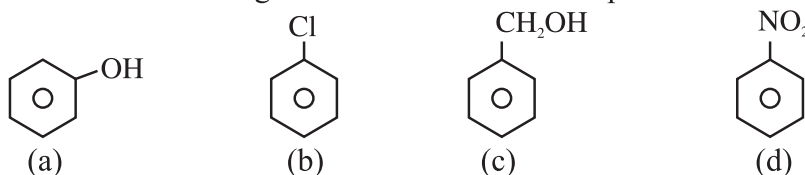
- Explain why ($-\text{NO}_2$) group is m-directing & reactivating group.
- Arrange the following compound in increase order of reactivity towards electrophilic substitution reaction



- Write the product in the following reaction



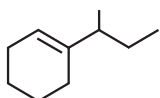
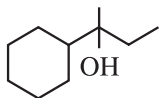
- Which of the following is most reactive to electrophilic attack.



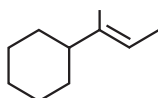
MULTIPLE CHOICE QUESTIONS (MCQ)

- Which of the following has zero dipole moment?
 - cis-But-2-ene
 - trans-But-2-ene
 - But-1-ene
 - 2-Methylprop-1-ene
- Bond length of (I) ethane, (II) ethene, (III) Acetylene, (IV) Benzene follows the order:
 - $\text{I} > \text{II} > \text{III} > \text{IV}$
 - $\text{I} > \text{II} > \text{IV} > \text{III}$
 - $\text{I} > \text{IV} > \text{II} > \text{III}$
 - $\text{III} > \text{IV} > \text{II} > \text{I}$
- The methyl group in benzene ring is:
 - Ortho directing
 - Ortho and meta directing
 - Para directing
 - Ortho and para directing

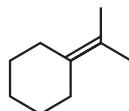
4. Which of the following is not the product of dehydration of



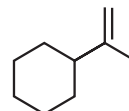
(a)



(b)

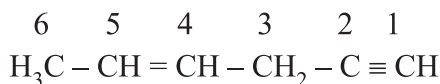


(c)



(d)

5. In the hydrocarbon :



The state of hybridization of carbon 1, 3 and 5 are in the order

(a) sp, sp^2, sp^3 (b) sp^3, sp^2, sp

(c) sp^2, sp, sp^3 (d) sp, sp^3, sp^2

6. Action of acetylene on dilute H_2SO_4 gives:

- (a) Acetic acid (b) Acetone
(c) Acetaldehyde (d) Ethyl alcohol

7. Which of the following compounds will exhibit cis-trans (geometrical) isomerism?

- (a) Butanol (b) 2-Butyne
(c) 2-Butenol (d) 2-Butene

8. Basic strength of :

$\text{H}_3\text{C}-\text{CH}$, $\text{H}_2\text{C}=\text{CH}$ and $\text{HC}\equiv\text{C}$ is in the order of

- (a) I > III > II (b) I > II > III
(c) II > I > III (d) III > II > I

9. Reaction of hydrogen bromide with propene in the absence of a peroxide is a/an

- (a) free radical reaction (b) nucleophilic substitution
(c) electrophilic addition (d) nucleophilic substitution

10. Among the following compounds, the one which is most reactive towards electrophilic nitration is:

- (a) Benzoic acid (b) Nitrobenzene
(c) Toluene (d) Benzene

ANSWERS: 1. b 2. c 3. d 4. a 5. d 6. c 7. d 8. c 9. c 10. c

FILL IN THE BLANKS

1. The addition of HBr to an unsymmetrical alkene takes place in accordance with _____ rule.
2. Benzene favours _____ substitution reaction.
3. The Dipole moment of Benzene is _____.
4. The nitro group in the benzene nucleus is _____ directing. It _____ the reactivity of the benzene ring.
5. Melting point and boiling point increase as the molar masses _____.

ANSWERS : 1. Markownikov's 2. electrophilic 3. Zero
4. Meta, decreases 5. Increase

TRUE AND FALSE TYPE QUESTIONS

1. Alkanes mainly undergo substitution reactions using the free-radical mechanism.
2. The decreasing order of boiling points among the isomeric pentanes is neo > iso > n.
3. The acidic character of three types of hydrocarbons follows the order alkanes > alkenes > alkynes.
4. The peroxide effect is observed only in addition of HBr, and not with HCl and HI.
5. Wurtz reaction is suitable for the preparation of both symmetrical and unsymmetrical alkanes.
6. For a compound to be aromatic it must have $(4n + 2)\pi$ electrons.
7. Benzene has planar structure.
8. The benzene molecule has two different carbon-carbon bond lengths, corresponding to alternate single and double bonds.
9. In Friedel-Crafts reaction, AlCl_3 is an electrophile.
10. An electron-donating substituent in benzene ring gives a meta product.

ANSWERS: 1. T 2. F 3. F 4. T 5. F 6. T 7. T 8. F 9. F 10. F

MATCH THE COLUMNS

Match the statements (a,b,c,d) in column I with the statements (i, ii, iii, iv) in column II.

- | 1. | Column I | Column II | Column III |
|----|---------------------------------|----------------------------|------------------------|
| | a. CH_4 | i. sp^2 | e. Ozonolysis |
| | b. $\text{CH}_2 = \text{CH}_2$ | ii. sp^3 | f. Oxidising agent |
| | c. $\text{CH} \equiv \text{CH}$ | iii. sp^3d | g. Saturated nature |
| | d. PCl_5 | iv. sp | h. Un Saturated nature |

2.	Column I	Column II
	a. Alkanes	i. Saturated nature
	b. Alkenes	ii. Ozonolysis
	c. Alkynes	iii. Geometrical isomerism
	d. Arenes	iv. Aromatic character

ANSWERS: 1. a. → ii. - g. b. → i.-h.-e. c. → i.-h.-e. d. → iii.-f.
 2. a. → i. b. → ii., iii. c. → ii. d. → i., iv.

ASSERTION-REASON TYPE QUESTIONS

Type 1. The questions given below consist of Assertion(A) and Reason (R). Use the following key to select correct answer.

- (a) If both assertion and reason are correct and reason is correct explanation for assertion.
- (b) If both assertion and reason are correct but reason is not correct explanation for assertion.
- (c) If assertion is correct but a reason is incorrect.
- (d) If assertion and reason both are incorrect.

1. **Assertion:** The IUPAC name of $\text{CH}_3\text{CH} = \text{CH} - \text{C} \equiv \text{CH}$ is pent-3-en-1-yne and not pent-2-en-4-yne.

Reason: While deciding the locants of double and triple Bonds, lowest sum rule is always followed.

2. **Assertion:** Tropylium cation  is aromatic in character.

Reason: The only property which decides the aromatic character is its planar nature.

3. **Assertion:** Friedel-craft reaction between benzene and acetic anhydride in the presence of anhydrous AlCl_3 yields acetophenone and not poly-substituted products.

Reason: Acetophenone formed poisons the catalyst preventing further reaction.

4. **Assertion:** But-1-ene on reacting with HBr in the presence of peroxide, products 1-bromobutane.

Reason: It involves the formation of a primary free radical.

5. **Assertion:** Cyclopentadienyl anion is aromatic in nature.

Reason: Cyclopentaclienyl anion has six π -electrons.

6. **Assertion:** Benzene reacts with chlorine in the form of light to form BHC.

Reason: BHC is also called gammexane or 666.

7. **Assertion:** All the hydrogen atoms in $\text{CH}_2 = \text{C} = \text{CH}_2$ lie in one plane.
Reason: All the carbon atoms in it are sp^2 hybridised.
8. **Assertion:** Propene reacts with HBr in the presence of benzoyl peroxide to yield 2-bromopropane.
Reason: In the presence of peroxide, the addition of HBr to propene follows ionic mechanism.
9. **Assertion:** Benzene does not decolourise bromine water.
Reason: Benzene is stabilised by resonance due to delocalisation of π electrons.
10. **Assertion:** Acidity of C-H bond decreases in the order:
 $\text{HC} \equiv \text{CH} > \text{H}_2\text{C} = \text{CH}_2 > \text{H}_3\text{C} - \text{CH}_3$
Reason: Greater the percentage s-character, more is the acidity of C-H bond.

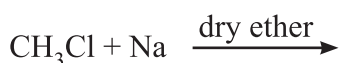
ANSWERS: 1.a 2.c 3.c 4.c 5.a 6.b 7.c 8.d 9.a 10.a

ONE WORD TYPE QUESTIONS

- What is the state of hybridisation of Carbon atoms in alkanes?
- What is the number of bonds in But-3-en-1-yne?
- Name the product formed when Propyne is treated with aqueous H_2SO_4 in the presence of dil.HgSO_4 .
- Name the product formed when Benzene reacts with CH_3Cl in the presence of anhydrous aluminium chloride.
- $-\text{COOH}$ is ortho, para directing or Meta directing group?


1-MARK QUESTIONS

- Write the reaction involved in Kolbe's electrolytic method to prepare ethane.
- Define term decarboxylation.
- Why dry ether and not water is used as a solvent in the preparation of alkane by Wurtz reaction?
- Sodium salt of which carboxylic acid will be needed for the preparation of propane by decarboxylation method?
- Complete the following reaction:



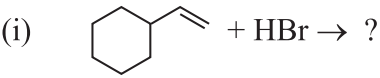
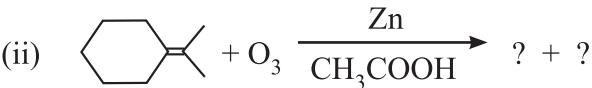
6. Amongst the following which one has the maximum boiling point?
n-Pentane, iso-pentane, neo-pentane.
7. Write IUPAC name of $\text{CH}_3\text{CH}=\text{CHCH}_2\text{CH}=\text{CCH}_2\text{CH}=\text{CH}_2$
 $\begin{array}{c} | \\ \text{CH}_2\text{CH}_3 \end{array}$
8. Draw the cis and trans isomers of $\text{CHCl}=\text{CHCl}$.
9. What happens when 2-Bromobutane is being treated with alc. KOH?
10. Name the reagents used to carry out the following conversions:
 $\text{CH}_3-\text{CH}=\text{CH}_2 \rightarrow \text{CH}_3\text{CH}(\text{OH})\text{CH}_2\text{OH}$
11. Complete the following reaction :



12. An alkene A on ozonolysis gives a mixture of ethanol and pentan-3-one. Write IUPAC name of element.
13. When alkyne is treated with bromine water then what will be the colour of the product?
14. Why alkynes do not exhibit geometrical isomerism?
15. Complete the following reaction:
- (i) $\text{CH}_3\text{C} \equiv \text{CH} \xrightarrow{\text{H}_2\text{O}, \text{Hg}^{2+}/\text{H}^+}$?
- (ii) $\text{CaC}_2 + 2\text{H}_2\text{O} \longrightarrow$ _____ + _____
16. How will you convert ethyne to benzene?
17. Write IUPAC name of $\text{C}_6\text{H}_5-\text{CH}_2-\text{CH}_2-\text{CH}=\text{CH}_2$.
18. Why is benzene extraordinarily stable although it contains three double bonds?
19. Write chemical reaction to exemplify Friedel-Crafts alkylation of benzene.
20. Why  is not aromatic?
21. C-C bond length in benzene is intermediate between C-C and C=C. Why?
22. Starting from benzene, how would you synthesize m- Bromonitrobenzene.
23. Give one example each of o, p-directing group and m-directing group.
24. Complete the reaction:



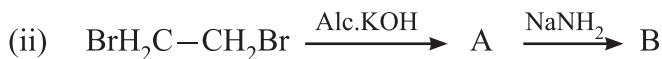
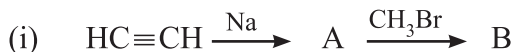
2-MARKS QUESTIONS

1. What effect does branching have on the boiling point of an alkane and why?
2. An alkene A contains three C–C eight C–H and one C=C (π) bond upon ozonolysis A gives two moles of an aldehyde of molar mass 44u. Write the IUPAC name of A.
3. Write the structures of all the alkenes which upon hydrogenation give 2-methyl butane.
4. Wurtz reaction cannot be used for the preparation of unsymmetrical alkanes? Give reason.
5. How can ethene be prepared from (i) Ethanol (ii) Ethyl bromide?
6. Melting point of cis-But-2-ene is lower than that of trans-But-2-ene. Give reason.
7. Draw the structures of cis and trans Hex-2-ene.
8. Explain with the help of equation : Ozonolysis of propene.
9. What do you understand by peroxide effect (Kharasch effect)?
10. What factor determines the stability of alkene?
11. Out of benzene, *m*-dinitro benzene and toluene, which will undergo nitration most easily and why.
12. Complete the reaction:
 - (i)  + HBr \rightarrow ?
 - (ii)  + O₃ $\xrightarrow[\text{CH}_3\text{COOH}]{\text{Zn}}$? + ?
13. An alkene on treatment with HBr in presence of peroxide can generate two types of free radicals $\text{CH}_3 - \underset{\text{CH}_3}{\text{C}} \cdot - \text{CH}_2 - \text{Br}$ and $\text{CH}_3 - \underset{\text{Br}}{\text{C}}(\text{CH}_3) - \text{CH}_2 \cdot$
 Predict the final product of the reaction and give reason.
 (Hint: Stability of free radicals)
14. What happens when But-2-ene reacts with acidified potassium permanganate solution?
15. You are provided with But-2-yne, how will you convert it into:
 - (i) cis-But-2-ene
 - (ii) trans-But-2-ene

16. An alkene C_4H_8 reacts with HBr both in the presence and absence of peroxide to give the same product. Identify the alkene.
17. Arrange ethane, ethene and ethyne in the order of increasing acidity.
18. Identify A and B in the following reaction:



19. Write the structures of the products A and B of the following reactions:



3-MARKS QUESTIONS

- Write the structures and name of products obtained in the reaction of sodium with a mixture of 1-Iodo-2-methylpropane and 2-Iodopropane.
- State Markownikov's rule. Using this rule, write the reaction of propene with (i) HCl & (ii) H_2O .
- Complete the following reactions:
 - $CH_3CH_2Br \xrightarrow{\text{Alc.KOH}}$
 - $CH_3CH=CH_2 + O_3 \xrightarrow{Zn/H_2O}$
 - $CH_2=CH_2 + H_2O + [O] \xrightarrow{\text{Dil.KMnO}_4}$
- Write the structure of 3, 4-Dimethylhept-3-ene.
 - Name the compounds obtained by ozonolysis of 3-Methylpent-2-ene.
- Complete the following reactions:
 - $CH \equiv CH \xrightarrow{NaNH_2, CH_3Br} ?$
 - $CH \equiv CH \xrightarrow{H_2O, HgSO_4/H_2SO_4} ?$
 - $CH_3C \equiv CH + H_2 \xrightarrow{Pt} ? \xrightarrow{H_2} ?$
- Write the mechanism of nitration of benzene.
- Arrange in the order of decreasing relative reactivity with an electrophile and explain:
Toluene, p-Nitrotoluene, 1, 4-Dinitrobenzene
- What is meant by delocalization of π electrons? How does it affect stability of benzene?

9. What are the conditions for a compound/species to be aromatic according to Huckel's rule?
10. How will you convert benzene into
 - (i) Acetophenone
 - (ii) m- Chloronitrobenzene?

5-MARKS QUESTIONS

1. Define isomerism. Write all the structural isomers of hexane(C_6H_{14}) and arrange them in increasing order of boiling points.
2. Write short note on (i) Wurtz reaction (ii) Kolbe's electrolysis (iii) Ozonolysis
3. An alkene 'A' of molecular mass '28u' on treatment with bromine gives a product 'B'. The Compound 'B' on further dehalogenation with zinc gives back 'A'. Give the structures of 'A' and 'B' and also the sequence of reactions.
4. An organic compound 'A' with formula C_4H_9Br on treatment with $KOH(alc.)$ gave two isomeric compounds 'B' and 'C' with formula C_4H_8 . Ozonolysis of 'B' gave only one product CH_3CHO while 'C' gave two different products. Identify A, B and C.
5. How will you convert Ethyne into (i) 1, 1, 2, 2-Tetrachloroethane (ii) Ethene (iii) Ethanal (iv) Benzene (v) Sodium ethynide

UNIT TEST-I

Time Allowed: 1 Hr.

Maximum Marks : 20

General Instructions:

- (i) All questions are compulsory.
- (ii) Maximum marks carried by each question are indicated against it.

-
1. Amongst the following which one has the maximum boiling point [1]
and why? n-Pentane , iso-pentane, neo-pentane
 2. What is the number of σ and π bonds in But-3-en-1-yne? [1]
 3. Action of acetylene on dilute $H_2SO_4/dil.HgSO_4$ gives: [1]
(a) Acetic acid (b) Acetone (c) Acetaldehyde (d) Ethyl alcohol

In the following questions a statement of Assertion (A) followed by Reason (R) is given. Use the following key to select correct answer :

- (a) Both Assertion and Reason are correct but Reason is the correct explanation of Assertion.
 - (b) Both Assertion and Reason are correct but Reason is not the correct explanation of Assertion.
 - (c) Both Assertion and Reason are incorrect.
 - (d) Assertion is not correct but Reason is correct.
4. **Assertion :** Benzene reacts with chlorine in the form of light to form BHC.

Reason : BHC is also called gammexane or 666. [1]

5. **Assertion:** Tropylium cation  is aromatic in character.

Reason: The only property which decides the aromatic character is its planar nature. [1]

6. Arrange the following alkenes in decreasing order of stability and [1]
give reason.



7. (i) Give a chemical test to distinguish between ethyne and ethene. [2]
(ii) Melting point of cis-But-2-ene is lower than that of trans-But-2-ene. Give reason.
8. Complete the following reactions: [3]
- (i) $\text{CH}_3\text{CH}_2\text{Br} \xrightarrow{\text{Alc.KOH}}$
- (ii) $\text{CH}_3\text{CH}=\text{CH}_2 + \text{O}_3 \xrightarrow{\text{Zn/H}_2\text{O}}$
- (iii) $\text{CH}_2=\text{CH}_2 + \text{H}_2\text{O} + [\text{O}] \xrightarrow{\text{Dil.KMnO}_4}$
9. (i) What are the conditions for a compound/species to be aromatic according to Huckel's rule? [3]
(ii) How will you convert Benzene to acetophenone?
10. (i) An alkene 'A' of molecular mass '28u' on treatment with bromine gives a product 'B'. The Compound 'B' on further dehalogenation with zinc gives back 'A'. Give the structures of 'A' and 'B' and also the sequence of reactions. [5]
(ii) Why is benzene extraordinarily stable although it contains three double bonds?
(iii) How can we convert ethyne into benzene?

UNIT TEST-II

Time Allowed: 1 Hr.

Maximum Marks : 20

General Instructions:

- (i) All questions are compulsory.
- (ii) Maximum marks carried by each question are indicated against it.

-
1. The methyl group in Benzene ring is [1]
(a) Ortho directing (b) Ortho and meta directing
(c) Para directing (d) Ortho and para directing
 2. Action of acetylene on dilute H_2SO_4 gives : [1]
(a) Acetic acid (b) Acetone
(c) Acetaldehyde (d) Ethyl alcohol
 3. What is the other name for Geometrical isomerism? [1]
- In the following questions a statement of Assertion (A) followed by Reason (R) is given. Use the following key to select correct answer :**
- (a) Both Assertion and Reason are correct but Reason is the correct explanation of Assertion.
 - (b) Both Assertion and Reason are correct but Reason is not the correct explanation of Assertion.
 - (c) Both Assertion and Reason are incorrect.
 - (d) Assertion is not correct but Reason is correct.
4. **Assertion:** Benzene does not decolourise bromine water.
Reason: Benzene is stabilised by resonance due to delocalisation of π electrons.
 5. **Assertion:** Acidity of C-H bond decreases in the order:
 $\text{HC} \equiv \text{CH} > \text{H}_2\text{C} = \text{CH}_2 > \text{H}_3\text{C} - \text{CH}_3$
Reason: Greater the percentage s-character, more is the acidity of C—H bond.
 6. How will you convert methyl bromide to ethane? [2]
 7. Explain with the help of equation ozonolysis of propene. [2]
 8. Write the mechanism of nitration of benzene. [3]
 9. How will you convert benzene into [3]
(i) Acetophenone
(ii) Toluene
 10. Write short note on the following : [5]
(i) Wurtz reaction.
(ii) Kolbe's electrolysis
(iii) Ozonolysis
