

## 12 Organic Chemistry-Some Basic Principles and Techniques

Book: H.C. Srivastava

### Exercise A

#### Q-1 Very Short Question Answers.

1. Name the organic compound that was first prepared in the laboratory. Who did prepare this compound?

Urea, Friedrich Wohler in 1828.

2. Define organic chemistry.

The branch of chemistry dealing with the study of hydrocarbons and the compounds which could be thought of as the derivatives of hydrocarbons.

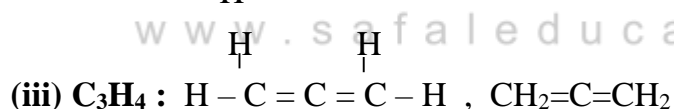
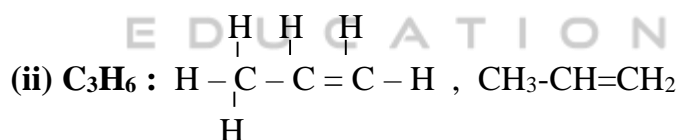
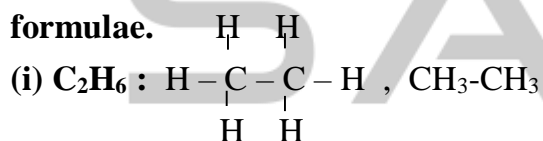
3. What do you understand by isomerism?

When two or more compounds having the same molecular formula differ in physical or chemical properties.

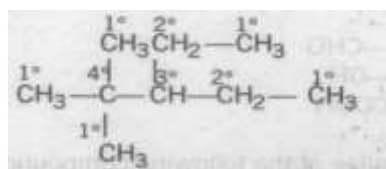
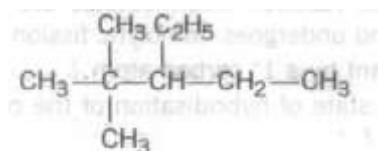
4. What are aromatic compounds? Give at least two examples.

The compounds made up of one or more rings of carbon atoms but the rings are specific type called benzene rings. e.g., Toluene, Naphthalene.

5. Write the structural and graphic formulae of the compounds having the following molecular formulae.

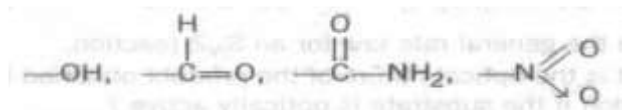


6. Identify primary, secondary, tertiary and quaternary carbon atoms in following compound:



7. Write the graphic formulae of the following alkyl groups: ethyl, n-propyl, iso-propyl, sec-butyl, t-butyl.

8. What suffixes or prefixes are used for the following functional groups?



(1) Suffix : -ol, Prefix : Hydroxy-

(2) Suffix : -al, Prefix : Formyl-

(3) Suffix : -amide , Prefix : Carbamoyl

(4) Suffix : -- , Prefix : Nitro-

**9. What are alicyclic compounds?**

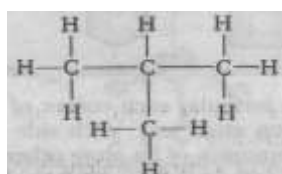
The compounds containing a ring of three or more carbon atoms and possess properties almost similar to those of aliphatic compounds.

**10. What are special names used for naming 1, 2; 1, 3; and 1,4 disubstituted derivatives of benzene?**

Ortho, meta and para

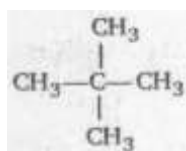
**11. Write the structure and IUPAC names of the following compounds :**

**(i) Isobutane**



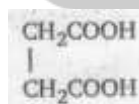
2-methyl propane

**(ii) Neopentane**



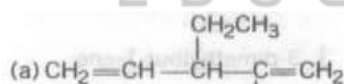
2,2-dimethylpropane

**(iii) Succinic acid.**

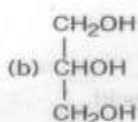


Butane-1,4-dioic acid

**12. Give the IUPAC names of the following compounds :**



(a) 2-chloro-3-ethylpenta-1,4-diene



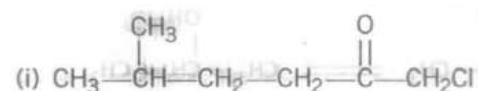
(b) Propane-1,2,3-triol

**13. Give the IUPAC names of the following compounds :**

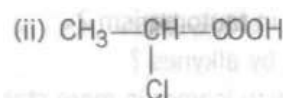
(i)  $(\text{CH}_3)_3\text{C}-\text{CH}=\text{CH}_2$  – 3,3-dimethylbut-1-ene

(ii)  $\text{C}_6\text{H}_5-\text{CH}=\text{CH}-\text{COOH}$  – 3-phenylprop-2-en-1-oic acid

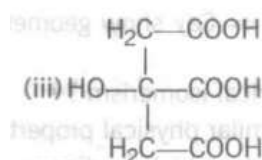
**14. Write the IUPAC names of the following compounds :**



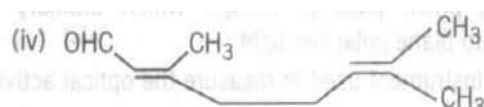
(i) 1-chloro-5-methylhexan-2-one



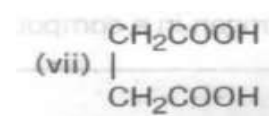
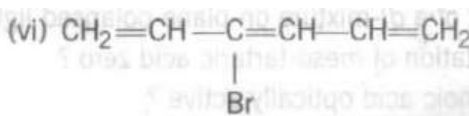
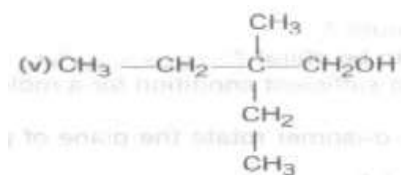
(ii) 2-chloropropan-1-oic acid



(iii) 2-carboxy-3 hydroxypentane-1, 5-dioic acid



(iv) 3,7-dimethylocta-2,6-diene-1-al



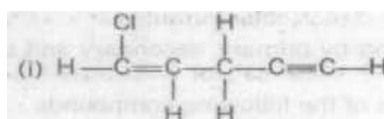
(v) 2-ethyl-2-methylbutan-1-ol (vi) 3-bromohexa-1,3,5-triene (vii) Butane-1,4-dioic acid

15. Select the principal group when the following groups are present in a molecule.

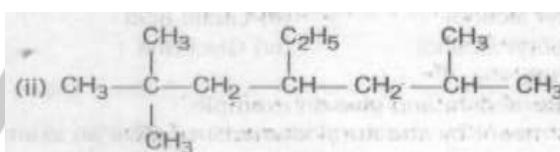
- (i) -Cl, -OH, -NO<sub>2</sub>, -CHO = -CHO  
 (ii) -Br, -NH<sub>2</sub>, -Cl, -OH = -OH  
 (iii) -OH, >C=O, -COOH = -COOH  
 (iv) -SH, -I, -CONH<sub>2</sub> = -CONH<sub>2</sub>

16. Write the structural formulae of the following compounds :

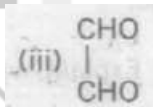
(i) 1-chloropent-1-ene-4-yne



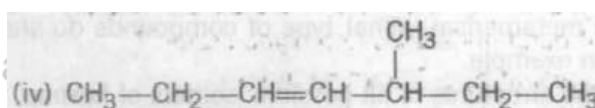
(ii) 4-ethyl-2,2,6-trimethylheptane



(iii) Ethane-1,2-dial



(iv) 5-methylhept-3-ene



17. Correct the following names :

- (i) 2-ol-2, 3- dimethylbutane      Ans. = 2, 3-dimethylbutan-2-ol  
 (ii) 1-chloro-4-pentyne-1-ene      Ans. = 1-chloropent-1-ene-4-yne  
 (iii) 4,4, 3-trimethyl-1-hexyne      Ans. = 3, 4, 4-trimethylhex-1-yne  
 (iv) 3-ethyl-2-chloro-1,4-pentadiene.      Ans. = 2-chloro-3-ethylpenta-1, 4-diene

18. Do structural isomers possess similar chemical properties?

No

19. What type of isomerism is shown by isopentane and neopentane?

Structural

20. What type of isomerism is shown by 1-butene and 2-butene?

Position

21. Write the possible functional isomers having the formula C<sub>3</sub>H<sub>6</sub>O<sub>2</sub>.

$\text{CH}_3\text{CH}_2\text{COOH}$  and  $\text{CH}_3\text{COOCH}_3$

22. What is the functional isomer of ethanol ?

Methoxymethane

23. Write the metamers having the formula  $\text{C}_4\text{H}_{11}\text{N}$ .

(i)  $\text{CH}_3\text{-CH}_2\text{-CH}_2\text{-NH-CH}_3$

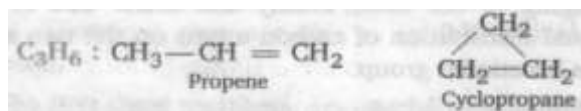
(ii)  $\text{CH}_3\text{-CH(NH-CH}_3\text{)-CH}_3$

(iii)  $\text{CH}_3\text{-CH}_2\text{-NH-CH}_2\text{-CH}_3$

24. How many chain isomers are possible with the formula  $\text{C}_7\text{H}_{16}$ ?

Nine

25. Give an example of ring-chain isomerism.



26. What type of isomerism is exhibited by the following equilibrium?



Keto-enol isomerism

27. What type of change is involved in tautomerism?

Reversible, intramolecular

28. Is geometrical isomerism shown by alkynes?

No

29. Out of cis and trans isomers, which isomer is more stable?

Trans

30. Can a compound of the type  $\text{axC=Cay}$  show geometrical isomerism?

Yes

31. What is the main cause of geometrical isomerism?

Restricted rotation of carbon atoms about a double bond

32. Do geometrical isomers possess similar physical properties?

No

33. Name the prism passing through which ordinary light changes into plane polarized light.

Nicol prism

34. Name the instrument used to measure the optical activity of a substance.

Polarimeter

35. Is the letter H chiral in nature?

No

36. When is a molecule said to be chiral?

When it possesses neither a plane of symmetry nor a centre of symmetry.

**37. What is the necessary and sufficient condition for a molecule to be optically active?**

Chirality

**38. In which direction does a d-isomer rotate the plane of plane polarized light?**

Clockwise

**39. What is the effect of a dl-mixture on plane polarized light?**

No net effect

**40. Why is the net rotation of meso-tartaric acid zero?**

Because it contains an axis of symmetry

**41. Is l-hydroxypropionic acid optically active?**

Yes

**42. What is soda-lime test for detection of nitrogen in a compound?**

Soda lime test is used for the detection of nitrogen in an unknown organic compound.

A small quantity of the unknown compound is mixed with double the amount of soda-lime (NaOH+ CaO) and heated in a test tube. The evolution of ammonia gas gives an indication of the presence of nitrogen in the given compound.

**43. What do you understand by Lassaigne solution?**

As in organic compound nitrogen is covalent bonded, it is first converted into ionic form and brought in solution. This solution is called Lassaigne's solution.

**44. What is chemical composition of Prussian blue colouration obtained in Lassaigne test for N<sub>2</sub>?**

$\text{Fe}_4[\text{Fe}(\text{CN})_6]_3$ .

**45. Why is Lassaigne solution boiled with conc. HNO<sub>3</sub> before testing halogens?**

To decompose NaCN or Na<sub>2</sub>S. These are present in Lassaigne solution if the compound contains N or S and interfere in the test of halogens.

**46. What colour will you get in Lassaigne's test if the compound contains both N and S?**

A blood red colouration is found

**47. What is chloroform layer test?**

It is used for the detection of the presence of bromine and iodine and is not interfered by the presence of nitrogen and sulphur in given compound.

**48. What is the role of reduced copper gauze in the estimation of nitrogen by Duma's method?**

The nitrogen oxides are reduced to nitrogen by the reduced copper gauze.

**49. Mention the principle on which Victor Meyer's method is based.**

The principle is : One gram equivalent of an acid always neutralizes one gram equivalent of a base.

**50. How are the empirical and molecular formulae of a compound related to each other?**

$M.F. = n \times e.F$

Where,  $n = \frac{M.W}{E.F. \text{ mass}}$

**51. What happens when the silver salt of a carboxylic acid is ignited?**

It decomposes to give metallic silver.

**52. What type of electrons get displaced in (i) inductive effect (ii) electromeric effect?**

(i)  $\sigma$ -electrons (ii)  $\pi$ -electrons

**53. What type of groups produce +I-effect?**

Less electronegative than carbon

**54. Which of the following are permanent effects? I-effect, E-effect, M-effect.**

I- and M-effects

**55. Amongst -OH, -CN, -Cl, -NO<sub>2</sub> groups, which do exert +M-effect when present in conjugation with a double bond?**

-OH and -Cl groups

**56. What type of reaction intermediates are obtained when a covalent bond undergoes homolytic fission?**

Free radicals

**57. What is meant by a 1° carbon atom?**

Carbon atom attached to no other carbon atom or attached to only one carbon atom.

**58. What is the state of hybridization of the central carbon in a carbocation?**

$sp^2$

**59. What is the state of hybridization of the central carbon in a carbanion?**

$sp^3$

**60. Sort out electrophiles and nucleophiles among the following : CH<sub>3</sub>C<sup>+</sup>H<sub>2</sub>, AlCl<sub>3</sub>, C<sub>2</sub>H<sub>5</sub>OH, CN<sup>-</sup>, C<sup>+</sup>H<sub>3</sub>, N<sup>+</sup>O<sub>2</sub>.**

Electrophiles : CH<sub>3</sub>C<sup>+</sup>H<sub>2</sub>, AlCl<sub>3</sub>, NO<sub>2</sub><sup>+</sup>; Nucleophiles : C<sub>2</sub>H<sub>5</sub>OH, CN<sup>-</sup>, CH<sub>3</sub><sup>-</sup>

**61. Write the general rate law for an S<sub>N</sub>2 reaction.**

Rate = K[Substrate] [Nucleophile]

**62. What is the optical nature of the product obtained in an S<sub>N</sub>1 reaction if the substrate is optically active?**

Racemic (Optically inactive)

**63. What is the reaction intermediate in a nitration process?**

NO<sub>2</sub><sup>+</sup>

**64. Define elimination reactions.**

The reaction involving the loss of two or four atoms or groups from the same or the adjacent carbon atoms in a substrate molecule leading to the formation of multiple bond.

**65. What type of structure is possessed by a triplet carbene?**

Linear

**66. Name a neutral electrophile and a neutral nucleophile.**

AlCl<sub>3</sub>, C<sub>2</sub>H<sub>5</sub>OH



## Q-2 Short Question Answers

### 1. Justify the Study of organic compounds as a separate branch of chemistry.

The organic compounds of carbon comprise about 90% of all the known compounds formed by all known elements. The organic compounds of carbon are therefore studied in a separate branch of chemistry.

### 2. What is catenation? Why is it most prominent for carbon?

**Catenation :** The property of atom of an element to link with one another by stable covalent bond to form straight chains, branched chains or rings.

In carbon, it is most prominent because it has a greater strength of carbon-carbon bonds and due to tetra covalency.

### 3. What are isomers? Write the isomers of butane and pentane.

When two or more compounds having the same molecular formula differ in physical or chemical properties, the phenomenon is known as isomerism and such compounds are called isomers.

Isomers of butane : butane, 2-methylpropane (isobutane)

Isomers of pentane : pentane, 2-methylbutane (isopentane), 2,2-dimethylpropane (neopentane).

### 4. What is the main difference between carbocyclic and heterocyclic compounds?

Carbocyclic compounds : When the rings consists of all the atoms of carbon.

Heterocyclic compounds : When rings consists of one or more atoms other than carbon.

### 5. Name the different types of hydrocarbons. Give two examples each.

Alkane : Butane, Pentane [single bond]

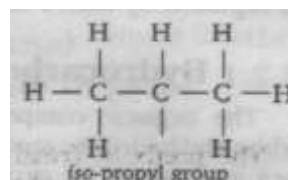
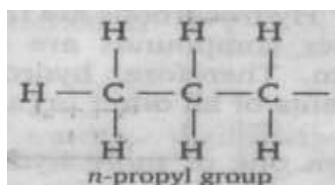
Alkene : Butene, Pentene [Double bond]

Alkyne : Butyne, Pentyne [triple bond]

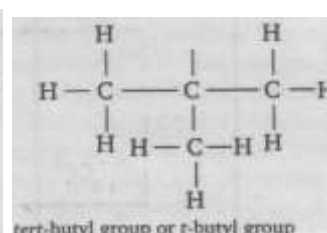
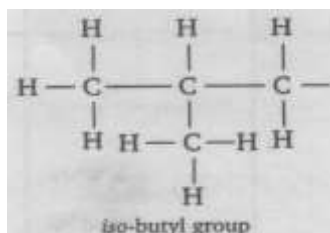
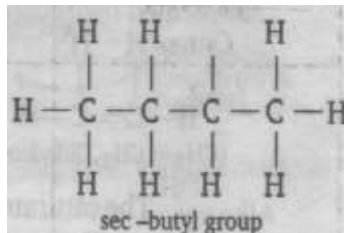
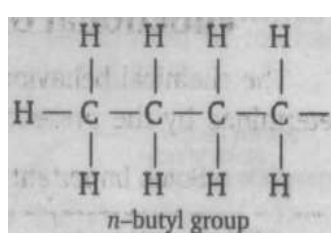
### 6. What are alkyl groups? Write the structures of all possible alkyl groups which can be obtained from propane and butane.

When a hydrogen atom is removed from an alkane, the group obtained is called an alkyl group or alkyl radical.

*Structures of alkyl groups of propane:*



*Structures of alkyl groups of butane:*



### 7. What do you understand by a functional group? What is its significance in organic chemistry?

A functional group may be defined as an atom or a group of atoms which largely decides the mode of activity of a given compound.

Organic compounds having the same functional group behave similarly and form a family. Thus, on the basis of functional groups present, organic compounds can be divided into families. This makes the study of organic compounds much easier, otherwise it would have been a Herculean task to study five million organic compounds individually.

**8. In what way does an alkane differ from other hydrocarbons?**

An alkane does not contain any multiple bond or functional group.

**9. What do you understand by a homologous Series? Write its important characteristics.**

It is a series of similarly constituted organic compounds in which the members possess the same functional group, have similar or almost similar chemical characteristics can be represented by the same general formula and the two consecutive member differ by  $-\text{CH}_2$  group in their molecular formula.

Its important characteristics are:

- (1) All the members of a series can be represented by the same molecular formula. For example, all the members of alcohol family can be represented by the general formula  $\text{C}_n\text{H}_{2n+1}\text{OH}$ , where  $n$  may have the values 1,2,3,.....; etc.
- (2) The two successive members differ by  $-\text{CH}_2$  group in their molecular formulae.
- (3) The molecular mass of a compound in the series differs by 14 amu ( $\text{CH}_2 = 12 + 2 \times 1 = 14$ ) from that of its neighbour.
- (4) All the members of a series possess the same functional group.
- (5) The chemical properties of all the members of a series are similar or almost similar. However, the first member may differ considerably from others.
- (6) The physical properties such as density, melting point, boiling point, solubility, etc., of the members of a homologous series show almost regular variation in ascending or descending the series.
- (7) The members present in a homologous series can be prepared almost by similar methods known as general methods of preparation.

**10. Explain why does carbon form a very large number of compounds.**

Carbon forms a very large number of compounds. The existence of such a large number of compounds is due to some unique properties of carbon. These are as follows.

- (1) *Catenation*: Carbon atoms possess an unique property to link to gather to form very long chains. This property is referred to as catenation. This is due to greater strength of carbon-carbon bond and due to tetra covalency of carbon. A large number of carbon atoms can join to gether to form straight chains, branched chains or rings.



(2) *Capability to forming multiple bonds*: Due to small size and presence of four valence electrons, a carbon atom can form multiple bonds with some other carbon atom as well as with other atoms like oxygen, nitrogen, etc. This increases the variety of compounds formed by it and hence the number of compounds is tremendously increased.

(3) *Isomerism*: The phenomenon of isomerism also helps carbon to increase the variety and hence the number of compounds.

### 11. How would you decide whether the two given compounds are homologues or not?

Homologues possess the same functional group and can be represented by the same general formula.

### 12. Write the systematic IUPAC names of the following compounds :

No.	Compound	IUPAC Name
1	(i) $\text{CH}_3-\text{C}=\text{C}-\underset{\text{C}_2\text{H}_5}{\overset{\text{CH}_3}{\text{C}}}-\text{CH}_3$	(i) $\overset{1}{\text{C}}\text{H}_3-\overset{2}{\text{C}}=\overset{3}{\text{C}}-\overset{4}{\text{C}}-\overset{5}{\text{CH}_2}-\overset{6}{\text{CH}_3}$ 4,4-dimethylhex-2-yne
2	(ii) $\text{CH}_2-\underset{\text{O}}{\text{CH}}-\text{CH}_2-\underset{\text{CH}_3}{\text{CH}}-\text{CH}_3$	1,2-epoxy -4-methylpentane
3	(iii) $\text{CH}_3-\underset{\text{CH}_3}{\text{CH}}-\text{CH}_2-\text{CH}_2-\underset{\text{CH}_3}{\text{CH}}-\text{CH}_2-\text{CH}_3$	2,5-dimethyl heptane
4	(iv) $\text{CH}_3-\text{CH}=\text{CH}-\underset{\text{H}-\text{C}-\text{CH}_3}{\overset{\text{CH}_3}{\text{C}}}-\text{CH}_2-\text{CHO}$ $\text{CH}_3-\underset{\text{CH}_3}{\text{C}}-\text{CH}_3$	(iv) $\overset{6}{\text{C}}\text{H}_3-\overset{5}{\text{C}}\text{H}=\overset{4}{\text{C}}\text{H}-\overset{3}{\text{C}}-\overset{2}{\text{C}}\text{H}_2-\overset{1}{\text{C}}\text{HO}$ 3-methyl-3-(1, 2, 2-trimethylpropyl)hex-4-en-1-al
5	(v) $\text{CH}_3-\underset{\text{CN}}{\text{CH}}-\text{CH}_2-\underset{\text{CH}_3}{\overset{\text{CH}_3}{\text{C}}}-\underset{\text{CH}_3}{\overset{\text{C}_2\text{H}_5}{\text{CH}}}-\text{CH}_2\text{Cl}$	(v) $\overset{1}{\text{CN}}-\overset{2}{\text{C}}\text{H}-\overset{3}{\text{C}}\text{H}_2-\overset{4}{\text{C}}-\overset{5}{\text{C}}\text{H}-\overset{6}{\text{C}}\text{H}_2\text{Cl}$ 6-chloro-5-ethyl-2, 4, 4-trimethylhexane-1-nitrile

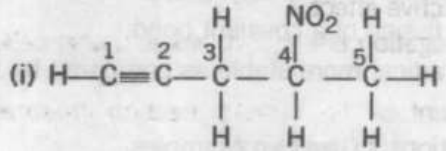
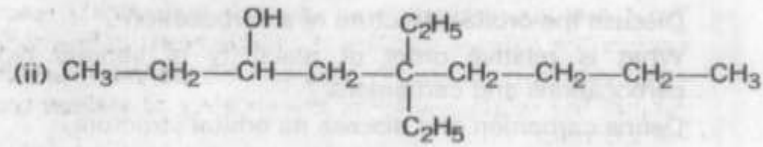
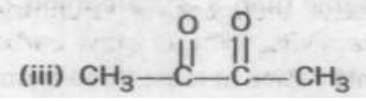
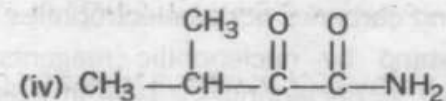
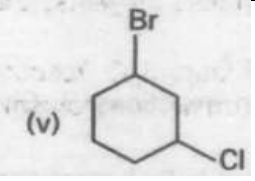
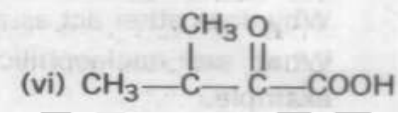
### 13. Find out the error in the following names and write the correct IUPAC names :

- (i) 3-methyl-4 ethyl-2-hexanol      Ans (i) 4-ethyl-3- methylhexan-2-ol  
(ii) 3-butanol-1-oic acid      Ans (ii) 3-hydroxybutan-1-oic acid  
(iii) 2-methyl-1-carboxypentene-3      Ans (iii) 2-methylpent-3-ene-1-oic acid

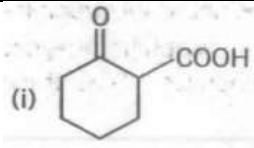

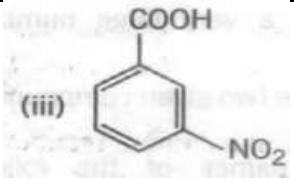
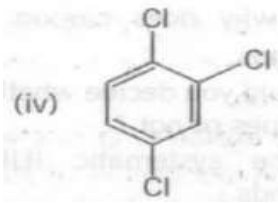
### 14. Draw the structures of the following compounds :

No.	Compound	Structure
-----	----------	-----------

# CHEMISTRY

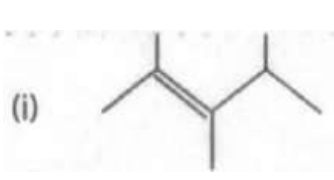
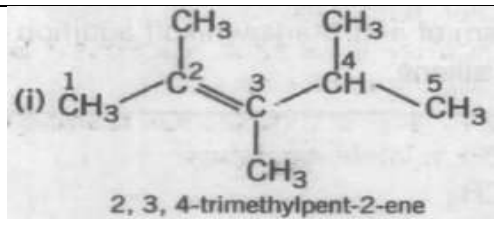
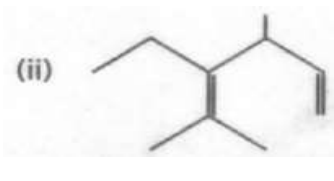
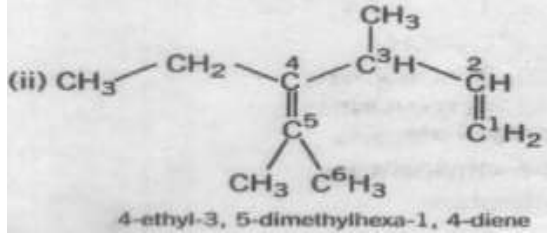
1	4-nitropent-1-yne	(i) 
2	5, 5-diethyl-3-nonanol	(ii) 
3	Butane-2,3-dione	(iii) 
4	2-keto-3-methylbutanamide	(iv) 
5	1-bromo-3-chlorocyclohexane	(v) 
6	3-methyl-2-oxobutanoic acid	(vi) 

## 15. Write the IUPAC names of the following compounds :

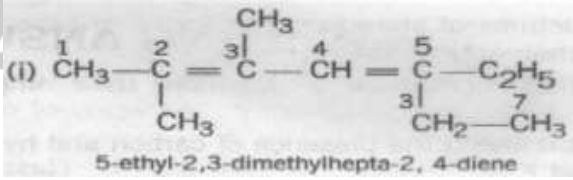
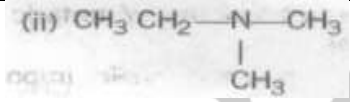
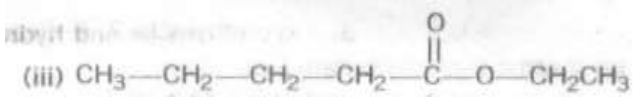
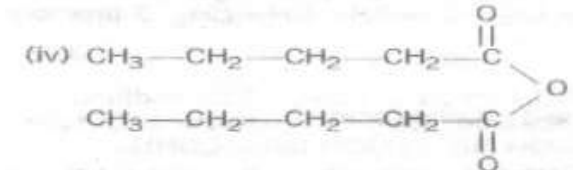
No.	Compound	IUPAC Name
1	(i) 	(i) 2-oxocyclohexan-1-oic acid
2	(ii) 	(ii) 3-methylcyclopent-1-ene
3	(iii) 	(iii) 3-nitrobenzoic acid or m-nitrobenzoic acid
4	(iv) 	(iv) 1,2,4-trichlorobenzene

## 16. Write the IUPAC names of the following compounds :

No.	Compound	IUPAC Name
-----	----------	------------

1	(i) 	(i)  2, 3, 4-trimethylpent-2-ene
2	(ii) 	(ii)  4-ethyl-3, 5-dimethylhexa-1, 4-diene

17. Write the IUPAC names of the following compounds :

No.	Compound	IUPAC Name
1	(i) $(\text{CH}_3)_2\text{C}=\text{C}(\text{CH}_3)\text{CH}=\text{C}(\text{C}_2\text{H}_5)_2$	(i)  5-ethyl-2,3-dimethylhepta-2, 4-diene
2	(ii) 	(ii) N, N-dimethylaminoethane
3	(iii) 	(iii) Ethylpentanoate
4	(iv) 	(iv) Pentanoic anhydride

18. What do you understand by primary, secondary and tertiary hydrogen atoms?

Hydrogen atoms attached to  $1^\circ$ ,  $2^\circ$  and  $3^\circ$  carbon atoms are referred to as primary, secondary and tertiary hydrogen atoms respectively.

19. Write the IUPAC names of the following compounds :

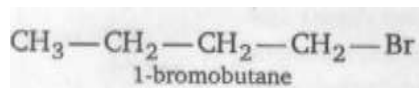
No.	Compound	IUPAC Name
1	t-butyl alcohol	2-methylpropan-2-ol
2	Lactic acid	2-hydroxypropan-1-oic acid
3	Isobutyl alcohol	2-methylpropan-1-ol
4	Glycerine	
5	Glycine	2-aminoethan-1-oic acid

20. Define isomerism and give an example.

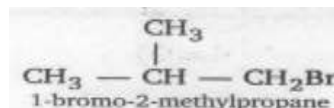
# CHEMISTRY

When two or more compounds having the same molecular formula differ in physical or chemical properties, the phenomenon is known as isomerism and such compounds are called isomers.

For example, 1-bromobutane and 1-bromo-2-methylpropane possess the same molecular formula, i.e.,  $C_4H_9Br$  but 1-bromobutane contains a straight chain of four carbon atoms, whereas 1-bromo-2-methylpropane has a chain of only three carbon atoms. Thus, the two differ in their carbon skeletons.

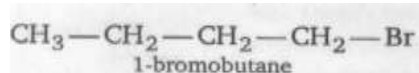


and

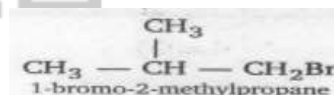


## 21. What is meant by structural isomerism? Give an example.

When two or more compounds having the same molecular formula possess different chemical structures on account of different arrangement of atoms in their molecules, the phenomenon is known as structural isomerism and such compounds are called structural isomers. Structural isomerism is of six types: (i) Chain isomerism (ii) Position isomerism (iii) Functional isomerism (iv) Metamerism (v) Ring chain isomerism (vi) Tautomerism.

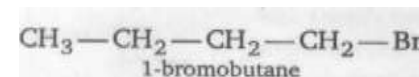


and

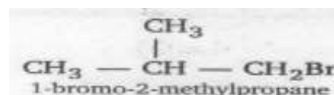


## 22. Define chain isomerism and give an example.

When two or more compounds having the same molecular formula possess different arrangement of carbon atoms in the main chain, the phenomenon is known as chain isomerism and such compounds are referred to as chain isomers. For example



and



## 23. Give two examples of position isomerism.

(1) But-1-ene :  $\text{CH}_2 = \text{CH} - \text{CH}_2 - \text{CH}_3$  and But-2-ene :  $\text{CH}_3 - \text{CH} = \text{CH} - \text{CH}_3$

(2) But-1-yne :  $\text{CH} \equiv \text{C} - \text{CH}_2 - \text{CH}_3$  and But-2-yne :  $\text{CH}_3 - \text{C} \equiv \text{C} - \text{CH}_3$

## 24. What is meant by functional isomerism? Explain with an example.

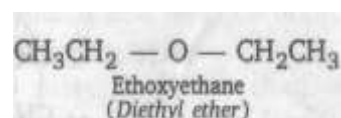
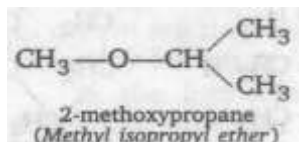
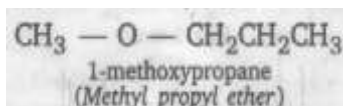
When two or more, compounds having the same molecular formula contain different functional group, the phenomenon is known as functional isomerism and such compounds are termed as functional isomers. For example Ethanol (ethyl alcohol) and methoxymethane (dimethyl ether) both have the same molecular formula,  $C_2H_6O$  but contain different functional groups.

$\text{CH}_3 - \text{CH}_2 - \text{OH}$  (Ethanol) and  $\text{CH}_2 - \text{O} - \text{CH}_3$  (Methoxy ethane)

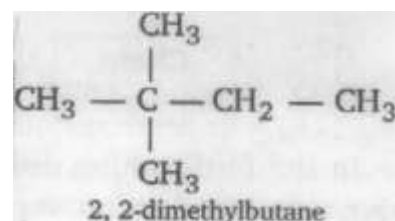
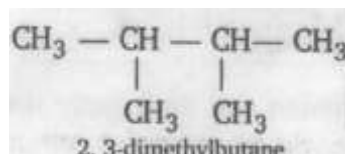
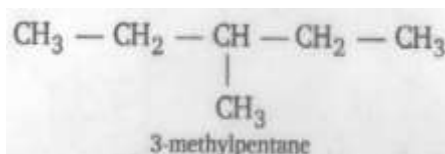
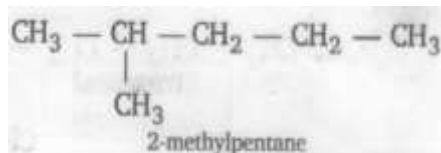
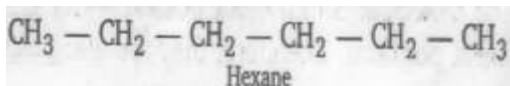
## 25. Define metamerism. What type of compounds do show it? Give an example.

When two or more compounds having the same molecular formula and the same functional group possess different type of alkyl group attached on both sides of functional groups, the phenomenon is known as metamerism and such compounds are termed as metamers. For example the molecular formula  $C_4H_{10}O$  represents following three ethers.



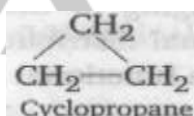
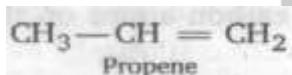


26. Write the structures of all possible isomers of hexane.



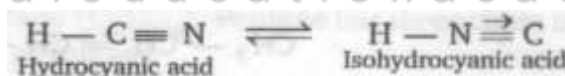
27. What is ring-chain isomerism? Give an example.

When two or more compounds having the same molecular formula differ in the mode of linking of carbon atoms and have open chain and closed chain structures, the phenomenon is called ring-chain isomerism and such compounds are referred to as ring-chain isomer. For example, Propene and cyclopropane have the same molecular formula C<sub>3</sub>H<sub>6</sub> but have different modes of linking of carbon atoms. Propene has an open chain structure, whereas cyclopropane has a cyclic structure.

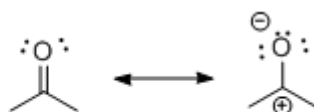


28. What is tautomerism and how does it differ from resonance? Explain with an example.

It is the phenomenon in which a single compound exist in two readily interconvertible forms which differ markedly in the relative position of at least one atomic molecules, generally hydrogen. For example, Hydrocyanic acid (HCN) exists in the following tautomeric forms



Resonance structures are different representations of the same structure. The atoms have the same connectivity, but they differ in the arrangement of their lone pairs and double bonds. Acetone can be represented by two different resonance structures. For example, in acetone the resonance structure on the right suggests that acetone would be nucleophilic at the oxygen and electrophilic at the carbon, which is true.



resonance: same structure - different representations

Tautomerization involves a change in connectivity of the atoms to yield two different constitutional isomers. Thus, tautomerization is an actual chemical reaction that can take place. The two tautomers will have different reactivity, boiling points, melting points, etc. They are two unique molecules. For



example, the ketone and enol forms of acetone. In order to change from keto to enol, making and breaking of sigma bonds take place.



tautomers: two different structures - constitutional isomers

**29. What are the characteristics of tautomeric changes?**

- (1) It is caused by the wandering of a hydrogen atom between two polyvalent atoms present in molecule.
- (2) It is a reversible intramolecular change.
- (3) The two tautomerism forms are not equally stable.

**30. What is geometrical isomerism and what type of compounds do exhibit it?**

When two or more compounds having the same molecular formula, similar chemical structures and a double bond possess different geometrical arrangements of atoms or groups about the double bonded carbon atoms, the phenomenon is known as geometrical isomerism and such compounds known as geometrical isomers. Two types of compounds do exhibit this isomerism (i) cis isomer and (ii) trans isomer. The isomer in which the similar groups are arranged on the same side of double bond is called cis isomer, whereas the isomer in which similar groups are arranged on opposite sides of double bond is called trans isomer.

**31. Describe the conditions necessary for a molecule to show geometrical isomerism.**

- (1) The molecule must have a double bond.
- (2) The molecule should be of the type either  $abC = Cab$  or  $axC = Cay$ .

**32. Discuss the cause of geometrical isomerism.**

The restricted rotation of carbon atoms about a double bond is the main cause of geometrical isomerism.

**33. Describe the important properties of geometrical isomers.**

- (1) They possess different physical properties like melting point, boiling point, dipole moment, tendency of being adsorbed etc.
- (2) The geometrical isomers have similar but not identical chemical properties.
- (3) The stability of two isomers are different. Trans-isomer is more stable than the corresponding cis-isomer.

**34. What is optical activity and how is it measured?**

The property of a substance of rotating the plane of plane polarised light through a definite angle is called optical activity and such a substance is said to be optically active. The rotation of the plane polarised light by an optically active substance is measured by polarimeter.

**35. On what factors does the rotation of light by an optically active substance depend?**

The optical active substance is depend on the presence of dissymmetry or chirality. A chiral object is non-superimposable on its mirror image.

### 36. Define specific rotation.

Specific rotation is number of observed degree of rotation caused by an optically active substance when plane polarized light is passed through one decimeter of its solution having concentration one gram per millilitre. The specific rotation of a substance is represented by  $[\alpha]_D^t$ , where t stands for temperature and D for D-line of sodium light. It may be calculated by the following expression

$$[\alpha]_D^t = \frac{\alpha_{obs.}}{l \times c}$$

Where,  $l$  represents the length of the solution in decimetres, and  $c$  is the concentration of the substance in  $\text{gm/cm}^3$ . The direction of rotation of light may be specified by putting a + (for clockwise rotation) or- (for anticlockwise rotation), sign, in the value of specific rotation.

### 37. What is meant by chirality? Explain with an example.

The term chirality is derived from the Greek word Kheir which means hand. Thus, the term chirality means having handedness i.e., being left handed or right handed. When an object is non-superimposable on its mirror image, it is said to be chiral. Chirality is also known as dissymmetry. Some common examples of chiral objects are a pair of hands, a pair of shoes, a pair of gloves and some of the alphabets like P, F, J, etc.

### 38. What is meant by an asymmetric carbon? Is it a chiral centre?

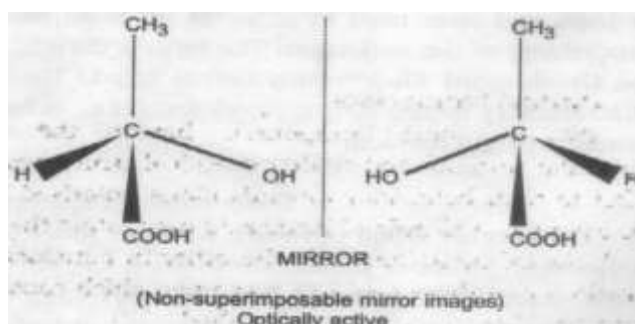
A carbon atom whose four valencies are satisfied with four different atoms or chiral centre is called asymmetric carbon. For example, if, four different atoms, e.g., H, F, Cl and Br are attached to a  $sp^3$  hybridised carbon we get fluorochlorobromomethane;  $(\text{CHFClBr})$ . This molecule is chiral and dissymmetric.

Yes, it is a chiral centre.

### 39. Discuss the cause of optical activity.

The main cause of optical activity, is the presence of dissymmetry or chirality in a molecule. When a molecule is dissymmetric, it can have different configurations in space. These configurations interact with the plane polarised light in different manners and thus give rise to the phenomenon of optical activity and optical isomerism. For example, lactic acid  $(\text{CH}_3\text{CHOHCOOH})$  is an optically active compound contains an asymmetric carbon atom. Since asymmetric carbon atom is a chiral centre,

the molecule of lactic acid possesses chirality. Its mirror image is not superimposable over it. This is why it shows optical activity.



**40. What are enantiomers? Mention their important properties and give an example.**

The stereoisomers which are the non-superimposable mirror images of each other are enantiomers.

Their important properties are :

- (1) Two enantiomers differ in the manner in which they rotate the plane of plane polarized light.
- (2) The absorption coefficients for left handed and right handed circularly polarised light are different for two enantiomers.
- (3) Enantiomers may possess different rates of reaction with other optically active compounds.
- (4) Enantiomers may differ physiologically.

**41. Define optical isomerism and explain what is meant by d- and l-isomers.**

When two or more compounds having the same molecular formula and similar chemical structures exhibit different effect on plane polarized light is called optical isomerism.

d-isomer : The enantiomer which rotates the plane of plane polarised light in clockwise direction.

l-isomer : The enantiomer which rotates the plane of plane polarized light in anti-clockwise direction.

**42. What do you understand by racemic mixture and why does it have no effect on plane polarized light?**

A mixture containing equal amounts of d- and l-isomers of a substance is called racemic mixture.

Racemic mixture has no effect on plane polarized light because it has an equal but opposite effect on plane polarized light.

**43. Describe briefly what do you understand by the terms racemisation and resolution.**

Racemisation : The process of converting d-form or l-form of an optically active substance into a racemic mixture.

Resolution : The process of separation of a racemic mixture into its d- and l-components.

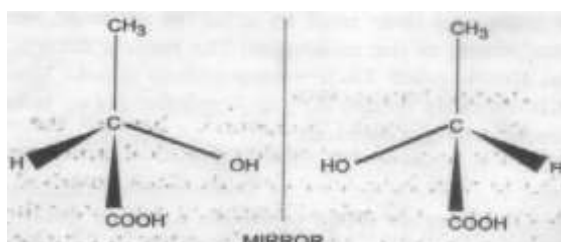
**44. What is meant by asymmetric synthesis? Give an example.**

The synthesis of an asymmetric compound from a symmetric compound without racemisation is called asymmetric synthesis.

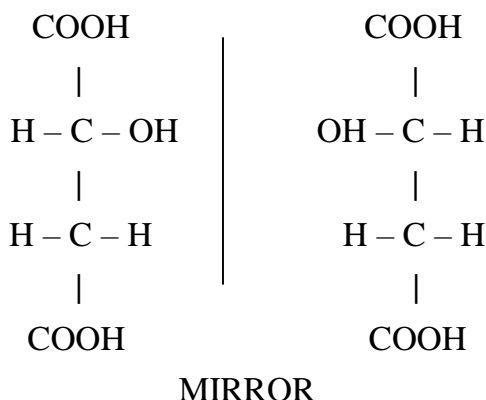
**45. Why is meso-tartaric acid regarded a chiral in nature?**

**46. Discuss the optical isomerism shown by lactic acid.**

Lactic acid ( $\text{CH}_3\text{CHOHCOOH}$ ) is an optically active compound. It contains an asymmetric carbon atom. Since asymmetric carbon atom is a chiral centre, the molecule of lactic acid possesses chirality. Its mirror image is not superimposable over it. This is why it shows optical activity. Its enantiomers are shown in figure.



47. Write the structures of stereoisomeric forms of tartaric acid and indicate their optical nature.



48. What are diastereoisomers? Mention their important properties.

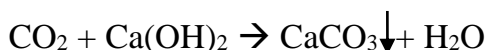
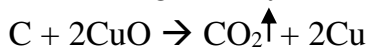
The optical isomer of a compound which are not the mirror image of each other. The properties of diastereoisomers are :

- (1) They differ in physical properties.
- (2) Chemical properties of diastereoisomers are similar but their rates of reaction with other optically active substance may be different.
- (3) Their mass spectra and N.M.R spectra may also be different.

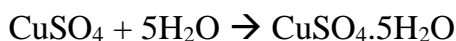
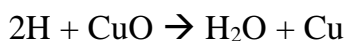
49. How would you detect the presence of carbon and hydrogen in a compound?

To detect the presence of carbon and hydrogen:

- (1) Mix a unknown compound with three times it weight of pure and dry CuO.
- (2) The mixture is taken in a well dried hard glass tube provided with a delivery tube having a bulb near one end.
- (3) The bulb contains anhydrous CuSO<sub>4</sub>.
- (4) The other end of delivery tube is dipped into lime water.
- (5) The turning of lime water milky indicates the presence of carbon in a compound.
- (6) The turning of anhydrous CuSO<sub>4</sub> to blue indicates the presence of hydrogen in a compound.



Lime water                  lime water milky



Anhydrous                          copper sulphate pentahydrate[Blue]

50. What is sodium extract and how is it prepared?

As in organic compound nitrogen is covalently bonded, it is first converted into ionic form and brought in solution. This solution is known as sodium extract.

*Preparation of sodium extract:* A small piece of dry Sodium metal is heated with an organic compound in a fusion tube for 2-3 minutes and the red hot tube is plunged in to distilled water

contained in a china dish. The contained of the china dish is boiled, cooled and filtered. The filtrate is known as Sodium fusion extract.

**51. Describe the chemistry of the Lassaigne's test for the detection of nitrogen.**

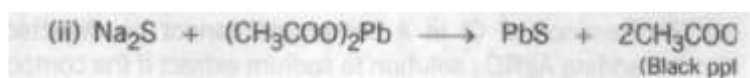
About 2 ml of sodium extract is taken in a test tube and a few drops of freshly prepared ferrous sulphate solution is added. A dirty green precipitate of ferrous hydroxide is obtained. In case it is not obtained, a few drops of sodium hydroxide are added. The contents of the test tube are now boiled and the solution is cooled. A few drops of ferric chloride and excess of concentrated HCl are then added to the cooled solution, if nitrogen is present, a prussian blue colouration or a Prussian blue precipitate is obtained. This confirms the presence of nitrogen in the given compound

**52. Explain why :**

**(1) A blood red colouration is obtained on addition of FeCl<sub>3</sub> to Lassaigne solution when the compound contains both N and S.**



**(2) A black precipitate is obtained in the Lassaigne's test for the detection of sulphur.**

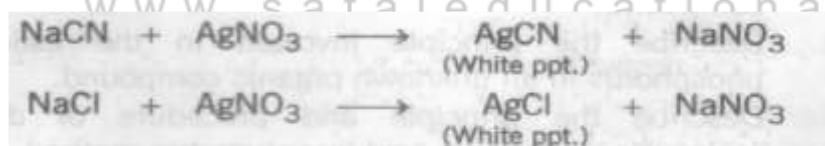


**(3) A blue or green colour in the flame is obtained during Beilstein's test for halogens,**

The halogen present in the compound reacts with copper to form a volatile copper halide which imparts blue or green colour to the flame.

**(4) Presence of Cl in a compound cannot be detected by adding AgNO<sub>3</sub> solution to sodium extract if the compound contains nitrogen also,**

If nitrogen is also present, the sodium extract will contain AgCN in addition to NaCl. Both give a white precipitate with AgNO<sub>3</sub>.



Therefore, it is not possible to detect Cl in presence of N by this method Cl can be detected only after the removal of NaCN.

**(5) No precipitate is obtained on adding AgNO<sub>3</sub> to chloromethane.**

Chloromethane is a covalent compound and Cl is not present in ionic form in it.

**53. Describe the principle involved in the quantitative estimation of nitrogen by Kjeldahl's method.**

When an organic compound containing nitrogen is heated with concentrated H<sub>2</sub>SO<sub>4</sub>, nitrogen present in it is quantitatively converted into Ammonium sulphate.

**54. Describe the Carius method for the estimation of sulphur in a compound.**

*The carius method:* A known amount of organic compound is heated with fuming nitric acid in a carius tube. Sulphur present gets oxidized to H<sub>2</sub>SO<sub>4</sub>. Now, the tube is cooled and the content are transferred to a beaker. The contents of beaker are warmed. About 1 cc of dil. HCl and excess of



BaCl<sub>2</sub> solution is added. White precipitate of BaSO<sub>4</sub> is obtained. The precipitate is filtered, washed, dried and weighed. From the mass of barium sulphate thus formed, percentage of sulphur in the given compound can be calculated.

**55. Describe the principle involved in the estimation of phosphorus in an unknown organic compound.**

The phosphorous present in an organic compound can quantitatively be converted to phosphoric acid by heating the compound with fuming HNO<sub>3</sub>.

**56. Describe the principle and procedure of determining molecular mass of an acid by volumetric method.**

The equivalent mass of the acid is determined by titrating a solution of acid containing a known mass of it against a standard alkali.

Procedure : Molecular mass =  $w \times 1000 \times \text{Basicity}$

$$\frac{N_1 \times V_1}{N_2 \times V_2}$$

**57. Describe the principle involved in the determination of molecular mass of an organic acid by silver salt method.**

Carboxylic acids form insoluble silver salts when treated with AgNO<sub>3</sub>. The silver salts are not much stable and decompose on heating to give metallic silver.

**58. On what principle is the chloroplatinate salt method for the determination of molecular mass of an organic base based?**

Most of the organic bases react with chloroplatinic acid [H<sub>2</sub>PtCl<sub>6</sub>] to form insoluble double salts known as chloroplatinates.

**59. What do you understand by inductive effect? Illustrate your answer with at least two examples.**

The displacement of  $\sigma$ -electrons along a saturated carbon chain due to the presence of an electron withdrawing or electron repelling group at one end of the chain resulting in the development of partial positive or negative charges in decreasing order of magnitude is known as inductive effect.

**60. How is +I-effect different from -I-effect? Illustrate with examples.**

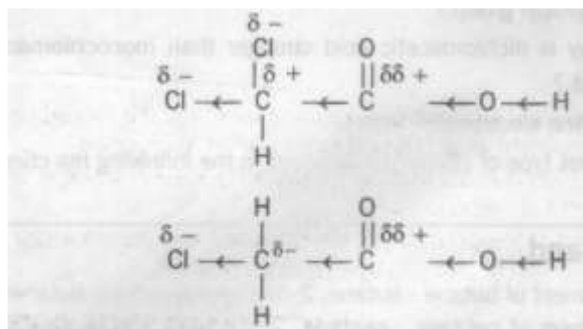
+I-effect		-I-effect	
1	When the substituent group attached to the chain of carbon atoms is an electron withdrawing group.	1	When an electron repelling group is attached to one end of a saturated carbon chain.
2	The electron withdrawing group is more electronegative than carbon.	2	The electron repelling is less electronegative than carbon.

**61. Why is the +I-effect of t-butyl group greater than that of isopropyl group?**

Because the +I-effect of the alkyl groups in the order 3<sup>o</sup>>2<sup>o</sup>>1<sup>o</sup> groups.

**62. Why is dichloro acetic acid stronger than monochloro acetic acid?**

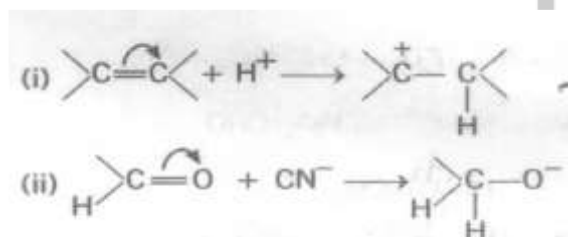
The -I-effect exerted by two Cl atoms facilitates the release of proton to a greater extent in dichloroacetic acid as compared to that in monochloroacetic acid which contains only one Cl atom.



**63. Define electromeric effect.**

The complete transfer of the shared pair of  $\pi$ -electrons of a multiple bond to one of the shared atoms in the presence of an attaching reagent is known as electromeric effect.

**64. What type of effects are involved in the following reactions?**



(i) +E-effect

(ii) -E-effect

**65. What are the main points of difference between inductive and electromeric effects?**

Inductive effect		Electromeric effect	
1	It is shown by the compounds containing single bond.	1	It is shown by the compounds containing double or triple bond.
2	It is a permanent effect.	2	It is a temporary effect.
3	This effect involves slight displacement of $\alpha$ -electrons from one atom towards another.	3	This effect involves the complete transfer of $\pi$ -electrons.

**66. When does mesomeric effect come into existence? Illustrate with examples.**

Mesomeric effect comes into existence when :

- ⇒ When an electron withdrawing or electron pumping group is in conjugation with a  $\pi$ -bond.
- ⇒ When an atom or group having at least one lone pair of electrons is in conjugation with a  $\pi$ -bond.

**67. Define mesomeric effect and differentiate +M-effect from -M-effect.**

The permanent effect involving the transfer of electrons relayed through  $\pi$ -electrons of multiple bonds in a chain of carbon atoms in a molecule is known as mesomeric effect.

+M-effect	-M-effect
-----------	-----------

1	When the transfer of electron is away from the atom or group in conjugation with a $\pi$ -bond.	1	When the transfer of electron is towards the atom or group in conjugation with a $\pi$ -bond
---	---	---	--

**68. Compare inductive effect with mesomeric effect.**

Inductive effect		Mesomeric effect	
1	It occurs in compounds containing single bonds.	1	It occurs in compounds containing multiple bonds particularly in conjugated systems.
2	It involves slight displacement of $\sigma$ -electrons.	2	It involves the transfer of $\pi$ -electrons.
3	It is transmitted over short distance.	3	In a conjugated system, it is transmitted over entire molecule.

**69. What do you understand by hyperconjugation effect? Illustrate with an example.**

The interaction of  $\sigma$ -electrons of carbon-hydrogen bond with  $\pi$ -electrons of double bonds of unsaturated system is called hyperconjugation.

**70. Why is hyperconjugation effect called ‘no bond resonance’?**

Since there is no bond between C and H<sup>+</sup> in these structures, hyperconjugation effect is also termed as ‘no bond resonance’.

**71. Why is the hyperconjugation effect exerted by a methyl group greater than that exerted by an ethyl group?**

-CH<sub>3</sub> group contains three C-H bonds, while -CH<sub>2</sub>CH<sub>3</sub> group contains only two C-H bonds at  $\alpha$ -position when present in conjugation to a double bond.

**72. Define heterolytic fission of a covalent bond.**

When a covalent bond breaks up in such a way that both the electrons belonging to the shared pair are taken away only by one of the atoms forming covalent bond is called heterolytic fission of a covalent bond.

**73. Why is a 3° free radical more stable as compared to 1° and 2° free radicals?**

Free radicals are short lived species and therefore they are quite reactive. Their order of stability follows the order 3° > 2° > 1°.

**74. What are carbocations? Give two examples.**

The chemical species which possess a positively charged carbon centre are carbocations.

**75. Discuss the orbital structure of a carbocation.**

The central carbon atom present in a carbocation is in a state of sp<sup>2</sup> hybridisation. The three sp<sup>2</sup> hybrid orbital of this carbon lie in one plane at an angle of 120°.

**76. What is relative order of reactivity of various types of carbocations and carbanions?**

The stability of different types of carbocations is in the order 3° > 2° > 1°.

The stability of different types of carbanions is in the order 1° > 2° > 3°.

**77. Define carbanion and discuss its orbital structure.**

The chemical species which possess a negatively charged carbon atoms is called carbanion.

Orbital Structure : The central carbon atom present in a carbanion is in a state of  $sp^3$  hybridisation lone pair electron.

**78. Why is 1° carbanion more stable than a 2° carbanion?**

Greater the number of alkyl groups attached to the central carbon atom, greater is the increase in magnitude of negative charge on central carbon due to +I-effect and lesser is the stability of carbanion.

**79. What are carbenes?**

Carbenes are the neutral carbon species in which the carbon atom is bonded in two monovalent atoms or groups and carries a lone pair of electron.

**80. What are electrophilic reagents? Give at least three examples.**

The species which possess an affinity for electrons. They possess a deficiency of electron and therefore in chemical reactions they attack on those centres which are rich in electrons.

e.g.,  $H^+$ ,  $H_3O^+$ ,  $NO^+$ , etc.

**81. Why do free radicals and carbenes act as electrophiles?**

Because they do not possess complete octet and have a tendency to achieve octet by taking electrons.

**82. What do you understand by nucleophilic reagents and what type of species act as nucleophiles? Give at least two examples.**

The species which possess an affinity for the positive charge. They are electron rich species and possess at least one lone pair of electron.

e.g.,  $OH^-$ ,  $CN^-$ ,  $H_2O$ ,  $NH_3$ .

**83. Why does ether act as a nucleophile?**

Due to the presence of lone pair of electrons on oxygen.

**84. What are nucleophilic substitution reactions? Give an example.**

The substitution reactions which are brought about by the attack of a nucleophile is called nucleophilic substitution.

**85. What are the reactive species involved in  $S_N1$  reactions?**

Carbocations.

**86. Explain why does a  $S_N2$  reaction involve an inversion in configuration.**

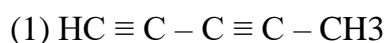
In the  $S_N2$  reactions, the attaching nucleophile attacks the substrate molecule from the rear side and the already present nucleophile leaves the molecule from the front side. Therefore, a  $S_N2$  reaction is followed by an inversion in configuration.

**87. Give three examples of electrophilic substitution reactions.**

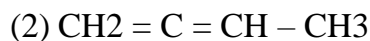
**88. Discuss the mechanism of anti-Markownikoff addition of HBr to an unsymmetrical alkene.**

**Q – 3 Important Question Answers.**

1. How many  $\sigma$  and  $\pi$  bonds are present in each of the following molecules?



Ans:  $\sigma_{\text{C}-\text{C}}:4$ ,  $\sigma_{\text{C}-\text{H}}:4$ ,  $\pi_{\text{C}=\text{C}}:4$



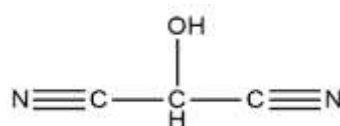
Ans:  $\sigma_{\text{C}-\text{C}}:3$ ,  $\sigma_{\text{C}-\text{H}}:6$ ,  $\pi_{\text{C}=\text{C}}:2$

2. Why are electrons easily available to the attacking reagents in  $\pi$ -bonds?

Ans: The electron charge cloud of the  $\pi$ -bond is located above and below the plane of bonding atoms.

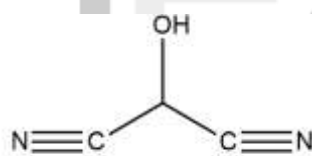
This results in the electrons being easily available to the attacking reagents.

3. Write the bond line formula for



Structure of  $\text{CNCHOHCN}$

Ans



Bond line structure of  $\text{CNCHOHCN}$

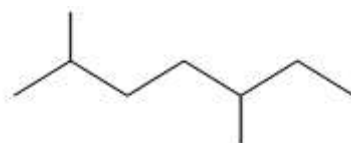
4. How are organic compounds classified?

Ans: (i) Acyclic or open chain compounds, (ii) Alicyclic or closed chain or ring compounds., (iii) Aromatic compounds.

5. Define homologous series?

Ans: A group or a series of organic compounds each containing a characteristic functional group forms a homologous series and the members of the series are called homologous.

6. Give the IUPAC name of the following:



Ans: 2,5-dimethyl heptane



## Q-3 Long Question Answers.

1. Discuss the main reasons for the existence of a very large number of organic compounds. Justify the study of organic compounds as a separate branch of chemistry.
2. What are organic compounds and how are they classified? Give two examples of each type.
3. What are functional groups? How are the organic compounds classified on the basis of functional groups? Mention the functional group of each class and give at least one example.
4. Discuss with examples the procedure of nomenclature of branched chain alkanes.
5. How would you name a compound when it contains two functional groups of different types? Illustrate your answer with examples.
6. What is structural isomerism? Define different types of structural isomerism and give an example of each.
7. Define tautomerism and give two examples. What is keto-enol tautomerism and describe its important characteristics.
8. Define geometrical isomerism and discuss the conditions necessary for it. Explain with at least two examples.
9. What type of molecules do exhibit geometrical isomerism? Discuss the cause of geometrical isomerism and describe the properties of geometrical isomers.
10. Do compounds having C=N and N=N bonds show geometrical isomerism? If yes, give two examples of each and name the isomers.
11. What is meant by optical activity? How is the rotation of plane polarised light by an optically active compound measured? Define specific rotation.
12. What is chirality and how is it related to optical activity? Explain with examples. Discuss the origin of chirality.
13. Discuss the cause of optical activity in a molecule. Support your answer with two examples.
14. Define optical isomerism and describe the characteristics of different types of optical isomers. What are enantiomers and diastereoisomers?
15. Discuss the optical isomerism exhibited by lactic and tartaric acids.
16. What is Lassaigne solution and how is it prepared? Discuss the chemistry of the tests used for the detection of following elements using this solution, (i) N (ii) Cl (iii) Br (iv) S
17. Describe the principle, apparatus used and the procedure for the estimation of C and H in an organic compound.

18. Describe Duma's method for the estimation of nitrogen in an organic compound.
19. Describe the principle, apparatus used and procedure for the estimation of nitrogen by Kjeldahl's method.
20. Describe Carius method for the estimation of halogens in an organic compound.
21. Explain the principle, apparatus used and procedure of determining the molecular mass of a volatile organic compound by Victor Meyer's method.
22. Describe the silver salt method for the determination of molecular mass of an organic acid.
23. Describe a chemical method commonly used for the determination of molecular mass of a base.
24. What do you understand by +I and -I-effects and what type of compounds show them? Give suitable examples. Mention the important features of inductive effect.
25. Define electromeric effect and differentiate between +E and -E-effects by taking suitable examples. What are the important features of these effects.
26. When does mesomeric effect come into existence? Discuss +M and -M-effects with suitable examples. How is the effect different from inductive effect?
27. What is hyper conjugation effect and why is it also called 'no bond resonance'?
28. Give a brief account of the various reaction intermediates usually involved in organic reactions.
29. What are free radicals and why are they highly reactive? Explain the relative stability of various types of free radicals.
30. What are carbocations? Discuss their orbital structure and explain the relative order of the stability of various types of carbocations.
31. What are carbanions? Discuss their orbital structure and explain the cause of their reactivity. Why is ethyl carbanion more reactive than methyl carbanion?
32. What are carbenes? Discuss the orbital structures of singlet and triplet carbenes.
33. What do you understand by electrophiles and nucleophiles and what type of substances act as these reagents? Explain with examples.
34. What do you understand by  $S_N1$  and  $S_N2$  reactions? Taking suitable examples, discuss their mechanism and stereochemistry.
35. Write short notes on (i) Electrophilic substitution reactions (ii) Free radical substitution reactions.
36. What are addition reactions? Discuss the mechanism of different types of addition reactions.
37. What do you understand by elimination reactions? Discuss the mechanism of  $E_1$  and  $E_2$  reactions.
38. What are intramolecular and intermolecular rearrangement reactions? Explain with suitable examples.