CHAPTER > 13

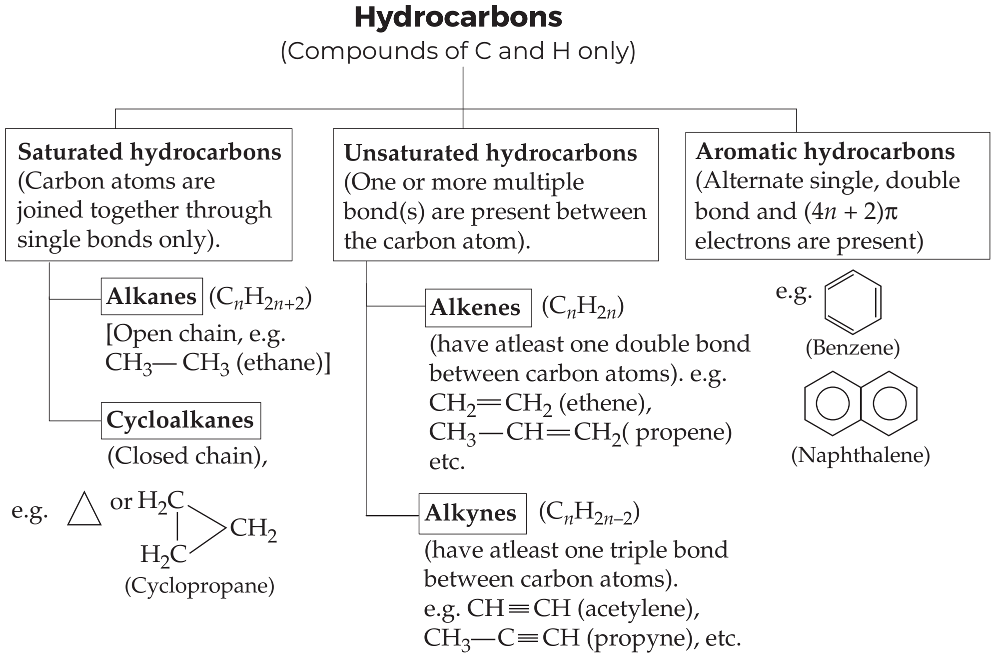
Hydrocarbons

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.



Hydrocarbons
(Compounds of C and H only)

Saturated hydrocarbons (Carbon atoms are joined together through single bonds only).

- **Alkanes** (C_nH_{2n+2}) [Open chain, e.g. $CH_3—CH_3$ (ethane)]
- **Cycloalkanes** (Closed chain), e.g. (Cyclopropane)

Unsaturated hydrocarbons (One or more multiple bond(s) are present between the carbon atom).

- **Alkenes** (C_nH_{2n}) (have atleast one double bond between carbon atoms). e.g. $CH_2{=}CH_2$ (ethene), $CH_3—CH{=}CH_2$ (propene) etc.
- **Alkynes** (C_nH_{2n-2}) (have atleast one triple bond between carbon atoms). e.g. $CH{\equiv}CH$ (acetylene), $CH_3—C{\equiv}CH$ (propyne), etc.

Aromatic hydrocarbons (Alternate single, double bond and $(4n + 2)\pi$ electrons are present)

e.g. (Benzene) (Naphthalene)

Alkanes

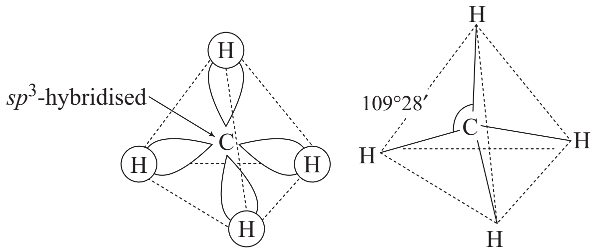
- Alkanes are **saturated** open chain hydrocarbons containing C—C single bonds.
- The general formula is C_nH_{2n+2}.
- In alkanes, tetrahedra are joined together in which C—C and C—H bond lengths are 154 pm and 112 pm respectively.

Nomenclature and Isomerism

- Steps to be followed while writing IUPAC names are as follows :
  (i) First of all, the longest chain of carbon atoms corresponding to the parent alkane is identified.
  (ii) The substituents attached to the carbon atoms are numbered such that the branched C atoms get the lowest possible numbers.
  (iii) 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 (CH_4) molecule

Preparation of Alkanes

- **From unsaturated hydrocarbons**

$$\underset{\text{Ethene}}{CH_2=CH_2} + H_2 \xrightarrow[\text{Hydrogenation}]{Pt/Pd/Ni} \underset{\text{Ethane}}{CH_3-CH_3}$$

$$\underset{\text{Propene}}{CH_3-CH=CH_2} + H_2 \xrightarrow{Pt/Pd/Ni} \underset{\text{Propane}}{CH_3-CH_2-CH_3}$$

$$\underset{\text{Propyne}}{CH_3-C\equiv C-H} + 2H_2 \xrightarrow{Pt/Pd/Ni} \underset{\text{Propane}}{CH_3-CH_2-CH_3}$$

- **From alkyl halides**

$$\underset{\text{Chloromethane}}{CH_3-Cl} + H_2 \xrightarrow{Zn,\ H^+} \underset{\text{Methane}}{CH_4} + HCl$$

- **Wurtz reaction**

$$\underset{\text{Bromomethane}}{CH_3Br} + 2Na + BrCH_3 \xrightarrow{\text{Dry ether}} \underset{\text{Ethane}}{CH_3-CH_3} + 2NaBr$$

- **From carboxylic acids**

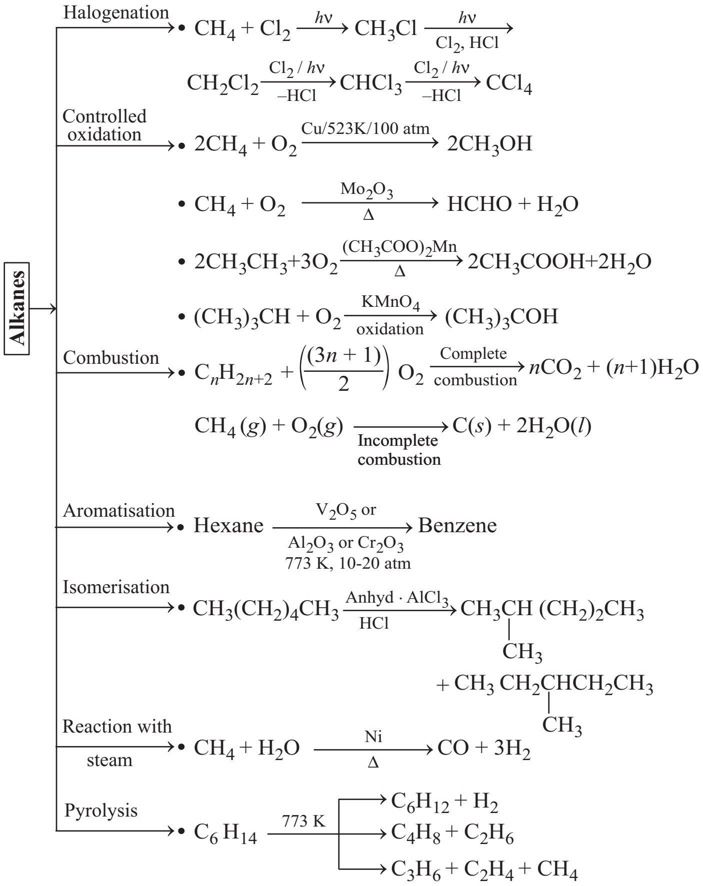
$$\underset{\text{Sodium ethanoate}}{CH_3COO^-Na^+} + NaOH \xrightarrow[\Delta]{CaO} CH_4 + Na_2CO_3$$

Decarboxylation

Physical Properties

- Alkanes are **non-polar** molecules.
- Due to the weak forces, the first four members, C_1 to C_4 are **gases**. C_5 to 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



Alkanes

Halogenation

$$CH_4 + Cl_2 \xrightarrow{h\nu} CH_3Cl \xrightarrow[Cl_2,\ HCl]{h\nu}$$

$$CH_2Cl_2 \xrightarrow[-HCl]{Cl_2/h\nu} CHCl_3 \xrightarrow[-HCl]{Cl_2/h\nu} CCl_4$$

Controlled oxidation

$$2CH_4 + O_2 \xrightarrow{Cu/523K/100\ atm} 2CH_3OH$$

$$CH_4 + O_2 \xrightarrow[\Delta]{Mo_2O_3} HCHO + H_2O$$

$$2CH_3CH_3 + 3O_2 \xrightarrow[\Delta]{(CH_3COO)_2Mn} 2CH_3COOH + 2H_2O$$

$$(CH_3)_3CH + O_2 \xrightarrow[\text{oxidation}]{KMnO_4} (CH_3)_3COH$$

Combustion

$$C_nH_{2n+2} + \left(\frac{(3n+1)}{2}\right) O_2 \xrightarrow[\text{combustion}]{\text{Complete}} nCO_2 + (n+1)H_2O$$

$$CH_4(g) + O_2(g) \xrightarrow[\text{Incomplete combustion}]{} C(s) + 2H_2O(l)$$

Aromatisation

$$\text{Hexane} \xrightarrow[Al_2O_3 \text{ or } Cr_2O_3,\ 773\ K,\ 10\text{-}20\ atm]{V_2O_5 \text{ or}} \text{Benzene}$$

Isomerisation

$$CH_3(CH_2)_4CH_3 \xrightarrow[HCl]{Anhyd\cdot AlCl_3} CH_3\underset{\underset{CH_3}{|}}{CH}(CH_2)_2CH_3 + CH_3CH_2\underset{\underset{CH_3}{|}}{CH}CH_2CH_3$$

Reaction with steam

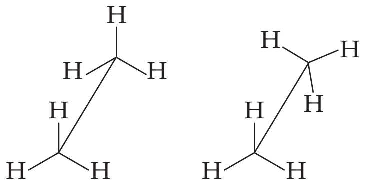
$$CH_4 + H_2O \xrightarrow[\Delta]{Ni} CO + 3H_2$$

Pyrolysis

$$C_6H_{14} \xrightarrow{773\ K} C_6H_{12} + H_2;\quad C_4H_8 + C_2H_6;\quad C_3H_6 + C_2H_4 + CH_4$$

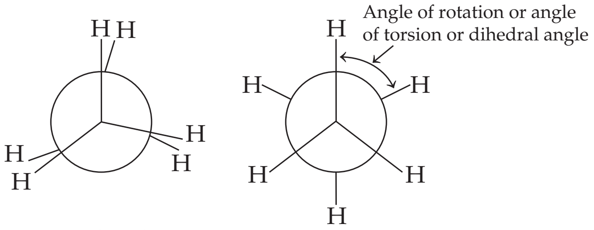
Conformations of Ethane

- 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 :



(i) Eclipsed (ii) Staggered

Sawhorse projection of ethane



(i) Eclipsed (ii) Staggered

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}.

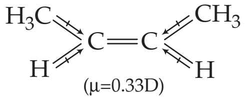
Alkenes are also known as olefins, since the first member, ethylene or ethene was found to form an oily liquid.

Nomenclature

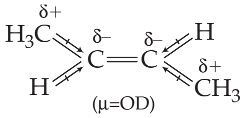
- For nomenclature of alkenes in IUPAC system, the longest chain of carbon atoms containing the double bond is selected.
- Numbering is done from the end which is nearer to double bond. The suffix 'ene' replaces 'ane'.

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.



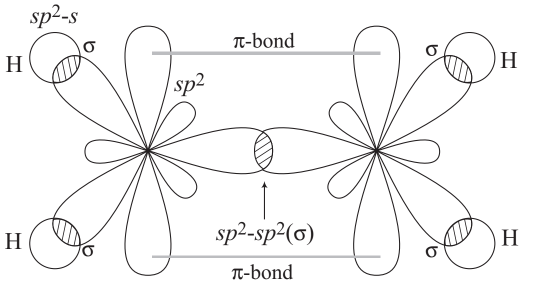
[*cis*-but-2-ene]



[*trans*-but-2-ene]

Structure of Double Bond

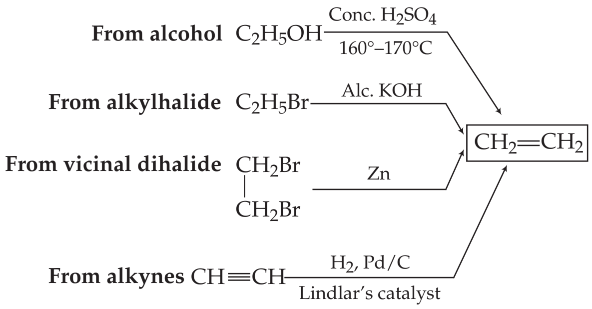
- Carbon-carbon double bond in alkenes consists of one strong sigma (σ) bond due to head on overlapping of sp^2-hybridised orbitals and one weak pi (π) bond obtained by lateral or sideways overlapping of the two 2*p*-orbitals of the two carbon atoms.
- The double bond is shorter in bond length (134 pm)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



Orbital diagram of ethene molecule

Preparation of Alkene

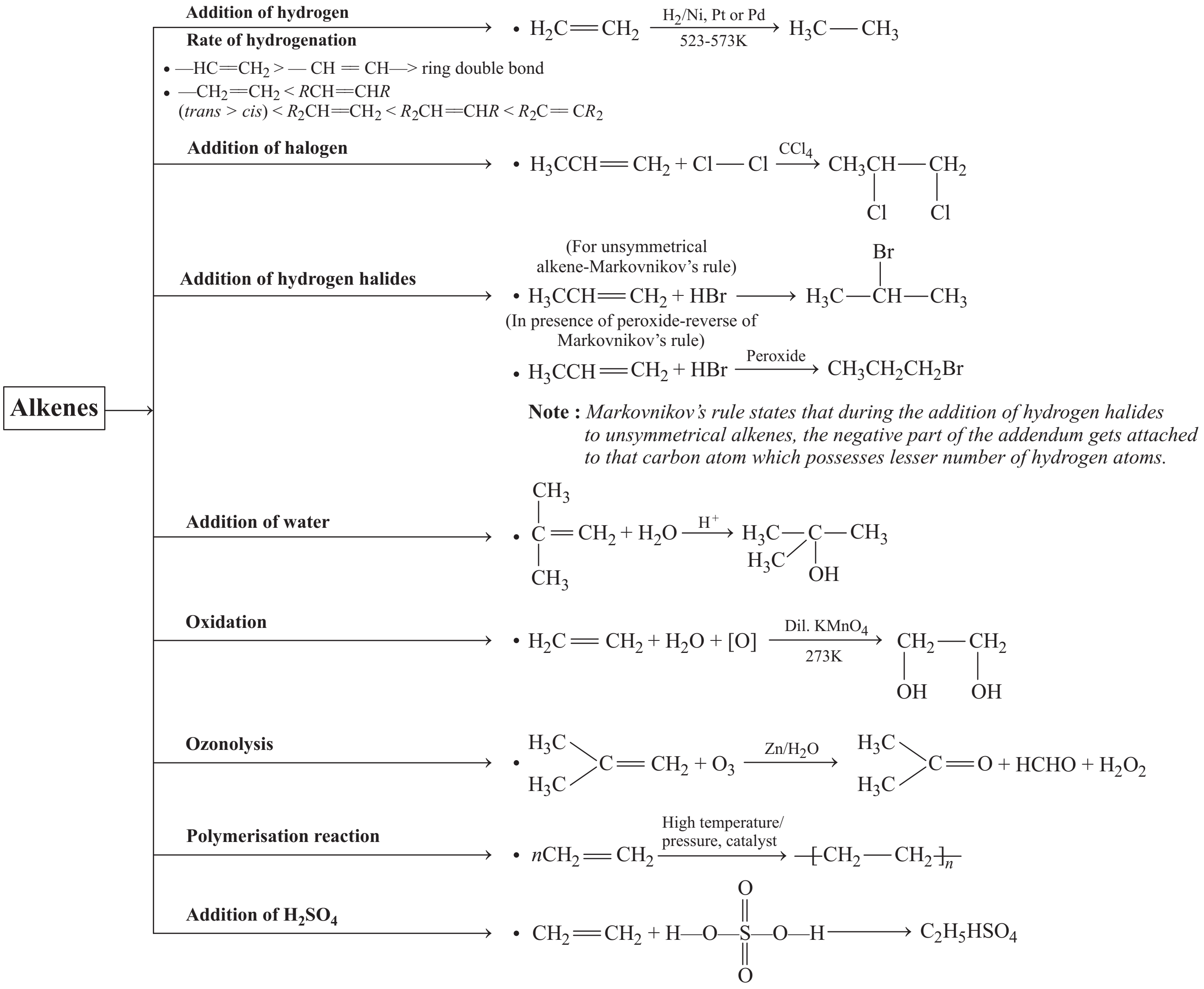
It can be summarised as follows :



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



Alkenes

Addition of hydrogen

- $H_2C{=}CH_2 \xrightarrow[523\text{-}573K]{H_2/Ni,\ Pt\ or\ Pd} H_3C{-}CH_3$

Rate of hydrogenation

- $—HC{=}CH_2 > — CH = CH—>$ ring double bond
- $—CH_2{=}CH_2 < RCH{=}CHR$ $(trans > cis) < R_2CH{=}CH_2 < R_2CH{=}CHR < R_2C{=}CR_2$

Addition of halogen

- $H_3CCH{=}CH_2 + Cl{-}Cl \xrightarrow{CCl_4} CH_3\underset{\underset{Cl}{|}}{CH}{-}\underset{\underset{Cl}{|}}{CH_2}$

Addition of hydrogen halides

(For unsymmetrical alkene-Markovnikov's rule)

- $H_3CCH{=}CH_2 + HBr \longrightarrow H_3C{-}\overset{\overset{Br}{|}}{CH}{-}CH_3$

(In presence of peroxide-reverse of Markovnikov's rule)

- $H_3CCH{=}CH_2 + HBr \xrightarrow{Peroxide} CH_3CH_2CH_2Br$

Note : *Markovnikov's rule states that during the addition of hydrogen halides to unsymmetrical alkenes, the negative part of the addendum gets attached to that carbon atom which possesses lesser number of hydrogen atoms.*

Addition of water

- $\underset{\underset{CH_3}{|}}{\overset{\overset{CH_3}{|}}{C}}{=}CH_2 + H_2O \xrightarrow{H^+} H_3C{-}\underset{\underset{OH}{|}}{C}(H_3C){-}CH_3$

Oxidation

- $H_2C{=}CH_2 + H_2O + [O] \xrightarrow[273K]{Dil.\ KMnO_4} \underset{\underset{OH}{|}}{CH_2}{-}\underset{\underset{OH}{|}}{CH_2}$

Ozonolysis

- $\begin{matrix}H_3C\\H_3C\end{matrix}\!\!>\!C{=}CH_2 + O_3 \xrightarrow{Zn/H_2O} \begin{matrix}H_3C\\H_3C\end{matrix}\!\!>\!C{=}O + HCHO + H_2O_2$

Polymerisation reaction

- $nCH_2{=}CH_2 \xrightarrow{\text{High temperature/ pressure, catalyst}} {-}\!\!\left[CH_2{-}CH_2\right]\!\!{-}_n$

Addition of H_2SO_4

- $CH_2{=}CH_2 + H{-}O{-}\overset{\overset{O}{\|}}{\underset{\underset{O}{\|}}{S}}{-}O{-}H \longrightarrow C_2H_5HSO_4$

Alkynes

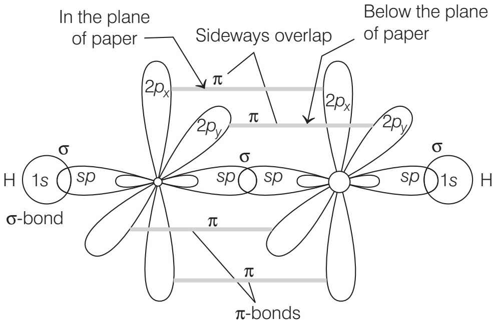
Alkynes are unsaturated hydrocarbons that contain at least one triple bond between two carbon atoms. Their general formula is C_nH_{2n-2}.

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 (σ) 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 1*s*-orbital of each of the two hydrogen atoms forming two C—H sigma bonds.
- 2*p*-orbital of one carbon atom is parallel to the 2*p*-orbital of other carbon atom.
- These orbitals undergo lateral or sideways overlapping to form two π bonds between two carbon atoms.
- Ethyne molecule consists of one C—C σ bond, two C—H σ bonds and two C—C π bonds as shown below :

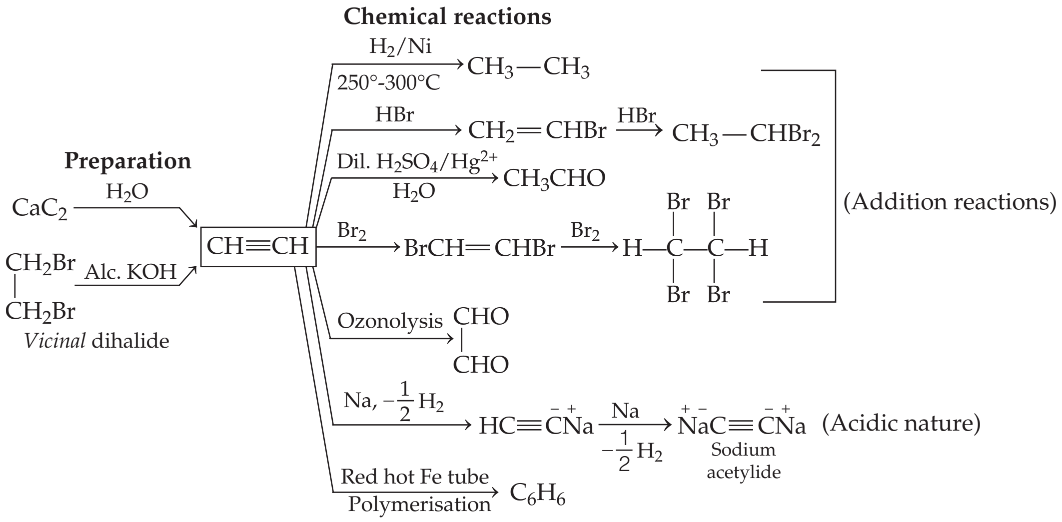


Orbital diagram of ethyne

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

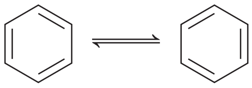
- Aromatic hydrocarbons, also known as **arenes**, were found to contain benzene ring (highly unsaturated).
- Aromatic compounds containing benzene ring are known as **benzenoids** and those not containing a benzene ring are known as **non-benzenoids.**

Nomenclature and Isomerism

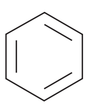
- In IUPAC nomenclature, the substituent is placed as prefix to the word benzene.
- When two hydrogen atoms in benzene are replaced by two similar or different monovalent atoms or groups, three different position isomers are possible.
- The 1, 2 or 1, 6 is known as the *ortho* (*o*-), the 1, 3 or 1,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

Structure of Benzene

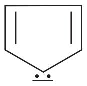
- Kekule suggested the structure of benzene by the concept of oscillating nature of double bonds as shown below :



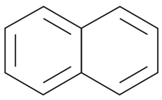
- Benzene has **unusual stability due to resonance.**
- X-ray diffraction data reveals that benzene is a planar molecule. C—C bond length is intermediate between C—C single bond and C—C double bond.
- For a compound to be aromatic, it must possess the following characteristics :
  - (i) Planarity (ii)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



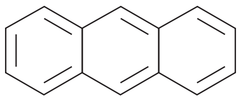
Benzene
$n = 1$
6π-electrons



Cyclopentadienyl anion
$n = 1$
6π-electrons

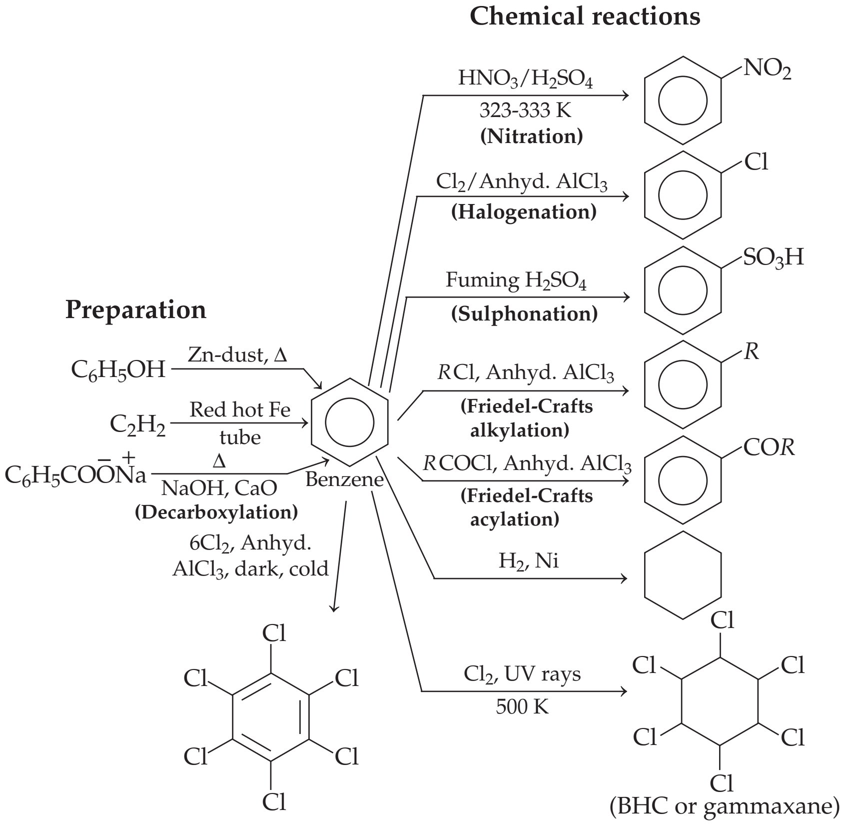


Naphthalene
$n = 2$
10π-electrons



Anthracene
$n = 3$
14π-electrons

Preparation and Chemical Reactions of Benzene



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. —OH, —NH_2, —NH*R*, —$NHCOCH_3$, —OCH_3, —CH_3, —C_2H_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. —NO_2, —CN, — CHO, —CO*R*, —COOH, —COO*R*, —SO_3H 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

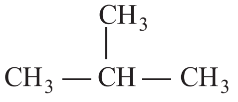
TOPIC 2 ~ *Alkanes*

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,

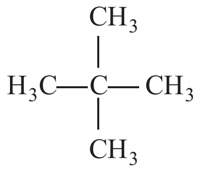


$CH_3 - \overset{\overset{\displaystyle CH_3}{|}}{CH} - CH_3$ and $CH_3CH_2CH_2CH_3$ are
(a) conformational isomers (b) chain isomers
(c) position isomers (d) functional isomers

10 The number of chain isomers of C_7H_{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 C_5H_{12}?
(a) One (b) Two (c) Three (d) Four

12 The IUPAC name of the following compound is

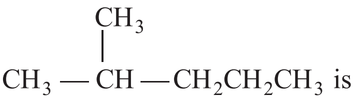


$$H_3C-\overset{\overset{\large CH_3}{|}}{\underset{\underset{\large CH_3}{|}}{C}}-CH_3$$

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

13 Possible structural isomers for C_6H_{14} are

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

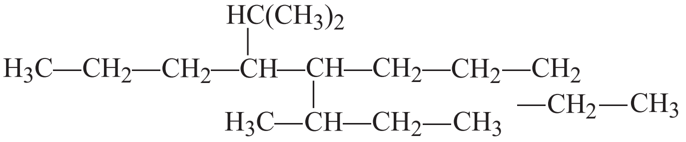
14 The IUPAC name of 

$$CH_3-\overset{\overset{\large CH_3}{|}}{CH}-CH_2CH_2CH_3$$

is

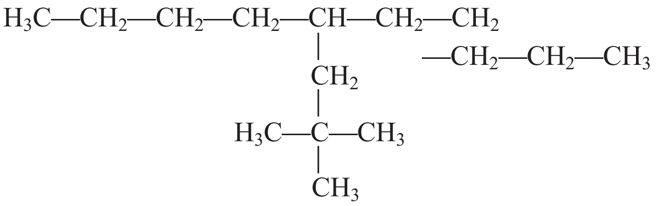
(a) *n*-hexane
(b) 2-methylpentane
(c) 4-methylpentane
(d) 3-methylpentane

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-pentyloctane
(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,

$$CH_3-Cl+H_2 \xrightarrow{Zn\ ,\ H^+} CH_4 + HCl$$ is an example of

(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) $NaOH + Ca(OH)_2$ (b) $NaOH + Mg(OH)_2$
(c) $NaOH + CaO$ (d) $NaOH + MgO$

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

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

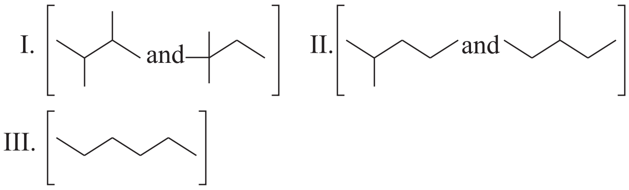
24 Which of the following method is used to synthesise alkanes having even number of carbon atoms?

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

25 Sodium acetate is electrolysed with water (H_2O). The product formed at anode is

(a) CH_4 (b) CO_2 (c) H_2 (d) 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) I > II > III (b) III > II > I (c) II > III > I (d) III > I > 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) $Cl-Cl \xrightarrow{hv} \dot{Cl} + \dot{Cl}$

(b) $CH_4 + Cl \xrightarrow{hv} \dot{C}H_3 + HCl$

(c) $CH_3Cl + \dot{Cl} \longrightarrow \dot{C}H_2Cl + HCl$

(d) $H_3\dot{C} + \dot{Cl} \longrightarrow CH_3Cl$

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

(a) 1° > 2° > 3° (b) 1° > 3° > 2°
(c) 2° > 1° > 3° (d) 3° > 2° > 1°

30 Iodination of alkanes is always carried out in the presence of some oxidising agents like 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) $C_nH_{2n+2}+\left(\frac{3n+2}{2}\right)O_2$ (b) $C_nH_{2n}+\left(\frac{3n-1}{2}\right)O_2$
(c) $C_nH_{2n}+\left(\frac{3n+2}{2}\right)O_2$ (d) $C_nH_{2n+2}+\left(\frac{3n+1}{2}\right)O_2$

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

(a) CO_2 (b) C
(c) CO (d) None of these

33 Consider the following reaction,

$$CH_4+O_2\xrightarrow[\Delta]{'X'}HCHO+H_2O$$

Here, 'X' is

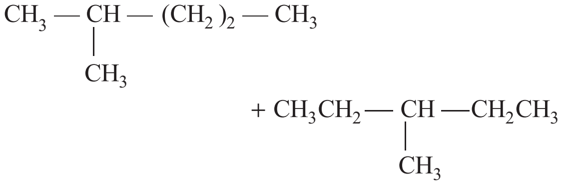
(a) Mo_2O_3 (b) Cu/523 K
(c) Both (a) and (b) (d) None of these

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

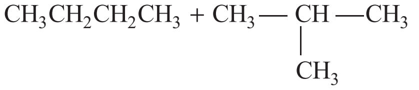
(a) Cu/523 K
(b) Mo_2O_3
(c) $KMnO_4$
(d) $(CH_3COO)_2Mn$

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

$$\underset{n\text{-hexane}}{CH_3(CH_2)_4CH_3}\xrightarrow[HCl]{\text{Anhyd AlCl}_3}A+B$$

(a) 
$CH_3-\underset{\substack{|\\CH_3}}{CH}-(CH_2)_2-CH_3+CH_3CH_2-\underset{\substack{|\\CH_3}}{CH}-CH_2CH_3$

(b) 
$CH_3CH_2-\underset{\substack{|\\CH_3}}{CH}-CH_2CH_3+CH_3CH_2CH_2CH_3$

(c) 
$CH_3CH_2CH_2CH_3+CH_3-\underset{\substack{|\\CH_3}}{CH}-CH_3$

(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

$$C_{12}H_{26}\xrightarrow[973\text{ K}]{\text{Pt/Pd/Ni}}$$

(a) C_7H_{16} (b) C_5H_{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) ∞

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

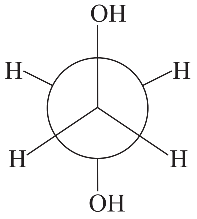
44 Which form of ethane has the least torsional strain?

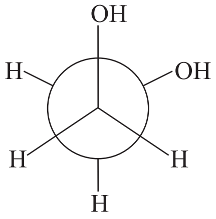
(a) Staggered (b) Skew boat
(c) Eclipsed (d) Boat

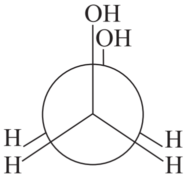
45 Energy difference between eclipsed and staggered form of ethane is
(a) 12.5 kJ mol^{-1}
(b) 15.5 kJ mol^{-1}
(c) 14.5 kJ mol^{-1}
(d) 12.5 J mol^{-1}

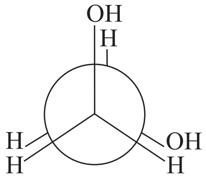
46 The energy required to overcome energy barrier between eclipsed and staggered conformation of ethane molecule is gained through
(a) intramolecular collisions
(b) intermolecular collisions
(c) molecular collisions
(d) atomic collisions

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

(a)


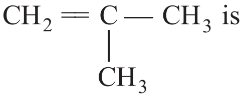
(b)


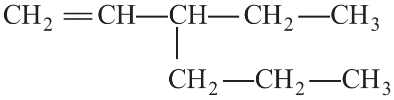
(c)


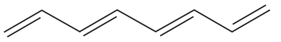
(d)


TOPIC 3 ~ *Alkenes*

48 Which type of overlapping results in the formation of σ and π-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

$CH_2 = \underset{\underset{CH_3}{|}}{C} — CH_3$ 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 ***JIPMER 2018***

$CH_2 = CH — \underset{\underset{CH_2 — CH_2 — CH_3}{|}}{CH} — CH_2 — CH_3$
(a) 3-propylpent-1-ene (b) 3-ethylpent-1-ene
(c) 4-ethylhex-1-ene (d) 3-ethylhex-1-ene

51 Number of σ-bonds and π-bonds present in

is

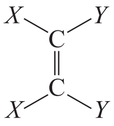
	σ-bond	π-bond		σ-bond	π-bond
(a)	17	4	(b)	14	3
(c)	18	4	(d)	15	3

52 Number of possible structural isomers of C_4H_8 is
(a) 3 (b) 4
(c) 5 (d) 2

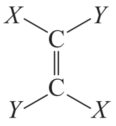
53 But-1-ene and 2-methylprop-1-ene are the examples of
(a) chain isomers (b) position isomers
(c) functional isomers (d) None of these

54 Which of the following is not a structural isomer of C_5H_{10}?
(a) Pent-1-ene (b) 2-methylbut-2-ene
(c) 3-methylbut-1-ene (d) 2,3-dimethylpropene

55 Consider the following isomers :



(a)



(b)

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***

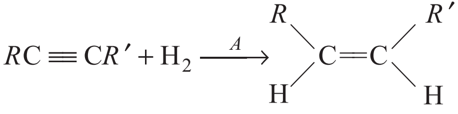
$$\underset{\delta}{CH_3} — \underset{\gamma}{CH_2} — \underset{\beta}{CH} = \underset{\alpha}{CH_2}$$

(a) β-hydrogen (b) δ-hydrogen
(c) γ-hydrogen (d) α-hydrogen

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

(a) Palladium
(b) Zn -H_2SO_4
(c) Partially deactivated palladised charcoal
(d) Zn amalgam

60 Consider the following reaction,

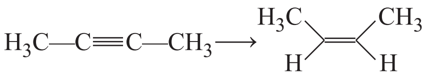


cis-alkene

What does A refers to?

(a) $Na / liq \cdot NH_3$ (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***



cis-2-butene

(a) $H_2, Pd / C$, quinoline (b) Zn/HCl
(c) $Hg^{2+} / H^+, H_2O$ (d) Na/liquid NH_3

62 The *trans*-alkenes are formed by the reduction of alkynes with ***JEE Main 2018***

(a) H_2-Pd/C, $BaSO_4$ (b) $NaBH_4$
(c) Na/liq. NH_3 (d) Sn-HCl

63 Consider the given reactions :

(i) $CH_3C \equiv CC_2H_5 + H_2 \xrightarrow[H_2]{Pd/C} A$

(ii) $CH_3C \equiv CC_2H_5 + H_2 \xrightarrow[NH_3]{Na/liq.} B$

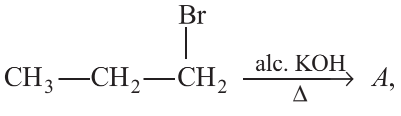
A and B respectively are

(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,



$CH_3—CH_2—\underset{|}{\overset{Br}{CH_2}} \xrightarrow[\Delta]{alc. KOH} A$,

A is

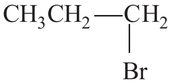
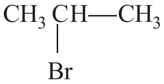
(a) $CH_2 = CH—CH_3$ (b) $CH_3CH_2—CH_3$
(c) $CH \equiv C—CH_3$ (d) Both (a) and (b)

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

$CH_3CHBr—CH_2Br + Zn \longrightarrow 'X'$

(a)  $CH_3CH_2—\underset{Br}{\underset{|}{CH_2}}$ (b)  $CH_3\,\underset{Br}{\underset{|}{CH}}—CH_3$

(c) $CH_3CH = CH_2$ (d) None of these

68 Alcohols on heating with conc.H_2SO_4 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_2SO_4.
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_2 (b) ZnX (c) ZnX_4 (d) Zn_2X

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_4, 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

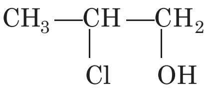
75 But-2-ene on reaction with alkaline $KMnO_4$ at elevated temperature followed by acidification will give ***JEE Main 2019***

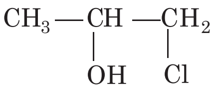
(a)  $CH_3—\underset{OH}{\underset{|}{CH}}—\underset{OH}{\underset{|}{CH}}—CH_3$

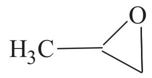
(b) one molecule of CH_3CHO and one molecule of CH_3COOH
(c) 2 molecules of CH_3COOH
(d) 2 molecules of CH_3CHO

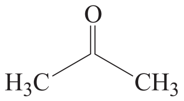
76 The major product of the following addition reaction is

$$H_3C—CH=CH_2 \xrightarrow{Cl_2/H_2O}$$ ***JEE Main 2019***

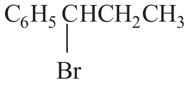
(a) 
$CH_3—\underset{Cl}{CH}—\underset{OH}{CH_2}$

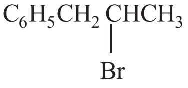
(b) 
$CH_3—\underset{OH}{CH}—\underset{Cl}{CH_2}$

(c) 

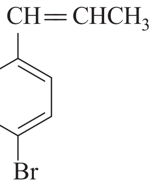
(d) 

77 The reaction of $C_6H_5CH=CHCH_3$ with HBr produces ***CBSE AIPMT 2014***

(a) 
$C_6H_5\underset{Br}{CH}CH_2CH_3$

(b) 
$C_6H_5CH_2\underset{Br}{CH}CH_3$

(c) $C_6H_5CH_2CH_2CH_2Br$

(d) 

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

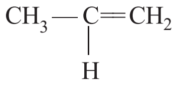
79 What will be the product of the following reaction?

$$CH_3—CH=CH_2 + HBr \xrightarrow{(C_6H_5CO)_2O_2} \text{Product}$$

(a) $CH_3CH_2CH_2Br$

(b) $CH_3CH(Br)CH_3$

(c) $CH_3CBr_2CH_3$

(d) 
$CH_3—\underset{H}{C}=CH_2$

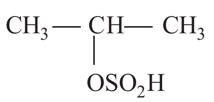
80 Addition of cold conc. H_2SO_4 to alkenes is an example of

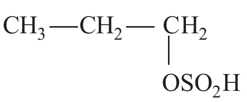
(a) electrophilic substitution reaction
(b) nucleophilic substitution reaction
(c) electrophilic addition reaction
(d) nucleophilic addition reaction

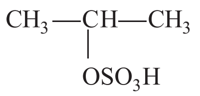
81 Consider the following reaction,

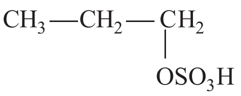
$$CH_3CH=CH_2 + HOSO_2OH \longrightarrow$$

The product obtained is

(a) 
$CH_3—\underset{OSO_2H}{CH}—CH_3$

(b) 
$CH_3—CH_2—\underset{OSO_2H}{CH_2}$

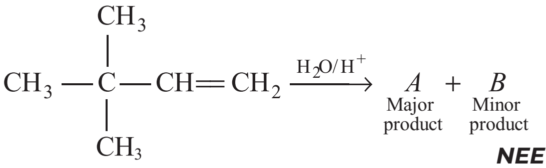
(c) 
$CH_3—\underset{OSO_3H}{CH}—CH_3$

(d) 
$CH_3—CH_2—\underset{OSO_3H}{CH_2}$

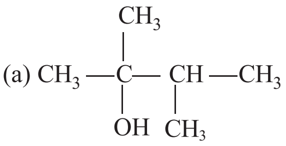
82 Addition of water in presence of conc. H_2SO_4 (few drops) to 2-methyl propene produces alcohols in accordance with

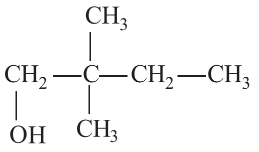
(a) Anti-Markovnikov's addition
(b) Markovnikov's rule
(c) Saytzeff's rule (d) Hofmann rule

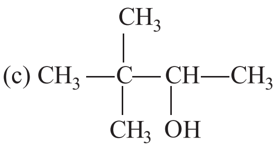
83 Consider in the following reaction.

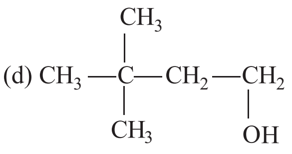

$$CH_3—\overset{CH_3}{\underset{CH_3}{C}}—CH=CH_2 \xrightarrow{H_2O/H^+} \underset{\substack{\text{Major}\\\text{product}}}{A} + \underset{\substack{\text{Minor}\\\text{product}}}{B}$$

NEET 2013

(a) 
$CH_3—\overset{CH_3}{\underset{OH}{C}}—\underset{CH_3}{CH}—CH_3$

(b) 
$\underset{OH}{CH_2}—\overset{CH_3}{\underset{CH_3}{C}}—CH_2—CH_3$

(c) 
$CH_3—\overset{CH_3}{\underset{CH_3}{C}}—\underset{OH}{CH}—CH_3$

(d) 
$CH_3—\overset{CH_3}{\underset{CH_3}{C}}—CH_2—\underset{OH}{CH_2}$

84 Choose the correct option regarding *A* and *B*.

$$CH_2=CH_2 + H_2O + [O] \xrightarrow[273\text{ K}]{\text{Dil. KMnO}_4} A$$

$$CH_3—CH=CH_2 + H_2O + [O] \xrightarrow[273\text{ K}]{\text{Dil. KMnO}_4} B$$

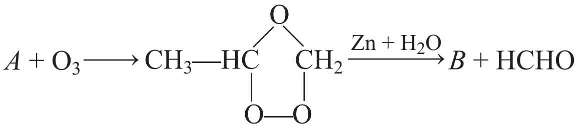
Codes

	A	*B*
(a)	$CH_2(OH)—CH_3$	$CH_3CH_2CH_2OH$
(b)	CH_3CH_2OH	$CH_3CHOHCH_3$
(c)	$CH_3CH(OH)CH_3$	$CH_3CH(OH)CH_2OH$
(d)	$CH_2(OH)CH_2(OH)$	$CH_3CH(OH)CH_2OH$

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

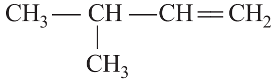
(a) propene and methanal (b) propane and ethanal
(c) propene and ethanol (d) propene and ethanal

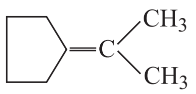
87 Ozonolysis of an organic compound *A* produces acetone and propionaldehyde in equimolar mixture. Here, *A* refers to

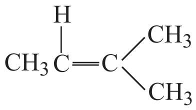
(a) 2-methyl pent-1-ene (b) pent-1-ene
(c) pent-2-ene (d) 2-methylpent-2-ene

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

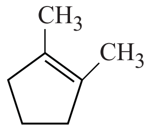
(a) $CH_3-CH=CH-CH_3$

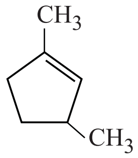
(b) 
$CH_3-\underset{\underset{CH_3}{|}}{CH}-CH=CH_2$

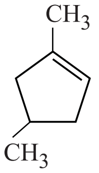
(c) 

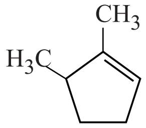
(d) 
$CH_3\overset{\overset{H}{|}}{C}=C\begin{smallmatrix}CH_3\\CH_3\end{smallmatrix}$

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

(a) 

(b) 

(c) 

(d) 

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

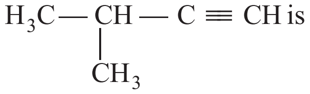
(a) high temperature, low pressure and presence of a catalyst
(b) high temperature and low volume and presence of a catalyst
(c) high temperature, high pressure and presence of catalyst
(d) Both (b) and (c)

91 Which of the following is an example of polythene?

(a) $n(CH\equiv CH)$
(b) $\left(\!-CH_2-CH_2-\!\right)_n$
(c) $\left(\!-C\equiv C-\!\right)_n$
(d) $\left(\!-CH_2=CH_2-\!\right)_n$

TOPIC 4~ *Alkynes*

92 The correct IUPAC name of the given structure


$H_3C-\underset{\underset{CH_3}{|}}{CH}-C\equiv CH$ is

(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 $CH_3CH_2-C\equiv CH$, 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 C_6H_{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 σ and π-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 $CaCO_3 \xrightarrow{\Delta} A + CO_2,\ A + \text{carbon} \rightarrow CaC_2 + CO$

Here, A refers to

(a) $Ca(CO)_2$
(b) Ca_2O
(c) CaO
(d) $Ca(OH)_2$

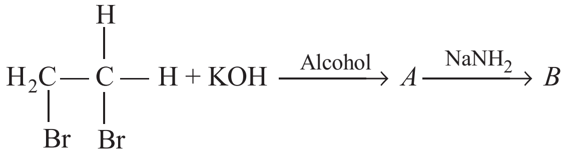
98 Consider the following reaction,

$$CaC_2 + H_2O \longrightarrow X$$

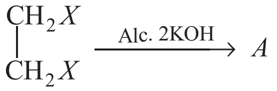
Here X refers to

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

99 What are A and B in following reaction?


$$H_2\underset{\underset{Br}{|}}{C}-\overset{\overset{H}{|}}{\underset{\underset{Br}{|}}{C}}-H + KOH \xrightarrow{\text{Alcohol}} A \xrightarrow{NaNH_2} B$$

(a) $A \Rightarrow H_2C=CH_2$ $B \Rightarrow CH\equiv CH$
(b) $A \Rightarrow CH_2=CHBr$ $B \Rightarrow CH\equiv CH$
(c) $A \Rightarrow CH_2=CHBr$ $B \Rightarrow CH_2=CH_2$
(d) $A \Rightarrow CH_2=CH_2$ $B \Rightarrow CH\equiv CBr$

100 
$$\begin{array}{l}CH_2X\\|\\CH_2X\end{array} \xrightarrow{\text{Alc. 2KOH}} A$$

Here, A refers to

(a) $CH_2=CH_2$
(b) CH_3-CH_2-OH
(c) $H-C\equiv CH$
(d) CH_3-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) $CH_2=CH_2 > CH_3-CH=CH_2 > CH_3-C\equiv CH > CH\equiv CH$
(b) $CH\equiv CH > CH_3-C\equiv CH > CH_2=CH_2 > CH_3-CH_3$
(c) $CH\equiv CH > CH_2=CH_2 > CH_3-C\equiv CH > CH_3-CH_3$
(d) $CH_3-CH_3 > CH_2=CH_2 > CH_3-C\equiv CH > CH\equiv CH$

103 $A \xleftarrow[\text{(ii) } H_2]{\text{(i) Pt/Pd/Ni}} R-C\equiv CH \xrightarrow{NaNH_2} B$

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

104 $CH_3-C\equiv CH + Br-Br \longrightarrow A.$

Here, A refers to
(a) $BrCH_2-CH=CHBr$
(b) $CH_3-CH=CBr_2$
(c) $Br-CH_2-CBr=CH_2$
(d) $CH_3-CBr=CHBr$

105 When $CH_3-C\equiv CH$ reacts with one mole of HBr then product obtained is
(a) bromoethene
(b) dibromopropane
(c) 2-bromopropene
(d) 1-bromopropane

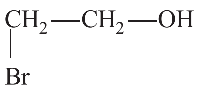
106 Which of the following reaction will yield 2,2-dibromopropane?
(a) $CH_3-CH=CH_2+HBr\longrightarrow$
(b) $CH_3-C\equiv CH+2HBr\longrightarrow$
(c) $CH_3-CH=CHBr+HBr\longrightarrow$
(d) $CH\equiv CH+2HBr\longrightarrow$

107 The major product of the following reaction is

$CH_3C\equiv CH \xrightarrow[\text{(ii) DI}]{\text{(i) DCl (1 equiv.)}}$ ***JEE Main 2019***

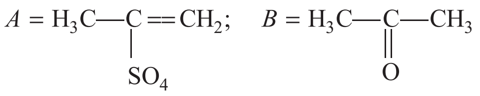
(a) $CH_3CD(Cl)CHD(I)$ (b) $CH_3CD_2CH(Cl)(I)$
(c) $CH_3CD(I)CHD(Cl)$ (d) $CH_3C(I)(Cl)CHD_2$

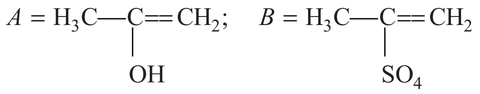
108 $CH\equiv CH \xrightarrow[H_2O]{Hg^{2+}/H^+} A \xrightarrow{LiAlH_4} B \xrightarrow{P/Br_2} C,$

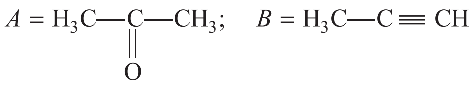
Final product C is ***JIPMER 2019***
(a) CH_3CH_2OH (b) CH_3CH_2-Br
(c) CH_3-CH_2-I (d)

$\underset{\underset{Br}{|}}{CH_2}-CH_2-OH$

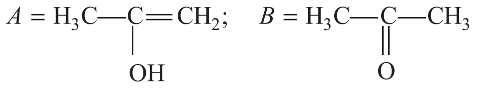
109 Predict the correct intermediate and product in the following reaction. ***NEET 2017***

$H_3C-C\equiv CH \xrightarrow[HgSO_4]{H_2O,\ H_2SO_4} \text{Intermediate } (A) \longrightarrow$ Product (B)

(a)

$A = H_3C-\underset{\underset{SO_4}{|}}{C}=CH_2;\quad B = H_3C-\underset{\underset{O}{||}}{C}-CH_3$

(b)

$A = H_3C-\underset{\underset{OH}{|}}{C}=CH_2;\quad B = H_3C-\underset{\underset{SO_4}{|}}{C}=CH_2$

(c)

$A = H_3C-\underset{\underset{O}{||}}{C}-CH_3;\quad B = H_3C-C\equiv CH$

(d)

$A = H_3C-\underset{\underset{OH}{|}}{C}=CH_2;\quad B = H_3C-\underset{\underset{O}{||}}{C}-CH_3$

110 The polymer polythene is represented as
(a) $\left(CH=CH-CH=CH \right)_n$
(b) $\left(CH=CH-CH_2 \right)_n$
(c) $\left(-CH=CH=CH \right)_n-$
(d) $\left(CH=CH-CH=CH-CH_2 \right)_n$

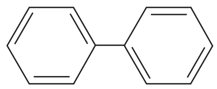
111 Which of the following molecules on passing through red hot iron tube at 873 K undergoes cyclic polymerisation?
(a) Ethene
(b) Ethyne
(c) Acetylene
(d) Both (b) and (c)

112 In the following reaction, ***NEET 2019***

$$H_3C-C\equiv CH \xrightarrow[873\text{ K}]{\text{Red hot iron tube}} A,$$

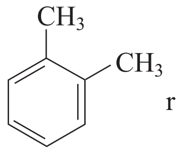
the number of sigma (σ) bonds present in the product A is
(a) 21
(b) 9
(c) 24
(d) 18

TOPIC 5~ *Aromatic Hydrocarbons and Carcinogenicity*

113 The given structure  is

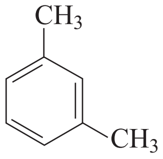
(a) biphenyl (b) naphthalene
(c) dibenzene (d) All of these

114 The common name and IUPAC name of



respectively are

(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

115 The IUPAC name of  is

(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

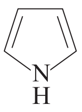
117 The number of sp^2-hybrid orbitals in a molecule of benzene is ***JEE Main 2020***

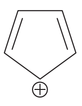
(a) 24 (b) 12
(c) 18 (d) 6

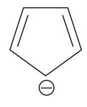
118 Which reaction confirms the presence of three double bonds in benzene?

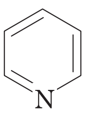
(a) Oxidation reaction
(b) Hydrolysis reaction
(c) Triozonolysis reaction
(d) Addition reaction

119 Which of the following compounds is not aromatic? ***JEE Main 2019***

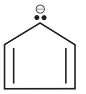
(a) 

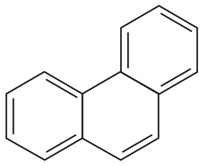
(b) 

(c) 

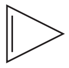
(d) 

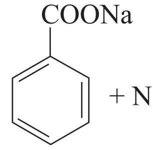
120 Four structures are given in options (a) to (d). Examine them and select the one that is not aromatic.

(a) 

(b) 

(c) 

(d) 

121  $+ \text{NaOH} \xrightarrow[\text{D}]{\text{CaO}} A + \text{Na}_2\text{CO}_3$, A is

(a) C_6H_6 (b) C_6H_5 — Na
(c) C_6H_5 — ONa (d) C_5H_5 — Na

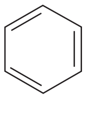
122 On passing vapours of phenol over heated zinc, dust it gets reduced to

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

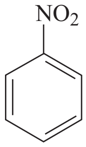
123 For an electrophilic substitution reaction, the presence of a halogen atom in the benzene ring

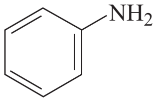
(a) deactivates the ring by inductive effect
(b) deactivates the ring by resonance
(c) increases the charge density at *ortho* position relative to *para*-position by resonance
(d) directs the incoming electrophile to *meta* -position by increasing the charge density relative to *ortho* and *para* -position

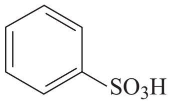
124 Consider the reaction given below.

 $+ \text{Conc. HNO}_3 + \text{Conc. H}_2\text{SO}_4 \xrightarrow{(323\text{–}333)\text{ K}} A + \text{H}_2\text{O}$,

Here, *A* refers to

(a) 

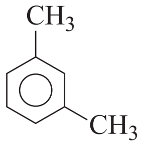
(b) 

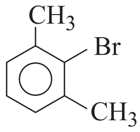
(c) 

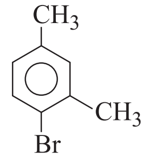
(d) All of these

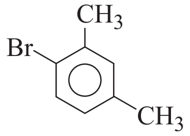
125 In an electrophilic substitution reaction of nitrobenzene, the presence of nitro group
(a) activates the ring by resonance effect
(b) activates the ring by inductive effect
(c) decreases the charge density at *ortho* and *para* -position of the ring relative to *meta* -position by resonance
(d) increases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

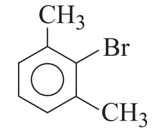
126 What products are formed when the following compound is treated with Br_2 in the presence of $FeBr_3$? ***CBSE AIPMT 2014***

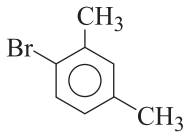


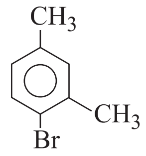
(a)


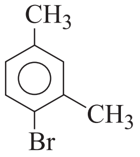
and


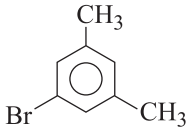
(b)


and


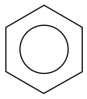
(c)


and


(d)


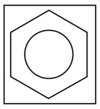
and


127 Consider the reaction given below.


$+ RX \xrightarrow{\text{Anhyd. } AlCl_3} A + HCl$, Here, *A* is

(a) methylbenzene (b) toluene
(c) alkylbenzene (d) ethylbenzene

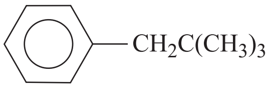
128 In the reaction,

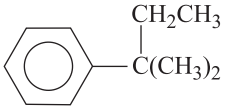
$X \xleftarrow{Cl_2}$

$+ \underset{\text{(Fuming sulphuric acid)}}{H_2SO_4} \xrightarrow{\Delta} Y,$

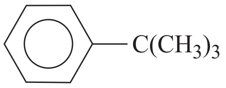
X and *Y* respectively are
(a) C_6H_5Cl and $C_6H_5SO_3H$
(b) C_6H_5Cl and C_6H_5OH
(c) $C_6H_4Cl_2$ and $C_6H_5SO_2$
(d) C_6H_5Cl and C_6H_5CHO

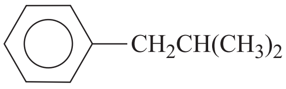
129 Acetophenone ($C_6H_5COCH_3$) is prepared from reaction of benzene (C_6H_6) with *A* in the presence of anhyd. $AlCl_3$. Here, *A* refers to
(a) CH_3COCH_3 (b) CH_3CHO
(c) CH_3CH_2CHO (d) CH_3COCl

130 Neopentyl chloride reacts with benzene in the presence of a Lewis acid ($AlCl_3$) to form ***JIPMER 2018***

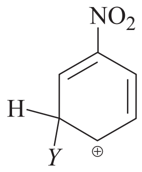
(a)


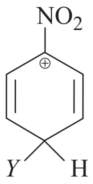
(b)


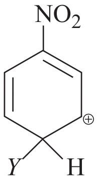
(c)


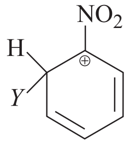
(d)


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

(a)


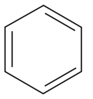
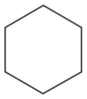
(b)


(c)


(d)


132 During nitration of benzene, the attacking electrophile is ***JIPMER 2019***
(a) NO_3^- (b) NO_2^-
(c) NO_2^+ (d) HNO_3

133 Consider the reaction given below.


$+ A \xrightarrow{Ni, \Delta}$


Here, *A* is
(a) H_2 (b) $2H_2$
(c) $3H_2$ (d) $4H_2$

134 Hexachlorobenzene is obtained by addition of *X* moles of Cl_2 with C_6H_6 in the presence of UV/500 K. The value of *X* is
(a) 2 (b) 4
(c) 3 (d) 8

135 When benzene is heated in air, it burns with sooty flame producing X and Y, as shown in the given reaction $C_6H_6 + \frac{15}{2}O_2 \longrightarrow X + Y$

Here, X and Y refer to

(a) C_6H_5 — OH, CO (b) CO_2, H_2O

(c) C_6H_{14}, CO_2 (d) C_6H_5OH, H_2

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

(a) —Cl (b) —OCH_3

(c) —CHO (d) All of these

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

(a) —NO_2, —NH_2, —COOH, — COO*R*

(b) —NO_2, —CHO, —SO_3H, — CO*R*

(c) — CN, — CHO, —$NHCOCH_3$, — COO*R*

(d) — CN, —NH_2, —NH*R*, — OCH_3

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

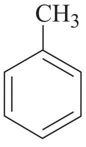
(a) electrophile, *meta*

(b) nucleophile, *meta*

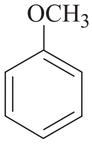
(c) deactivating group, *para*

(d) activating group, *meta*

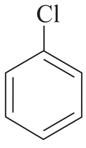
139 Correct order of electrophilic substitution reaction is



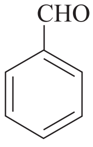
(*A*)



(*B*)



(*C*)



(*D*)

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(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

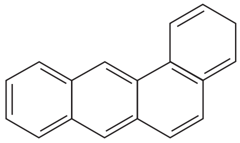
(a) addition (b) combustion (c) elimination (d) substitution

SPECIAL TYPES QUESTIONS

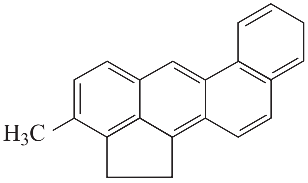
I. Statement Based Questions

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

I.



II.



(a) 1,2-benzanthracene and 3-methylcholanthrene respectively

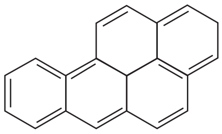
(b) 1,2-benzanthracene and 3-ethylcholanthroctane respectively

(c) 1,2-benzenenapthalate and 2-methylcholanthrace respectively

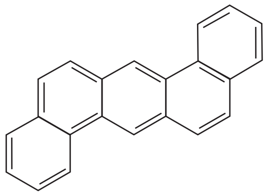
(d) 1,2-benzenenaphthalene and 1,2-methylcholanthrane respectively

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

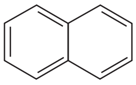
(a)



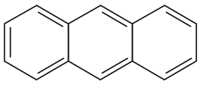
(b)



(c)



(d)



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_2 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

I. $\mathrm{CH_4 + Cl^{\bullet} \xrightarrow{h\nu} \dot{C}H_3 + H - Cl}$

II. $\mathrm{Cl - Cl \xrightarrow{h\nu} 2\dot{C}l}$

III. $\mathrm{\dot{C}H_3 + Cl_2 \longrightarrow CH_3{-}Cl + Cl^{\bullet}}$

IV. $\mathrm{\dot{C}l + \dot{C}l \longrightarrow Cl{-}Cl}$

$\mathrm{\dot{C}H_3 + \dot{C}H_3 \longrightarrow CH_3 - CH_3}$

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 posseses more energy as compared to staggered form.
IV. Energy of staggered molecule is lower than that of eclipsed form.

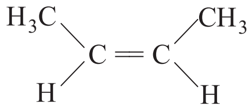
Choose the correct option.

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

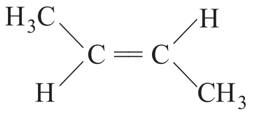
149 Which of the following statement is/are correct?

(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?



cis
A



trans
B

(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 π-bond
(d) Ethyne molecule consists of two C—C σ-bonds

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

I. $\mathrm{CH \equiv CH > CH_2 = CH_2 > CH_3 - CH_3}$

II. $\mathrm{HC \equiv CH > CH_3C \equiv CH > CH_3C \equiv CCH_3}$

(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°

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 σ-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 π-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 $—NH_2$, $—NHR$, $—NHCOCH_3$, $—OCH_3$, $—CH_3$, $—C_2H_5$ 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.

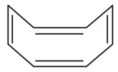
161 **Assertion** (A) Propene reacts with HI in the presence of peroxide to give 1-iodopropane. ***AIIMS 2019***

Reason (R) 1° free radical is less stable than 2° 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 8π-electron system but it is not an aromatic compound.

Reason (R) $(4n+2)$ π-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.

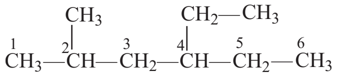
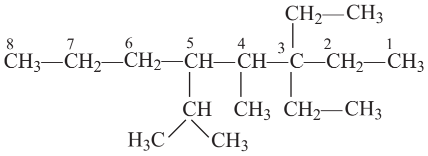
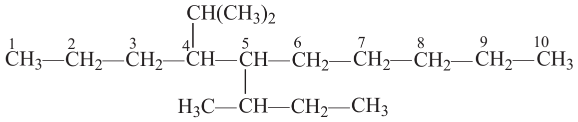
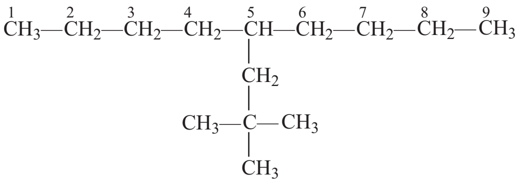
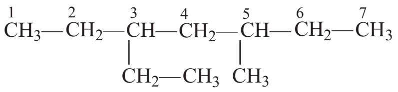
Reason (R) The mixture of concentrated sulphuric acid and concentrated nitric acid produces the electrophile, NO_2^+. ***AIIMS 2018***

165 **Assertion** (A) In the electrophilic substitution of aryl halides, the incoming electrophile gets attached to the *meta* position.

Reason (R) Aryl halides are moderately deactivating.

III. Matching Type Questions

166 Match the Column I with Column II where Column I represents structural formula and IUPAC name of the organic compound and Column II represents rule incorporated in the naming of organic compound and choose the correct option from the codes given below.

	Column I (Structure and IUPAC name)		**Column II** (Rules incorporated)
A.	 $CH_3-\overset{CH_3}{CH}-CH_2-\overset{CH_2-CH_3}{CH}-CH_2-CH_3$ (4-ethyl-2-methylhexane)	1.	*sec* is not considered while arranging alphabetically; isopropyl is taken as one word.
B.	 (3,3-diethyl-5-*iso*-propyl-4-methyloctane)	2.	Further numbering to the substituents of the side chain.
C.	 5-*sec*-butyl-4-*iso*-propyldecane	3.	Alphabetical priority order.
D.	 5-(2,2-dimethylpropyl) nonane	4.	Lowest sum rule and alphabetical arrangements.
E.	 $CH_3-CH_2-\underset{CH_2-CH_3}{CH}-CH_2-\underset{CH_3}{CH}-CH_2-CH_3$ 3-ethyl-5-methylheptane	5.	di, tri etc, are not considered while arranging alphabetically.

Codes

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

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.	$CH_4 + O_2 \longrightarrow CH_3OH$	1. Cu/523 K/100 atm
B.	$CH_4 + O_2 \longrightarrow HCHO$	2. Mo_2O_3, Δ
C.	$2CH_3CH_3 + 3O_2 \longrightarrow 2CH_3COOH + 2H_2O$	3. $(CH_3COO)_2Mn$
D.	$(CH_3)_3CH \longrightarrow (CH_3)_3COH$	4. $KMnO_4$

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

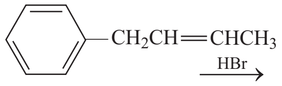
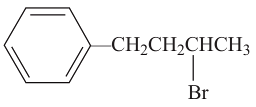
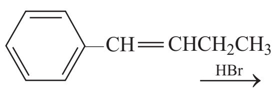
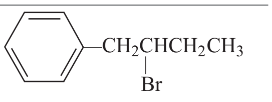
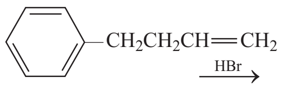
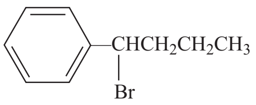
168 Match the following reactants in Column I with the corresponding reaction products in Column II and select the correct answer using the given codes below :

	Column I	Column II
A.	Alkane + $X_2 \xrightarrow{h\nu}$	1. Water + carbon dioxide
B.	Alkane + $O_2 \xrightarrow{\Delta}$	2. Alkanal
C.	Alkane + $O_2 \xrightarrow{Mo_2O_3}$	3. Haloalkane
D.	n-hexane $\xrightarrow[10\text{-}20\ atm]{\Delta,\ 773\ K}$	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

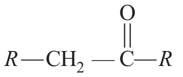
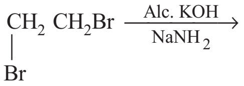
169 Match the Column I and Column II and choose the correct option from the codes given below.

	Column I		Column II
A.		1.	
B.		2.	
C.		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.	$RC\equiv CR \xrightarrow[CH_3COOH]{BH_3,\ THF}$	1.	$CH_3-C\equiv C-Na$
B.	$RC\equiv CR \xrightarrow[H_2]{Pd/Ni}$	2.	 $R-CH_2-\overset{\overset{O}{\parallel}}{C}-R$
C.	 $\underset{\underset{Br}{\vert}}{CH_2}\ CH_2Br \xrightarrow[NaNH_2]{Alc.\ KOH}$	3.	$CH_3-C\equiv C-OH$
D.	$CH_3C\equiv CH \xrightarrow{NaNH_2}$	4.	$R-CH_2-CH_2-R$
		5.	$CH\equiv CH$

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 + $Cl_2 \xrightarrow{AlCl_3}$	1. Benzene sulphonic acid
B.	Benzene + $CH_3Cl \xrightarrow{AlCl_3}$	2. Methyl phenyl ketone
C.	Benzene + $CH_3COCl \xrightarrow{AlCl_3}$	3. Toluene
D.	Benzene $\xrightarrow{H_2SO_4}$	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

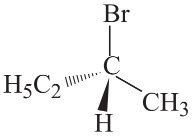
NCERT & NCERT Exemplar

MULTIPLE CHOICE QUESTIONS

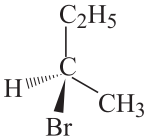
NCERT

172 The IUPAC names of the products obtained by the ozonolysis of 1-phenylbut-1-ene are
(a) propanal and benzaldehyde
(b) propanoic acid and benzoic acid
(c) propanal and benzoic acid
(d) propanoic acid and benzaldehyde

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



A



B

$CH_3-CH_2-CH_2-CH_2-Br$

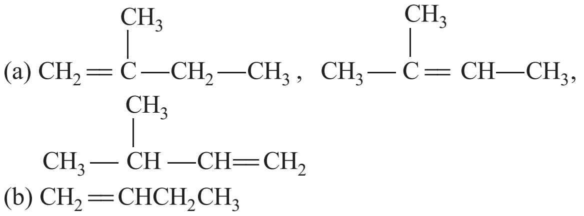
C

The mixture consists of
(a) *A* and *B* as major and *C* as minor products
(b) *B* as major, *A* and *C* as minor products
(c) *B* as minor, *A* and *C* as major products
(d) *A* and *B* as minor and *C* as major products

174 An alkene *A* contains three C—C, eight C—H σ-bonds and one C—C π-bond. *A* on ozonolysis gives two moles of an aldehyde of molar mass 44 u. Write IUPAC name of *A*.
(a) Prop-1-ene
(b) But-2-ene
(c) But-1-ene
(d) Both (b) and (c)

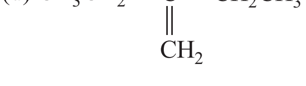
175 Arrange benzene, *n*-hexane and ethyne in decreasing order of acidic behaviour.
(a) Benzene > hexane > ethyne
(b) Benzene > ethyne > hexane
(c) Ethyne > benzene > hexane
(d) Hexane > benzene > ethyne

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



(a) $CH_2=\overset{\overset{CH_3}{|}}{C}-CH_2-CH_3$, $CH_3-\overset{\overset{CH_3}{|}}{C}=CH-CH_3$, $CH_3-\overset{\overset{CH_3}{|}}{CH}-CH=CH_2$

(b) $CH_2=CHCH_2CH_3$
(c) $CH_3CH_2CH=CH-CH_3$



(d) $CH_3CH_2-\underset{\underset{CH_2}{\|}}{C}-CH_2CH_3$

177 Arrange the following set of compounds in order of their decreasing relative reactivity with an electrophile, E^+: chlorobenzene, 2, 4-dinitrochlorobenzene, *p*-nitrochlorobenzene
(a) chlorobenzene > 2, 4-dinitrochlorobenzene > *p*-nitrochlorobenzene
(b) chlorobenzene > *p*-nitrochlorobenzene > 2, 4-dinitro chlorobenzene
(c) *p*-nitrochlorobenzene > chlorobenzene > 2, 4-dinitro chlorobenzene
(d) 2, 4-dinitrochlorobenzene > *p*-nitrochlorobenzene > chlorobenzene

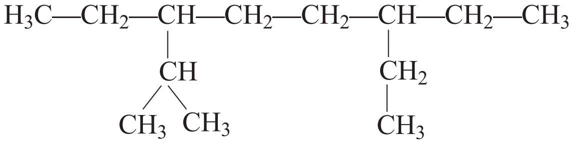
NCERT Exemplar

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

179 Arrange the halogens F_2, Cl_2, Br_2, I_2 in order of their increasing reactivity with alkanes.
(a) $I_2 < Br_2 < Cl_2 < F_2$
(b) $Br_2 < Cl_2 < F_2 < I_2$
(c) $F_2 < Cl_2 < Br_2 < I_2$
(d) $Br_2 < I_2 < Cl_2 < F_2$

180 The increasing order of reduction of alkyl halides with zinc and dil. HCl is
(a) $R-Cl < R-I < R-Br$
(b) $R-Cl < R-Br < R-I$
(c) $R-I < R-Br < R-Cl$
(d) $R-Br < R-I < R-Cl$

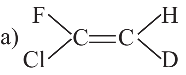
181 The correct IUPAC name of the following alkane is

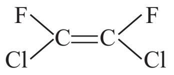


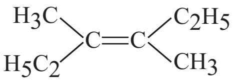
$H_3C-CH_2-\underset{\underset{CH_3\ \ CH_3}{\underset{/\ \backslash}{CH}}}{\underset{|}{CH}}-CH_2-CH_2-\underset{\underset{CH_3}{\underset{|}{CH_2}}}{\underset{|}{CH}}-CH_2-CH_3$

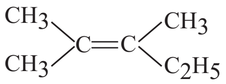
(a) 3,6-diethyl-2-methyloctane
(b) 5-isopropyl -3-ethyloctane
(c) 3-ethyl-5-isopropyloctane
(d) 3-isopropyl-6-ethyloctane

182 Which of the following will not show geometrical isomerism?

(a)


(b)


(c)


(d)


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

(a) HCl > HBr > HI (b) HBr > HI > HCl

(c) HI > HBr > HCl (d) HCl > HI > HBr

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

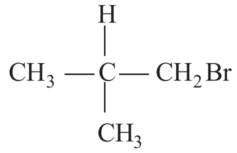
A. $H_3C-C\equiv C^-$ *B.* $H-C\equiv C^-$

C. $H_3C-\bar{C}H_2$

(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 β-elimination reaction with alc. KOH.

A. 
$CH_3-\underset{CH_3}{\overset{H}{C}}-CH_2Br$ B. CH_3-CH_2-Br

C. $CH_3-CH_2-CH_2-Br$

(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) $2CH_4 + O_2 \xrightarrow{Cu/523\ K/100\ atm} 2CH_3OH$

(b) $CH_4 + O_2 \xrightarrow{Mo_2O_3} HCHO + H_2O$

(c) $CH_4 + O_2 \longrightarrow C(s) + 2H_2O(l)$

(d) $CH_2 + 2O_2(g) + 2H_2O(l)$

■ **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) 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 $CH_3-CH=CH_2$ gives some product given in Column II as per the codes given below :

	Column I		Column II
A.	$O_3 / Zn + H_2O$	1.	Acetic acid and CO_2
B.	$KMnO_4 / H^+$	2.	Propan-1-ol
C.	$KMnO_4 / OH^-$	3.	Propan-2-ol
D.	H_2O / H^+	4.	Acetaldehyde and formaldehyde
E.	B_2H_6 / $NaOH^+$ and H_2O_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.	$CH_2=CH_2 + H_2O \xrightarrow{H^+} CH_3CH_2OH$	1.	Hydrogenation
B.	$CH_2=CH_2 + H_2 \xrightarrow{Pd} CH_3-CH_3$	2.	Halogenation
C.	$CH_2=CH_2 + Cl_2 \longrightarrow Cl-CH_2-CH_2-Cl$	3.	Polymerisation
D.	$3\ CH\equiv CH \xrightarrow[Heat]{Cu\ tube} C_6H_6$	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.	*n*-pentane	1.	282.5 K
B.	*iso*-pentane	2.	309 K
C.	*neo*-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 Questinos

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)	

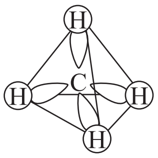
Hints & Explanations

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 (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.



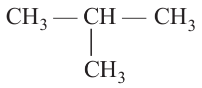
8 (*c*) Butane (C_4H_{10}) has two chain isomers.

These are as follows :

I. $CH_3-CH_2-CH_2-CH_3$

Butane

II.



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

2-methylpropane

9 (*b*) The given isomers are :

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

2-methylpropane *n*-butane

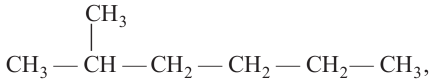
Since, their molecular formulas are same but the chain of C-atoms is different, these are chain isomers.

10 (*a*) C_7H_{16} has 9 chain isomers. These are as follows :

(i) $CH_3-CH_2-CH_2-CH_2-CH_2-CH_2-CH_3$,

n-heptane

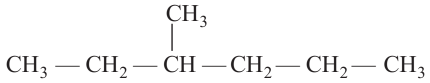
(ii)



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

2-methylhexane

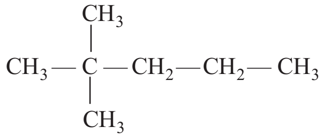
(iii)



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

3-methylhexane

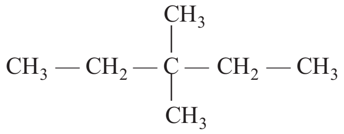
(iv)



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

2, 2-dimethylpentane

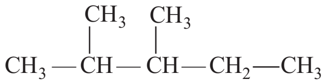
(v)



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

3, 3- dimethylpentane

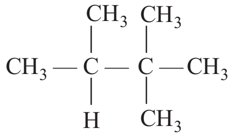
(vi)



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

2, 3- dimethylpentane

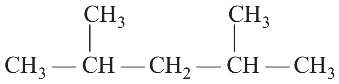
(vii)



$CH_3-\overset{\overset{CH_3}{|}}{\underset{\underset{H}{|}}{C}}-\overset{\overset{CH_3}{|}}{\underset{\underset{CH_3}{|}}{C}}-CH_3$

2, 2, 3-trimethylbutane

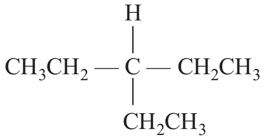
(viii)



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

2, 4-dimethylpentane

(ix)

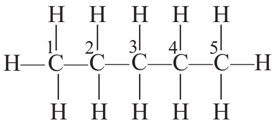


$CH_3CH_2-\overset{\overset{H}{|}}{\underset{\underset{CH_2CH_3}{|}}{C}}-CH_2CH_3$

3-ethyl pentane

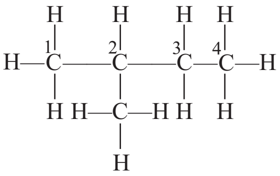
So, the number of chain isomers of C_7H_{16} is nine.

11 (*c*) Five C atoms and twelve H atoms of C_5H_{12} can be joined in following three ways :



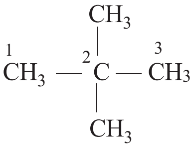
$H-\overset{\overset{H}{|}}{\underset{\underset{H}{|}}{{}^{1}C}}-\overset{\overset{H}{|}}{\underset{\underset{H}{|}}{{}^{2}C}}-\overset{\overset{H}{|}}{\underset{\underset{H}{|}}{{}^{3}C}}-\overset{\overset{H}{|}}{\underset{\underset{H}{|}}{{}^{4}C}}-\overset{\overset{H}{|}}{\underset{\underset{H}{|}}{{}^{5}C}}-H$

Pentane (*n*-pentane)



$H-\overset{\overset{H}{|}}{\underset{\underset{H}{|}}{{}^{1}C}}-\overset{\overset{H}{|}}{\underset{\underset{H-\underset{\underset{H}{|}}{C}-H}{|}}{{}^{2}C}}-\overset{\overset{H}{|}}{\underset{\underset{H}{|}}{{}^{3}C}}-\overset{\overset{H}{|}}{\underset{\underset{H}{|}}{{}^{4}C}}-H$

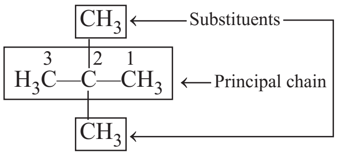
2-methyl butane (*iso*-pentane)



$\overset{1}{CH_3}-\overset{\overset{CH_3}{|}}{\underset{\underset{CH_3}{|}}{{}^{2}C}}-\overset{3}{CH_3}$

2, 2-dimethyl propane (*neo*-pentane)

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



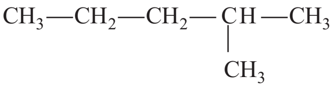
13 (*d*) Possible structural isomers for C_6H_{14} are five.

These are as shown below :

(i) $CH_3-CH_2-CH_2-CH_2-CH_2-CH_3$

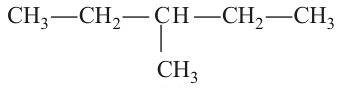
Hexane

(ii)

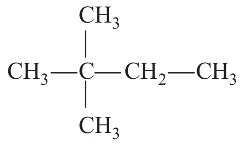


$CH_3-CH_2-CH_2-\underset{\underset{CH_3}{|}}{CH}-CH_3$

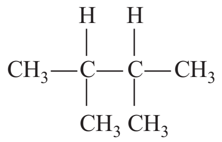
2-methylpentane

(iii) 
$CH_3-CH_2-\underset{\underset{CH_3}{|}}{CH}-CH_2-CH_3$

3-methylpentane

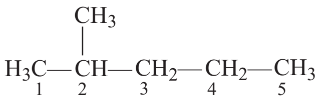
(iv) 
$CH_3-\overset{\overset{CH_3}{|}}{\underset{\underset{CH_3}{|}}{C}}-CH_2-CH_3$

2, 2-dimethylbutane

(v) 
$CH_3-\overset{\overset{H}{|}}{\underset{\underset{CH_3}{|}}{C}}-\overset{\overset{H}{|}}{\underset{\underset{CH_3}{|}}{C}}-CH_3$

2, 3-dimethylbutane

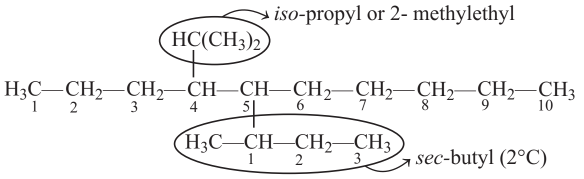
14 (*b*) Numbering of substituent in the given compound is done according to lowest locant rule as shown below :


$$\underset{1}{H_3C}-\underset{2}{\overset{\overset{CH_3}{|}}{CH}}-\underset{3}{CH_2}-\underset{4}{CH_2}-\underset{5}{CH_3}$$

2-methylpentane

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

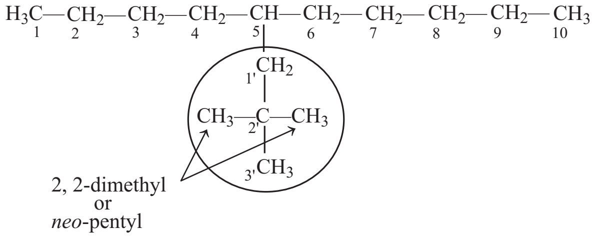
15 (*d*) The given compound is shown below :



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 :

$$CH_3-Cl + H_2 \xrightarrow{Zn,\ H^+} CH_4 + HCl$$

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.

i.e. $R-Cl + 2Na + R-Cl \longrightarrow \underset{\text{Alkane}}{R-R} + 2NaCl$

Thus, methane cannot be prepared by this reaction.

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

$$\underbrace{CH_3X + 2Na + CH_3X \xrightarrow[\text{Ether}]{\text{Dry}} \underset{\text{Ethane}}{CH_3-CH_3} + 2NaX}_{\text{Wurtz reaction}}$$

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 :

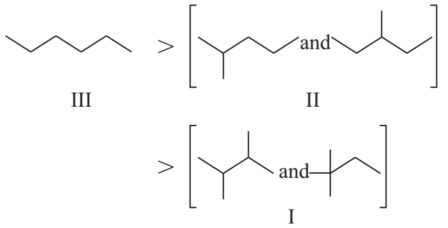
$$\underset{\text{Sodium acetate}}{2CH_3CO\overset{-}{O}\overset{+}{Na}} + 2H_2O$$

$$\Big\downarrow \text{Electrolysis}$$

$$\underbrace{CH_3-CH_3 + 2CO_2}_{\text{At anode}} + \underbrace{H_2}_{\text{At cathode}} + \underset{\text{In solution}}{2NaOH}$$

The products formed at anode are ethane and 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 :

$$3° > 2° > 1°$$

This is because 3° H is more reactive than 2° H, which in turn is more reactive than 1° H.

30 (*b*) Iodination is very slow and a reversible reaction. It can be carried out in the presence of oxidising agents like HIO_3 or HNO_3 which oxidises the HI formed into I_2 as shown below :

$$CH_4 + I_2 \rightleftharpoons CH_3I + HI$$
$$HIO_3 + 5HI \longrightarrow 3I_2 + 3H_2O$$

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

$$\underbrace{C_nH_{2n+2} + \left(\frac{3n+1}{2}\right) O_2}_{\text{Reactants}} \longrightarrow \underbrace{nCO_2 + (n+1)\, H_2O}_{\text{Products}}$$

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

$$CH_4(g) + O_2(g) \xrightarrow[\text{combustion}]{\text{Incomplete}} C(s) + 2H_2O(l)$$

33 (*a*) $Mo_2O_3(X)$ acts as a catalyst to oxidise methane to formaldehyde. Complete reaction is as follows :

$$CH_4 + O_2 \xrightarrow[\Delta]{Mo_2O_3(X)} HCHO + H_2O$$

Cu/523K/100 atm oxidises methane to methanol. The reaction is as follows :

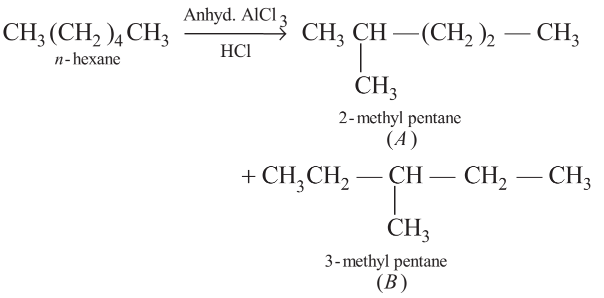
$$\underset{\text{Methane}}{2CH_4} + O_2 \xrightarrow{Cu/523\text{ K}/100\text{ atm}} \underset{\text{Methanol}}{2CH_3OH}$$

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

$$\underset{\text{2-methylpropane}}{(CH_3)_3CH} \xrightarrow[\text{Oxidation}]{KMnO_4(X)} \underset{\text{2-methylpropan-2-ol}}{(CH_3)_3COH}$$

So, X is $KMnO_4$.

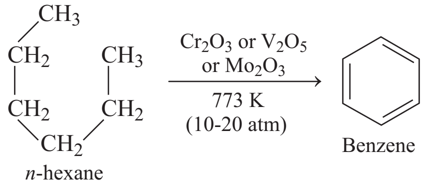
35 (*a*) The given reaction represents isomerisation reaction as shown below :



$$\underset{n\text{-hexane}}{CH_3(CH_2)_4CH_3} \xrightarrow[HCl]{\text{Anhyd. }AlCl_3} \underset{\underset{(A)}{\text{2-methyl pentane}}}{CH_3\underset{|}{CH}\text{—}(CH_2)_2\text{—}CH_3 \atop \quad CH_3} + \underset{\underset{(B)}{\text{3-methyl pentane}}}{CH_3CH_2\text{—}\underset{|}{CH}\text{—}CH_2\text{—}CH_3 \atop CH_3}$$

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 :



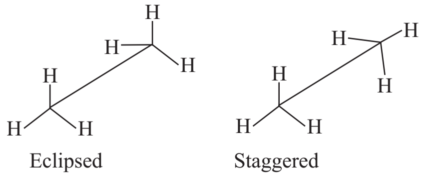
37 (*c*) Dodecane ($C_{12}H_{26}$) on heating to 973K in the presence of Pt, Pd, Ni gives a mixture of heptane, pentene and other products. Reaction involved is as follows :

$$C_{12}H_{26} \xrightarrow[973\text{ K}]{Pt/Pd/Ni} C_7H_{16} + C_5H_{10} + \text{ Other products}$$

The principle involved in this reaction is pyrolysis.

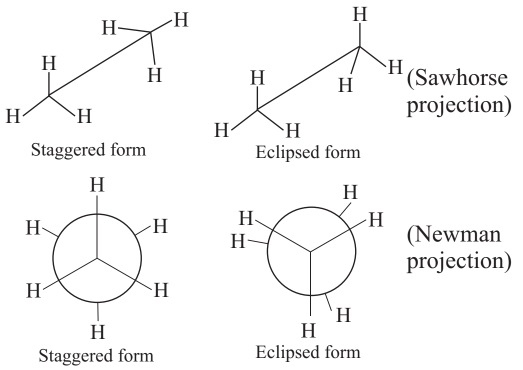
38 (*c*) Cracking is the process of breaking a heavier hydrocarbon into two or more smaller hydrocarbons. Liquid hydrocarbon can be converted into a mixture of gaseous hydrocarbon by cracking.

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 (∞) 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.

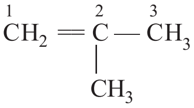
45 (*b*) Among the given structures, structure (*a*) and (*b*) are staggered forms of ethane-1, 2 diol. On the other hand, structure (*c*) and (*d*) are eclipsed forms of ethane-1, 2-diol. Eclipsed forms are less stable than staggered forms due to electronic repulsion.

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

Hence, option (b) is correct.

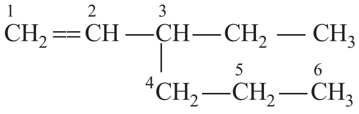
48 (*c*) C—C double bond in alkenes consist of one strong σ-bond (bond enthalpy about 397 kJ mol^{-1}) due to head on overlapping of sp^2 -hybridised orbitals and one weak π-bond (bond enthalpy about 284 kJ mol^{-1}) obtained by lateral or sideways overlapping of the two 2*p*-orbitals of the two C-atoms.

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



$\overset{1}{CH_2}=\overset{2}{C}(CH_3)-\overset{3}{CH_3}$ is 2-methylprop-1-ene.

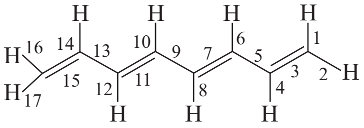
50 (*d*) For naming the given compound, the longest possible carbon chain is selected, numbered according to IUPAC rules.
Thus, the correct IUPAC name of the given compound is 3-ethylhex-1-ene.



$\overset{1}{CH_2}=\overset{2}{CH}-\overset{3}{CH}(\overset{4}{CH_2}-\overset{5}{CH_2}-\overset{6}{CH_3})-CH_2-CH_3$

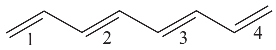
3-ethylhex-1-ene

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



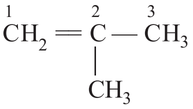
Hence, 17σ-bonds are present.

The π-bonds can be represented as shown below.



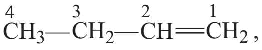
Hence, 4π-bonds are present.

52 (*a*) Structural isomers of molecular formula C_4H_8 can be written in the following three ways :

1. $\overset{1}{CH_2}=\overset{2}{CH}-\overset{3}{CH_2}-\overset{4}{CH_3}$
But-1-ene
2. $\overset{1}{CH_3}-\overset{2}{CH}=\overset{3}{CH}-\overset{4}{CH_3}$
But-2-ene
3. 
$\overset{1}{CH_2}=\overset{2}{C}(CH_3)-\overset{3}{CH_3}$
2-methylprop-1-ene

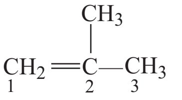
Hence, the number of structural isomers is 3.

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



$\overset{4}{CH_3}-\overset{3}{CH_2}-\overset{2}{CH}=\overset{1}{CH_2}$,

But-1-ene



$\underset{1}{CH_2}=\underset{2}{C}(CH_3)-\underset{3}{CH_3}$

2-methylprop-1-ene

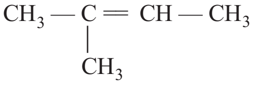
These compounds have different carbon chains.

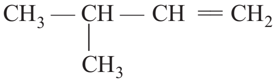
Hence, they are examples of chain isomers.

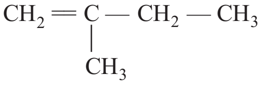
54 (*d*) Possible structural isomers of C_5H_{10} are :

(i) $CH_2=CH-CH_2-CH_2-CH_3$
Pent-1-ene

(ii) $CH_3-CH=CH-CH_2-CH_3$
Pent-2-ene

(iii) 
$CH_3-C(CH_3)=CH-CH_3$
2-methylbut-2-ene

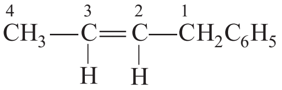
(iv) 
$CH_3-CH(CH_3)-CH=CH_2$
3-methylbut-1-ene

(v) 
$CH_2=C(CH_3)-CH_2-CH_3$
2-methylbut-1-ene

Hence, 2, 3-dimethylpropene is not a structural isomer of C_5H_{10}.

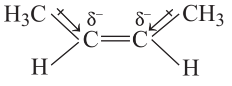
55 (*c*) The type of isomerism exhibited by given isomers (a) and (b) is geometrical isomerism and they both are geometrical isomers. In these molecules, the restricted rotation of atoms or groups around the doubly bonded carbon atoms gives rise to different geometries of the compounds.

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

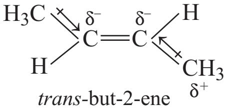


$\overset{4}{CH_3}-\overset{3}{C}(H)=\overset{2}{C}(H)-\overset{1}{CH_2}C_6H_5$

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 :

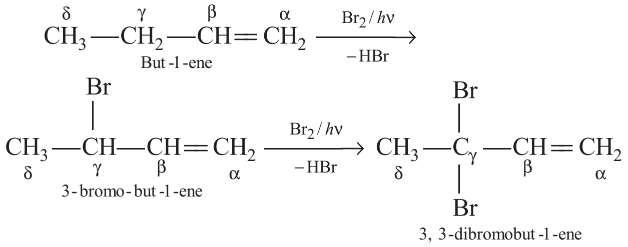


cis-but-2-ene
(μ = 0.33 D)



trans-but-2-ene
(μ = 0)

58 (*c*) The compound (*E*) has two allyl-hydrogen atoms (γ). When *E* reacts with $Br_2/h\nu$, it readily undergoes allylic free radical substitution and forms 3, 3-dibromobut-1-ene



$$\overset{\delta}{CH_3}-\overset{\gamma}{CH_2}-\overset{\beta}{CH}=\overset{\alpha}{CH_2} \xrightarrow[-HBr]{Br_2/h\nu}$$

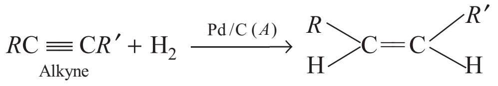
But-1-ene

$$\underset{\delta}{CH_3}-\underset{\gamma}{\overset{\overset{\displaystyle Br}{|}}{CH}}-\underset{\beta}{CH}=\underset{\alpha}{CH_2} \xrightarrow[-HBr]{Br_2/h\nu} \underset{\delta}{CH_3}-\underset{\underset{\displaystyle Br}{|}}{\overset{\overset{\displaystyle Br}{|}}{C_\gamma}}-\underset{\beta}{CH}=\underset{\alpha}{CH_2}$$

3-bromo-but-1-ene

3, 3-dibromobut-1-ene

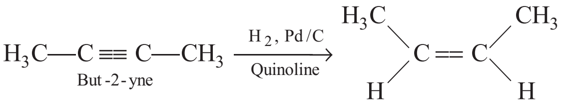
60 (*b*) The complete reaction is shown below :



cis-alkene

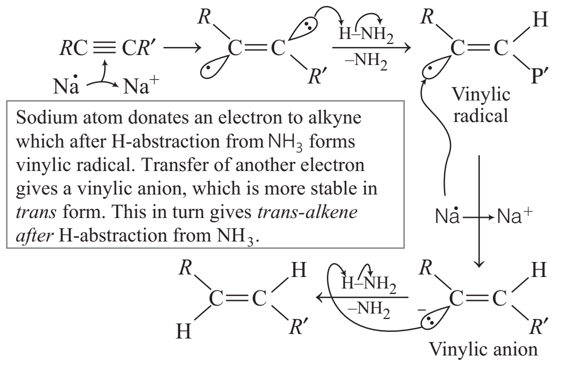
Reduction of alkyne using Pd/C gives *cis*-alkene as major product whereas reduction by using Na in liquid, ammonia gives *trans*-alkene as major product.

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 :



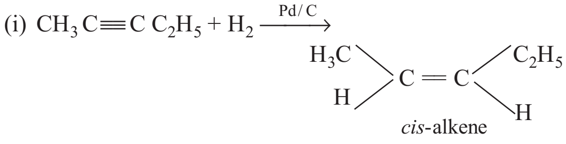
cis-2-butene
(*syn* addition)

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.

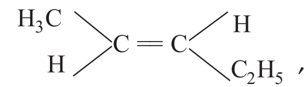


Sodium atom donates an electron to alkyne which after H-abstraction from NH_3 forms vinylic radical. Transfer of another electron gives a vinylic anion, which is more stable in *trans* form. This in turn gives *trans-alkene after* H-abstraction from NH_3.

63 (*a*) The complete reactions are shown below :

(i) 

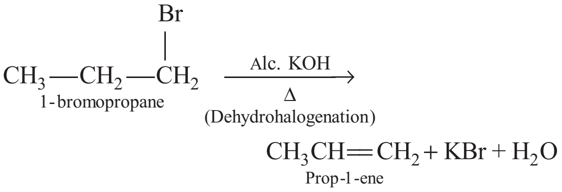
cis-alkene

(ii) 

trans-alkene

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_3 forms *trans*-alkene as the major product.

65 (*a*) The complete reaction is shown below :

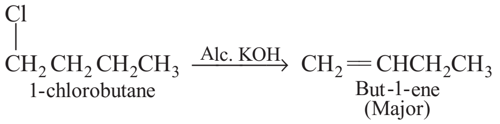


$$CH_3-CH_2-\overset{\overset{\displaystyle Br}{|}}{CH_2} \xrightarrow[\Delta]{\text{Alc. KOH}} CH_3CH=CH_2 + KBr + H_2O$$

1-bromopropane (Dehydrohalogenation) Prop-1-ene (*A*)

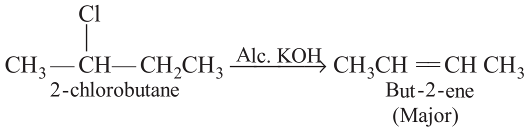
Hence, *A* is $CH_2=CH-CH_3$.

66 (*d*) The complete reactions are given below :

(i) 

$$\overset{\overset{\displaystyle Cl}{|}}{CH_2}CH_2CH_2CH_3 \xrightarrow{\text{Alc. KOH}} CH_2=CHCH_2CH_3$$

1-chlorobutane But-1-ene (Major)

(ii) 

$$CH_3-\overset{\overset{\displaystyle Cl}{|}}{CH}-CH_2CH_3 \xrightarrow{\text{Alc. KOH}} CH_3CH=CH\,CH_3$$

2-chlorobutane But-2-ene (Major)

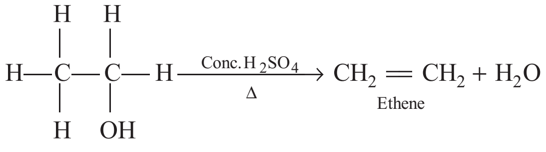
Hence, mixture of but-1-ene and but-2-ene is formed.

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_2 as shown below :

$$CH_3CHBr-CH_2Br + Zn \longrightarrow CH_3CH=CH_2 + ZnBr_2$$

1,2-dibromo propane Propene

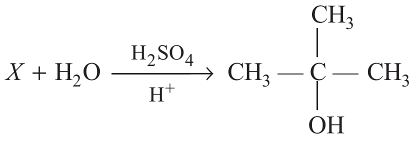
68 (*d*) In the given reaction, water molecule is eliminated from the alcohol molecule in the presence of an acid. This reaction is known as acidic dehydration of alcohols. It is also an example of β-elimination reaction since —OH group takes out one hydrogen atom from β-carbon atom as shown below :



$$H-\underset{\underset{\displaystyle H}{|}}{\overset{\overset{\displaystyle H}{|}}{C}}-\underset{\underset{\displaystyle OH}{|}}{\overset{\overset{\displaystyle H}{|}}{C}}-H \xrightarrow[\Delta]{\text{Conc. }H_2SO_4} CH_2=CH_2+H_2O$$

Ethanol Ethene

69 (*c*) The reaction is given below :



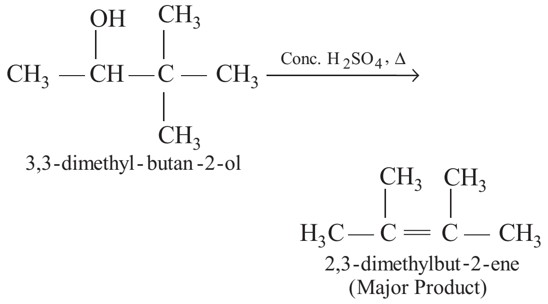
$$X + H_2O \xrightarrow[H^+]{H_2SO_4} CH_3-\underset{\underset{\displaystyle OH}{|}}{\overset{\overset{\displaystyle CH_3}{|}}{C}}-CH_3$$

2-methylpropan-2-ol

Formation of 2-methylpropan-2-ol confirms that H^+/OH^- is added to *X* and as H_2O is removed from this compound.

So, *X* is $CH_3-\underset{\underset{\displaystyle CH_3}{|}}{C}=CH_2$, that is 2-methylpropene.

70 (*b*)

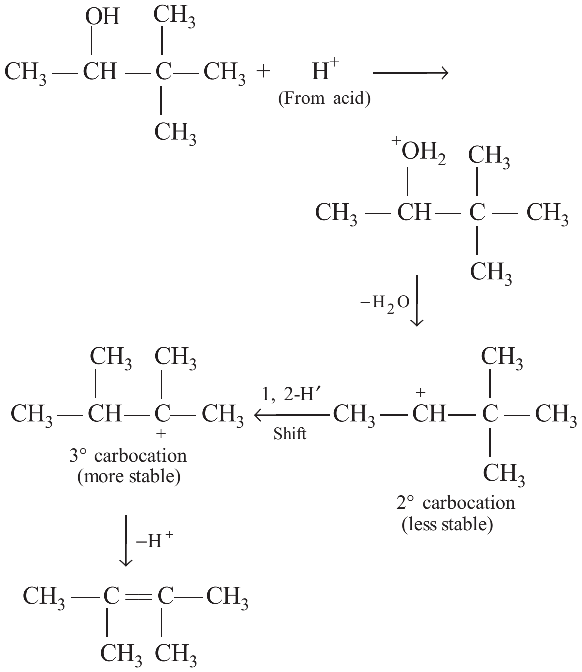


$$CH_3-\underset{|}{\overset{OH}{CH}}-\underset{CH_3}{\overset{CH_3}{C}}-CH_3 \xrightarrow{\text{Conc. } H_2SO_4,\ \Delta} H_3C-\overset{CH_3}{C}=\overset{CH_3}{C}-CH_3$$

3,3-dimethyl-butan-2-ol

2,3-dimethylbut-2-ene (Major Product)

The reaction takes place by the following mechanism :



$$CH_3-\overset{OH}{CH}-\underset{CH_3}{\overset{CH_3}{C}}-CH_3 + \underset{\text{(From acid)}}{H^+} \longrightarrow CH_3-\overset{^+OH_2}{CH}-\underset{CH_3}{\overset{CH_3}{C}}-CH_3 \xrightarrow{-H_2O} CH_3-\overset{+}{CH}-\underset{CH_3}{\overset{CH_3}{C}}-CH_3$$

2° carbocation (less stable)

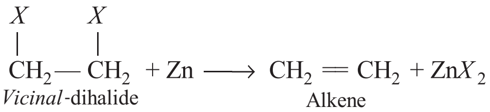
$$\xrightarrow[\text{Shift}]{1,\,2\text{-}H'} CH_3-\overset{CH_3}{CH}-\underset{+}{\overset{CH_3}{C}}-CH_3$$

3° carbocation (more stable)

$$\xrightarrow{-H^+} CH_3-\underset{CH_3}{C}=\underset{CH_3}{C}-CH_3$$

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

71 (*a*) The complete reaction is shown below :

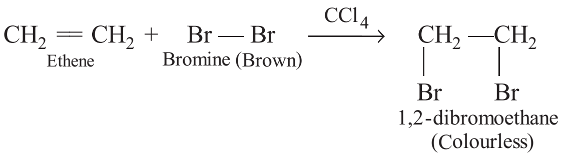


$$\underset{\textit{Vicinal}\text{-dihalide}}{\overset{X}{CH_2}-\overset{X}{CH_2}} + Zn \longrightarrow \underset{\text{Alkene}}{CH_2=CH_2} + ZnX_2$$

Hence, a molecule of ZnX_2 is lost by the *vicinal* dihalide to form an alkene.

72 (*a*) Alkenes are the rich source of loosely held pi (π) 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 :



$$\underset{\text{Ethene}}{CH_2=CH_2} + \underset{\text{Bromine (Brown)}}{Br-Br} \xrightarrow{CCl_4} \underset{Br}{CH_2}-\underset{Br}{CH_2}$$

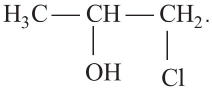
1,2-dibromoethane (Colourless)

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 HI > HBr > HCl.

75 (*c*) But-2-ene on reaction with alkaline $KMnO_4$ at elevated temperature followed by acidification will give acetic acid (CH_3COOH). Hot alkaline solution of potassium permanganate followed by acidification oxidatively cleaved alkenes. The reaction proceed as follows :

$$\underset{\text{But-2-ene}}{CH_3-CH=CH-CH_3} \xrightarrow[H_3O^+]{\text{Alk. } KMnO_4,\text{ heat}} \underset{\text{Acetic acid}}{2CH_3COOH}$$

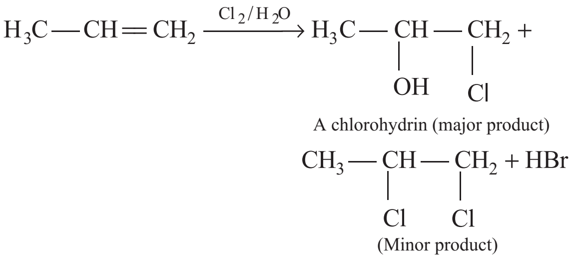
76 (*b*) The major product of the given addition reaction is



$H_3C-\underset{OH}{CH}-\underset{Cl}{CH_2}$. In this reaction,

H_2O is used as a solvent and the major product of the reaction will be a *vicinal* halohydrin.

The reaction occurs as follows :

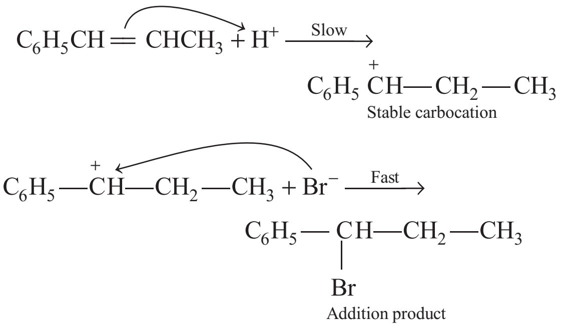


$$H_3C-CH=CH_2 \xrightarrow{Cl_2/H_2O} H_3C-\underset{OH}{CH}-\underset{Cl}{CH_2} + CH_3-\underset{Cl}{CH}-\underset{Cl}{CH_2} + HBr$$

A chlorohydrin (major product)

(Minor product)

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



$$C_6H_5CH=CHCH_3 + H^+ \xrightarrow{\text{Slow}} C_6H_5\overset{+}{CH}-CH_2-CH_3$$

Stable carbocation

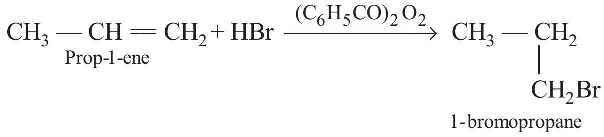
$$C_6H_5-\overset{+}{CH}-CH_2-CH_3 + Br^- \xrightarrow{\text{Fast}} C_6H_5-\underset{Br}{CH}-CH_2-CH_3$$

Addition product

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 :



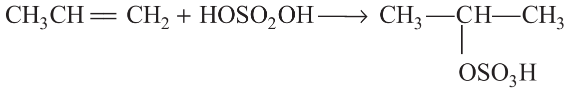
$$\underset{\text{Prop-1-ene}}{CH_3-CH=CH_2} + HBr \xrightarrow{(C_6H_5CO)_2O_2} CH_3-\underset{CH_2Br}{CH_2}$$

1-bromopropane

80 (*c*) Cold conc. H_2SO_4 adds to alkenes electrophilic addition reaction in accordance with Markovnikov's rule to form alkyl hydrogen sulphate.

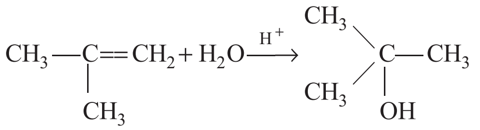
$$\underbrace{CH_2=CH_2+HO-SO_3H}_{\text{Electrophilic addition reaction}}\longrightarrow \underset{\text{Ethyl hydrogen sulphate}}{CH_3-CH_2-OSO_2OH}$$

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



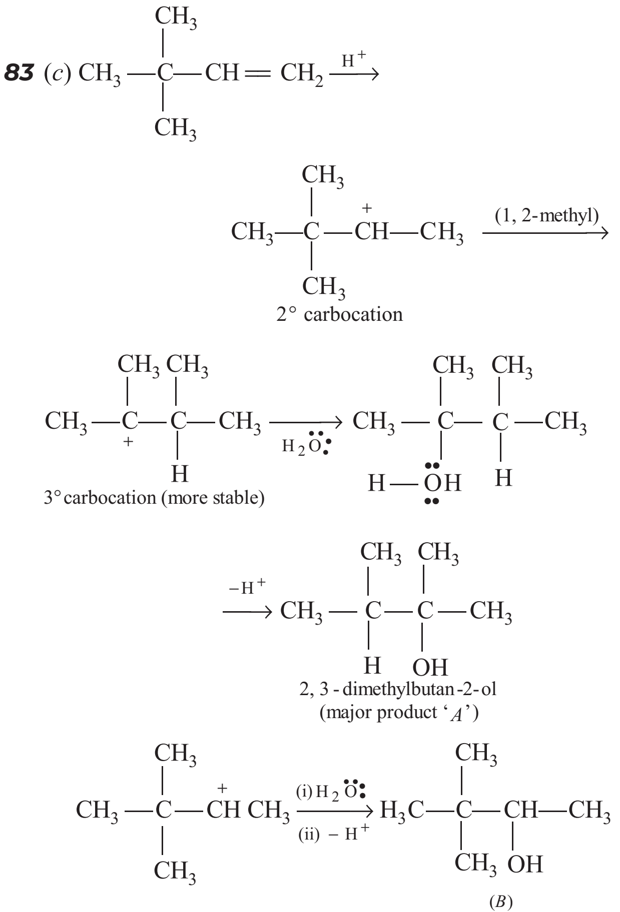
$$CH_3CH=CH_2+HOSO_2OH\longrightarrow CH_3-\underset{OSO_3H}{\underset{|}{CH}}-CH_3$$

82 (*b*) In the presence of few drops of conc. H_2SO_4, alkenes react with water to form alcohols, in accordance with Markovnikov's rule. The reaction of water in the presence of conc. H_2SO_4 with 2-methylpropene is given below :



2-methyl prop-1-ene

2-methyl propan-2-ol

83 

$$(c)\ CH_3-\underset{CH_3}{\underset{|}{\overset{\overset{CH_3}{|}}{C}}}-CH=CH_2\xrightarrow{H^+}$$

$$CH_3-\underset{CH_3}{\underset{|}{\overset{\overset{CH_3}{|}}{C}}}-\overset{+}{CH}-CH_3\xrightarrow{(1,\ 2\text{-methyl})}$$

2° carbocation

$$CH_3-\underset{+}{\overset{\overset{CH_3}{|}}{C}}-\underset{H}{\underset{|}{\overset{\overset{CH_3}{|}}{C}}}-CH_3\xrightarrow[H_2\ddot{O}:]{}CH_3-\underset{H-\ddot{O}H}{\underset{|}{\overset{\overset{CH_3}{|}}{C}}}-\underset{H}{\underset{|}{\overset{\overset{CH_3}{|}}{C}}}-CH_3$$

3° carbocation (more stable)

$$\xrightarrow{-H^+}CH_3-\underset{H}{\underset{|}{\overset{\overset{CH_3}{|}}{C}}}-\underset{OH}{\underset{|}{\overset{\overset{CH_3}{|}}{C}}}-CH_3$$

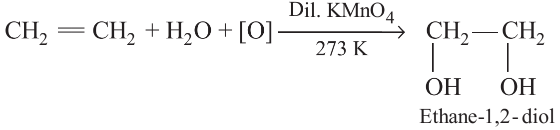
2, 3 - dimethylbutan-2-ol (major product '*A*')

$$CH_3-\underset{CH_3}{\underset{|}{\overset{\overset{CH_3}{|}}{C}}}-\overset{+}{CH}\,CH_3\xrightarrow[(ii)\ -H^+]{(i)\,H_2\ddot{O}:}H_3C-\underset{CH_3}{\underset{|}{\overset{\overset{CH_3}{|}}{C}}}-\underset{OH}{\underset{|}{CH}}-CH_3$$

(*B*)
Minor product

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 $KMnO_4$ solution is used as a test for unsaturation.



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

Ethane-1,2-diol
(Glycol) (*A*)

$$CH_3-CH=CH_2+H_2O+[O]\xrightarrow[273\text{ K}]{\text{Dil. }KMnO_4}$$

$$CH_3CH(OH)CH_2OH$$

Propane-1,2-diol
(*B*)

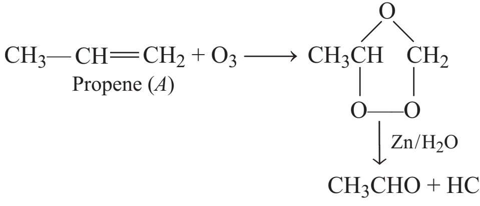
So, *A* is ethane-1, 2-diol and *B* is propane-1, 2-diol.

85 (*a*) Acidic potassium permanganate ($KMnO_4$) or acidic $K_2Cr_2O_7$ oxidises alkenes to produce ketones and/or acids depending upon the nature of alkenes as shown below :

$$\text{i.e. }(CH_3)_2C=CH_2\xrightarrow{KMnO_4,\ H^+}\underset{\text{Propan-2-one}}{(CH_3)_2C=O}+CO_2+H_2O$$

$$\underset{\text{But-2-ene}}{CH_3-CH=CH-CH_3}\xrightarrow{KMnO_4,\ H^+}\underset{\text{Acid}}{2CH_3COOH}$$

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

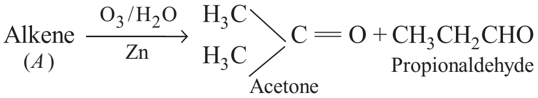


Propene (*A*)

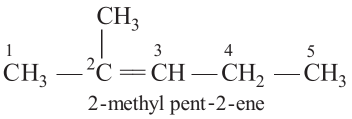
Ethanal (*B*)

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

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



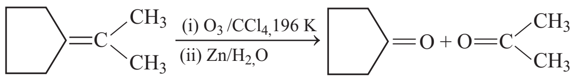
Formation of ketone confirms that double bond is present at second carbon (C-2) atom and formation of propionaldehyde confirms that three carbon atoms are attached with (C-2) double bond.

Hence, *A* is 

$$\overset{1}{CH_3}-{}^2\overset{\overset{CH_3}{|}}{C}=\overset{3}{CH}-\overset{4}{CH_2}-\overset{5}{CH_3}$$

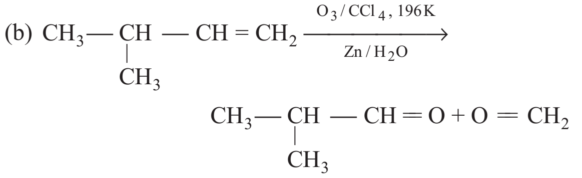
2-methyl pent-2-ene

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 :

(c) 

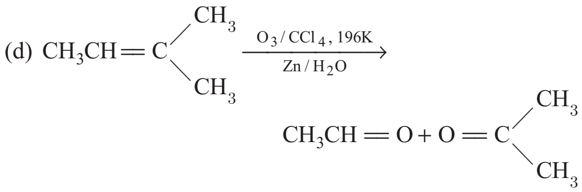
On the other hand, alkenes (a) and (b) give a mixture of two aldehydes.

(a) $$CH_3CH=CH—CH_3 \xrightarrow[Zn/H_2O]{O_3/CCl_4,\ 196K} CH_3CH=O+O=CHCH_3$$

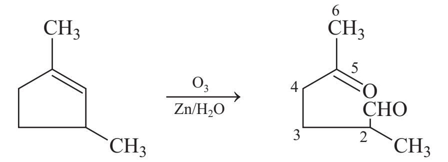
(b) 

$$\underset{\displaystyle CH_3}{CH_3—\underset{|}{CH}—}CH=CH_2 \xrightarrow[Zn/H_2O]{O_3/CCl_4,\ 196K} CH_3—\underset{\displaystyle CH_3}{\underset{|}{CH}}—CH=O+O=CH_2$$

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

(d) 

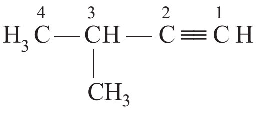
89 (b) The compound (b) on ozonolysis gives 5-keto-2-methyl hexanal as shown below :



1,3-dimethyl cyclopent-1-ene 5-keto-2-methyl hexanal

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 :

$$\underset{\text{Ethene}}{n(CH_2=CH_2)} \xrightarrow[\text{Catalyst}]{\text{High temperature /pressure}} \underset{\text{Polythene}}{\left(CH_2—CH_2 \right)_n}$$

92 (d) The given compound is 

$$\overset{4}{H_3C}—\underset{\displaystyle CH_3}{\underset{|}{\overset{3}{CH}}}—\overset{2}{C}\equiv\overset{1}{CH}$$

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

93 (b) The given compound is $CH_3—CH_2—C\equiv CH$.

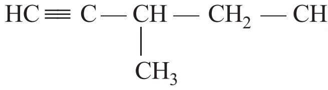
The common name is ethylacetylene and IUPAC name is but-1-yne.

94 (a) Possible isomers of C_6H_{10} are 7. These are as shown below :

1. $HC\equiv C—CH_2—CH_2—CH_2—CH_3$
Hex-1-yne

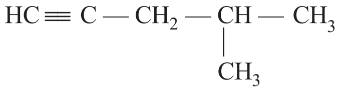
2. $CH_3—C\equiv C—CH_2—CH_2—CH_3$
Hex-2-yne

3. $CH_3—CH_2—C\equiv C—CH_2—CH_3$
Hex-3-yne

4. 

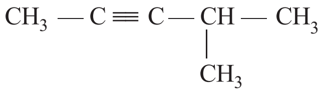
$$HC\equiv C—\underset{\displaystyle CH_3}{\underset{|}{CH}}—CH_2—CH_3$$

3-methylpent-1-yne

5. 

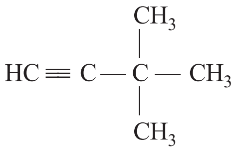
$$HC\equiv C—CH_2—\underset{\displaystyle CH_3}{\underset{|}{CH}}—CH_3$$

4-methylpent-1-yne

6. 

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

4-methylpent-2-yne

7. 

$$HC\equiv C—\overset{\displaystyle CH_3}{\overset{|}{\underset{\displaystyle CH_3}{\underset{|}{C}}}}—CH_3$$

3,3-dimethylbut-1-yne

95 (a) The molecule of ethyne is shown below

$$H—C\equiv C—H$$

The shape of ethyne is linear. (∵ sp-hybridised)

96 (b) The ethyne molecule is shown below :

$$H\overset{\sigma}{—}C\underset{\sigma}{\overset{2\pi}{\equiv}}C\overset{\sigma}{—}H$$

The number of σ bonds is 3 and the number of π-bonds is 2.

97 (c) The complete reaction is shown below.

$$\begin{tikzcd} CaCO_3 \arrow[r, "\Delta"] & \underset{(A)}{CaO} + CO_2 \arrow[d, "\text{Carbon}"] \\ & CaC_2 + CO \end{tikzcd}$$

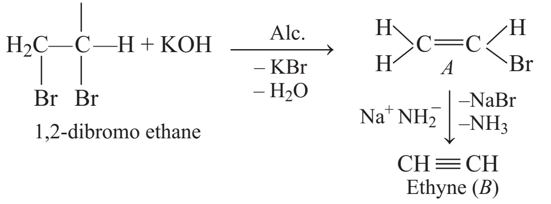
Hence, A is CaO.

98 (b) The complete reaction is shown below :

$$CaC_2 + 2H_2O \longrightarrow Ca(OH)_2 + \underset{\substack{\text{Ethyne}\\(X)}}{C_2H_2}$$

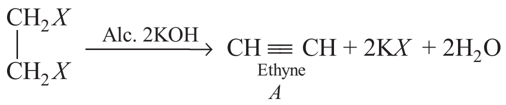
Hence, X is ethyne.

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 $CH_2=CHBr$ and B is $CH\equiv CH$.

100 (*c*) The complete reaction is shown below :



$$\begin{matrix} CH_2X \\ | \\ CH_2X \end{matrix} \xrightarrow{\text{Alc. 2KOH}} \underset{\substack{\text{Ethyne} \\ A}}{CH \equiv CH} + 2KX + 2H_2O$$

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^2-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.

	$CH \equiv CH$	$CH_2{=}CH_2$	$CH_3{-}CH_3$
Hybridisation :	*sp*	sp^2	sp^3
s-character :	50%	33%	25%

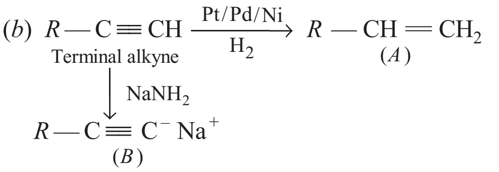
Electronegativity : $\xleftarrow{\text{Max.}}$

Acidic character of terminal H $\xleftarrow{\text{Max.}}$

Thus, the correct order of acidity is given below :

$$CH{\equiv}CH > CH_3C{\equiv}CH > CH_2{=}CH_2 > CH_3{-}CH_3$$

103 (*b*)



$$\underset{\text{Terminal alkyne}}{R{-}C{\equiv}CH} \xrightarrow[H_2]{\text{Pt/Pd/Ni}} \underset{(A)}{R{-}CH{=}CH_2}$$
$$\downarrow \text{NaNH}_2$$
$$\underset{(B)}{R{-}C{\equiv}C^- Na^+}$$

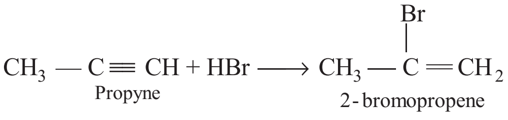
Thus, *A* is $R{-}CH{=}CH_2$ and *B* is $R{-}C{\equiv}C^-Na^+$.

104 (*d*) The complete reaction is shown below.

$$\underset{\text{Propyne}}{CH_3{-}C{\equiv}CH} + Br{-}Br \longrightarrow \underset{\substack{A \\ \text{1, 2-dibromopropene.}}}{CH_3CBr{=}CHBr}$$

Thus, *A* is $CH_3CBr{=}CHBr$.

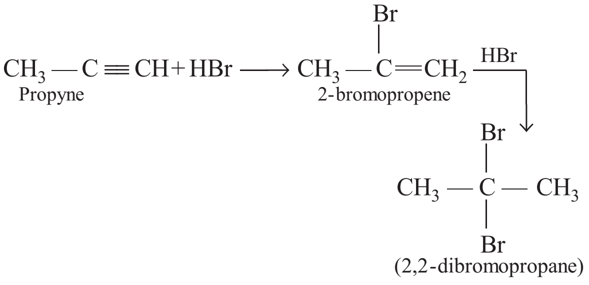
105 (*c*) The complete reaction is shown below :



$$\underset{\text{Propyne}}{CH_3{-}C{\equiv}CH} + HBr \longrightarrow \underset{\text{2-bromopropene}}{CH_3{-}\overset{\overset{Br}{|}}{C}{=}CH_2}$$

Thus, product is 2-bromopropene.

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



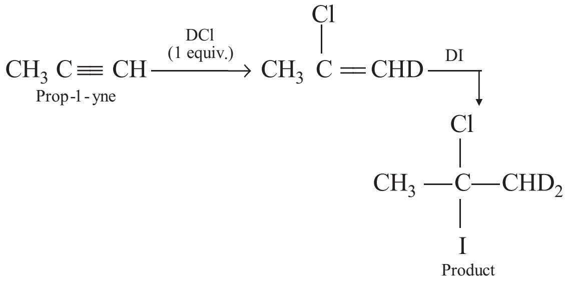
$$\underset{\text{Propyne}}{CH_3{-}C{\equiv}CH} + HBr \longrightarrow \underset{\text{2-bromopropene}}{CH_3{-}\overset{\overset{Br}{|}}{C}{=}CH_2} \xrightarrow{HBr} \underset{\text{(2,2-dibromopropane)}}{CH_3{-}\overset{\overset{Br}{|}}{\underset{\underset{Br}{|}}{C}}{-}CH_3}$$

107 (*d*) The major product obtained in the given reaction is $CH_3C\,(I)\,(Cl)\,CHD_2$.

$$CH_3C{\equiv}CH \xrightarrow[\text{2. DI}]{\text{1. DCl (1 equiv.)}} CH_3C(I)(Cl)CHD_2$$

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

Reaction proceed as follows :

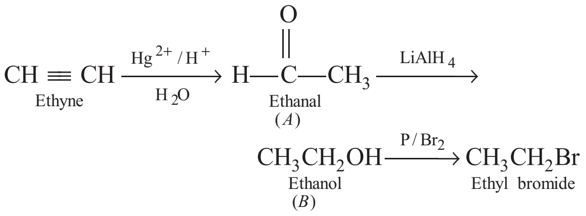


$$\underset{\text{Prop-1-yne}}{CH_3\,C{\equiv}CH} \xrightarrow[\text{(1 equiv.)}]{DCl} CH_3\,\overset{\overset{Cl}{|}}{C}{=}CHD \xrightarrow{DI} \underset{\text{Product}}{CH_3{-}\overset{\overset{Cl}{|}}{\underset{\underset{I}{|}}{C}}{-}CHD_2}$$

108 (*b*) The given road map problem is :

$$CH \equiv CH \xrightarrow[H_2O]{Hg^{2+}/H^+} A \xrightarrow{LiAlH_4} B \xrightarrow{P/Br_2} C$$

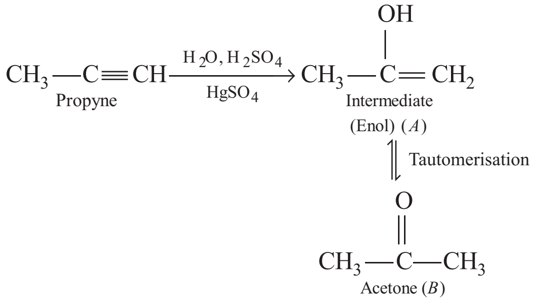
The reaction takes place as follows :



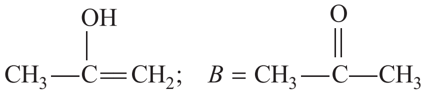
$$\underset{\text{Ethyne}}{CH \equiv CH} \xrightarrow[H_2O]{Hg^{2+}/H^+} \underset{\substack{\text{Ethanal} \\ (A)}}{H{-}\overset{\overset{O}{\|}}{C}{-}CH_3} \xrightarrow{LiAlH_4} \underset{\substack{\text{Ethanol} \\ (B)}}{CH_3CH_2OH} \xrightarrow{P/Br_2} \underset{\text{Ethyl bromide}}{CH_3CH_2Br}$$

Thus, *C* is $CH_3CH_2{-}Br$.

109 (*d*)



$$\underset{\text{Propyne}}{CH_3{-}C{\equiv}CH} \xrightarrow[HgSO_4]{H_2O,\,H_2SO_4} \underset{\substack{\text{Intermediate} \\ \text{(Enol) } (A)}}{CH_3{-}\overset{\overset{OH}{|}}{C}{=}CH_2} \xrightleftharpoons{\text{Tautomerisation}} \underset{\text{Acetone } (B)}{CH_3{-}\overset{\overset{O}{\|}}{C}{-}CH_3}$$

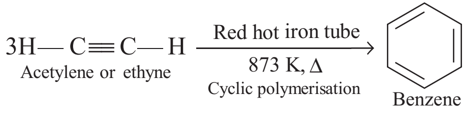


Thus, $A = CH_3{-}\overset{\overset{OH}{|}}{C}{=}CH_2$; $B = CH_3{-}\overset{\overset{O}{\|}}{C}{-}CH_3$

110 (*a*) Polymer polythene is represented as,

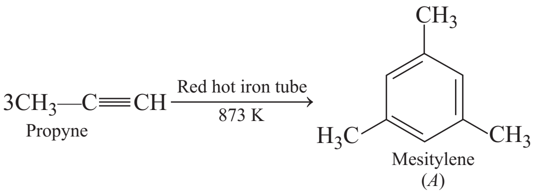
$$\left(CH{=}CH{-}CH{=}CH \right)_n$$

111 (*d*) The complete reaction is given below :

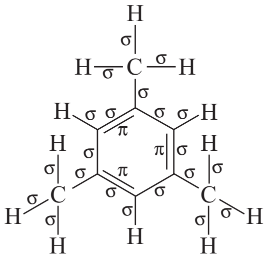


$$\underset{\text{Acetylene or ethyne}}{3H{-}C{\equiv}C{-}H} \xrightarrow[\substack{873\text{ K}, \Delta \\ \text{Cyclic polymerisation}}]{\text{Red hot iron tube}} \text{Benzene}$$

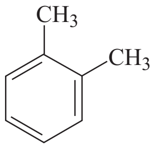
112 (*a*) Alkynes form aromatic compounds when their vapours are passed over red hot iron tube.
The reaction is shown below :



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

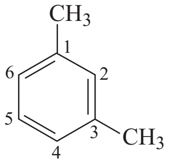


114 (b) The given compound is shown below :



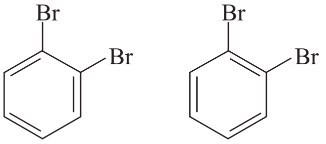
The common name of the compound is o-xylene and IUPAC name of the compound is 1,2-dimethylbenzene.

115 (c) The given compound is shown below :



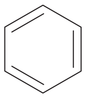
The IUPAC name of the compound is 1, 3-dimethylbenzene.

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 :



1, 2-dibromobenzene

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

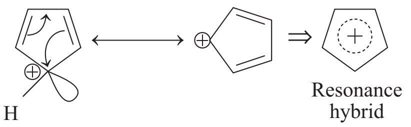


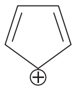
Each sp^2-hybridised atom has three sp^2 hybrid orbitals.

$\therefore$ Total number of sp^2 hybrid orbitals in a molecule of benzene is $= 6 \times 3 = 18$

118 (c) Benzene forms a triozonide 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:



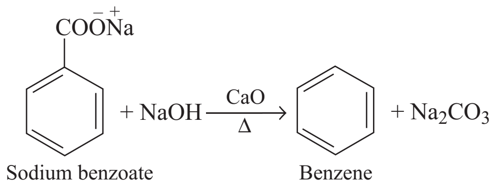
Hence,  is anti-aromatic does not follow Huckel's rule as it has conjugated 4π-electron ($4n\pi$, $n = 1$) system. Rest of the species are aromatic as each of them belongs to 6π-electron [$(4n + 2)\pi$, $n = 1$] system.

120 (d) Aromaticity requires following conditions :

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

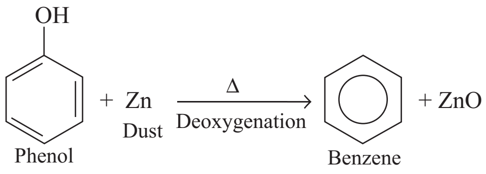
The compound  is not aromatic as there is no delocalisation of pi (π) electrons in the ring.

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



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

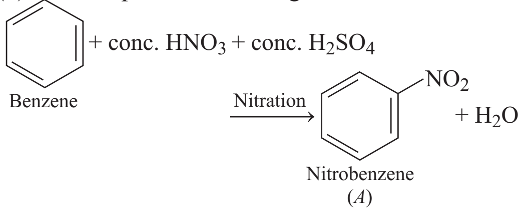
122 (c) The complete reaction is given as follows :



Benzene is formed as the final product.

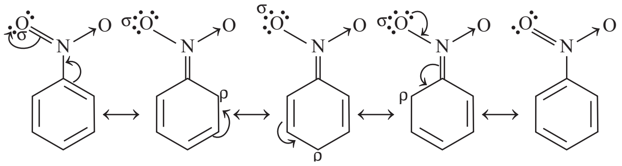
123 (a) For an electrophilic substitution reaction, the presence of halogen atom in the benzene ring deactivates the ring by inductive effect and increases the charge density at *ortho* and *para* -position relative to *meta*-position by resonance.

124 (a) The complete reaction is given below.



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

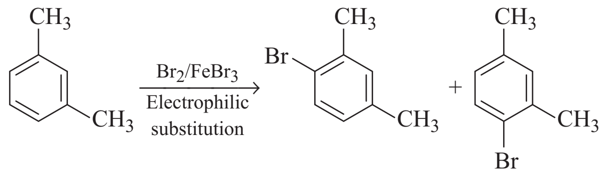
125 (*c*) Nitro group by virtue of $-I$-effect withdraws electron from the benzene ring and decreases the charge density on *ortho* and *para* position as shown below.

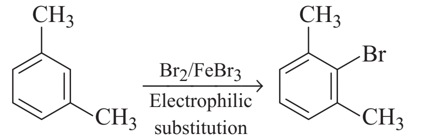


Thus, electron density decreases at *o*/ *p*-positions in case of $—NO_2$ and, hence the electrophile attacks at comparatively electron rich *meta*-position.

126 (*c*) $—CH_3$ (an alkyl group) is an *ortho* and *para*-directing group, thus 2 isomeric products are formed.

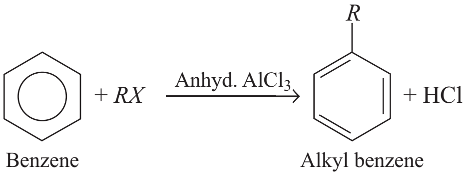
Out of these 2 products, *ortho* one is a minor product, while *para* product can be represented as :



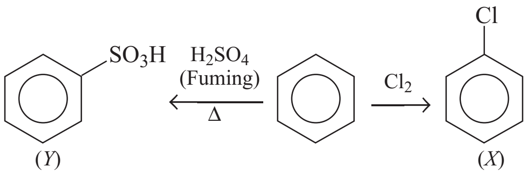


[Not possible due to steric hindrance]

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.



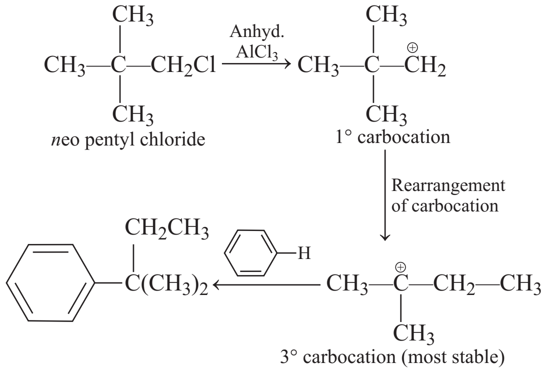
Hence, *X* is C_6H_5Cl and *Y* is $C_6H_5SO_3H$.

129 (*d*) The reaction of benzene with an acyl halide or acid anhydride in the presence of Lewis acid ($AlCl_3$) yields acyl benzene.

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

$$C_6H_6 + CH_3COCl \xrightarrow{\text{Anhyd. } AlCl_3} \underset{\text{Acetophenone}}{C_6H_5COCH_3} + HCl$$

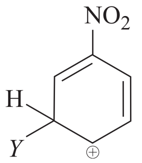
130 (*b*) The complete reaction is shown below :



131 (*a*) $—NO_2$ 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.

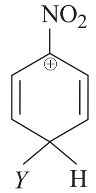
In option (a), the positive charge is at maximum distance to NO_2 group, so $-I$ effect due to NO_2 group will be minimum and stability will be maximum.

(a)

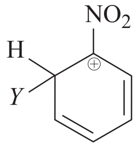


In option (b) and (d), the positive charges is at minimum distance to NO_2 group, hence the stability will be minimum.

(b)

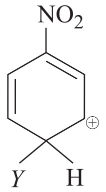


(d)



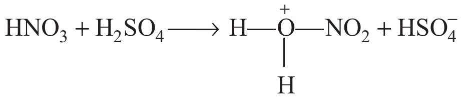
Also, in option (c), the distance of positive charge to NO_2 group is more than *ortho* but less than *para*, so it will be less stable as compared to option (a).

(c)

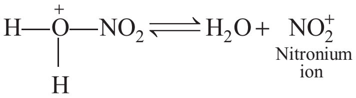


This resonating structure is less stable than option (a)

132 (*c*) During nitration of benzene, the attacking electrophile is NO_2^+. It is formed by the reaction between HNO_3 and H_2SO_4 as shown below :



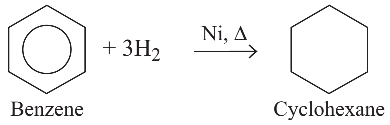
$$HNO_3 + H_2SO_4 \longrightarrow H—\underset{\underset{H}{|}}{\overset{+}{O}}—NO_2 + HSO_4^-$$



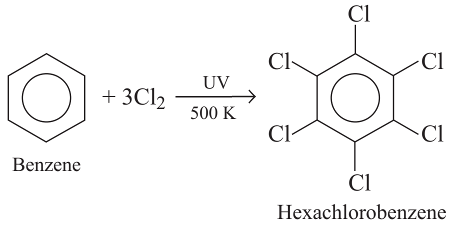
$$H—\underset{\underset{H}{|}}{\overset{+}{O}}—NO_2 \rightleftharpoons H_2O + \underset{\text{Nitronium ion}}{NO_2^+}$$

133 (*c*) A is three moles of H_2.

Complete reaction is as follows :



134 (*c*) The complete reaction is shown below :



3 moles of chlorine (Cl_2) take part in reaction, so $X = 3$.

135 (*b*) When heated in air, benzene burns with sooty flame producing CO_2 and H_2O as shown below :

$$C_6H_6 + \frac{15}{2}O_2 \longrightarrow 6CO_2 + 3H_2O$$

Hence, X and Y refer to CO_2 and H_2O.

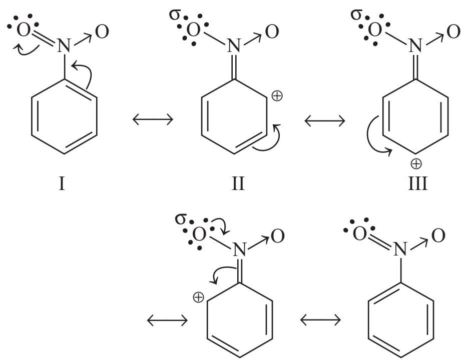
136 (*a*) Cl^- shows strong $-I$-effect, so it deactivates the benzene ring towards electrophilic substitution. However, due to resonance, the electron density on *o*-and *p*-position is greater than that at the *m*-position.

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 $—NO_2$, —CN, —CHO, —CO*R*, —COOH, —COO*R*, $—SO_3H$ 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. $—CH_3$) show $(+I)$ effect, but lesser than $—OCH_3$ due to presence of oxygen atom, thus $C_6H_5—OCH_3$ show better electrophilic substitution than that of $C_6H_5—CH_3$.

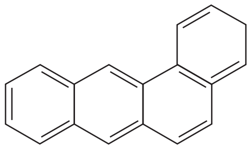
(b) Chlorine, i.e. Cl show $-I$ and $+R$ effect due to presence of lone pair of electrons, while —CHO group of $(-R)$ nature. Thus, C_6H_5Cl show more electrophilic substitution than $C_6H_5—CHO$.

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

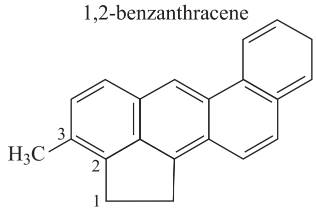
Hence, correct order is
$B > A > C > D$ and option (c) is correct.

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 :

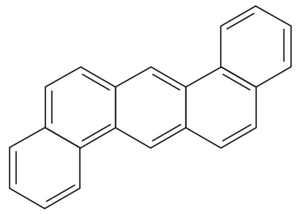


1,2-benzanthracene



3-methylcholanthrene

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 :

(a) Alkanes are almost non-polar molecules.

(b) Alkanes are covalent in nature.

(d) 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_2 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

$$Cl-Cl \longrightarrow \underset{\text{Chlorine free radicals}}{Cl^{\bullet} + Cl^{\bullet}}$$

I. **Propagation** $CH_4 + Cl^{\bullet} \xrightarrow{h\nu} \dot{C}H_3 + HCl$

III. $\dot{C}H_3 + Cl-Cl \longrightarrow CH_3Cl + \dot{Cl}$

$$CH_3Cl + Cl^{\bullet} \longrightarrow \dot{C}H_2Cl + HCl$$

$$\dot{C}H_2Cl + Cl-Cl \longrightarrow CH_2Cl_2 + \dot{Cl}$$

IV. **Termination** $Cl^{\bullet} + Cl^{\bullet} \longrightarrow Cl-Cl$

$$H_3\dot{C} + \dot{C}H_3 \longrightarrow CH_3-CH_3$$

$$\dot{C}H_3 + \dot{Cl} \longrightarrow CH_3-Cl$$

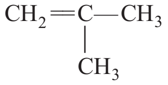
Hence, correct sequence is represented by option (a).

148 (*c*) I. $CH_2{=}CH{-}CH_2{-}CH_3$,

Compound I is asymmetrical alkene.

II. $CH_3{-}CH{=}CH{-}CH_3$

Compound II is symmetrical alkene.

III. 

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

Compound III is asymmetrical alkene.

Markovnikov's addition is not applicable on symmetrical alkenes.

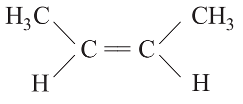
Hence, it is applicable for I and III, but not for II.

150 (*d*) Statements (a) and (b) are correct, while the statement (c) is incorrect. It's correct form is as follows :

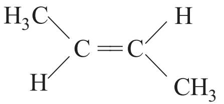
Arrangement of atoms or groups in space in the two structures is different.

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.



cis-but-2-ene
(b.p. 277 K)



trans-but-2-ene
(b.p. 274 K)

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 π bonds.

(d) Ethyne molecule consists of one C—C σ 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 :

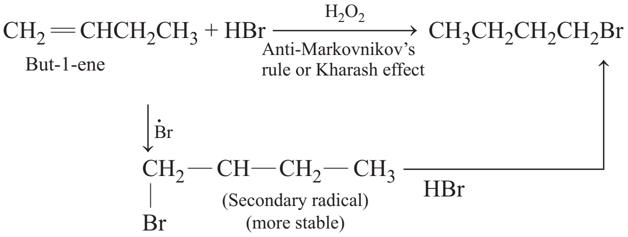
C—Hσ bond is obtained by head on overlapping of sp^2 hybridised orbital of C and 1*s* orbital of H-atom.

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 :



$$\underset{\text{But-1-ene}}{CH_2{=}CHCH_2CH_3} + HBr \xrightarrow[\text{Anti-Markovnikov's rule or Kharash effect}]{H_2O_2} CH_3CH_2CH_2CH_2Br$$

$$\downarrow \dot{B}r$$

$$\underset{\substack{|\\ Br}}{CH_2}-\underset{\substack{\text{(Secondary radical)}\\\text{(more stable)}}}{\dot{C}H-CH_2-CH_3} \xrightarrow{HBr} CH_3CH_2CH_2CH_2Br$$

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.

$$\underset{\text{Propene}}{CH_3-CH{=}CH_2} + HI \xrightarrow{\text{Peroxide}} \underset{\text{1-iodopropane}}{CH_3-CH_2-CH_2I}$$

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.

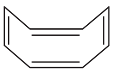
162 (*b*) The reactions for the given statements are shown below :

$$\underset{\text{Hex-1-yne}}{CH_3CH_2CH_2CH_2C{\equiv}CH} \xrightarrow[\text{catalyst }(H_2)]{\text{Lindlar's}} \underset{(\textit{cis}\text{ hex-1-ene})}{CH_3CH_2CH_2CH_2CH{=}CH_2}$$

$$CH_3CH_2CH_2CH_2C{\equiv}CH \xrightarrow[2H_2]{Pd/Ni} n\text{-hexane}$$

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

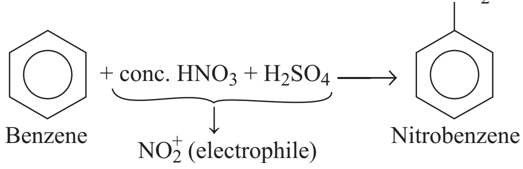
163 (*a*)



is cyclic and has conjugated 8π-electron system but it is not an aromatic compound because here $(4n+2)\pi$-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 :

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

A. $2CH_4 + O_2 \xrightarrow[100\text{ atm}]{Cu/523\text{ K}} 2CH_3OH$

B. $CH_4 + O_2 \xrightarrow[\Delta]{Mo_2O_3} HCHO + H_2O$

C. $2CH_3CH_3 + 3O_2 \xrightarrow[\Delta]{(CH_3COO)_2Mn} 2CH_3COOH + 2H_2O$

D. $(CH_3)_3CH \xrightarrow{KMnO_4} (CH_3)_3COH$

172 (*a*) The ozonolysis reaction is given below :

$$\underset{\text{1-phenylbut-1-ene}}{\overset{4}{C}H_3-\overset{3}{C}H_2-\overset{2}{C}H{=}\overset{1}{C}H-C_6H_5} \xrightarrow[\text{(ii) }Zn/H_2O]{\text{(i) }O_3/CH_2Cl_2,\ 196\text{ K}}$$

$$\underset{\text{Propanal}}{CH_3-CH_2-CH{=}O} + \underset{\text{Benzaldehyde}}{C_6H_5CHO}$$

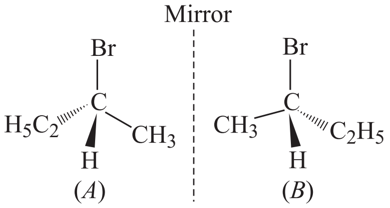
The IUPAC name of the products are propanal and benzaldehyde.

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

$$\underset{\text{But-1-ene}}{CH_3-CH_2-CH{=}CH_2} + H-Br \longrightarrow \underset{\text{(Major product) }(A\text{ and }B)}{CH_3-CH_2-CHBr-CH_3}$$

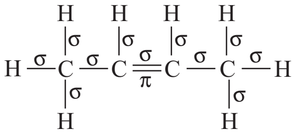
$$+ \underset{\text{(Minor product) }(C)}{CH_3-CH_2-CH_2-CH_2Br}$$

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



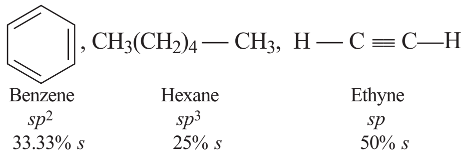
174 (*b*) The aldehyde having molar mass 44 u is ethanal, CH_3CHO. To obtain the structure of *A*, the following method is employed. Write the structures of two molecules of ethanal in such a way that their oxygen atoms are pointing towards each other. Join the two ends through the double bond with the removal of both of the oxygen atoms to obtain alkene *A*.

$$\underset{\text{Ethanal}}{CH_3CH}=\boxed{O+O}=\underset{\text{Ethanal}}{CHCH_3}\longleftarrow \underset{\substack{\text{But-2-ene}\\(A)}}{CH_3-CH=CH-CH_3}$$



The alkene (A) i.e. but-2-ene contains three C—C, eight C—H, σ-bonds and one C—C π-bond (as given in the question).

175 (c) The hybridisation state of carbon in the given compounds is,

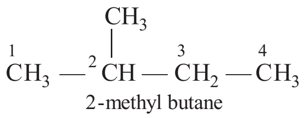


Acidic character increases with increasing s-character of the orbital.

Hence, decreasing order of acidic behaviour of benzene, n-hexane and ethyne is

ethyne > benzene > hexane

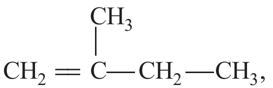
176 (a) Structure of 2-methylbutane is



$$\overset{1}{CH_3}-\overset{2}{CH}(CH_3)-\overset{3}{CH_2}-\overset{4}{CH_3}$$

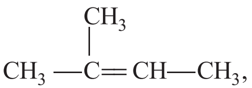
2-methyl butane

The structures of alkenes which on hydrogenation gives 2-methylbutane are as follows :



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

2-methylbut-1-ene



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

2-methylbut-2-ene

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

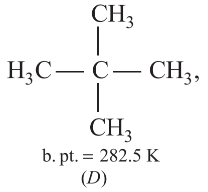
3-methylbut-1-ene

177 (b) Presence of electron releasing group (or activating group) increases the electron density in benzene nucleus. Therefore, electrophile will attack benzene nucleus easily. But the presence of electron withdrawing group like —NO_2 decreases the electron density in benzene ring. Therefore, electrophile will attack benzene nucleus with difficulty.

Thus, the order of reactivity towards electrophile, E^+ in order of their decreasing relative reactivity is

chlorobenzene > p-nitrochlorobenzene
> 2,4-dinitrochlorobenzene

178 (d) As the number of carbon atom increases, boiling point increases. Boiling point decreases with branching.



$H_3C-C(CH_3)_2-CH_3$,

b. pt. = 282.5 K

(D)

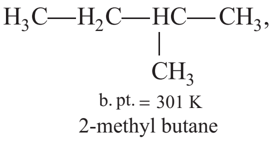
$H_3C-CH_2-CH_2-CH_2-CH_3$,

b. pt. = 309.1 K

n-pentane

(C)

2, 2-dimethyl propane



$H_3C-H_2C-HC(CH_3)-CH_3$,

b. pt. = 301 K

2-methyl butane

(B)

$H_3C-H_2C-CH_2-CH_3$

b. pt. = 273 K

(A)

n-butane

Thus, the order of boiling point is

$$C > B > D > A$$

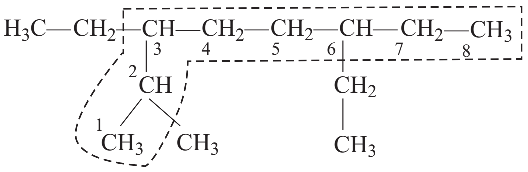
179 (a) Rate of reaction of halogens with alkanes is,

$$F_2 > Cl_2 > Br_2 > I_2$$

Alkanes react with F_2 vigorously. It is because of the high electronegativity of fluorine. With I_2, the reaction is too slow and it requires a catalyst. Reactivity decreases with decrease in electronegativity which decreases down the group.

180 (b) The reactivity of halogens toward alkane is $F_2 > Cl_2 > Br_2 > I_2$. Hence, reduction of alkyl halide with Zn and dil. HCl follows reverse order, i.e. R—I> R — Br > R — Cl. Further, the reactivity of this reduction increases as the strength of C− X bond decreases.

181 (a) The correct IUPAC name is



Longest chain is 8C-atom, i.e. parent alkane is octane. Branch on 2, 3, 6 follows lowest sum rule. Branch on C-2 is methyl and that on C-3 and C-6 is ethyl. Ethyl comes alphabetically before methyl. Hence, the corect IUPAC name is 3,6-diethyl-2-methyloctane.

182 (d) Carbon attached with double bond has two same groups (CH_3). Thus, the rotation around carbon will not produce a new compound.
Hence, geometrical isomerism is not possible.

183 (c) The correct order of reactivity with propene is

HI > HBr > HCl

184 (b) +I-effect decreases the stability of carbon anion. Since, (CH_3) group has + I-effect, therefore it intensifies the negative charge and hence destabilises (A) relative to (B). sp-hybridised carbanion is more stabilised than sp^3.

The correct order is shown below :

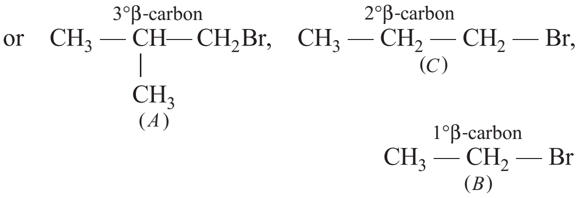
$$\underset{(B)}{CH \equiv C^-} > \underset{(A)}{CH_3—C \equiv C^-_{sp}} > \underset{(C)}{CH_3—CH^s_2}$$

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 β -carbon atom.

Nature of alkyl group determines rate of reaction.

i.e. $3° > 2° > 1°$



$$\text{or}\quad \underset{(A)}{CH_3 — \overset{3°\beta\text{-carbon}}{\underset{\underset{CH_3}{|}}{CH}} — CH_2Br},\quad CH_3 — \underset{(C)}{\overset{2°\beta\text{-carbon}}{CH_2}} — CH_2 — Br,\quad CH_3 — \underset{(B)}{\overset{1°\beta\text{-carbon}}{CH_2}} — Br$$

Thus, decreasing order of rate of reaction is

$$A > C > B.$$

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.

Thus, $CH_4(g) + O_2(g) \xrightarrow[\text{combustion}]{\text{Incomplete}} C(s) + 2H_2O(l)$

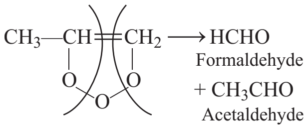
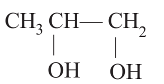
187 (*a*) Toluene has $—CH_3$ group attached to benzene which activates the benzene ring for the attack of an electrophile.

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. → (4), B. → (1), C. → (5), D. → (3), E. → (2)

Reagent	Reaction with propene
A. $O_3/Zn + H_2O$	 $\rightarrow$ HCHO Formaldehyde + CH_3CHO Acetaldehyde
B. $KMnO_4/H^+$	$CH_3CH{=}CH_2 \xrightarrow[H^+]{KMnO_4} CH_3COOH + CO_2$ Acetic acid
C. $KMnO_4/OH^-$	$CH_3—CH{=}CH_2 \xrightarrow[OH^-]{KMnO_4}$  $CH_3\underset{\underset{OH}{|}}{CH}—\underset{\underset{OH}{|}}{CH_2}$ Propan-1, 2-diol
D. H_2O/H^+	$CH_3CH{=}CH_2 \xrightarrow[\text{(Markovnikov addition)}]{H_2O/H^+} CH_3—CH(OH)—CH_3$ Propan −2−ol
E. $B_2H_6/NaOH^+$ and H_2O_2	$CH_3CH{=}CH_2 \xrightarrow[\text{(ii) NaOH/H}_2\text{O}_2\text{ (Hydroboration -oxidation)}]{\text{(i) B}_2\text{H}_6} CH_3CH_2CH_2OH$ Propan-1-ol

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

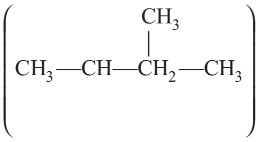
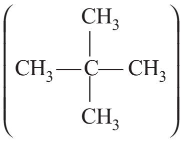
A.→(4), B. → (1), C. → (2), D. → (3)

Reactions	Types of reaction	
A. $CH_2{=}CH_2 + H_2O \xrightarrow{H^+} CH_3CH_2OH$	Hydration	(Addition of water)
B. $CH_2{=}CH_2 + H_2 \xrightarrow{Pd} CH_3—CH_3$	Hydrogenation	(Addition of hydrogen)
C. $CH_2{=}CH_2 + Cl_2 \longrightarrow Cl—CH_2—CH_2—Cl$	Halogenation	(Addition of halogen)
D. $3CH \equiv CH \xrightarrow[\text{Heat}]{\text{Cu tube}} C_6H_6$	Polymerisation	

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

The correct match is given below.

A. → (2), B. → (3), C. → (1)

Hydrocarbons	Boiling point	
A. *n*-pentane	309 K due to	(no branch)
B. *iso*-pentane	301 K due to one branch	 $\left(CH_3—\overset{\overset{CH_3}{|}}{CH}—CH_2—CH_3\right)$
C. *neo*-pentane	282.5 K due to two branches	 $\left(CH_3—\underset{\underset{CH_3}{|}}{\overset{\overset{CH_3}{|}}{C}}—CH_3\right)$