

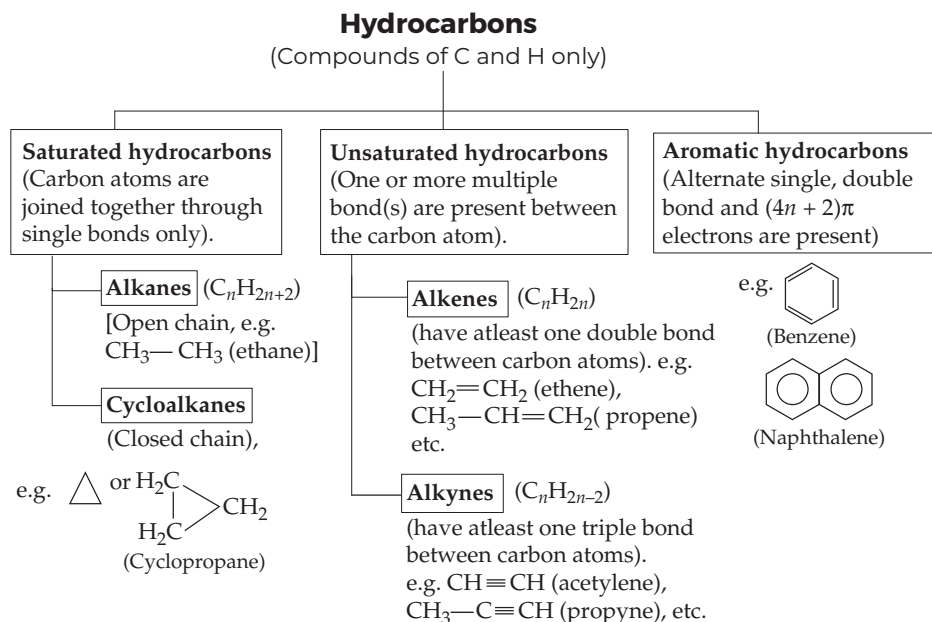
# Hydrocarbons

## KEY NOTES

**Hydrocarbons** are the compounds of carbon and hydrogen. They are obtained from coal and petroleum.

### Classification

Hydrocarbons are classified into three main categories, i.e. saturated (C—C and C—H single bonds), unsaturated (C—C multiple bonds—double and triple) and aromatic hydrocarbons.



### Alkanes

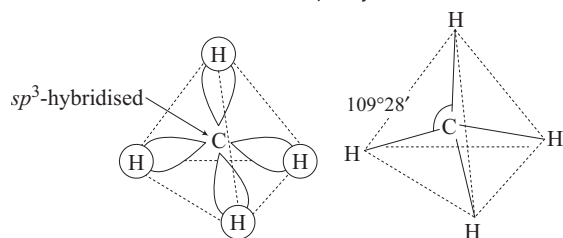
- Alkanes are **saturated** open chain hydrocarbons containing C—C single bonds.
- The general formula is  $C_nH_{2n+2}$ .
- In alkanes, tetrahedra are joined together in which C—C and C—H bond lengths are 154 pm and 112 pm respectively.

## Nomenclature and Isomerism

- Steps to be followed while writing IUPAC names are as follows :
  - First of all, the longest chain of carbon atoms corresponding to the parent alkane is identified.
  - The substituents attached to the carbon atoms are numbered such that the branched C atoms get the lowest possible numbers.
  - The substituents are written in alphabetical order before the name of parent alkane.
- The phenomenon in which hydrocarbons possess same molecular formula but different structures is known as **isomerism**.
- Alkanes show structural position and chain isomerism. Difference in properties is due to difference in their structures and chain of carbon atoms.
- Based upon the number of carbon atoms attached to a carbon atom, the carbon atom is termed as primary (1°), secondary (2°), tertiary (3°) or quaternary (4°).
- Terminal carbon atoms are primary. Carbon attached to two carbon atoms is known as secondary. Tertiary C is attached to three carbon atoms and quaternary C to four C atoms.

## Structure

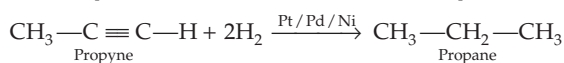
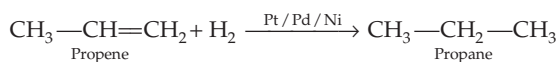
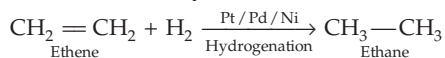
All the C-atoms in alkanes are  $sp^3$ -hybridised.



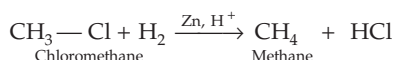
Structure of methane ( $\text{CH}_4$ ) molecule

## Preparation of Alkanes

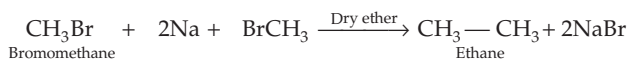
- From unsaturated hydrocarbons**



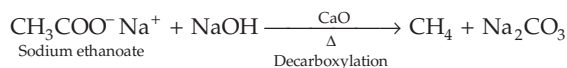
- From alkyl halides**



- Wurtz reaction**



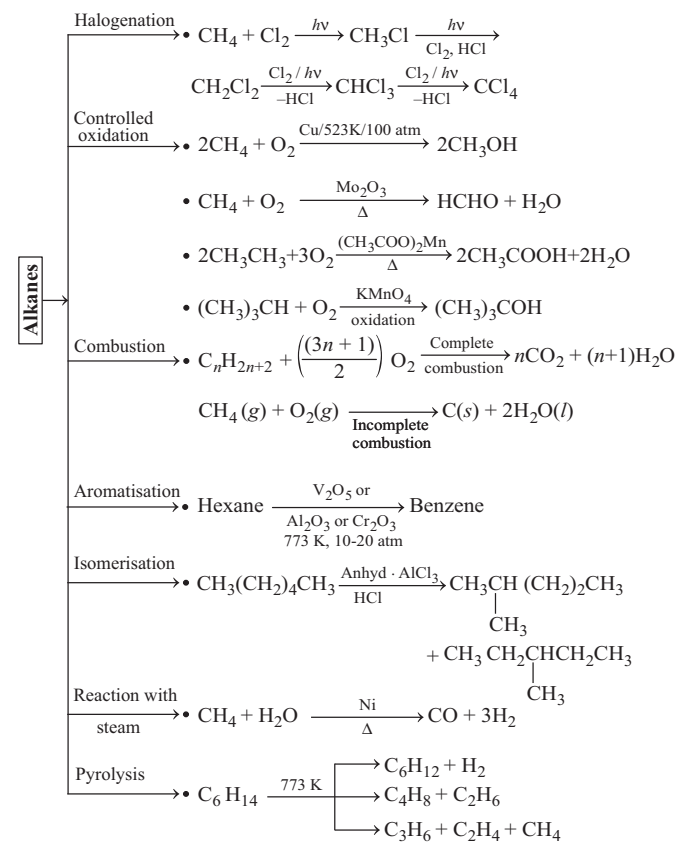
- From carboxylic acids**



## Physical Properties

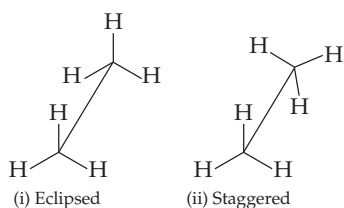
- Alkanes are **non-polar** molecules.
- Due to the weak forces, the first four members,  $\text{C}_1$  to  $\text{C}_4$  are **gases**.  $\text{C}_5$  to  $\text{C}_{17}$  are **liquids** and those containing 18 carbon atoms or more are **solids** at 298 K
- Alkanes possess weak van der Waals' forces.
- Alkanes are **colourless** and **odourless**.
- Boiling point** of alkanes increases with increase in molecular mass.

## Chemical Reactions of Alkanes

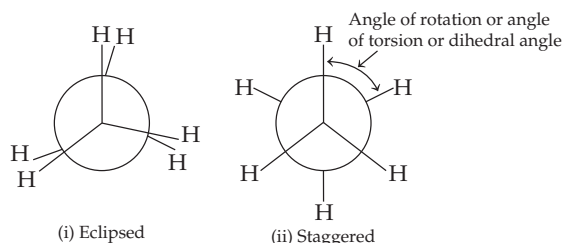


## Conformations of Ethane

- Electron distribution of the sigma MO in alkane is symmetrical which is not disturbed due to rotation about its axis. The rotation results into different spatial arrangements of atoms in space which can change into one another. These are called conformations or **conformers** or **rotamers**.
- There are infinite number of conformations of ethane.
- The two extreme cases are : **eclipsed** (hydrogen atoms attached to two carbons are as close together as possible) and **staggered** (hydrogens are as far apart as possible).
- Any other intermediate conformation is called a **skew conformation**. Eclipsed and staggered conformations can be represented by **Sawhorse** and **Newmann projections** as shown below :



Sawhorse projection of ethane



Newmann projection of ethane

## Relative Stability of Conformations

- In staggered form of ethane, the electron clouds of C—H bonds are as far apart as possible and have minimum repulsive forces.
- The repulsive interaction between the electron clouds, which affects stability of conformation is called **torsional strain**.
- Magnitude of torsional strain depends upon the angle of rotation about C—C bond. This angle is called **dihedral angle** or **torsional angle**.
- Out of staggered and eclipsed conformations of ethane, staggered conformation is more stable as H-atoms are farthest.

## Alkenes

Alkenes are unsaturated hydrocarbons containing at least one double bond having general formula  $C_nH_{2n}$ .

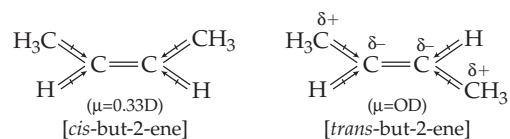
Alkenes are also known as olefins, since the first member, ethylene or ethene was found to form an oily liquid.

## Nomenclature

- For nomenclature of alkenes in IUPAC system, the longest chain of carbon atoms containing the double bond is selected.
- Numbering is done from the end which is nearer to double bond. The suffix 'ene' replaces 'ane'.

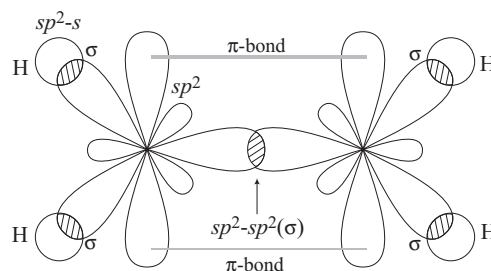
## Isomerism

- Alkanes show both structural and geometrical isomerism.
- Alkenes exhibit **geometrical (cis-trans) isomerism** due to restricted rotation around the C—C double bond.
- *cis*-form of alkene is found to be more polar than *trans*-form because dipole moment of *trans*-form is almost zero.



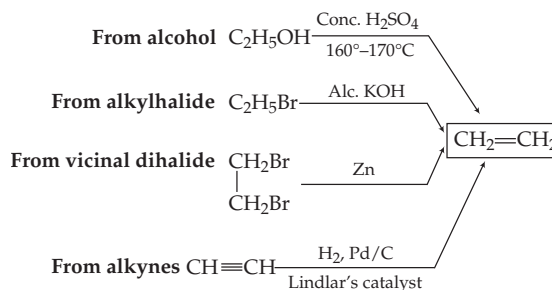
## Structure of Double Bond

- Carbon-carbon double bond in alkenes consists of one strong sigma ( $\sigma$ ) bond due to head on overlapping of  $sp^2$ -hybridised orbitals and one weak pi ( $\pi$ ) bond obtained by lateral or sideways overlapping of the two  $2p$ -orbitals of the two carbon atoms.
- The double bond is shorter in bond length (134 pm) than the C—C single bond (154 pm).



## Preparation of Alkene

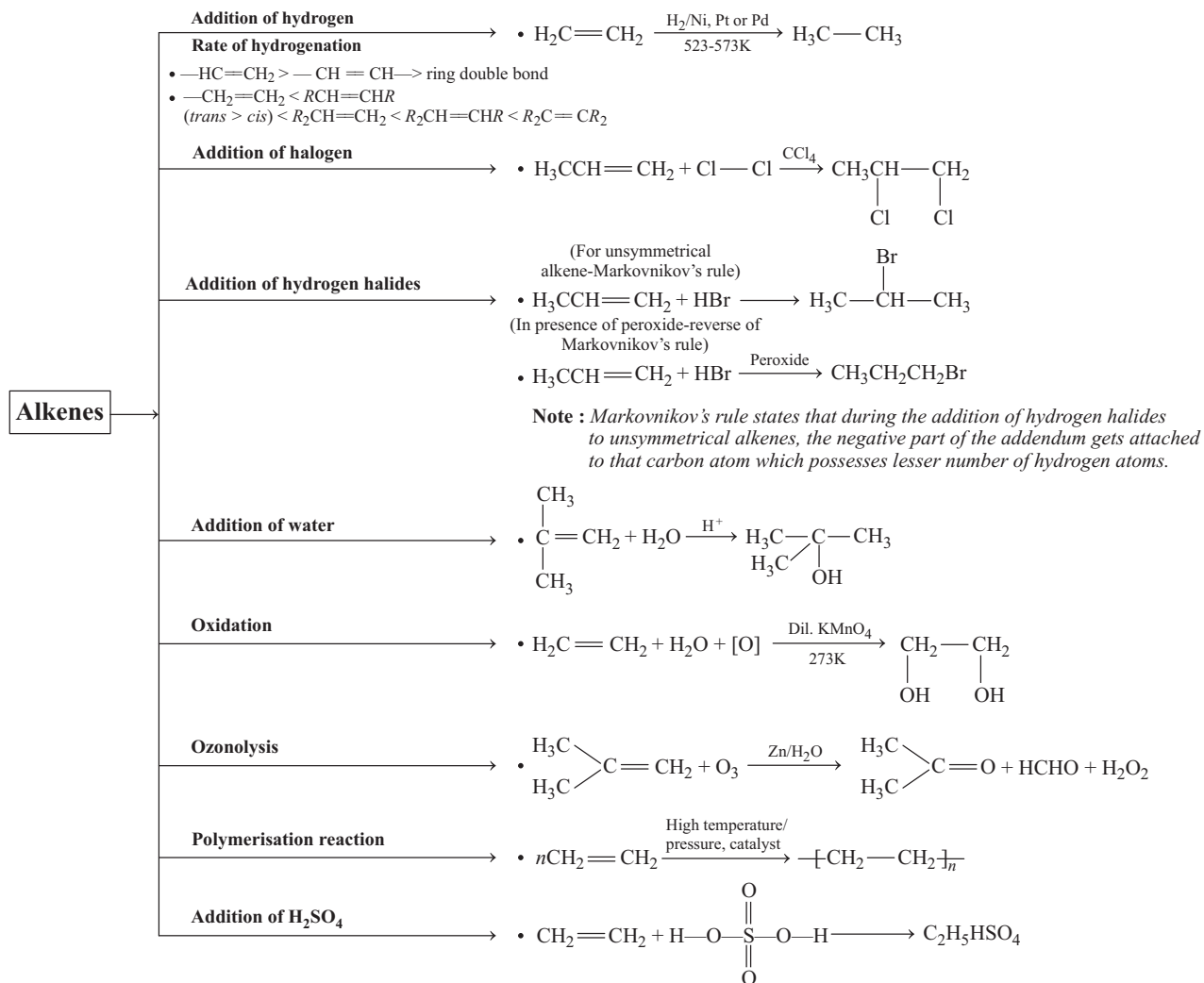
It can be summarised as follows :



## Physical Properties

- First three members are **gases**, the next fourteen are **liquids** and higher ones are **solids**.
- Other alkenes are colourless and odourless, insoluble in water but fairly soluble in non-polar solvents.
- They show a regular increase in **boiling point** with increase in size.

## Chemical Properties



## Alkynes

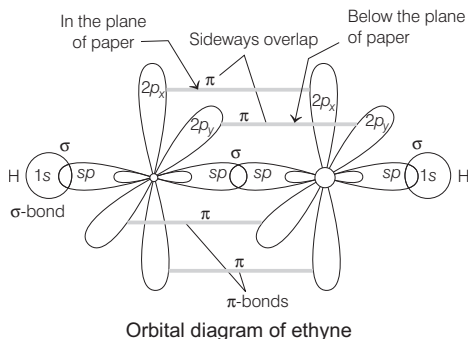
Alkynes are unsaturated hydrocarbons that contain at least one triple bond between two carbon atoms. Their general formula is  $\text{C}_n\text{H}_{2n-2}$ .

### Nomenclature and Isomerism

- In IUPAC system, they are named as derivatives of the corresponding alkanes replacing 'ane' by the suffix 'yne'.
- These generally show position isomerism. Here, two compounds differ in their structures due to the position of triple bond.

## Structure of Triple Bond

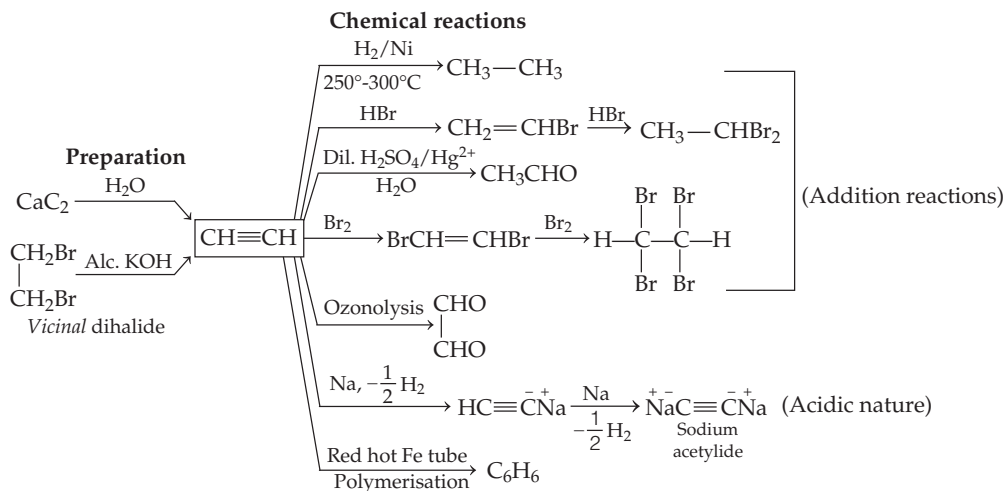
- Each carbon atom of ethyne has two  $sp$ -hybridised orbitals.
- C—C ( $\sigma$ ) bond is obtained by the head on overlapping of two  $sp$ -hybridised orbitals of two carbon atoms.
- The remaining  $sp$ -hybridised orbital of each carbon atom undergoes overlapping along the internuclear axis with  $1s$ -orbital of each of the two hydrogen atoms forming two C—H sigma bonds.
- $2p$ -orbital of one carbon atom is parallel to the  $2p$ -orbital of other carbon atom.
- These orbitals undergo lateral or sideways overlapping to form two  $\pi$  bonds between two carbon atoms.
- Ethyne molecule consists of one C—C  $\sigma$  bond, two C—H  $\sigma$  bonds and two C—C  $\pi$  bonds as shown below :



## Physical Properties of Alkynes

- First three members are **gases**, next eight are **liquids** and higher ones are **solids**.
- All alkynes are **colourless**.
- These are weakly polar in nature.
- They are lighter than  $H_2O$  and immiscible with water but soluble in organic solvent.
- Their melting and boiling point increases with increase in molar mass.

## Preparation and Chemical Reactions of Alkynes



## Aromatic Hydrocarbons

- Aromatic hydrocarbons, also known as **arenes**, were found to contain benzene ring (highly unsaturated).
- Aromatic compounds containing benzene ring are known as **benzenoids** and those not containing a benzene ring are known as **non-benzenoids**.

## Nomenclature and Isomerism

- In IUPAC nomenclature, the substituent is placed as prefix to the word benzene.
- When two hydrogen atoms in benzene are replaced by two similar or different monovalent atoms or groups, three different position isomers are possible.
- The 1, 2 or 1, 6 is known as the *ortho* (*o*-), the 1, 3 or 1, 5 as *meta* (*m*-) and the 1, 4 as *para* (*p*-) disubstituted compounds.

## Structure of Benzene

- Kekule suggested the structure of benzene by the concept of oscillating nature of double bonds as shown below :



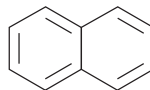
- Benzene has **unusual stability due to resonance**.
- X-ray diffraction data reveals that benzene is a planar molecule. C—C bond length is intermediate between C—C single bond and C=C double bond.
- For a compound to be aromatic, it must possess the following characteristics :
  - Planarity
  - Complete delocalisation of the  $\pi$ -electrons in the ring.
  - Presence of  $(4n + 2)$   $\pi$  electrons in the ring, where  $n$  is an integer ( $n = 0, 1, 2, \dots$ )
- Examples of a few aromatic compounds are given below :



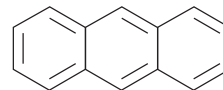
Benzene  
 $n = 1$   
 $6\pi$ -electrons



Cyclopentadienyl anion  
 $n = 1$   
 $6\pi$ -electrons



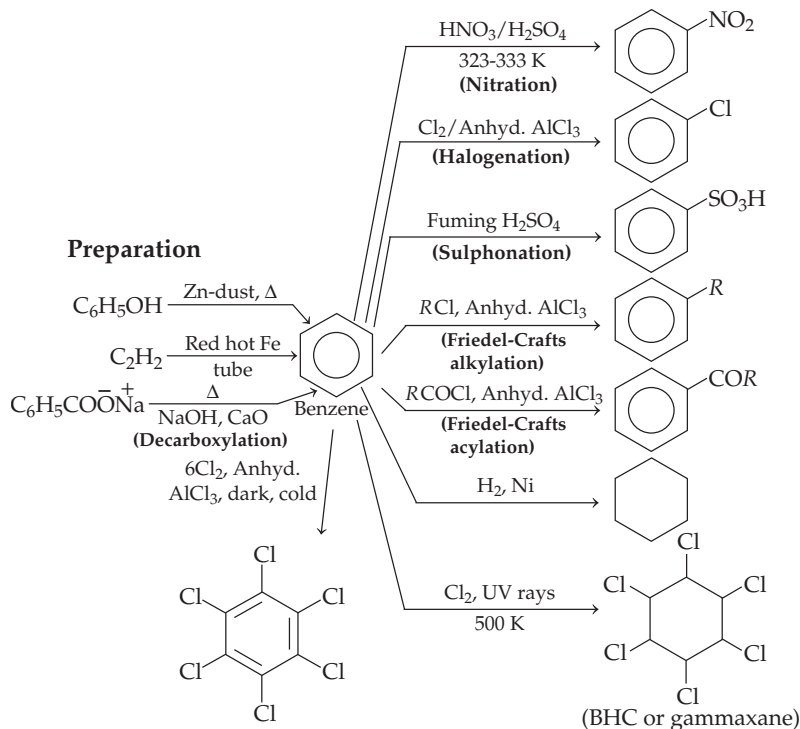
Naphthalene  
 $n = 2$   
 $10\pi$ -electrons



Anthracene  
 $n = 3$   
 $14\pi$ -electrons

## Preparation and Chemical Reactions of Benzene

### Chemical reactions



### Physical Properties

- These are non-polar molecules and are colourless liquids or solids.
- These are immiscible with water but are readily miscible with organic solvents.

### ortho and para-directing Groups

- The groups, e.g.  $-\text{OH}$ ,  $-\text{NH}_2$ ,  $-\text{NHR}$ ,  $-\text{NHCOCH}_3$ ,  $-\text{OCH}_3$ ,  $-\text{CH}_3$ ,  $-\text{C}_2\text{H}_5$  etc. are called *ortho* and *para*-directing as well as activating groups.
- They activate benzene ring towards electrophilic substitution.

**Exception** Halogens are deactivating but they are *ortho* and *para* directing groups.

### meta-directing Groups

- The groups, e.g.  $-\text{NO}_2$ ,  $-\text{CN}$ ,  $-\text{CHO}$ ,  $-\text{COR}$ ,  $-\text{COOH}$ ,  $-\text{COOR}$ ,  $-\text{SO}_3\text{H}$  etc., are called *meta*-directing as well as deactivating groups.
- They reduce the electron density in the benzene ring due to its strong  $-I$ -effect.

### Carcinogenicity and Toxicity

- Benzene and polynuclear hydrocarbons containing more than two benzene rings fused together are toxic and said to possess cancer producing (carcinogenic) property.
- They enter into human body and damage DNA.

# Mastering NCERT

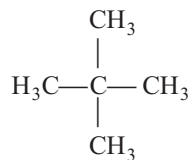
## MULTIPLE CHOICE QUESTIONS

### TOPIC 1 ~ Classification

- 1 Which of the following is obtained by the liquefaction of natural gas?  
(a) CNG (b) LNG  
(c) Petrol (d) None of these
- 2 Which of the following is obtained by the distillation of petroleum?  
(a) Petrol (b) Diesel  
(c) Kerosene oil (d) All of these
- 3 If different carbon atoms are joined together to form an open chain of carbon atoms with single bond only in a compound, then such compounds are termed as  
(a) alkenes (b) alkynes  
(c) benzene (d) alkanes
- 4 The compound in which the C-atoms form a closed chain are termed as  
(a) aliphatic hydrocarbons (b) cycloalkanes  
(c) alkanes (d) alkenes
- 5 What type of compounds are aromatic compounds ?  
(a) Cyclic compounds  
(b) Aliphatic compounds  
(c) Saturated compounds  
(d) All of the above

### TOPIC 2 ~ Alkanes

- 6 Alkanes are known as paraffins because they  
(a) are inert under normal conditions  
(b) they do not react with acids, bases and other reagents  
(c) Both (a) and (b)  
(d) None of the above
- 7 According to VSEPR theory, which of the following structure is exhibited by methane?  
(a) Triangular planar (b) Square bipyramidal  
(c) Linear (d) Tetrahedral
- 8 How many chain isomers can be formed by butane?  
(a) One (b) Three  
(c) Two (d) Four
- 9 The given structures,  
$$\begin{array}{c} \text{CH}_3 \\ | \\ \text{CH}_3 - \text{CH} - \text{CH}_3 \end{array}$$
 and  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$  are  
(a) conformational isomers (b) chain isomers  
(c) position isomers (d) functional isomers
- 10 The number of chain isomers of  $\text{C}_7\text{H}_{16}$  are  
(a) 9 (b) 4 (c) 6 (d) 7
- 11 In how many ways you can join five C-atoms and twelve H-atoms of  $\text{C}_5\text{H}_{12}$ ?  
(a) One (b) Two (c) Three (d) Four
- 12 The IUPAC name of the following compound is



- (a) 1-methylisobutane (b) 2, 2-dimethylbutane  
(c) 2, 2-dimethylpropane (d) 2-methylisobutane

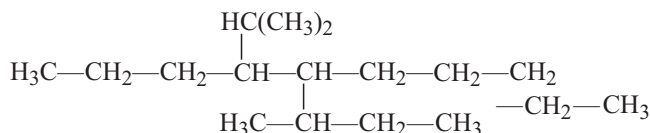
**13** Possible structural isomers for  $\text{C}_6\text{H}_{14}$  are

- (a) 4 (b) 9  
(c) 22 (d) 5

**14** The IUPAC name of  $\text{CH}_3-\overset{\text{CH}_3}{\underset{|}{\text{CH}}}-\text{CH}_2\text{CH}_2\text{CH}_3$  is

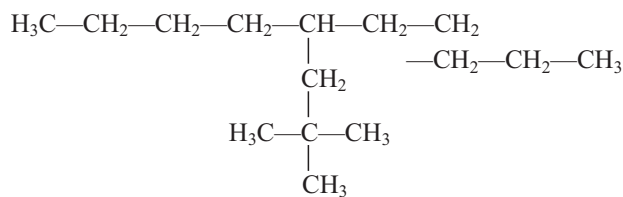
- (a) *n*-hexane  
(b) 2-methylpentane  
(c) 4-methylpentane  
(d) 3-methylpentane

**15** The correct IUPAC name of the following compound is



- (a) 5-butyl-4-isopropyldecane  
(b) 5-ethyl-4-propyldecane  
(c) 6-*sec*-butyl-7-*iso*-propyldecane  
(d) 4-(1-methylethyl)-5-(1-methylpropyl)-decane

**16** Which of the following is the correct IUPAC name of the following compound?



- (a) 5-(2, 2 -dimethylpropyl)-decane  
(b) 4-butyl-2,2-dimethylnonane  
(c) 2,2-dimethyl-4-pentyldecane  
(d) 6-*neo*-pentyldecane

**17** Addition of dihydrogen gas to alkenes and alkynes in the presence of finely divided catalysts like Ni, Pt, Pd is called

- (a) dehydrogenation (b) catenation  
(c) carbonation (d) hydrogenation

**18** All alkyl halides undergo reduction process except

- (a) fluorides (b) chlorides  
(c) iodides (d) bromides

**19** The given reaction,



- (a) hydration (b) dehydrogenation  
(c) carbocation (d) reduction process

**20** Among the following, which hydrocarbon is not produced by Wurtz reaction?

- (a) methane (b) ethane (c) butane (d) octane

**21** When methyl halide reacts with sodium in the presence of dry ether, it gives

- (a) methane (b) ethane (c) propane (d) butane

**22** Soda lime is a mixture of

- (a)  $\text{NaOH} + \text{Ca}(\text{OH})_2$  (b)  $\text{NaOH} + \text{Mg}(\text{OH})_2$   
(c)  $\text{NaOH} + \text{CaO}$  (d)  $\text{NaOH} + \text{MgO}$

**23** The process of elimination of carbon dioxide from carboxylic acid is termed as

- (a) carboxylation (b) decarboxylation  
(c) hydrogenation (d) All of these

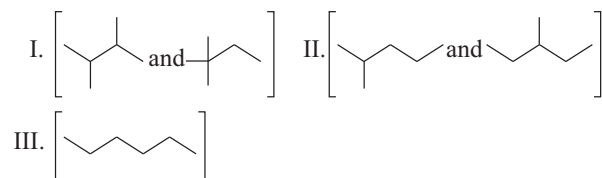
**24** Which of the following method is used to synthesise alkanes having even number of carbon atoms?

- (a) Decarboxylation  
(b) Kolbe's electrolytic method  
(c) Hydrogenation  
(d) None of the above

**25** Sodium acetate is electrolysed with water ( $\text{H}_2\text{O}$ ). The product formed at anode is

- (a)  $\text{CH}_4$  (b)  $\text{CO}_2$  (c)  $\text{H}_2$  (d)  $\text{NaOH}$

**26** Based on branching, isomers of hexane are divided into three distinct classes as shown below :



The correct order of their boiling point is

- (a)  $\text{I} > \text{II} > \text{III}$  (b)  $\text{III} > \text{II} > \text{I}$  (c)  $\text{II} > \text{III} > \text{I}$  (d)  $\text{III} > \text{I} > \text{II}$

**27** Which of the following are appropriate conditions for halogenation?

- (a) High temperature (573-773 K)  
(b) Presence of diffused light  
(c) Presence of ultraviolet light  
(d) All of the above

**28** Which of the following is a termination step in halogenation?

- (a)  $\text{Cl}-\text{Cl} \xrightarrow{h\nu} \dot{\text{C}}\text{l} + \dot{\text{C}}\text{l}$   
(b)  $\text{CH}_4 + \text{Cl} \xrightarrow{h\nu} \dot{\text{C}}\text{H}_3 + \text{HCl}$   
(c)  $\text{CH}_3\text{Cl} + \dot{\text{C}}\text{l} \longrightarrow \dot{\text{C}}\text{H}_2\text{Cl} + \text{HCl}$   
(d)  $\text{H}_3\dot{\text{C}} + \text{Cl} \longrightarrow \text{CH}_3\text{Cl}$



**29** Rate of replacement of hydrogens of alkanes in halogenation process is

- (a)  $1^\circ > 2^\circ > 3^\circ$  (b)  $1^\circ > 3^\circ > 2^\circ$   
 (c)  $2^\circ > 1^\circ > 3^\circ$  (d)  $3^\circ > 2^\circ > 1^\circ$

**30** Iodination of alkanes is always carried out in the presence of some oxidising agents like  $\text{HIO}_3$ . This is because

- (a) it is a very fast process (b) it is a reversible reaction  
 (c) I—I bond is very weak (d) All of these

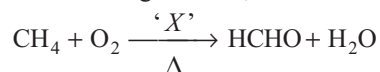
**31** The reactants involved in general combustion equation for any alkane is represented as

- (a)  $\text{C}_n\text{H}_{2n+2} + \left(\frac{3n+2}{2}\right)\text{O}_2$  (b)  $\text{C}_n\text{H}_{2n} + \left(\frac{3n-1}{2}\right)\text{O}_2$   
 (c)  $\text{C}_n\text{H}_{2n} + \left(\frac{3n+2}{2}\right)\text{O}_2$  (d)  $\text{C}_n\text{H}_{2n+2} + \left(\frac{3n+1}{2}\right)\text{O}_2$

**32** Which of the following is formed during incomplete combustion of alkanes with insufficient amount of air or dioxygen?

- (a)  $\text{CO}_2$  (b) C  
 (c) CO (d) None of these

**33** Consider the following reaction,



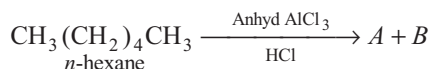
Here, 'X' is

- (a)  $\text{Mo}_2\text{O}_3$  (b) Cu/523 K  
 (c) Both (a) and (b) (d) None of these

**34** In presence of X, ordinary alkanes resist oxidation but alkanes having tertiary H-atom can be easily oxidised to alcohols. Identify 'X'.

- (a) Cu/523 K  
 (b)  $\text{Mo}_2\text{O}_3$   
 (c)  $\text{KMnO}_4$   
 (d)  $(\text{CH}_3\text{COO})_2\text{Mn}$

**35** Choose the correct option regarding product (A and B) of the given reaction

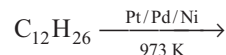


- (a)  $\text{CH}_3 - \underset{\text{CH}_3}{\text{CH}} - (\text{CH}_2)_2 - \text{CH}_3$   
 $+ \text{CH}_3\text{CH}_2 - \underset{\text{CH}_3}{\text{CH}} - \text{CH}_2\text{CH}_3$   
 (b)  $\text{CH}_3\text{CH}_2 - \underset{\text{CH}_3}{\text{CH}} - \text{CH}_2\text{CH}_3 + \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$   
 (c)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3 + \text{CH}_3 - \underset{\text{CH}_3}{\text{CH}} - \text{CH}_3$   
 (d) None of the above

**36** Name the process in which *n*-hexane on heating to 773 K at 10-20 atm pressure in the presence of oxides of vanadium, molybdenum or chromium supported by alumina produces benzene.

- (a) Reforming (b) Reduction  
 (c) Aromatisation (d) Both (a) and (c)

**37** The product(s) obtained in the following reaction is/are



- (a)  $\text{C}_7\text{H}_{16}$  (b)  $\text{C}_5\text{H}_{10}$   
 (c) Both (a) and (b) (d) None of these

**38** Liquid hydrocarbons can be converted to a mixture of gaseous hydrocarbons by **CBSE AIPMT 2012**

- (a) hydrolysis  
 (b) oxidation  
 (c) cracking  
 (d) distillation under reduced pressure

**39** The electronic distribution of the sigma bond molecular orbital is symmetrical around the internuclear axis of C—C bond which permits free rotation around C—C bond. Such spatial arrangements of atoms in which conversion of one another takes place by rotation around C—C bond is known as

- (a) rotamers (b) conformers  
 (c) conformations (d) All of these

**40** The possible rotamers of ethane is/are

- (a) 2 (b) 3 (c) 4 (d)  $\infty$

**41** Eclipsed and the staggered conformations of ethane can be represented by

- (a) Sawhorse projection  
 (b) Newman projection  
 (c) Both (a) and (b)  
 (d) None of the above

**42** Conformation of ethane in which hydrogen atoms attached to two carbon atoms are closest to each other is known as

- (a) eclipsed  
 (b) skew boat  
 (c) staggered  
 (d) partially eclipsed

**43** The repulsive interaction between the electron clouds, which affects stability of a conformation is termed as

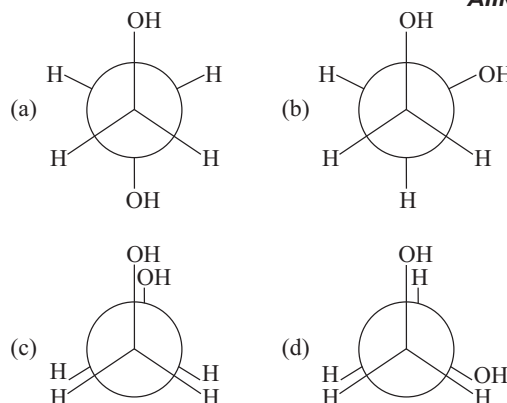
- (a) torsional strain  
 (b) dihedral angle  
 (c) torsional angle  
 (d) conformation

**44** Which form of ethane has the least torsional strain?

- (a) Staggered (b) Skew boat  
 (c) Eclipsed (d) Boat

- 45** Energy difference between eclipsed and staggered form of ethane is  
 (a)  $12.5 \text{ kJ mol}^{-1}$   
 (b)  $15.5 \text{ kJ mol}^{-1}$   
 (c)  $14.5 \text{ kJ mol}^{-1}$   
 (d)  $12.5 \text{ J mol}^{-1}$
- 46** The energy required to overcome energy barrier between eclipsed and staggered conformation of ethane molecule is gained through  
 (a) intramolecular collisions  
 (b) intermolecular collisions  
 (c) molecular collisions  
 (d) atomic collisions

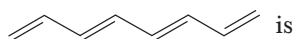
- 47** Which is most stable conformer of ethane-1, 2-diol? **AIIMS 2019**



## TOPIC 3 ~ Alkenes

- 48** Which type of overlapping results in the formation of  $\sigma$  and  $\pi$ -bonds, respectively?  
 (a) Lateral and sideways (b) Sideways and head on  
 (c) Head on and sideways (d) Head on and head on
- 49** The IUPAC name of  $\text{CH}_2 = \underset{\text{CH}_3}{\text{C}} - \text{CH}_3$  is  
 (a) 2-methylbutene (b) 1-methylpropene  
 (c) 2-methylbut-2-ene (d) 2-methylprop-1-ene
- 50** The IUPAC name of the following compound is  
 $\text{CH}_2 = \text{CH} - \underset{\text{CH}_2 - \text{CH}_2 - \text{CH}_3}{\text{CH}} - \text{CH}_2 - \text{CH}_3$  **JIPMER 2018**  
 (a) 3-propylpent-1-ene (b) 3-ethylpent-1-ene  
 (c) 4-ethylhex-1-ene (d) 3-ethylhex-1-ene

- 51** Number of  $\sigma$ -bonds and  $\pi$ -bonds present in



- | $\sigma$ -bond | $\pi$ -bond | $\sigma$ -bond | $\pi$ -bond |
|----------------|-------------|----------------|-------------|
| (a) 17         | 4           | (b) 14         | 3           |
| (c) 18         | 4           | (d) 15         | 3           |

- 52** Number of possible structural isomers of  $\text{C}_4\text{H}_8$  is  
 (a) 3 (b) 4  
 (c) 5 (d) 2

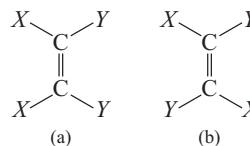
- 53** But-1-ene and 2-methylprop-1-ene are the examples of

- (a) chain isomers (b) position isomers  
 (c) functional isomers (d) None of these

- 54** Which of the following is not a structural isomer of  $\text{C}_5\text{H}_{10}$ ?

- (a) Pent-1-ene (b) 2-methylbut-2-ene  
 (c) 3-methylbut-1-ene (d) 2,3-dimethylpropene

- 55** Consider the following isomers :



The type of isomer (a) and (b) are

- (a) chain isomers (b) functional isomers  
 (c) geometrical isomers (d) positional isomers

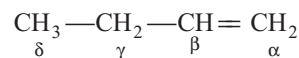
- 56** Which of the following compounds will exhibit geometrical isomerism? **JEE Main 2015**

- (a) 1-phenyl-2-butene (b) 3-phenyl-1-butene  
 (c) 2-phenyl-1-butene (d) 1, 1-diphenyl-1-propene

- 57** Which of the following has higher dipole moment; *cis*-2-butene or *trans*-2-butene?

- (a) *cis*-but-2-ene  
 (b) *trans*-but-2-ene  
 (c) Both have same dipole moment  
 (d) None of the above

- 58** Which hydrogen in compound (*E*) is easily replaceable during bromination reaction in presence of light? **JEE Main 2019**

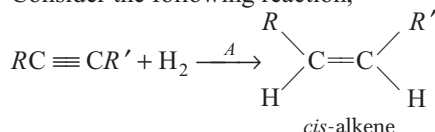


- (a)  $\beta$ -hydrogen (b)  $\delta$ -hydrogen  
 (c)  $\gamma$ -hydrogen (d)  $\alpha$ -hydrogen

59 Which of the following acts as Lindlar's catalyst ?

- (a) Palladium  
 (b) Zn -H<sub>2</sub>SO<sub>4</sub>  
 (c) Partially deactivated palladised charcoal  
 (d) Zn amalgam

60 Consider the following reaction,

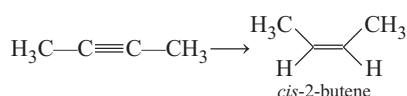


What does A refers to?

- (a) Na / liq. NH<sub>3</sub>                      (b) Pd / C  
 (c) Both (a) and (b)                    (d) None of these

61 The most suitable reagent for the following conversion, is

**NEET (National) 2019**



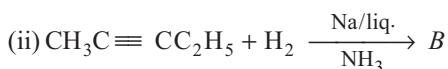
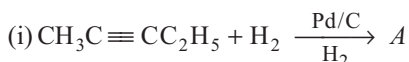
- (a) H<sub>2</sub>, Pd/C, quinoline                (b) Zn/HCl  
 (c) Hg<sup>2+</sup>/H<sup>+</sup>, H<sub>2</sub>O                      (d) Na/liquid NH<sub>3</sub>

62 The *trans*-alkenes are formed by the reduction of alkynes with

**JEE Main 2018**

- (a) H<sub>2</sub>-Pd/C, BaSO<sub>4</sub>                    (b) NaBH<sub>4</sub>  
 (c) Na/liq. NH<sub>3</sub>                          (d) Sn-HCl

63 Consider the given reactions :



A and B respectively are

- (a) *cis* and *trans*-alkene                (b) *trans* and *cis*-alkene  
 (c) alkane and alkene                    (d) alkene and alkane

64 The rate of reaction of halogen towards β-elimination reaction is

- (a) chlorine > bromine > iodine  
 (b) iodine > bromine > chlorine  
 (c) bromine > iodine > chlorine  
 (d) chlorine > iodine > bromine

65 In the reaction,  $CH_3-CH_2-\overset{\text{Br}}{\underset{|}{CH_2}} \xrightarrow[\Delta]{alc. KOH} A$ ,

A is

- (a) CH<sub>2</sub> = CH—CH<sub>3</sub>                    (b) CH<sub>3</sub>CH<sub>2</sub>—CH<sub>3</sub>  
 (c) CH ≡ C—CH<sub>3</sub>                        (d) Both (a) and (b)

66 A mixture of 1-chlorobutane and 2-chlorobutane when treated with alc. KOH gives

- (a) but-1-ene  
 (b) but-2-ene  
 (c) *iso*-butene  
 (d) mixture of but-1-ene and but-2-ene

67 The product (X) obtained in the following reaction is



- (a)  $CH_3CH_2-\underset{\text{Br}}{\underset{|}{CH_2}}$                       (b)  $CH_3-\underset{\text{Br}}{\underset{|}{CH}}-CH_3$   
 (c) CH<sub>3</sub>CH = CH<sub>2</sub>                        (d) None of these

68 Alcohols on heating with conc. H<sub>2</sub>SO<sub>4</sub> form alkenes with elimination of one water molecule. This reaction is also known as

- (a) β-elimination reaction  
 (b) basic dehydration of alcohols  
 (c) acidic dehydration of alcohols  
 (d) Both (a) and (c)

69 2-methylpropan-2-ol is obtained by the reaction of X with water in the presence of conc. H<sub>2</sub>SO<sub>4</sub>.

The compound X is

- (a) 1-methylpropene  
 (b) 2,2-dimethylhexane  
 (c) 2-methylpropene  
 (d) 2-methylbutane

70 The major product formed when 3,3-dimethyl butan-2-ol is heated with concentrated sulphuric acid is

- (a) 2,3-dimethylbut-1-ene  
 (b) 2,3-dimethylbut-2-ene  
 (c) 3,3-dimethylbut-1-ene  
 (d) *cis* and *trans*-isomers of 2,3-dimethylbut-1-ene

71 Vicinal dihalides on treatment with zinc metal forms alkene by losing a molecule of

- (a) ZnX<sub>2</sub>                                    (b) ZnX                                    (c) ZnX<sub>4</sub>                                    (d) Zn<sub>2</sub>X

72 Which of the following is the correct reason for the addition reactions on alkenes?

- (a) loosely held π-electrons            (b) tightly held π-electrons  
 (c) loosely held σ-electrons            (d) tightly held σ-electrons

73 Ethene reacts with one mole of bromine in the presence of CCl<sub>4</sub>, to give

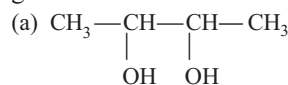
- (a) 1,1-dibromoethane                (b) 2,2-dibromoethane  
 (c) 2,2-dibromobutane                (d) 1,2-dibromoethane

74 The correct order of reactivity of the hydrogen halides with alkenes is

- (a) HI > HBr > HCl                    (b) HCl > HBr > HI  
 (c) HI > HCl > HBr                    (d) HBr > HCl > HI

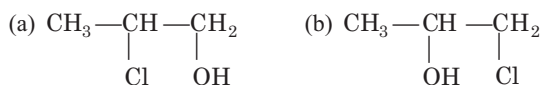
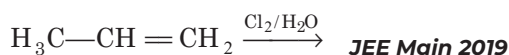
75 But-2-ene on reaction with alkaline KMnO<sub>4</sub> at elevated temperature followed by acidification will give

**JEE Main 2019**



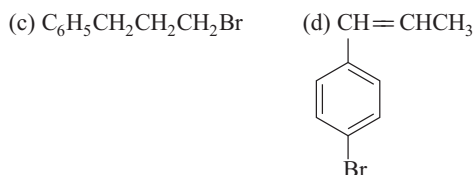
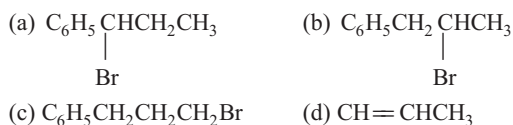
- (b) one molecule of CH<sub>3</sub>CHO and one molecule of CH<sub>3</sub>COOH  
 (c) 2 molecules of CH<sub>3</sub>COOH  
 (d) 2 molecules of CH<sub>3</sub>CHO

76 The major product of the following addition reaction is



77 The reaction of  $\text{C}_6\text{H}_5\text{CH}=\text{CHCH}_3$  with HBr produces

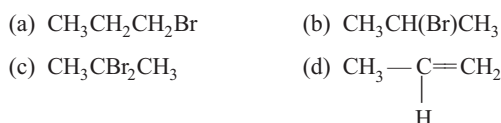
CBSE AIPMT 2014



78 The rule which states that negative part of the addendum gets attached to that carbon atom which possesses less number of hydrogen atoms is called

- (a) Saytzeff rule  
(b) Hofmann rule  
(c) Markovnikov's rule  
(d) Anti-Markovnikov's addition

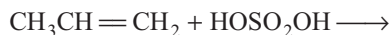
79 What will be the product of the following reaction?



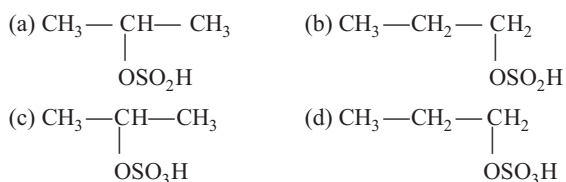
80 Addition of cold conc.  $\text{H}_2\text{SO}_4$  to alkenes is an example of

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

81 Consider the following reaction,



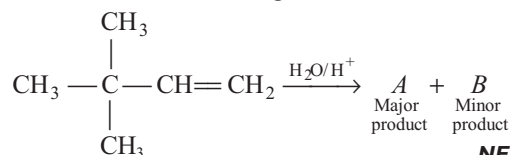
The product obtained is



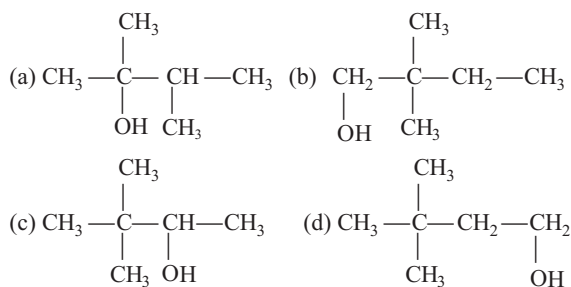
82 Addition of water in presence of conc.  $\text{H}_2\text{SO}_4$  (few drops) to 2-methyl propene produces alcohols in accordance with

- (a) Anti-Markovnikov's addition  
(b) Markovnikov's rule  
(c) Saytzeff's rule      (d) Hofmann rule

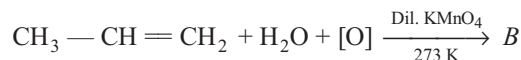
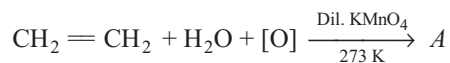
83 Consider in the following reaction.



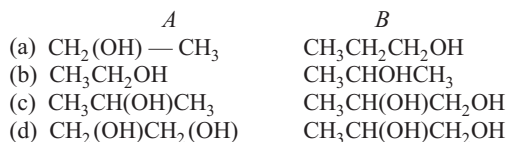
NEET 2013



84 Choose the correct option regarding A and B.



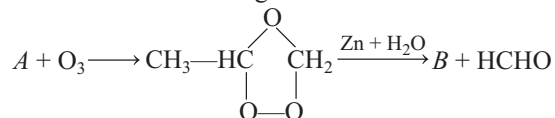
Codes



85 Acidic potassium permanganate/potassium dichromate oxidises alkenes to produce

- (a) ketones/acids      (b) ketones/aldehyde  
(c) ketones/alcohols      (d) ketones/ether

86 Consider the reaction given below.



Here, A and B respectively are

- (a) propene and methanal      (b) propane and ethanal  
(c) propene and ethanol      (d) propene and ethanal

87 Ozonolysis of an organic compound A produces acetone and propionaldehyde in equimolar mixture. Here, A refers to

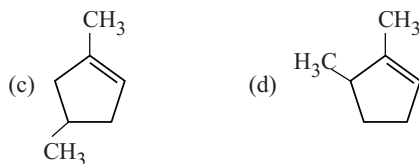
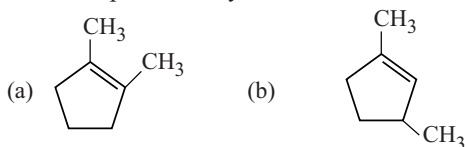
- (a) 2-methyl pent-1-ene      (b) pent-1-ene  
(c) pent-2-ene      (d) 2-methylpent-2-ene

88 Which of the following alkenes on ozonolysis gives a mixture of ketones only?

- (a)  $\text{CH}_3-\text{CH}=\text{CH}-\text{CH}_3$   
 (b)  $\text{CH}_3-\underset{\text{CH}_3}{\text{CH}}-\text{CH}=\text{CH}_2$



89 Which compound would give 5-keto-2-methyl hexanal upon ozonolysis?



90 Polythene is obtained by the combination of large number of ethene molecules at

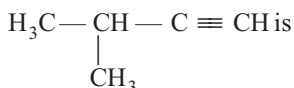
- (a) high temperature, low pressure and presence of a catalyst  
 (b) high temperature and low volume and presence of a catalyst  
 (c) high temperature, high pressure and presence of catalyst  
 (d) Both (b) and (c)

91 Which of the following is an example of polythene?

- (a)  $n(\text{CH} \equiv \text{CH})$  (b)  $-(\text{CH}_2-\text{CH}_2)_n-$   
 (c)  $-(\text{C} \equiv \text{C})_n-$  (d)  $-(\text{CH}_2 = \text{CH}_2)_n-$

## TOPIC 4~ Alkynes

92 The correct IUPAC name of the given structure



- (a) 2-methylbut-1-yne (b) 1-methylbut-3-yne  
 (c) 2-methylbut-3-yne (d) 3-methylbut-1-yne

93 The common name and IUPAC name of  $\text{CH}_3\text{CH}_2-\text{C} \equiv \text{CH}$ , respectively are

- (a) dimethylacetylene and but-2-yne  
 (b) ethylacetylene and but-1-yne  
 (c) acetylene and but-2-yne  
 (d) methylacetylene and but-2-yne

94 How many isomers are possible for  $\text{C}_6\text{H}_{10}$ ?

- (a) 7 (b) 6 (c) 4 (d) 5

95 The geometry of ethyne molecule is

- (a) linear (b) trigonal planar  
 (c) tetrahedral (d) bent

96 Total number of  $\sigma$  and  $\pi$ -bonds present in ethyne are

- (a) 4 and 3 respectively (b) 3 and 2 respectively  
 (c) 2 and 3 respectively (d) 1 and 2 respectively

97  $\text{CaCO}_3 \xrightarrow{\Delta} A + \text{CO}_2$ ,  $A + \text{carbon} \rightarrow \text{CaC}_2 + \text{CO}$

Here,  $A$  refers to

- (a)  $\text{Ca}(\text{CO})_2$  (b)  $\text{Ca}_2\text{O}$   
 (c)  $\text{CaO}$  (d)  $\text{Ca}(\text{OH})_2$

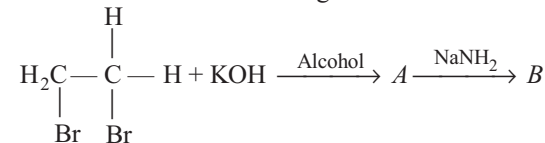
98 Consider the following reaction,



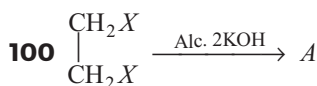
Here  $X$  refers to

- (a) ethene (b) ethyne  
 (c) methyne (d) None of these

99 What are  $A$  and  $B$  in following reaction?



- (a)  $A \Rightarrow \text{H}_2\text{C} = \text{CH}_2$  (b)  $B \Rightarrow \text{CH} \equiv \text{CH}$   
 (c)  $A \Rightarrow \text{CH}_2 = \text{CHBr}$  (d)  $B \Rightarrow \text{CH} \equiv \text{CH}$   
 (e)  $A \Rightarrow \text{CH}_2 = \text{CH}_2$  (f)  $B \Rightarrow \text{CH}_2 = \text{CH}_2$   
 (g)  $A \Rightarrow \text{CH}_2 = \text{CH}_2$  (h)  $B \Rightarrow \text{CH} \equiv \text{CBr}$



Here,  $A$  refers to

- (a)  $\text{CH}_2 = \text{CH}_2$  (b)  $\text{CH}_3-\text{CH}_2-\text{OH}$   
 (c)  $\text{H}-\text{C} \equiv \text{CH}$  (d)  $\text{CH}_3-\text{CH}_3$

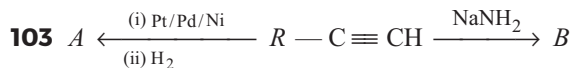
101 Hydrogen atoms of ethyne attached to triply bonded carbon atom are acidic in nature due to

- (a) maximum percentage of  $s$ -character of  $sp$   
 (b) highest electronegativity of  $sp$ -orbital than  $sp^2$  and  $sp^3$ -orbitals

- (c) Both (a) and (b)  
 (d) None of the above

102 Which one is the correct order of acidity? **NEET 2017**

- (a)  $\text{CH}_2 = \text{CH}_2 > \text{CH}_3-\text{CH} = \text{CH}_2 > \text{CH}_3-\text{C} \equiv \text{CH} > \text{CH} \equiv \text{CH}$   
 (b)  $\text{CH} \equiv \text{CH} > \text{CH}_3-\text{C} \equiv \text{CH} > \text{CH}_2 = \text{CH}_2 > \text{CH}_3-\text{CH}_3$   
 (c)  $\text{CH} \equiv \text{CH} > \text{CH}_2 = \text{CH}_2 > \text{CH}_3-\text{C} \equiv \text{CH} > \text{CH}_3-\text{CH}_3$   
 (d)  $\text{CH}_3-\text{CH}_3 > \text{CH}_2 = \text{CH}_2 > \text{CH}_3-\text{C} \equiv \text{CH} > \text{CH} \equiv \text{CH}$



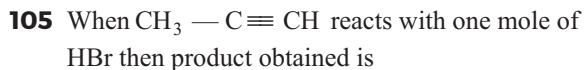
Here,  $A$  and  $B$  refers to

- (a)  $R - CH = CH_2$  and  $R - C \equiv C - NH_2$   
 (b)  $R - CH = CH_2$  and  $R - C \equiv C^- Na^+$   
 (c)  $H - C \equiv C - H$  and  $R - C \equiv C^- Na^+$   
 (d) None of the above

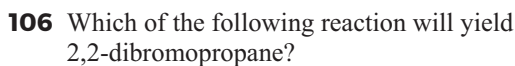


Here,  $A$  refers to

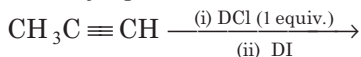
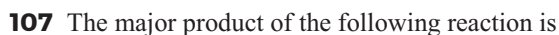
- (a)  $BrCH_2 - CH = CHBr$   
 (b)  $CH_3 - CH = CBr_2$   
 (c)  $Br - CH_2 - CBr = CH_2$   
 (d)  $CH_3 - CBr = CHBr$



- (a) bromoethene  
 (b) dibromopropane  
 (c) 2-bromopropene  
 (d) 1-bromopropane

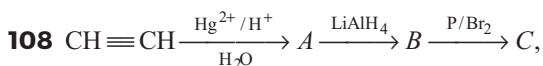


- (a)  $CH_3 - CH = CH_2 + HBr \longrightarrow$   
 (b)  $CH_3 - C \equiv CH + 2HBr \longrightarrow$   
 (c)  $CH_3 - CH = CHBr + HBr \longrightarrow$   
 (d)  $CH \equiv CH + 2HBr \longrightarrow$



**JEE Main 2019**

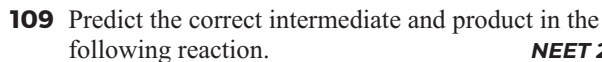
- (a)  $CH_3CD(Cl)CHD(I)$  (b)  $CH_3CD_2CH(Cl)(I)$   
 (c)  $CH_3CD(I)CHD(Cl)$  (d)  $CH_3C(I)(Cl)CHD_2$



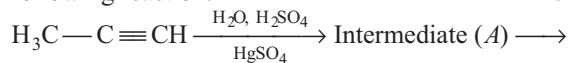
Final product  $C$  is

**JIPMER 2019**

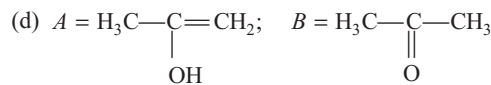
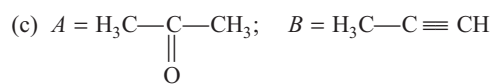
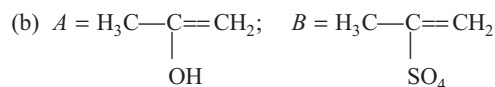
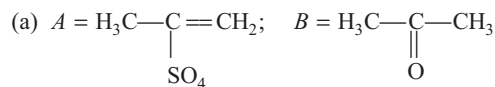
- (a)  $CH_3CH_2OH$  (b)  $CH_3CH_2 - Br$   
 (c)  $CH_3 - CH_2 - I$  (d)  $\begin{array}{c} CH_2 - CH_2 - OH \\ | \\ Br \end{array}$



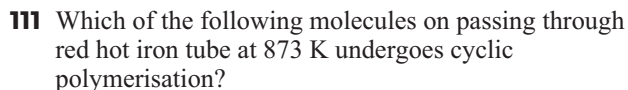
**NEET 2017**



Product ( $B$ )



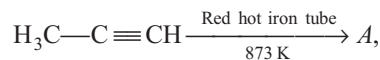
- (a)  $\left( -CH=CH-CH=CH- \right)_n$   
 (b)  $\left( -CH=CH-CH_2- \right)_n$   
 (c)  $\left( -CH=CH=CH- \right)_n$   
 (d)  $\left( -CH=CH-CH=CH-CH_2- \right)_n$



- (a) Ethene  
 (b) Ethyne  
 (c) Acetylene  
 (d) Both (b) and (c)



**NEET 2019**



the number of sigma ( $\sigma$ ) bonds present in the product  $A$  is

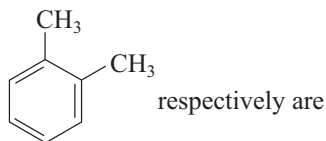
- (a) 21  
 (b) 9  
 (c) 24  
 (d) 18

# TOPIC 5 ~ Aromatic Hydrocarbons and Carcinogenicity

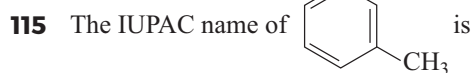


- (a) biphenyl (b) naphthalene  
(c) dibenzene (d) All of these

114 The common name and IUPAC name of



- (a) *o*-xylene and toluene  
(b) *o*-xylene and 1,2-dimethylbenzene  
(c) *o*-xylene and 1,2-dimethyltoluene  
(d) *p*-xylene and 1,2-dimethylbenzene



- (a) dimethylbenzene  
(b) methyltoluene  
(c) 1,3-dimethylbenzene  
(d) 1,4-dimethylbenzene

116 How many isomers of 1,2-dibromobenzene are possible according to Kekule?

- (a) 1 (b) 2 (c) 3 (d) 4

117 The number of  $sp^2$ -hybrid orbitals in a molecule of benzene is **JEE Main 2020**

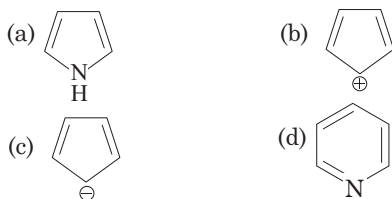
- (a) 24 (b) 12  
(c) 18 (d) 6

118 Which reaction confirms the presence of three double bonds in benzene?

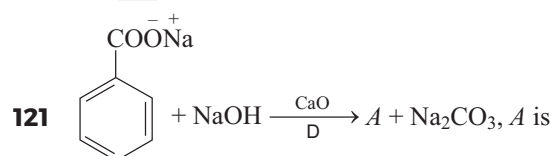
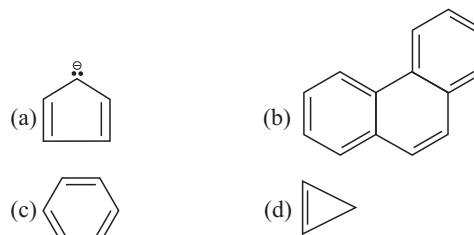
- (a) Oxidation reaction  
(b) Hydrolysis reaction  
(c) Triozonolysis reaction  
(d) Addition reaction

119 Which of the following compounds is not aromatic?

**JEE Main 2019**



120 Four structures are given in options (a) to (d). Examine them and select the one that is not aromatic.



- (a) C<sub>6</sub>H<sub>6</sub> (b) C<sub>6</sub>H<sub>5</sub> — Na  
(c) C<sub>6</sub>H<sub>5</sub> — ONa (d) C<sub>5</sub>H<sub>5</sub> — Na

122 On passing vapours of phenol over heated zinc, dust it gets reduced to

- (a) toluene (b) aniline  
(c) benzene (d) phenol

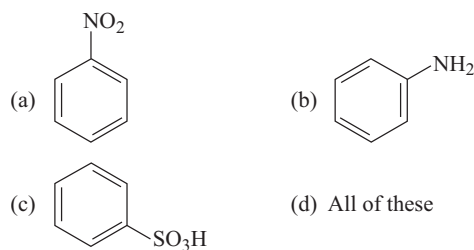
123 For an electrophilic substitution reaction, the presence of a halogen atom in the benzene ring

- (a) deactivates the ring by inductive effect  
(b) deactivates the ring by resonance  
(c) increases the charge density at *ortho* position relative to *para*-position by resonance  
(d) directs the incoming electrophile to *meta* -position by increasing the charge density relative to *ortho* and *para* -position

124 Consider the reaction given below.

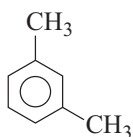


Here, A refers to



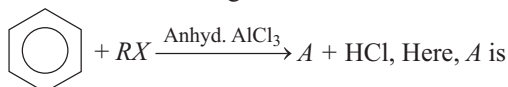
- 125** In an electrophilic substitution reaction of nitrobenzene, the presence of nitro group
- activates the ring by resonance effect
  - activates the ring by inductive effect
  - decreases the charge density at *ortho* and *para* -position of the ring relative to *meta* -position by resonance
  - increases the charge density at *meta* -position relative to the *ortho* and *para* -positions of the ring by resonance

- 126** What products are formed when the following compound is treated with  $\text{Br}_2$  in the presence of  $\text{FeBr}_3$ ? **CBSE AIPMT 2014**



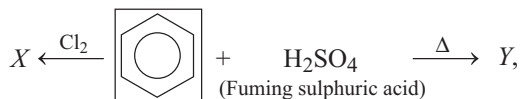
- (a) and
- (b) and
- (c) and
- (d) and

- 127** Consider the reaction given below.



- methylbenzene
- toluene
- alkylbenzene
- ethylbenzene

- 128** In the reaction,



X and Y respectively are

- $\text{C}_6\text{H}_5\text{Cl}$  and  $\text{C}_6\text{H}_5\text{SO}_3\text{H}$
- $\text{C}_6\text{H}_5\text{Cl}$  and  $\text{C}_6\text{H}_5\text{OH}$
- $\text{C}_6\text{H}_4\text{Cl}_2$  and  $\text{C}_6\text{H}_5\text{SO}_2$
- $\text{C}_6\text{H}_5\text{Cl}$  and  $\text{C}_6\text{H}_5\text{CHO}$

- 129** Acetophenone ( $\text{C}_6\text{H}_5\text{COCH}_3$ ) is prepared from reaction of benzene ( $\text{C}_6\text{H}_6$ ) with A in the presence of anhyd.  $\text{AlCl}_3$ . Here, A refers to

- $\text{CH}_3\text{COCH}_3$
- $\text{CH}_3\text{CHO}$
- $\text{CH}_3\text{CH}_2\text{CHO}$
- $\text{CH}_3\text{COCl}$

- 130** Neopentyl chloride reacts with benzene in the presence of a Lewis acid ( $\text{AlCl}_3$ ) to form **JIPMER 2018**

- 
- 
- 
- 

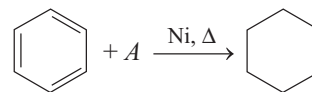
- 131** Which of the following carbocations is expected to be most stable? **NEET 2018**

- 
- 
- 
- 

- 132** During nitration of benzene, the attacking electrophile is **JIPMER 2019**

- $\text{NO}_3^-$
- $\text{NO}_2^-$
- $\text{NO}_2^+$
- $\text{HNO}_3$

- 133** Consider the reaction given below.



Here, A is

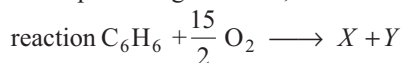
- $\text{H}_2$
- $2\text{H}_2$
- $3\text{H}_2$
- $4\text{H}_2$

- 134** Hexachlorobenzene is obtained by addition of X moles of  $\text{Cl}_2$  with  $\text{C}_6\text{H}_6$  in the presence of UV/500 K. The value of X is

- 2
- 4
- 3
- 8



**135** When benzene is heated in air, it burns with sooty flame producing  $X$  and  $Y$ , as shown in the given



Here,  $X$  and  $Y$  refer to

- (a)  $\text{C}_6\text{H}_5$ ,  $\text{—OH}$ ,  $\text{CO}$                       (b)  $\text{CO}_2$ ,  $\text{H}_2\text{O}$   
 (c)  $\text{C}_6\text{H}_{14}$ ,  $\text{CO}_2$                         (d)  $\text{C}_6\text{H}_5\text{OH}$ ,  $\text{H}_2$

**136** Which of the following deactivates the benzene ring towards electrophilic substitution and is *o/p* directing?

- (a)  $\text{—Cl}$     (b)  $\text{—OCH}_3$   
 (c)  $\text{—CHO}$                                         (d) All of these

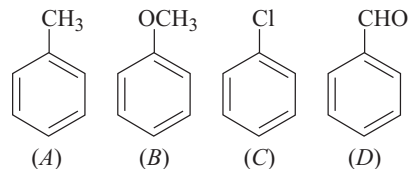
**137** Which of the following set of functional groups is *meta*-directing?

- (a)  $\text{—NO}_2$ ,  $\text{—NH}_2$ ,  $\text{—COOH}$ ,  $\text{—COOR}$   
 (b)  $\text{—NO}_2$ ,  $\text{—CHO}$ ,  $\text{—SO}_3\text{H}$ ,  $\text{—COR}$   
 (c)  $\text{—CN}$ ,  $\text{—CHO}$ ,  $\text{—NHCOCH}_3$ ,  $\text{—COOR}$   
 (d)  $\text{—CN}$ ,  $\text{—NH}_2$ ,  $\text{—NHR}$ ,  $\text{—OCH}_3$

**138** In nitrobenzene, the  $X$  attacks on comparatively electron rich *meta*-position resulting in  $Y$  substitution. Here,  $X$  and  $Y$  refer to

- (a) electrophile, *meta*  
 (b) nucleophile, *meta*  
 (c) deactivating group, *para*  
 (d) activating group, *meta*

**139** Correct order of electrophilic substitution reaction is



**AIIMS 2019**

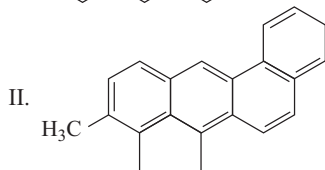
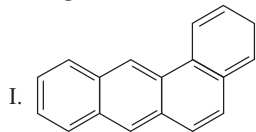
- (a)  $A > B > C > D$                               (b)  $D > B > A > C$   
 (c)  $B > A > C > D$                               (d)  $B > A > D > C$

**140** Polynuclear hydrocarbons are formed by an incomplete process of organic materials. This process is termed as  
 (a) addition (b) combustion (c) elimination (d) substitution

## SPECIAL TYPES QUESTIONS

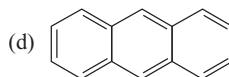
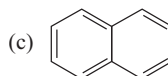
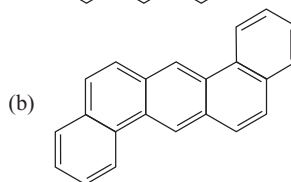
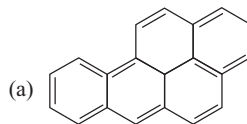
### I. Statement Based Questions

**141** Which of the following are the correct IUPAC names of the given structures?



- (a) 1,2-benzanthracene and 3-methylcholanthrene respectively  
 (b) 1,2-benzanthracene and 3-ethylcholanthroctane respectively  
 (c) 1,2-benzenenaphthalate and 2-methylcholanthrace respectively  
 (d) 1,2-benzenenaphthalene and 1,2-methylcholanthrane respectively

**142** The correct structure of 1,2,5,6-dibenzanthracene is



- 143** Which of the following statement is correct?  
 (a) Alkanes are polar molecules  
 (b) Alkanes are ionic in nature  
 (c) Alkanes have very little electronegativity difference between carbon and hydrogen atom  
 (d) Alkanes are very reactive

- 144** Which of the following statements are correct regarding Kolbe's electrolytic process?  
 I. Alkanes containing even number of C-atoms are prepared.  
 II. Sodium or potassium salts of carboxylic acids are taken as substrate.  
 III. Methane can be prepared by this method.  
 IV. H<sub>2</sub> gas is liberated at anode.  
 Choose the correct statement.

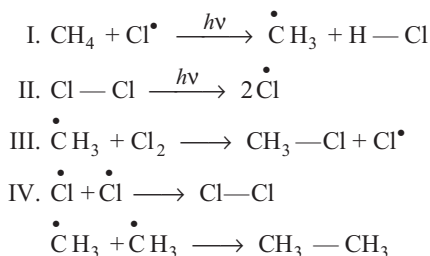
**Codes**

- (a) Both I and II (b) Both II and III  
 (c) Both I and III (d) All of these
- 145** With respect to the conformers of ethane, which of the following statements is correct? **NEET 2017**  
 (a) Bond angle remains same but bond length changes  
 (b) Bond angle changes but length remains same  
 (c) Both bond angle and bond length change  
 (d) Both bond angles and bond length remain same

- 146** Which of the following statement(s) is/are correct regarding rotation around internuclear axis of C—C bond?  
 I. Rotation produces rotamers.  
 II. Magnitude of torsional strain depends upon the angle of rotation about C—C bond.  
 III. Repulsive interaction between adjacent bond is termed as torsional strain.  
 IV. Ethane has only four conformational isomers.

Choose the correct option.

- (a) Both I and II are correct (b) I, II and III  
 (c) I, III and IV (d) All of these
- 147** Arrange the correct sequence for mechanism of chlorination of methane



Choose the correct option.

- (a) II, I, III and IV  
 (b) I, II, III and IV  
 (c) IV, III, II and I  
 (d) II, III, I and IV

- 148** Which of the following statements are correct regarding relative stability of conformations of ethane?

- I. There is minimum repulsive force and maximum stability of molecule in the case of staggered form.  
 II. There is maximum repulsive force and minimum stability of molecule in case of eclipsed form.  
 III. Due to repulsive force, eclipsed form possesses more energy as compared to staggered form.  
 IV. Energy of staggered molecule is lower than that of eclipsed form.

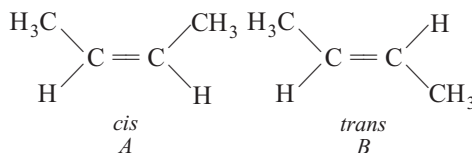
Choose the correct option.

- (a) I, II and III  
 (b) Both I and II  
 (c) I, III and IV  
 (d) All of these

- 149** Which of the following statement is/are correct?

- (a) Dipole moment of *trans*-form is almost zero  
 (b) *Trans*-isomer is non-polar  
 (c) *Trans*-isomer has higher melting point than the *cis*-form.  
 (d) All of the above

- 150** Which of the statement(s) is correct regarding the following structures?



- (a) *A* and *B* are stereoisomers of each other  
 (b) *A* has more boiling point than *B*  
 (c) *B* has more boiling point than *A*  
 (d) Both (a) and (b)

- 151** Which of the following statement is correct for ethyne molecule?

- (a) Electron cloud between two C-atoms is cylindrically symmetrical  
 (b) It a non-linear molecule  
 (c) It has one  $\pi$ -bond  
 (d) Ethyne molecule consists of two C—C  $\sigma$ -bonds

- 152** Which of the following order is correct regarding acidic character of hydrocarbons given below?

- I.  $\text{CH} \equiv \text{CH} > \text{CH}_2 = \text{CH}_2 > \text{CH}_3 - \text{CH}_3$   
 II.  $\text{HC} \equiv \text{CH} > \text{CH}_3\text{C} \equiv \text{CH} > \text{CH}_3\text{C} \equiv \text{CCH}_3$

- (a) Only I (b) Only II  
 (c) Both I and II (d) None of these

- 153** Which of the following statement is correct?

- (a) Aromatic hydrocarbons are polar molecules  
 (b) Aromatic hydrocarbons are coloured liquids  
 (c) Aromatic hydrocarbons are immiscible with water  
 (d) Aromatic hydrocarbons are immiscible with organic solvents

- 154** Which one of these is incorrect for benzene?  
 (a) It forms only one type of monosubstituted product  
 (b) There are three C—C single bonds and three C=C double bonds  
 (c) The heat of hydrogenation of benzene is less than the theoretical value  
 (d) The bond-angle between the C—C bond is  $120^\circ$

- 155** Which of the following statements are correct regarding structure of benzene?  
 I. All the six carbons in benzene are  $sp^2$ -hybridised.  
 II.  $sp^2$ -hybridised orbital of carbon combines with another  $sp^2$ -hybridised orbital of carbon to give C—C sigma bonds.  
 III. C—H  $\sigma$ -bond is obtained by lateral overlapping of  $sp^2$ -hybridised orbital of C and  $1s$ -orbital of H-atom.

Choose the correct statements.

- (a) I, II and III are correct      (b) I and II are correct  
 (c) I and III are correct          (d) II and III are correct
- 156** X-ray diffraction study of benzene reveals that  
 I. it is a planar molecule.  
 II. C—C bond lengths are of the same order which is intermediate between C—C single bond and C=C double bond.  
 III. benzene is reluctant towards the addition reaction under normal conditions.  
 IV. it explains the unusual behaviour of benzene.

Which of the above statements are true?

- (a) I, II and III                      (b) II, III and IV  
 (c) I, III and V                      (d) All of these
- 157** Any ring system will be 'aromatic' in nature if it possesses  
 I. planarity.  
 II. complete delocalisation of the  $\pi$ -electrons in the ring.  
 III. it follows Huckel rule.

Choose the correct option.

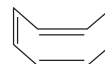
- (a) Both I and II                      (b) Both II and III  
 (c) Both I and III                      (d) All of these
- 158** Consider the following statements :  
 I. The —OH group present in phenol is *ortho* and *para*-directing.  
 II. Directive influence of a functional group in monosubstituted benzene depends on the nature of the substituent already present in the benzene ring.  
 III. The —OH group activates the benzene ring for the attack by an electrophile.  
 IV. Groups such as —NH<sub>2</sub>, —NHR, —NHCOCH<sub>3</sub>, —OCH<sub>3</sub>, —CH<sub>3</sub>, —C<sub>2</sub>H<sub>5</sub> etc, are examples of activating groups.
- Select the correct option.
- (a) I and II                              (b) II and III  
 (c) II, III and IV                      (d) All of these

- 159** Which of the following statement is incorrect regarding nitration of aromatic compounds?  
 I. The rate of nitration of benzene decreases at 323-333 K.  
 II. The rate of nitration of toluene is greater than that of benzene.  
 III. The rate of nitration of chlorobenzene is greater than that of benzene.  
 IV. Nitration is an electrophilic substitution reaction.
- Choose the incorrect statement.  
 (a) Only I  
 (b) Both I and III  
 (c) II and IV  
 (d) All of these

## II. Assertion and Reason

■ **Direction** (Q.Nos. 160-165) *In the following questions, a statement of assertion (A) is followed by a corresponding statement of reason (R). Of the following statements, choose the correct one.*

- (a) Both A and R are correct; R is the correct explanation of A  
 (b) Both A and R are correct; R is not the correct explanation of A  
 (c) A is correct; R is incorrect  
 (d) R is correct; A is incorrect
- 160 Assertion** (A) 1-butene on reaction with HBr in the presence of a peroxide, produces 1-bromobutane.  
**Reason** (R) It involves the formation of a primary radical.
- 161 Assertion** (A) Propene reacts with HI in the presence of peroxide to give 1-iodopropane. **AIIMS 2019**  
**Reason** (R)  $1^\circ$  free radical is less stable than  $2^\circ$  free radical.
- 162 Assertion** (A) 1-hexyne is converted to *cis*-1-hexene by Lindlar's catalyst.  
**Reason** (R) 1-hexyne is converted to *n*-hexane by the reduction with hydrogen gas in the presence of Pd/Ni.
- 163 Assertion** (A) The compound cyclooctatetraene has the following structural formula.



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

**Reason** (R)  $(4n + 2)$   $\pi$ -electron rule does not hold good and ring is not planar.

- 164 Assertion** (A) Nitration of benzene with nitric acid requires the use of concentrated sulphuric acid.  
**Reason** (R) The mixture of concentrated sulphuric acid and concentrated nitric acid produces the electrophile,  $\text{NO}_2^+$ .

**AIIMS 2018**



- 167** Which of the following is the correct match regarding controlled oxidation of alkane and catalyst used in the reaction?

Column I	Column II
A. $\text{CH}_4 + \text{O}_2 \longrightarrow \text{CH}_3\text{OH}$	1. Cu/523 K/100 atm
B. $\text{CH}_4 + \text{O}_2 \longrightarrow \text{HCHO}$	2. $\text{Mo}_2\text{O}_3, \Delta$
C. $2\text{CH}_3\text{CH}_3 + 3\text{O}_2 \longrightarrow 2\text{CH}_3\text{COOH} + 2\text{H}_2\text{O}$	3. $(\text{CH}_3\text{COO})_2\text{Mn}$
D. $(\text{CH}_3)_3\text{CH} \longrightarrow (\text{CH}_3)_3\text{COH}$	4. $\text{KMnO}_4$

**Codes**

A	B	C	D	A	B	C	D
(a) 2	3	4	1	(b) 1	2	3	4
(c) 2	1	3	4	(d) 4	3	2	1

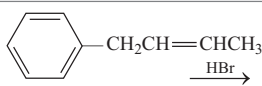
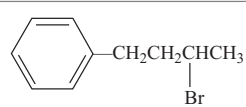
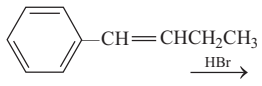
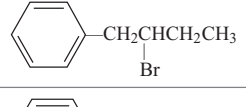
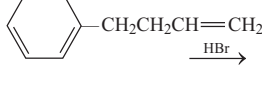
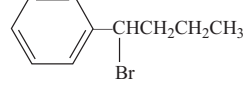
- 168** Match the following reactants in Column I with the corresponding reaction products in Column II and select the correct answer using the given codes below :

Column I	Column II
A. Alkane + $X_2 \xrightarrow{h\nu}$	1. Water + carbon dioxide
B. Alkane + $\text{O}_2 \xrightarrow{\Delta}$	2. Alkanal
C. Alkane + $\text{O}_2 \xrightarrow{\text{Mo}_2\text{O}_3}$	3. Haloalkane
D. <i>n</i> -hexane $\xrightarrow[10-20 \text{ atm}]{\Delta, 773 \text{ K}}$	4. Benzene

**Codes**

A	B	C	D	A	B	C	D
(a) 1	2	3	4	(b) 1	2	4	3
(c) 3	1	2	4	(d) 3	1	4	2

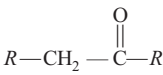
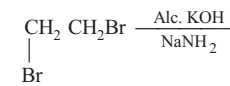
- 169** Match the Column I and Column II and choose the correct option from the codes given below.

Column I	Column II
A.  $\xrightarrow{\text{HBr}}$	1. 
B.  $\xrightarrow{\text{HBr}}$	2. 
C.  $\xrightarrow{\text{HBr}}$	3. 

**Codes**

A	B	C
(a) 2	3	1
(b) 1	2	3
(c) 1	3	2
(d) 3	2	1

- 170** Match the Column I with Column II and choose the correct option from the codes given below.

Column I	Column II
A. $\text{RC}\equiv\text{CR} \xrightarrow[\text{CH}_3\text{COOH}]{\text{BH}_3, \text{THF}}$	1. $\text{CH}_3 - \text{C}\equiv\text{C} - \text{Na}$
B. $\text{RC}\equiv\text{CR} \xrightarrow[\text{H}_2]{\text{Pd/Ni}}$	2. 
C.  $\xrightarrow[\text{NaNH}_2]{\text{Alc. KOH}}$	3. $\text{CH}_3 - \text{C}\equiv\text{C} - \text{OH}$
D. $\text{CH}_3\text{C}\equiv\text{CH} \xrightarrow{\text{NaNH}_2}$	4. $\text{R}-\text{CH}_2-\text{CH}_2-\text{R}$
	5. $\text{CH}\equiv\text{CH}$

**Codes**

A	B	C	D
(a) 2	4	5	1
(b) 2	4	5	3
(c) 2	5	4	1
(d) 2	4	3	5

- 171** Match the following reactants in Column I with the corresponding reaction products in Column II and choose the correct option from the codes given below.

Column I	Column II
A. Benzene + $\text{Cl}_2 \xrightarrow{\text{AlCl}_3}$	1. Benzene sulphonic acid
B. Benzene + $\text{CH}_3\text{Cl} \xrightarrow{\text{AlCl}_3}$	2. Methyl phenyl ketone
C. Benzene + $\text{CH}_3\text{COCl} \xrightarrow{\text{AlCl}_3}$	3. Toluene
D. Benzene $\xrightarrow{\text{H}_2\text{SO}_4}$	4. Chlorobenzene

**Codes**

A	B	C	D	A	B	C	D
(a) 4	3	2	1	(b) 4	3	1	2
(c) 3	4	1	2	(d) 3	4	2	1

# NCERT & NCERT Exemplar

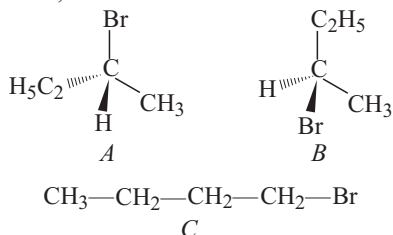
## MULTIPLE CHOICE QUESTIONS

### NCERT

**172** The IUPAC names of the products obtained by the ozonolysis of 1-phenylbut-1-ene are

- propanal and benzaldehyde
- propanoic acid and benzoic acid
- propanal and benzoic acid
- propanoic acid and benzaldehyde

**173** The addition of HBr to 1-butene gives a mixture of products *A*, *B* and *C*.



The mixture consists of

- A* and *B* as major and *C* as minor products
- B* as major, *A* and *C* as minor products
- B* as minor, *A* and *C* as major products
- A* and *B* as minor and *C* as major products

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

- Prop-1-ene
- But-2-ene
- But-1-ene
- Both (b) and (c)

**175** Arrange benzene, *n*-hexane and ethyne in decreasing order of acidic behaviour.

- Benzene > hexane > ethyne
- Benzene > ethyne > hexane
- Ethyne > benzene > hexane
- Hexane > benzene > ethyne

**176** The structures of alkenes which on hydrogenation give 2-methyl butane are

- $$\begin{array}{c} \text{CH}_3 \\ | \\ \text{CH}_2 = \text{C} \text{---} \text{CH}_2 \text{---} \text{CH}_3, \quad \text{CH}_3 \text{---} \text{C} = \text{CH} \text{---} \text{CH}_3, \\ | \\ \text{CH}_3 \\ \text{CH}_3 \text{---} \text{CH} \text{---} \text{CH} = \text{CH}_2 \end{array}$$
- $\text{CH}_2 = \text{CHCH}_2\text{CH}_3$
- $\text{CH}_3\text{CH}_2\text{CH} = \text{CH} \text{---} \text{CH}_3$
- $$\text{CH}_3\text{CH}_2 \text{---} \text{C} \text{---} \text{CH}_2\text{CH}_3 \\ || \\ \text{CH}_2$$

**177** Arrange the following set of compounds in order of their decreasing relative reactivity with an electrophile,  $E^+$ : chlorobenzene,

2, 4-dinitrochlorobenzene, *p*-nitrochlorobenzene

- chlorobenzene > 2, 4-dinitrochlorobenzene > *p*-nitrochlorobenzene
- chlorobenzene > *p*-nitrochlorobenzene > 2, 4-dinitrochlorobenzene
- p*-nitrochlorobenzene > chlorobenzene > 2, 4-dinitrochlorobenzene
- 2, 4-dinitrochlorobenzene > *p*-nitrochlorobenzene > chlorobenzene

### NCERT Exemplar

**178** Arrange the following in decreasing order of their boiling points.

- A.* *n*-butane                      *B.* 2-methylbutane  
*C.* *n*-pentane                      *D.* 2, 2-dimethylpropane

- $A > B > C > D$
- $B > C > D > A$
- $D > C > B > A$
- $C > B > D > A$

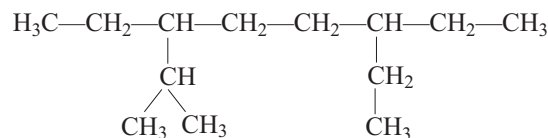
**179** Arrange the halogens  $\text{F}_2$ ,  $\text{Cl}_2$ ,  $\text{Br}_2$ ,  $\text{I}_2$  in order of their increasing reactivity with alkanes.

- $\text{I}_2 < \text{Br}_2 < \text{Cl}_2 < \text{F}_2$
- $\text{Br}_2 < \text{Cl}_2 < \text{F}_2 < \text{I}_2$
- $\text{F}_2 < \text{Cl}_2 < \text{Br}_2 < \text{I}_2$
- $\text{Br}_2 < \text{I}_2 < \text{Cl}_2 < \text{F}_2$

**180** The increasing order of reduction of alkyl halides with zinc and dil. HCl is

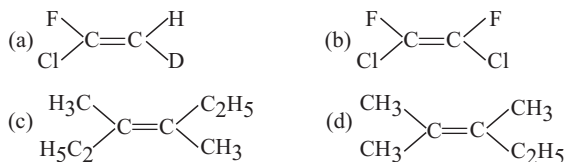
- $R\text{---Cl} < R\text{---I} < R\text{---Br}$
- $R\text{---Cl} < R\text{---Br} < R\text{---I}$
- $R\text{---I} < R\text{---Br} < R\text{---Cl}$
- $R\text{---Br} < R\text{---I} < R\text{---Cl}$

**181** The correct IUPAC name of the following alkane is



- 3,6-diethyl-2-methyloctane
- 5-isopropyl -3-ethyloctane
- 3-ethyl-5-isopropyloctane
- 3-isopropyl-6-ethyloctane

**182** Which of the following will not show geometrical isomerism?



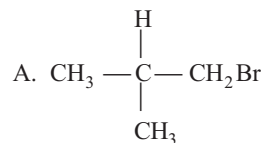
**183** Arrange the following hydrogen halides in order of their decreasing reactivity with propene.

- (a)  $\text{HCl} > \text{HBr} > \text{HI}$  (b)  $\text{HBr} > \text{HI} > \text{HCl}$   
 (c)  $\text{HI} > \text{HBr} > \text{HCl}$  (d)  $\text{HCl} > \text{HI} > \text{HBr}$

**184** Arrange the following carbanions in order of their decreasing stability.

- A.  $\text{H}_3\text{C}-\text{C}\equiv\text{C}^-$  B.  $\text{H}-\text{C}\equiv\text{C}^-$   
 C.  $\text{H}_3\text{C}-\text{CH}_2^-$   
 (a)  $A > B > C$  (b)  $B > A > C$   
 (c)  $C > B > A$  (d)  $C > A > B$

**185** Arrange the following alkyl halides in decreasing order of the rate of  $\beta$ -elimination reaction with alc. KOH.

- A.  B.  $\text{CH}_3-\text{CH}_2-\text{Br}$   
 C.  $\text{CH}_3-\text{CH}_2-\text{CH}_2-\text{Br}$   
 (a)  $A > B > C$  (b)  $C > B > A$   
 (c)  $B > C > A$  (d)  $A > C > B$

**186** Which of the following reactions of methane is incomplete combustion

- (a)  $2\text{CH}_4 + \text{O}_2 \xrightarrow{\text{Cu}/523\text{ K}/100\text{ atm}} 2\text{CH}_3\text{OH}$   
 (b)  $\text{CH}_4 + \text{O}_2 \xrightarrow{\text{Mo}_2\text{O}_3} \text{HCHO} + \text{H}_2\text{O}$   
 (c)  $\text{CH}_4 + \text{O}_2 \longrightarrow \text{C}(s) + 2\text{H}_2\text{O}(l)$   
 (d)  $\text{CH}_2 + 2\text{O}_2(g) + 2\text{H}_2\text{O}(l)$

■ **Direction** (Q.No. 187) *In the following questions, a statement of assertion (A) is followed by a corresponding statement of reason (R). Of the following statements, choose the correct one.*

- (a) Both A and R are correct; R is the correct explanation of A  
 (b) Both A and R are correct; R is not the correct explanation of A  
 (c) A is correct; R is incorrect  
 (d) R is correct but A is incorrect

**187 Assertion** (A) Toluene on Friedal Crafts methylation gives *o* and *p*-xylene.

**Reason** (R)  $\text{CH}_3$  group bonded to benzene ring increases electron density at *o* and *p*- position.

**188** Match the reagent from Column I which on reaction with  $\text{CH}_3-\text{CH}=\text{CH}_2$  gives some product given in Column II as per the codes given below :

Column I	Column II
A. $\text{O}_3 / \text{Zn} + \text{H}_2\text{O}$	1. Acetic acid and $\text{CO}_2$
B. $\text{KMnO}_4 / \text{H}^+$	2. Propan-1-ol
C. $\text{KMnO}_4 / \text{OH}^-$	3. Propan-2-ol
D. $\text{H}_2\text{O} / \text{H}^+$	4. Acetaldehyde and formaldehyde
E. $\text{B}_2\text{H}_6 / \text{NaOH}^+$ and $\text{H}_2\text{O}_2$	5. Propane-1, 2-diol

**Codes**

- A B C D E  
 (a) 1 3 2 4 5  
 (b) 2 4 1 3 5  
 (c) 4 1 5 3 2  
 (d) 5 4 3 2 1

**189** Match the reactions given in Column I with the reaction types in Column II.

Column I	Column II
A. $\text{CH}_2 = \text{CH}_2 + \text{H}_2 \xrightarrow{\text{H}^+} \text{CH}_3\text{CH}_2\text{OH}$	1. Hydrogenation
B. $\text{CH}_2 = \text{CH}_2 + \text{H}_2 \xrightarrow{\text{Pd}} \text{CH}_3-\text{CH}_3$	2. Halogenation
C. $\text{CH}_2 = \text{CH}_2 + \text{Cl}_2 \longrightarrow \text{Cl}-\text{CH}_2-\text{CH}_2-\text{Cl}$	3. Polymerisation
D. $3\text{CH}\equiv\text{CH} \xrightarrow[\text{Heat}]{\text{Cu tube}} \text{C}_6\text{H}_6$	4. Hydration

**Codes**

- A B C D  
 (a) 1 2 3 4  
 (b) 4 1 2 3  
 (c) 3 4 1 2  
 (d) 2 3 4 1

**190** Match the hydrocarbons in Column I with the boiling points given in Column II.

Column I	Column II
A. <i>n</i> -pentane	1. 282.5 K
B. <i>iso</i> -pentane	2. 309 K
C. <i>neo</i> -pentane	3. 301 K

**Codes**

- A B C A B C  
 (a) 1 3 2 (b) 2 3 1  
 (c) 2 1 3 (d) 3 2 1

# Answers

## > Mastering NCERT with MCQs

1 (b)	2 (d)	3 (d)	4 (b)	5 (a)	6 (c)	7 (d)	8 (c)	9 (b)	10 (a)
11 (c)	12 (c)	13 (d)	14 (b)	15 (d)	16 (a)	17 (d)	18 (a)	19 (d)	20 (a)
21 (b)	22 (c)	23 (b)	24 (b)	25 (b)	26 (b)	27 (d)	28 (d)	29 (d)	30 (b)
31 (d)	32 (b)	33 (a)	34 (c)	35 (a)	36 (d)	37 (c)	38 (c)	39 (d)	40 (d)
41 (c)	42 (a)	43 (a)	44 (a)	45 (a)	46 (b)	47 (b)	48 (c)	49 (d)	50 (d)
51 (a)	52 (a)	53 (a)	54 (d)	55 (c)	56 (a)	57 (a)	58 (c)	59 (c)	60 (b)
61 (a)	62 (c)	63 (a)	64 (b)	65 (a)	66 (d)	67 (c)	68 (d)	69 (c)	70 (b)
71 (a)	72 (a)	73 (d)	74 (a)	75 (c)	76 (b)	77 (a)	78 (c)	79 (a)	80 (c)
81 (c)	82 (b)	83 (c)	84 (d)	85 (a)	86 (d)	87 (d)	88 (c)	89 (b)	90 (c)
91 (b)	92 (d)	93 (b)	94 (a)	95 (a)	96 (b)	97 (c)	98 (b)	99 (b)	100 (c)
101 (c)	102 (b)	103 (b)	104 (d)	105 (c)	106 (b)	107 (d)	108 (b)	109 (d)	110 (a)
111 (d)	112 (a)	113 (a)	114 (b)	115 (c)	116 (b)	117 (a)	118 (c)	119 (b)	120 (d)
121 (a)	122 (c)	123 (a)	124 (a)	125 (c)	126 (c)	127 (c)	128 (a)	129 (d)	130 (b)
131 (a)	132 (c)	133 (c)	134 (c)	135 (b)	136 (a)	137 (b)	138 (a)	139 (c)	140 (b)
141 (a)	142 (b)								

## > Special Types Questions

143 (c)	144 (a)	145 (d)	146 (b)	147 (a)	148 (d)	149 (d)	150 (d)	151 (a)	152 (c)
153 (c)	154 (b)	155 (b)	156 (d)	157 (d)	158 (a)	159 (b)	160 (c)	161 (b)	162 (b)
163 (a)	164 (a)	165 (d)	166 (b)	167 (b)	168 (c)	169 (a)	170 (a)	171 (a)	

## > NCERT & NCERT Exemplar Questions

172 (a)	173 (a)	174 (b)	175 (c)	176 (a)	177 (b)	178 (d)	179 (a)	180 (b)	181 (b)
182 (d)	183 (c)	184 (b)	185 (d)	186 (c)	187 (a)	188 (c)	189 (b)	190 (b)	



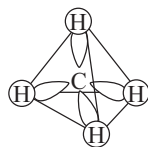
## Hints & Explanations

2 (d) Petrol, diesel and kerosene oil all are obtained by the distillation of petroleum.

4 (b) If carbon atoms form a closed chain in the compound then the compound is known as cycloalkanes.

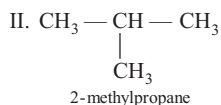
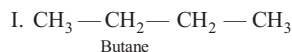
6 (c) Alkanes are known as paraffins because these are inert under normal conditions as they do not react with acids, bases and other reagents.

7 (d) According to VSEPR theory, methane ( $\text{CH}_4$ ) has a tetrahedral structure, in which carbon atom lies at the centre and the four hydrogen atoms lie at the corners of a regular tetrahedron.

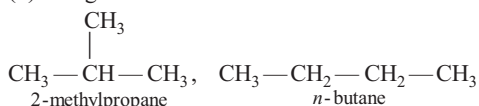


8 (c) Butane ( $\text{C}_4\text{H}_{10}$ ) has two chain isomers.

These are as follows :

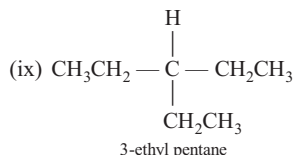
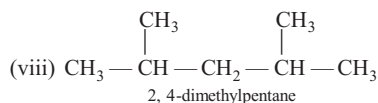
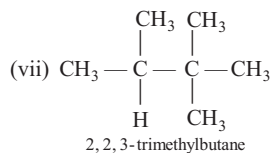
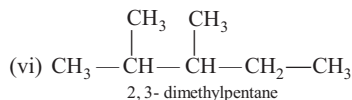
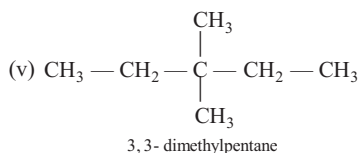
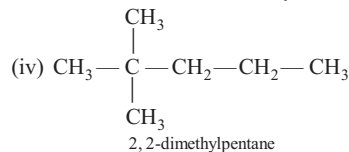
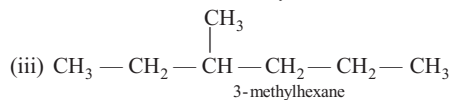
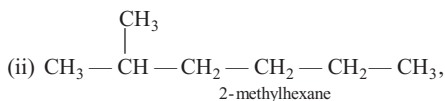
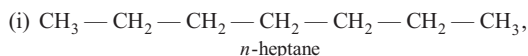


9 (b) The given isomers are :



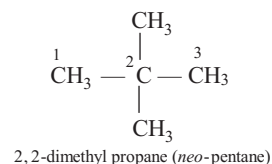
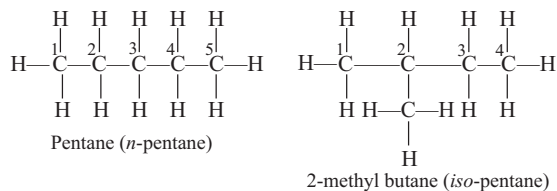
Since, their molecular formulas are same but the chain of C-atoms is different, these are chain isomers.

10 (a)  $\text{C}_7\text{H}_{16}$  has 9 chain isomers. These are as follows :

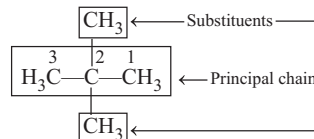


So, the number of chain isomers of  $\text{C}_7\text{H}_{16}$  is nine.

11 (c) Five C atoms and twelve H atoms of  $\text{C}_5\text{H}_{12}$  can be joined in following three ways :

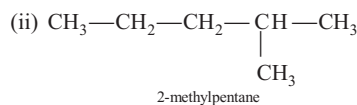
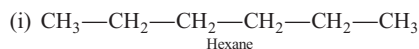


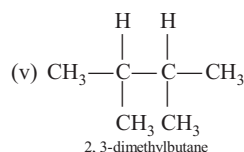
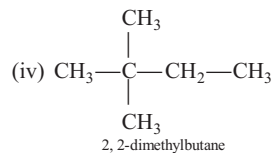
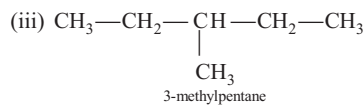
12 (c) The IUPAC name of the given compound is 2, 2-dimethylpropane.



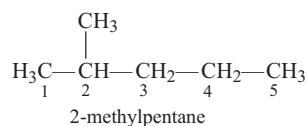
13 (d) Possible structural isomers for  $\text{C}_6\text{H}_{14}$  are five.

These are as shown below :



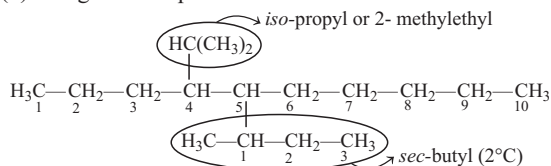


- 14 (b)** Numbering of substituent in the given compound is done according to lowest locant rule as shown below :



Thus, the IUPAC name of the given compound is 2-methylpentane.

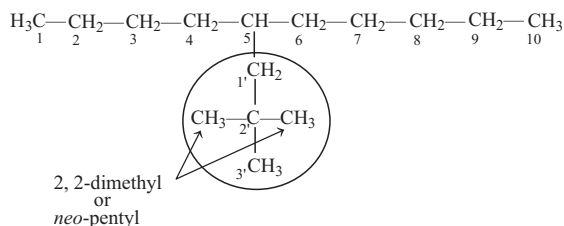
- 15 (d)** The given compound is shown below :



The IUPAC name of the compound is 5-*sec*-butyl-4-*iso*-propyldecane or 4-(1-methylethyl)-5-(1-methylpropyl)-decane

Although, IUPAC name for *sec*-butyl and *isopropyl* groups are 1-methylpropyl and 1-methylethyl respectively yet both these names, are also recommended for IUPAC nomenclature.

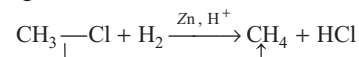
- 16 (a)** The given compound is shown below :



The IUPAC name of the compound is 5-(2, 2-dimethylpropyl)-decane or 5-*neo*-pentyldecane  
[∵ The IUPAC name for *neo*-pentyl group is 2, 2-dimethyl propyl.]

- 18 (a)** All alkyl halides undergo reduction process except alkyl fluorides, because of high electronegativity and small size of fluoride ion.

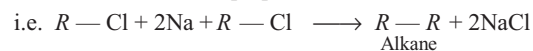
- 19 (d)** The given reaction is shown below :



Reaction involves addition of hydrogen and removal of electronegative element (Cl)

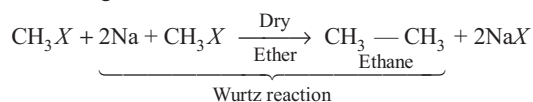
This reaction is an example of reduction process.

- 20 (a)** By Wurtz reaction, higher alkanes with even number of carbon atoms can be prepared.



Thus, methane cannot be prepared by this reaction.

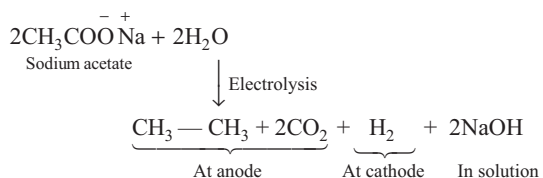
- 21 (b)** The reaction of methyl halide with Na in the dry ether is given below :



Thus, ethane is formed in the above reaction.

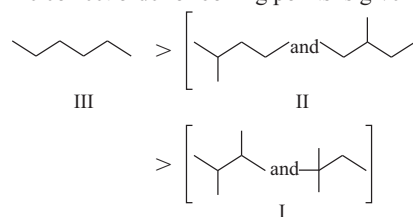
- 24 (b)** Kolbe's electrolytic method is used to synthesise alkanes having even number of carbon atoms. In this method, an aqueous solution of sodium or potassium salt of a carboxylic acid undergoes electrolysis to give alkane.

- 25 (b)** On electrolysis of sodium acetate with water, following reactions take place :



The products formed at anode are ethane and  $\text{CO}_2$ .

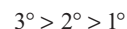
- 26 (b)** The correct order of boiling points is given below :



On moving from left to right (III to I), branching increases, surface area decreases and hence, boiling point decreases.

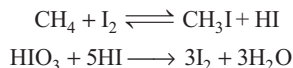
- 28 (d)** Reaction (d) is a termination step in halogenation. This step stops the consumption of reactants and/or chain is terminated as free radicals are consumed.

- 29 (d)** In halogenation process, rate of replacement of hydrogens of alkanes is as follows :

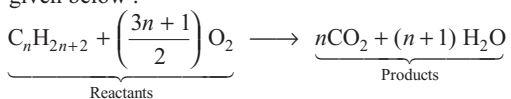


This is because  $3^\circ$  H is more reactive than  $2^\circ$  H, which in turn is more reactive than  $1^\circ$  H.

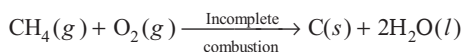
- 30 (b)** Iodination is very slow and a reversible reaction. It can be carried out in the presence of oxidising agents like  $\text{HIO}_3$  or  $\text{HNO}_3$  which oxidises the HI formed into  $\text{I}_2$  as shown below :



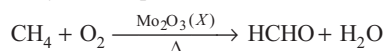
- 31 (d)** The general combustion equation for any alkane is given below :



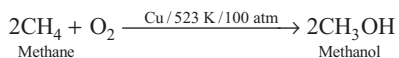
- 32 (b)** During incomplete combustion of alkanes with insufficient amount of air or dioxygen, carbon black is formed. The reaction involved is as follows :



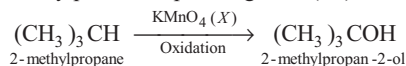
- 33 (a)**  $\text{Mo}_2\text{O}_3(X)$  acts as a catalyst to oxidise methane to formaldehyde. Complete reaction is as follows :



$\text{Cu}/523\text{K}/100 \text{ atm}$  oxidises methane to methanol. The reaction is as follows :

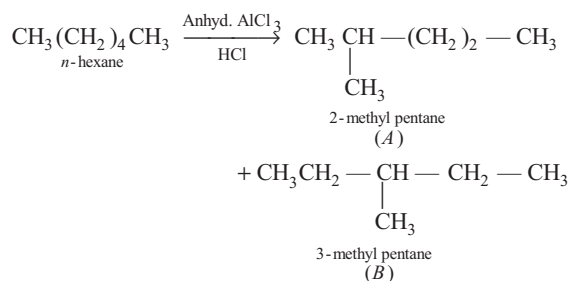


- 34 (c)** Generally, alkanes resist oxidation but alkanes having tertiary H-atom can be easily oxidised to corresponding alcohols by potassium permanganate ( $X$ ).



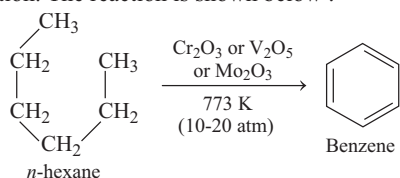
So,  $X$  is  $\text{KMnO}_4$ .

- 35 (a)** The given reaction represents isomerisation reaction as shown below :

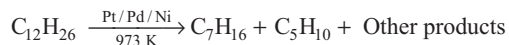


Here,  $A$  and  $B$  are chain isomers of each other.

- 36 (d)** The reaction of conversion of  $n$ -hexane to benzene in the presence of oxides of V, Mo or Cr supported by alumina is called aromatisation reaction or reforming reaction. The reaction is shown below :



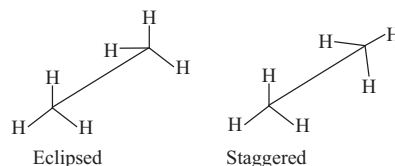
- 37 (c)** Dodecane ( $\text{C}_{12}\text{H}_{26}$ ) on heating to  $973\text{K}$  in the presence of Pt, Pd, Ni gives a mixture of heptane, pentene and other products. Reaction involved is as follows :



The principle involved in this reaction is pyrolysis.

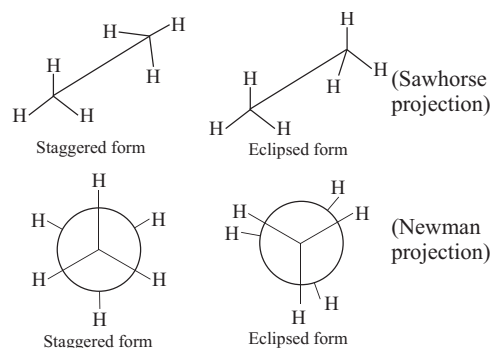
- 38 (c)** Cracking is the process of breaking a heavier hydrocarbon into two or more smaller hydrocarbons. Liquid hydrocarbon can be converted into a mixture of gaseous hydrocarbon by cracking.

- 39 (d)** Difference in spatial arrangement of atoms around C—C bond is known as conformations, conformers or rotamers. e.g. conformations of ethane are given below :



- 40 (d)** Infinite number ( $\infty$ ) of conformations/rotamers of ethane are possible due to rotation around C—C single bond by every small change in angle between two C—H bonds.

- 41 (c)** Eclipsed and staggered conformations of ethane can be represented as Sawhorse and Newman projections as shown below :



- 42 (a)** Conformation of ethane in which hydrogen atoms attached to two carbons are as close together as possible is called eclipsed conformation and the other in which hydrogens are as far apart as possible is known as the staggered conformation. Any other intermediate conformation is called a skew conformation.

**Note** In all the conformations, the bond angles and the bond lengths remain the same.

- 44 (a)** The staggered form of ethane has the least torsional strain because the repulsive interaction between the electron clouds, which affects the stability of conformation, is the least and the eclipsed form has the maximum torsional strain.

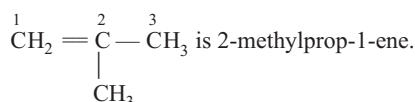
**45 (b)** Among the given structures, structure (a) and (b) are staggered forms of ethane-1, 2 diol. On the other hand, structure (c) and (d) are eclipsed forms of ethane-1, 2-diol. Eclipsed forms are less stable than staggered forms due to electronic repulsion.

Between (a) and (b), structure (b) shows H-bonding due to which it is more stable than structure (a).

Hence, option (b) is correct.

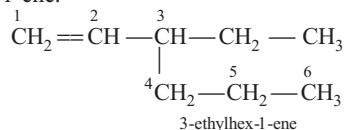
**48 (c)** C—C double bond in alkenes consist of one strong  $\sigma$ -bond (bond enthalpy about  $397 \text{ kJ mol}^{-1}$ ) due to head on overlapping of  $sp^2$ -hybridised orbitals and one weak  $\pi$ -bond (bond enthalpy about  $284 \text{ kJ mol}^{-1}$ ) obtained by lateral or sideways overlapping of the two  $2p$ -orbitals of the two C-atoms.

**49 (d)** The IUPAC name of the compound

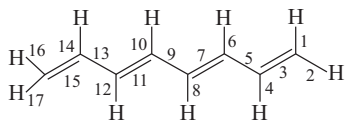


**50 (d)** For naming the given compound, the longest possible carbon chain is selected, numbered according to IUPAC rules.

Thus, the correct IUPAC name of the given compound is 3-ethylhex-1-ene.

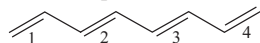


**51 (a)** A single bond is always a  $\sigma$ -bond and a double bond contains one  $\sigma$  and one  $\pi$ -bond. The  $\sigma$ -bonds can be represented as shown below :



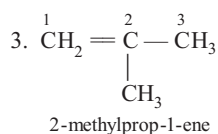
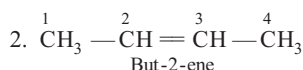
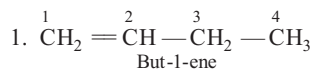
Hence, 17 $\sigma$ -bonds are present.

The  $\pi$ -bonds can be represented as shown below.



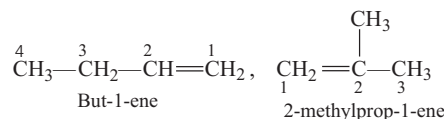
Hence, 4 $\pi$ -bonds are present.

**52 (a)** Structural isomers of molecular formula  $\text{C}_4\text{H}_8$  can be written in the following three ways :



Hence, the number of structural isomers is 3.

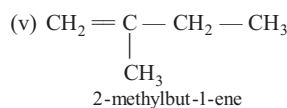
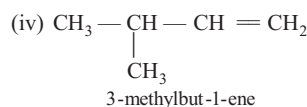
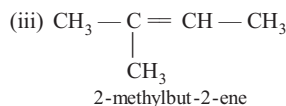
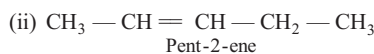
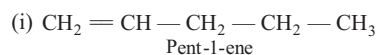
**53 (a)** The structures of the given compounds are shown below :



These compounds have different carbon chains.

Hence, they are examples of chain isomers.

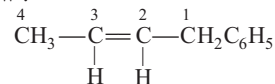
**54 (d)** Possible structural isomers of  $\text{C}_5\text{H}_{10}$  are :



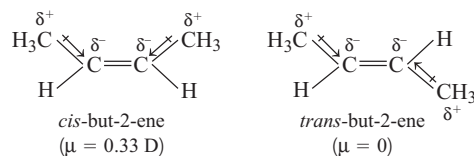
Hence, 2, 3-dimethylpropene is not a structural isomer of  $\text{C}_5\text{H}_{10}$ .

**55 (c)** The type of isomerism exhibited by given isomers (a) and (b) is geometrical isomerism and they both are geometrical isomers. In these molecules, the restricted rotation of atoms or groups around the doubly bonded carbon atoms gives rise to different geometries of the compounds.

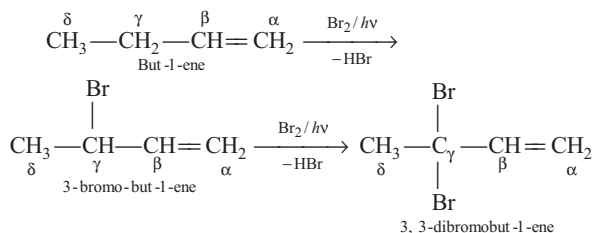
**56 (a)** The compound 1-phenyl-2-butene exhibits geometrical isomerism. The structure of compound is given below :



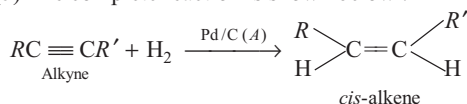
**57 (a)** *cis*-form of alkene is found to be more polar than *trans*-form. e.g. dipole moment of *cis*-but-2-ene is 0.33 Debye, whereas dipole moment of the *trans* form is almost zero or it can be said that *trans*-but-2-ene is non-polar as shown below :



**58 (c)** The compound (*E*) has two allyl-hydrogen atoms ( $\gamma$ ). When *E* reacts with  $\text{Br}_2/h\nu$ , it readily undergoes allylic free radical substitution and forms 3, 3-dibromobut-1-ene

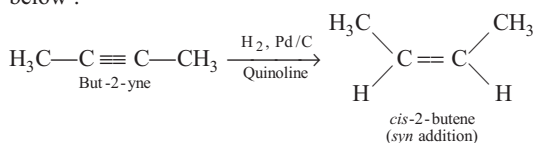


60 (b) The complete reaction is shown below :

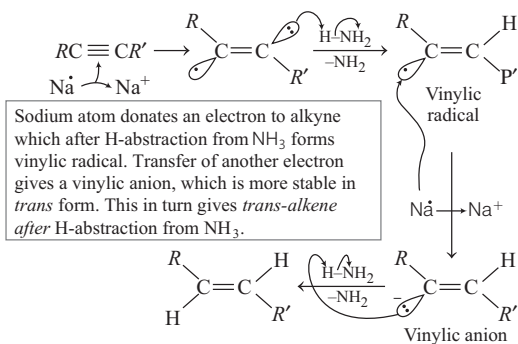


Reduction of alkyne using Pd/C gives *cis*-alkene as major product whereas reduction by using Na in liquid ammonia gives *trans*-alkene as major product.

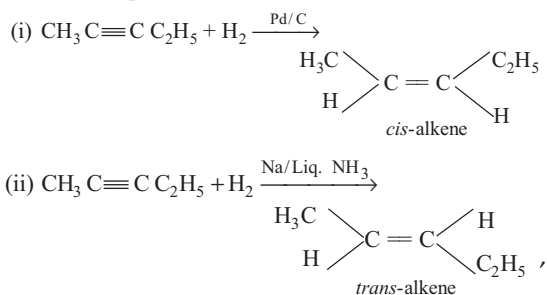
61 (a) Hydrogenation of alkynes in the presence of Pd/C, quinoline proceeds through *syn* addition of hydrogen and the alkene thus formed has *cis*-configuration as shown below :



62 (c) Sodium metal in liquid ammonia reduces alkynes with anti stereochemistry to give *trans* alkenes. The reduction is selectively *anti* since the vinyl radical formed during reduction is more stable in *trans* configuration.

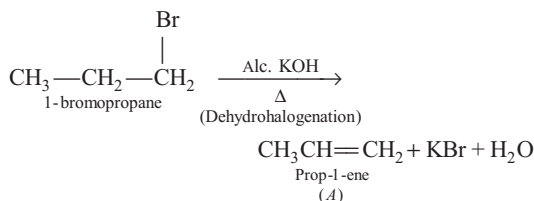


63 (a) The complete reactions are shown below :



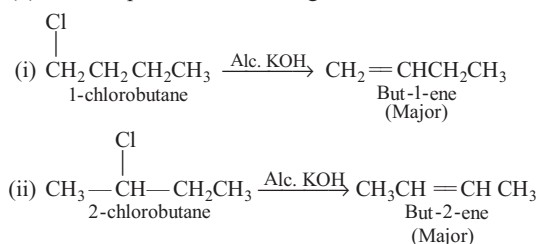
Hydrogenation of alkynes in the presence of Pd/C forms *cis*-alkene as the major product, whereas hydrogenation in the presence of Na in liquid NH<sub>3</sub> forms *trans*-alkene as the major product.

65 (a) The complete reaction is shown below :



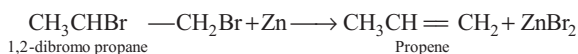
Hence, A is CH<sub>2</sub> = CH—CH<sub>3</sub>.

66 (d) The complete reactions are given below :

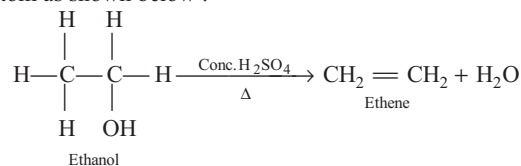


Hence, mixture of but-1-ene and but-2-ene is formed.

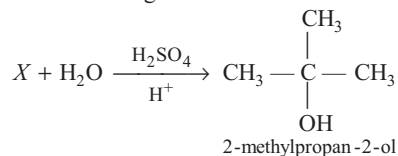
67 (c) Dihalides in which two halogen atoms are attached to two adjacent carbon atoms are known as *vicinal* dihalides. On reaction with Zn, these form alkene by losing a molecule of ZnX<sub>2</sub> as shown below :



68 (d) In the given reaction, water molecule is eliminated from the alcohol molecule in the presence of an acid. This reaction is known as acidic dehydration of alcohols. It is also an example of β-elimination reaction since —OH group takes out one hydrogen atom from β-carbon atom as shown below :

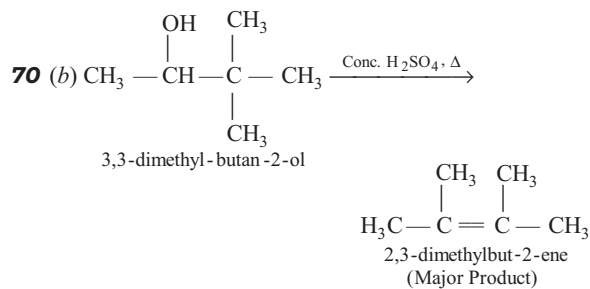


69 (c) The reaction is given below :

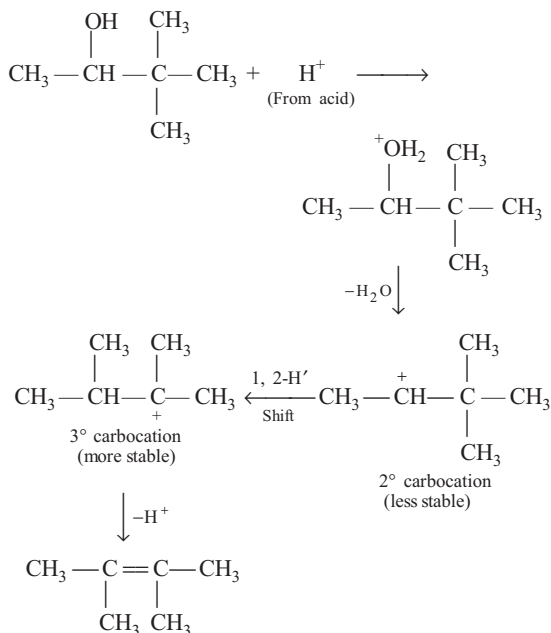


Formation of 2-methylpropan-2-ol confirms that H<sup>+</sup>/OH<sup>-</sup> is added to X and as H<sub>2</sub>O is removed from this compound.

So, X is CH<sub>3</sub> — C = CH<sub>2</sub>, that is 2-methylpropene.

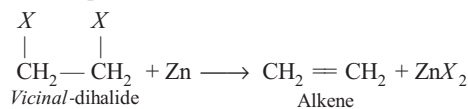


The reaction takes place by the following mechanism :



Hence, the major product formed is 2, 3-dimethylbut-2-ene.

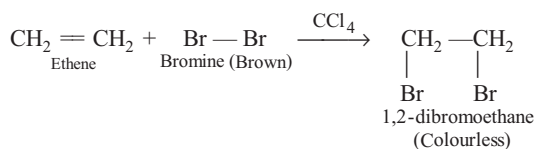
71 (a) The complete reaction is shown below :



Hence, a molecule of  $\text{ZnX}_2$  is lost by the vicinal dihalide to form an alkene.

72 (a) Alkenes are the rich source of loosely held pi ( $\pi$ ) electrons, due to which they show addition reactions in which the electrophiles add on to the C—C double bond to form an addition product.

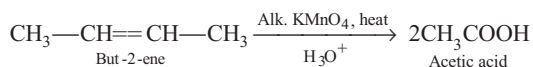
73 (d) The complete reaction is shown below :



74 (a) As the size of halogen atom increases, H—X bond length increases, thus reactivity increases. Hence, the

order of reactivity of hydrogen halides towards alkenes is  $\text{HI} > \text{HBr} > \text{HCl}$ .

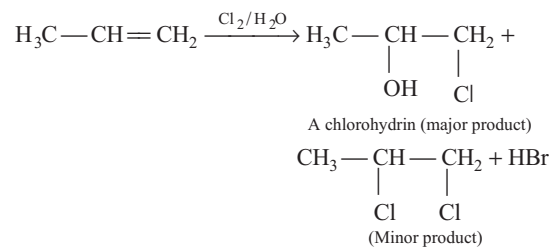
75 (c) But-2-ene on reaction with alkaline  $\text{KMnO}_4$  at elevated temperature followed by acidification will give acetic acid ( $\text{CH}_3\text{COOH}$ ). Hot alkaline solution of potassium permanganate followed by acidification oxidatively cleaved alkenes. The reaction proceed as follows :



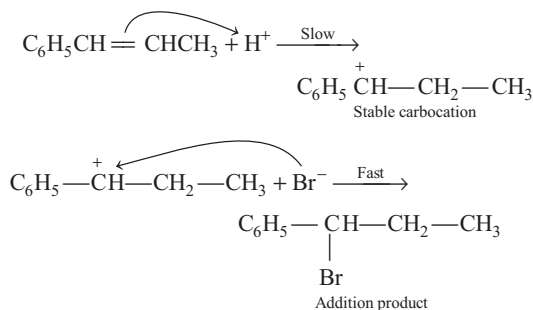
76 (b) The major product of the given addition reaction is  $\text{H}_3\text{C}-\underset{\text{OH}}{\text{CH}}-\underset{\text{Cl}}{\text{CH}_2}$ . In this reaction,

$\text{H}_2\text{O}$  is used as a solvent and the major product of the reaction will be a vicinal halohydrin.

The reaction occurs as follows :



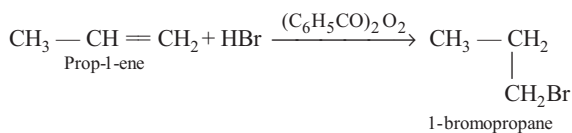
77 (a) The reaction proceeds *via* the following steps :



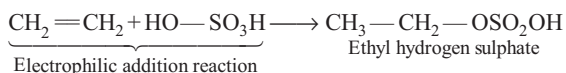
Electrophilic addition reaction takes place *via* more stable carbocation.

78 (a) In the presence of peroxide, addition of HBr to unsymmetrical alkenes like propene takes place contrary to the Markovnikov's rule. This happens only with HBr but not with HCl and HI. This reaction is known as peroxide or Kharash effect or anti-Markovnikov's rule.

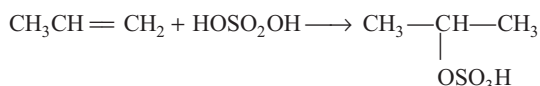
The reaction is shown below :



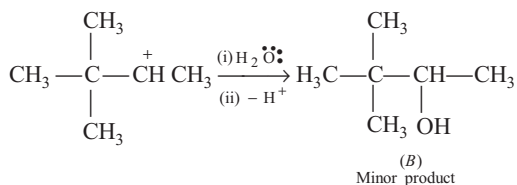
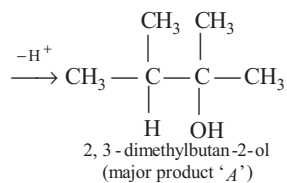
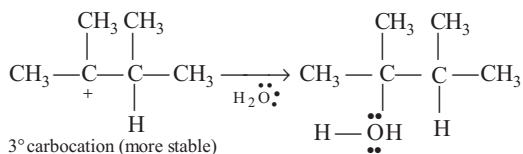
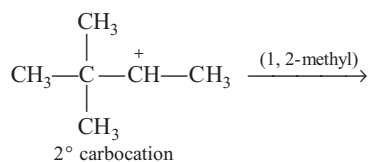
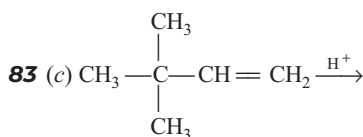
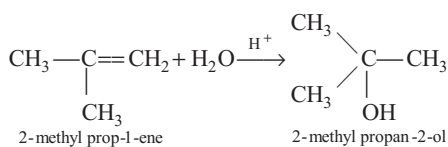
**80 (c)** Cold conc.  $\text{H}_2\text{SO}_4$  adds to alkenes electrophilic addition reaction in accordance with Markovnikov's rule to form alkyl hydrogen sulphate.



**81 (c)** The product obtained is propyl hydrogen sulphate. The reaction is given as follows :

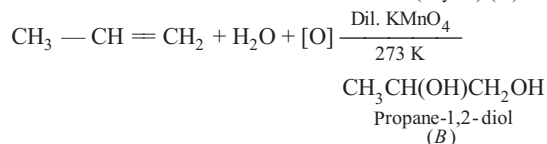
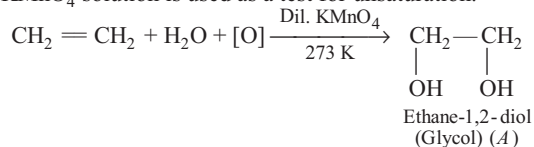


**82 (b)** In the presence of few drops of conc.  $\text{H}_2\text{SO}_4$ , alkenes react with water to form alcohols, in accordance with Markovnikov's rule. The reaction of water in the presence of conc.  $\text{H}_2\text{SO}_4$  with 2-methylpropene is given below :



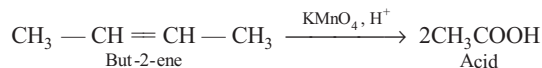
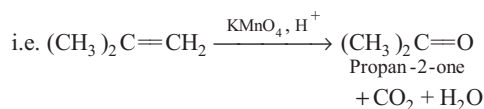
So, *A* is 2, 3-dimethylbutan-2-ol and *B* is 3,3-dimethylbutan-2-ol.

**84 (d)** Alkenes on reaction with cold, dilute, aqueous solution of potassium permanganate (Baeyer's reagent) produce *vicinal* glycols. Decolorisation of  $\text{KMnO}_4$  solution is used as a test for unsaturation.

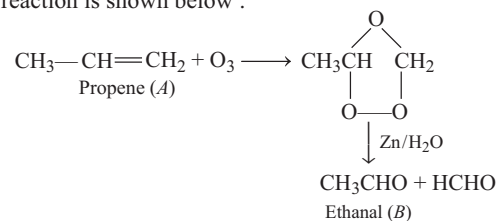


So, *A* is ethane-1, 2-diol and *B* is propane-1, 2-diol.

**85 (a)** Acidic potassium permanganate ( $\text{KMnO}_4$ ) or acidic  $\text{K}_2\text{Cr}_2\text{O}_7$  oxidises alkenes to produce ketones and/or acids depending upon the nature of alkenes as shown below :

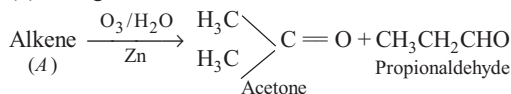


**86 (d)** Ozonolysis takes place in alkenes. So, *A* will be a double bond containing compound. The complete reaction is shown below :

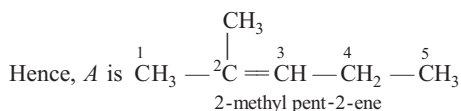


So, *A* is propene and *B* is ethanal.

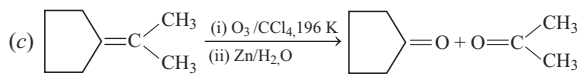
**87 (d)** The given reaction is shown below :



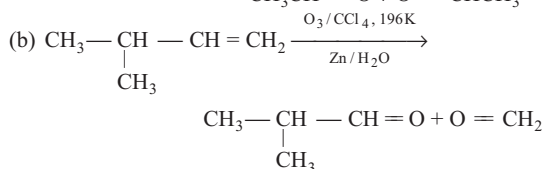
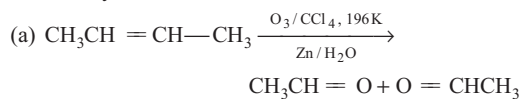
Formation of ketone confirms that double bond is present at second carbon (C-2) atom and formation of propionaldehyde confirms that three carbon atoms are attached with (C-2) double bond.



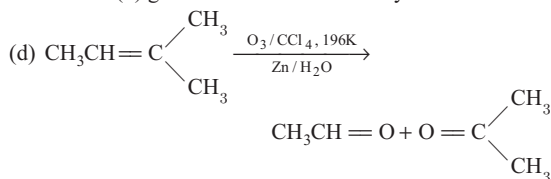
**88 (c)** Alkenes which have two substituents on each C-atom of the double bond, give mixture of ketones on ozonolysis. Thus, option (c) gives mixture of ketones as shown below :



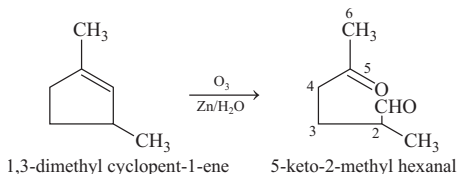
On the other hand, alkenes (a) and (b) give a mixture of two aldehydes.



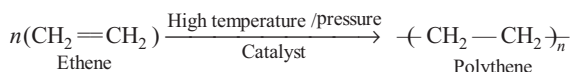
Alkene (d) gives a mixture of an aldehyde and a ketone.



- 89 (b) The compound (b) on ozonolysis gives 5-keto-2-methyl hexanal as shown below :



- 90 (c) Polythene is obtained by the combination of large number of ethene molecules at high temperature, high pressure and in the presence of a catalyst. The large molecules thus obtained are called polymers. This reaction is known as polymerisation as shown below :



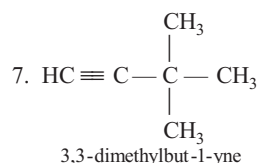
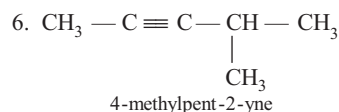
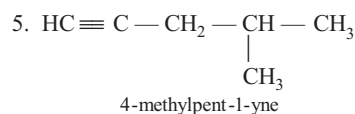
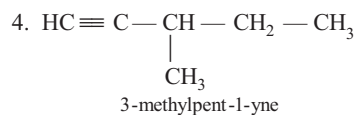
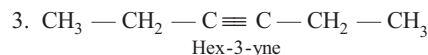
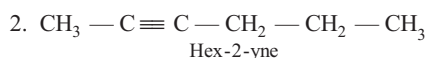
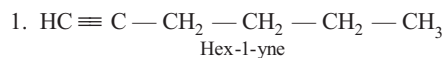
- 92 (d) The given compound is  $\text{H}_3\text{C}-\underset{\text{CH}_3}{\text{CH}}-\overset{4}{\text{C}}-\overset{3}{\text{CH}}-\overset{2}{\text{C}}\equiv\overset{1}{\text{C}}\text{H}$

The IUPAC name of the given compound is 3-methyl but-1-yne.

- 93 (b) The given compound is  $\text{CH}_3-\text{CH}_2-\text{C}\equiv\text{CH}$ .

The common name is ethylacetylene and IUPAC name is but-1-yne.

- 94 (a) Possible isomers of  $\text{C}_6\text{H}_{10}$  are 7. These are as shown below :

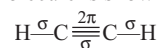


- 95 (a) The molecule of ethyne is shown below



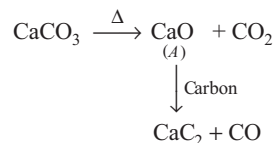
The shape of ethyne is linear. ( $\therefore sp$ -hybridised)

- 96 (b) The ethyne molecule is shown below :



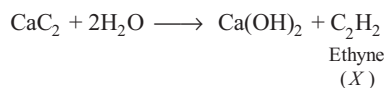
The number of  $\sigma$  bonds is 3 and the number of  $\pi$ -bonds is 2.

- 97 (c) The complete reaction is shown below.



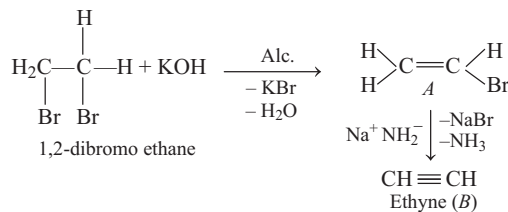
Hence, A is CaO.

- 98 (b) The complete reaction is shown below :



Hence, X is ethyne.

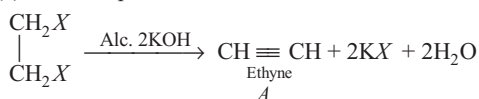
- 99 (b) Vicinal dihalides on treatment with alcoholic potassium hydroxide undergo dehydrohalogenation. One molecule of hydrogen halide is eliminated to form alkenyl halide which on treatment with sodamide gives alkyne.



Hence, A is  $\text{CH}_2=\text{CHBr}$  and B is  $\text{CH}\equiv\text{CH}$ .



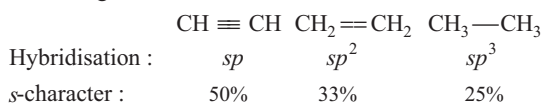
100 (c) The complete reaction is shown below :



101 (c) Due to the maximum percentage of *s*-character (50%), the *sp*-hybridised orbitals of carbon atoms in ethyne molecules have highest electronegativity. Hence, these attract the shared electron pair of the C—H bond of ethyne to a greater extent than the *sp*<sup>2</sup>-hybridised orbitals.

Thus, H atom of ethyne can be liberated as proton more easily as compared to ethene and ethane and, hence are acidic.

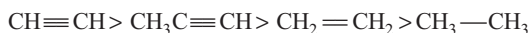
102 (b) Greater the *s*-character of C-atom in hydrocarbons, greater the electronegativity of that carbon and, thus greater the acidic nature of the H attached to electronegative carbon.



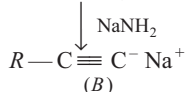
Electronegativity : ←————— Max.

Acidic character of terminal H ←————— Max.

Thus, the correct order of acidity is given below :

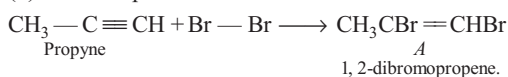


103 (b)  $R - \text{C} \equiv \text{CH} \xrightarrow[\text{H}_2]{\text{Pt/Pd/Ni}}$   $R - \text{CH} = \text{CH}_2$   
Terminal alkyne (A)



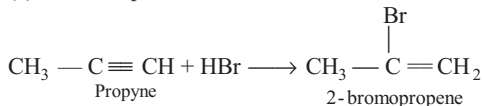
Thus, A is  $R - \text{CH} = \text{CH}_2$  and B is  $R - \text{C} \equiv \text{C}^- \text{Na}^+$ .

104 (d) The complete reaction is shown below.



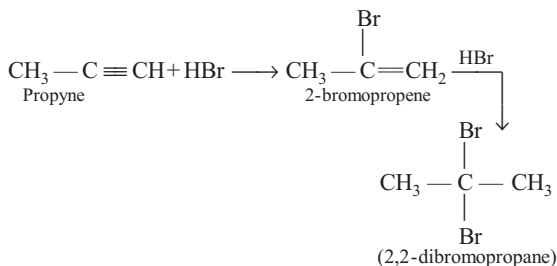
Thus, A is  $\text{CH}_3\text{CBr} = \text{CHBr}$ .

105 (c) The complete reaction is shown below :

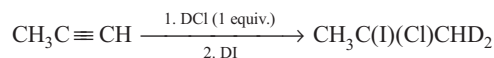


Thus, product is 2-bromopropene.

106 (b) Reaction (b) will yield 2,2-dibromopropane.

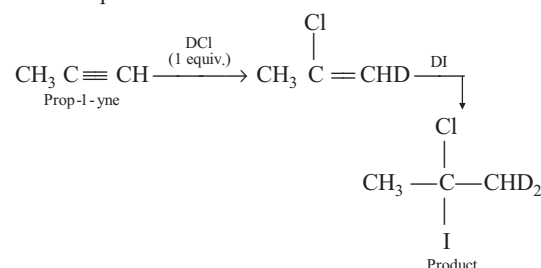


107 (d) The major product obtained in the given reaction is  $\text{CH}_3\text{C}(\text{I})(\text{Cl})\text{CHD}_2$ .

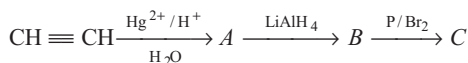


Addition in unsymmetrical alkynes takes place according to Markovnikov's rule.

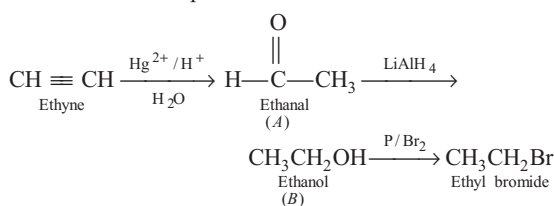
Reaction proceed as follows :



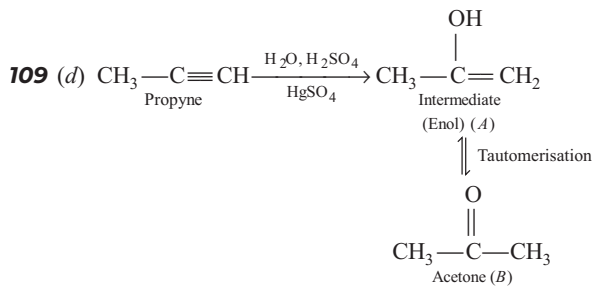
108 (b) The given road map problem is :



The reaction takes place as follows :



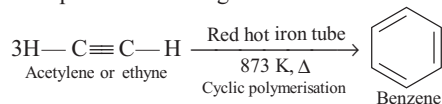
Thus, C is  $\text{CH}_3\text{CH}_2 - \text{Br}$ .



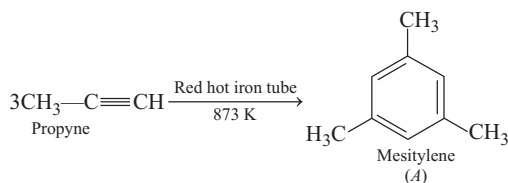
Thus, A =  $\text{CH}_3 - \text{C}(\text{OH}) = \text{CH}_2$ ; B =  $\text{CH}_3 - \text{C}(=\text{O}) - \text{CH}_3$

110 (a) Polymer polythene is represented as,  $(-\text{CH} = \text{CH} - \text{CH} = \text{CH})_n$

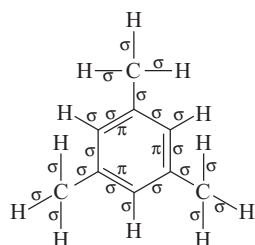
111 (d) The complete reaction is given below :



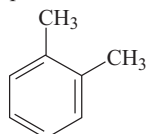
112 (a) Alkynes form aromatic compounds when their vapours are passed over red hot iron tube. The reaction is shown below :



The number of sigma ( $\sigma$ ) bonds present in the product (A) is 21 as shown below.

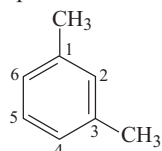


114 (b) The given compound is shown below :



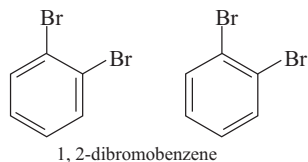
The common name of the compound is *o*-xylene and IUPAC name of the compound is 1,2-dimethylbenzene.

115 (c) The given compound is shown below :



The IUPAC name of the compound is 1,3-dimethylbenzene.

116 (b) The Kekule structure indicates the possibility of two isomeric 1,2-dibromobenzenes. In one of the isomers, the bromine atoms are attached to the doubly bonded carbon atoms, whereas in the other, they are attached to the singly bonded carbons as shown below :



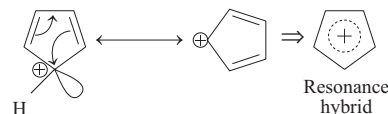
117 (c) In benzene, every carbon atom is  $sp^2$ -hybridised.



Each  $sp^2$ -hybridised atom has three  $sp^2$  hybrid orbitals.  
 $\therefore$  Total number of  $sp^2$  hybrid orbitals in a molecule of benzene is  $= 6 \times 3 = 18$

118 (c) Benzene forms a triozone which indicates the presence of three double bonds and reaction involves triozonolysis.

119 (b) Aromaticity of a compound can be decided by Huckel's rule. In cyclopentadienyl cation (b), resonance takes place as follows:



Hence, is anti-aromatic does not follow

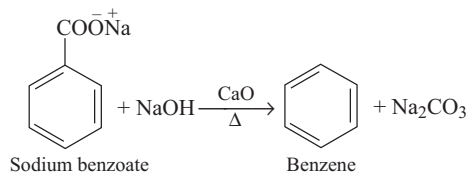
Huckel's rule as it has conjugated  $4\pi$ -electron ( $4n\pi$ ,  $n = 1$ ) system. Rest of the species are aromatic as each of them belongs to  $6\pi$ -electron [ $(4n + 2)\pi$ ,  $n = 1$ ] system.

120 (d) Aromaticity requires following conditions :

- (i) Planarity
- (ii) Complete delocalisation of  $\pi$ -electrons in the ring
- (iii) Presence of  $(4n + 2)\pi$ -electrons in the ring

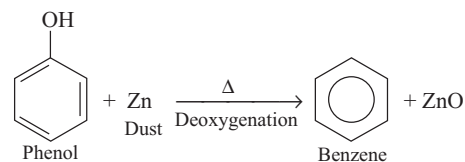
The compound is not aromatic as there is no delocalisation of pi ( $\pi$ ) electrons in the ring.

121 (a) The complete reaction is given as follows :



The above reaction is known as **decarboxylation of aromatic acids**.

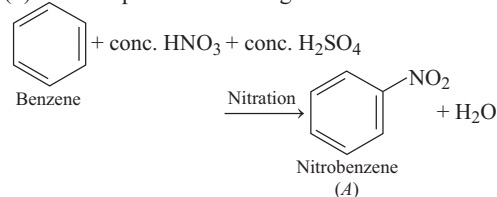
122 (c) The complete reaction is given as follows :



Benzene is formed as the final product.

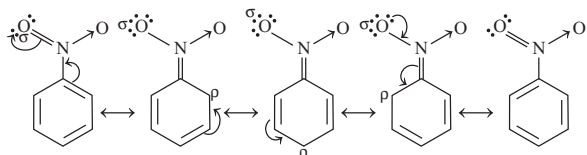
123 (a) For an electrophilic substitution reaction, the presence of halogen atom in the benzene ring deactivates the ring by inductive effect and increases the charge density at *ortho* and *para* -position relative to *meta*-position by resonance.

124 (a) The complete reaction is given below.



Thus, nitrobenzene is formed and the correct option is (a).

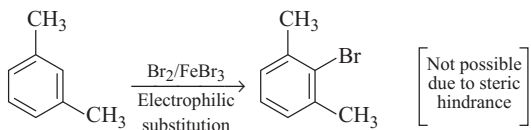
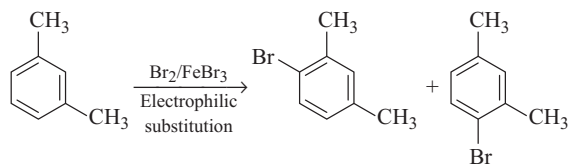
**125 (c)** Nitro group by virtue of  $-I$ -effect withdraws electron from the benzene ring and decreases the charge density on *ortho* and *para* position as shown below.



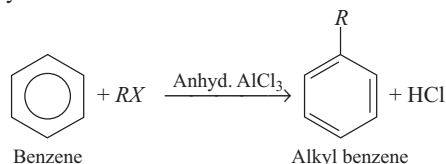
Thus, electron density decreases at *o/p*-positions in case of  $-\text{NO}_2$  and, hence the electrophile attacks at comparatively electron rich *meta*-position.

**126 (c)**  $-\text{CH}_3$  (an alkyl group) is an *ortho* and *para*-directing group, thus 2 isomeric products are formed.

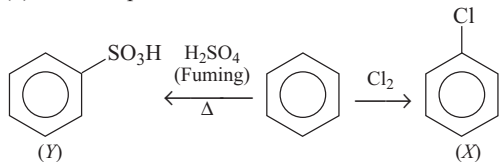
Out of these 2 products, *ortho* one is a minor product, while *para* product can be represented as :



**127 (c)** When benzene is treated with an alkyl halide in the presence of anhydrous aluminium chloride, alkylbenzene is formed. This reaction is called Friedel-Craft's alkylation reaction as shown below :



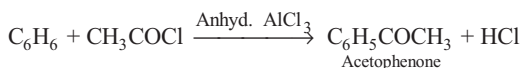
**128 (a)** The complete reaction is shown below.



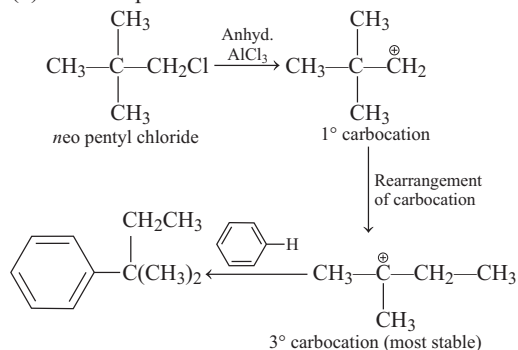
Hence, X is  $\text{C}_6\text{H}_5\text{Cl}$  and Y is  $\text{C}_6\text{H}_5\text{SO}_3\text{H}$ .

**129 (d)** The reaction of benzene with an acyl halide or acid anhydride in the presence of Lewis acid ( $\text{AlCl}_3$ ) yields acyl benzene.

This reaction is called Friedel-Craft's acylation reaction as shown below :

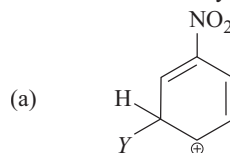


**130 (b)** The complete reaction is shown below :

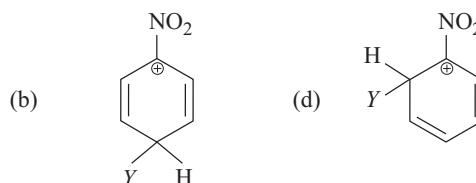


**131 (a)**  $-\text{NO}_2$  group is an electron withdrawing group and exhibit  $-I$ -effect. This effect increases with decrease in distance of positive charge present on C-atom and, hence lesser is the stability of carbocation.

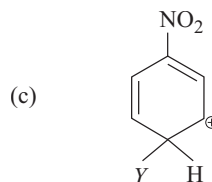
In option (a), the positive charge is at maximum distance to  $\text{NO}_2$  group, so  $-I$  effect due to  $\text{NO}_2$  group will be minimum and stability will be maximum.



In option (b) and (d), the positive charges is at minimum distance to  $\text{NO}_2$  group, hence the stability will be minimum.

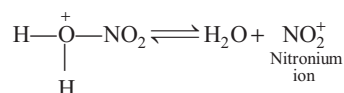
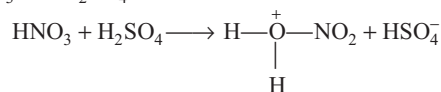


Also, in option (c), the distance of positive charge to  $\text{NO}_2$  group is more than *ortho* but less than *para*, so it will be less stable as compared to option (a).



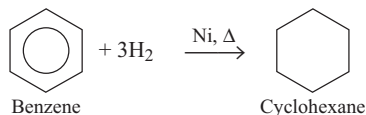
This resonating structure is less stable than option (a)

**132 (c)** During nitration of benzene, the attacking electrophile is  $\text{NO}_2^+$ . It is formed by the reaction between  $\text{HNO}_3$  and  $\text{H}_2\text{SO}_4$  as shown below :

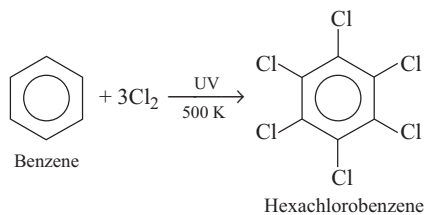


133 (c) A is three moles of H<sub>2</sub>.

Complete reaction is as follows :

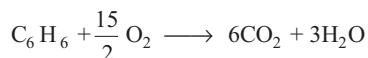


134 (c) The complete reaction is shown below :



3 moles of chlorine (Cl<sub>2</sub>) take part in reaction, so X = 3.

135 (b) When heated in air, benzene burns with sooty flame producing CO<sub>2</sub> and H<sub>2</sub>O as shown below :

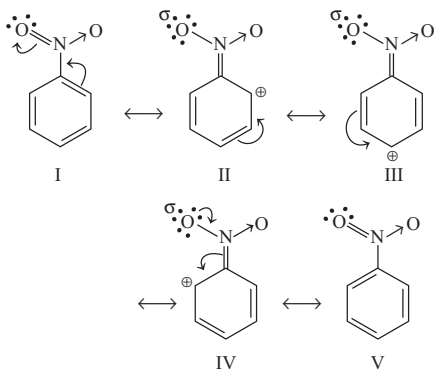


Hence, X and Y refer to CO<sub>2</sub> and H<sub>2</sub>O.

136 (a) Cl<sup>-</sup> shows strong -I-effect, so it deactivates the benzene ring towards electrophilic substitution. However, due to resonance, the electron density on *o*- and *p*-position is greater than that at the *m*-position. Hence, it is *o/p*-directing.

137 (b) The groups which direct the incoming group to *meta*-position are called *meta*-directing groups. Some examples of *meta*-directing groups are —NO<sub>2</sub>, —CN, —CHO, —COR, —COOH, —COOR, —SO<sub>3</sub>H etc.

138 (a) Nitro group reduces the electron density in the benzene ring due to its strong -I-effect. Nitrobenzene is a resonance hybrid of the following structures:



In this case, the overall electron density on benzene ring decreases making further substitution difficult, therefore these groups are also called 'deactivating groups'.

The electron density on *o*- and *p*-position is comparatively less than that at *meta*-position.

Hence, the electrophile attacks on comparatively electron rich *meta*-position resulting in *meta*-substitution.

139 (c) Electron donating group when bonded with benzene ring will activate the ring due to (+I) effect and show better electrophilic substitution reaction, whereas electron withdrawing groups show (-I) effect and decreases the nature of electrophilic substitution.

(a) Here, alkyl group (i.e. —CH<sub>3</sub>) show (+I) effect, but lesser than —OCH<sub>3</sub> due to presence of oxygen atom, thus C<sub>6</sub>H<sub>5</sub>—OCH<sub>3</sub> show better electrophilic substitution than that of C<sub>6</sub>H<sub>5</sub>—CH<sub>3</sub>.

(b) Chlorine, i.e. Cl show -I and +R effect due to presence of lone pair of electrons, while —CHO group of (-R) nature. Thus, C<sub>6</sub>H<sub>5</sub>Cl show more electrophilic substitution than C<sub>6</sub>H<sub>5</sub>—CHO.

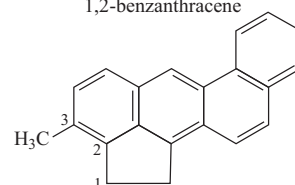
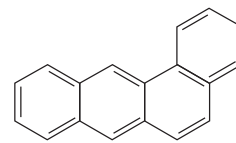
Groups that show (+I) and (+R) effect have more electrophilic substitution tendency than those that show either or (-I) and (+R) effect.

Hence, correct order is

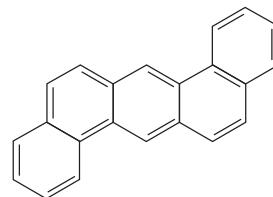
B > A > C > D and option (c) is correct.

140 (b) Polynuclear hydrocarbons are formed on incomplete combustion of organic materials like tobacco, coal and petroleum.

141 (a) The given compounds and their IUPAC names are shown below :



142 (a) The correct structure of 1, 2, 5, 6-dibenzanthracene is shown below :



143 (c) Statement (c) is correct, while the other statements are incorrect. Corrected form are as follows :

- Alkanes are almost non-polar molecules.
- Alkanes are covalent in nature.
- Due to very little electronegativity difference between carbon and hydrogen atoms, they are inert.

**144** (a) Statements I and II are correct, while the statements III and IV are incorrect.

Corrected form are as follows :

III. Methane cannot be prepared by Kolbe's electrolytic process.

IV. CO<sub>2</sub> gas is liberated at anode.

**145** (d) Statement (d) is correct with respect to the conformers of ethane, which is explained as given below :

Isomers which are possible by rotation about single bonds without cleavage of any bond are called conformers. In ethane, an infinite number of conformations are possible.

There are two extreme forms, the staggered conformation, which is the most stable and the eclipsed conformation which is least stable. Among the conformers of ethane, bond angle and bond length remain same while their energy, stability and dihedral angle are different.

**146** (b) Statements I, II and III are correct, while the statement IV is incorrect.

It's correct form is as follows :

Spatial arrangements of atoms which can be converted into one another by rotation around a C—C single bond are called conformations or conformers or rotamers.

Alkanes can thus have infinite number of conformations by rotation around C—C single bonds.

Ethane has infinite number of conformers.

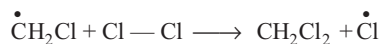
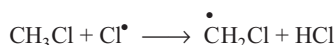
**147** (a) Halogenation (chlorination here) of alkane proceeds through free radical mechanism as follows :

II. **Initiation** Homolysis of chlorine molecule

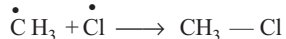
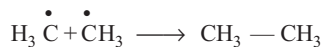


I. **Propagation**  $\text{CH}_4 + \overset{\cdot}{\text{Cl}} \xrightarrow{h\nu} \overset{\cdot}{\text{C}}\text{H}_3 + \text{HCl}$

III.  $\overset{\cdot}{\text{C}}\text{H}_3 + \text{Cl} - \text{Cl} \longrightarrow \text{CH}_3\overset{\cdot}{\text{C}}\text{H}_2 + \overset{\cdot}{\text{Cl}}$



IV. **Termination**  $\overset{\cdot}{\text{Cl}} + \overset{\cdot}{\text{Cl}} \longrightarrow \text{Cl} - \text{Cl}$



Hence, correct sequence is represented by option (a).

**148** (c) I.  $\text{CH}_2=\text{CH}-\text{CH}_2-\text{CH}_3$ ,

Compound I is asymmetrical alkene.

II.  $\text{CH}_3-\text{CH}=\text{CH}-\text{CH}_3$

Compound II is symmetrical alkene.

III.  $\text{CH}_2=\overset{\text{CH}_3}{\text{C}}-\text{CH}_3$

Compound III is asymmetrical alkene.

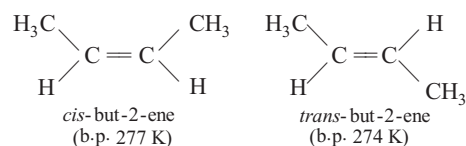
Markovnikov's addition is not applicable on symmetrical alkenes.

Hence, it is applicable for I and III, but not for II.

**150** (d) Statements (a) and (b) are correct, while the statement (c) is incorrect. It's correct form is as follows : Arrangement of atoms or groups in space in the two structures is different.

Therefore, they are stereoisomers.

The isomer of the type (A) in which two identical atoms or groups lie on the same side of the double bond is called *cis*-isomer and the other isomer of the type (B), in which identical atoms or groups lie on the opposite sides of the double bond is called *trans* isomer.



Boiling point of *cis* form is higher than that of *trans* form.

**151** (a) Statement (a) is correct, while the other statements are incorrect.

Corrected form are as follows :

(b) Ethyne is a linear molecule.

(c) Ethyne has two  $\pi$  bonds.

(d) Ethyne molecule consists of one C—C  $\sigma$  bond.

**152** (c) Both the orders regarding acidity of hydrocarbon are correct.

I. Acidic strength  $\propto$  per cent *s*-character and *s*-character is 50% in alkynes, 33% in alkanes and 25% in alkanes.

II. Inductive effect defines acidic strength and polarity of C—H bond of alkyne. Groups having +*I*-effect increases electron density around C—H bond, hence polarity decreases and acidic strength of alkyne decreases.

**153** (c) Statement (c) is correct, while other statements are incorrect.

Corrected form are as follows :

(a) Aromatic hydrocarbons are non-polar molecules.

(b) Aromatic are usually colourless liquids or solids with a characteristic aroma.

(d) Aromatic are readily miscible with organic solvents.

**154** (b) Statement (b) is incorrect for benzene.

It's correct form is as follows :

There are six C—C single bonds and three C—C double bonds in benzene.

Rest other statements are correct.

**155** (b) Statements I and II are correct, while the statement III is incorrect.

It's correct form is as follows :

C—H  $\sigma$  bond is obtained by head on overlapping of  $sp^2$  hybridised orbital of C and 1s orbital of H-atom.

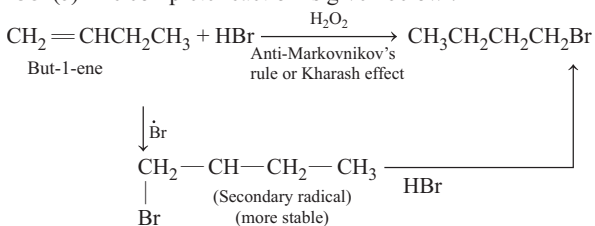
159 (b) Statements I and III are incorrect.

It's correct form is as follows :

- I. The rate of nitration of benzene increases at high temperature, i.e. 323-333 K.  
 III. The rate of nitration of chlorobenzene is lower than that of benzene.

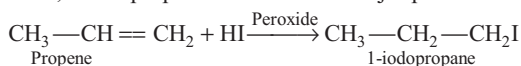
Rest other statements are correct.

160 (c) The complete reaction is given below :



Thus, A is correct but R is incorrect.

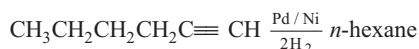
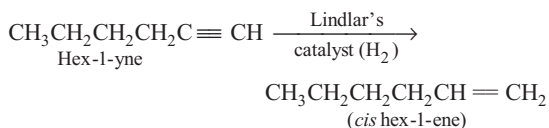
161 (b) When propene reacts with HI in the presence of peroxide, it shows anti-Markovnikov's addition. Thus, 1-iodopropane is obtained as major product.




It is also true that, 2° free radical is more stable than 1° free radical but it is not the reason of the given assertion.

Thus, both A and R are correct but R is not the correct explanation for A.

162 (b) The reactions for the given statements are shown below :



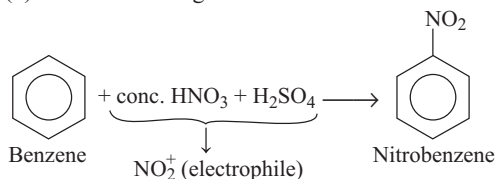
Thus, both A and R are correct but R is not the correct explanation of A.

163 (a)  is cyclic and has conjugated 8π-electron

system but it is not an aromatic compound because here (4n + 2)π-electrons rule does not hold good and ring is not planar.

Thus, both A and R are correct and R is the correct explanation of A.

164 (a) The reaction is given below :



Thus, both A and R are correct and R is the correct explanation of A.

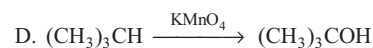
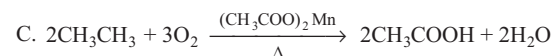
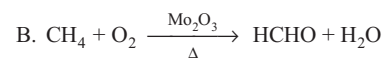
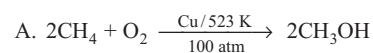
165 (d) In the electrophilic substitution of aryl halides, the incoming electrophile gets attached to the *ortho* and/or *para* position. This is because, even though aryl halides have strong -I-effect, the electron density on *ortho* and *para* positions is greater than that at *meta* position due to resonance.

Hence, the incoming electrophile is directed at the *ortho* and/or *para* position.

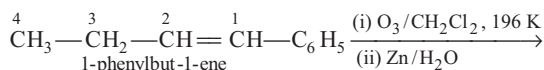
Thus, R is correct but A is incorrect.

167 (b) The correct match is :

A → 1, B → 2, C → 3, D → 4

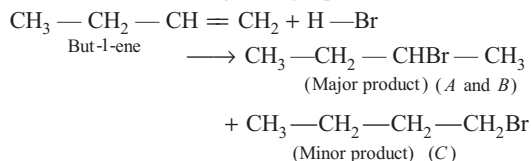


172 (a) The ozonolysis reaction is given below :

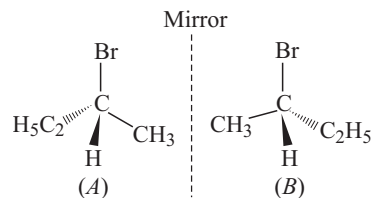


The IUPAC name of the products are propanal and benzaldehyde.

173 (a) The alkene is unsymmetrical, hence will follow Markovnikov's rule to give major product as shown below :



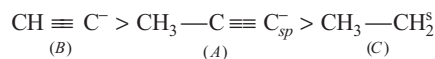
Since, A contains a chiral carbon, it exists in two enantiomeric forms (A and B) which are mirror images of each other.



174 (b) The aldehyde having molar mass 44 u is ethanal, CH<sub>3</sub>CHO. To obtain the structure of A, the following method is employed. Write the structures of two molecules of ethanal in such a way that their oxygen atoms are pointing towards each other. Join the two ends through the double bond with the removal of both of the oxygen atoms to obtain alkene A.



The correct order is shown below :

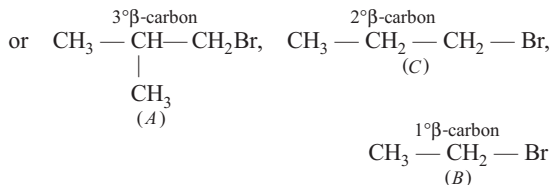


Hence, the order  $B > A > C$  is correct.

**185** (d) Alkyl halides on heating with alcoholic potash eliminates one molecule of halogen, acid to form alkene. Hydrogen is eliminated from  $\beta$ -carbon atom.

Nature of alkyl group determines rate of reaction.

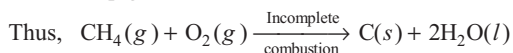
i.e.  $3^\circ > 2^\circ > 1^\circ$



Thus, decreasing order of rate of reaction is



**186** (c) During incomplete combustion of alkanes with insufficient amount of air or dioxygen, carbon black is formed which is used in the manufacture of ink, printer ink, black pigments and as filters.



**187** (a) Toluene has  $-\text{CH}_3$  group attached to benzene which activates the benzene ring for the attack of an electrophile.

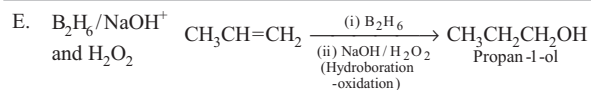
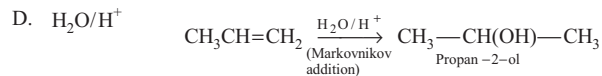
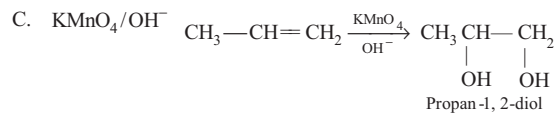
In resonating structure of toluene, electron density is more on *ortho* and *para* position. Hence, substitution takes place mainly at these positions.

Thus, both A and R are correct and R is the correct explanation of A.

**188** (c) The correct match is given below :

A.  $\rightarrow$  (4), B.  $\rightarrow$  (1), C.  $\rightarrow$  (5), D.  $\rightarrow$  (3), E.  $\rightarrow$  (2)

Reagent	Reaction with propene
A. $\text{O}_3/\text{Zn} + \text{H}_2\text{O}$	$\text{CH}_3-\overset{\text{O}}{\underset{\text{O}}{\text{C}}}\text{H}=\overset{\text{O}}{\text{C}}\text{H}_2 \rightarrow \text{HCHO} + \text{CH}_3\text{CHO}$ <p style="text-align: center;">Formaldehyde + Acetaldehyde</p>
B. $\text{KMnO}_4/\text{H}^+$	$\text{CH}_3\text{CH}=\text{CH}_2 \xrightarrow[\text{H}^+]{\text{KMnO}_4} \text{CH}_3\text{COOH} + \text{CO}_2$ <p style="text-align: center;">Acetic acid</p>



**189** (b) The correct match is given below :

A.  $\rightarrow$  (4), B.  $\rightarrow$  (1), C.  $\rightarrow$  (2), D.  $\rightarrow$  (3)

Reactions	Types of reaction
A. $\text{CH}_2=\text{CH}_2 + \text{H}_2\text{O} \xrightarrow{\text{H}^+} \text{CH}_3\text{CH}_2\text{OH}$	Hydration (Addition of water)
B. $\text{CH}_2=\text{CH}_2 + \text{H}_2 \xrightarrow{\text{Pd}} \text{CH}_3-\text{CH}_3$	Hydrogenation (Addition of hydrogen)
C. $\text{CH}_2=\text{CH}_2 + \text{Cl}_2 \longrightarrow \text{Cl}-\text{CH}_2-\text{CH}_2-\text{Cl}$	Halogenation (Addition of halogen)
D. $3\text{CH} \equiv \text{CH} \xrightarrow[\text{Heat}]{\text{Cu tube}} \text{C}_6\text{H}_6$	Polymerisation

**190** (b) Branching of hydrocarbons decreases boiling point of compound.

The correct match is given below.

A.  $\rightarrow$  (2), B.  $\rightarrow$  (3), C.  $\rightarrow$  (1)

Hydrocarbons	Boiling point
A. <i>n</i> -pentane	309 K due to (no branch)
B. <i>iso</i> -pentane	301 K due to one branch $\left( \text{CH}_3-\text{CH}-\overset{\text{CH}_3}{\text{CH}_2}-\text{CH}_3 \right)$
C. <i>neo</i> -pentane	282.5 K due to two branches $\left( \text{CH}_3-\overset{\text{CH}_3}{\text{C}}-\text{CH}_3 \right)$