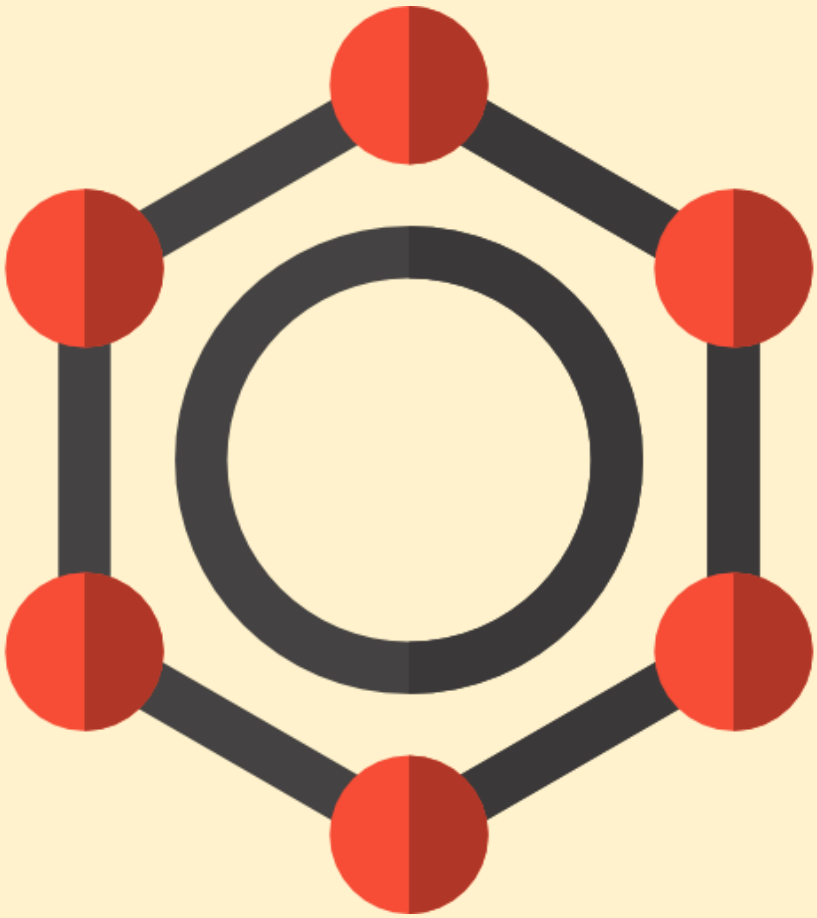
2024
UPDATED
SYLLABUS

CHEMISTRY
NCERT - 11

- Useful for CBSE, JEE & NEET exams
- Each topic contains Detailed Theory with images
- Every topic contains Exercises and Detailed solutions

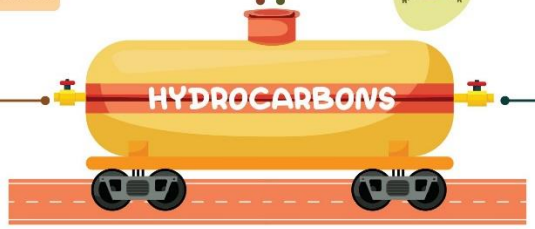
13. HYDROCARBONS



Chemistry Smart Booklet

Theory + NCERT MCQs + Topic Wise Practice MCQs + NEET PYQs

HYDROCARBONS



ALKANES C_nH_{2n-2}

PREPARATION

From unsaturated hydrocarbons

$CH_2=CH_2 \xrightarrow[H_2]{Pt/Pd/Ni} CH_3-CH_3$

From alkyl halides

$CH_3-CH_2-Cl \xrightarrow[H^+]{Zn} CH_3CH_3 + NaCl$

$2CH_3-Na \xrightarrow[\text{dry ether}]{\text{WURTZ RX}} CH_3CH_3$

From carboxylic acids (Kolbe's Electrolytic Method)

$CH_3-CH_2-Cl \xrightarrow[H^+]{Zn} CH_3CH_3 + NaCl$

$2CH_3-Na \xrightarrow[\text{dry ether}]{\text{WURTZ RX}} CH_3CH_3$

CHEMICAL PROPERTIES

Substitution Reaction — Halogenation

1. INITIATION: $Cl2 \xrightarrow{h\nu} \dot{C}l + \dot{C}l$
2. PROPAGATION: $Cl_4 + \dot{C}l \rightarrow \dot{C}H_3 + HCl$; $\dot{C}H_3 + Cl-Cl \rightarrow CH_3 + \dot{C}l$
3. TERMINATION: $\dot{C}l + \dot{C}l \rightarrow Cl_2$; $\dot{C}H_3 + \dot{C}l \rightarrow CH_3Cl$

Combustion

$CxHy + (x + y/4)O2 \rightarrow xCO2 + y/2H2O$

Controlled Oxidation

$CH_4 + O_2 \xrightarrow[10\text{ atoms}]{Cu/523\ K} 2CH_3OH$

$CH_4 + O_2 \xrightarrow{Mo_2O_3} HCHO + H_2O$

Isomerization

$2CH3(CH2)4CH3 \xrightarrow[HCl]{\text{Anhyd. AlCl3}}$

Aromatic Reforming

$\xrightarrow[773\ K]{Cr_2/O_3}$

Reaction with Steam

$CH4 + H2O \xrightarrow{Ni} CO + 3H2$

Pyrolysis

$C_nH_{2n} \xrightarrow{773\ K} C_nH_{22} + H_2$; $C_nH_4 + C_3H_6 + H_2$; $C_3H_6 + C_2H_4 + CH_4$

PHYSICAL PROPERTIES

- ALKANES ARE HYTROPHOBIC
- GENERALLY, NON-POLAR IN NATURE
- BOILING POINT INCREASES WITH INCREASE IN
- BOILING POINT DECREASES WITH INCREASE IN BRANCHING

CONFORMERS

Sawhorse Projection

Eclipsed — Staggered

Newman Projection

Staggered — Eclipsed

ALKENES

PREPARATION

Electrophilic Reactions

- $CH_3-CH=CH_2 \xrightarrow{\text{conc. } H_2SO_4} CH_3-\underset{O-SO_3H}{CH}-CH_3$
- $CH_3-CH=CH_2 \xrightarrow[H^+]{H_2O} CH_3-\underset{OH}{CH}-CH_3$

From acidic dehydration of alcohols

$HO-CH_2-CH_3 \xrightarrow{\text{conc. } H_2SO_4} + H_2O$

From vicinal dihalides

$Br-CH_2-CH_2-Br \xrightarrow{Zn} + ZnBr_2$

From alkyl halides

$CH_3-CH_2-X \xrightarrow{\text{alc. KOH}} + HX$

From alkynes

$R_2C=CR_2 + H_2 \xrightarrow{Pd/C}$

CHEMICAL PROPERTIES

Ozonolysis

$\xrightarrow[H_2O]{Zn}$

Oxidation

$CH_2=CH_2 + H_2O \xrightarrow[273\ K]{\text{dil. } KMnO_4} \underset{OH}{CH_2}-\underset{OH}{CH_2}$

Polymerization

$n\text{-}CH_2=CH_2\text{-} \xrightarrow[\text{High pressure catalyst}]{\text{High temp.}} \text{-}CH_2-CH_2\text{-}_n$

Aromatic Reforming

$CH_2=CH_2 + Br_2 \rightarrow \underset{Br}{CH_2}-\underset{Br}{CH_2}$

ADDITION OF HYDROGEN HALIDES

Markovnikov's Rule

"Negative part of the addendum gets attached to the carbon containing lesser number of hydrogens". (I) is major product.

Anti-Markovnikov Effect / Kharash Effect/ Apnti-Peroxide Effect

This mechanism proceeds via free radical mechanism and the minor product via Markovnikov effect becomes major product. (II) is major product.

Symmetrical Alkene

$CH_2=CH_2 + HBr \rightarrow BrCH_2-CH_3$

Asymmetrical alkene

$CH_3-CH=CH2 + HBr$

(I) $CH_3CH_2BrCH_3$ (II) $CH_3CH_2CH_2Br$

PHYSICAL PROPERTIES

- Alkenes have a short odour
- First few members are gases and rest are liquids & solids.
- Increase in branching leads to decrease in boiling point
- Alkenes are insoluble in water but soluble Non-Polar solvents

ALKYNES C_nH_{2n-2}

HC≡CH

PHYSICAL PROPERTIES

- First few members of alkynes are gases
- Boiling point decreases with increase in the branching
- Soluble in none-polar solvents and insoluble in water
- Boiling point of alkene increases as the chain length increases
- Most of them are odourless except for thyne

CHEMICAL PROPERTIES

HC≡CH

- $\xrightarrow[Pt,\ Pd,\ Ni]{H_2}$ $CH_2=CH_2$ $\xrightarrow{H_2}$ CH_2-CH_2
- $\xrightarrow{Br_2}$ $\underset{Br\ Br}{CH=CH}$
- $\xrightarrow[Hg^{2+},\ H^+]{H_2O}$ $\underset{OH}{CH_2=C-H}$
- $\xrightarrow{HCl/CH_3COOH}$ $CH_2=CHCl$
- Polymerisation

Cyclic polymerisation — Iron tube, Red hot 873 K

Linear polymerisation — High temp./ High pressure

PREPARATION

From Calcium Carbide: $CaO + 2H_2O \rightarrow C_2H_2 + Ca(OH)_2$

From Vicinal dihalides: $BrCH2-CH_2Br \xrightarrow[\Delta]{\text{alc. KOH}} CH\equiv CH + 2H_2O + KBr$

ARENES

PREPARATION

Decarboxylation of carboxylic acids

$COONa \xrightarrow[\Delta]{NaOH} + Na_2CO_3$

Reduction of Phenol Using Zn Dust

$OH \xrightarrow[\Delta]{Zn} + ZnO$

CHEMICAL PROPERTIES

Electrophilic Substitution Reaction

- Conc. HNO_3 / Conc. H_2SO_4 (323-333 K) → NO_2
- Conc. $H_2SO_4 + SO_3$ → HSO_3
- Anhyd. $AlCl_3 + Cl_2$ → Cl
- Anhyd. $AlCl_3 + CH_3Cl$ → CH_3
- Anhyd. $AlCl_3 + CH_3COCl$ → $C(=O)CH_3$

Addition Reaction

- $\xrightarrow[\Delta]{3H_2,\ Ni}$
- $\xrightarrow[500\ K]{3Cl_2,\ UV}$

PHYSICAL PROPERTIES

- Immiscibel in water but completely soluble in Polar
- Characteristic Smell
- Highly Notable in Nature
- Burn with a Sooty flame

Huckel's Rule of Aromaticity

1. Planarity
2. Delocalisation of π-electrons
3. Presence of $(4n + 2)$-π electrons

Carcinogenicity and Toxicity

1. 2-benzanthracene — 1. 2-benzpyrene

Aromatics are toxic in nature and most of them are classified as carcinogens.

HYDROCARBONS

Introduction

The term 'hydrocarbon' is self-explanatory meaning compounds of carbon and hydrogen only. Hydrocarbons hold economic potential in our daily life. Natural gas and petroleum are chief sources of aliphatic hydrocarbons at the present time, and coal is one of the major sources of aromatic hydrocarbons. Petroleum is a dark, viscous mixture of many organic compounds, most of them being hydrocarbons, mainly alkanes, cycloalkanes and aromatic hydrocarbons.

Classification

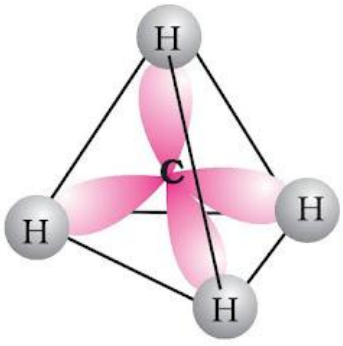
As we are quite aware that there are different types of hydrocarbons. Depending upon the types of carbon-carbon bonds present, they can be classified into three main categories:

1. Saturated hydrocarbons.
2. Unsaturated hydrocarbons.
3. Aromatic hydrocarbons.

Saturated hydrocarbons contain carbon-carbon and carbon-hydrogen single bonds. If different carbon atoms are joined together to form open chain of carbon atoms with single bonds, they are termed as alkanes. On the other hand, if carbon atoms form a closed chain or ring, they are termed as cycloalkanes. Unsaturated hydrocarbons contain carbon-carbon multiple bonds – double bonds, triple bonds or both. Aromatic hydrocarbons are a special type of cyclic compounds.

ALKANES

These are the saturated chains of hydrocarbons containing carbon-carbon single bonds. Methane (CH_4) is the first member of this family containing single carbon atom. Since it is found in coal mines and marshy areas, is also known as 'marsh gas'. These hydrocarbons exhibited low reactivity or no reactivity under normal conditions with acids, bases and other reagents, they were earlier known as paraffins. The general formula for alkane is C_nH_{2n+2}, where n stands for number of hydrogen atoms in the molecule.



Structure of Methane

1. Nomenclature

For nomenclature of alkanes in IUPAC system, the longest chain of carbon atoms containing the single bond is selected. Numbering of the chain is done from the one end so that maximum carbon will be included in chain. The suffix 'ane' is used for alkanes. The first member of the alkane series is CH_4 known as methylene (common name) or methene (IUPAC name). IUPAC names of a few members of alkenes are given below:

S. No.	Structure	IUPAC Name
1.	CH_4	Methane
2.	C_2H_6	Ethane
3.	C_3H_8	Propane
4.	C_4H_{10}	Butane
5.	C_5H_{12}	Pentane
6.	C_6H_{14}	Hexane
7.	C_7H_{16}	Heptane
8.	C_8H_{18}	Octane
9.	C_9H_{20}	Nonane
10.	$C_{10}H_{22}$	Decane

2. Preparation of Alkanes

Though petroleum and natural gas are the main sources of alkanes, it can be prepared by several other methods as well.

i. **From unsaturated hydrocarbons:** The addition of dihydrogen to unsaturated hydrocarbons like alkenes and alkynes in the presence of a suitable catalyst under a given set of conditions produces saturated hydrocarbons or alkanes. This process of addition of dihydrogen is known as hydrogenation process.

$CH_2{=}CH_2 + H_2 \longrightarrow CH_3\text{-}CH_3$

$CH{\equiv}CH + 2H_2 \longrightarrow CH_3\text{-}CH_3$

ii. From alkyl halides

a) **Reduction:** Alkyl halides undergo reduction with zinc and dilute hydrochloric acid to give alkanes. In general, the reaction can be represented as

$CH_3\text{-}Cl \longrightarrow CH_4$

b) **Wurtz reaction:** Alkyl halides on treatment with sodium metal in dry ether give higher alkanes. This reaction is known as Wurtz reaction.

$CH_3Br + 2Na + BrCH_3 \longrightarrow CH_3\text{-}CH_3 + 2NaBr$

iii. From carboxylic acids

a) **By decarboxylation of carboxylic acids:** Sodium salts of carboxylic acids on heating with soda lime give alkanes containing one carbon atom less than the carboxylic acid. A molecule of carbon dioxide is eliminated which dissolves in NaOH to form sodium carbonate.

$CH_3COONa + NaOH \longrightarrow CH_4 + Na_2CO_3$

b) **Kolbe's electrolytic method:** An aqueous solution of sodium or potassium salt of a carboxylic acid on electrolysis gives alkane containing even number of carbon atoms at anode.

$CH_3COONa + 2H_2O \longrightarrow CH_3\text{-}CH_3 + 2CO_2 + H_2 + NaOH$

3. Properties of Alkanes

I. **Physical Properties**

i. **State:** Due to the weak van der Waals forces, the first four members C1 to C4 i.e., methane, ethane, propane and butane are gases. From C5 to C17 are liquids and those containing 18 carbon atoms or more are solids at 298 K. They all are colourless and odourless.

ii. **Solubility:** Alkanes are generally insoluble in water or in polar solvents, but they are soluble in non-polar solvents like, ether, benzene, carbontetrachloride etc. The solubility of alkanes follow the property "Like Dissolves like".

iii. **Boiling point:** The boiling points of straight chain alkanes increase regularly with the increase of number of carbon atoms. This is due to the fact that the intermolecular van der Waals forces increase with increase in the molecular size or the surface area of the molecule.

II. **Chemical Properties**

Generally, alkanes show inertness or low reactivity towards acids, bases, oxidizing and reducing agents at ordinary conditions because of their non-polar nature and absence of π bond. The C–C and C–H bonds are strong sigma bonds which do not break under ordinary conditions but they undergo certain reactions under given suitable conditions.

i. **Halogenation reaction:** When hydrogen atom of an alkane is replaced by a halogen, it is known as halogenation reaction. Halogenation takes place either at high temperature (300–500°C) or in the presence of diffused sunlight or ultraviolet light.

$CH_4 + Cl_2 \longrightarrow CH_3Cl + HCl$

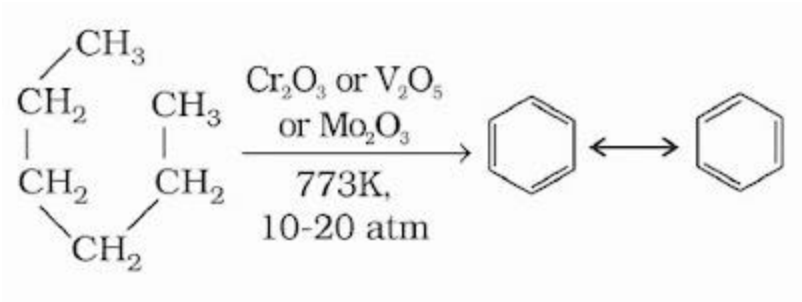
ii. **Combustion:** Alkanes on heating in presence of air gets completely oxidized to carbon dioxide and water. It burns with a non-luminous flame. The combustion of alkanes is an exothermic process i.e., it produces a large amount of heat.

$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$

iii. **Controlled oxidation:** When methane and dioxygen compressed at 100 atm are passed through heated copper tube at 523K yield methanol.

$2CH_4 + O_2 \longrightarrow 2CH_3OH$

iv. **Aromatization:** The conversion of aliphatic compounds into aromatic compounds is known as aromatisation. n-Alkanes having six or more carbon atoms on heating to 773K at 10–20 atmospheric pressure in the presence of oxides of vanadium, molybdenum or chromium supported over alumina get dehydrogenated and cyclised to benzene and its homologues. This reaction is also known as reforming.



v. **Reaction with steam:** Methane reacts with steam at 1273K in the presence of nickel catalyst to form carbon monoxide and dihydrogen. This method is used for industrial preparation of dihydrogen gas.

$CH_4 + H_2O \longrightarrow CO + 3H_2$

ALKENES

Alkenes are unsaturated hydrocarbons containing at least one carbon-carbon double bond with general formula C_nH_{2n}. Alkenes are also known as olefins (oil forming) since the first member, ethylene or ethene (C_2H_4) was found to form an oily liquid on reaction with chlorine.

1. Nomenclature

For nomenclature of alkenes in IUPAC system, the longest chain of carbon atoms containing the double bond is selected. Numbering of the chain is done from the end which is nearer to the double bond. The suffix 'ene' replaces 'ane' of alkanes. The first member of the alkene series is C_2H_4 known as ethylene (common name) or ethene (IUPAC name). IUPAC names of a few members of alkenes are given below:

S.No.	Structure	IUPAC Name
1.	C_2H_4	Ethene
2.	C_3H_6	Propene
3.	C_4H_8	Butene
4.	C_5H_{10}	Pentene
5.	C_6H_{12}	Hexene
6.	C_7H_{14}	Heptene
7.	C_8H_{16}	Octene
8.	C_9H_{18}	Nonene
9.	$C_{10}H_{20}$	Dekene

2. Preparation

i. **From alkynes:** Alkynes undergo partial reduction with calculated amount of dihydrogen producing alkenes.

$CH \equiv CH + H_2 \longrightarrow CH_2 = CH_2$

ii. **From alkyl halides:** Alkyl halides (R–X) on heating with alcoholic potash eliminates one molecule of halogen acid to form alkenes. This reaction is known as dehydrohalogenation i.e., removal of halogen acid.

$CH_3CH_2Cl \longrightarrow CH_2 = CH_2 + HCl$

iii. **From alcohols by acidic dehydration:** Alcohols on heating with concentrated sulphuric acid form alkenes with the elimination of one water molecule since a water molecule is eliminated from the alcohol molecule in the presence of an acid, this reaction is known as acidic dehydration of alcohols.

$CH_3CH_2OH \longrightarrow CH_2 = CH_2 + H_2O$

3. Properties of Alkenes

I. Physical properties

i. The first three members of alkenes are gases, the next fourteen are liquids and the higher ones are solids.

ii. Ethene is a colourless gas with a faint sweet smell. All other alkenes are colourless and odourless, insoluble in water but fairly soluble in non-polar solvents like benzene, petroleum ether.

iii. They show a regular increase in boiling point with increase in size i.e., every $-CH_2$ group added increase the boiling point by 20–30K.

II. Chemical properties

i. **Addition of dihydrogen:** Alkenes adds one mole of dihydrogen gas in presence of catalysts such as Ni at 200–250°C, or finely divided Pt or Pd at room temperature to give an alkane.

$CH_2 = CH_2 + H\text{-}H \longrightarrow CH_3\text{-}CH_3$

ii. **Addition of halogens:** Halogens like bromine or chlorine add up to alkene to form vicinal dihalides in presence of CCl_4 as solvent. The order of reactivity of halogens is F > Cl > Br > I.

$CH_2 = CH_2 + Br\text{-}Br \longrightarrow Br\text{-}CH_2\text{-}CH_2\text{-}Br$

iii. **Addition of hydrogen halides:** Hydrogen halides (HCl, HBr, HI) add upto alkenes to form alkyl halides. The order of reactivity of hydrogen halides is HI > HBr > HCl. Like addition of halogens to alkenes, addition of hydrogen halides is an example of electrophilic addition reaction.

$CH_2=CH_2 + H\text{-}Br \longrightarrow CH_3\text{-}CH_2\text{-}Br$

Markovnikov rule: According to the rule, the negative part of the addendum (adding molecule) adds to that carbon atom of the unsymmetrical alkene which is maximum substituted or which possesses lesser number of hydrogen atoms.

$CH_3CH=CH_2 + HBr \longrightarrow CH_3\text{-}CH(Br)\text{-}CH_3$

Anti Markovnikov addition or Peroxide effect or Kharash effect: In the presence of peroxide, addition of HBr to unsymmetrical alkenes like propene takes place contrary to the Markovnikov rule. This happens only with HBr but not with HCl or HI. This reaction is known as peroxide or Kharash effect or addition reaction anti to Markovnikov rule.

$CH_3CH=CH_2 + HBr \longrightarrow CH_3\text{-}CH_2\text{-}CH_2\text{-}Br$

iv. **Polymerisation:** Polymerisation is the process where monomers combines together to form polymers. The large molecules thus obtained are called polymers. Other alkenes also undergo polymerisation.

$n(CH_2=CH_2) \longrightarrow (-CH_2\text{-}CH_2\text{-})_n$

Alkenes

Like alkenes, alkynes are also unsaturated hydrocarbons with general formula C_nH_{2n-2}. They contain at least one triple bond between two carbon atoms. These have four H-atoms less compared to alkanes. The first stable member of alkyne series is ethyne commonly known as acetylenes.

1. Nomenclature

In common system, alkynes are named as derivatives of acetylene. In IUPAC system, they are named as derivatives of the corresponding alkanes replacing 'ane' by the suffix 'yne'. The position of the triple bond is indicated by the first triply bonded carbon. Common and IUPAC names of a few members of alkyne series are given in the table below:

S.No.	Structure	IUPAC Name
1.	C_2H_2	Ethyne
2.	C_3H_4	Propyne
3.	C_4H_6	Butyne
4.	C_5H_8	Pentyne
5.	C_6H_{10}	Hexyne

2. Preparation

i. **From calcium carbide:** On industrial scale, ethyne is prepared by reacting calcium carbide with water. Calcium carbide is prepared by heating quick lime with coke. Quick lime can be obtained by heating limestone as shown in the following reactions:

$CaCO_3 \longrightarrow CaO + CO_2$

$CaO + 3C \longrightarrow CaC_2 + CO$

$CaC_2 + 2H_2O \longrightarrow Ca(OH)_2 + C_2H_2$

ii. **From vicinal dihalides**: Vicinal dihalides on treatment with alcoholic potassium hydroxide undergo dehydrohalogenation. One molecule of hydrogen halide is eliminated to form alkenyl halide which on treatment with sodamide gives alkyne.

$CH_2(Br)\text{-}CH_2(Br) + KOH \longrightarrow CH_2{=}CH_2 \longrightarrow CH{\equiv}CH$

4. Properties of Alkenes

I. Physical properties

i. The first three members (acetylene, propyne and butynes) are gases, the next eight are liquids and higher ones are solids.

ii. All alkynes are colourless. All alkynes except ethyne which have an offensive characteristic odour, are odourless.

iii. Alkynes are weakly polar in nature and nearly insoluble in water. They are quite soluble in organic solvents like ethers, carbon tetrachloride and benzene.

iv. Their melting point, boiling point and density increase with increase in molar mass.

II. Chemical properties

i. **Addition of dihydrogen:** Alkynes contain a triple bond, so they add up, two molecules of dihydrogen.

$CH{\equiv}CH + H_2 \longrightarrow CH_2{=}CH_2 \longrightarrow CH_3\text{-}CH_3$

ii. Addition of halogens: Alkynes contain a triple bond, so they add up, two molecules of halogen.

$CH{\equiv}CH + Cl_2 \longrightarrow CH(Cl){=}CH(Cl) \longrightarrow CH(Cl)_2\text{-}CH(Cl)_2$

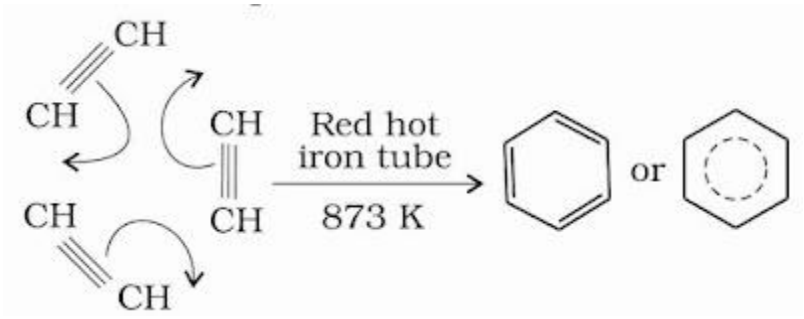
iii. **Addition of hydrogen halides:** Two molecules of hydrogen halides (HCl, HBr, HI) add to alkynes to form gemdihalides (in which two halogens are attached to the same carbon atom).

$CH \equiv CH + HCl \longrightarrow CH_2 = CH(Cl)$

iv. **Addition of water:** Like alkanes and alkenes, alkynes are also immiscible and do not react with water. However, one molecule of water adds to alkynes on warming with mercuric sulphate and dilute sulphuric acid at 333K to form carbonyl compounds.

$CH \equiv CH + H_2O \longrightarrow CH_3\text{-}CHO$

v. **Polymerisation:** Ethyne on passing through red hot iron tube at 873K undergoes cyclic polymerization. Three molecules polymerise to form benzene, which is the starting molecule for the preparation of derivatives of benzene, dyes, drugs and large number of organic compounds.



vi. Oxidation:

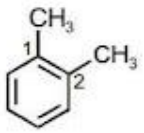
$2C_2H_2 + 5O_2 \longrightarrow 4CO_2 + 2H_2O$

Aromatic Hydrocarbon

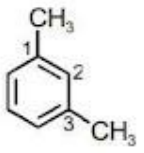
Aromatic hydrocarbons are also known as 'arenes'. Since most of them possess pleasant odour (Greek; aroma meaning pleasant smelling), the class of compounds are known as 'aromatic compounds'. Most of the compounds are found to have benzene ring. Benzene ring is highly unsaturated and in a majority of reactions of aromatic compounds, the unsaturation of benzene ring is retained. Aromatic compounds containing benzene ring are known as benzenoids and those, not containing a benzene ring are known as non-benzenoids.

1. Nomenclature

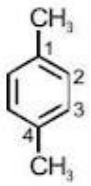
Since all the six hydrogen atoms in benzene are equivalent; so it forms one and only one type of monosubstituted product. When two hydrogen atoms in benzene are replaced by two similar or different monovalent atoms or groups, three different position isomers are possible which differ in the position of substituents. So we can say that disubstituted products of benzene show position isomerism. The three isomers obtained are 1, 2 or 1, 6 which is known as the ortho (o-), the 1, 3 or 1, 5 as meta (m-) and 1, 4 as para (p-) disubstitued compounds.



1, 2-Dimethyl benzene
or o-Dimethylbenzene or o-Xylene



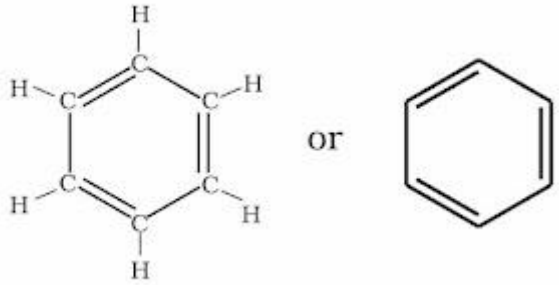
1, 3-Dimethylbenzene
or m-Dimethylbenzene or m-Xylene



1, 4-Dimethyl benzene
or p-Dimethylbenzene or p-Xylene

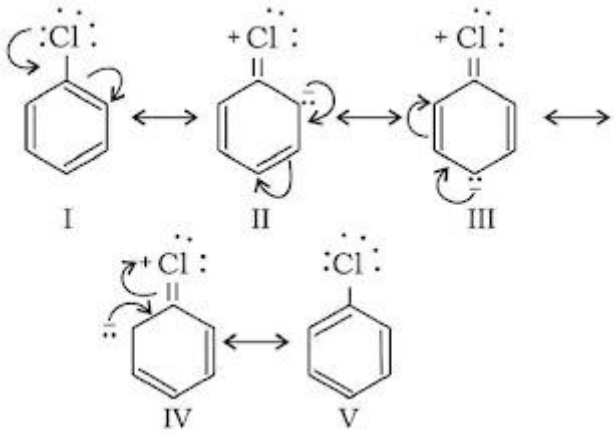
2. Structure

The molecular formula of benzene, C_6H_6, indicates a high degree of unsaturation. All the six carbon and six hydrogen atoms of benzene are identical. On the basis of this observation August Kekule in 1865 proposed the following structure for benzene having cyclic arrangement of six carbon atoms:



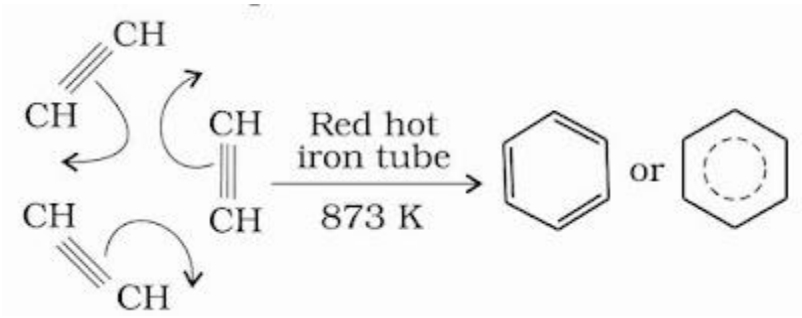
3. Resonance

Even though the double bonds keep on changing their positions. The structures produced is such that the position of nucleus remains the same in each of the structure. The structural formula of such a compound is somewhat intermediate (hybrid) between the various propose formulae. This state is known as Resonance.

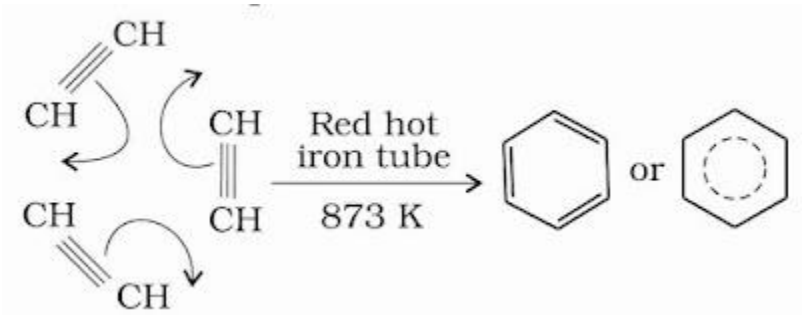


4. Preparation of Benzene

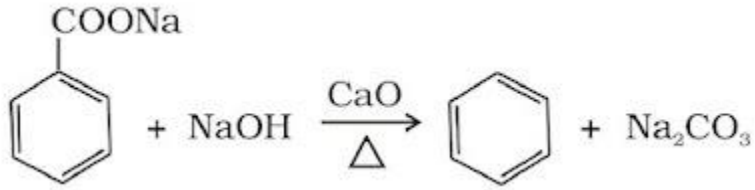
i. **Cyclic polymerisation of ethyne:** Ethyne on passing through red hot iron tube at 873K undergoes cyclic polymerization.



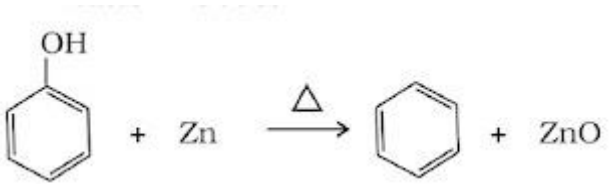
ii. **Decarboxylation of aromatic acids:** Sodium salt of benzoic acid i.e., sodium benzoate on heating with sodalime gives benzene.



iii. **Decarboxylation of aromatic acids:** Sodium salt of benzoic acid i.e., sodium benzoate on heating with sodalime gives benzene.



iv. **Reduction of phenol:** Phenol is reduced to benzene by passing its vapour over heated zinc dust.



5. Properties of Benzene

I. Physical Properties

i. Aromatic hydrocarbons are non-polar molecules and are usually colourless liquids or solids with a characteristic aroma.

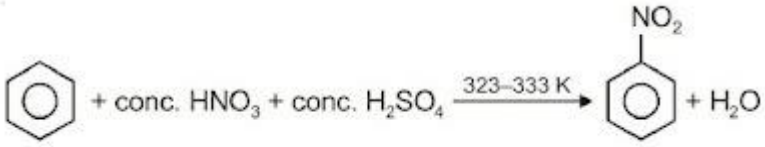
ii. The napthalene balls used in toilets and for preservation of clothes because of unique smell of the compound.

iii. Aromatic compounds are insoluble in water but soluble in organic solvents such as alcohol and ether.

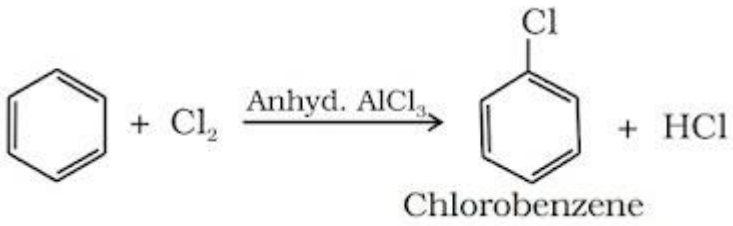
iv. They burn with sooty flame.

II. Chemical properties

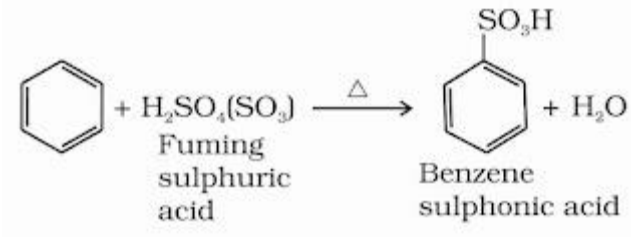
i. **Nitration:** A nitro group is introduced into the benzene ring when benzene is heated with a mixture of concentrated nitric acid and concentrated sulphuric acid.



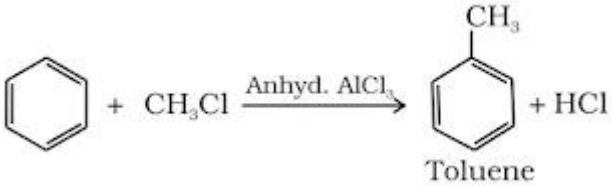
ii. **Halogenation:** Arenes undergo halogenation when it is treated with halogens in presence of Lewis catalyst such as anhy. $FeCl_3$, $FeBr_3$ or $AlCl_3$ to yield haloarenes.



iii. **Sulphonation**: The replacement of a hydrogen atom by a sulphonic acid group in a ring is called sulphonation. It is carried out by heating benzene with fuming sulphuric acid or oleum (conc. H_2SO_4 + SO_3).



iv. **Friedel-Crafts alkylation reaction:** When benzene is treated with an alkyl halide in the presence of anhydrous aluminium chloride, alkylbenzene is formed.



Activating Groups: Electron donating groups (EDG, +M, +I, +H. C. effect) in the benzene ring will more stabilize the σ-complex (Arenium ion complex) with respect to that of benzene and hence they are known as activator.

Deactivating Groups: Electron drawing groups (–M, –I effects) will destabilize σ-complex as compared to that of benzene. Therefore substituted benzenes where substituents are electron withdrawing decreases reactivity towards SE reactions.

Summary-

1. **Hydrocarbons:** The compounds which are made up of only carbon and hydrogen elements.
2. LPG (Liquefied petroleum gas), LNG (Liquefied natural gas) and CNG (Compressed natural gas) are important fuels.
3. Alkanes are saturated hydrocarbons having general formula C_nH_{2n+2}. They contain only C—C and C—H sigma bonds.
4. Alkenes are unsaturated hydrocarbons having general formula C_nH_2n. They contain a carbon-carbon double bond.
5. Alkynes are unsaturated hydrocarbons having general formula C_nH_{2n-2}. They contain a carbon-carbon triple bond.
6. Alkanes exhibit conformational isomerism due to almost free rotation about C—C sigma bond.
7. Alkenes exhibit geometric isomerism due to restricted rotation about carbon-carbon double bond.
8. The cis isomer is more polar and has higher boiling point than the trans isomer. On the other hand the melting point of trans isomer is higher.
9. **Cracking:** The process of decomposing higher hydrocarbons into lower hydrocarbons by strong heating.
10. **Reforming or Aromatisation:** The process of converting aliphatic and alicyclic hydrocarbons into aromatic hydrocarbons by heating in the presence of suitable catalysts such as platinum.
11. **Grignard reagent:** RMgX, Alkyl magnesium halide.
12. Soda-lime decarboxylation of sodium salts of carboxylic acids leads to formation of alkane with one carbon less than the starting compound.
13. Dehydrohalogenation of Alkyl halides is carried out by heating with alcoholic solution of KOH.
14. Branched chain hydrocarbons have lower boiling points than straight chain hydrocarbons having same number of carbon atoms.
15. Among isomeric xylenes, para isomer has the highest melting point.
16. **Baeyer's reagent:** 1% cold and alkaline solution of $KMnO_4$.
17. **Markovnikov's rule:** During electrophilic addition across unsymmetrical double bond, the negative part of the adding molecule goes to that carbon which has less number of hydrogen atoms.
18. **Kharash effect:** Anti-Markovnikov addition of HBr to alkenes in the presence of organic peroxides.

19. Arenes are aromatic hydrocarbons. They contain at least one benzene ring.
20. The important reactions of alkanes are free radical substitution reactions while that of alkenes and alkynes are electrophilic addition reactions.
21. Aromatic hydrocarbons are undergo mainly electrophilic substitution reactions inspire of high degree of unsaturation present in them.
22. Aromaticity in aromatic compounds is due to the presence cyclic, delocalized system of (4n+2) π electrons.
23. Substitution reactions are common for alkanes and arenes whereas addition reactions are common for alkenes and alkynes.
24. The catalyst for Friedel-Craft reaction is anhydrous $AlCl_3$.
25. Terminal alkynes are acidic in character.
26. Electron releasing groups increase the reactivity of benzene ring towards electrophilic substitution reactions. Some examples are $-R$, $-OH$, $-NH_2$, $-OR$, $-NHCOCH_3$, etc.

NCERT LINE BY LINE QUESTIONS

(1.) A Compound is treated with $NaNH_2$ to give sodium salt. Identify the compound.

(a.) C_2H_2 (b.) C_6H_6

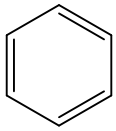
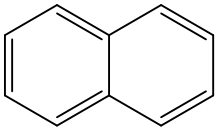
(c.) C_2H_6 (d.) C_2H_4

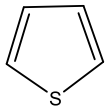
(2.) Which of the following has zero dipole moment

(a.) 1-Butene (b.) 2-Methyl-l-Propene

(c.) Cis-2-Burene (d.) trans-2-Butene

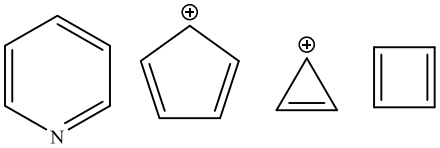
(3.) Which of the following chemical system is non- aromatic

(a.)  (b.) 

(c.) 

(d.) 

(4.) Which of the following species are anti-aromatic .



(a.) I, II (b.) II, III

(c.) I, IV (d.) II, IV

(5.) Cis-2-butene and trans-2-butene are

(a.) Conformational Isomers (b.) Structural Isomers

(c.) Configurational Isomers (d.) Optical Isomers

(6.) Which one is the correct order of acidity?

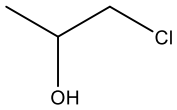
(a.) $CH \equiv CH > CH_3 - C \equiv CH > CH_2 = CH_2 > CH_3 - CH_3$

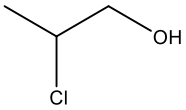
(b.) $CH \equiv CH > CH_2 = CH_2 > CH_3 - C \equiv CH > C$

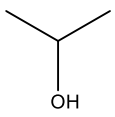
(c.) $CH_3 - CH_3 > CH_2 = CH_2 > CH_3 - C \equiv CH > CH \equiv CH$

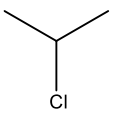
(d.) $CH_2 = CH_2 > CH_3 - CH = CH_2 > CH_3 - C \equiv C$

(7.) Propene on reaction with chlorine water gives

(a.) 

(b.) 

(c.) 

(d.) 

(8.) **Assertion (A)**: Alkyl benzene is not prepared by Friedel-Craft alkylation of benzene.
Reason (R): Alkyl halides are less reactive than 1 acyl halides

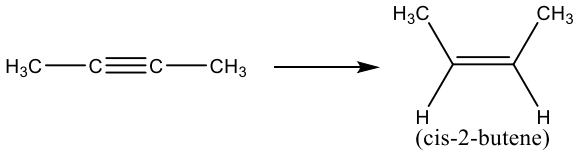
(a.) Both A and R are true and R is the correct explanation of A.

(b.) Both A and R are true but R is nor the correct explanation of A.

(c.) A is true but R is false.

(d.) Both A and R are false.

(9.) The most suitable reagent for following conversion is:



(a.) $Na / liq.NH_3$

(b.) $H_2, pd / c, quinoline$

(c.) Zn / HCl

(d.) $Hg^{2+} / H^+, H_2O$

(10.) Which among the following is not aromatic)

(a.) Cyclopemadienyl cation

(b.) Cyclopropenyl cation

(c.) Tropylium cation

(d.) Cyclopentadienyl anion

(11.) Which of the following can be used as the halide component for Friedel-Craft's reaction

(a.) Chlorobenzene

(b.) Bromobenzene

(c.) Chloromethane

(d.) Isopropyl Chloride

(12.) General formula of alkyne is

(a.) C_nH_{2n}

(b.) C_nH_{2n+1}

(c.) C_nH_{2n+2}

(d.) C_nH_{2n-2}

(13.) Alkynes can be reduced to alkenes by the hydrogenation in presence of

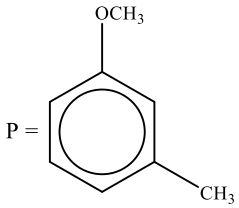
(a.) Raney Ni

(b.) Anhyd. $AlCl_3$

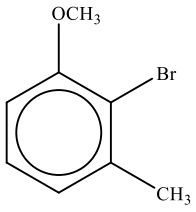
(c.) Pd

(d.) Lindlar's Catalyst

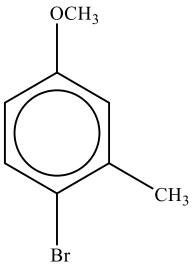
(14.) The major product formed on monobromination $(Br_2 / FeBr_3)$ of the following compound P

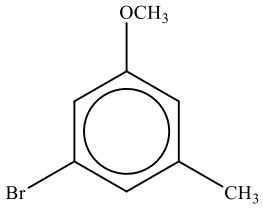


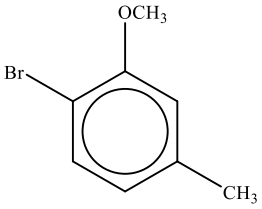
(a.)



(b.)



(c.) 

(d.) 

(15.) Aromatisation can takes place in presence of

(a.) Cr_2O_3 (b.) V_2O_5

(c.) Mo_2O_3 (d.) all (a.), (b) and (c)

(16.) Matrix Match

Column 1	Column 2
$(A)\ CH_2=CH_2+H_2O \xrightarrow{H^+} CH_3CH_2OH$	(P) Halogenation
$(B)\ CH_2=CH_2+H_2 \xrightarrow{Pd} CH_3-CH_3$	(Q) Polymerisation
$(C)\ CH_2=CH_2+Cl_2 \rightarrow Cl-CH_2-CH_2-Cl$	(R) Hydrogenation
$(D)\ 3CH\equiv CH \xrightarrow[Heat]{Cu\ tube} C_6H_6$	(S) Condensation
	(T) Hydration

(a.) $A \rightarrow P, B \rightarrow R, C \rightarrow T, D \rightarrow Q$ (b.) $A \rightarrow R, B \rightarrow P, C \rightarrow T, D \rightarrow S$

(c.) $A \rightarrow T, B \rightarrow R, C \rightarrow Q, D \rightarrow P$ (d.) $A \rightarrow T, B \rightarrow R, C \rightarrow P, D \rightarrow Q$

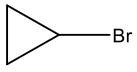
(17.) The pair of electrons in the given carbanion, $CH_3C\equiv C^{\ominus}$, is present in which of the following orbitals

(a.) sp^2 (b.) sp

(c.) $2p$ (d.) sp^3

(18.) The main product of the following reaction is $CH_3CH=CH_2+HBr \xrightarrow{(C_6H_5CO)_2O_2}$

(a.) $CH_3CH(Br)-CH_3$ (b.) $CH_3CH_2CH_2Br$

(c.) $BrCH_2-CH=CH_2$ (d.) 

(19.) Which of the compound with molecular formula C_5H_{10} fields acetone on ozonolysis

(a.) 3-methyl-1-butene (b.) Cyclopentane

(c.) 2-methyl-1-butene (d.) 2-methyl-2-butene

(20.) In the following reaction $C_6H_6 \xrightarrow{CH_3Cl/AlCl_3} P \xrightarrow{KMnO_4} Q$ Here Q is

(a.) Benzoic Acid (b.) Benzoyl Chloride

(c.) Benzaldehyde (d.) Chlorobenzene

(21.) Which of the following statements are correct

(i) Decomposition reaction of higher alkane into smaller fragments by the application of heat is called pyrolysis. (ii) Pyrolysis and cracking are different processes. (iii) Dodecane on pyrolysis gives a mixture of heptane and pentene. (iv) Pyrolysis follows free radical mechanism.

(a.) (i), (ii), (iii) (b.) (i)2 (ii), (iv)

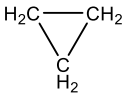
(c.) (i), (iii), (iv) (d.) (ii), (iv)

(22.) 2-Hexyne gives trans-2-hexene on treatment with

(a.) Li / NH_3 (b.) $Pd / BaSO_4$

(c.) $LiAlH_4$ (d.) Pt / H_2

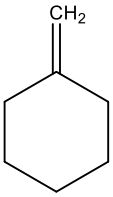
(23.) Which of the following compounds shall not produce propene by reaction with HBr followed by the elimination or direct only elimination reaction .

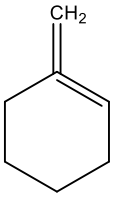
(a.) 

(b.) $H_3C-CH_2-CH_2OH$

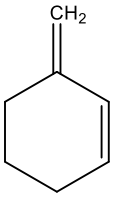
(c.) $H_2C=C=O$ (d.) $H_3C-CH_2-CH_2Br$

(24.) In the reaction with HCl, an alkene reacts in accordance with Markovnikov's rules to give a product 1-chloro-l-methylcyclohexane. The possible alkene is ?

(a.) 

(b.) 

(c.) Both a and b

(d.) 

(25.) Consider the nitration of benzene using mixed conc. H_2SO_4 and HNO_3. If a large amount of $KHSO_4$ is added to the mixture, the rate of nitration will be:

(a.) Double (b.) F aster

(c.) Slower (d.) Unchanged

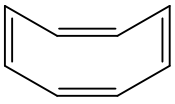
(26.) Consider the following sequence of reactions

$CaC_2 \xrightarrow{H_2O} X \xrightarrow[\text{Fe tube}]{\text{Red hot}} Y$ The Product Y is

(a.) Acetylene (b.) Benzene

(c.) Mesitylene (d.) Xylene

(27.) **Assertion (A):** The compound cyclooctane has the following structural formula.



It is cyclic and has conjugated $8\pi - e^-$ system but it is not an aromatic compound.

Reason (R): $(4n+2)\pi$ electrons rule does not hold good and the ring is not planar.

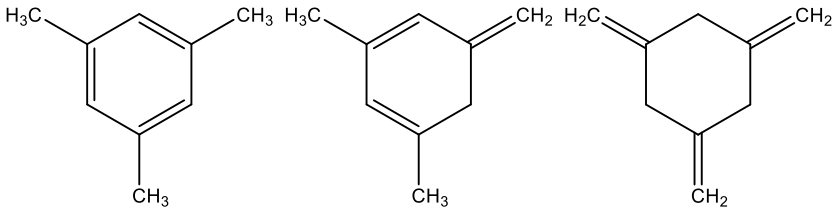
(a.) Both A and R are true and R is the correct explanation of A.

(b.) Both A and R are true but R is not the correct explanation of A.

(c.) A is true but R is false.

(d.) Both A and R are false.

(28.) Given



(I)(II)(III)

The enthalpy of the hydrogenation of these compounds will be in the order as:

(a.) III > II > I (b.) II > III > I

(c.) II > I > III (d.) I > II > III

(29.) Which of the following reaction is shown by alkynes

(a.) Addition (b.) Substitution

(c.) Polymerisation (d.) All of these

(30.) When acetylene is passed over heated iron tube, the product obtained is

(a.) C_2H_2 (b.) C_4H_4

(c.) C_6H_6 (d.) C_8H_8

(31.) Predict wrong option for stability

(a.) 2,3-Dimethylbut-2-ene > 2-Methylpent-2-ene (b.) trans-Hex-3-ene > Cis-Hex-3-ene

(c.) cis-Hex-3-ene > Hex-l-ene (d.) trans-Hex-2-ene > 2-Methylpent-2-ene

(32.) Assertion (A): Benzene does not decolorise Br_2 water.

Reason (R): Benzene is stabilised by resonance due to delocalisation of π-electrons.

(a.) Both A and R are true and R is the correct explanation of A. (b.) Both A and R are true but R is not the correct explanation of A.

(c.) A is true but R is false. (d.) Both A and R are false.

(33.) Benzene can be directly obtained from

(a.) Acetylene (b.) Phenol

(c.) Chlorobenzene (d.) All of the Above

(34.) The number of σ (Sigma) and π (Pie) bonds in benzene is [Page: 385]

(a.) 6σ and 6π (b.) 6σ and 3π

(c.) 12σ and 3π (d.) 3σ and 3π

(35.) **Assertion (A):** Acidity of C —H bond decreases in the order of. $HC \equiv CH > H_2C = CH_2 > CH_3 - CH_3$.

Reason (R): Acidity of C —H bond increases as the electronegativity of the carbon to which it is attached increases.

(a.) Both A and R are true and R is the correct explanation of A. (b.) Both A and R are true but R is not the correct explanation of A.

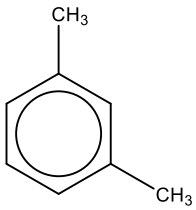
(c.) A is true but R is false. (d.) Both A and R are false.

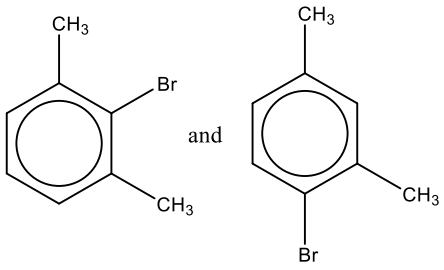
(36.) 2-Butene shows geometrical isomerism due to

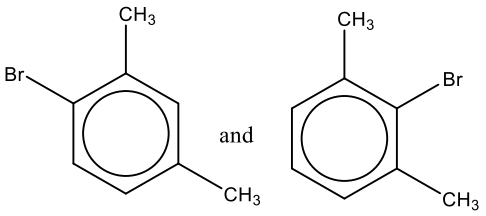
(a.) restricted rotation about double bond. (b.) free rotation about double bond.

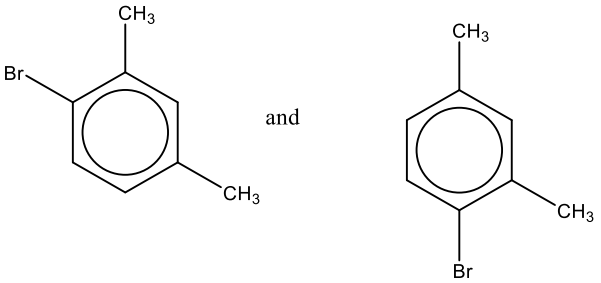
(c.) free rotation about single bond. (d.) chiral carbon.

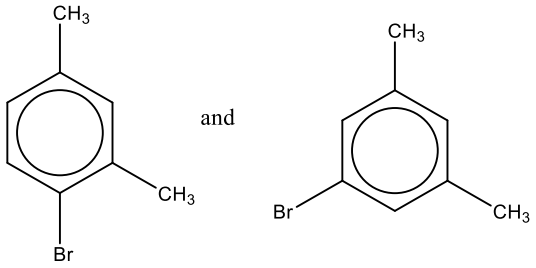
(37.) What products are formed when the following compound is treated with Br_2 in the presence of $FeBr_3$?



(a.) 

(b.) 

(c.) 

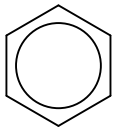
(d.) 

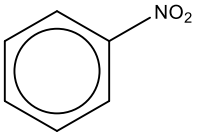
(38.) Count the σ and π bonds in the following structure $H_2C=C\left(CH_2CH_2CH_3\right)_2$

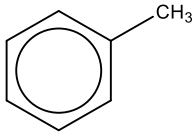
(a.) 26σ and 0π (b.) 19σ and 1π

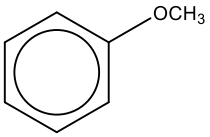
(c.) 18σ and 1π (d.) 23σ and 1π

(39.) Which of the following will have fastest rate of reaction with $Br_2 / FeBr_3$.

(a.) 

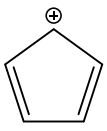
(b.) 

(c.) 

(d.) 

(40.) Among the following the aromatic compound is **[Page: 399]**

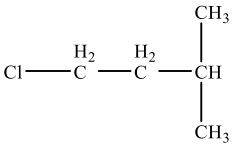
(a.) 

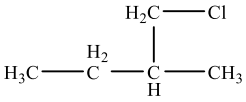
(b.) 

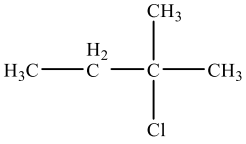
(c.) 

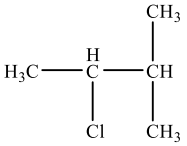
(d.) 

(41.) An alkene 'A' on reaction with O_3 and $Zn-H_2O$ gives propanone and ethanal in equimolar ratio. Addition of HCl to alkene 'A' gives 'B' as the major product. The structure of 'B' is

(a.) 

(b.) 

(c.) 

(d.) 

(42.) Which of the following reagent will be able to distinguish between 1-butyne and 2-butyne .

(a.) $NaNH_2$ (b.) HCl

(c.) O_2 (d.) Br_2

(43.) In which of the following reactions, addition does not occur according to Markovnikov's rule

(a.) $CH_3CH=CH_2+HCl \xrightarrow{ROOR}$ (b.) $CH_3CH=CH_2+HBr \xrightarrow{ROOR}$

(c.) $CH_2=CH_2+HI \xrightarrow{ROOR}$ (d.) $CH_3CH=CHCH_3+HBr \xrightarrow{ROOR}$

(44.) Which of the following alkenes will react faster with H_2 under catalytic hydrogenation conditions?

(a.) $C=C$ (b.) $C=C$

(c.) $C=C$ (d.) $C=C$

(45.) For an electrophilic substitution reaction, the presence of a halogen atom in the benzene ring

(a.) deactivates the ring by resonance.

(b.) directs the incoming electrophile to meta position by increasing the charge density relative to ortho a para position.

(c.) Activates the ring by inductive effect.

(d.) deactivates the ring by inductive effect.

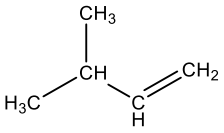
(46.) Benzene reacts with I_2 in presence of which of the following to give iodobenzene?

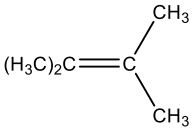
(a.) HNO_3 (b.) HI

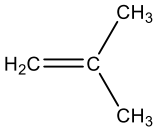
(c.) SO_2 (d.) H_2O

(47.) Which among the following alkenes on ozonolysis give a mixture of ketone only.

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

(b.) 

(c.) 

(d.) 

(48.) Catalytic hydrogenation of benzene gives

(a.) Xylene (b.) Cyclohexane

(c.) Benzoic Acid (d.) Toulene

(49.) A gas decolourises alkaline $KMnO_4$ solution but does not give precipitate with $AgNO_3$. It is

(a.) CH_4 (b.) C_2H_4

(c.) C_2H_2 (d.) C_2H_6

(50.) Alkenes usually show which type of reaction

(a.) Substitution (b.) Addition

(c.) Elimination (d.) None of these

TOPIC WISE PRACTICE QUESTIONS

TOPIC 1: Alkanes

1. Pure methane can be produced by
   1) Wurtz reaction 2) Kolbe's electrolytic method
   3) Soda-lime decarboxylation 4) Reduction with H2
2. In the eclipsed conformation of ethane, the dihedral angle between the hydrogen atoms of adjacent methyl groups is
   1) 60° 2) 120° 3) 0° 4) 180°
3. Photochemical halogenation of alkane is an example of
   1) electrophilic substitution 2) electrophilic addition
   3) nucleophilic substitution 4) free radical substitution
4. The most stable conformation of *n*-butane is
   1) skew boat 2) gauche 3) staggered-anti 4) eclipsed
5. For preparing an alkane, a concentrated solution of sodium or potassium salt of a saturated carboxylic acid is subjected to
   1) hydrolysis 2) oxidation 3) hydrogenation 4) electrolysis
6. Which of the following liberates methane on treatment with water?
   1) Silicon carbide 2) Calcium carbide 3) Beryllium carbide 4) Magnesium carbide
7. The reaction/method that does not give an alkane is
   1) catalytic hydrogenation of alkenes
   2) dehydrohalogenation of an alkyl halide
   3) hydrolysis of alkylmagnesium bromide
   4) Kolbe's electrolytic method
8. To prepare a pure sample of *n*-hexane using sodium metal as one reactant, the other reactant will be
   1) ethyl chloride and *n*-butyl chloride 2) methyl bromide and *n*-pentyl bromide
   3) *n*-propyl bromide 4) ethyl bromide and *n*-butyl bromide
9. In Wurtz reaction, if we take CH3Cl and C2H5Cl then product, will be
   1) propane + ethane 2) propane 3) propane + ethane + butane 4) propane + butane
10. Which one of the following reactions is expected to readily give a hydrocarbon product in good yields?
    1) $RCOOK \xrightarrow[\text{oxidation}]{\text{Electrolytic}}$ 2) $RCOO^-Ag^+ \xrightarrow{Br_2}$
    3) $CH_3CH_3 \xrightarrow[h\upsilon]{Cl_2}$ 4) $(CH_3)_3CCl \xrightarrow{C_2H_5OH}$

11. 2-Methylbutane on reacting with bromine in the presence of sunlight gives mainly
1) 1-bromo-3-methylbutane 2) 2-bromo-3-methylbutane
3) 2-bromo-2-methylbutane 4) 1-bromo-2-methylbutane

12. Spatial arrangements of atoms which can be converted into one another by rotation around a C–C single bond are called
1) Stereoisomers 2) Tautomers 3) Optical isomers 4) Conformers

13. The reagent used for the conversion, $CH_3CH_2COOH \rightarrow CH_3CH_2CH_3$ is
1) LiAlH4 2) soda-lime 3) red P and concentrated HI 4) Zn – Hg/conc. HCl

14. When isobutane is treated with bromine at 127°C, the product formed is
1) a mixture of isobutyl bromide and *tert*-butyl bromide.
2) a mixture of *sec*-butyl bromide and *tert*- butyl bromide.
3) a mixture of isobutyl bromide, *sec*- butyl bromide and *tert*- butyl bromide as the major product.
4) almost 100% *tert*-butyl bromide.

15. Complete combustion of CH_4 gives:
1) $CO_2 + H_2O$ 2) $CO_2 + H_2$ 3) $COCl_2$ 4) $CO + CO_2 + H_2O$

16. Which of the following statements are correct?
(i) Decomposition reaction of higher alkanes into smaller fragments by the application of heat is called pyrolysis.
(ii) Pyrolysis and cracking are different processes.
(iii) Dodecane on pyrolysis gives a mixture of heptane and pentene.
(iv) Pyrolysis follows free radical mechanism.
1) (i), (ii) and (iii) 2) (i), (ii) and (iv) 3) (i), (iii) and (iv) 4) (ii) and (iv)

17. Natural gas is a mixture of:
1) $CH_4 + C_2H_6 + C_3H_8$ 2) $CO + H_2 + CH_4$ 3) $CO + H_2$ 4) $H_2O + CO_2$

18. A petroleum fraction having boiling range 70-200 °C and containing 6-9 carbon atoms per molecule is called
1) natural gas 2) gas oil 3) gasoline 4) kerosene

19. Which of the following statements are correct?
(i) Stability of conformation is affected due to torsional strain.
(ii) Magnitude of torsional strain depends upon the angle of rotation about C – C bond.
(iii) Eclipsed form has least torsional strain.
(iv) Staggered form has maximum torsional strain.
1) (i) and (iii) 2) (i) and (ii) 3) (iii) and (iv) 4) (i) and (iv)

TOPIC 2: Alkenes

20. Which one of the following heptanols can be dehydrated to hept-3-ene only?
1) Heptan-3-ol 2) Heptan-4-ol 3) Heptan-2-ol 4) Heptan-1-ol

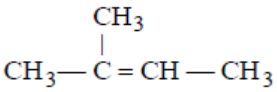
21. Isobutene is the exclusive product of dehydrohalogenation (by a strong base) of
1) isobutyl chloride 2) *tert*-butyl bromide
3) both 1) and 2) 4) neither 1) nor 2)

22. Compound which gives acetone on ozonolysis:
1) $CH_3 — CH = CH — CH_3$ 2) $(CH_3)_2C = C(CH_3)_2$ 3) $C_6H_5CH = CH_2$ 4) $CH_3CH = CH_2$

23. Correct statement about 1, 3 -butadiene is
1) Conjugated double bonds are present 2) Reacts with HBr 3) Forms polymer 4) All of these

24. Allene (C_3H_4) contains
1) one double bond, one triple bond and one single bond. 2) one triple and two double bonds.
3) two triple and one double bonds. 4) two double and four single bonds.

25. The compound



on reaction with NaIO4 in the presence of KMnO4 gives

1) $CH_3CHO + CO_2$ 2) CH_3COCH_3 3) $CH_3COCH_3 + CH_3COOH$ 4) $CH_3COCH_3 + CH_3CHO$

26. Reaction of HBr with propene in the presence of peroxide gives

1) isopropyl bromide 2) 3-bromo propane

3) allyl bromide 4) *n*-propyl bromide

27. Acid catalyzed hydration of alkenes except ethene leads to the formation of

1) mixture of secondary and tertiary alcohols 2) mixture of primary and secondary alcohols

3) secondary or tertiary alcohol 4) primary alcohol

28. Alkenes usually show which type of reactions?

1) addition 2) substitution 3) elimination 4) superposition

29. Select the incorrect statement:

1) Bromine is more selective and less reactive.

2) Chlorine is less selective and more reactive.

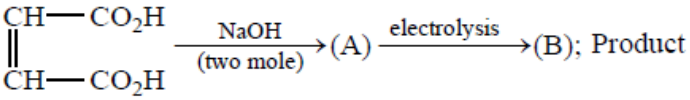
3) Benzyl free radical is more stable than 2° free radical.

4) Vinyl free radical more stable than alkyl free radical.

30. Conversion of cyclohexene to cyclohexanol can be conveniently achieved by

1) $NaOH + H_2O$ 2) $Br_2—H_2O$ 3) hydroboration, oxidation 4) hydroboration hydrolysis

31.



(B) of the reaction is:

(a) $CH_3—CH_3$

(b) $H_2C=CH_2$

(c) $H—C\equiv C—H$

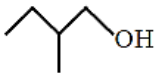
(d) $CH_2=CH—CH=CH_2$

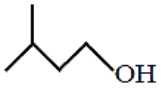
32. Addition of BH3 followed by H2O2 to trans-2-butene wouldgive a product which is

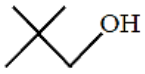
1) achiral 2) racemic 3) meso 4) optically active

33. Which of the following alcohols cannot be prepared from hydration of an alkene?

(a) 

(b) 

(c) 

(d) 

34. One mole of a symmetrical alkene on ozonolysis gives two moles of an aldehyde having a molecular mass of 44 u. The alkene is

1) propene 2) 1-butene 3) 2-butene 4) ethene

35. In the hydroboration - oxidation reaction of propene with diborane, H_2O_2 and NaOH, the organic compound formed is:

1) CH_3CH_2OH 2) $CH_3CHOHCH_3$ 3) $CH_3CH_2CH_2OH$ 4) $(CH_3)_3COH$

36. The test for unsaturation is confirmed by the decolourisation of which of the following

1) Iodine water 2) $CuSO_4$ solution 3) Bromine water 4) All of these

37. In reaction sequence

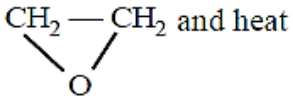
$$CH_2 = CH_2 \xrightarrow[\text{acid}]{\text{Hypochlorous}} M \xrightarrow{R} \begin{matrix} CH_2OH \\ | \\ CH_2OH \end{matrix}$$

molecule 'M' and reagent 'R' respectively are

(a) CH_3CH_2Cl and NaOH

(b) CH_3CH_2OH and H_2SO_4

(c) $CH_2(Cl)CH_2OH$ and aqueous $NaHCO_3$

(d)  and heat

38. Hyperconjugation is more pronounced in

1) 2-methylpropene 2) but-2-ene 3) 2, 3-dimethylbut-2-ene 4) 2-methylbut-2-ene

39. Isopropyl alcohol is obtained by reacting which of the following alkenes with conc. H_2SO_4 and H_2O

1) Ethylene 2) Propylene 3) 2-methyl propene 4) Isoprene

40. In preparation of alkene from alcohol using Al_2O_3 which is effective factor?

1) Temperature 2) Concentration 3) Surface area of Al_2O_3 4) Porosity of Al_2O_3

41. In the presence of peroxide, HCl and HI do not give anti- Markownikoff's addition of alkenes because

1) one of the steps is endothermic in HCl and HI

2) both HCl and HI are strong acids

3) HCl is oxidizing and the HI is reducing

4) all the steps are exothermic in HCl and HI

42. The nodal plane in the p-bond of ethene is located in

1) the molecular plane

2) a plane parallel to the molecular plane

3) a plane perpendicular to the molecular plane which bisects the carbon - carbon s -bond at right angle

4) a plane perpendicular to the molecular plane which contains the carbon - carbon s -bond.

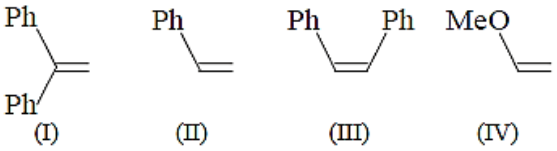
43. The IUPAC name of the compound having the formula $(CH_3)_3CCH = CH_2$ is –

1) 3, 3, 3-trimethyl-1-propane 2) 1, 1, 1-trimethyl-1-butene

3) 3, 3-dimethyl-1-butene 4) 1, 1-dimethyl-1, 3-butene

44. The only alcohol that can be prepared by the indirect hydration of alkene is

1) Ethyl alcohol 2) Propyl alcohol 3) Isobutyl alcohol 4) Methyl alcohol

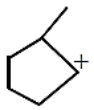
45. 

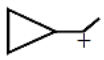
(I) (II) (III) (IV)

Order of rate of electrophilic addition reaction with HBr will be :

1) IV > I > III > II 2) I > II > III > IV 3) I > III > II > IV 4) IV > I > II > III

46. Which of the following would not rearrange to a more stable form?

(a)  (b) 

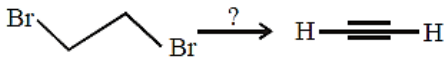
(c)  (d) 

TOPIC 3: Alkynes

47. Number of alkynes for formula C_5H_8 is –

1) 2 2) 3 3) 4 4) 5

48. The reagent(s) for the following conversion,



1) alcoholic KOH
2) alcoholic KOH followed by $NaNH_2$
3) aqueous KOH followed by $NaNH_2$
4) Zn/CH_3OH

49. $R-CH_2-CCl_2-R \xrightarrow{\text{Reagent}} R-C\equiv C-R$

The reagent is

1) Na 2) HCl in H_2O 3) KOH in C_2H_5OH 4) Zn in alcohol.

50. A compound is treated with $NaNH_2$ to give sodium salt. Identify the compound

1) C_2H_2 2) C_6H_6 3) C_2H_6 4) C_2H_4

51. Which of these will not react with acetylene?

1) NaOH 2) Ammonical $AgNO_3$ 3) Na 4) HCl.

52. Which of the following is used for the conversion of 2-hexyne into *trans*-2-hexene?

1) $H_2/Pd/BaSO_4$ 2) H_2, PtO_2 3) $NaBH_4$ 4) Liq.NH_3/C_2H_5OH

53. In the reaction

$CH_3C\equiv C^- - Na^+ + (CH_3)_2CH-Cl \longrightarrow ?$

the product formed is

1) propene 2) propyne 3) propyne and propene 4) 4-methylpentyne-2

54. Ammonical silver nitrate forms a white precipitate easily with

1) $CH_3C\equiv CH$ 2) $CH_3C\equiv CCH_3$ 3) $CH_3CH=CH_2$ 4) $CH_2=CH_2$

55. When acetylene passed through dil. H_2SO_4 in presence of $HgSO_4$, the compound formed is

1) ether 2) acetaldehyde 3) acetic acid 4) ketone

56. Identify the reagent from the following list which can easily distinguish between 1-butyne and 2-butyne

1) bromine, CCl_4 2) H_2, Lindlar catalyst 3) dilute H_2SO_4, $HgSO_4$ 4) ammonical Cu_2Cl_2 solution

57. But–2–yne on chlorination gives

1) 1 –chlorobutane 2) 1, 2 –dichlorobutane
3) 1, 1, 2, 2 –tetrachlorobutane 4) 2, 2, 3, 3 –tetrachlorobutane

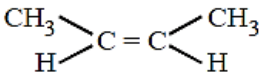
58. Combustion of which of the following compound (in the presence of excess of oxygen) does not result in the change in hybrid state of C atom

1) CH_4 2) $CH_2=CH_2$ 3) CH_3-CH_3 4) $HC\equiv CH$

59. Which of the following polymer can be used as electrodes in batteries?

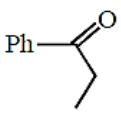
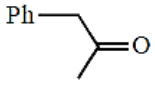
1) Polypropene 2) Polyacetylene 3) Polyethene 4) Polyisoprene

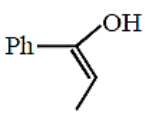
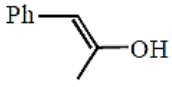
60. Which of the following has the lowest dipole moment?

(a)  (b) $CH_3C\equiv CCH_3$

(c) $CH_3CH_2C\equiv CH$ (d) $CH_2=CH-C\equiv CH$

61. $Ph-C\equiv CCH_3 \xrightarrow{Hg^{2+}/H^+} A$, A is

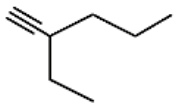
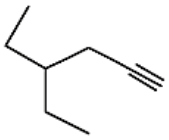
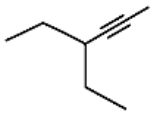
(a)  (b) 

(c)  (d) 

62. The synthesis of 3-octyne is achieved by adding a bromoalkane into a mixture of sodium amide and an alkyne. The bromoalkane and alkyne respectively are

(a) $BrCH_2CH_2CH_2CH_2CH_3$ and $CH_3CH_2C \equiv CH$
(b) $BrCH_2CH_2CH_3$ and $CH_3CH_2CH_2C \equiv CH$
(c) $BrCH_2CH_2CH_2CH_2CH_3$ and $CH_3C \equiv CH$
(d) $BrCH_2CH_2CH_2CH_3$ and $CH_3CH_2C \equiv CH$

63. Which alkyne will give 3-ethylhexane on catalytic hydrogenation?

(a) 
(b) 
(c) 
(d) All of these

64. Reduction of 2-butyne with sodium in liquid ammonia gives predominantly

1) *cis* - 2 - butene 2) *n*-butane
3) *trans* - 2 - butene 4) no reaction

65. Acetylene reacts with HCN in the presence of $Ba(CN)_2$ to yield

1) 1, 1 -dicyanoethane 2) 1, 2-dicyanoethane
3) vinyl cyanide 4) None of these

66. Which of the following will have least hindered rotation around carbon - carbon bond?

1) Ethane 2) Ethylene 3) Acetylene 4) Hexachloroethane

67. Which one of the following compounds will react with methylmagnesium iodide?

1) $CH_3CH_2CH_2CH_2CH_3$ 2) $CH_3CH = CH - CH = CH_2$
3) $CH_3C \equiv CCH_2CH_3$ 4) $CH_3CH_2CH_2C \equiv CH$

68. Butyne-2 contains:

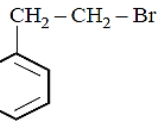
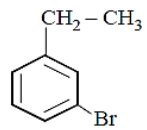
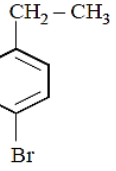
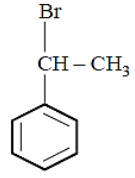
1) *sp* hybridised carbon atoms only 2) sp^3 hybridised carbon atoms only
3) both *sp* and sp^2 hybridised carbon atoms 4) both *sp* and sp^3 hybridised carbon atoms

69. Acetylenic hydrogens are acidic because

1) Sigma electron density of C – H bond in acetylene is nearer to carbon, which has 50% *s*-character
2) Acetylene has only one hydrogen on each carbon
3) Acetylene contains least number of hydrogens among the possible hydrocarbons having two carbons
4) Acetylene belongs to the class of alkynes with molecular formula, C_nH_{2n-2}.

TOPIC 4 : Aromatic Hydrocarbons

70. The product of the reaction between ethyl benzene and N-bromosuccinamide is

(a) 
(b) 
(c) 
(d) 

71. n-Butylbenzene on oxidation will give

1) benzoic acid 2) butanoic acid 3) benzyl alcohol 4) benzaldehyde

72. Aromatic compounds burn with sooty flame because

1) they have a ring structure of carbon atoms
2) they have a relatively high percentage of hydrogen
3) they have a relatively high percentage of carbon 4) they resist reaction with oxygen of air

73. Using anhydrous $AlCl_3$ as catalyst, which one of the following reactions produces ethylbenzene (PhEt)?
1) $H_3C - CH_2OH + C_6H_6$ 2) $CH_3 - CH = CH_2 + C_6H_6$
3) $H_2C = CH_2 + C_6H_6$ 4) $H_3C - CH_3 + C_6H_6$

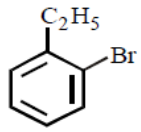
74. The conditions for aromaticity is:
1) molecule must have cyclic clouds of delocalised p electrons
2) molecule must contain $(4n + 2)$ p electrons
3) Both 1) and 2) 4) None of the above

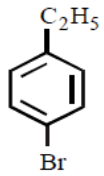
75. Benzene is highly unsaturated but it does not undergo addition reaction because
1) p-electrons of benzene are delocalised.
2) cyclic structures do not show addition reaction
3) benzene is a non-reactive compound 4) All of the above

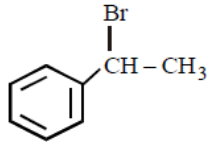
76. Which of the following statements are correct?
(i) Polynuclear hydrocarbons contain two or more benzene rings fused together.
(ii) Polynuclear hydrocarbons have carcinogenic property.
(iii) Polynuclear hydrocarbons are formed on incomplete combustion of organic materials like tobacco, coal and petroleum.
(iv) They are also produced in human body due to various biochemical reactions.
1) (i), (ii) and (iv) 2) (i), (iii) and (iv)
3) (ii), (iii) and (iv) 4) (i), (ii) and (iii)

77. The most reactive among the following towards sulphonation is
1) toluene 2) chlorobenzene 3) nitrobenzene 4) *m*-Xylene

78. Bromination of ethyl benzene in presence of light gives

(a) 

(b) 

(c) 

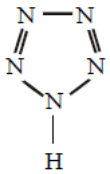
(d) Both (a) and (b)

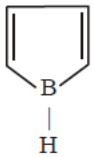
79. During monoalkylation of benzene with CH3Cl in presence of anhydrous AlCl3, an excess of C6H6 must be used because this will
1) increase the chance for collision between CH3+ and C6H6
2) decrease collision between CH3+ and C6H5CH3
3) both 1) and 2) 4) decrease the chance for collision between CH3+ and C6H6.

80. Which of the following is an antiaromatic compound?

(a) 

(b) 

(c) 

(d) 

NEET PREVIOUS YEARS QUESTIONS

1. Hydrocarbon (A) reacts with bromine by substitution to form an alkyl bromide which by Wurtz reaction is converted to gaseous hydrocarbon containing less than four carbon atoms. (A) is

   1) $CH \equiv CH$ 2) $CH_2 = CH_2$ 3) CH_4 4) $CH_3 - CH_3$

2. Which one is the correct order of acidity?

   (a) $CH \equiv CH > CH_3 - C \equiv CH > CH_2 = CH_2 > CH_3 - CH_3$

   (b) $CH \equiv CH > CH_2 = CH_2 > CH_3 - C \equiv CH > CH_3 - CH_3$

   (c) $CH_3 - CH_3 > CH_2 = CH_2 > CH_3 - C \equiv CH > CH \equiv CH$

   (d) $CH_2 = CH_2 > CH_3 - CH = CH_2 > CH_3 - C \equiv CH > CH \equiv CH$

3. With respect to the conformers of ethane, which of the following statements is true?

   1) Bond angle changes but bond length remains same
   2) Both bond angle and bond length change
   3) Both bond angles and bond length remains same
   4) Bond angle remains same but bond length changes

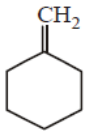
4. In the reaction $H - C \equiv CH \xrightarrow[(2)\,CH_3CH_2Br]{(1)\,NaNH_2\,/\,liq.NH_3} X \xrightarrow[(2)\,CH_3CH_2Br]{(1)\,NaNH_2\,/\,liq.NH_3} Y$ X and Y are

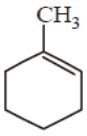
   1) X = 1-Butyne ; Y = 3-Hexyne 2) X = 2-Butyne ; Y = 3-Hexyne
   3) X = 2-Butyne ; Y = 2-Hexyne 4) X = 1-Butyne ; Y = 2-Hexyne

5. The correct statement regarding the comparison of staggered and eclipsed conformation of ethane, is

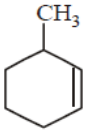
   1) The staggered conformation of ethane is less stable than eclipsed conformation, because staggered conformation has torsional strain
   2) The eclipsed conformation of ethane is more stable than staggered conformation, because eclipsed conformation has no torsional strain
   3) The eclipsed conformation of ethane is more stable than staggered conformation even though the eclipsed conformation has torsional strain
   4) The staggered conformation of ethane is more stable than eclipsed conformation, because staggered conformation has no torsional strain.

6. In the reaction with HCl, an alkene reacts in accordance with the Markovnikov's rule, to give a product -chloro-1-methylcyclohexane. The possible alkene is:

   (a) 

   (b) 

   (c) (a) and (b)

   (d) 

7. 2,3-Dimethyl-2-butene can be prepared by heating which of the following compounds with a strong acid?

   1) $(CH_3)_2 CH - \underset{\displaystyle CH_3}{\underset{|}{CH}} - CH = CH_2$ 2) $(CH_3)_3 C - CH = CH_2$

   3) $(CH_3)_2 C = CH - CH_2 - CH_3$ 4) $(CH_3)_2 CH - CH_2 - CH = CH_2$

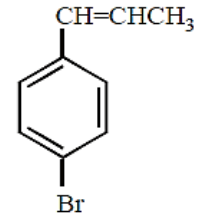
8. The oxidation of benzene by V2O5 in presence of air produces:

   1) Benzoic anhydride 2) Maleic anhydride 3) Benzoic acid 4) Benzaldehyde

9. The reaction of $C_6H_5CH = CHCH_3$ with HBr produces:

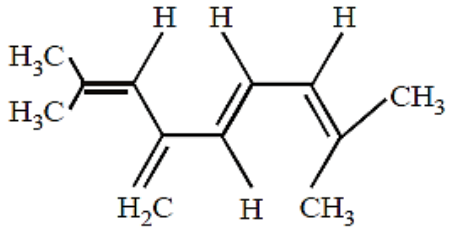
(a) $C_6H_5CH_2\underset{\underset{Br}{|}}{C}HCH_3$

(b) $C_6H_5CH_2CH_2CH_2Br$

(c) 

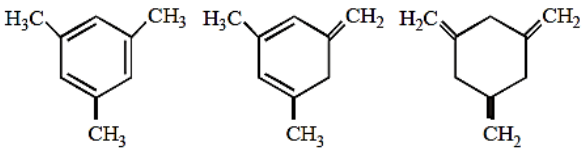
(d) $C_6H_5\underset{\underset{Br}{|}}{C}HCH_2CH_3$

10. The total number of π-bond electrons in the following structure is :-



1)8 2)12 3)16 4)4

11. Given:

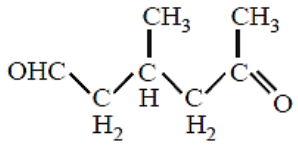


(I) (II) (III)

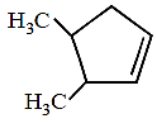
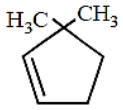
The enthalpy of the hydrogenation of these compounds will be in the order as :-

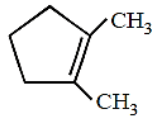
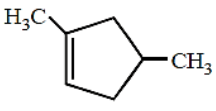
1) III > II > I 2) II > III > I 3) II > I > III 4) I > II > III

12. A single compound of the structure:



is obtainable from ozonolysis of which of the following cyclic compounds?

(a)  (b) 

(c)  (d) 

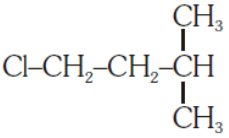
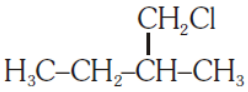
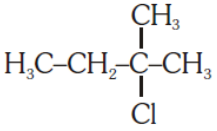
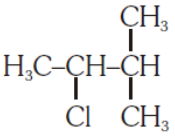
13. Which of the following organic compounds has same hybridization as its combustion product (CO_2)?

1) Ethane 2) Ethyne 3) Ethene 4) Ethanol

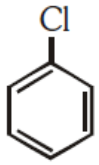
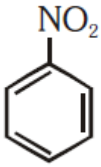
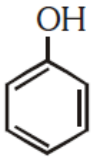
14. The most suitable reagent for the following conversion is :-

(1) Na/liquid NH_3 (2) H_2, Pd/C, quinolone (3) Zn/HCl (4) Hg^{2+}/H^+, H_2O

15. An alkene "A" on reaction with O_3 and $Zn–H_2O$ gives propanone and ethanal in equimolar ratio. Addition of HCl to alkene "A" gives "B" as the major product. The structure of product "B" is :-

(1) 
(2) 
(3) 
(4) 

16. Which of the following compound is most reactive in electrophilic aromatic substitution?

(1) 
(2) 
(3) 
(4) 

17. Which of the following is a free radical substitution reaction?

(1) Benzene with $Br_2/AlCl_3$ (2) Acetylene with HBr
(3) Methane with Br_2/hv (4) Propene with $HBr/(C_6H_5COO)_2$

18. Dihedral angle of least stable conformer of ethane is :

1. 180^0 2. 60^0 3. 0^0 4. 120^0

19. $CH_3CH_2COO^-Na^+ \xrightarrow[Heat]{NaOH,+?} CH_3CH_3 + Na_2CO_3$.

Consider the above reaction and identify the missing reagent/chemical.

1) Red Phosphorus 2) CaO 3) DIBAL-H 4) B_2H_6

20. Compound X on reaction with O_3 followed by Zn/ H_2O gives formaldehyde and 2- methyl propanal as products. The compound X is:

1)3-Methylbut-1-ene 2) 2-Methylbut-1-ene

3) 2-Methylbut-2-ene 4) pent-2-ene

NCERT LINE BY LINE QUESTIONS – ANSWERS

(1.)	a	**(2.)**	d	**(3.)**	d	**(4.)**	d	**(5.)**	c
(6.)	a	**(7.)**	a	**(8.)**	b	**(9.)**	b	**(10.)**	a
(11.)	d	**(12.)**	d	**(13.)**	d	**(14.)**	b	**(15.)**	d
(16.)	d	**(17.)**	b	**(18.)**	b	**(19.)**	d	**(20.)**	a
(21.)	a	**(22.)**	a	**(23.)**	c	**(24.)**	c	**(25.)**	c
(26.)	b	**(27.)**	a	**(28.)**	a	**(29.)**	d	**(30.)**	c
(31.)	d	**(32.)**	c	**(33.)**	d	**(34.)**	c	**(35.)**	a
(36.)	a	**(37.)**	c	**(38.)**	d	**(39.)**	d	**(40.)**	a
(41.)	c	**(42.)**	a	**(43.)**	b	**(44.)**	b	**(45.)**	d
(46.)	a	**(47.)**	c	**(48.)**	b	**(49.)**	b	**(50.)**	b

TOPIC WISE PRACTICE QUESTIONS - ANSWERS

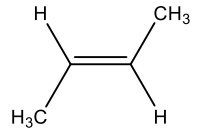
1) 3	**2)** 3	**3)** 4	**4)** 3	**5)** 4	**6)** 3	**7)** 2	**8)** 3	**9)** 3	**10)** 1
11) 3	**12)** 4	**13)** 3	**14)** 4	**15)** 1	**16)** 3	**17)** 1	**18)** 3	**19)** 2	**20)** 2
21) 3	**22)** 2	**23)** 4	**24)** 4	**25)** 3	**26)** 4	**27)** 3	**28)** 1	**29)** 4	**30)** 3
31) 3	**32)** 2	**33)** 4	**34)** 3	**35)** 3	**36)** 3	**37)** 3	**38)** 3	**39)** 2	**40)** 1
41) 1	**42)** 1	**43)** 3	**44)** 1	**45)** 4	**46)** 3	**47)** 2	**48)** 2	**49)** 3	**50)** 1
51) 1	**52)** 4	**53)** 3	**54)** 1	**55)** 2	**56)** 4	**57)** 4	**58)** 4	**59)** 2	**60)** 2
61) 1	**62)** 4	**63)** 4	**64)** 3	**65)** 3	**66)** 1	**67)** 4	**68)** 4	**69)** 1	**70)** 4
71) 1	**72)** 3	**73)** 3	**74)** 3	**75)** 1	**76)** 4	**77)** 4	**78)** 3	**79)** 3	**80)** 4

NEET PREVIOUS YEARS QUESTIONS-ANSWERS

1) 3	**2)** 1	**3)** 3	**4)** 1	**5)** 4	**6)** 3	**7)** 2	**8)** 2	**9)** 4	**10)** 1
11) 1	**12)** 4	**13)** 2	**14)** 2	**15)** 3	**16)** 4	**17)** 3	**18)** 3	**19)** 2	**20)** 1

NCERT LINE BY LINE QUESTIONS – SOLUTIONS

(1.) (a) Alkynes react with strong base like $NaNH_2$ ro form sodium acerylide derivative known as acetylides



trans-2-butene

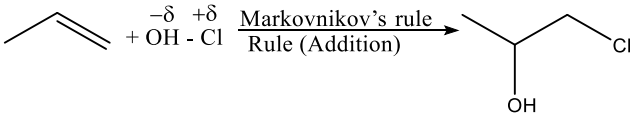
(2.) (d) both methyl group cancel each other so net zero dipole moment exists.

(3.) (d) The molecules which do not satisfy Huckel's Rule or $(4n+2)\pi$ - electrons rule are said to be non-aromatic. The compound (D) has total $4\pi e^-$. It does not follow $(4n+2)$ rule. So, it is non-aromatic compound. Acl other compounds (A, B, C) are planar and have $6\pi e^-$ so, they are aromatic.

(4.) (d) Both II and IV contains $4n\pi e^-$ and hence, anti- aromatic.

(5.) (c) Configurational Isomers

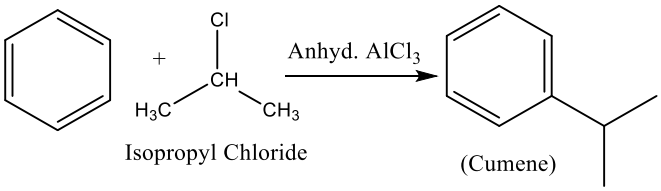
(6.) (a) Acidic strength $\propto$ Electronegativity of carbon $\propto 0\%$ of s-character. So correct order of acidic strength $\underset{sp}{CH \equiv CH} > \underset{sp^3}{CH_3 - C \equiv CH} > \underset{sp^2}{CH_2 = CH_2} > \underset{sp^3}{CH_3 - CH_3}$ Ethyne proton can be released more easily than ethene and ethane due to $+I$ effect of $-CH_3$ group.

(7.) (a) 

(8.) (b) Correct explanation Due to $(+)$ I effect of alkyl group, electron density increases in alkyl benzene relative to benzene and hence further substitution occurs to form a polyalkyl-substituted benzene.

(9.) (b)

(10.) (a) Cyclopemadienyl cation is a planar cyclic system of 4π- electrons and hence is not aromatic but it is anti-aromatic.

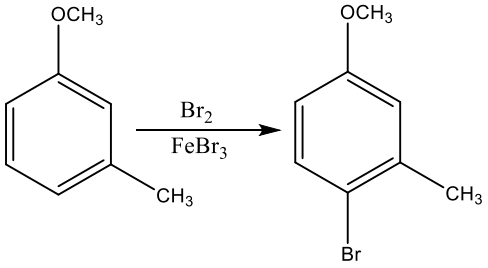


(11.) (d) Friedel-Craft's reaction. Chlorobenzene, bromobenzene and chloroethene are not suitable halide component as the C-X bond acquires some double bond character due to resonance of lone pair of electrons with π bonds.

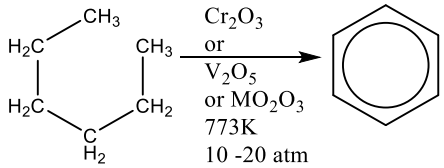
(12.) (d) C_nH_{2n-2}

(13.) (d) $CH \equiv CH \xrightarrow[Catalyft]{Lindlar} CH_2 = CH_2$ Lindlar Catalyst prevents further reduction of ethene to ethane

(14.) (b) Both OCH_3 and CH_3 are o, p-directing groups. The possible positions of attack which are



facilitated both by OCH_3 and CH_3 groups are shown. since, CH_3O group is bulkier than CH_3 so, due to steric hindrance, the reaction does not occur at positions 2 and 6 but instead occurs at position 4.

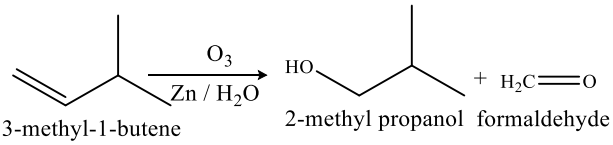
(15.) (d) 

(16.) (d) (A) $\rightarrow$T (Hydration) (B) $\rightarrow$R (Hydrogenation) (C) $\rightarrow$P (Halogenation) (D) $\rightarrow$Q (Polymerisation)

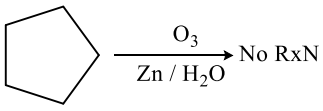
(17.) (b) $CH_3 - \overset{sp}{C} \equiv \overset{sp}{C}$ Thus, pair of electrons is present in sp-hybridised orbital.

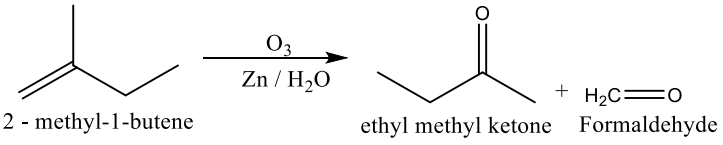
(18.) (b) $CH_3CH_2CH_2Br$ $CH_3CH = CH_2 + HBr \xrightarrow[Anti\ Mark.\ Add\ Rule.]{(C_6H_5CO)_2O_2} CHCH_2CH_2Br$

(19.) (d)

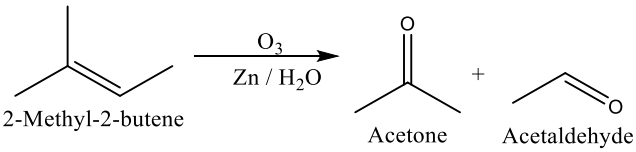


3-methyl-1-butene — 2-methyl propanol — formaldehyde



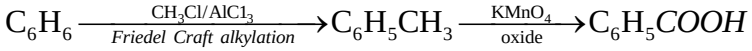


2 - methyl-1-butene — ethyl methyl ketone — Formaldehyde



2-Methyl-2-butene — Acetone — Acetaldehyde

(20.) (a) Benzoic Acid

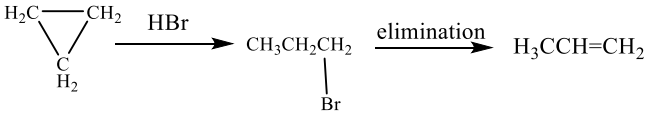


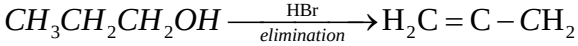
Benzene — *Touluene* — *Benzoic Acid*

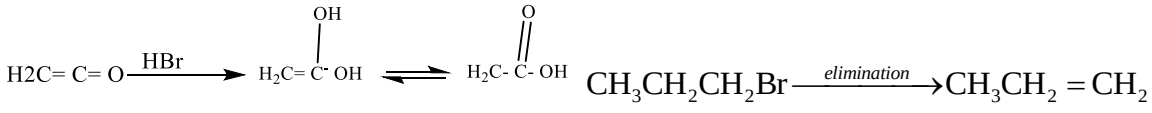
(21.) (a)

(22.) (a) Li/NH_3

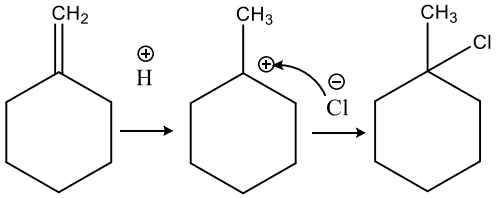
(23.) (c)



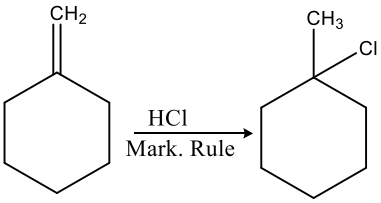


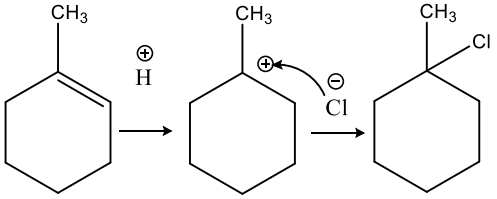


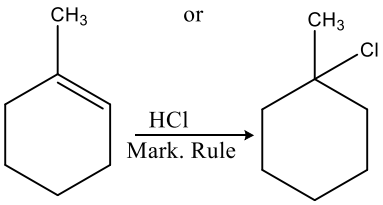
(24.) (c)



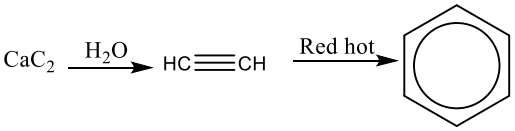
Or







(25.) (c) If large amount of $KHSO_4$ is added concentration of $NO_2^{\oplus}$ will decrease and hence the rate of nitration will be slower. or Mechanism of nitration is $HNO_3 + 2H_2SO_4 \rightarrow NO_2^{\oplus} + 2HSO_4^{\ominus} + H_3O^{\oplus}$ If a large amount of $KHSO_4$ is added then conc. of HSO_4^- ions increases and the reaction will be shifted in a backward direction and rate of nitration will be slower.



Benzene

(26.) (b) Benzene.

(27.) (a)

(28.) (a) enthalpy of hydrogenation $\propto \frac{1}{\text{stability of Alkene}}$ Stability of alkene $I > II > III$ Enthalpy of hydrogenation: $III > II > I$.

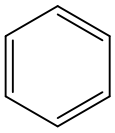
(29.) (d) Addition $HC \equiv CH + 3H_2 \xrightarrow{Ni} CH_3 - CH_3$ Substitution $CH \equiv CH + Na \rightarrow CH \equiv C^-Na^+ + \frac{1}{2}H_2$ Polymerisation $3CH \equiv CH \xrightarrow[Polymerisation]{hot\ Cu\ tube} C_6H_6$

(30.) (c)

(31.) (d) Stability depends on hyperconiugation which further depends on αH.

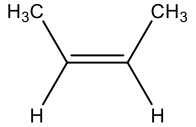
(32.) (c) Pyrolysis and cracking are the same process.

(33.) (d) Benzene can be obtained by all the compounds given.

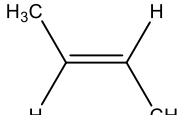
(34.) (c) 12σ and 3π 

(35.) (a)

(36.) (a) Due to restricted rotation about double bond, 2-butene shows geometrical isomerism.

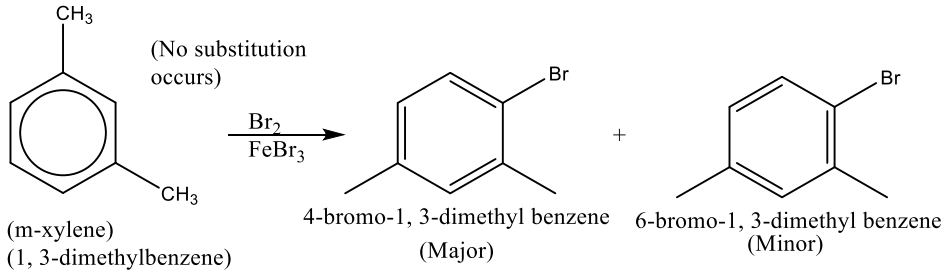


Cis



trans

(37.) (c) $-CH_3$ group is o, p- directing. of crowding, no substitution occurs at the carbon atom between the two $-CH_3$ groups in m- xylene, even though two $-CH_3$ groups activate that position.

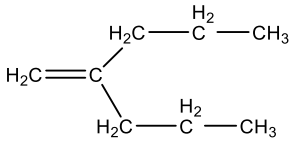


(m-xylene)
(1, 3-dimethylbenzene)

4-bromo-1, 3-dimethyl benzene
(Major)

6-bromo-1, 3-dimethyl benzene
(Minor)

(38.) (d)



23 σ
1 π

(39.) (d) OCH_3 group is a stronger electron donating group than CH_3 group so, $C_6H_5OCH_3$ has the fastest rate of reaction with $Br_2 / FeBr_3$.

(40.) (a) Structure (A) has a cyclic planar system of 2π electrons so, aromatic

(41.) (c)

(42.) (a) 1-Butyne reacts with $NaNH_2$ to give sodium salt while 2-butyne does not react only terminal alkynes are acidic $CH_3 - CH_2 - C \equiv C - H \xrightarrow{NaNH_2} H_3CCHC \equiv CNa + \frac{1}{2}H_2$

1 *Butyne*

$H_3C - C \equiv C - CH_3 \xrightarrow{NaNH_2} No\ Reaction$ Terminal alkyne (1-butyne) reacts with $NaNH_2$ to form sodium acetylide and evolves hydrogen but 2-butyne not.

(43.) (b) In presence of peroxides, only the addition of HBr to unsymmetrical alkenes does not occur according to Markovnikov's rule. Since, alkene (b) is unsymmetrical while alkene (d) is symmetrical. So, correct option (b).

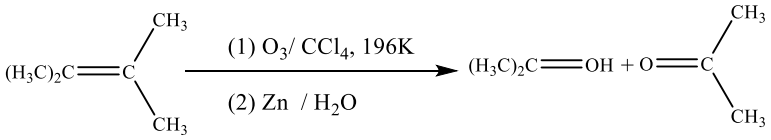
(44.) (b) During catalytic hydrogenation, the hydrogens are transferred from the catalyst to the same side of the double bond. Evidently, smaller the number of R substituents, lesser is the steric

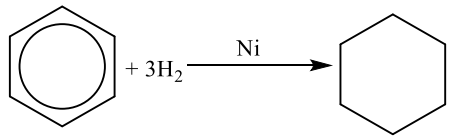
hindrance and hence faster is the rate of hydrogenation. So, option (b) with two R groups on the same side of the molecule is correct.

(45.) (d)

(46.) (a) Iodination is a reversible process so $C_6H_6 + I_2 \rightleftharpoons C_6H_5I + HI$, HI formed is oxidised by HNO_3 to I_2 otherwise HI will reduce C_6H_5I back to C_6H_6.

(47.) (c)





(48.) (b)

(49.) (b) $C_2H_4(CH_2 = CH_2)$ decolourise $KMnO_4$ solution but does not give PPt. with $AgNO_3$ solution.

(50.) (b) Alkenes are unsaturated hydrocarbons having double bond so, it gives addition reaction.

TOPIC WISE PRACTICE QUESTIONS - SOLUTIONS

1. (3) Other three methods can be used for the preparation of alkane having at least two carbon atoms.
2. (3)
3. (4)
4. (3) Order of stability : staggered anti > gauche > skew boat > eclipsed.
5. (4)
6. (3)
7. (2) Dehydrohalogenation of an alkyl halide gives an alkene
8. (3)
9. 3)

$$(1)\ CH_3\boxed{Cl + 2Na + Cl} - CH_3 \rightarrow \underset{\text{Ethane}}{CH_3 - CH_3}$$

$$(2)\ CH_3\boxed{Cl + 2Na + Cl} - CH_2 - CH_3 \rightarrow \underset{\text{Propane}}{CH_3 - CH_2 - CH_3}$$

$$(3)\ CH_3 - CH_2\boxed{Cl + 2Na + Cl} - CH_2 - CH_3 \rightarrow \underset{\text{Butane}}{CH_3 - CH_2 - CH_2 - CH_3}$$

10. (1) Electrolysis of a concentrated aqueous solution of either sodium or potassium salts of saturated monocarboxylic acids yields higher alkane at anode.

$$2RCOOK \xrightarrow[\text{Oxidation}]{\text{Electrolytic}} \underset{\text{Anode}}{2RCOO^-} + \underset{\text{Cathode}}{2K^+}$$

At anode

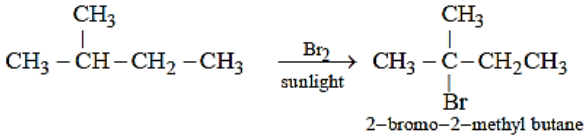
$$2RCOO^- \rightarrow 2RCOO + 2e^- \longrightarrow R - R + 2CO_2$$

At Cathode $2K^+ + 2e^- \rightarrow 2K$

$$2K + H_2O \rightarrow 2KOH + H_2\uparrow$$

(Kolbe's Method)

11. 3)

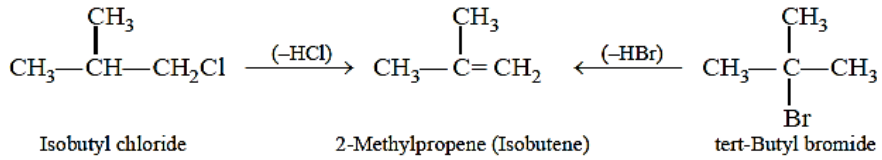


2–bromo–2–methyl butane

Ease of replacement of H-atom 3° > 2° > 1°.

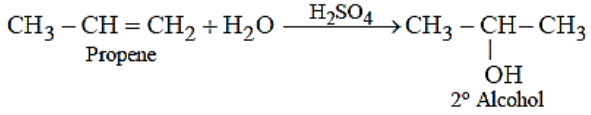
12. 4) Spatial arrangements of atoms which can be converted around a C – C single bond are called conformations or conformers or rotamers.
13. 3)
14. 4) Bromine is less reactive than chlorine and hence more selective, leading to the formation of the product corresponding to 3° free radical, *i.e. tert*-butyl bromide.
15. 1) Complete combustion of all organic compounds leads to formation of $CO_2 + H_2O$.
16. 3) Pyrolysis and cracking are same process.
17. 1) Natural gas is a mixture of CH_4, C_2H_6 and C_3H_8.
18. 3)
19. 2) Eclipsed form has maximum torsional strain, while staggered form has the least.
20. 2) Heptan-4-ol has similar alkyl group on both ends of the carbon atom bearing –OH group, hence dehydration of alcohol will form only one alkene, not a mixture of two alkenes

21. 3)

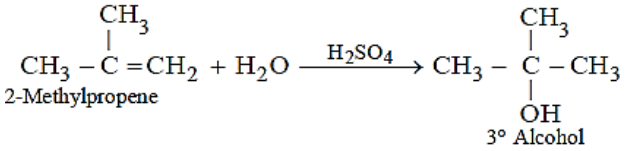


Isobutyl chloride — 2-Methylpropene (Isobutene) — tert-Butyl bromide

22. 2)
23. 4) $CH_2 = CH - CH = CH_2$
1, 3-Butadiene
24. 4)Allene is $H_2C = C = CH_2$
25. 3)
26. 4)
27. 3)



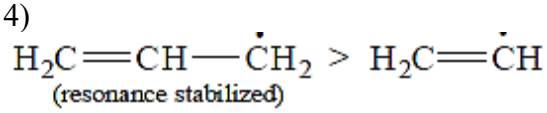
Propene — 2° Alcohol



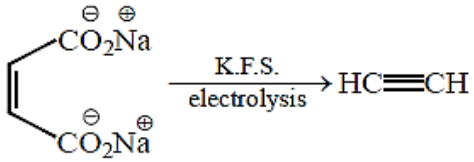
2-Methylpropene — 3° Alcohol

Addition follows Markownikoff's rule.

28. 1) Alkenes are unsaturated hydrocarbon having double bond so generally gives addition reactions.
29. 4)



30. 3) Hydroboration – oxidation reaction.
31. 3)



32. 2) Hydroboration - oxidation reaction is a syn-addition.

33. (4) Corresponding alkene is not possible.

34. (3) The given molecular formula suggests that the aldehyde formed will be acetaldehyde hence the alkene will be

$$CH_3CH = CH - CH_3 \xrightarrow[(ii)\ Zn/H_2O]{(i)\ O_3} 2CH_3CHO$$

35. 3) $CH_3CH = CH_2 \xrightarrow[H_2O_2, NaOH]{B_2H_6} CH_3CH_2CH_2OH$

36. (3) By adding bromine water to a solution, if the colour of bromine water decolourises then the compound is unsaturated. This is a confirmatory test for unsaturation.

37. 3) $CH_2 = CH_2 + HOCl \rightarrow \underset{CH_2Cl}{\overset{CH_2OH}{|}} \xrightarrow[R]{NaHCO_3} \underset{CH_2OH}{\overset{CH_2OH}{|}}$

38. 3)

39. 2)

$$CH_3 - CH = CH_2 + H_2O \xrightarrow[\text{Markonikoff's rule}]{\text{Conc. } H_2SO_4}$$

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

Isopropyl alcohol

40. 1)

$$R - CH_2 - CH_2OH \xrightarrow[350°C-380°C]{Al_2O_3}$$

$$R - CH = CH_2 + H_2O$$

While at 220 °C – 250 °C it forms ether

41. (1)

42. (1) The p bond is formed by the sideways overlapping of two *p*-orbitals of the two carbon atoms. The molecular plane does not have any p electron density as the *p*-orbitals are perpendicular to the plane containing the ethene molecule. The nodal plane in the p-bond of ethene is located in the molecular plane.

43. (3)

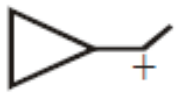
44. 1)

$$\underset{CH_2}{\overset{CH_2}{\|}} + H_2SO_4 \rightarrow \underset{CH_2HSO_4}{\overset{CH_3}{|}} \xrightarrow{H_2O} \underset{CH_2OH}{\overset{CH_3}{|}} + H_2SO_4$$

Except ethyl alcohol, no other primary alcohol can be prepared by this method as the addition of H_2SO_4 follows Markownikoff's rule. Generally secondary and tertiary alcohols are obtained.

45. (4) Rate of electrophilic addition $\propto$ Nucleophilicity of alkene μ stability of carbocation, so order IV > I > II > III.

46. (3)



is stable carbocation due to presence of s-resonance so it will not rearrange.

47. (2) Three alkynes are possible for the formula C_5H_8.

$CH_3CH_2CH_2C \equiv CH$

$CH_3-\underset{\displaystyle CH_3}{\underset{|}{CH}}-C \equiv CH$

$CH_3CH_2C \equiv CCH_3$

48. 2)

49. 3) On heating ethylene chloride (1, 1-dichloroethane) with alcoholic potash followed by sodamide alkyne is obtained

$$R-CH_2-CCl_2-R \xrightarrow{\text{alc.KOH}} R-CH=CCl-R$$

$$\xrightarrow{NaNH_2} R-C \equiv C-R$$

50. 1)

51. 1) Acetylene reacts with the other three as:

$$CH \equiv CNa \xleftarrow[\text{liq. } NH_3]{Na} CH \equiv CH \xrightarrow{+HCl} \underset{\displaystyle CHCl}{\overset{\displaystyle CH_2}{\overset{\|}{\underset{|}{}}}}$$

$$\xrightarrow{+HCl} \underset{\displaystyle CHCl_2}{\overset{\displaystyle CH_3}{\underset{|}{\overset{|}{}}}}$$

$$CH \equiv CH \xrightarrow{[AgNO_3+NH_4OH]} \underset{\text{white ppt.}}{AgC \equiv CAg} + NH_4NO_3$$

52. 4)

53. 3)

$$CH_3-\underset{\displaystyle Cl}{\underset{|}{CH}}-CH_3 + CH_3C \equiv C^-Na^+ \longrightarrow$$

$$\underset{\text{Propene}}{CH_3-CH=CH_2} + \underset{\text{Propyne}}{CH_3C \equiv CH} + NaCl$$

54. (1) Terminal alkynes give a white precipitate easily on reaction with ammonical silver nitrate solution.

55. 2)

$$CH \equiv CH + H_2O \xrightarrow[HgSO_4.60\,^\circ C]{dil.H_2SO_4}$$

$$[CH_2=CHOH] \longrightarrow CH_3CHO$$

56. (4) In 1-butyne terminal hydrogen is acidic where as in 2-butyne there is no terminal hydrogen. Thus 2-butyne will not react with ammonical Cu_2Cl_2. While 1-butyne, being terminal alkyne, will give red ppt. with ammonical cuprous chloride

57. (4)

58. (4)

59. (2) Thin film of polyacetylene can be used as electrodes in batteries. These films are good conductors, lighter and cheaper than the metal conductors.

60. (2) $CH_3C \equiv CCH_3$, being symmetrical, has the lowest dipole moment

61. (1)

62. (4)

63. (4) All alkyne on catalytic hydrogenation give 3-ethylhexane.

64. (3)

65. 3)

$$CH \equiv CH + H - CN \xrightarrow{Ba(CN)_2} \underset{\text{Vinyl cyanide}}{CH_2 = CHCN}$$

66. (1) Ethylene has restricted rotation, acetylene has no rotation, hexachloroethane has more rotation than ethylene but less than ethane because of greater size of the substituent (chlorine) in hexachloroethane than in ethane (substituent is hydrogen).

67. (4)

68. (4)

69. (1) The acidity of acetylene or 1–alkyne can be explained on the basis of molecular orbital concept according to which formation of C—H bond in acetylene involves *sp*-hybridised carbon atom. Now since s electrons are closer to the nucleus than *p* electrons, the electrons present in a bond having more *s* character will be correspondingly more closer to the nucleus. Thus owing to high *s* character of the C—H bond in alkynes (*s* = 50%), the electrons constituting this bond are more strongly held by the carbon nucleus i.e., the acetylenic carbon atom or the *sp* orbital acts as more electronegative species than the sp^2 and sp^3 with the result the hydrogen present on such a carbon atom (ºC—H) can be easily removed as a proton.

70. 4)

71. 1)

72. 3)

73. 3) $C_6H_6 + CH_2 = CH_2 \xrightarrow{AlCl_3} C_6H_5CH_2CH_3$

74. 3)

75. (1) π-Electrons of benzene rings are delocalised throughout the molecule. This makes the molecule very stable. The stability resists breaking of double bonds for addition.

76. (4) Polynuclear hydrocarbons are not produced in human body by any biochemical reaction. However, when they enter into human body they undergo various biochemical reactions which finally damage DNA and cause cancer.

77. (4)

78. (3) Bromination in presence of light leads to side chain substitution. For nuclear substitution we require halogen carrier.

79. (3)

80. (4)

NEET PREVIOUS YEARS QUESTIONS-EXPLANATIONS

1. 3) $CH_4 \xrightarrow[hv]{Br_2} CH_3 - Br \xrightarrow[ether]{Na} \underset{\text{(less than four 'C')}}{CH_3 - CH_3}$

Only one central metal atom/ion is present and it follows EAN rule, so it is mononuclear.

2. 1) Correct order is

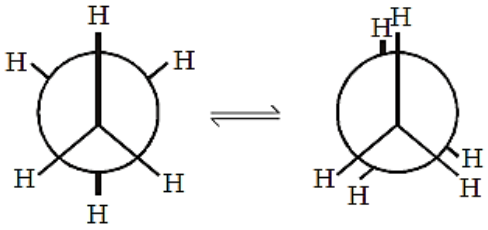
$$\underset{\text{(Two acidic hydrogens)}}{H-C\equiv C-H} > \underset{\text{(One acidic hydrogen)}}{H_3C-C\equiv C-H} > H_2C=CH_2 > CH_3-CH_3$$

3. (3) There is no change in bond angles and bond lengths in the conformations of ethane.

4. 1)

$$HC\equiv CH \xrightarrow[liq.\ NH_3]{NaNH_2} HC\equiv C^{\ominus}Na^{\oplus} \xrightarrow{H_3C-CH_2-Br} \underset{\text{(X) 1-Butyne}}{HC\equiv C-CH_2-CH_3} \xrightarrow[liq.\ NH_3]{NaNH_2} H_3C-CH_2-C\equiv C^{\ominus}Na^{\oplus} \xrightarrow{H_3C-CH_2-Br} \underset{\text{3-Hexyne}}{H_3C-CH_2-C\equiv C-CH_2-CH_3}$$

5. 4) In stggered conformation any two hydrogen atoms on adjacent carbon atoms are as far apart as possible thereby minimising repulsion between the electron clouds of σ-bonds of two non-bonded H-atomic (torsional strain)

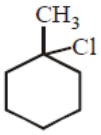


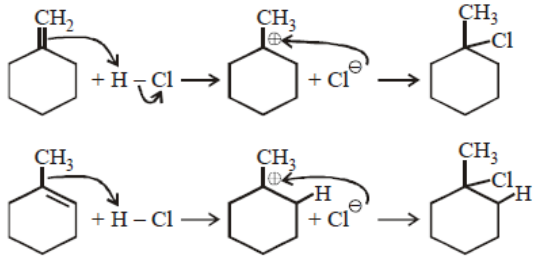
Staggered form Eclipsed form

No torsional strain

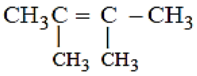
6. 3)

1-chloro-1-methylcyclohexane.



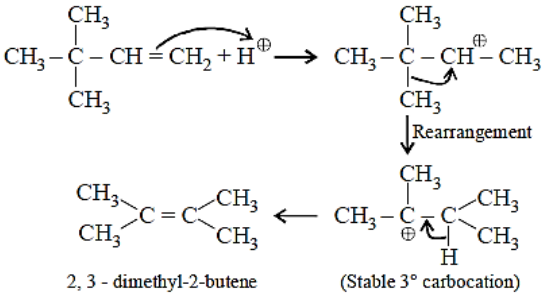


7. 2)



2,3-Dimethyl-2-butene

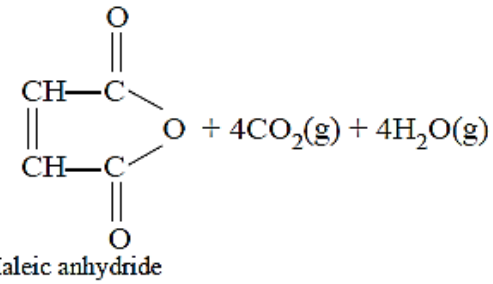
$(CH_3)_2CH-\underset{\displaystyle CH_3}{\underset{|}{CH}}-CH=CH_2$ contain 7 carbon atoms



2, 3 - dimethyl-2-butene (Stable 3° carbocation)

8. 2)

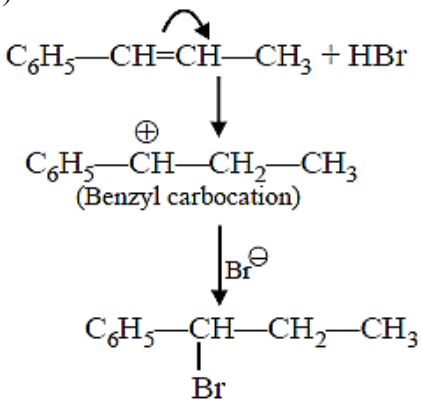
$$2C_6H_6(g) + 9O_2(g) \xrightarrow[410°C]{V_2O_5}$$



$+ 4CO_2(g) + 4H_2O(g)$

Maleic anhydride

9. 4)



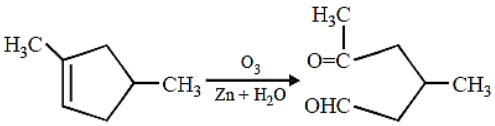
10. (1) No. of double bonds = 4
No. of π bond electrons = 2 × no. of double bond = 2 × 4 = 8

11. 1) Enthalpy of hydrogenation

$$\propto \frac{1}{\text{stability of alkene}}$$

$\therefore$ III > II > I

12. 4)

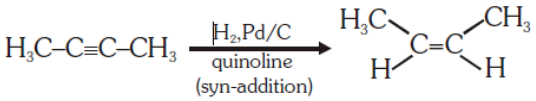


13. 2) The combustion reaction of ethylene is

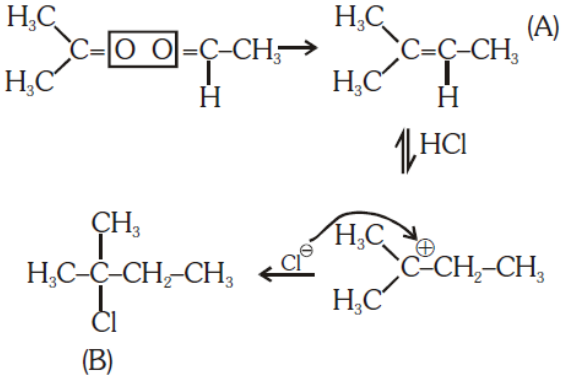
$$C_2H_2 + \frac{5}{2}O_2 \rightarrow 2CO_2 + H_2O$$

Both HC≡CH and CO_2 have *sp* hybridization.

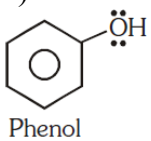
14. 2)



15. 3)



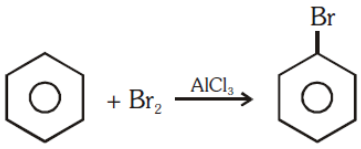
16. 4)



Phenol

+ R effect of -OH group enhances the reactivity inaromatic electrophilic substitution reaction.

17. 3)



(Aromatic electrophilic substitution)

$HC\equiv CH \xrightarrow{HBr} CH_2=CH-Br$

(Electrophilic addition)

$CH_4+Br_2 \xrightarrow{h\nu} CH_3-Br+HBr$

(Free radical substitution)

$CH_3-CH=CH_2+HBr \xrightarrow{(C_6H_5COO)_2} CH_2(Br)-CH(H)-CH_2$

(Free radical addition)

18. 3)Dihedral angle of least stable conformer of ethane at 0^0

19. 2) $CH_3CH_2COO^-Na^+ \xrightarrow[CaO/\Delta]{NaOH} CH_3CH_3 + Na_2CO_3$

$NaOH + CaO \rightarrow$ Sodalime .

20. 3-Methylbut-1-ene l