CHAPTER > 12

Organic Chemistry : Some Basic Principles and Techniques

KEY NOTES

- Carbon forms covalent bonds with other carbon atoms. It also forms covalent bonds with other elements like H, O, N, S, P and *X*. The resulting compounds are studied under separate branch of chemistry called **organic chemistry**.
- Organic chemistry deals with study of hydrocarbons and their derivatives.
- **Catenation** is responsible for large number of carbon compounds.

Bonding in Organic Compounds

- **Tetravalency of carbon** It can be explained in terms of its electronic configuration and the hybridisation of *s* and *p*-orbitals. Hybridisation influences both length and enthalpy in bonds.
- **Characteristic feature of π-bond** In π-bond formation, parallel orientation of two *p*-orbitals on adjacent atoms is necessary for a proper sideways overlap. The electron charge cloud of the π-bond is located above and below the plane of bonding atoms.

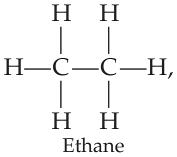
Structural Representation of Organic Compounds

These are represented in several ways. Some are as follows :

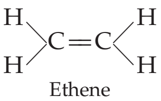
- **Lewis structure** Electrons are represented as dots.

$$\mathrm{H}^{\bullet},\ \mathrm{He}\colon,\quad \mathrm{H}\colon\ddot{\underset{\cdot\cdot}{\mathrm{O}}}\colon\mathrm{H}$$

- **Dash structure** The two electron covalent bond is represented by a dash (–). Lone pair of electrons on hetero atoms may or may not be shown.



Ethane

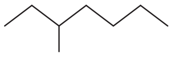


Ethene

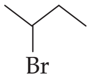
- **Condensed structure** The formula is written by omitting some or all of the dashes representing covalent bonds and by representing the number of identical groups attached to an atom by a subscript.

CH_3CH_3 Ethane $\qquad$ $H_2C=CH_2$ Ethene

- **Bond line structure** Carbon and hydrogen are not shown and the lines representing C—C bonds are drawn in a *zig-zag* fashion.



3-methyl heptane

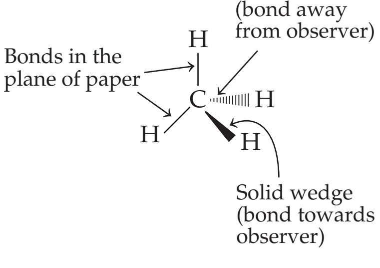


2-bromobutane

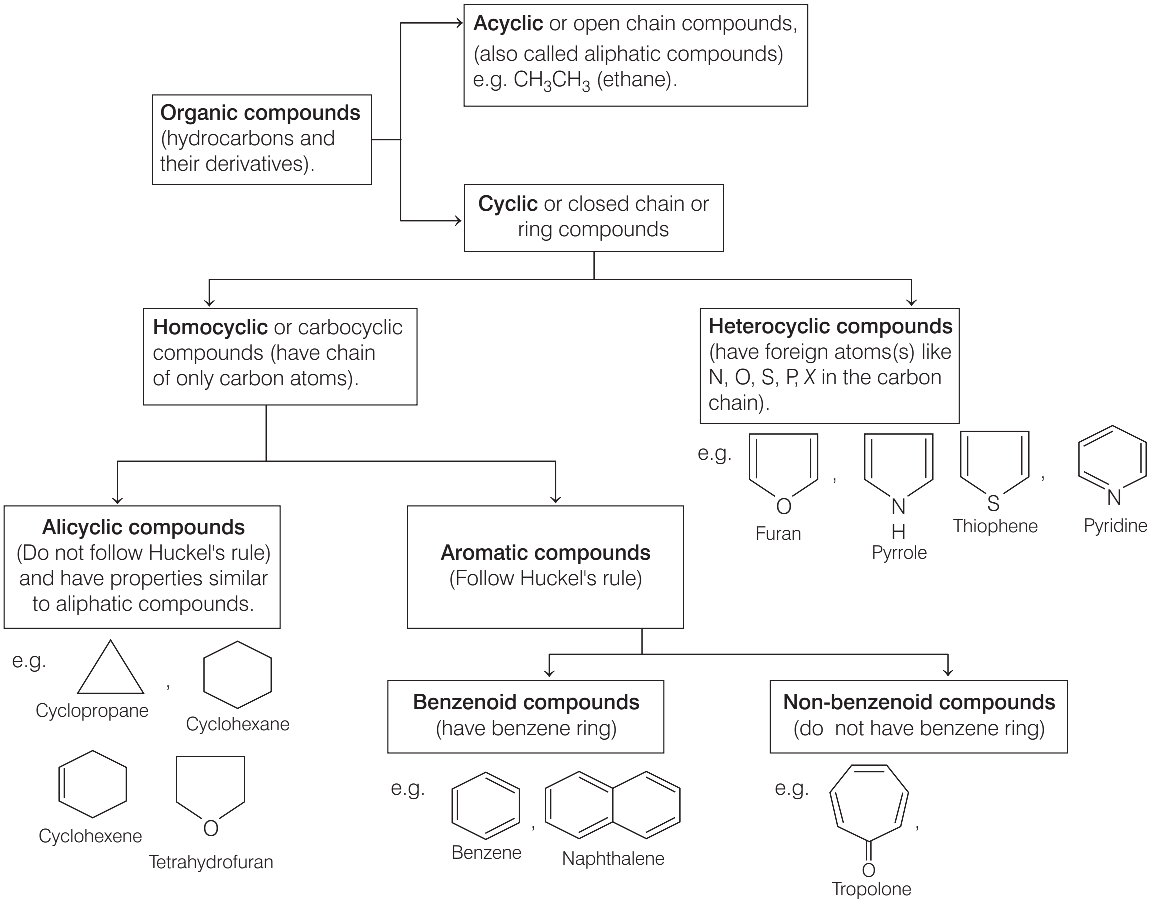
Three Dimensional Representation of Organic Molecule

It can be represented on paper by using solid (◀) and dashed (⋯) wedge formula.

In these formulas, the solid wedge is used to indicate a bond projecting out of the plane of paper, towards observer. The dashed wedge is used to depict the bond projecting away from the observer.



Classification of Organic Compounds



- **Functional group** It is an atom or a group of atoms joined to the carbon chain which is responsible for the characteristic chemical properties of organic compound. e.g. —OH (hydroxyl group), —CHO (aldehyde group) — COOH (carboxylic acid) etc.
- **Homologous series** A group or series of organic compounds each containing a characteristic functional group forms a homologous series.

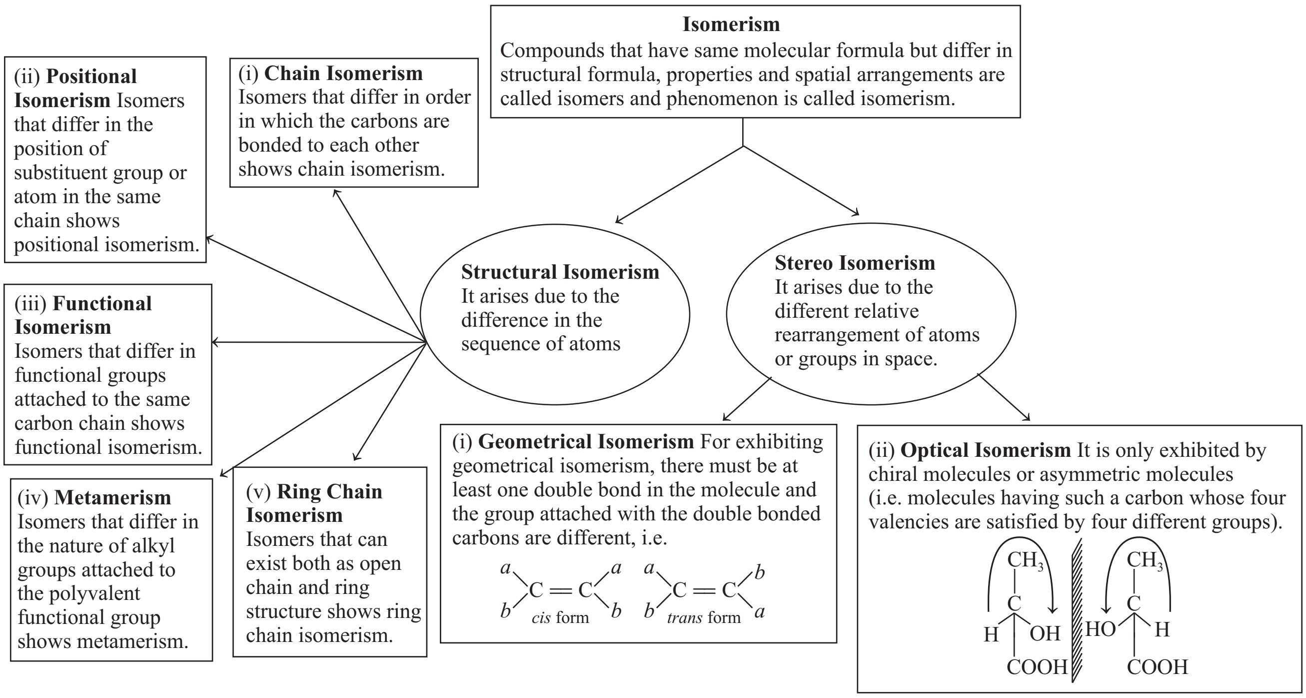
IUPAC Nomenclature of Organic Compounds

Rules for IUPAC Nomenclature

- First of all, the longest carbon chain in the molecule is identified.
- Numbering is started from the terminal carbon from where branching is nearest.
- If the two substituents are found in equivalent positions, the numbering is done alphabetically.
- If there are two chains of equal size, then that chain is to be selected which contains more number of side chains.
- The longest chain of carbon atoms containing the functional group is numbered in such a way that the functional group is attached at the carbon atom possessing lowest possible number in the chain.
- In polyfunctional compounds, one of the functional group is chosen (priority wise) as the principal functional group and the compound is then named on that basis.
- The order of decreasing priority for some functional groups are as follows :

$$—COOH, —SO_3H, —COOR, —COCl, —CONH_2, —CN, —CHO, —OH, —NH_2, >C{=}C<, —C{\equiv}C—.$$

Isomerism



Isomerism
Compounds that have same molecular formula but differ in structural formula, properties and spatial arrangements are called isomers and phenomenon is called isomerism.

Structural Isomerism
It arises due to the difference in the sequence of atoms

(i) **Chain Isomerism**
Isomers that differ in order in which the carbons are bonded to each other shows chain isomerism.

(ii) **Positional Isomerism** Isomers that differ in the position of substituent group or atom in the same chain shows positional isomerism.

(iii) **Functional Isomerism**
Isomers that differ in functional groups attached to the same carbon chain shows functional isomerism.

(iv) **Metamerism**
Isomers that differ in the nature of alkyl groups attached to the polyvalent functional group shows metamerism.

(v) **Ring Chain Isomerism**
Isomers that can exist both as open chain and ring structure shows ring chain isomerism.

Stereo Isomerism
It arises due to the different relative rearrangement of atoms or groups in space.

(i) **Geometrical Isomerism** For exhibiting geometrical isomerism, there must be at least one double bond in the molecule and the group attached with the double bonded carbons are different, i.e.

(ii) **Optical Isomerism** It is only exhibited by chiral molecules or asymmetric molecules
(i.e. molecules having such a carbon whose four valencies are satisfied by four different groups).

Fundamental Concepts in Organic Reaction Mechanism

Reaction mechanism is the sequential account of each step, describing details of electron movement, energetics during bond cleavage and bond formations and the rates of transformation of reactants into products.

The general reaction is

$$\underset{\text{molecule}}{\text{Organic}} \xrightarrow{\text{Attacking reagent}} \underset{\text{by products.}}{\text{Intermediate}} \longrightarrow \text{Product(s)}$$

Note *A molecule whose carbon is involved in new bond formation is called substrate and other one is called reagent.*

Fission of a Covalent Bond

The organic reaction begins with the breakage of covalent bond and this breakage or fission are of two types:

Heterolytic Cleavage or Heterolysis

- This cleavage involves breaking of a covalent bond in such a way that shared pair of electrons remain with one of the fragments.

$$X—Y \xrightarrow{\text{Heterolysis}} X^+ + Y^-$$

(when X is less electronegative than Y)

$$X—Y \xrightarrow{\text{Heterolysis}} X^- + Y^+$$

(when Y is less electronegative than X)

Heterolytic cleavage results in formation of two types of species. These are :

- **Carbocation or carbonium ion** If the carbon has sextet of electrons and a positive charge, then the species is called **carbocation** (earlier called carbonium ion), e.g. CH_3^+ (methyl carbonium ion).

  The order of stability of carbocations are :

  $$\overset{+}{C}H_3 < CH_3\overset{+}{C}H_2 < (CH_3)_2\overset{+}{C}H < (CH_3)_3C^+$$

  or methyl carbocation < 1° < 2° < 3°.

- **Carbanion** If the carbon of the obtained species is negatively charged and have octet of electrons in its valence shell, then the species is called carbanion.

  The order of stability of carbanion is as follows :

  $$(C_6H_5)_3\bar{C} > (C_6H_5)_2CH^- > C_6H_5\bar{C}H_2 >$$

  $$\text{allyl} > \bar{C}H_3 > (1° > 2° > 3° \text{ carbanions})$$

Homolytic Cleavage or Homolysis

- This cleavage involves movement of only one electron, which is represented by half headed (fish hook) curved arrow .

e.g.

$$R—X \xrightarrow[\text{Light}]{\text{Heat or}} \underset{\text{Alkyl free radical}}{R^\bullet} + X^\bullet$$

The neutral chemical species, thus formed are called the **free radicals**. Alkyl free radicals are also classified as primary, secondary or tertiary.

Like carbocations, the order of stability of alkyl free radicals is

$$\underset{\substack{\text{Methyl}\\\text{free radical}}}{\dot{C}H_3} < \underset{\substack{\text{Ethyl}\\\text{free radical}\\(1^\circ)}}{\dot{C}H_2CH_3} < \underset{\substack{\text{Isopropyl}\\\text{free radical}\\(2^\circ)}}{\dot{C}H(CH_3)_2} < \underset{\substack{\textit{tert}\text{-butyl}\\\text{free radical}\\(3^\circ)}}{\dot{C}(CH_3)_3}$$

Nucleophiles and Electrophiles

- **Nucleophiles or Nucleophilic Reagents** An electron rich species having a lone pair of electrons is called a nucleophile ($Nu{:}$), i.e. nucleus loving species.

  e.g. Negatively charged species like, H^-, Cl^-, Br^-, I^-, carbanions, $\bar{O}H$, $\bar{O}R$, $\bar{S}R$, CN^-.

  Nucleophiles can also be seen in the form of neutral molecules.

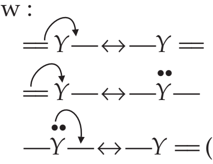
  $$H_2\ddot{\underset{\cdot\cdot}{O}},\ \ddot{N}H_3,\ R\ddot{N}H_2,\ R\ddot{\underset{\cdot\cdot}{O}}H,\ R\ddot{\underset{\cdot\cdot}{S}}H, \text{ etc.}$$

- **Electrophiles or Electrophilic Reagents** An electrophile is defined as electron deficient species which attacks on electron rich areas. e.g. H^+, Cl^+, Br^+, I^+, NO_2^+, SO_3^+ and carbocations.

  The electrophiles can also be seen in the form of neutral molecules, e.g. carbanes (${:}CR_2$), nitrenes ($\ddot{N}R$), BF_3 etc.

Electron Movement in Organic Reactions

It can be shown by curved-arrow notation. It shows how changes in bonding occur due to electronic redistribution during the reaction. Presentation of shifting of electron is given below :



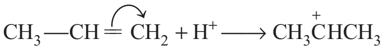
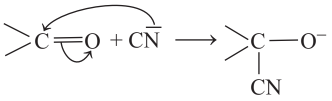
(from π-bond to adjacent bond)

(from π-bond to adjacent bond)

(from atom to adjacent bond position)

Movement of single electron is indicated by a single barbed 'fish hooks'. (i.e. half-headed curved arrow).

Electron Displacement in Effects in Covalent Bonds

Effect	Definition	Types and Examples	Applications
Inductive effect	• It is defined as the polarity produced in a molecule due to the presence of polar bond. • It is a permanent effect. • It operates through σ bonds. • It decreases in magnitude as we move away from the cause of polarity.	• $-I$ effect (electron withdrawing) e.g. R_3N^+, NO_2, SO_3H, —CN, —COCl, —COOR, —OR etc. • $+I$ effect (electron releasing) e.g. :— O^-, — COO^-, — CH_3 etc.	• In determining the stability of free radicals, carbocations and carbanions. 3° > 2° > 1° (stability order for carbocation and free radical). 1° > 2° > 3° (stability order for carbanion). • In determining the strength of acids and bases. (i) Strength of an acid $\propto K_a \propto \frac{1}{pK_a}$ $\propto$ stability of acid anion. Stability of acid anion $\propto -I$ power of group. (ii) Strength of base $\propto +I$ power of group $\propto K_b$.
Electromeric effect	• It is defined as the polarity produced in a multiple bonded molecule as a reagent approaches it. • It is a temporary effect.	• $+E$ effect (π-electron of double bond are transferred to that atoms of the double bond to which the reagent gets finally attached).  $CH_3—CH{=}CH_2 + H^+ \longrightarrow CH_3\overset{+}{C}HCH_3$ • $-E$ effect (π-electrons of the double bond are transferred to an atom of the double bond other than the one to which the reagent gets finally attached). 	• It helps in determining the direction of a reaction. • It is the basis for the nucleophilic addition reactions of carbonyl compound and electrophilic addition in unsaturated hydrocarbons.
Mesomeric effect	• Polarity produced in a molecule due to conjugation. • It is a permanent effect. • It operates in unsaturated and conjugated compounds.	• $+M$-effect (electron repelling), e.g. —O^-, —NH_2, —OH —OR, —NHAc. • $-M$-effect (electron releasing), e.g. —NH_3^+, —NO_2, —CX_3, —SO_3H.	• In determining the relative acidity of phenol and alcohol. Phenols are more acidic than alcohols. • Aryl halides are less reactive than alkyl halides towards nucleophilic substitution. This can be explained by $+M$ effect of halogen atom.

Effect	Definition	Types and Examples	Applications
Resonance effect	• When all the properties of a molecule cannot be shown by a single structure and two or more structures are required to show all the properties of that molecule, then those structures are called resonating structures. • This phenomenon is called resonance.	• $+R$ effect (electron donating groups). eg. —OH, —OR, —SH, —SR, —NH_2, —NHR, —NR_2, etc. • —R effect (electron withdrawing groups) e.g. $>C=O$, —CHO, —COOR, —CN, —NO_2, etc.	• In determining the stability of molecules. • Resonance structures with a greater number of covalent bonds are more stable than those with less number.
Hyper-conjugation	• It involves delocalisation of σ-electrons of the bond of an alkyl group directly attached to an atom with an unshared p-orbital. • It is also called no bond resonance or Baker - Nathan effect.	• (C—H) π - conjugation [occur in alkenes] • (C—H), positive charge conjugation [occur in alkyl carbocation]. • (C—H) odd electron conjugation [occur in free radicals]	• Stability order of carbocations and free radicals. • Stability order of benzyl carbocation. • Stability order of alkene.

Types of Organic Reactions and Mechanisms

Organic reactions can be classified into the following categories:

- Substitution reactions
- Addition reactions
- Elimination reactions
- Rearrangement reactions

Methods of Purification of Organic Compounds

Methods	Principle	Process	Applications
Filteration	• It is based on the difference in filterability of different components present in a solution.	• A filteration apparatus with a filter paper is used. • Large quantity of material is filtered by Buchner funnel.	• Separation of sand from salt by dissolving in water. • Separation of tea leaves from tea is done by this method.
Crystallisation	• It is based on the difference in the solubilities of the compound and the impurities in the suitable solvent.	• In this method, a hot concentrated solution of the compound is prepared. • This upon filteration and cooling gives the crystals of the pure compound.	• Sugar having common salt as impurity can be crystallised through hot ethanol as it is soluble in hot ethanol but common salt does not.
Sublimation	• This process is employed for those solids which directly convert from solid to vapour. • On heating, the solid changes to vapour without converting into vapour liquid phase and the vapours upon cooling give back the solid.	• In this process, the impure solid is taken into China dish and is covered with a perforated filter paper. • An inverted funnel is placed over the dish and stem is plugged with cotton. • On heating, solid get converted into vapours.	• Impure samples of naphthalene, anthracene, camphor, benzoic acid, NH_4Cl, dry ice, salicylic acid can be purified by this process. • The vapours on cooling condense to give crystals at the neck of funnel.
Distillation	• It is based upon the difference in the boiling points of two liquids or two components. • It is generally used if an organic liquid contains a non-volatile impurity.	• In this process, a liquid is heated to its boiling point and is converted into vapours. • The vapours on cooling condense to give back the original liquid in its pure form.	• Separation of mixture of hexane (b.pt 342 K) and toluene (b. pt 384 K) • Separation of mixture of chloroform (b.pt 334 K) and aniline (b.pt 457 K)
Fractional Distillation	• This method is based upon the separation of two liquids having nearly equal boiling points.	• The distillation is carried out with the help of specially designed fractionating columns.	• A mixture of acetone and methyl alcohol is separated by this process.
Distillation under Reduced Pressure	• It is used for those liquids which have a tendency to decompose at a temperature below their boiling point.	• Under reduced pressure, the liquid will boil at low temperature.	• At 12 mm of Hg pressure, glycerol boils at 453 K without decomposition.
Steam Distillation	• It is used for steam volatile substances and non-volatile impurities.	• Compound is distilled with steam under reduced pressure at a temperature below its boiling point. • Pure compound comes out with steam and separates on cooling.	• *ortho* and nitro phenols, compounds like aniline, nitrobenzene, terpentine oil are purified by this process.
Differential Extraction	• It is based on the more solubility of solute in a suitable organic compound as compared to water.	• Process involves shaking of solution with a suitable organic solvent in which compound is more soluble as compared to water.	• Benzoic acid is separated from water by using benzene.

Methods	Principle	Process	Applications
Chromatography	• It is based upon the principle of distribution of components of a given organic mixture between two phases. **Types of Chromatography** – Column chromatography – Thin layer chromatography – High performance liquid chromatography – Partition chromatography	• In this process, the stationary phase can either be solid or liquid supported over a solid. • The mobile phase may be a liquid or a gas.	• For separation of sugars and amino acids.

Qualitative and Quantitative Analysis

Element	Qualitative Analysis			Quantitative Analysis
	Method/Detection Test	**Confirmatory Test**	**Chemical Reactions**	**Reactions Involved and Formula**
Carbon and hydrogen	• Heat the compound with copper (II) oxide	• CO_2 reacts with lime water which develops turbidity. • H_2O reacts with anhyd. $CuSO_4$ that develops blue colour.	• $C + 2CuO \xrightarrow{\Delta} 2Cu + CO_2$ • $CO_2 + Ca(OH_2) \longrightarrow CaCO_3 + H_2O$ • $2H + CuO \xrightarrow{\Delta} Cu + H_2O$ • $5H_2O + CuSO_4 \xrightarrow{\Delta} CuSO_4 \cdot 5H_2O$	**Liebig's Combustion Method** • $C\,\% = \frac{12 \times \text{mass of } CO_2 \times 100}{44 \times \text{mass of compound}}$ • $H\% = \frac{2 \times \text{mass of } H_2O \times 100}{18 \times \text{mass of compound}}$
Nitrogen	• Boil Lassaigne's extract with $FeSO_4$ and then acidify with conc. H_2SO_4.	• Formation of prussian blue colour.	• $Na + C + N \xrightarrow{\Delta} NaCN$ • $6\ CN + Fe^{2+} \longrightarrow [Fe(CN)_6]^{4-}$ • $3\ [Fe(CN)_6]^{4-} + 4\ Fe^{3+} \xrightarrow{x\,H_2O} Fe_4[Fe(CN)_6]_3 + H_2O$	**Duma's Method** • $N\% = \frac{28 \times \text{volume of } N_2 \text{ gas} \times 100}{22400 \times \text{mass of compound}}$ **Kjeldahl's Method** $N\% = 1.4\ N_1V_1/\text{mass of organic compound}$
Sulphur	• Add acetic acid and lead acetate in Lassaigne's extract. • Add sodium nitroprusside in Lassaigne's extract.	• Formation of black precipitate. • Formation of violet colour.	• $2Na + S \xrightarrow{\Delta} Na_2S$ • $S^{2-} + Pb^{2+} \longrightarrow PbS$ • $S^{2-} + [Fe(CN)_5NO]^{2-} \longrightarrow [Fe(CN)_5NOS]^{4-}$	**Carius Method** • $S\% = \frac{32 \times \text{mass of } BaSO_4 \times 100}{233 \times \text{mass of compound}}$
Halogen	• Acidify Lassaigne's extract with HNO_3 and then add $AgNO_3$.	• White ppt. soluble in NH_4OH shows presence of chlorine. • Yellow ppt. sparingly soluble in NH_4OH shows presence of bromine. • A yellow ppt. insoluble in NH_4OH shows presence of iodine.	• $Na + X \xrightarrow{\Delta} NaX$ • $X^- + Ag^+ \longrightarrow AgX$	**Carius Method** • $Cl\% = \frac{35.5 \times \text{mass of AgCl} \times 100}{143.5 \times \text{mass of compound}}$ • $Br\,\% = \frac{80 \times \text{mass of AgBr} \times 100}{188 \times \text{mass of compound}}$ • $I\% = \frac{127 \times \text{mass of AgI} \times 100}{235 \times \text{mass of compound}}$
Phosphorus	• Heat the compound with sodium peroxide. • Then boil the solution with HNO_3 and treat it with $(NH_4)_2MoO_4$.	• Formation of yellow colouration or ppt.	• $Na_3PO_4 + 3HNO_3 \longrightarrow H_3PO_4 + 3NaNO_3$ • $H_3PO_4 + 12\ (NH_4)_2MoO_4 + 21\ HNO_3 \longrightarrow (NH_4)_3PO_4 \cdot 12MoO_3 + 21NH_4NO_3 + 12H_2O$	**Ignition Method** • $P\% = \frac{62 \times \text{mass of } Mg_2P_2O_7 \times 100}{222 \times \text{mass of compound}}$
Oxygen	• No specific method for qualitative analysis of oxygen.			• $O\% = \frac{32 \times \text{mass of } CO_2 \times 100}{88 \times \text{mass of compound}}$

Mastering NCERT

MULTIPLE CHOICE QUESTIONS

TOPIC 1 ~ *General Introduction and Tetravalence of Carbon*

1 Which of the following chemist proposed that a inital force was responsible for the formation of organic compounds?

(a) Kolbe
(b) Berthelot
(c) Berzilius
(d) None of these

2 Consider the following reaction,

$$\underset{\text{Ammonium cyanate}}{NH_4CNO} \xrightarrow{\text{Heat}} A$$

Here, A refers to

(a) NH_2COCl
(b) NH_2COOH
(c) NH_2COCH_3
(d) NH_2CONH_2

3 The first organic compound prepared in the laboratory from its elements was

(a) acetylene (b) methane (c) urea (d) acetic acid

4 Which of the following compound is synthesised by Kolbe and Berthelot respectively that shows that organic compounds could be synthesised from inorganic sources in a laboratory?

(a) Ethane, methane
(b) Methane, ethane
(c) Methane, acetic acid
(d) Acetic acid, methane

5 The percentage *s*-character in sp^3-hybridisation is

(a) 25% *s* -character
(b) 50% *s* -character
(c) 75% *s* -character
(d) 100% *s* -character

6 The ratio of percentage *s* -character of C-atom in ethyne and ethene is equal to

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

7 Which of the following compounds does not contain all the carbon atoms in the same hybridisation state?

(a) $H—C\equiv C—C\equiv C—H$
(b) $HC\equiv CH$
(c) $CH_2=C=CH_2$
(d) $CH_2=CH—CH=CH_2$

8 The correct order of electronegativity of carbon in ethane, ethene and ethyne is

(a) ethane < ethene < ethyne
(b) ethyne < ethene < ethane
(c) ethene < ethyne < ethane
(d) ethene < ethane < ethyne

9 $\sigma_{C—C}:4; \sigma_{C—H}:6;\ \pi_{C=C}:1; \pi_{C\equiv C}:2.$

These number of σ and π -bonds are present in which of the following molecule?

(a) $CH\equiv C—CH=CH—CH_3$
(b) $CH_2=C=CH—CH_3$
(c) $CH_2=CH—CH=CH—CH_3$
(d) None of the above

10 The type of hybridisation of each carbon in $CH_3CH=CHCN$ is

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

11 Which of the following molecules represents the order of hybridisatin sp^2, sp^2, sp, sp from left to right atoms? ***NEET 2018***

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

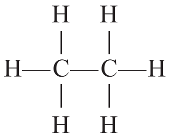
12 The state of hybridisation of carbon and shape of each molecule given below is

(i) $H_2C=O$ (ii) $HC\equiv N$

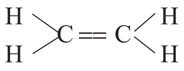
(a) (i) sp^3, tetrahedral (ii) sp^2, trigonal planar
(b) (i) sp^3, tetrahedral (ii) sp, trigonal planar
(c) (i) sp^2, trigonal planar (ii) sp, linear
(d) (i) sp^2, trigonal planar (ii) sp^2, linear

TOPIC 2 ~ *Structural Representation and Classification of Organic Compounds*

13 Which of the following compound is the structural representation of complete structural formulas?

(a) 

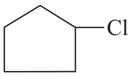
$$\begin{array}{ccccccc} & & H & & H & & \\ & & | & & | & & \\ H & — & C & — & C & — & H \\ & & | & & | & & \\ & & H & & H & & \end{array}$$

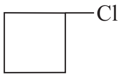
(b) 

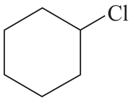
(c) $H—C \equiv C—H$

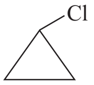
(d) All of these

14 In cyclic compounds, the bond-line formula for chlorocyclohexane is represented by which of the following representations?

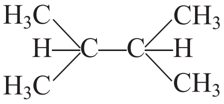
(a) 

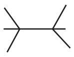
(b) 

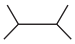
(c) 

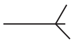
(d) 

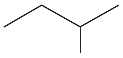
15 Choose the correct bond-line formula for



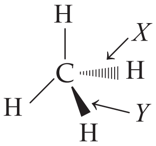
(a) 

(b) 

(c) 

(d) 

16 Consider the following methane molecule on paper.



Here, X and Y are respectively

(a) dashed wedge, solid wedge
(b) solid wedge, dashed wedge
(c) both are bonds in the plane of paper
(d) both are dashed wedge

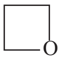
17 Types of molecular models used for 3-D representation of organic molecules are

(a) framework model
(b) ball and stick model
(c) space filling model
(d) All of these

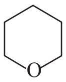
18 The space-filling model emphasises the relative size of each atom based on its

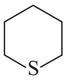
(a) ionic radius
(b) van der Waals' radius
(c) atomic radius
(d) All of these

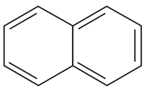
19 Which of the following is a homocyclic alicyclic compound?

(a) 

(b) 

(c) 

(d) 

20 Which type of compound is shown by the following structure  ?

(Naphthalene)

(a) Alicyclic compound
(b) Benzenoid aromatic compound
(c) Non-benzenoid aromatic compound
(d) Acyclic compound

21 Which of the following compounds is/are heterocyclic aromatic compound?

(a) Furan
(b) Thiophene
(c) Pyridine
(d) All of these

TOPIC 3 ~ *Nomenclature of Organic Compounds*

22 Which is the correct full form for IUPAC?

(a) Interpret Union of Pure and Applied Chemistry
(b) International Union of Pure and Application Chemistry
(c) International Union of Pure and Applied Chemistry
(d) International United of Pure and Application Chemistry

23 Observe the table given below carefully.

Name	Molecular formula	Name	Molecular formula
Methane	CH_4	Heptane	C_7H_{16}
Ethane	C_2H_6	Octane	C_8H_{18}
Propane	C_3H_8	Nonane	B
Butane	C_4H_{10}	Decane	$C_{10}H_{22}$

Name	Molecular formula	Name	Molecular formula
A	C_5H_{12}	C	$C_{20}H_{42}$
Hexane	C_6H_{14}	D	$C_{30}H_{62}$

Complete the above table by selecting proper alternatives in place of A, B, C and D respectively.

Codes

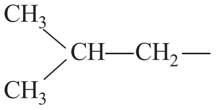
	A	B	C	D
(a)	Pentane	C_9H_{20}	Icosane	Triacontane
(b)	Pentene	C_9H_{18}	Icosane	Triacontane
(c)	Pentane	C_9H_{20}	Triacontane	Icosane
(d)	Pentane	C_9H_{18}	Triacontane	Icosane

24 An alkyl group is derived from

(a) a saturated hydrocarbon by removing a hydrogen atom from carbon
(b) an unsaturated hydrocarbon by removing a hydrogen atom from carbon
(c) Both (a) and (b)
(d) None of the above

25 The structure of *iso*-butyl group in an organic compound is ***NEET 2013***

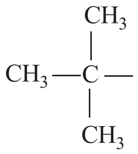
(a)



(b) $CH_3-CH_2-CH_2-CH_3$

(c) $CH_3-CH_2-CH_2-CH_2-$

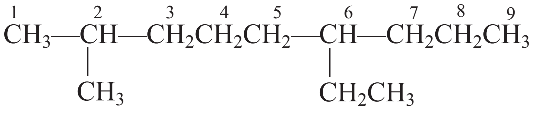
(d)



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

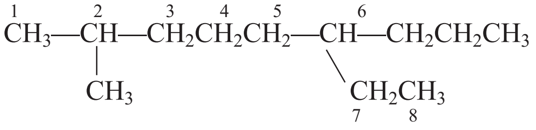
26 Among the following two, which carbon chain should be selected as parent chain, according to IUPAC nomenclature?

Chain-I



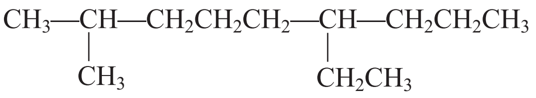
$$\overset{1}{CH_3}-\underset{CH_3}{\overset{2}{CH}}-\overset{3}{CH_2}\overset{4}{CH_2}\overset{5}{CH_2}-\underset{CH_2CH_3}{\overset{6}{CH}}-\overset{7}{CH_2}\overset{8}{CH_2}\overset{9}{CH_3}$$

Chain-II



(a) Chain-I
(b) Chain-II
(c) Both chain-I and chain-II are selected
(d) No chain can be selected

27 What is the correct IUPAC name of the given compound?



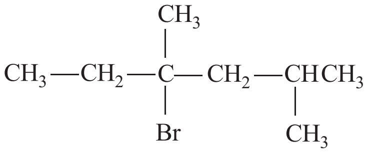
$$CH_3-\underset{CH_3}{CH}-CH_2CH_2CH_2-\underset{CH_2CH_3}{CH}-CH_2CH_2CH_3$$

(a) 6-ethyl-2-methylnonane
(b) 2-methyl-6-ethylnonane
(c) 2,6-ethyl-methyl nonane
(d) None of the above

28 Which of the following is not in accordance to IUPAC system? ***CBSE AIPMT 2012***

(a) $Br-CH_2-CH=CH_2$
1-bromoprop-2-ene

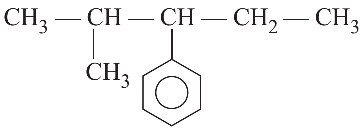
(b)



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

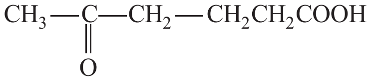
4-bromo- 2, 4-dimethylhexane

(c)



2-methyl-3- phenylpentane

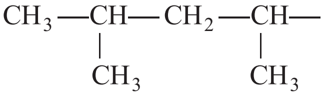
(d)



$$CH_3-\underset{\overset{\|}{O}}{C}-CH_2-CH_2CH_2COOH$$

5-oxohexanoic acid

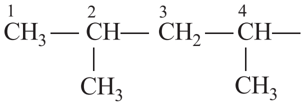
29 The correct way of numbering the given structure,



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

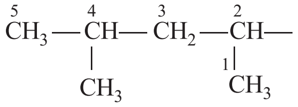
will be

(a)



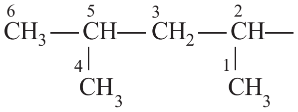
$$\overset{1}{CH_3}-\underset{CH_3}{\overset{2}{CH}}-\overset{3}{CH_2}-\underset{CH_3}{\overset{4}{CH}}-$$

(b)



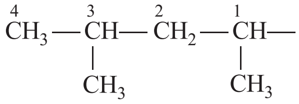
$$\overset{5}{CH_3}-\underset{CH_3}{\overset{4}{CH}}-\overset{3}{CH_2}-\underset{{}^{1}CH_3}{\overset{2}{CH}}-$$

(c)



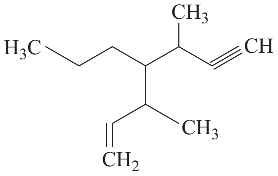
$$\overset{6}{CH_3}-\underset{{}^{4}CH_3}{\overset{5}{CH}}-\overset{3}{CH_2}-\underset{{}^{1}CH_3}{\overset{2}{CH}}-$$

(d)



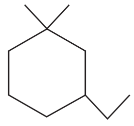
$$\overset{4}{CH_3}-\underset{CH_3}{\overset{3}{CH}}-\overset{2}{CH_2}-\underset{CH_3}{\overset{1}{CH}}-$$

30 The IUPAC name for the following compound is ***JEE Main 2019***



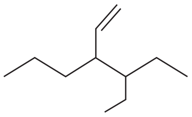
(a) 3-methyl-4-(3-methylprop-1-enyl)-1-heptyne
(b) 3, 5-dimethyl-4-propylhept-6-en-1-yne
(c) 3-methyl-4-(1-methylprop-2-ynyl)-1-heptene
(d) 3, 5-dimethyl-4-propylhept-1-en-6-yne

31 What is the correct IUPAC name of the following?



(a) 3-ethyl-1,1-dimethylcyclohexane
(b) 1-ethyl-3,3-dimethylcyclohexane
(c) 1,1-dimethyl-3-ethylcyclohexane
(d) None of the above

32 The correct IUPAC name of the compound,



is

CBSE AIPMT 2011

(a) 3-(1-ethyl propyl) hex-1-ene
(b) 4-ethyl-3-propylhex-1-ene
(c) 3-ethyl-4-ethenylheptane
(d) 3-ethyl-4-propylhex-5-ene

33 The correct structure for 3-methylpenta-1, 3-diene is

(a) $CH_3CH{=}C(CH_3)CH{=}CH_2$
(b) $CH_2{=}CHCH(CH_3)CH_2CH_3$
(c) $CH_3CH{=}C(CH_3)_2$
(d) $CH_2{=}CH(CH_2)_2CH_3$

34 The correct way of numbering the longest chain of carbon atoms containing the functional group is

(a) carbon atom containing functional group should possess lowest possible number in chain
(b) carbon atom containing largest carbons should be chosen irrespective of functional group
(c) carbon chain should exclude functional group
(d) None of the above

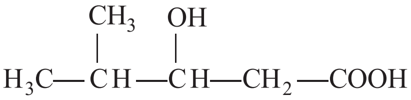
35 The IUPAC name of the following compound. $HOCH_2(CH_2)_3CH_2COCH_3$ is

(a) 7-hydroxyheptan-2-ol
(b) 7-hydroxyheptan-2-one
(c) 2-oxoheptan-7-ol
(d) Heptan-2-oxo-7-ol

36 The correct IUPAC name of $CH_2(OH)CH_2(OH)$ is

(a) ethane-1, -4-diol (b) ethane-1, 2-diol
(c) ethan-1, 2-diol (d) eth-1, 2-diol

37 The IUPAC name of the following compound is

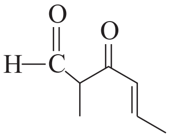


$$H_3C{-}\underset{}{\overset{CH_3}{\overset{|}{C}}}H{-}\overset{OH}{\overset{|}{C}}H{-}CH_2{-}COOH$$

JEE Main 2019

(a) 4,4 - dimethyl -3-hydroxybutanoic acid
(b) 2-methyl-3-hydroxypentan-5-oic acid
(c) 3- hydroxy -4- methylpentanoic acid
(d) 4-methyl-3-hydroxypentanoic acid

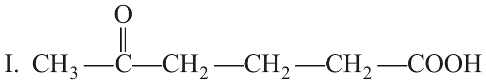
38 The IUPAC name of the compound ***NEET 2017***



is ....

(a) 3-keto-2-methylhex-4-enal
(b) 5-formylhex-2-en-3-one
(c) 5-methyl-4-oxohex-2-en-5-al
(d) 3-keto-2-methylhex-5-enal

39 The correct IUPAC name of the given structures will be



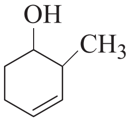
$$\text{I. } CH_3{-}\overset{O}{\overset{\|}{C}}{-}CH_2{-}CH_2{-}CH_2{-}COOH$$

II. $CH{\equiv}C{-}CH{=}CH{-}CH{=}CH_2$

Choose the correct option.

	I	II
(a)	Hexane-dione	Hexa-1,3-dien-5-yne
(b)	5-oxohexanoic acid	Hexa-1,3-dien-5-yne
(c)	5-oxohexanoic acid	Hexadiene-5-yne
(d)	3-oxohexanoic acid	Hexadiene-5-yne

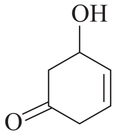
40 IUPAC name of



is ***JIPMER 2019***

(a) 4-hydroxy-3-methyl cyclohexene
(b) 2-methyl cyclohex-3-en-1-ol
(c) 3-hydroxy-2-methyl cyclohexene
(d) 1-hydroxy-3-methyl cyclohexene

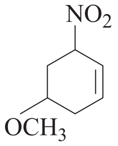
41 The correct IUPAC name of the given compound is



AIIMS 2018

(a) 7-hydroxycyclohex -5-en-1-one
(b) 3-hydroxycyclohex-5-en-1-one
(c) 8-hydroxycyclohex -3-en-1-one
(d) 5-hydroxycyclohex -3-en-1-one

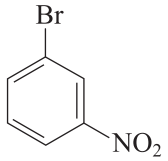
42 Write IUPAC name of following compound.



AIIMS 2019

(a) 4-methoxy-6-nitrocyclohexene
(b) 5-methoxy-3-nitrocyclohexene
(c) 3-nitro-1-methoxycyclohex-4-ene
(d) 3-nitro-5-methoxycyclohexene

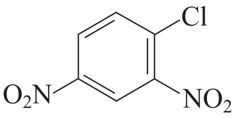
43 The IUPAC name of the following compound



is

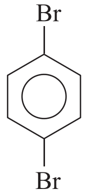
(a) 1, 3-dibromobenzene
(b) *m*-dibromobenzene
(c) 1, 5-dibromobenzene
(d) None of the above

44 Write the correct IUPAC name of the following.



(a) 1-chloro-2, 4- dinitrobenzene
(b) 6-chloro-1, 3- dinitrobenzene
(c) 1-chloro-4, 6-dinitrobenzene
(d) 2-chloro-1, 5-dinitrobezene

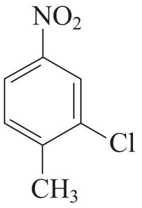
45 Write the IUPAC name of given structure



JIPMER 2019

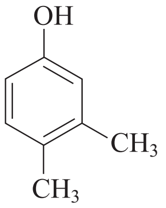
(a) *para*-bromobenzene (b) 1,4-dibromobenzene
(c) Both (a) and (b) (d) *meta* bromobenzene

46 The correct IUPAC name of the following compounds



I

and



II

respectively are

(a) 2-chloro-1-methyl-4-nitrobenzene and 3,4-dimethylphenol
(b) 4-methyl-5-chloronitrobenzene and 3,4-dimethylphenol
(c) 2-methyl-1-chloro-5-nitrobenzene and dimethylphenol
(d) 3-chloro-4-methyl- nitrobenzene and dimethylphenol

TOPIC 4~ *Isomerism*

47 The phenomenon of existence of two or more compounds possessing the same molecular formula but different properties is called
(a) polymerism (b) isotropism
(c) homomerism (d) isomerism

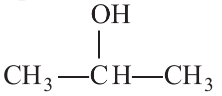
48 Among the following, which one is an isomer of alcohol?
(a) Methanol (b) Acetone
(c) Diethylether (d) Dimethylether

49 The number of structural isomers possible from the molecular formula $= C_3H_9N$ is ***CBSE AIPMT 2015***
(a) 4 (b) 5 (c) 2 (d) 3

50 How many chain isomers are given by the compound, C_5H_{12}?
(a) Three (b) Two (c) Four (d) Only one

51 The type of isomerism present between

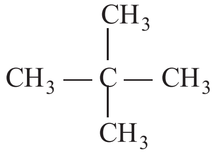
$CH_3CH_2CH_2OH$ and



$CH_3—\underset{}{\overset{OH}{\overset{|}{C}}}H—CH_3$ is

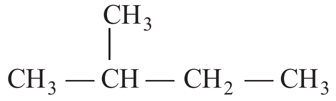
(a) position isomerism
(b) chain isomerism
(c) functional group isomerism
(d) metamerism

52 Study the structures given below carefully and choose the type of isomerism they represent.



$$CH_3—\underset{\underset{CH_3}{|}}{\overset{\overset{CH_3}{|}}{C}}—CH_3$$

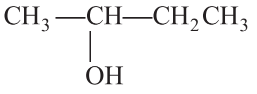
and



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

(a) chain isomerism (b) position isomerism
(c) functional isomerism (d) metamerism

53 Consider the following isomers of $C_4H_{10}O$.
(i) $CH_3OCH_2CH_2CH_3$ (ii) $CH_3CH_2CH_2CH_2OH$
(iii) $CH_3CH_2OCH_2CH_3$ (iv)

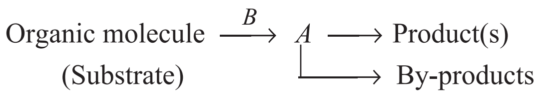


$CH_3—\underset{\underset{OH}{|}}{CH}—CH_2CH_3$

The metamers among the given structure is/are
(a) (i) and (ii)
(b) (ii) and (iii)
(c) (i) and (iii)
(d) (ii) and (iv)

TOPIC 5 ~ Fundamental Concepts in Organic Reaction Mechanism

54 The general reaction as depicted below :



$$\text{Organic molecule (Substrate)} \xrightarrow{B} A \longrightarrow \text{Product(s)}; \quad A \longrightarrow \text{By-products}$$

Here, A and B refer to

A B

(a) catalyst, chemical reagent
(b) enzyme, organic reagent
(c) intermediate, attacking reagent
(d) poison, attacking reagent

55 Relative stabilities of the following carbocations will be in the order **JIPMER 2018**

$$\underset{(A)}{\overset{\oplus}{C}H_3}, \underset{(B)}{CH_3\overset{\oplus}{C}H_2}, \underset{(C)}{\overset{\oplus}{C}H_2OCH_3}$$

(a) $C > B > A$ (b) $C < B < A$ (c) $B > C > A$ (d) $C > A > B$

56 The correct order of decreasing stability of the following carbocation is **AIIMS 2018**

$$\underset{\text{I}}{CH_3 - \overset{\oplus}{C}H - CH_3}, \qquad \underset{\text{II}}{CH_3 - \overset{\oplus}{C}H - OCH_3},$$

$$\underset{\text{III}}{CH_3 - \overset{\oplus}{C}H - CH_2 - OCH_3}$$

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

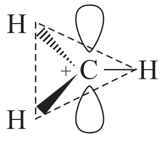
57 The most stable carbocation, among the following is **NEET (Odisha) 2019**

(a) $(CH_3)_3C - \overset{\oplus}{C}H - CH_3$
(b) $CH_3 - CH_2 - \overset{\oplus}{C}H - CH_2 - CH_3$
(c) $CH_3 - \overset{\oplus}{C}H - CH_2 - CH_2 - CH_3$
(d) $CH_3 - CH_2 - \overset{\oplus}{C}H_2$

58 The shape of carbocation is

(a) square planar
(b) trigonal planar
(c) octahedral
(d) trigonal pyramidal

59 Look at the figure below and find the hybridisation of carbon atom.



Shape of methyl cation

(a) sp^3
(b) sp^2
(c) sp
(d) None of these

60 The intermediate formed during the homolytic cleavage is

(a) free radical
(b) carbocation
(c) carbanion
(d) Both (a) and (b)

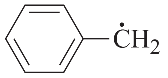
61 The correct chemical reaction of homolytic cleavage is

(a) $CH_3 - Br \longrightarrow \dot{C}H_3 + Br^-$
(b) $CH_3 - Br \xrightarrow[\text{or light}]{\text{Heat}} \dot{C}H_3 + Br^\bullet$
(c) $CH_3 - Br \longrightarrow CH_3^+ + Br^\bullet$
(d) $CH_3 - Br \xrightarrow[\text{or light}]{\text{Heat}} \overset{+}{C}H_3 + Br^-$

62 The reaction intermediate produced by homolytic cleavage of a bond is called

(a) carbene
(b) carbocation
(c) carbanion
(d) free radical

63 The radical is aromatic because it has **NEET 2013**



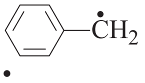
(a) $6p$-orbitals and 6 unpaired electrons
(b) $7p$-orbitals and 6 unpaired electrons
(c) $7p$-orbitals and 7 unpaired electrons
(d) $6p$-orbitals and 7 unpaired electrons

64 The correct order of stability of alkyl radical is

(a) $\dot{C}H(CH_3)_2 < \dot{C}H_3 < \dot{C}H_2CH_3 < \dot{C}(CH_3)_3$
(b) $\dot{C}(CH_3)_3 < \dot{C}H(CH_3)_2 < \dot{C}H_3 < \dot{C}H_2CH_3$
(c) $\dot{C}(CH_3)_3 < \dot{C}H(CH_3)_2 < \dot{C}H_2CH_3 < \dot{C}H_3$
(d) $\dot{C}H_3 < \dot{C}H_2CH_3 < \dot{C}H(CH_3)_2 < \dot{C}(CH_3)_3$

65 Compare stability of free radicals **AIIMS 2019**

I. $CH_3 - \dot{C}H - CH_3$

II. 

III. $\dot{C}H_2 - CH(CH_3)_2$

IV. $\dot{C}H_2 - CH_3$

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

66 Electrophiles are electron seeking species. Which of the following groups contain only electrophiles?

(a) $BF_3, \overset{+}{C}H_3, NO_2$
(b) $AlCl_3, SO_3, NO_2^+$
(c) $NO_2^+, CH_3^+, CH_3 - C^+ = O$
(d) $C_2H_5^-, C_2H_5, C_2H_5^+$

67 The electron displacements due to the influence of an atom or a substituent group present in the molecule cause

(a) temporary polarisation of the bond
(b) permanent polarisation of the bond
(c) permanent cleavage of the bond
(d) temporary cleavage of the bond

68 The permanent displacement of electron through a chain involving only σ -bonds is called

(a) inductive effect
(b) hyperconjugation effect
(c) electromeric effect
(d) mesomeric effect

69 Examples of electron withdrawing groups relative to hydrogen are

(a) $—NO_2$ (b) — COOH
(c) $—COOR$ (d) All of these

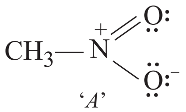
70 $+I$ -effect is shown by

(a) $—CH_3$ (b) —Br (c) —Cl (d) $—NO_2$

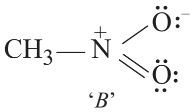
71 Which of the following is correct with respect to $-I$ effect of the substituents? ($R =$ alkyl) ***NEET 2018***

(a) $—NH_2 > —OR > —F$
(b) $—NR_2 < —OR < —F$
(c) $—NH_2 > —OR < —F$
(d) $—NH_2 > —OR > —F$

72 The given two structures are :



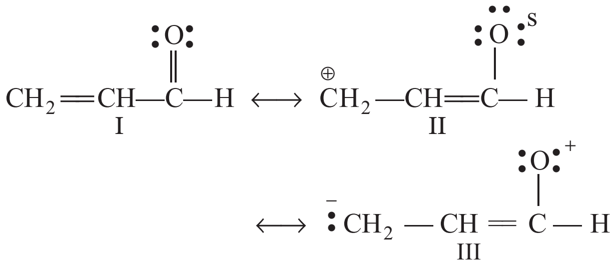
'A'



'B'

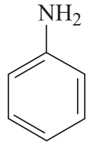
(a) resonating structures (b) Lewis structures
(c) Both (a) and (b) (d) None of these

73 The order of relative stability of the contributing structures are



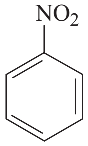
(a) II > I > III (b) I > II > III
(c) III > II > I (d) I = II = III

74 Consider the following compounds,



Aniline
(I)

and



Nitrobenzene
(II)

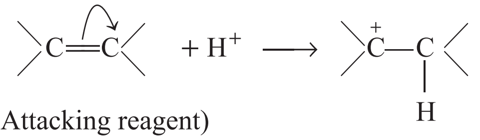
Which of the following option is/are true regarding I and II?

(a) I shows + R -effect, whereas II shows $-R$ -effect
(b) I shows $-R$ -effect, whereas II shows + R -effect
(c) Both I and II show $+R$ -effect
(d) Both I and II show $-R$ -effect

75 Which of the following shows $-R$-effect?

(a) $—OR$ (b) $—NHCOR$
(c) $—NH_2$ (d) —COOH

76 Observe the effect carefully and predict the nature of it.



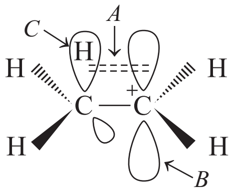
Choose the correct option.

(a) Negative electromeric effect
(b) Resonance effect
(c) Positive electromeric effect
(d) Inductive effect

77 Hyperconjugation involves overlapping of which of the following orbitals.

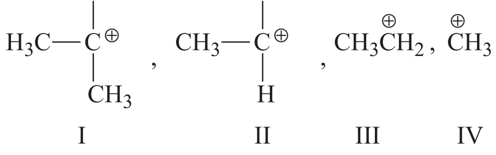
(a) σ - σ (b) σ - p (c) p - p (d) π - π

78 Observe the orbital diagram showing hyperconjugation in ethyl cation. Here A, B and C refer to



(a) $A \rightarrow$ hyperconjugation, $B \rightarrow$ empty $2p$ -orbital of carbon, $C \rightarrow C_{sp^3} - H_{1s}$ bond
(b) $A \rightarrow$ inductive effect, $B \rightarrow i\,2p$ -orbital of carbon, $C \rightarrow C_{sp^2} - H_{1s}$ bond
(c) $A \rightarrow$ electromeric effect, $B \rightarrow$ empty $2p$-orbital of carbon, $C \rightarrow C_{sp^3} - H_{1s}$ bond
(d) $A \rightarrow$ resonance effect, $B \rightarrow i\,2p$-orbital of carbon, $C \rightarrow C_{sp^3} - H_{1s}$ bond

79 Choose the correct order of stability of carbocation using the concept of hyperconjugation.



I II III IV

(a) I < II < III < IV (b) IV < III < II < I
(c) III < IV < II < I (d) None of these

80 Which of the following effect helps in deciding the stability of *iso*-butylene?

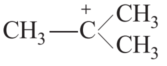
(a) Inductive effect (b) Mesomeric effect
(c) Hyperconjugative effect (d) Steric effect

81 The hyperconjugation is also regarded

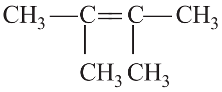
(a) σ-bond resonance (b) no bond resonance
(c) π-bond resonance (d) σ-π bond resonance

82 In which of the following molecule, hyperconjugation is not possible?

(a) $CH_3—CH=CH_2$ (b) $CH_2=CH_2$

(c) 

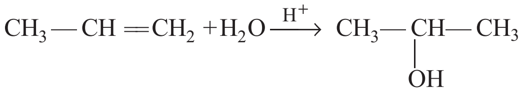
$CH_3—\overset{+}{C}(CH_3)_2$

(d) 

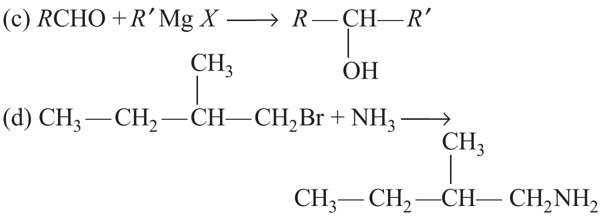
$CH_3—\underset{CH_3}{\underset{|}{C}}=\underset{CH_3}{\underset{|}{C}}—CH_3$

83 Which one is a nucleophilic substitution reaction among the following? ***CBSE AIPMT 2010***

(a) $CH_3CHO + HCN \longrightarrow CH_3CH(OH)CN$

(b) 

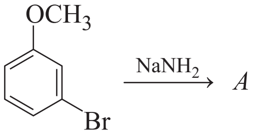
$CH_3—CH=CH_2 + H_2O \xrightarrow{H^+} CH_3—\underset{OH}{\underset{|}{CH}}—CH_3$



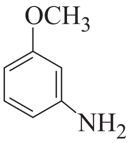
(c) $RCHO + R'MgX \longrightarrow R—\underset{OH}{\underset{|}{CH}}—R'$

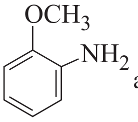
(d) $CH_3—CH_2—\overset{CH_3}{\overset{|}{CH}}—CH_2Br + NH_3 \longrightarrow CH_3—CH_2—\overset{CH_3}{\overset{|}{CH}}—CH_2NH_2$

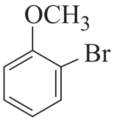
84 Identify *A* and predict the type of reaction(s)

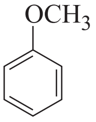


AIPMT

(a)  and substitution reaction

(b)  and elimination addition reaction

(c)  and cine substitution reaction

(d)  and cine substitution reaction

TOPIC 6 ~ *Methods of Purification of Organic Compounds*

85 Naphthalene can be easily purified by

(a) sublimation (b) crystallisation
(c) distillation (d) vaporisation

86 Which of the following can be used to remove impurity that impart colour to solution?

(a) Activated palladium (b) Activated charcoal
(c) Activated nickel (d) All of these

87 Aniline and chloroform are easily separated by the technique of

(a) sublimation (b) crystallisation
(c) distillation (d) solvent extraction

88 Which of the following process is used to separate volatile liquid from non-volatile impurities?

(a) Distillation (b) Sublimation
(c) Differential extraction (d) Crystallisation

89 Which of the following distillation is used if the difference in boiling points of two liquids is not much?

(a) Steam distillation (b) Simple distillation
(c) Fractional distillation
(d) Distillation under reduced pressure

90 Which of the following is fitted over the mouth of the round bottom flask of simple distillation apparatus to change it to fractional distillation apparatus?

(a) Capillary tube
(b) Octadecyl column
(c) C-18 column
(d) Fractionating column

91 Glycerol can be separated from spent-lye in soap industry by

(a) chromatography
(b) sublimation
(c) fractional distillation
(d) distillaltion under reduced pressure

92 Which of the following processes is suitable for the purification of aniline?

(a) Simple distillation
(b) Fractional distillation
(c) Fractional crystallisation
(d) Steam distillation

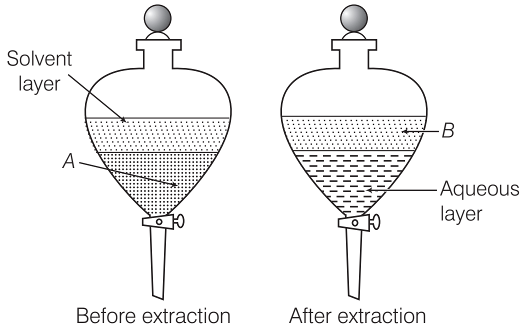
93 A mixture of *o*-nitrophenol and *p*-nitrophenol can be separated by

(a) fractional distillation (b) sublimation
(c) chemical separation (d) steam distillation

94 The technique in which extraction of compound takes place on the basis of more solubility of one compound in another solvent, is

(a) differential extraction (b) chromatography
(c) sublimation (d) crystallisation

95 What does A and B refer to, in the figure of differential extraction?



Choose the correct option.

(a) $A \rightarrow$ Organic compound in aqueous layer
$B \rightarrow$ Organic compound in solvent layer
(b) $A \rightarrow$ Organic compound in solvent layer
$B \rightarrow$ Organic compound in aqueous layer
(c) $A \rightarrow$ Inorganic compound in aqueous layer
$B \rightarrow$ Inorganic compound in aqueous layer
(d) $A \rightarrow$ Inorganic compound in aqueous layer
$B \rightarrow$ Inorganic compound in aqueous layer

96 In which technique same solvent is repeatedly used for extraction of the compound?

(a) Continuous extraction
(b) Non-continuous extraction
(c) Diffraction extraction
(d) Non-differential extraction

97 Which chromatography is based on the fact that different compounds are adsorbed on an adsorbent to different degrees?

(a) Partition chromatography
(b) Adsorption chromatography
(c) Absorption chromatography
(d) Paper chromatography

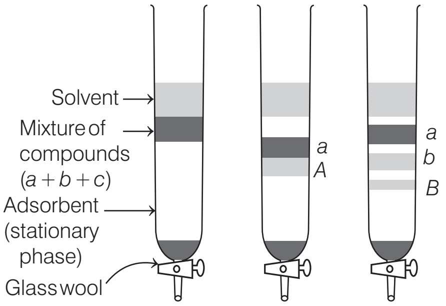
98 Which of the following adsorbent is used in thin layer chromatography?

(a) Silica gel
(b) Alumina
(c) Sodium benzoate
(d) Both (a) and (b)

99 Compound that act as an adsorbent in column chromatography is

(a) Na_2O
(b) Na_2SO_4
(c) Al_2O_3
(d) NaCl

100 Look at the picture of column chromatography carefully and labels A and B, are



(a) $A = b + c, B = c$
(b) $A = K$ (constant), $B = b + c$
(c) $A = a, B = b$
(d) $A =$ no component, $B = a$

101 The paper used in paper chromatography selectively retains different components according to their differing partition in two phases. The paper strip so developed is known as

(a) chroma paper
(b) chromatogram
(c) chromatography
(d) chroma

102 In chromatography, which of the following statements is incorrect for R_f? ***JEE Main 2019***

(a) R_f value depends on the type of chromatography
(b) Higher R_f value means higher adsorption
(c) R_f value is dependent on the mobile phase
(d) The value of R_f can not be more than one

TOPIC 7 ~ Analysis of Organic Compounds (Qualitative and Quantitative)

103 Which of the following should be added in the compound for the detection of carbon and hydrogen?

(a) Cu(I) oxide
(b) Cu(II) oxide
(c) Zn dust
(d) Activated charcoal

104 During the fusion of an organic compound with sodium metal, nitrogen of the organic compound is converted into

(a) $NaNO_2$ (b) $NaNH_2$
(c) NaCN (d) NaNC

105 In Lassaigne's test, a blue colour is obtained if the organic compound contains nitrogen. The blue colour is due to the formation of

(a) $K_4[Fe(CN)_6]$ (b) $Fe_4[Fe(CN)_6]_3$
(c) $Na_3[Fe(CN)_6]$ (d) $Cu_2[Fe(CN)_6]$

106 Acidified sodium fusion extract on addition of ferric chloride solution gives blood red colouration. This confirms the presence of which of the following element(s)?

(a) Both S and Cl
(b) Both N and S
(c) Only N
(d) Only S

107 In phosphorus detection of an organic compound, the oxidised phosphorus compound solution is boiled with nitric acid and then treated with ammonium molybdate. Yellow colour is due to the formation of

(a) $(NH_4)_3PO_3 \cdot MoO_3$
(b) $(NH_4)_3PO_4 \cdot 12MoO_3$
(c) $Na_4[Mo(NH_4)_3 \cdot PO_3]$
(d) None of these

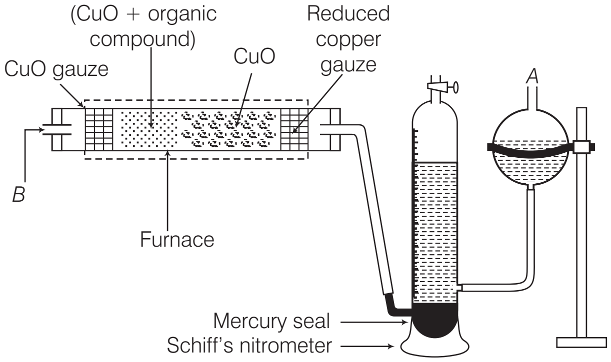
108 Lassaigne's test is not used for the detection of which element?

(a) Carbon (b) Halogens
(c) Nitrogen (d) Sulphur

109 On complete combustion, 0.246 g of an organic compound gave 0.198 g of carbon dioxide and 0.1014 g of water. The percentage composition of carbon and hydrogen in the compound respectively are

	%C	%H
(a)	21.95	4.58
(b)	21.95	5.58
(c)	11.95	5.58
(d)	11.95	4.58

110 Observe the figure given below carefully for Duma's method and label *A* and *B*. Here, *A* and *B* refer to



Duma's method

	A	*B*		*A*	*B*
(a)	CO_2,	nitrogen	(b)	nitrogen,	CO_2
(c)	neon,	KOH	(d)	nitrogen,	oxygen

111 How many grams equal to the 22400 mL N_2 at STP?

(a) 26 g (b) 27 g (c) 28 g (d) 29 g

112 An organic compound is estimated through Dumas method and was found to evolved 6 moles of CO_2, 4 moles of H_2O and 1 mole of nitrogen gas. The formula of the compound is

JEE Main 2019

(a) C_6H_8N (b) $C_{12}H_8N$
(c) $C_{12}H_8N_2$ (d) $C_6H_8N_2$

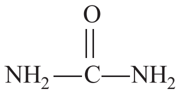
113 Quantitative measurement of nitrogen in an organic compound is done by

(a) Berthelot method (b) Beilstein method
(c) Lassaigne method (d) Kjeldahl's method

114 Kjeldahl's method cannot be used to estimate nitrogen for which of the following compounds?

JEE Main 2020

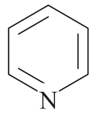
(a) $C_6H_5NO_2$

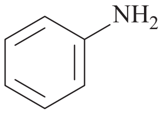
(b) 
$NH_2—\overset{\overset{\displaystyle O}{\|}}{C}—NH_2$

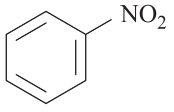
(c) $CH_3CH_2—C\equiv N$ (d) $C_6H_5NH_2$

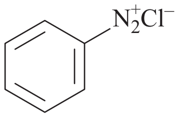
115 Which of the following compounds will be suitable for Kjeldahl's method for nitrogen estimation?

JEE Main 2018

(a) 

(b) 

(c) 

(d) 

116 Percentage of N in Kjeldahl' method

$$= \frac{1.4 \times M \times 2\left(V - \frac{V_1}{2}\right)}{m}$$

What does V_1 represents in the above formula?

(a) Volume of NaOH of molarity, M used for titration of excess of sulphuric acid
(b) Volume of NaOH of normality, N used for titration of excess of sulphuric acid
(c) Volume of H_2SO_4 of molarity, M
(d) Volume of H_2SO_4 of normality, N

117 In the Kjeldahl's method for estimation of nitrogen present in a soil sample, ammonia evolved from 0.75 g of sample neutralised 10 mL of 1 M H_2SO_4. The percentage of nitrogen in the soil is **_CBSE AIPMT 2014_**

(a) 37.33 (b) 45.33 (c) 35.33 (d) 45.33

118 In Carius method of estimation of halogens, 250 mg of an organic compound gave 141 mg of AgBr. The percentage of bromine in the compound is (atomic mass Ag $=108$ and Br $=80$) **_JEE Main 2015_**

(a) 24 (b) 36 (c) 48 (d) 60

119 Which method is used to find halogen in organic compound? **_JIPMER 2019_**

(a) Duma's method (b) Leibig's method
(c) Kjeldahl method (d) Carius method

120 What is the name of tube in which a known mass of an organic compound is heated for the quantitative analysis of sulphur?

(a) Borosil tube (b) Carius tube
(c) Kjeldahl tube (d) None of these

121 In the estimation of sulphur, which reagent is heated alongwith organic compound in a Carius tube?

(a) Sodium peroxide
(b) Dil. nitric acid
(c) Silver nitrate
(d) Sodium hydroxide

122 Percentage of sulphur present in any sample can be calculated as $= \frac{32 \times m_1 \times 100}{233 \times m}$.

Here, m_1 refers to

(a) mass of barium sulphate formed
(b) mass of barium oxide formed
(c) mass of barium chloride formed
(d) None of the above

123 In sulphur estimation, 0.157 g of an organic compound gave 0.4813 g of barium sulphate. The percentage of sulphur in the compound is

(a) 42.10 (b) 52.10
(c) 21.05 (d) 40.01

124 Which of the following apparatus is used to determine, the elements, carbon, hydrogen and nitrogen present in a compound?

(a) CNN elemental analyser
(b) CHH elemental analyser
(c) CHN elemental analyser
(d) Automatic experimental analyser

SPECIAL TYPES QUESTIONS

I. Statements Based Questions

125 Which of the following statements is incorrect?

(a) Aromatic compounds may have hetero atom in the ring
(b) Tropolone is a non-benzenoid compound
(c) Pyridine is a heterocylic aromatic compound
(d) Aniline is a non-benzenoid compound

126 Read the statements carefully.

I. The 3-D structure of organic molecules can be represented by using solid (◀) and dashed (⫼) line in wedged formula.
II. The solid-wedge is used to depict the bond projecting out of the plane of the paper and away from the observer.

The incorrect statement(s) is/are

(a) Only I (b) Only II
(c) Neither I nor II (d) Both I and II

127 Which of the following statements is/are correct?

I. When two or more compounds have similar molecular formula but different carbon skeletons they are referred as chain isomers.
II. When two or more compounds differ in the position of substituent atom or functional group on the carbon skeleton, they are called functional isomers.
III. The isomerism which arises due to the presence of different alkyl chains on either side of the functional group in the molecule is referred to as metamerism.

Choose the correct option.

(a) I, II and III
(b) Both II and III
(c) Only III
(d) Both I and III

128 Consider the following statements :

I. Chain isomers have similar molecular formula but different carbon skeletons.

II. Metamerism arises due to different alkyl chains on either side of the functional group in the molecule.

III. Stereoisomerism can be classified as geometrical and *cis-trans* isomers.

Read the given statements and choose the correct option.

(a) Only I
(b) Only III
(c) Both I and II
(d) I, II and III

129 Consider the following statements :

I. The presence of functional group disables systematisation of organic compound into different classes.

II. In polyfunctional compounds, one of the functional group is chosen as the principal functional group.

III. The order of priority for functional group is

$$—COCl > —COOR > —SO_3H > —COOH$$

IV. $CH_2(OH)CH_2(OH)$ is named as ethane-1, 2-diol.

Read the given statements and choose the correct option.

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

130 Consider the following statements :

I. In the trivial system of nomenclature the terms *ortho*, *meta* and *para* are used as prefixes to indicate the relative positions 1, 2; 1, 3 and 1, 4 respectively.

II. 1,3-dibromobenzene is named as *o*-dibromobenzene.

III. When a benzene ring is attached to an alkane having a functional group, it is considered as parent.

Read the given statement and choose the incorrect option.

(a) Only I
(b) Only II
(c) Both II and III
(d) Both I and III

131 Consider the following statements :

I. In heterolytic cleavage, the bond breaks in such a fashion that shared pair of electrons remains with one of the fragments.

II. In homolytic cleavage, one of the electrons of the shared pair in a covalent bond goes with each of the bonded atoms.

III. The single electron movement is shown by 'half-headed' (fish hook : ,) curved arrow.

IV. Free radicals contain a paired electron.

V. Homolytic fission gives free radical and also called non-homopolar or polar reactions.

Read the given statements and choose the correct option.

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

132 The correct statement regarding electrophile is **NEET 2019**

(a) electrophile is a negatively charge species and can form a bond by accepting a pair of electrons from a nucleophile
(b) electrophile is a negatively charged species and can form a bond by accepting a pair of electrons from another electrophile
(c) electrophiles are generally neutral species and can form a bond by accepting a pair of electrons from a nucleophile
(d) electrophile can be either neutral or positively charged species and can form a bond by accepting a pair of electrons from a nucleophile

133 Which of the following statement is incorrect?

(a) Benzene has uniform C—C bond distances of 139 pm a value intermediate between C—C single and C ═ C double bonds
(b) The resonance structure are hypothetical and individually do not represent any real molecule
(c) Resonance structure contribute to the actual structure in proportion to stability
(d) Less the number of contributing structures, the more is the resonance energy

134 Consider the following statements :

I. The resonance structures have different positions of nuclei.

II. Resonance structures have the same number of unpaired electrons.

III. Among the resonance structures, the one which has more number of covalent bonds, all the atoms with octet of electrons and more dispersal of charge is more stable than others.

Read the given statements and choose the incorrect option.

(a) Only I
(b) Both II and III
(c) Only III
(d) All the statements are incorrect

135 Which of the following statements is incorrect?

(a) The purity of a compound is ascertained by determining its melting or boiling point
(b) Most of the pure compounds have sharp melting points and boiling points
(c) New methods of checking the purity of an organic compound are based on different types of chromatographic and spectroscopic techniques
(d) Techniques like sublimation, crystallisation and distillation are not commonly used for purification of organic compounds

136 What is the technological applications of fractional distillation?

(a) To separate different fractions of crude oil in petroleum industry
(b) To separate different fractions of volatile and non-volatile solvents
(c) To separate mixture of amino acids
(d) No technological application of fractional distillation

137 Which of the following statements is true for calculation of the volume of nitrogen at STP in Duma's method?

I. Volume of nitrogen at STP $= \dfrac{p_1V_1 \times 273}{760 \times T_1}$
II. p_1 and V_1 are the pressure and volume of nitrogen.
III. p_1 is different from the atmospheric pressure at which nitrogen gas is collected,
p_1 = atmospheric pressure – aqueous tension

Choose the correct option.

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

II. Assertion and Reason

■ **Directions** (Q Nos. 138-156) *In the following questions, an Assertion* (A) *is followed by a corresponding Reason* (R). *Use the following keys to choose the appropriate answer.*

(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.

138 **Assertion** (A) In $H_2C{=\!=}CH_2$ molecule, the rotation about carbon-carbon double bond ($C{=\!=}C$) is restricted

Reason (R) Rotation of one CH_2 fragment with respect to other interferes with maximum overlap of p-orbitals.

139 **Assertion** (A) In bond-line structural representations, only atoms specifically written are oxygen, chlorine, nitrogen etc.

Reason (R) In bond-line structural representations, line junctions denote carbon atoms bonded to appropriate number of hydrogens required to satisfy the valency of the carbon atoms.

140 **Assertion** (A) Acyclic compounds consist of straight or branched chain compounds.

Reason (R) Alicyclic compounds contain carbon atoms joined in the form of a ring.

141 **Assertion** (A) The names of straight chain compounds are based on their chain structure and carry a prefix indicating the number of carbon atoms present in the chain.

Reason (R) From CH_4 to C_4H_{10}, the prefixes are derived from common or trivial names.

142 **Assertion** (A) The compounds that have the same constitution and sequence of covalent bonds but differ in relative positions of their atoms or groups in space are called stereoisomers.

Reason (R) Stereoisomerism is a special type of isomerism which can be classified as geometrical and optical isomerism.

143 **Assertion** (A) When a covalent bond is formed between atoms of different electronegativity, the electron density is more towards the more electronegative atom of the bond.

Reason (R) Shift of electron density results in a polar covalent bond.

144 **Assertion** (A) A covalent bond may be cleaved either by heterolytic cleavage or by homolytic cleavage.

Reason (R) Heterolytic cleavage of CH_3Br will give $\overset{+}{C}H_3$ and $\overset{-}{B}r$.

145 **Assertion** (A) Inductive effect and resonance effect cause permanent polarisation of bond.

Reason (R) These involve electron displacements due to the influence of an atom or a substituted group present in the molecule.

146 **Assertion** (A) Conjugated system show abnormal behaviour, it contains alternate single and double bonds in an open chain or cyclic system.

Reason (R) In conjugated system, π-electrons are delocalised and the system develops polarity.

147 **Assertion** (A) If one of the substances in the mixture is water and the other a water insoluble substance, then the mixture will boil close to but higher 373 K.

Reason (R) Aniline is separated by using separating funnel technique from aniline-water mixture.

148 **Assertion** (A) A liquid boils at a temperature at which its vapour pressure is lower than the external pressure.

Reason (R) Glycerol can be separated from spent-lye in soap industry by using the technique of distillation under reduced pressure.

149 **Assertion** (A) In steam distillation, the liquid boils when the sum of vapour pressures due to the organic liquid (p_1) and that due to water (p_2) becomes equal to the atmospheric pressure (p), i.e. $p = p_1 + p_2$.

Reason (R) p_1 is lower than p, the organic liquid vaporises at lower temperature than its boiling point.

150 **Assertion** (A) Carbon and hydrogen are detected by heating the compound with copper (II) oxide.

Reason (R) Carbon and hydrogen present in the compound are oxidised to carbon dioxide and water respectively.

151 **Assertion** (A) Phosphorus present in the organic compound is oxidised to phosphoric acid. It is precipitated as ammonium phosphomolybdate by adding ammonium hydroxide.

Reason (R) Phosphoric acid may be precipitated as $MgNH_4PO_4$ by adding magnesia mixture which on ignition yields $Mg_2P_2O_7$.

152 **Assertion** (A) Percentage of carbon can be estimated by using the formula $\frac{12 \times m_2 \times 100}{44 \times m}$

Reason (R) Molar mass of carbon dioxide is 12.

153 **Assertion** (A) In Dumas method, the nitrogen containing organic compound, when heated with copper oxide in an atmosphere of carbon dioxide yields free nitrogen in addition to carbon dioxide and water.

Reason (R) The correct equation representing this method is

$$C_xH_yN_z + (2x + y/2)\,CuO \longrightarrow x\,CO_2 + y/2\,H_2O + z/2N_2 + (2x + y/2)\,Cu$$

154 **Assertion** (A) Kjeldahl's method is not applicable to compounds containing nitrogen in the form of nitro and azo groups and nitrogen present in the ring (e.g. pyridine).

Reason (R) Nitrogen of nitro and azo group containing compounds does not change to ammonium sulphate by Kjeldahl's method.

155 **Assertion** (A) % of phosphorus in an organic compound can be estimated by formula

$$\frac{31 \times m_1 \times 100}{1877 \times m}$$

Reason (R) Molar mass of

$$(NH_4)_3PO_4 \cdot 12MoO_3 = 1877\text{ g}$$

156 **Assertion** (A) The percentage of oxygen in an organic compound is usually found by difference between the total percentage composition (100) and the percentages of all other elements.

Reason (R) Oxygen is present everywhere.

III. Matching Type Questions

157 Match the terms of Column I with Column II and choose the correct option from the codes given below.

	Column I (Structure of compound)		Column II (Hybridisation of carbon)
A.	CH_3Cl	1.	sp^3 and sp^2
B.	$(CH_3)_2CO$	2.	sp^2
C.	CH_3CN	3.	sp^3
D.	$HCONH_2$	4.	sp^3 and sp

Codes

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

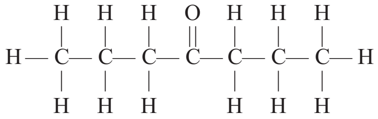
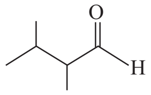
158 Match the compound given in Column I with common name given in Column II.

	Compound		Common name
A.	CH_3COOH	1.	Anisole
B.	$(H_3C)_2CO$	2.	Ethyl methyl ether
C.	$C_6H_5COCH_3$	3.	Acetone
D.	$CH_3OCH_2CH_3$	4.	Acetic acid

Codes

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

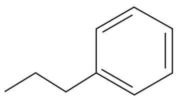
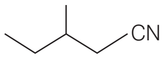
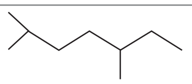
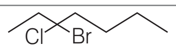
159 Match the terms of Column I with Column II and choose the correct option from the codes given below.

	Column I (Name of the molecule)		Column II (Formulae)
A.	*Iso*-propyl alcohol	1.	 $\mathrm{H-\underset{H}{\overset{H}{C}}-\underset{H}{\overset{H}{C}}-\underset{H}{\overset{H}{C}}-\overset{O}{\overset{\Vert}{C}}-\underset{H}{\overset{H}{C}}-\underset{H}{\overset{H}{C}}-\underset{H}{\overset{H}{C}}-H}$
B.	2,3-dimethyl butanal	2.	
C.	Heptan-4-one	3.	$(CH_3)_2CHOH$

Codes

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

160 Match terms of Column I with Column II and choose the correct option from the codes given below.

	Column I (Bond-line formula for the molecule)		Column II (Name of the molecule)
A.		1.	2,5-dimethylheptane
B.		2.	3-methylpentanenitrile
C.		3.	3-bromo-3-chloroheptane
D.		4.	4-chlorobutanal
E.		5.	propylbenzene

Codes

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

161 Match the terms of Column I with Column II and choose the correct option from the codes given below.

Column I (Definition)		**Column II** (Type of compounds)	
A.	Compounds containing carbon atoms joined in the form of a ring.	1.	Homocyclic compounds
B.	When atoms other than carbon atoms are present in the ring	2.	Non-benzenoid compound
C.	Benzene and other related ring compounds	3.	Heterocyclic compound
D.	Compounds which do not contain benzene ring but aromatic in nature.	4.	Benzenoid compound

Codes

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

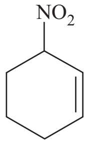
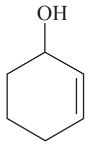
162 Match the organic compounds given in Column I with their names given in Column II and choose the correct option using the codes given below.

Column I (Compounds)		**Column II** (Common/Trivial names)	
A.	$H_3CCH_2CH_2OH$	1.	Acetophenone
B.	CH_3COOH	2.	Acetic acid
C.	$C_6H_5OCH_3$	3.	*n*-propyl alcohol
D.	$C_6H_5COCH_3$	4.	*Iso*-butane
E.	$CH_3OCH_2CH_3$	5.	Ethyl methyl ether
F.	$(H_3C)_2CHCH_3$	6.	Anisole

Codes

	A	B	C	D	E	F
(a)	6	5	3	4	2	1
(b)	5	4	3	6	1	2
(c)	3	2	6	1	5	4
(d)	3	6	5	1	4	2

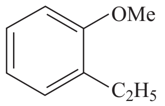
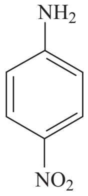
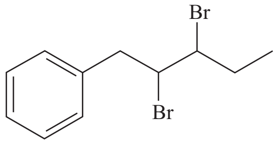
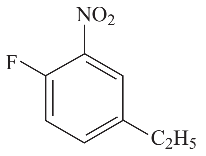
163 Match the items of Column I with Column II and choose the correct option from the codes given below.

Column I (IUPAC name of the molecule)		**Column II** (Structure of molecule)	
A.	Hex-1,3-dien-5-yne	1.	
B.	2-chlorohexane	2.	$CH_2{=}CHCH_2CH(OH)CH$
C.	Pent-4-ene-2-ol	3.	
D.	3-nitrocyclohexene	4.	$CH_3CH_2CH_2CH_2CH(Cl)CH_3$
E.	Cyclohex-2-ene-1-ol	5.	$CH{\equiv}C{-}CH{=}CHCH{=}CH$
F.	6-hydroxyheptanal	6.	$CH_3CH(OH)CH_2CH_2CH_2CH_2CHO$

Codes

	A	B	C	D	E	F
(a)	5	4	2	1	3	6
(b)	1	2	3	4	5	6
(c)	6	4	3	2	1	5
(d)	4	3	2	1	5	6

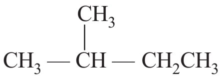
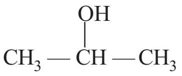
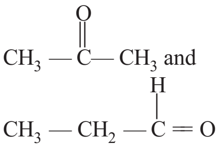
164 Match the terms of Column I with Column II and choose the correct option from the codes given below.

Column I (Name of the compound)		**Column II** (Structure of the compound)	
A.	*o*-ethylanisole	1.	
B.	*p*-nitroaniline	2.	
C.	2, 3-dibromo-1-phenylpentane	3.	
D.	4-ethyl-1-fluoro 2-nitrobenzene	4.	

Codes

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

165 Match the items of Column I with the Column II and choose the correct option from the codes given below.

	Column I (Structure of compounds)		**Column II** (Type of isomerism)
A.	$CH_3CH_2CH_2CH_2CH_3$ and  $CH_3-\overset{\overset{\displaystyle CH_3}{\vert}}{CH}-CH_2CH_3$	1.	Chain isomerism
B.	$CH_3CH_2CH_2OH$ and  $CH_3-\overset{\overset{\displaystyle OH}{\vert}}{CH}-CH_3$	2.	Position isomerism
C.	 $CH_3-\overset{\overset{\displaystyle O}{\Vert}}{C}-CH_3$ and $CH_3-CH_2-\overset{\overset{\displaystyle H}{\vert}}{C}=O$	3.	Metamerism
D.	$CH_3OC_3H_7$ and $C_2H_5OC_2H_5$	4.	Functional group isomerism

Codes

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

166 Match the items of Column I with Column II and choose the correct option from the codes given below.

	Column I		**Column II**
A.	Adsorbent	1.	Silica gel or alumina
B.	R_f value	2.	Brown spots
C.	The spots of colourless compounds, which are invisible to eye	3.	Ninhydrin solution
D.	Crystals of iodine	4.	Fluorescent in ultraviolet light.
E.	Spraying reagent	5.	Acts as stationary phase.
F.	Chromatography paper contains water trapped in it.	6.	$\dfrac{\text{Distance moved by the substance from base line } (x)}{\text{Distance moved by the solvent from base line } (y)}$

Codes

	A	B	C	D	E	F
(a)	5	6	4	2	3	1
(b)	6	4	5	1	3	2
(c)	2	3	4	5	6	1
(d)	1	6	4	2	3	5

167 The correct match between items I and II is

JEE Main 2019

	Item I (Mixture)		**Item II** (Separation method)
A.	H_2O : Sugar	P.	Sublimation
B.	H_2O : Aniline	Q.	Recrystallisation
C.	H_2O : Toluene	R.	Steam distillation
		S.	Differential extraction

(a) (A) → (Q); (B) → (R); (C) → (S)
(b) (A) → (Q); (B) → (R); (C) → (P)
(c) (A) → (S); (B) → (R); (C) → (P)
(d) (A) → (R); (B) → (P); (C) → (S)

168 Match the items of Column I with Column II and choose the correct option from the codes given below.

	Column I (Test for element)		**Column II** (Products involved in the chemical reaction)
A.	Test for nitrogen	1.	$(NH_4)_3PO_4 \cdot 12MoO_3$ Ammonium phosphomolybdate
B.	Test for sulphur	2.	$Fe_4[Fe(CN)_6]_3 \cdot xH_2O$ Prussian blue
C.	Test for both nitrogen and sulphur	3.	AgX
D.	Test for halogens	4.	$[Fe(SCN)]^{2+}$ Blood red
E.	Test for phosphorus	5.	PbS Black

Codes

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

169 Match the items of Column I with the items of Column II appropriately and choose the correct option from the codes given below.

	Column I		**Column II**
A.	Carius method	1.	$\dfrac{1.4 \times M \times 2\,(V - V_1/2)}{m}$
B.	Percentage of sulphur	2.	$\dfrac{62 \times m_1 \times 100}{222 \times m}\%$
C.	Percentage of phosphorus	3.	$\dfrac{\text{atomic mass of } X \times m_1 \times 100}{\text{molecular mass of Ag}X \times m}$
D.	Percentage of halogen	4.	$S = \dfrac{32 \times m_1 \times 100}{233 \times m}$
E.	Percentage of nitrogen	5.	Organic compound is heated with fuming nitric acid in the presence of silver nitrate.

Codes

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

NCERT & NCERT Exemplar

MULTIPLE CHOICE QUESTIONS

NCERT

170 Which of the following represents the correct IUPAC name for the compounds concerned?

(a) 2, 2-dimethylpentane (b) 2, 5, 7-trimethyloctane
(c) 4-chloro-2 methylpentane (d) But-4-ol-1-yne

171 Why is nitric acid added to sodium extract before adding silver nitrate for testing halogens?

(a) To avoid bumping
(b) To remove NaCN and Na_2S
(c) For proper reaction with $AgNO_3$
(d) Both (b) and (c)

172 An organic compound contains 69% carbon and 4.8% hydrogen, the remainder being oxygen. Calculate the masses of carbon dioxide and water produced, when 0.20 g of this substance is subjected to complete combustion?

(a) 0.108g, 0.0832g (b) 0.232 g, 0.0892 g
(c) 0.50 g, 0.0864 g (d) 0.502 g, 0.0852 g

173 A sample of 0.50 g of an organic compound was treated according to Kjeldahl's method. The ammonia evolved was absorbed in 50 mL of 0.5 M H_2SO_4. The residual acid required 60 mL of 0.5 M solution of NaOH for neutralisation. Find the percentage composition of nitrogen in the compound.

(a) 56% (b) 78% (c) 62% (d) 82%

174 0.3780 g of an organic chloro compound gave 0.5740 g of silver chloride in Carius estimation. Calculate the percentage of chlorine present in the compound.

(a) 32.662% (b) 37.566%
(c) 72.662% (d) None of these

175 In the estimation of sulphur by Carius method, 0.468 g of an organic sulphur compound afforded 0.668 g of barium sulphate. Find the percentage of sulphur in the given compound.

(a) 52.60% (b) 36.20%
(c) 19.60% (d) None of these

176 In the organic compound, $CH_2{=}CH{-}CH_2{-}CH_2{-}C{\equiv}CH$, the pair of hybridised orbitals involved in the formation of $C_2{-}C_3$ bond is

(a) sp- sp^2 (b) sp-sp^3 (c) sp^2-sp^3 (d) sp^3-sp^3

177 The reaction,

$$CH_3CH_2I + KOH\ (aq) \longrightarrow CH_3CH_2OH + KI$$

is classified as

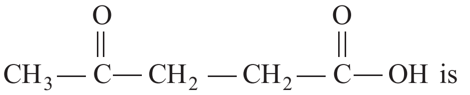
(a) electrophilic substitution (b) nucleophilic substitution
(c) elimination (d) addition

NCERT Exemplar

178 Which of the following is the correct IUPAC name?

(a) 3-ethyl-4, 4-dimethylheptane
(b) 4,4-dimethyl-3-ethylheptane
(c) 5-ethyl-4, 4-dimethylheptane
(d) 4,4-*bis*(methyl)-3-ethylheptane

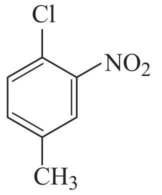
179 The IUPAC name for



$$CH_3{-}\overset{\overset{\displaystyle O}{\|}}{C}{-}CH_2{-}CH_2{-}\overset{\overset{\displaystyle O}{\|}}{C}{-}OH$$ is

(a) 1-hydroxypentane-1,4-dione
(b) 1,4-dioxopentanol
(c) 1-carboxybutan-3-one
(d) 4-oxopentanoic acid

180 The IUPAC name for



(a) 1-chloro-2-nitro-4-methylbenzene
(b) 1-chloro-4-methyl-2-nitrobenzene
(c) 2-chloro-1-nitro-5-methylbenzene
(d) *m*-nitro-*p*-chlorotoluene

181 Electronegativity of carbon atoms depend upon their state of hybridisation. In which of the following compounds, the carbon marked with asterisk is most electronegative?

(a) $CH_3 - CH_2 - {}^*CH_2 - CH_3$
(b) $CH_3 - {}^*CH = CH - CH_3$
(c) $CH_3 - CH_2 - C \equiv {}^*CH$
(d) $CH_3 - CH_2 - CH = {}^*CH_2$

182 In which of the following, functional group isomerism is not possible?

(a) Alcohols (b) Aldehydes
(c) Alkyl halides (d) Cyanides

183 The fragrance of flowers is due to the presence of some steam volatile organic compounds called essential oils. These are generally insoluble in water at room temperature but are miscible with water vapour in vapour phase. A suitable method for the extraction of these oils from the flowers is

(a) distillation
(b) crystallisation
(c) distillation under reduced pressure
(d) steam distillation

184 During hearing of a court case, the judge suspected that some changes in the documents had been carried out. He asked the forensic department to check the ink used at two different places. According to you which technique can give the best results?

(a) Column chromatography
(b) Solvent extraction
(c) Distillation
(d) Thin layer chromatography

185 The principle involved in paper chromatography is

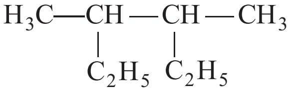
(a) adsorption (b) partition
(c) solubility (d) volatility

186 What is the correct order of decreasing stability of the following cations?

$$\underset{\text{I}}{CH_3-\overset{\oplus}{C}H-CH_3} \qquad \underset{\text{II}}{CH_3-\overset{\oplus}{C}H-OCH_3}$$

$$\underset{\text{III}}{CH_3-\overset{\oplus}{C}H-CH_2-OCH_3}$$

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

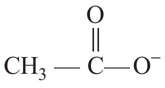
187 Correct IUPAC name for  $H_3C-\underset{C_2H_5}{\underset{|}{C}H}-\underset{C_2H_5}{\underset{|}{C}H}-CH_3$ is

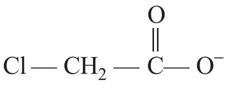
(a) 2-ethyl-3-methylpentane
(b) 3, 4-dimethylhexane
(c) 2-*sec*-butylbutane
(d) 2, 3-dimethylbutane

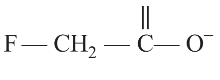
188 In which of the following compounds the carbon marked with asterisk is expected to have greatest positive charge?

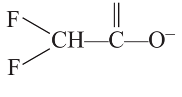
(a) $^{*}CH_3-CH_2-Cl$ (b) $^{*}CH_3-CH_2-Mg^{+}Cl^{-}$
(c) $^{*}CH_3-CH_2-Br$ (d) $^{*}CH_3-CH_2-CH_3$

189 Ionic species are stabilised by the dispersal of charge. Which of the following carboxylate ion is the most stable?

(a)  $CH_3-\overset{\overset{\displaystyle O}{\|}}{C}-O^-$

(b)  $Cl-CH_2-\overset{\overset{\displaystyle O}{\|}}{C}-O^-$

(c)  $F-CH_2-\overset{\overset{\displaystyle O}{\|}}{C}-O^-$

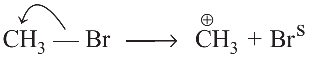
(d) 

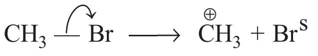
190 Electrophilic addition reactions proceed in two steps. The first step involves the addition of an electrophile. Name the type of intermediate formed in the first step of the following addition reaction.

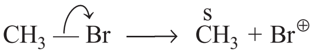
$$H_3C-HC=CH_2+H^+ \longrightarrow ?$$

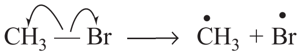
(a) 2° carbanion (b) 1° carbocation
(c) 2° carbocation (d) 1° carbanion

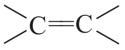
191 Covalent bond can undergo fission in two different ways.
The correct representation involving a heterolytic fission of CH_3-Br is

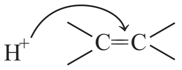
(a) 

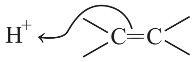
(b) 

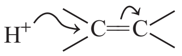
(c) 

(d) 

192 The addition of HCl to an alkene proceeds in two steps. The first step is the attack of H^+ ion to  portion which can be shown as

(a) 

(b) 

(c) 

(d) All of these are possible

■ **Directions** (Q Nos. 193-198) *In the following questions, an Assertion* (A) *is followed by a corresponding Reason* (R). *Use the following keys to choose the appropriate answer.*

(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.

193 **Assertion** (A) Energy of resonance hybrid is equal to the average of energies of all canonical forms.

Reason (R) Resonance hybrid cannot be presented by a single structure.

194 **Assertion** (A) Simple distillation can help in separating a mixture of propan-1-ol (boiling point 97°C) and propanone (boiling point 56°C).

Reason (R) Liquids with a difference of more than 20°C in their boiling points can be separated by simple distillation.

195 **Assertion** (A) Components of a mixture of red and blue inks can be separated by distributing the components between stationary and mobile phases in paper chromatography.

Reason (R) The coloured components of inks migrate at different rates because paper selectively retains different components according to the difference in their partition between two phases.

196 **Assertion** (A) Pent-1-ene and pent-2-ene are position isomers.

Reason (R) Position isomers differ in the position of functional group or a substituent.

197 **Assertion** (A) All the carbon atoms in $H_2C = C = CH_2$ are sp^2- hybridised.

Reason (R) In this molecule, all the carbon atoms are attached to each other by double bonds.

198 **Assertion** (A) Sulphur present in an organic compound can be estimated quantitatively by Carius method.

Reason (R) Sulphur is separated easily from other atoms in the molecule and gets precipitated as light yellow solid.

199 Match the terms mentioned in Column I with the terms in Column II and choose the correct option from codes given below.

Column I	**Column II**
A. Carbocation	1. Cyclohexane and 1-hexene
B. Nucleophile	2. Conjugation of electrons of C—H σ-bond with empty *p*-orbital present at adjacent positively charged carbon.
C. Hyperconjugation	3. sp^2-hybridised carbon with empty *p*-orbital.
D. Isomers	4. Ethyne
E. *sp*-hybridisation	5. Species that can receive a pair of electrons.
F. Electrophile	6. Species that can supply a pair of electrons.

Codes

	A	B	C	D	E	F
(a)	1	2	3	4	5	6
(b)	3	6	2	1	4	5
(c)	6	5	4	3	2	1
(d)	4	2	3	5	6	1

200 Match the type of mixture of compounds in Column I with the technique of separation/ purification given in Column II.

Column I	**Column II**
A. Two solids which have different solubilities in a solvent and do not undergo reaction when dissolved in it.	1. Steam distillation
B. Liquids that decompose at its boiling point	2. Fractional distillation
C. Steam volatile liquid	3. Simple distillation
D. Two liquids which have boiling points close to each other	4. Distillation under reduced pressure
E. Two liquids with large difference in boiling points.	5. Crystallisation

Codes

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

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

Column I	**Column II**
A. Duma's method	1. $AgNO_3$
B. Kjeldahl's method	2. Silica gel
C. Carius method	3. Free radicals
D. Chromatography	4. Nitrogen gas
E. Homolysis	5. Ammonium sulphate

Codes

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

Answers

Mastering NCERT with MCQs

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

Special Types Questions

125 (d)	126 (b)	127 (d)	128 (c)	129 (b)	130 (c)	131 (a)	132 (d)	133 (d)	134 (a)
135 (d)	136 (a)	137 (d)	138 (a)	139 (b)	140 (b)	141 (b)	142 (b)	143 (b)	144 (b)
145 (a)	146 (a)	147 (d)	148 (d)	149 (b)	150 (a)	151 (d)	152 (c)	153 (a)	154 (a)
155 (a)	156 (a)	157 (a)	158 (b)	159 (c)	160 (a)	161 (a)	162 (c)	163 (a)	164 (d)
165 (d)	166 (d)	167 (a)	168 (b)	169 (a)					

NCERT & NCERT Exemplar Questions

170 (a)	171 (b)	172 (c)	173 (a)	174 (b)	175 (c)	176 (c)	177 (b)	178 (a)	179 (d)
180 (b)	181 (c)	182 (c)	183 (d)	184 (d)	185 (b)	186 (a)	187 (b)	188 (a)	189 (d)
190 (c)	191 (b)	192 (b)	193 (d)	194 (d)	195 (b)	196 (a)	197 (d)	198 (b)	199 (b)
200 (d)	201 (b)								

Hints & Explanations

2 (*d*) *A* refers to urea (NH_2CONH_2).
Complete reaction is as follows :

$$\underset{\text{Ammonium cyanate}}{NH_4CNO} \xrightarrow[\text{(Rearrangement)}]{\Delta} \underset{\text{Urea}}{NH_2CONH_2}$$

4 (*d*) The synthesis of acetic acid by Kolbe (1845) and that of methane by Berthelot (1856) showed that organic compounds could be synthesised from inorganic sources in a laboratory.

5 (*a*) In sp^3-hybrid orbital, *s*-character is

$$= \frac{1}{4} \times 100 = 25\%$$

6 (*c*) The percentage s-character of C-atom in ethyne is 50%
The percentage *s*-character of C-atom in ethene is 33%
So, the ratio of percentage *s*-character of C-atom

$$= \frac{50}{33} = \frac{3}{2}$$

7 (*c*) Hybridisation of carbon atoms in different compounds is shown below :

(a) $\underset{sp}{HC} \equiv \underset{sp}{C} - \underset{sp}{C} \equiv \underset{sp}{CH}$

(b) $H - \underset{sp}{C} \equiv \underset{sp}{C} - H$

(c) $\underset{sp^2}{CH_2} = \underset{sp}{C} = \underset{sp^2}{CH_2}$

(d) $\underset{sp^2}{CH_2} = \underset{sp^2}{CH} - \underset{sp^2}{CH} = \underset{sp^2}{CH_2}$

In options (a), (b) and (d), all carbon atoms are in same hybridisation state, i.e. in *sp*, *sp* and sp^2 -hybridisation respectively. Only option (c) does not contain all the carbon atom in same hybridisation.

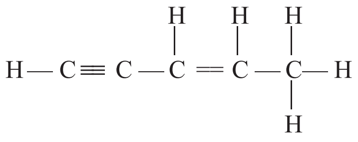
8 (*a*)

Hydrocarbons	Molecular formula	% *s*-character
Ethane	$CH_3 - CH_3$	25%
Ethene	$CH_2 = CH_2$	33%
Ethyne	$CH \equiv CH$	50%

As we know that,
electronegativity ∝ % *s*-character ∝ acidic character
Hence, correct order of electronegativity in the given compounds is,

ethane < ethene < ethyne.

9 (*a*) Option (a) is correct regarding the given number of σ and π-bonds present in the molecule.



$$H - C \equiv C - \overset{H}{\overset{|}{C}} = \overset{H}{\overset{|}{C}} - \underset{\underset{H}{|}}{\overset{H}{\overset{|}{C}}} - H$$

$$\sigma_{C-C} \Rightarrow 4$$
$$\sigma_{C-H} \Rightarrow 6$$
$$\pi_{C=C} \Rightarrow 1$$
$$\pi_{C\equiv C} \Rightarrow 2$$

11 (*b*) The order of hybridisation sp^2, sp^2, sp, sp from left to right atom occur in following compound.
i.e. option (b).

$$\overset{sp^2}{CH_2} = \overset{sp^2}{CH} - \overset{sp}{C} \equiv \overset{sp}{CH}$$

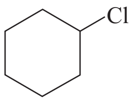
The hybridisation in other molecules is as follows :

$$\overset{sp^2}{CH_2} = \overset{sp^2}{CH} - \overset{sp^2}{CH} = \overset{sp^2}{CH_2}$$

$$\overset{sp}{HC} \equiv \overset{sp}{C} - \overset{sp}{C} \equiv \overset{sp}{CH}$$

$$\overset{sp^3}{CH_3} - \overset{sp^2}{CH} = \overset{sp^2}{CH} - \overset{sp^3}{CH_3}$$

14 (*c*) In cyclic compounds, the bond-line formula for chloro-cyclohexane is represented by following formula :

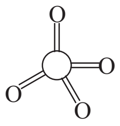


16 (*a*) *X* is dashed wedge (bond away from observer) and *Y* is solid wedge (bond towards observer). In these formulas, the solid wedge is used to indicate a bond projecting out of the plane of paper towards the observer.

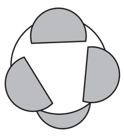
The dashed wedge is used to depict the bond projecting out of the plane of paper and away from the observer.

17 (*d*) The three types of molecular models are used (i) framework model (ii) Ball and stick model (iii) Space filling model. These models are shown below.

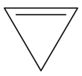

Framework model



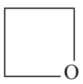
Ball and stick model

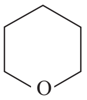

Space filling model

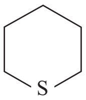
19 (*b*) Alicyclic (aliphatic cyclic) compounds contain carbon atoms joined in the form of a ring.
Homocyclic means it contains only C-atoms in two ring, e.g.


Cyclopropene

Other given compounds contain atoms other than carbon also, e.g.

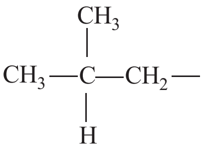






20 (*b*) The given compound contains benzene nucleus so, naphthalene is a benzenoid aromatic compound.

25 (*a*) '*iso*' means one Me group is present at side chain. Hence, the structure of *iso*-butyl group is



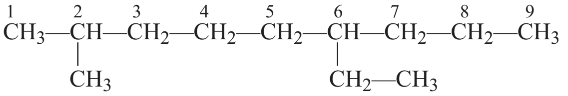
$$CH_3-\overset{\overset{\displaystyle CH_3}{|}}{\underset{\underset{\displaystyle H}{|}}{C}}-CH_2-$$

'yl' suffix is used to represent one —H less than the parent hydrocarbon.

26 (*a*) First of all, longest carbon chain of the molecule is identified. In the example, the longest chain has nine carbons and it is considered as the parent or root chain.

27 (*a*) The correct IUPAC name of the given compound is 6-ethyl-2-methylnonane

It is shown below :

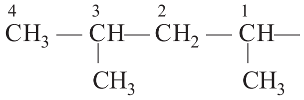


$$\overset{1}{CH_3}-\underset{\underset{\displaystyle CH_3}{|}}{\overset{2}{CH}}-\overset{3}{CH_2}-\overset{4}{CH_2}-\overset{5}{CH_2}-\underset{\underset{\displaystyle CH_2-CH_3}{|}}{\overset{6}{CH}}-\overset{7}{CH_2}-\overset{8}{CH_2}-\overset{9}{CH_3}$$

(lowest locant rule and alphabetical order rule is followed.)

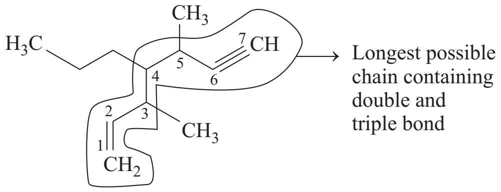
28 (*a*) Option (a) is not in accordance with IUPAC system. In IUPAC system of nomenclature, preference is given to multiple bond than halogen substituent, so the correct name is $\underset{\text{3-bromoprop-1-ene}}{Br-\overset{3}{CH_2}-\overset{2}{CH}=\overset{1}{CH_2}}$

29 (*d*) The correct way of numbering the given structure is option (d). The carbon atom of the branch that attaches to the root alkane is numbered 1 as below.



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

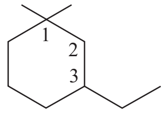
30 (*d*) The IUPAC name for the given compound is 3, 5-dimethyl-4-propylhept-1-en-6-yne.



Longest possible chain containing double and triple bond

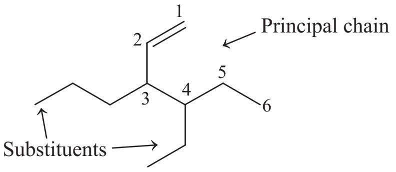
If both double and triple bonds are present in the compound, the endings like-en-yne, a (numeral) dien-(numeral)-yne etc., are used. Numbers as low as possible are given to double and triple bonds as a set.

31 (*a*) The correct IUPAC name of given compound is 3-ethyl-1, 1-dimethyl cyclohexane. It is a saturated monocyclic compound named by prefixing 'cyclo' to the corresponding straight chain alkane. If side chain are present, then the general rules of naming are applied. Thus, the correct IUPAC name of the following structure is



3-ethyl-1,1-dimethylcyclohexane
(Substituent name in alphabetical order)

32 (*b*) The correct IUPAC name of the compound is 4-ethyl-3-propylhex-1-ene. Principal chain should be chosen in such a way that should contain double bond. It is shown as follows :

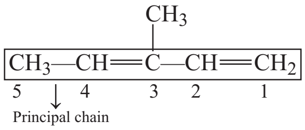


Principal chain

Substituents

4-ethyl-3-propylhex-1-ene

33 (*b*) The correct structure for 3-methylpenta-1, 3-diene is



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

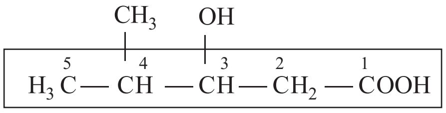
Principal chain

Hence, option (b) is correct.

35 (*b*) The correct IUPAC name of the given compound $HOCH_2(CH_2)_3CH_2COCH_3$ is 7-hydroxyheptan-2-one. A compound containing both an alcohol and a keto group is named as hydroxy alkanone since the keto group is preferred over hydroxy group.

36 (*b*) The correct IUPAC name of $CH_2(OH)CH_2(OH)$ is ethane-1, 2-diol. In this compound, more than one functional group of the same type are present, so their number is indicated by adding di, tri etc., before the class suffix. In such cases, the full name of the parent alkane is written before the class suffix.

37 (*c*) The IUPAC name of the given compound is 3-hydroxy-4-methylpentanoic acid.

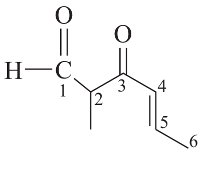


$$\boxed{\overset{5}{H_3C}-\overset{\overset{\displaystyle CH_3}{|}}{\overset{4}{CH}}-\overset{\overset{\displaystyle OH}{|}}{\overset{3}{CH}}-\overset{2}{CH_2}-\overset{1}{COOH}}$$

Principal chain

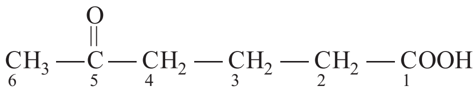
While naming the compound, the longest chain that have principal functional group —COOH is choosen and numbered in such a manner that the principal functional group gets the lowest possible number. —OH act as substituent and used as prefix in nomenclature.

38 (*a*) The IUPAC name of the given compound is 3-keto-2-methyl hex-4-enal



In this compound, — CHO group gets higher priority over >C$=$O and $\rangle$C$=$C$\langle$ group in numbering of principal carbon chain.

39 (*b*) I.



$$\underset{6}{CH_3}-\overset{\overset{\large O}{\|}}{\underset{5}{C}}-\underset{4}{CH_2}-\underset{3}{CH_2}-\underset{2}{CH_2}-\underset{1}{COOH}$$

In the given compound, two functional groups namely ketone and carboxylic acid are present. The principal functional group is the carboxylic acid group, hence the parent chain will be suffixed with 'oic acid'. Numbering of the chain starts from carbon of — COOH functional group. The keto group in the chain at carbon 5 is indicated by 'oxo'.

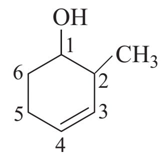
The longest chain including the principal functional group has 6 carbon atoms; hence the parent hydrocarbon is hexane. The compound is, therefore, named as **5-oxohexanoic acid**.

II. $\underset{6}{CH}\equiv\underset{5}{C}-\underset{4}{CH}=\underset{3}{CH}-\underset{2}{CH}=\underset{1}{CH_2}$

The two C$=$ C functional groups are present at carbon atoms 1 and 3, while the C $\equiv$ C functional group is

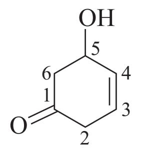
present at carbon 5. These groups are indicated by suffixes 'diene' and 'yne' respectively. The longest chain containing the functional group has 6 carbon atoms. Hence, the parent hydrocarbon is hexane. Thus, the name of compound is **hexa-1,3- dien-5 yne**.

40 (*b*) IUPAC name of given compound is 2-methylcyclohex-3-en-1-ol.



41 (*d*) The correct IUPAC name of the given compound is 5-hydroxycyclohex -3-en-1-one.

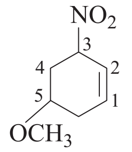
The structure of the given compound is shown below :



42 (*b*) The IUPAC name of given compound is 5-methoxy-3-nitrocyclohexene. While numbering in IUPAC system, double bonds get top there after —NO_2 group is placed and —OCH_3 comes in last (as per lowest sum rule).

While writing the name in IUPAC system, substituents are written first in alphabetical order followed by functional group.

Here, methoxy (—OCH_3) is at number (5) position, nitro (—NO_2) is at number (3) position, both are secondary prefix and 'hex' is the word-root. 'ene' and 'cyclo' are primary prefix.

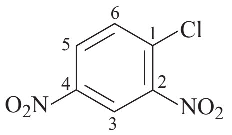


Hence, option (b) is the correct.

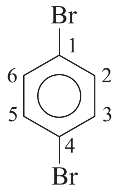
43 (*a*) The correct IUPAC name of given compound is 1, 3-dibromobenzene. When benzene ring is disubstituted, the position of substituents is defined by numbering the carbon atoms of the ring such that the substituents are located at the lowest numbers possible. In trivial system of nomenclature, *meta* is used.

It is not termed as IUPAC name.

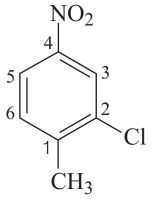
44 (*a*) The correct IUPAC name of compound is 1-chloro-2,4-dinitrobenzene (not 4-chloro-1,3-dinitrobenzene).



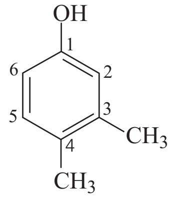
45 (*b*) The IUPAC name of compound is 1, 4-dibromobenzene while interval system it is called *para* bromobenzene.



46 (*a*) The IUPAC name of the given compound are as follows :



2-chloro-1-methyl-4-nitrobenzene
(not -4-methyl-5-chloronitrobenzene)



3,4-dimethylphenol

47 (*d*) The phenomenon of existence of two or more compounds possessing the same molecular formula but different properties is known as isomerism. Such compounds are called isomers.

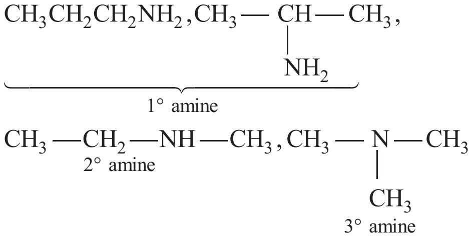
48 (*d*) Dimethyl ether is an isomer of ethanol. It is a functional isomer of ethanol. Both of them have same molecular formula but different functional group.

These are as follows :

$$\underset{\text{Ethanol}}{C_2H_5OH}\,,\qquad \underset{\text{Dimethyl ether}}{CH_3OCH_3}$$

49 (*a*) The number of structural isomers possible from molecular formula C_3H_9N is 4.

These are as follows :

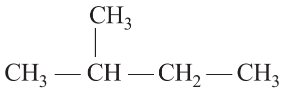


$$\underbrace{CH_3CH_2CH_2NH_2, CH_3-\underset{\underset{NH_2}{|}}{CH}-CH_3,}_{1^\circ\text{ amine}}$$

$$\underset{2^\circ\text{ amine}}{CH_3-CH_2-NH-CH_3}, \underset{3^\circ\text{ amine}}{CH_3-\underset{\underset{CH_3}{|}}{N}-CH_3}$$

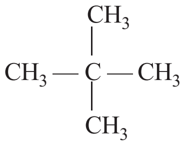
50 (*a*) Three chain isomers are given by the compound C_5H_{12}. These are as follows :

1. $CH_3CH_2CH_2CH_2CH_3$ (Pentane)



$$2.\ CH_3-\overset{\overset{CH_3}{|}}{CH}-CH_2-CH_3$$

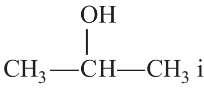
Iso-pentane (2-methylbutane)



$$3.\ CH_3-\overset{\overset{CH_3}{|}}{\underset{\underset{CH_3}{|}}{C}}-CH_3$$

neo-pentane (2,2-dimethylpropane)

51 (*a*) The type of isomerism present between $CH_3CH_2CH_2OH$ and

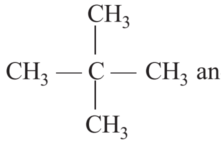


$$CH_3-\overset{\overset{OH}{|}}{CH}-CH_3$$

is position isomerism.

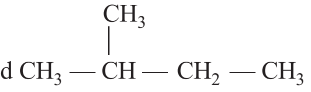
Here, two compounds differ in the position of substituent atom or functional group on the carbon skeleton.

52 (*a*)



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

and



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

are chain isomers because they have different carbon chains.

53 (*c*) (i) and (iii) are the metamers of the compound having formula $C_4H_{10}O$ as they differ in the nature of alkyl groups attached to the polyvalent functional group.

54 (*c*) In the given reaction,

A = Intermediate, B = Attacking reagent

In an organic reaction, the organic molecule (also referred as a substrate) reacts with an appropriate attacking reagent and leads to the formation of one or more intermediate (s) and finally product(s).

The general reaction is depicted as follows :

$$\begin{array}{c}\text{Organic}\\ \text{molecule}\\ \text{(substrate)}\end{array} \xrightarrow{\begin{array}{c}\text{Attacking}\\ \text{reagent}\end{array}} \underset{\underset{\text{By products}}{\downarrow}}{[\text{Intermediate}]} \longrightarrow \text{Product (s)}$$

55 (*a*) The dispersal of the charge stabilises the carbocation. More the number of alkyl groups, the greater is the dispersal of positive charge and therefore, more is the stability of carbocation.

Thus, the correct order is

$$\underset{C}{\overset{\oplus}{C}H_2OCH_3} > \underset{B}{CH_3\overset{\oplus}{C}H_2} > \underset{A}{\overset{\oplus}{C}H_3}$$

56 (*a*) Stability of the given cations can be understood by following structures :

$$\underset{\text{I}}{CH_3 \rightarrow \overset{+}{C}H \leftarrow CH_3}, \quad \underset{\text{II}}{CH_3 \rightarrow \overset{+}{C}H-\ddot{\underset{\cdot\cdot}{O}}-CH_3},$$

$+I$ -effect of two methyl groups stabilises the carbocation (I)

Strong $+R$ -effect of —OCH_3 groups stabilises the carbocation (II)

$$\underset{\text{III}}{CH_3-\overset{+}{C}H-CH_2 \rightarrow OCH_3}$$

$-I$ -effect of —OCH_3 groups destabilises the carbocation (III)

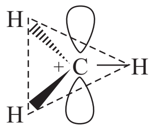
Thus, the stability of carbocation decreases in the order

II > I > III.

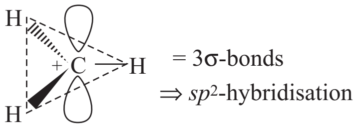
57 (*c*) $CH_3\overset{+}{C}HCH_2CH_2CH_3$ is the most stable carbocation among the given carbocations. It is because the number of α-H atom attached to carbocation is maximum in $CH_3\overset{\oplus}{C}HCH_2CH_2CH_3$. Thus, it has maximum number of hyperconjugating structure. Hence, it is most stable.

58 (*b*) The shape of carbocation is trigonal planar with positively charged carbon being sp^2-hybridised.

It is shown below :



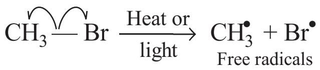
59 (*b*) The shape of CH_3^+ may be considered as being derived from the overlap of three equivalent C-(sp^2)-hybridised orbitals with 1*s*-orbital of each of the three hydrogen atoms. Each bond may be represented as C(sp^2)—H (1*s*) sigma bond. The remaining carbon orbital is perpendicular to the molecular plane and contains no electrons.



Shape of methyl cation

60 (*a*) Homolytic cleavage results in the formation of free radical. It is a neutral (species which contains an unpaired electron).

61 (*b*) Reaction (b) is the correct equation for homolytic cleavage.

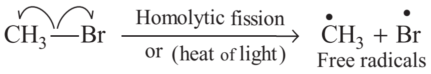


$$CH_3—Br \xrightarrow[\text{light}]{\text{Heat or}} \dot{C}H_3 + Br^{\bullet}$$

Free radicals

Organic reactions, which proceed through homolytic fission are called free radical or homopolar or non-polar reactions.

62 (*d*) In homolytic cleavage, covalent bond is cleaved in such a way that each atom takes its shared electrons with itself and free radicals are formed.

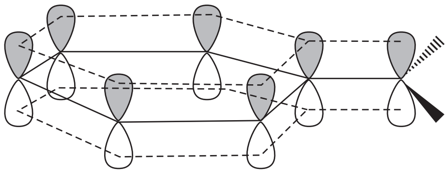


$$CH_3—Br \xrightarrow[\text{or (heat of light)}]{\text{Homolytic fission}} \dot{C}H_3 + \dot{B}r$$

Free radicals

63 (*c*) Because of the presence of $7p$ -orbitals and 7 unpaired electrons. It is aromatic in nature as these unpaired electrons delocalise in *p*-orbitals.

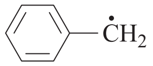
The structure of benzyl free radical is



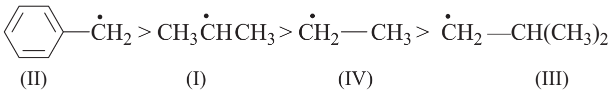
64 (*d*) As number of electron donating groups ($—CH_3$) directly linked to carbon atom containing radical or cation increases, stability of free radical also increases. Thus, stability of alkyl radical increases as we proceed from primary to tertiary.

The correct order is as follows :

$$\underset{\substack{\text{Methyl}\\\text{free}\\\text{radical}}}{\dot{C}H_3} < \underset{\substack{\text{Ethyl}\\\text{free}\\\text{radical}}}{\dot{C}H_2CH_3} < \underset{\substack{\textit{iso}\text{-propyl}\\\text{free}\\\text{radical}}}{(CH_3)_2\dot{C}H} < \underset{\substack{\textit{tert}\text{-butyl}\\\text{free}\\\text{radical}}}{(CH_3)_3\dot{C}}$$

65 (*b*) Among the given free radicals,  is most stable due to resonance. In the remaining free radicals, more the alkyl groups bonded to the electron deficient carbon, more stable is the radical.

Thus, the correct order of stability of given free radicals is



$$C_6H_5\dot{C}H_2 > CH_3\dot{C}HCH_3 > \dot{C}H_2—CH_3 > \dot{C}H_2—CH(CH_3)_2$$

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

66 (*b*) $AlCl_3$, SO_3 (Lewis acids), NO_2^+, CH_3^+, $CH_3—\overset{+}{C}{=}O$ are electron deficient species. Hence, these acts as electrophiles.

67 (*b*) The electron displacements due to the influence of an atom or a substituent group present in the molecule cause permanent polarisation of the bond. Inductive effect and resonance effects are examples of this type of electron displacements.

Inductive effect is passed on to the other carbon, that decreases rapidly as the number of intervening bonds increases and becomes vanishingly small after three bonds. It is shown as follows :

$$\overset{\delta\delta^+}{CH_3} \rightarrow \overset{\delta^+}{CH_2} \rightarrow \overset{\delta^-}{Cl}$$

68 (*a*) The permanent displacement of electron through a chain involving only σ-bonds is called inductive effect. It involves the electron displacement along the chain of saturated carbon atoms due to the presence of a polar covalent bond at one end of the chain.

69 (*d*) All the given examples act as electron withdrawing group relative to hydrogen. Based on the ability of a substituent to withdraw or donate electron density, the substituents can be classified as electron-withdrawing or electron donating groups relative to hydrogen. Halogens and many other group such as nitro ($—NO_2$), cyano ($—CN$), carboxy ($—COOH$), ester ($—COOR$), aryloxy ($—OAr$, e.g. $—OC_6H_5$), etc. are electron-withdrawing groups. On the other hand, the alkyl groups like methyl ($—CH_3$) and ethyl ($—CH_2—CH_3$) are usually considered as electron donating groups.

70 (*a*) $+I$ -effect is shown by $—CH_3$ while $-I$ -effect is shown by —Br, —Cl and $—NO_2$.

71 (*b*) $-I$-effect is related to the ability of substituent for the electron attraction capacity from the attached carbon atom, i.e. it is based on electronegativity of an atom. This effect increases with increase in the electronegativity of an atom.

From above we can conclude that options (b) and (c) are correct.

$-NR_2 < -OR < -F$ ($-I$-effect)

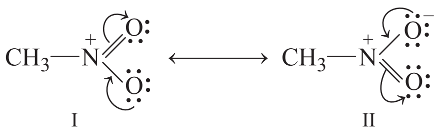
$-NH_2 < -OR < -F$ ($-I$-effect)

Also, options (a) and (d) shows the order of $+I$-effect.

$—NH_2 > -OR > -F$ ($+I$-effect)

$—NR_2 > -OR > -F$ ($+I$-effect)

72 (*c*) Nitromethane (CH_3NO_2) can be represented by following two Lewis structures (I and II). There are two types of N—O bonds in these structures.

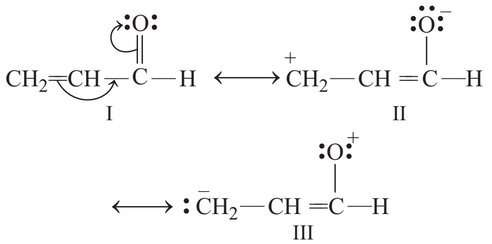


However, it is known that the two N—O bonds of nitromethane are of the same length (intermediate between a N—O single bond and a N$=$O double bond). The actual structure of nitromethane is therefore a resonance hybrid of the two canonical forms I and II.

Hence, both (a) and (b) are correct.

73 (*b*) The order of relative stability of the contributing structures are

$$I > II > III$$

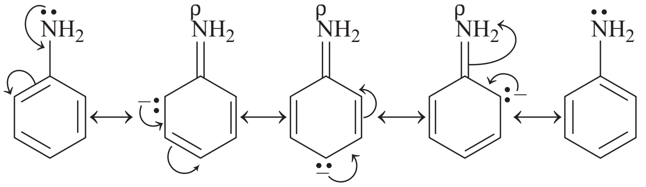


The reason for this order is

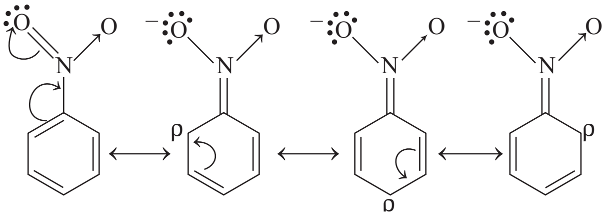
- I. The resonating structure which is most stable has more number of covalent bonds, each carbon and oxygen atom has complete octet and no separation of opposite charges.
- II. negative charge on more electronegative atom and positive charge on more electropositive atom.
- III. structure does not contribute as oxygen has positive charge and carbon has negative charge, hence least stable.

74 (*a*) Aniline (I) shows $+R$ -effect, whereas nitrobenzene (II) shows $-R$ -effect. In $+R$ -effect, the transfer of electrons is away from an atom or substituent group attached to the conjugated system. This electron displacement make certain positions in the molecule of high electron densities.

This effect in aniline is shown as :



$-R$ -effect is observed when the transfer of electrons is toward the atom or substituent group is attached to the conjugated system, e.g. in nitrobenzene this electron displacement can be depicted as.



75 (*d*) The atoms or substituent groups, which represent $+R$ or $-R$ electron displacement effects are as follows :

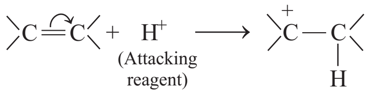
$+R$ -effect: — halogen, —OH, —OR, — OCOR, —NH_2, —NHR, —NR_2, —NHCOR.

$-R$ -effect; —COOH, —CHO, $\rangle C=O$, —CN, —NO_2.

Thus, —COOH is a $-R$-effect showing group, while other options show $+R$-effect.

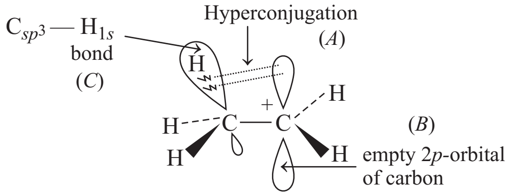
76 (*c*) In the given reaction, π-electrons of the multiple bond are transferred to that atom on which the attacking reagent get attached. So, it is an example of positive electromeric effect ($+E$ -effect).

e.g.



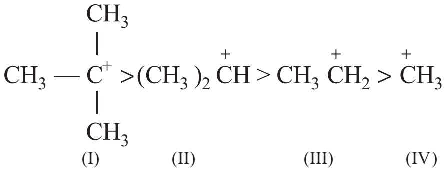
77 (*b*) Hyperconjugation involves overlapping of the σ-p-orbitals. It is a general stabilising interaction. It involves delocalisation of σ-electrons of C—H bond of an alkyl group directly attached to an atom of unsaturated system or to an atom with an unshared system or to an atom with an unshared p -orbital. The σ-electrons of C—H bond of the alkyl group enter into partial conjugation with the attached unsaturated system or with the unshared p-orbital. It is a permanent effect.

78 (*a*) In $CH_3\overset{+}{C}H_2$ (ethyl cation), the positively charged carbon atom has an empty p -orbital . One of the C—H bonds of the methyl group can align in the plane of this empty p-orbital and the electrons constituting the C—H bond in plane with this p-orbital can then be delocalised into the empty p-orbital as depicted below :



79 (*b*) Greater the number of alkyl groups attached to a positively charged carbon atom, the greater is the hyper conjugation interaction and stabilisation of the cation.

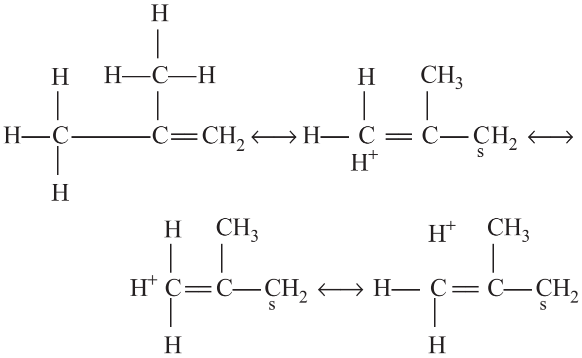
Thus, the correct order of stability of carbocation using the concept of hybridisation is



$$CH_3-\overset{CH_3}{\underset{CH_3}{C^+}} > (CH_3)_2\overset{+}{C}H > CH_3\overset{+}{C}H_2 > \overset{+}{C}H_3$$

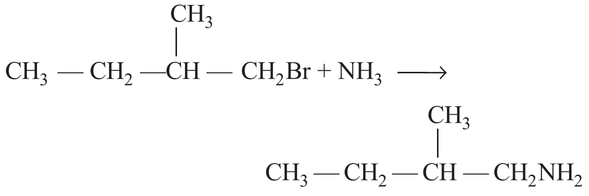
(I) (II) (III) (IV)

80 (*c*) Hyperconjugative effect helps in deciding the stability of *iso*-butylene. The structures are as follows :

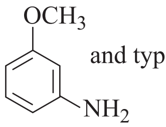


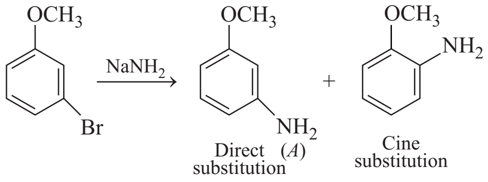
82 (*b*) Hyperconjugation is not possible in $H_2C=CH_2$ because it does not contain alkyl group directly attached to an atom of unsaturated system. As a result, delocalisation of σ-electrons of C—H bond does not occur.

83 (*d*) Option (d) is a nucleophilic substitution reaction. In this reaction, $\bar{N}H_2$ group act as a nucleophile.



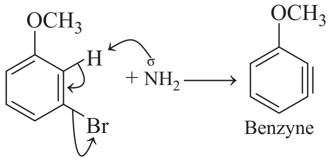
$$CH_3-CH_2-\overset{\overset{CH_3}{|}}{C}H-CH_2Br+NH_3\longrightarrow CH_3-CH_2-\overset{\overset{CH_3}{|}}{C}H-CH_2NH_2$$

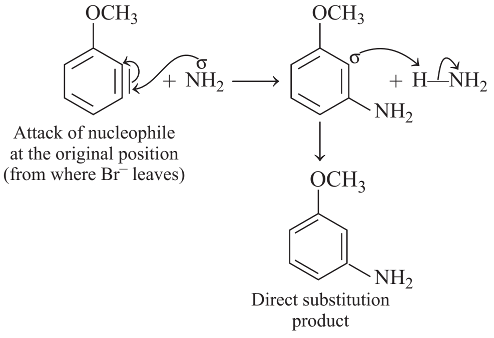
84 (*a*) Product *A* is  and type of reaction is substitution reaction. Complete reaction is as follows :

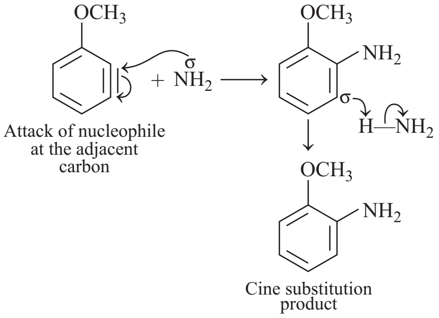


If nucleophile occupies same position of the leaving group, product is called direct substitution product.

If nucleophile occupies adjacent position of the leaving group, product is called cine substitution product. Intermediate involved in reaction is benzyne.







85 (*a*) Substances which sublime on heating are usually purified by sublimation. Hence, naphthalene is purified by sublimation.

88 (*a*) Distillation is based on the difference in the boiling points of liquids. Thus, it is used to separate volatile liquid from non-volatile impurities.

89 (*c*) Fractional distillation is used when the difference in boiling points of two liquids is not much. Simple distillation cannot be used to separate them because the vapours of such liquids are formed within the same temperature range and are condensed simultaneously.

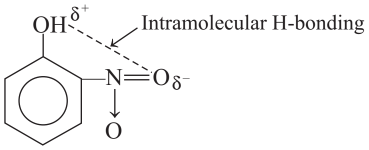
90 (*d*) In fractional distillation process, fractionating column is fitted over the mouth of the round bottom flask. There are two type of fractionating columns: (*a*) simple packed column (*b*) bubble plate column.

91 (*d*) Glycerol can be separated from spent-lye in soap industry by distillation under reduced pressure. This method is used because glycerol decomposes at its boiling point.

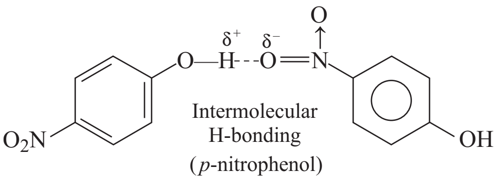
92 (*d*) The organic compounds, which are volatile in steam are purified by steam distillation. Since, aniline is a steam volatile compound. So, it can be purified by steam distillation method.

93 (*d*) A mixture of *o*-nitrophenol and *p*-nitrophenol can be separated by steam distillation. *o*-nitrophenol is steam volatile due to intramolecular hydrogen bonding, whereas *p*-nitrophenol is less volatile due to intermolecular hydrogen bonding.

Structures are as follows :



o-nitrophenol
(Intramolecular H-bonding)



So, these two are separated by steam distillation.

97 (*b*) Adsorption chromatography is based on the fact that different compounds are adsorbed on an adsorbent to different degrees. Commonly used adsorbents are silica gel and alumina.

98 (*d*) Both silica gel and alumina is used as an adsorbent in thin layer chromatography. A thin layer (about 0.2 mm thick) of silica gel or alumina is spread over glass plate of suitable size.

100 (*a*) In the given figure,

$$A = b + c \text{ and } B = c$$

Column chromatography involves separation of a mixture over a column of adsorbent (stationary phase) packed in a glass tube. The column is fitted with a stopcock at its lower end.

102 (*b*) In chromatography, the expression of retention factor (R_f) is

$$R_f = \frac{\text{Distance travelled by the compound from origin}}{\text{Distance travelled by the solvent from origin}} < 1$$

The value of R_f signifies the relative ratio of migration of each component of the mixture with respect to the developing solvent used. R_f value depends on the type of adsorption chromatography like TLC (Thin-Layer Chromatography), paper chromatography etc. The R_f value is also the characteristic of a compound (sample) for a given developing solvent at a given temperature.

When the compound in the sample (usually less polar) is weakly adsorbed the spot will travel a shorter distance from the origin and hence the R_f value will be decreased.

103 (*b*) Carbon and hydrogen are detected by heating the compound with Cu(II) oxide. Carbon present in the compound is oxidised to carbon dioxide (tested with lime-water, which develop turbidity) and hydrogen to water (tested with anhydrous copper sulphate, which turns blue).

Reactions involved are as follows :

$$C + 2CuO \xrightarrow{\Delta} 2Cu + CO_2\uparrow$$
$$2H + CuO \xrightarrow{\Delta} Cu + H_2O$$
$$CO_2 + Ca(OH)_2 \longrightarrow \underset{\text{White turbidity}}{CaCO_3\downarrow} + H_2O$$

104 (*c*) When organic compound is fused with sodium metal, nitrogen of the compound is converted into sodium cyanide as

$$Na + C + N \longrightarrow NaCN$$

105 (*b*) If nitrogen is present in the organic compound then sodium extract contains NaCN.

$$Na + C + N \xrightarrow{\text{Fuse}} NaCN$$
$$FeSO_4 + 6NaCN \longrightarrow Na_4[Fe(CN)_6] + Na_2SO_4$$

It changes to prussian blue $Fe_4[Fe(CN)_6]_3$ on reaction with $FeCl_3$.

$$4FeCl_3 + 3Na_4[Fe(CN)_6] \longrightarrow \underset{\text{Prussian blue}}{Fe_4[Fe(CN)_6]_3} + 12NaCl$$

Hence, option (b) is correct.

106 (*b*) Acidified sodium fusion extract on addition of ferric chloride solution gives blood red colouration, which confirms the presence of both N and S.

Reactions are as follows :

$$Na + C + N + S \longrightarrow NaSCN$$
$$Fe^{3+} + SCN^- \longrightarrow \underset{\text{Blood red}}{[Fe(SCN)]^{2+}}$$

107 (*b*)Yellow colour is due to the formation of $(NH_4)_3\,PO_4 \cdot 12\,MoO_3$.

Reactions involved in phosphorus detection of an organic compound are as follows :

$$Na_3PO_4 + 3HNO_3 \longrightarrow H_3PO_4 + 3NaNO_3$$
$$H_3PO_4 + 12(NH_4)_2MoO_4 + 21HNO_3 \longrightarrow$$
$$\underset{\substack{\text{Ammonium}\\\text{phosphomolybdate}}}{(NH_4)_3PO_4 \cdot 12MoO_3} + 21NH_4NO_3 + 12H_2O$$

108 (*a*) Lassaigne's test is not used for the detection of carbon element. It can be used for detection of halogens, nitrogen and sulphur.

109 (*a*) Given mass of $CO_2 = 0.198$ g and mass of $H_2O = 0.1014$ g

As we know, $\% \text{ of } C = \frac{12}{44} \times \frac{m_{CO_2}}{w} \times 100$

$$\text{Percentage of carbon} = \frac{12 \times 0.198 \times 100}{44 \times 0.246} = 21.95\%$$

Also, $H = \frac{2}{18} \times \frac{m_{H_2O}}{w} \times 100$

$$\text{Percentage of hydrogen} = \frac{2 \times 0.1014 \times 100}{18 \times 0.246} = 4.58\%$$

111 (*c*) 22400 mL N_2 denotes 1 mole of N_2 and mass of 1 mole of N_2 is 28 g.

112 (*d*) In Dumas method, organic compound is heated with dry cupric oxide in a combustion tube in the atmosphere of CO_2. Upon heating, C and H present are oxidised to CO_2 and water vapours while N_2 is set free.
Let, the molecular formula of the organic compound (1 mol) be $C_xH_yN_z$. In Dumas method,

$$\underset{1\text{ mol}}{C_xH_yN_z} + \left(2x + \frac{y}{2}\right)CuO \rightarrow \underset{x\text{ mol}}{xCO_2} + \underset{\frac{y}{2}\text{ mol}}{\frac{y}{2}H_2O} + \underset{\frac{z}{2}\text{ mol}}{\frac{z}{2}N_2} + \left(2x + \frac{y}{2}\right)Cu$$

Now, $x = 6, \frac{y}{2} = 4 \Rightarrow y = 8$ and $\frac{z}{2} = 1 \Rightarrow z = 2$

$\therefore$ Molecular formula of the compound is $C_6H_8N_2$.

114 (*b*) Kjeldahl's method cannot be used for nitro compounds, diazo compounds and compounds with nitrogen in a ring, because these on reaction with H_2SO_4 do not give ammonium ion.

115 (*b*) Estimation of nitrogen through Kjeldahl's method is not suitable for organic compounds containing nitrogen in ring or nitrogen in nitro or azo groups. It is because of the fact that nitrogen of these compounds does not show conversion to Ammonium sulphate $((NH_4)_2SO_4)$ during the process. Hence, among the given compounds only aniline can be used suitably for estimation of nitrogen by Kjeldahl's method.

117 (*a*) In Kjeldahl's method, percentage of N is given by

$$\% \text{ N} = \frac{1.4 \times \text{normality of acid} \times \text{volume of acid}}{\text{weight of compound}}$$

$$1 \text{ M } H_2SO_4 \equiv 2\text{N } H_2SO_4, V = 10 \text{ mL}$$

$$\therefore \quad \% \text{ N} = \frac{1.4 \times 2 \times 10}{0.75} = 37.33\%$$

Thus, the percentage of nitrogen in the soil is 37.33.

118 (*a*) Given, weight of organic compound = 250 mg

Weight of AgBr = 141 mg

∴ According to the formula, % of bromine by Carius method is as follows :

$$\% \text{ of Br} = \frac{\text{atomic weight of Br}}{\text{molecular weight of AgBr}} \times \frac{\text{weight of AgBr}}{\text{weight of organic bromide}} \times 100$$

$$\therefore \quad \% \text{ of Br} = \frac{80}{188} \times \frac{141}{250} \times 100 = \frac{1128000}{47000} = 24\%$$

Thus, the percentage of bromine in the compound is 24.

119 (*d*) Carius method is used to find halogen in an organic compound. In this method, the weighed amount of organic compound is heated in a sealed tube with fuming HNO_3 in the presence of $AgNO_3$. As a result, halogen present in organic compound is converted into AgX which is weighed. The percentage of halogens can be calculated with the help of direct formula as :

$$\% \text{ of chlorine} = \frac{35.5}{143.5} \times \frac{\text{mass of AgCl} \times 100}{\text{mass of compound}}$$

$$\% \text{ of bromine} = \frac{80}{188} \times \frac{\text{mass of AgBr} \times 100}{\text{mass of compound}}$$

$$\% \text{ of iodine} = \frac{127}{235} \times \frac{\text{mass of AgI} \times 100}{\text{mass of compound}}$$

121 (*a*) In the estimation of sulphur, sodium peroxide reagent is heated alongwith organic compound in a Carius tube. Sulphur present in the compound is oxidised to sulphuric acid. It is precipitated as barium sulphate by adding excess of barium chloride solution in water.

The precipitate is filtered, washed, dried and weighed.

The percentage of sulphur can be calculated from the mass of barium sulphate.

123 (*a*) Percentage of sulphur can be calculated by calculating amount of sulphur present in given amount of barium sulphate.

Molecular mass of $BaSO_4 = 137 + 32 + 64 = 233$ g

233 g $BaSO_4$contains 32 g sulphur

0.4813 g $BaSO_4$ contains $\frac{32 \times 0.4813}{233}$ g sulphur

$$\text{Percentage of sulphur} = \frac{32 \times 0.4813 \times 100}{233 \times 0.157} = 42.10\%$$

The percentage of sulphur in the compound is 42.10.

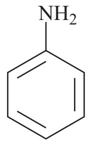
124 (*c*) The elements, carbon, hydrogen and nitrogen present in an organic compound are determined by an apparatus, known as CHN elemental analyser.

The analyser requires only a very small amount of the substance (1-3 mg) and displays the values on a screen with in a short time.

125 (*d*) Statement (d) is incorrect.

It's correct form is as follows :

Aniline is a benzenoid aromatic compound because it contains benzene ring.



Rest other statements are correct.

126 (*b*) Statement II is incorrect.

It's correct form is as follows :

The solid-wedge is used to depict the bond projecting out of the plane of paper and towards the observer.

Rest other statement I is correct.

127 (*d*) Statements I and III are correct, while statement II is incorrect.

It's correct form is as follows :

When two or more compounds differ in the position of substituent atom or functional group on the carbon skeleton, they are called position isomers.

128 (*c*) Statements I and II are correct, while statement III is incorrect.

It's correct form is as follows :

Stereoisomerism can be classified as geometrical (*cis-trans* isomerism) and optical isomerism.

129 (*b*) Statement II and IV are correct, while the statement I and III are incorrect.

Corrected form are as follows :

I. The presence of functional group enables systematisation of organic compound into different classes.

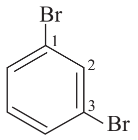
III. The order of priority of functional groups is

$$—COOH > —SO_3H > —COOR > —COCl$$

130 (*c*) Statement II and III are incorrect.

It's correct form are as follows :

II. 1,3-dibromobenzene is named as *m*-dibromobenzene



1,3-dibromobenzene
(*m*-dibromobenzene)

III. When a benzene ring is attached to an alkane having a functional group, it is considered as substituent, instead of a parent.

Rest other statement I is correct.

131 (*a*) Statements I, II and III are correct, while the statement IV are incorrect. It's correct form is as follows :

IV. Free radicals contain unpaired electron.

V. Homolytic fission is also called non-polar reactions.

132 (*d*) An electrophile is defined as electron deficient species which attacks on electron rich areas. Being electron deficient, the electrophiles behave as Lewis acid.

e.g. $H^+, Cl^+, Br^+, \overset{+}{N}O_2, \overset{+}{N}O$, etc.

The electrophiles can be seen in the form of neutral molecules also,

e.g. $:CR_2, \ddot{N}R, BF_3$ etc.

Thus, we can say that electrophile can be either neutral, or positively charged species and can form a bond by accepting a pair of electrons from a nucleophile.
Thus, correct statement is (d).

133 (*d*) Statement (d) is incorrect.
It's correct form is as follows :

More the number of contributing structures, the more is the resonance energy.
Rest other statements are correct.

134 (*a*) Statement I is incorrect.
It's correct form is as follows :
The following rules are applied while writing resonance structures:
The resonance structures have same positions of nuclei.
Rest other statements are correct.

135 (*d*) Statement (d) is incorrect.
It's correct form is as follows :

Sublimation, crystallisation and distillation are the common techniques used for the purification of organic compounds.
Rest other statements are correct.

136 (*a*) The technological application of fractional distillation is to separate different fractions of crude oil in petroleum industry.

Thus, statement (a) is correct.

138 (*a*) In $CH_2 = CH_2$ molecule, all the atoms must be in the same plane. The p -orbitals are mutually parallel and are perpendicular to the plane of the molecule.

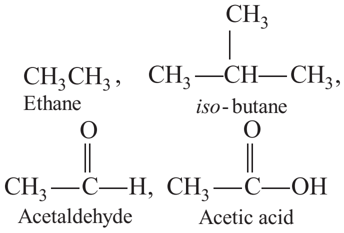
Rotation of one $—CH_2$ fragment with respect to other interferes with maximum overlap of p-orbital and therefore such rotation about $C=C$ bond is restricted.

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

139 (*b*) In bond-line structural representations only atoms specifically written are oxygen, chlorine, nitrogen etc. Also the terminal position denote methyl $(—CH_3)$ group while line-junctions denote carbon atoms bonded to appropriate number of hydrogens required to satisfy the valency of the carbon atoms.

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

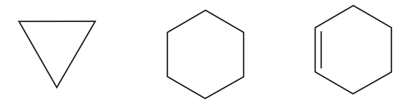
140 (*b*) Acyclic or open chain compounds are also called aliphatic compounds and consist of straight or branched chain of carbon atoms.



CH_3CH_3, $CH_3—\underset{}{\overset{CH_3}{\overset{|}{C}H}}—CH_3$,
Ethane *iso*-butane

$CH_3—\overset{O}{\overset{\|}{C}}—H$, $CH_3—\overset{O}{\overset{\|}{C}}—OH$
Acetaldehyde Acetic acid

Alicyclic or closed chain or ring compounds contain carbon atoms joined in the form of a ring (homocyclic). Some examples of this type of compounds are



Cyclopropane Cyclohexane Cyclohexene

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

141 (*b*) The names of straight chain compounds are based on their chain structure and end with suffix '-ane', carry a prefix indicating the number of carbon atoms present in the chain (except from CH_4 to C_4H_{10} where the prefixes are derived from trivial names).

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

142 (*b*) The compounds that have the same constitution and sequence of covalent bonds but differ in relative position of their atoms or groups in space are called stereoisomers. This special type of isomerism is called stereoisomerism and can be classified as geometrical and optical isomerism.

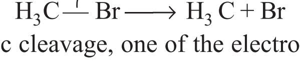
Thus, both A and R are correct and R is not the correct explanation of A.

143 (*b*) When a covalent bond is formed between atoms of different electronegativity, the electron density is more towards the more electronegative atom of the bond. Such a shift of electron density results in a polar covalent bond. Bond polarity leads to various electronic effects in organic compounds.

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

144 (*b*) A covalent bond may be cleaved either by heterolytic cleavage or by homolytic cleavage.

In heterolytic cleavage, the bond breaks in such a fashion that the shared pair of electrons remains with one of the fragments.



$$H_3C—Br \longrightarrow H_3\overset{r}{C} + \overset{s}{Br}$$

In homolytic cleavage, one of the electrons of the shared pair in a covalent bond goes with each of the bonded atoms.

$$R—X \xrightarrow{\text{Heat or light}} \underset{\text{Alkyl free radical}}{R^{\bullet}} + \dot{X}$$

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

145 (*a*) The electron displacements in an organic molecule due to the influence of an atom or a substituted group present in the molecule cause permanent polarisation of the bond. Inductive effect and resonance effect are examples of this type of electronic displacement.

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

146 (*a*) Presence of alternate single and double bonds in an open chain or cyclic system is termed as conjugated system. These systems often show abnormal behaviour as in them the π- electrons are delocalised and the develops polarity. Examples are 1, 3- butadiene, aniline and nitrobenzene etc.

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

147 (*d*) If one of the substances in the mixture is water and the other, a water insoluble substance, then the mixture will boil close to but lower than 373 K.

Thus, R is correct but A is incorrect.

148 (*d*) A liquid boils at a temperature at which its vapour pressure becomes equal to the external pressure. Distillation under reduced pressure method is used to purify liquids having very high boiling points and those, which decompose at or below their boiling points.
Glycerol can be separated from spent-lye in soap industry by using this technique.
Thus, R is correct but A is incorrect.

150 (*a*) When compound containing C and H is heated with copper (II) oxide, the C and H gets oxidise into CO_2 and H_2O respectively. CO_2 turns lime water milky while water turns only copper sulphate blue. From the mass of CO_2 and H_2O obtained C and H are detected.
Thus, both A and R are correct and R is the correct explanation of A.

151 (*d*) Phosphorus containing organic compound is heated with fuming nitric acid to oxidise phosphorus into phosphoric acid. It is precipitated as ammonium phosphomolybdate, $(NH_4)_3\,PO_4\cdot 12MoO_3$, by adding ammonia and ammonium molybdate. Alternatively, phosphoric acid may be precipitated as $MgNH_4PO_4$ by adding magnesia mixture which on ignition yields $Mg_2P_2O_7$.
Thus, R is correct but A is incorrect.

152 (*c*) Percentage of carbon can be calculated by following relation :

$$\%\text{ of carbon} = \frac{12\times m_2\times 100}{44\times m}$$

$$\text{Molar mass of } CO_2 = 12+2\times16 = 44\text{ u}$$

Thus, A is correct but R is incorrect.

153 (*a*) In Kjeldahl's method, the compound containing nitrogen is heated with concentrated sulphuric acid. Nitrogen in the compound gets converted to ammonium sulphate. The resulting acid mixture is then heated with excess of sodium hydroxide. The liberated ammonia gas is absorbed in an excess of standard solution of sulphuric acid.

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

154 (*a*) Kjeldahl's method is not applicable to compounds containing nitrogen in the form of nitro and azo groups and nitrogen present in the ring (e.g. pyridine) because nitrogen of these compounds does not change to ammonium sulphate under these conditions.

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

155 (*a*) Since, molar mass of $(NH_4)_3\,PO_4\cdot 12MoO_3$ is 1877 g, the % of P can be calculated as

$$\%\text{ of } P = \frac{31\times m_1\times 100}{1877\times m}\%$$

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

156 (*a*) The percentage of oxygen in an organic compound is usually found by difference betweeen the total percentage composition (100) and the sum of the percentages of all other elements as oxygen is present everywhere.

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

167 (*a*) The correct option is :

$$(A)\rightarrow(Q);\ (B)\rightarrow(R);\ (C)\rightarrow(S)$$

(A) **H_2O and sugar mixture** They do not react chemically. On heating, solubility of sugar in H_2O increases and on rapid cooling of saturated solution, sugar recrystallises (*Q*).

(B) **H_2O and aniline mixture** Aniline is steam volatile but insoluble in H_2O. So, steam distillation (*R*) is employed for their separation.

(C) **H_2O and toluene mixture** Toluene is steam non-volatile and also insoluble in H_2O. So, differential extraction method (S) can be used to separate them.

168 (*b*) The correct match is

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

A. Test for nitrogen : $6CN^- + Fe^{2+} \longrightarrow [Fe(CN)_6]^{4-}$

$$3[Fe(CN)_6]^{4-} + 4Fe^{3+} \xrightarrow{xH_2O} \underset{\text{Prussian blue}}{Fe_4[Fe(CN)_6]_3\cdot xH_2O}$$

B. Test for sulphur : $S^{2-} + Pb^{2+} \longrightarrow \underset{\text{Black}}{PbS}$

$$S^{2-} + [Fe(CN)_5NO]^{2-} \longrightarrow \underset{\text{Violet}}{[Fe(CN)_5NOS]^{4-}}$$

C. Test for both nitrogen and sulphur :

$$Na + C + N + S \longrightarrow NaSCN$$

$$Fe^{3+} + SCN^- \longrightarrow \underset{\text{Blood red}}{[Fe(SCN)]^{2+}}$$

$$NaSCN + 2Na \longrightarrow NaCN + Na_2S$$

D. Test for halogen : $X^- + Ag^+ \longrightarrow AgX$

E. Test for phosphorus :

$$Na_3PO_4 + 3HNO_3 \longrightarrow H_3PO_4 + 3NaNO_3$$

$$H_3PO_4 + \underset{\text{Ammonium molybdate}}{12(NH_4)_2MoO_4} + 21HNO_3 \longrightarrow$$

$$\underset{\text{Ammonium phosphomolybdate}}{(NH_4)_3PO_4 \cdot 12MoO_3} + 21NH_4NO_3 + 12H_2O$$

170 (*a*) 2, 2-dimethylpentane is the correct IUPAC name.

(a) Because for the two alkyl groups on the same carbon, its locant is repeated twice.

Other options are incorrect. These are shown below :

2, 4, 7-trimethyloctane (because 2, 4, 7-locant set is lower than 2, 5, 7).

2-chloro-4-methylpentane, (alphabetical order of substituents).

But-3-yne-1-ol (because lower locant for the principal functional group, i.e. alcohol).

171 (*b*) Sodium extract is boiled with nitric acid to remove NaCN and Na_2S, if present.

Reactions are as follows :

$$NaCN + HNO_3 \longrightarrow NaNO_3 + HCN\uparrow$$

$$Na_2S + 2HNO_3 \longrightarrow 2NaNO_3 + H_2S\uparrow$$

If cyanide and sulphide are not removed, they will react with $AgNO_3$ and hence, will interfere with the silver nitrate test for halogens.

$$NaCN + AgNO_3 \longrightarrow \underset{\text{(White ppt.)}}{AgCN} + NaNO_3$$

$$Na_2S + 2AgNO_3 \longrightarrow \underset{\text{(Black ppt.)}}{Ag_2S} + 2NaNO_3$$

172 (*c*) To calculate the mass of CO_2 and H_2O produced.

$$\%\ C = \frac{12}{44} \times \frac{\text{mass of } CO_2 \text{ formed}}{\text{mass of substance taken}} \times 100$$

$$69 = \frac{12}{44} \times \frac{\text{mass of } CO_2 \text{ formed}}{0.2} \times 100$$

$$\therefore \text{ Mass of } CO_2 \text{ formed} = \frac{69 \times 44 \times 0.2}{12 \times 100} = 0.50 \text{ g}$$

$$\%\ H = \frac{2}{18} \times \frac{\text{mass of } H_2O \text{ formed}}{\text{mass of substance taken}} \times 100$$

$$4.8 = \frac{2}{18} \times \frac{\text{mass of } H_2O \text{ formed}}{0.2} \times 100$$

$$\therefore \text{Mass of } H_2O \text{ formed} = \frac{4.8 \times 18 \times 0.2}{2 \times 100} = 0.0864 \text{ g}$$

173 (*a*) Volume of the acid taken = 50 mL of 0.5 M H_2SO_4

= 25 mL of 1.0 M H_2SO_4

Volume of alkali used for neutralisation of excess acid

= 60 mL of 0.5 M NaOH = 30 mL of 1.0 M NaOH

$$H_2SO_4 + 2NaOH \longrightarrow Na_2SO_4 + 2H_2O$$

1 mole of $H_2SO_4 \equiv$ 2 moles of NaOH

Hence, 30 mL of 1.0 M NaOH = 15 mL of 1.0 M H_2SO_4

$\therefore$ Volume of acid used by ammonia = 25 − 15 = 10 mL

$$\%\text{ of nitrogen} = \frac{1.4 \times N_1 \times \text{volume of acid used}}{w}$$

(where, N_1 = normality of acid and w = mass of the organic compound taken)

$$\%\text{ of nitrogen} = \frac{1.4 \times 2 \times 10}{0.5} = 56.0\%$$

174 (*b*) Mass of the organic compound taken = 0.3780 g

Mass of AgCl formed = 0.5740 g

Percentage of chlorine

$$= \frac{35.5}{143.5} \times \frac{\text{mass of AgCl formed}}{\text{mass of substance taken}} \times 100$$

$$= \frac{35.5}{143.5} \times \frac{0.5740}{0.3780} \times 100$$

= 37.566%

175 (*c*) The mass of organic compound taken = 0.468 g

Mass of $BaSO_4$ formed = 0.668 g

Percentage of sulphur

$$= \frac{32}{233} \times \frac{\text{mass of } BaSO_4 \text{ formed}}{\text{mass of substance taken}} \times 100$$

$$= \frac{32}{233} \times \frac{0.668}{0.468} \times 100 = 19.60\%$$

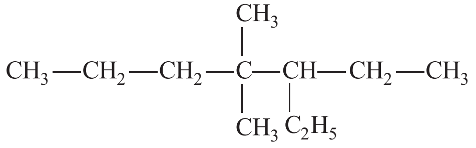
176 (*c*) When double and triple bonds both are present at equivalent positions, then preference is given to double bond, while numbering the carbon chain. Thus,

$$\overset{1}{\underset{sp^2}{CH_2}} = \overset{2}{\underset{sp^2}{CH}} - \overset{3}{\underset{sp^3}{CH_2}} - \overset{4}{\underset{sp^3}{CH_2}} - \overset{5}{\underset{sp}{C}} \equiv \overset{6}{\underset{sp}{CH}}$$

$\therefore$ C_2— C_3 bond is formed by overlap of sp^2 and sp^3 orbitals.

177 (*b*) The given reaction is an example of nucleophilic substitution reaction because the nucleophile I^- is replaced by the nucleophile OH^-.

178 (*a*) The correct **IUPAC name** is 3-ethyl-4, 4-dimethylheptane. Its structure is as follows :



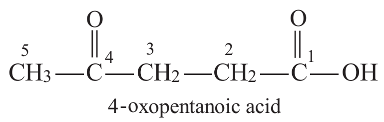
$$CH_3-CH_2-CH_2-\underset{\underset{CH_3}{|}}{\overset{\overset{CH_3}{|}}{C}}-\underset{\underset{C_2H_5}{|}}{CH}-CH_2-CH_3$$

While writing IUPAC name, alkyl groups are written in alphabetical priority, thus lower locant 3 is assigned to ethyl.

Note Prefix di, tri, tetra are not included in alphabetical order.

179 (*d*) When more than one functional group lie in the main chain, nomenclature is done according to that functional group which has higher priority.

Carboxylic acid (— COOH) has more priority than ketone $\left(\gt C=O \right)$. So, the IUPAC name is

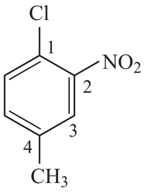


$$\overset{5}{CH_3}-\overset{\overset{O}{\|}}{\underset{4}{C}}-\overset{3}{CH_2}-\overset{2}{CH_2}-\overset{\overset{O}{\|}}{\underset{1}{C}}-OH$$

4-oxopentanoic acid

180 (*b*)The **IUPAC name** of given compound is 1-chloro-4-methyl-2-nitrobenzene. For tri or higher substituted benzene derivatives, the compounds are named by identifying substituent, positions on the ring by following the lowest locant rule. Substituent of the base compound is assigned number 1 and then the direction of numbering is chosen such that the next substituent gets the lowest number.

The substituents are arranged in alphabetical order.



181 (*c*) Electronegativity of carbon atom depends on their state of hybridisation. More the *s*-character, more is the electronegativity.

$$sp^3 \quad < \quad sp^2 \quad < \quad sp$$

$$25\%\ s \quad 33\%\ s \quad 50\%\ s$$

Thus, *sp*-carbon has the highest electronegativity, i.e. $(CH_3—CH_2—C\equiv{}^*CH)$.

So, correct option is (c).

182 (*c*) Two or more compounds having the same molecular formula but different functional groups are called functional isomers.

Functional isomer of alcohol is ether.

Functional isomer of aldehyde is ketone.

Functional isomer of cyanide is isocyanide

However, alkyl halides do not show functional isomerism.

183 (*d*) As we know, essential oils are insoluble in water and have high vapour-pressure at 373K but are miscible with water-vapour in vapour phase, it means these are steam volatile.

Hence, steam distillation technique is used for the extraction of essential oils.

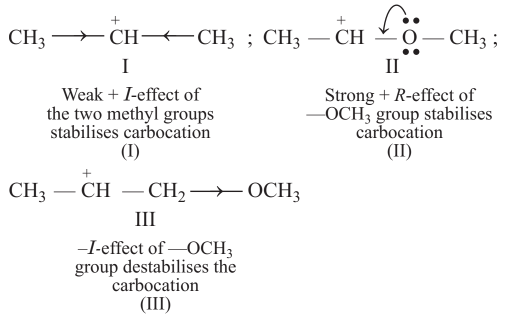
184 (*d*) Thin layer chromatography (TLC) is a type of adsorption chromatography which involves separation of substances of a mixture over a thin layer of an adsorbent coated on a glass plate.

A thin layer of an adsorbent is spread over a glass plate of suitable size and glass plate is placed in an eluant. As eluant rises, components of the mixture move up alongwith the eluant to different distances depending on their degree of adsorption and separation takes place.

Therefore, this TLC technique will give best results in identifying the different types of ink used at different places in the documents.

185 (*b*) The principle involved in paper chromatography is partition. It is based on continuous differential partitioning of components of a mixture between stationary and mobile phases. Paper chromatography is a type of partition chromatography.

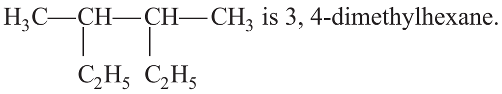
186 (*a*) Stability of the given cations can be understood by the following structures:



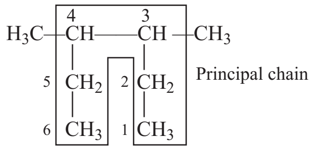
Hence, the stability of carbocation decreases as

$$\text{II} > \text{I} > \text{III}$$

187 (*b*) Correct IUPAC name for



$$H_3C—\underset{C_2H_5}{\underset{|}{C}H}—\underset{C_2H_5}{\underset{|}{C}H}—CH_3 \text{ is 3, 4-dimethylhexane.}$$



188 (*a*) Electronegativity of Cl, Br, C and Mg follows the order Cl > Br > C > Mg.

$${}^*CH_3 \rightarrow CH_2 \rightarrow Cl \quad (-I\text{-effect})$$

$${}^*CH_3 \leftarrow CH_2 \leftarrow Mg^+Cl^- \quad (+I\text{ -effect})$$

$${}^*CH_3 \rightarrow CH_2 \rightarrow Br \quad (-I\text{-effect})$$

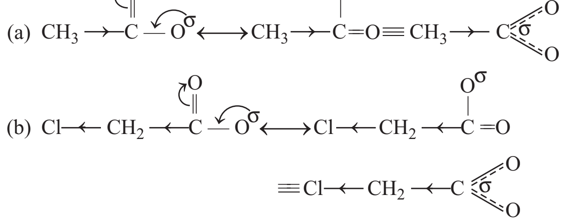
$${}^*CH_3 — CH_2 — CH_3 \quad (+I\text{-effect}) -I\text{-effect of Cl} > \text{Br.}$$

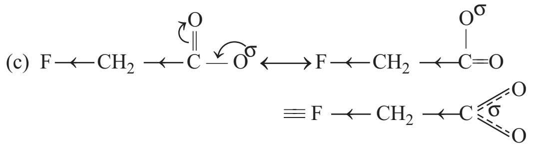
Hence, $CH_3—CH_2—Cl$ has the greatest positive charge.

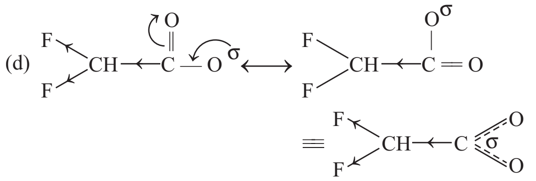
189 (*d*) In all the given carboxylate ions, the negative charge is dispersed which stabilises these carboxylate ion.

Here, the negative charge is dispersed by two factors, i.e. +*R*-effect of the carboxylate ion (conjugation) and –*I*-effect of the halogens.

These effects are shown below in the carboxylate ion:



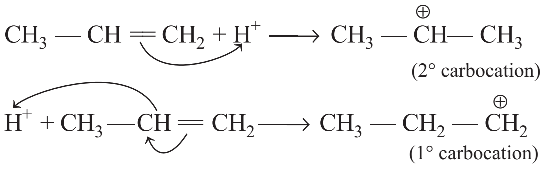




As it is clearly evident from the above structures, that +*R*-effect is common in all the four structures, therefore, overall dispersal of negative charge depends upon the number of halogen atoms and its electronegativity. Since, F has the highest electronegativity and two F-atoms are present in option (d), thus, dispersal of negative charge is maximum in option (d).

Note *In above structure (a), methyl group (*CH_3*) increases the density on C-atom.*

190 (*c*) If unsymmetrical alkene, i.e. $CH_3CH{=}CH_2$ undergoes electrophilic addition (addition of H^+ ion), then first step could lead to two different carbocation



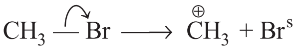
$$CH_3 - CH = CH_2 + H^+ \longrightarrow CH_3 - \overset{\oplus}{C}H - CH_3$$
(2° carbocation)

$$H^+ + CH_3 - CH = CH_2 \longrightarrow CH_3 - CH_2 - \overset{\oplus}{C}H_2$$
(1° carbocation)

As 2° carbocation is more stable than 1° carbocation thus first addition is more feasible.

Note *Stability of carbocations is the basis of Markownikoff's rule.*

191 (*b*) Arrow denotes the direction of movement of electrons.

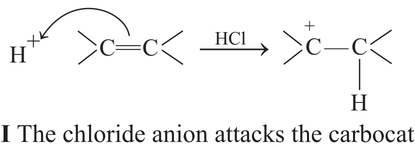


$$CH_3 - Br \longrightarrow \overset{\oplus}{C}H_3 + Br^s$$

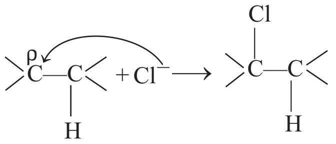
Since, Br is more electronegative than carbon, hence heterolytic fission occurs in such a way that CH_3 gets the positive charge and Br gets the negative charge.

Thsu, option (b) is correct.

192 (*b*) ***Step* I** π-bonds of the alkene creates an electron cloud and form a bond with the electrophile (H^+) to form a carbocation.



***Step* II** The chloride anion attacks the carbocation.



193 (*d*) The energy of actual structure of the molecule (the resonance hybrid) is lower than that of any of the canonical structures. The difference in energy between the actual structure and the lower energy resonance structure is called the resonance stabilisation energy.

Thus, R is correct but A is incorrect.

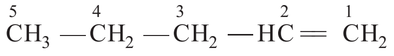
194 (*a*) Liquids having a difference more than 20°C in their boiling points can be separated by simple distillation, e.g. separation of propan-1-ol and propanone.

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

195 (*a*) Paper chromatography is a type of partition chromatography. The paper selectively retains different components according to their differing partition in the stationary and mobile phases. Hence, components of inks are separated.

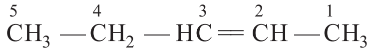
Thus, both A and R are correct and R is the correct explanation of A.

196 (*a*) Pent-1-ene and pent-2-ene are position isomers because these compounds differ in the position of substituent atom or functional group on the carbon skeleton then it is position isomerism. Double bond is a functional group whose position varies.



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

Pent-1-ene

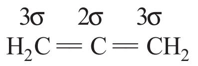


$$\overset{5}{C}H_3 - \overset{4}{C}H_2 - H\overset{3}{C} = \overset{2}{C}H - \overset{1}{C}H_3$$

Pent-2-ene

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

197 (*d*) Hybridisation can be determined by counting σ- bond



$$\overset{3\sigma}{H_2C} = \overset{2\sigma}{C} = \overset{3\sigma}{CH_2}$$

3σ − *sp*² hybridisation

2σ − *sp* hybridisation

In $H_2C = C = CH_2$, the central carbon is *sp*-hybridised whereas the terminal carbons are *sp*²-hybridised.

198 (*b*) Sulphur present in an organic compound can be estimated quantitatively by Carius method. In this method, a known weight of organic compound is heated with fuming HNO_3, S present in it gets converted into H_2SO_4. On adding $BaCl_2$, H_2SO_4 gets precipitated as $BaSO_4$ which may be of light yellow or white in colour.

If light yellow colour is obtained, it means some impurities are present. It is then filtered, washed, purified and then dried and finally pure $BaSO_4$ of white colour is obtained.

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