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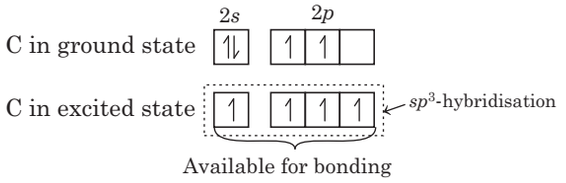
Organic Compounds and their Nomenclature

Compounds of carbon other than its oxides and carbonates are called **organic compounds**. These are studied under separate branch of chemistry, called the **organic chemistry.** Organic compounds are vital for sustaining life on the earth and include complex molecules like carbohydrates, lipids, nucleic acid and proteins.

Tetravalency of Carbon

We are familiar with the fact that carbon is the essential element of all the organic molecules and its electronic configuration is 2,4, or $1s^2, 2s^2, 2p^2$. In the ground state its two *p*-orbitals are half-filled, and hence, carbon is expected to exhibit a valency of two. But in all of its compounds, it exhibits tetravalency.

According to classical concept of bonding, the tetravalency of carbon can be explained through the fact that in excited state one of the paired 2*s*-electron is moved to empty 2*p*-orbital by gaining energy from the system. However, according to modern concept of bonding presence of 4 equivalent C—H bonds in CH_4 is explained on the basis of concept of hybridisation.



Being tetravalent carbon requires four electrons to complete its octet. But it is not possible for carbon to accept or donate four reach at electrons to reach at inert gas configuration, due to energy conceptions. Thus, carbon always combines with other atoms by mutual sharing of electrons and forms covalent bonds.

IN THIS CHAPTER ....

σ and π-Bonding in Organic Compounds

Carbon has a unique property that it can form both the types of covalent bonds, i.e. the σ (sigma) and the π (pi).

A single bonds contains only one σ-bond. On the other hand, there are one σ-and one π-bonds in case of a double bond and one σ-and two π-bonds in case of a triple bond.

Shapes of Simple Molecules

The shapes of organic molecules can be decided by the number of σ-bonds or by the concept of hybridisation. We all know that organic compounds being covalent are the result of overlapping of orbitals of different elements.

Hybridisation and Shapes

Usually saturated hydrocarbons are sp^3-hybridised while unsaturated hydrocarbons may be sp^2 or sp-hybridised. A sp^3-hybridised molecule is generally tetrahedral (if lone pairs are not present), a sp^2-hybridised molecule is generally trigonal planar and a sp hybridised molecule is planar.

Hybridisation and Bond Parameters

Bond parameters like bond length, bond angle etc., are affected by hybridisation. The effect of hybridisation on different bond parameters is discussed below.

1. Bond Length

The size of p-orbitals is much larger as compared to the size of s-orbitals. Secondly, a larger orbital forms a longer bond. Therefore, C—C sigma bond length increases as the number of hybridised p-orbitals increases. The carbon bonded through triple bond are sp-hybridised, i.e. with one p-orbital and (50%) p-character.

Similarly, the carbon atoms that bonded through double bond are sp^2-hybridised, i.e. with two p-orbitals and 66.7% p-character. Lastly, the carbon atoms that bonded through single bond are sp^3-hybridised, i.e. with 3 p-orbitals and 75% p-character. Thus, the order of percentage of p-character in different hybridisation is

$$\underset{(sp^3)}{>C-C<} > \underset{(sp^2)}{>C=C<} > \underset{(sp)}{-C\equiv C-}$$

Therefore, the order of bond length is also as

$$\underset{\uparrow}{>C-C<} > \underset{\uparrow}{>C=C<} > \underset{\uparrow}{-C\equiv C-}$$

154 pm 134 pm 120 pm

Similarly, the C—H bond in alkanes, alkenes and alkynes, may also differ C—H bond in these compounds is/are formed between s-orbital of hydrogen and sp / sp^2 / sp^3 hybrid orbital of C-atom. So, as the size of the hybrid orbital decreases, the C—H bond lengths also decrease accordingly as,

$$\underset{111\text{ pm}}{C(sp^3)-H} > \underset{110\text{ pm}}{C(sp^2)-H} > \underset{108\text{ pm}}{C(sp)-H}$$

2. Bond Strengths

Shorter the bond length, greater is the bond strength. Thus, the σ-bond formed by sp-hybridised carbon is the strongest as sp-orbital has highest electron density. On the other hand,that formed by sp^3-hybridised carbon is the weakest as sp^3-orbital has lowest electron density.

The bond energies of different C—H and C—C bonds follow the following order

(i) $\underset{507\text{ kJ mol}^{-1}}{C(sp)-H} > \underset{443\text{ kJ mol}^{-1}}{C(sp^2)-H} > \underset{435\text{ kJ mol}^{-1}}{C(sp^3)-H}$

(ii) $\underset{433\text{ kJ mol}^{-1}}{C(sp)-C(sp)} > \underset{383\text{ kJ mol}^{-1}}{C(sp^2)-C(sp^2)} > \underset{347\text{ kJ mol}^{-1}}{C(sp^3)-C(sp^3)}$

A carbon-carbon **double bond** because of the presence of a strong σ-bond and a weak π-bond is, however, stronger (598 kJ mol^{-1}) as compared to a carbon-carbon single bond which contains only a σ-bond. Similarly, a carbon-carbon **triple bond** is still stronger (803 kJ mol^{-1}) as compared to a carbon-carbon double or single bond.

3. Bond Angles

As the s-character in hybridised orbital decreases, the bond angle also decreases. The bond angle is 180° in sp-hybridisation; 120° in case of sp^2-hybridisation and, 109°.28′ in case of sp^3-hybridisation.

Along with above written bond angles parameters like **electronegativity** of C-atom also show variations with change of hybridisation. It varies directly with s-character but inversely with p-character, i.e. greater the s-character of the hybrid orbitals, more is the electronegativity of the atom. Thus, the order of the electronegativity of C-atom is as,

Hybridisation	sp	> sp^2	> sp^3
Electronegativity	3.3	2.75	2.5

Note If no double or triple bonds are present in a molecule, the carbons of the molecules are usually sp^3-hybridised.

Organic Compounds

More than a century ago all substances then known were classified on the basis of sources from which they were derived.

The compounds which were of mineral origin were called **inorganic** and those of vegetable or animal origin were called **organic** as the word organic signifies life. It was assumed that the organic compounds could be produced only by living beings inside their body.

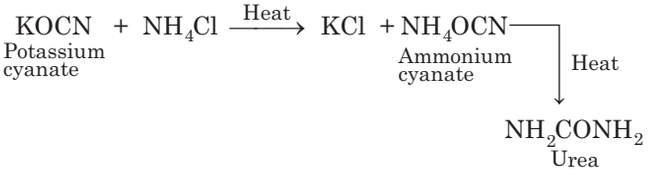
Vital Force Theory

- **Lavoisier** 'The Father of Chemistry', in 1785, showed that these organic compounds always contain C and H and frequently N and P. **Berzelius** assumed that some vital force infact life force was necessary to produce these organic compounds and synthesis of these

compounds in laboratory was impossible. This concept was commonly named as vital force theory.

- The vital force theory was suffered a blow in 1828, when German chemist **Friedrich Wholer** heated ammonium cyanate and obtained the organic compound **urea.** This ammonium cyanate was derived from inorganic substances.
- The urea thus, formed was proved to be identical in all respects with urea isolated from the urine of living beings.

This complete route of urea formation is given below



This synthesis did not immediately break down the old concept of vital force. A further blow to vital force theory was given by **Kolbe** in 1845, when he synthesised **acetic acid** (CH_3COOH).

- It was the first organic compound synthesised in laboratory from its elements. Afterwards **Berthelot** (1865) synthesised **methane** in the laboratory. Since, then a large number of organic compounds have been synthesised with their formation governed by simple laws of formation.
- Although, the original meaning of the term organic chemistry is no longer applicable, but this word has been retained because so many substances involved in organic chemistry do come directly or indirectly from living beings. In modern terms, *the organic compounds are defined as the hydrides of carbon* or *hydrocarbons and their derivatives*.

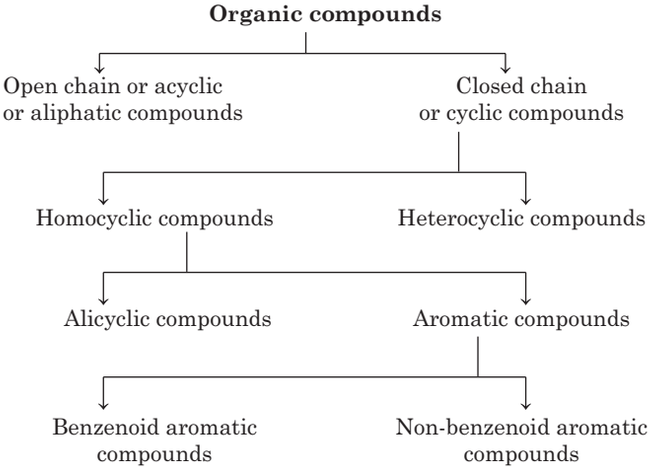
Classification of Organic Compounds

Due to the unique power of catenation in C-atom, organic compounds number in millions. In order to facilitate the study of such a large number of compounds, it is necessary to classify them.

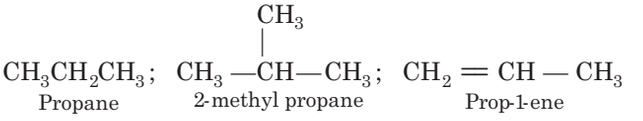
The organic compounds have been classified on the basis of their **carbon skeleton** or structure or **functional groups with the concept of homology.**

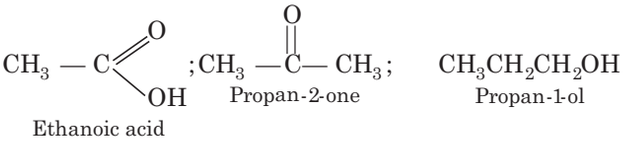
Classification Based on Structure

Depending on the structure, the organic compounds can be classified as,

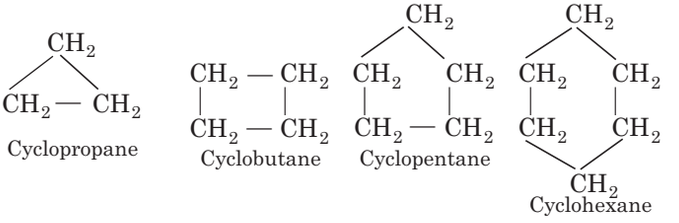


- *Some examples of aliphatic compounds are*

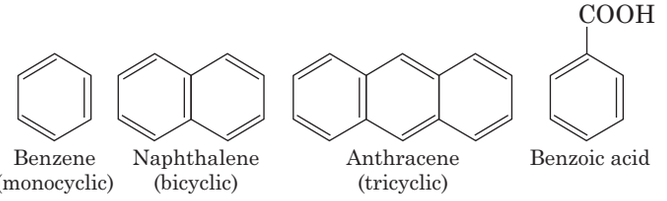




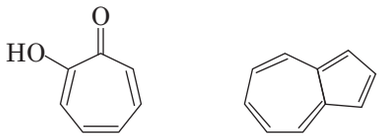
- *Some examples of alicyclic compounds are*



- *Some examples of benzenoid aromatic compounds are*



- *Some examples of non-benzenoid aromatic compounds are*

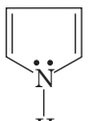


Tropolone

Azulene

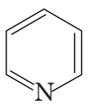
- *Some examples of heterocyclic compounds are*

Furan

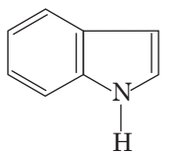


Pyrrole

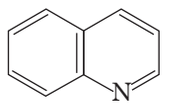
Thiophene



Pyridine



Indole



Quinoline

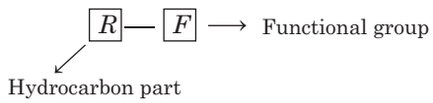
Classification Based on Functional Group

The compounds of carbon and hydrogen or hydrocarbon are considered as the parents of all the organic compounds. All other organic compounds are obtained from them by the replacement of one or more H-atoms with other atoms or groups as shown below.

$$\underset{\text{Hydrocarbon}}{R\text{—H}} \xrightarrow[-X]{-H} \underset{\text{Hydrocarbon derivative}}{R\text{—}Y}$$

Thus, except hydrocarbons all the organic compounds carry two parts; one hydrocarbon part (*R*) and other functional group (*Y*).

In an organic molecule like



R— can be **alkyl** group if hydrocarbon portion belongs to alkane, i.e. contains only single bond. It can be an **alkenyl** group if hydrocarbon portion belongs to alkene, i.e. contains at least one double bond. It can be an **alkynyl** group if hydrocarbon portion belongs to alkynes, i.e. contains atleast one triple bond.

The functional group *Y* is responsible for chemical properties whereas hydrocarbon part affects the properties. Thus,

"A functional group is an atom or group of atoms, in an organic molecule, which is responsible for the chemical properties of that molecule."

e.g. double and triple bonds are functional groups. Their other examples include —Cl, —Br, —OH, —NH_2 etc., groups.

Each functional group have its own characteristic reactions and by recognising the functional group in a molecule, it is possible to predict the reaction, which that molecule can undergo.

An organic molecule may contain more than one functional group and then it said to be **poly-functional.** In poly-functional compounds properties of each functional group may be modified by the presence of the other functional groups.

Homologous Series

It is a series of compounds which contains members with similar or graded properties. The individual members are called **homologues**.

The general characteristics of a homologous series are as follows

- All the members of a series contain same elements and the functional group.
- All the members can be represented by a single general formula. e.g. C_nH_{2n+2} is the general formula for alkanes. $C_nH_{2n+1}OH$ is the general formula for alcohols.
- The molecular formula of each homologue differs from its previous and successive member by a —CH_2 unit, or their molecular mass differs by 14 units.
- All members of a series can be prepared by almost similar methods.
- There is a gradual variation seen in physical properties of homologous with increasing molecular weight.
- All the members of a series show almost similar chemical properties.
- The homologous series of alcohols is given below

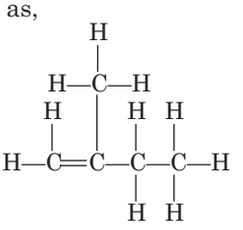
CH_3OH	Methyl alcohol
CH_3CH_2OH	Ethyl alcohol
$CH_3CH_2CH_2OH$	Propyl alcohol
$CH_3CH_2CH_2CH_2OH$	Butyl alcohol
$CH_3CH_2CH_2CH_2CH_2OH$	Pentyl alcohol

Structural Representation of Organic Compounds

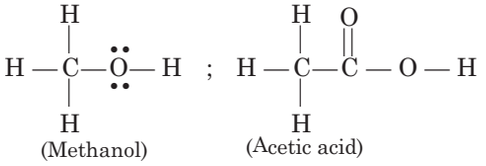
An organic compound can be represented in following ways

1. Complete Notation

Complete notation means all the bonds (either single or double or triple) present between any two atoms are shown clearly. e.g. The complete notation of 2-methyl but-1-ene is shown as,



Similarly, the complete notations of methanol and acetic acid are shown below



2. Condensed Structure

When all the bonds (except double and triple bonds between two carbon atoms) are omitted, the obtained structure is called condensed structure.

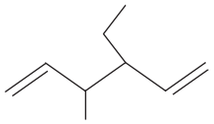
e.g. $CH_2 = C(CH_3)CH_2CH_3$; CH_3OH (Methanol); CH_3COOH (Acetic acid)

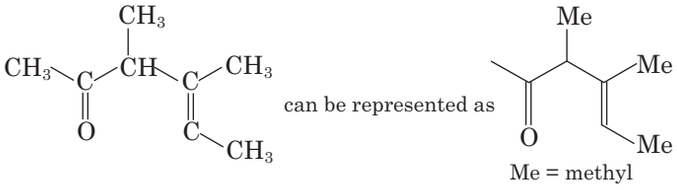
3. Bond Line Notation

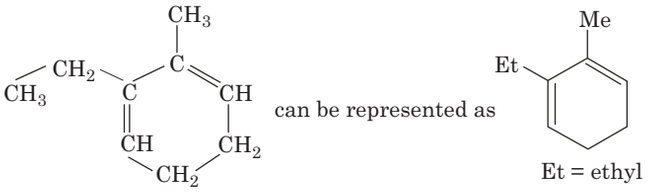
It is one of the most simple and convenient method of representing structures. In this notation bonds are represented by lines and C-atoms by line ends and intersections. It is assumed that required number of H-atoms are present wherever, they are necessary to satisfy tetravalency of carbon, e.g.

$CH_2 = CH - CH(CH_3) - CH(C_2H_5) - CH = CH_2$ can be

represented as,







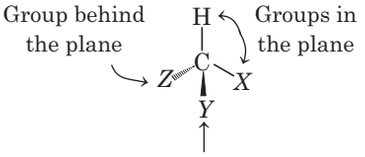
4. Projection Formulae

Different projection formulae have been given to define the structure of a molecule completely. These have the ability of interconversion as will.

In particular following two are of most common use.

(i) **Wedge-Dash formula** In this formula the configuration of organic molecules can be visualised as three-dimensional (3D) structure.

Any compound through this formula can be depicted by following representations



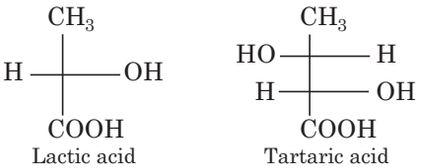
Here, the thick solid (solid wedge) line represents the bonds lying above the plane of paper i.e. projecting towards the viewer. Thin lines indicate the bonds lying within the plane of paper; while the dotted line indicates the bonds lying below the plane of paper, i.e. projecting away from the viewer.

(ii) **Fischer projection formulae** A planar representation of the three dimensional structure is called Fischer projection formulae.

Following guidelines are used to draw it.

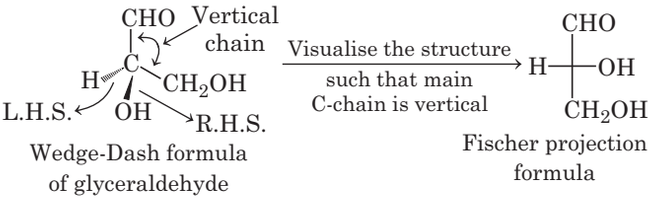
- The chain of carbon atoms is arranged vertically in such a way that the most oxidised carbon occupy the top position.
- The asymmetric carbon atom lies is the plane of paper and is represented at the interception of crossed lines.
- The bonds going away from the viewer are represented by vertical lines.
- In other words, vertical lines represent the groups present behind the plane of paper.
- The bonds coming towards the viewer are represented by horizontal lines. In other words, group attached to the horizontal lines represent the groups present above the plane of the paper.

Using the above guidelines, the Fischer projection formulae for lactic acid and tartaric acid are shown below as

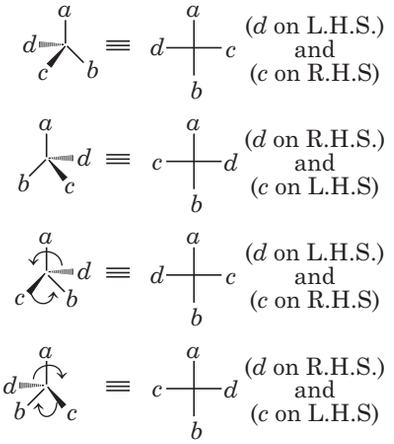


(iii) **Interconversion of Wedge-Dash formula to Fischer formula** In case of molecules having several C atoms, it is customary to orient the molecule in such a way that the C-chain is vertical.

Substituents which are left and right of the viewer are written at left and right, respectively, and other two substituents which appear above and below are written at top and bottom positions, e.g.

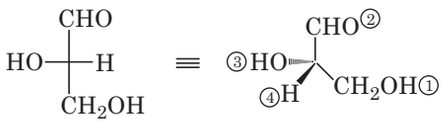


Although, the Fischer projections are planar structures, still these can be rotated end-for-end on the plane of paper only in multiples of 180° but not 90° at a time. Also a Fischer projection formula may not be taken out of the plane of paper and flipped over.



(iv) **Interconversion of Fischer formula to Wedge-Dash formula** While drawing the 3D formulae from the corresponding Fischer formula, it is better to draw the group at the lower end of the vertical line towards right hand side first.

Then write the group at the top of vertical line and arrange the horizontal groups at the end as shown below.



Fischer formula Wedge-Dash formula

Systems of Nomenclature of Organic Compounds

Different system of naming of organic compound are as follows

1. Trivial System

It is the oldest system of naming organic compounds. These names have no part used in a systematic sense. So, whenever a new compound was discovered, it was given an individual name.

Such a name was assigned at the wish of discoverer and had no system. These names are also called **common names** and are generally based on the source or some important property or any other reason. Quite frequently these names had their Latin or Greek roots, e.g.

(i) Acetic acid (*Acetum* = Vinegar). Vinegar is liquid which contain CH_3COOH as its chief constituent.
(ii) Oxalic acid (derived from *Oxalus*)
(iii) Malic acid (derived from *Pyrus malus*)
(iv) Citric acid (derived from *Citrus*)
(v) Formic acid (first obtained from red ants *Formicus*)
(vi) Urea and uric acid (from urine in which both are present)
(vii) Methyl alcohol (from *methu hul* means wine alcohol)
(viii) Butyric acid (from *butyrum*, i.e. butter)

2. Semitrivial System

It is a name in which at least one part is used in a systematic sense, e.g. Glycer(ol), Acet(one), Styr(ene), 5-α-cholest(ane)

Here, words in brackets are used in systematic sense.

As these names are derived from two sources, hence these are also called **derived names.**

3. IUPAC System

In 1957, the International Union of Pure and Applied Chemistry evolved a scheme for giving systematic name to organic compounds on the basis of their structure. This is known as the **IUPAC system of nomenclature.** This system has set of rules for naming organic molecules on the basis of their structures.

One organic compound can have only one IUPAC name and it is always superior to all common and derived names.

After knowing the IUPAC names it is possible to draw the structures of organic compounds also. Remember IUPAC amends these rules from time to time and in this book we are following the 1993 (most recent) recommendations of IUPAC nomenclature.

Guidelines of IUPAC Nomenclature

According to IUPAC the name of an organic compound consists of following components

Prefixes	+	Root word	+	Suffixes
Tells us about the branches or substituents except in the case of multiple bonds		Tells us about the length of longest possible chain		Tells us about the principal functional groups mostly except in the case of halogens

or

Primary prefix + Secondary prefix + [Root word] + Primary suffix + Secondary suffix

Out of these the generalised details of prefixes and suffixes are given below.

I. **Prefix** It is used to indicate the substituents and is of the following two types
   (i) **Primary prefixes** Those prefixes
   - which are usually used to distinguish between cyclic and acyclic compounds just like cyclo, bicyclo etc.,

- the prefixes used to tell us about the number of substituents present just like *bi, di, tri, tetra, tris, tetrakis, ter, quater* etc.

(ii) **Secondary prefixes** These are infact

- the names of those groups to which IUPAC consider as substituents or branch either always (e.g. halogens) or
- under certain conditions, i.e. whenever principal functional group is present alongwith the substituents in polyfunctional compounds. These prefixes are always written immediately before the root word. Some of these prefixes are given below

Prefixes for Substituents

Substituent	Prefix	Substituent	Prefix
—F	Fluoro	—N═N—	diazo
—Cl	Chloro	—N═O	nitroso
—Br	Bromo	—NO_2	nitro

The prefixes used for functional group are given below in the table alongwith their suffixes.

II. **Suffix** It is used to indicate the functional group. The suffix are also of two types

(i) **Primary suffixes** are those words which tells us about the saturation or unsaturation of longest possible chain. The three basic primary suffixes are
– **ane** for saturated chain,
– **ene** for unsaturated chain with a double bond,
– **yne** for unsaturated chain with a triple bond.

(ii) **Secondary suffixes** are infact the names of principal functional groups either in monofunctional or in polyfunctional compounds. These along with prefixes in the order of priority are given in the following table.

Prefix and Suffix of Various Functional Groups
(as given under the 1993 recommendations of IUPAC)

Class	Formula	Prefix	Suffix
Carboxylic acids	—COOH	carboxy-	–carboxylic acid
	—(C)OOH	—	–oic acid
Sulphonic acids	—SO_2 — OH	sulpho-	–sulphonic acid
Esters (of carboxylic acids)	—COO*R**	(*R**)-oxy-carbonyl	(*R**)… carboxylate
	—(C)OO*R**	(*R**)-oxycarbonyl	(*R**)…oate
Acid halides	—C(=O)—*X*, —(C)(=O)—*X* where, *X* = halogen	halocarbonyl –	–carbonyl halide –oyl halide
Amides	—CO—NH_2	carbamoyl–	–carboxamide
	—(C)O — NH_2	—	–amide
Nitriles	—C≡N	cyano–	–carbonitrile
	—C≡N	—	–nitrile
Aldehydes	—CHO	formyl–	–carbaldehyde
	—(C)HO	—	–al
Ketones	>C═O	oxo	–one
Alcohols, Phenols	—OH	hydroxy–	–ol
Thiols	—SH	sulphanyl-	–thiol
Amines	—NH_2	amino–	–amine
Imines	═NH	imino–	–imine
	═N*R**	(*R**)-imino	
Ethers	—O*R**	(*R**)-oxy	–

*In the above table *R* designates any alkyl group and C-atom in ( ) means when it is included in the main chain while C-atom without ( ) means it is not included in the main chain.

Steps for Writing the IUPAC Names

Following steps are used to write the IUPAC name of an organic compound

***Step* I** Locate or select the longest chain with as many possible secondary functional groups alongwith multiple bonds, i.e. choose the longest possible chain.

***Step* II** Select the word root corresponding to the length of longest possible chain. For one to four carbon atoms, special word roots are used whereas, for five or more carbon atoms, Greek numericals are used. The word roots alongwith the number of carbon atoms are tabulated below

Word Root Representing C-atoms

Chain length	Word root	Chain length	Word root
C_1	Meth–	C_7	Hept–
C_2	Eth–	C_8	Oct–
C_3	Prop–	C_9	Non–
C_4	But–	C_{10}	Dec–
C_5	Pent–	C_{11}	Undec–
C_6	Hex–	C_{12}	Dodec–

***Step* III** Number the longest possible chain in accordance with the rules to give an identification number to each C-atom of longest possible chain.

***Step* IV** Add suitable prefixes and suffixes alongwith numerals to indicate the number and position of each side chain, substituent or functional group present in the compound.

Rules for Writing IUPAC Names

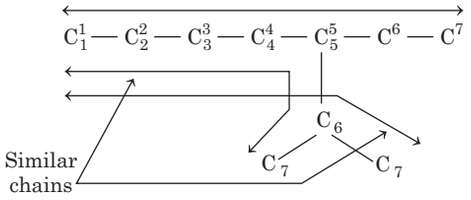
Following rules are followed while giving IUPAC name to an organic compound.

Rules to Select the Longest Chain

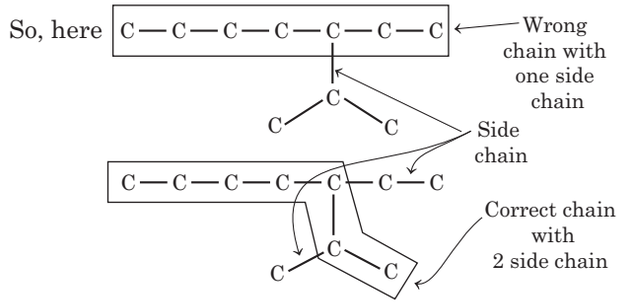
The longest possible chain can be selected in accordance with the following rules

I. Normally the chain with maximum number of C–atoms will be the longest possible chain.

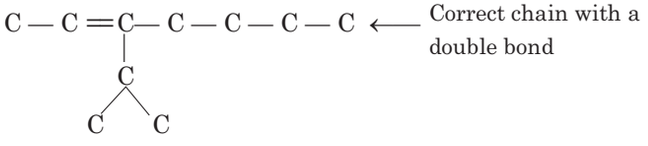
II. In case of two or more chains with same number of C–atoms are present then select the chain with maximum number of side chains as the longest possible chain. IUPAC prefers such a situation to avoid complicated names, e.g.



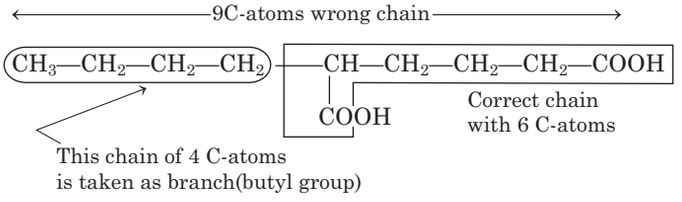
In this example, all the 3 possible chains contain 7 C-atoms in them. Out of these, two chains are similar as shown in diagram.



III. If any double bond/triple bond/functional group is present in the molecule, then it must be included in the longest possible chain, e.g.



IV. Avoid the longest chain rule even if the chain containing multiple bonds or functional group falls smaller than other chains (the rule of exception), e.g.



In this particular case, although the longest chain has 9 C-atoms but the preference will be given to the chain of 6 C-atoms.

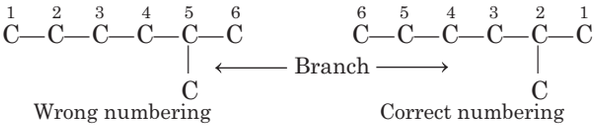
So, the longest possible chain can be defined as "the chain containing the principal functional group + secondary functional group + multiple bonds as many as possible".

Rules of Numbering the Longest C-Chain

In numbering a chain following rules are considered

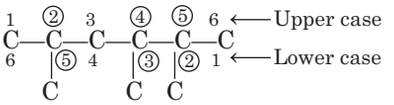
I. Numbering can be done from either of its ends for a symmetrical compound.

If a single branch or chain is present in the compound then numbering must be done in such a manner so that this branch acquires the least possible number, e.g.



II. If more than one side chains are present in the compound and if

(i) All the chains are of same length, then numbering must be done in accordance with **lowest sum rule** i.e. numbering should be done in such a way that the sum of numbers of side chains will be the least, e.g.



Sum

for upper case 2 + 4 + 5 = 11 (wrong numbering)

for lower case 2 + 3 + 5 = 10 (correct numbering)

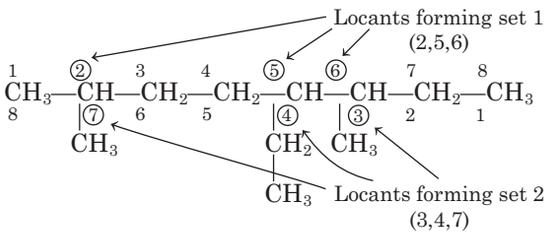
Here, as the sum of lower case is least that is why, it is preferred.

(ii) In case of branches of different lengths, the numbering must be done in accordance with **"lowest set of locants rule".**

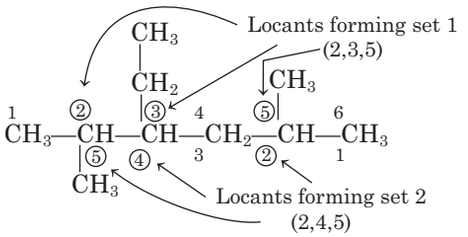
The word "locant" is used by IUPAC for those C-atoms in a chain which bear a branch or a multiple bond or a functional group.

According to this rule "while comparing two or more different sets of locants containing the same number of terms then that set of locants is considered as lowest which when compared term by term has the lowest term at the first point of difference, e.g.

***Case* 1** Suppose in a chain two sets of locants come as (2, 5, 6) and (3, 4, 7) then the first set will be preferred because the first term, i.e. 2 in the first set is lower than the first term in the second set, i.e. 3.

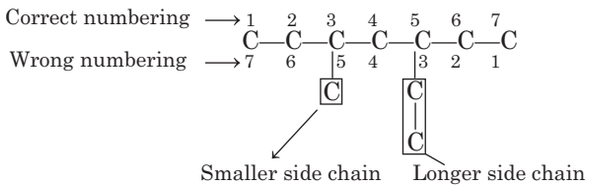


Case 2 Similarly, suppose, if 2 sets of locants come as (2, 3, 5) and (2, 4, 5) then here again first set is preferred because the second term in the first set is smaller as first term is being same in both the sets.

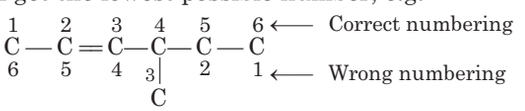


Now, from the above two examples it is clear that we are comparing the set of locants one by one and while comparing that set of locants is preferred which has a lower number at the first point of difference. That's why the rule is also called sometimes as **first point of difference rule.**

(iii) If the side chains of different lengths are present at the equal distance from the ends, then the chain with lesser number of carbon atoms must get the least possible number, e.g.

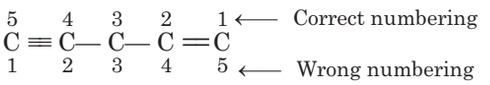


III. If multiple bonds, i.e. either double or triple bond is present alongwith the side chain then numbering must be done in such a manner that multiple bond will get the lowest possible number, e.g.



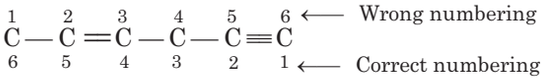
*multiple bond ⇒ double bond or triple bond

IV. If double bonds and triple bond both are present in the compound then double bond must be preferred.



Remember here, the comparison can be made only if the bonds are present on the same footings, i.e. situated at equal distance from the ends as shown above.

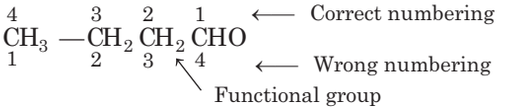
Otherwise, the bond near to the end is preferred, e.g.



In the above example, triple bond and single bonds are not present at the same footings. Hence, out of these two, triple bond will be preferred, i.e. numbering must be done in such a manner that the triple bond will get least possible number.

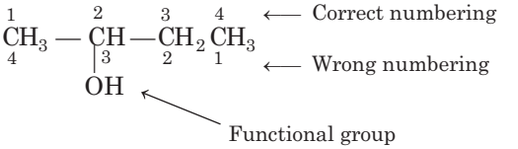
V. If any other functional group is present in the compound then numbering must be done in such a manner that the functional group will get the lowest possible number.

e.g.



The above example is for those functional groups which contain C-atom in them.

VI. For those functional groups which does not contain C-atom in them, the example is written below.



Here, C-atom to which functional group is attached is considered as C-atom of functional group and this must get least possible number.

VII. If more than one functional groups are present in the compound then the group which comes first (up) in the following preferential order will be considered as **principal functional group** and rest of the functional groups are considered as **substituent groups or branch.** This order is taken directly from the 1993 recommendation of IUPAC nomenclature.

Here, numbering must be done in such a way, so that the principal functional groups get the IUPAC least possible number.

Order of Various Preferential Functional Group (As per 1993 recommendation)

The order of priority of various functional groups are as follows

- Radicals
- Anions
- Cations
- Zwitter ionic compounds
- Acids (in the order COOH then their S and Se derivatives followed by sulphonic, sulphinic, selenonic, etc., phosphonic, arsonic, etc., acids)
- Acid halides
- Anhydrides
- Esters
- Imides
- Amides
- Hydrazides
- Nitriles
- Aldehydes followed by thioaldehydes, selenoaldehydes and telluroaldehydes.
- Ketones followed by thioketones, selenoketones and telluroketones.
- Alcohols and phenols followed by thiols, selenols and tellurols.
- Hydroperoxides followed by thiohydroperoxides, selenohydroperoxides and tellurohydroperoxides.
- Amines
- Imines

- Hydrazines, phosphanes, etc.
- Ethers followed by sulphides, selenides and tellurides
- Peroxides followed by disulphides, diselenides and ditellurides.
- Alkene
- Alkyne
- Halo, nitroso, nitro, alkoxy
- Oxiranes (cyclic ethers)

Functional Groupwise IUPAC Nomenclature

After the study of rules and steps for writing IUPAC name, one can write the name of any class of compound. However, we are providing the details of nomenclature of different functional group series step by step, for better understanding of IUPAC nomenclature.

Hydrocarbons

These are the compounds that contain carbon and hydrogen only. These are of the following types

1. Alkanes

Alkanes are the hydrocarbons that contain only single bonds (saturated). The first four members of the series are known by their common names, i.e. **methane, ethane, propane** and **butane.**

The names of larger alkanes are derived from the Greek prefixes that indicate the number of C-atoms in the molecule, e.g. **pentane** (with 5 C-atoms), **hexane** (with 6 C-atoms) and so on.

Infact the names of the alkanes are obtained by adding '–ane' to the root word.

Root word + -ane = alkane

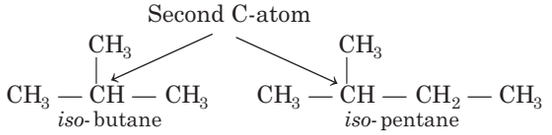
In the common system all isomeric alkanes have the same parent name, e.g. two isomeric C_4H_{10} alkanes are known as butanes. The names of various isomers are distinguished by prefixes.

The prefix indicates the type of branching present in the molecule.

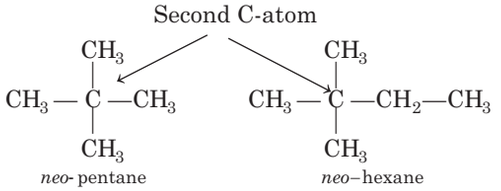
(i) **Prefix *n*** is used for those alkanes in which all carbons are in one continuous chain. The prefix *n*-stands for normal or straight chain of carbon atoms. e.g.

$CH_3CH_2CH_2CH_3$ (*n*-butane) $\qquad$ $CH_3CH_2CH_2CH_2CH_2CH_3$ (*n*-hexane)

(ii) **Prefix *iso*** is used for those alkanes which have a methyl group —CH_3 attached to the second or second last carbon atom of the continuous chain. e.g.



(iii) **Prefix *neo*** is used for those alkanes which have two methyl groups attached to the second or second last carbon atom of the continuous chain. e.g.



However, IUPAC does not recognise these prefixes.

According to IUPAC,

- *n*-butane or *n*-hexane is only butane or hexane.
- *iso*-butane is 2-methylpropane.
- *iso*-pentane is 2-methyl butane.
- *neo*-pentane is 2, 2-dimethylpropane.
- *neo*-hexane is 2, 2-dimethylbutane.

Primary, Secondary, Tertiary and Quaternary Carbons

The structural formula of alkanes contain four types of carbons. These are as follows

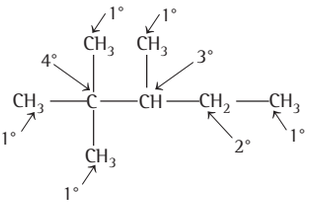
(i) Primary carbon (or 1° carbon atom) It is the carbon atom which is attached to one or no other carbon atom.

(ii) Secondary carbon (or 2° carbon atom) It is the carbon atom that is attached to two other carbon atoms.

(iii) Tertiary carbon (or 3° carbon atom) It is the carbon atom that is attached to three other carbon atoms.

(iv) Quaternary carbon (or 4° carbon atom) It is the carbon atom which is attached to four other carbon atoms.

All these C-atoms are shown below



Hydrogen atoms attached to these carbon atoms are often referred to as primary, secondary and tertiary hydrogen atoms.

However, **names of these carbon and hydrogen atoms are not recognised by IUPAC**.

Alkyl Group

When a hydrogen atom is removed from an alkane, the remaining group is called alkyl group and represented by '*R*'. e.g. —CH_3 (methyl group) is obtained by removing one H-atom from methane (CH_4).

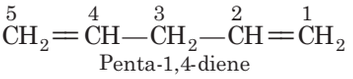
2. Alkenes

Alkenes are the hydrocarbons that contain one or more carbon-carbon double bond. Their common names are obtained by changing the ending **–ane** to **–ene**. i.e.

alkane –ane + ene = alkene

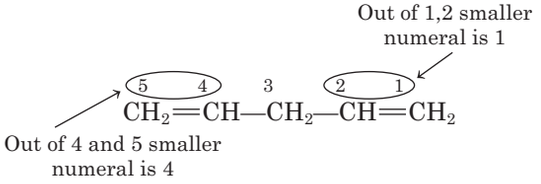
If parent chain contains 2, 3 or 4 double bonds than numerical prefixes like **di** (for two), **tri** (for three) or **tetra** (for four) are added to primary suffix.

Remember in all such cases –a of ane is retained. e.g. alkadiene, alkatriene etc., e.g.



Penta-1,4-diene

While writing the position of double bond, always write the smaller numeral of the two atoms between which the bond is present. e.g. In the above example



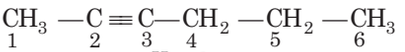
Hence, 1 and 4 are included in the name, e.g. penta-1,4-diene.

Remember Alkyl group just like alkyl groups, the groups formed after removed of one hydrogen from an alkane is called **alkenyl**, e.g. —CH=CH$_2$ is called ethenyl group.

3. Alkynes

Alkynes are the hydrocarbons that contain C—C triple bonds (C≡C). The IUPAC rules for naming alkynes are analogous to those for alkenes, i.e.

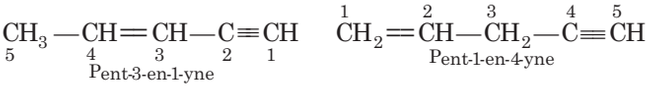
alkane – ane + yne = alkyne

e.g. 

Hex-2-yne

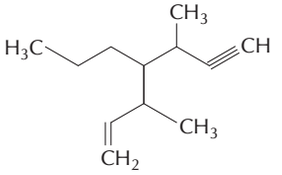
If both double and triple bonds are present in the compound, the endings like -en-yne, a (numeral) dien-(numeral)-yne etc., are used.

Numbers as low as possible are given to double and triple bonds as a set, e.g.



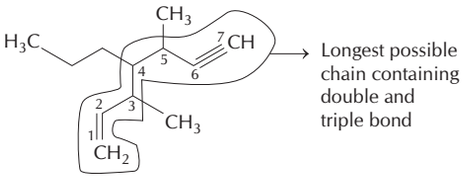
Pent-3-en-1-yne Pent-1-en-4-yne

Example 1. *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

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

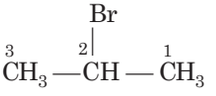


If both double and triple bonds are present in the compound, at the equal footings then always double bond is preferred.

Alkyl Halides

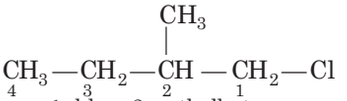
These are the compounds which contains carbon-halogen bonds. Their name is written by adding prefix 'halo' (chloro, bromo, iodo) with the position number to the name of parent alkane.

n-halo + alkane ⟶ *n*-haloalkane

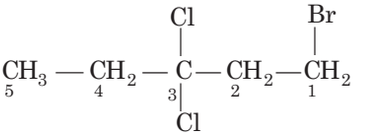
e.g. 

2-bromopropane

If there are two or more identical halogen substituents, the prefix, di, tri, tetra etc., are used.

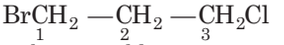
e.g. 

1-chloro-2-methylbutane



1-bromo-3,3-dichloropentane

If the two different halo group occupy the same position from the opposite sides of the parent chain, the perference will be given to the halogen according to alphabetical order e.g.



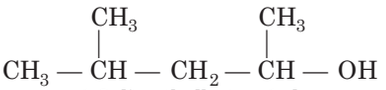
1-bromo-3-chloropropane

Alcohols

These are the compounds in which a hydroxyl group (—OH) is bonded to a saturated carbon. They are classified as primary, secondary, or tertiary, depending upon whether the —OH group is attached to a primary, secondary, or tertiary carbon atom. Abbreviations for these terms are 1°, 2° and 3° respectively. However, terms primary, secondary and tertiary are not recognised by IUPAC.

Their name is obtained by dropping the final –e from the name of the alkane that contains the same number of carbon atoms and adding the ending '–ol'. e.g.

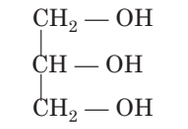
alkane – e + ol ⟶ alkanol



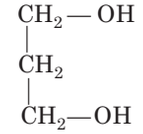
1,3-dimethylbutan-1-ol

Alcohols containing two or three —OH groups are named as *alkanediols* and *alkanetriols* respectively.

Note that -'e' of the corresponding alkane name is retained in such cases.



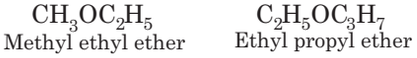
Propane-1,2,3-triol



Propane-1,3-diol

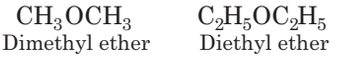
Ethers

These are the compounds in which an oxygen atom is bonded to two alkyl groups (*R*—O—*R*). In the common system, the two alkyl groups attached to the oxygen atom are named in alphabetic order and the word ether is added, e.g.



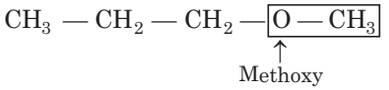
Methyl ethyl ether Ethyl propyl ether

If the groups are same then prefix di is used as :



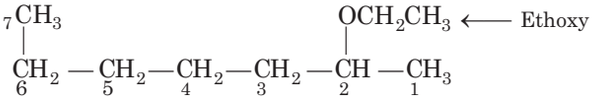
Dimethyl ether Diethyl ether

In the **IUPAC system**, ethers are named as **alkoxyalkanes.** The smaller alkyl group plus the oxygen atom is considered as an **alkoxy substituent.**



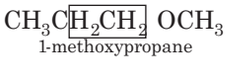
Methoxy

The IUPAC name of the compound is 1-methoxypropane.

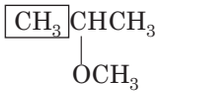


The IUPAC name of the compound is 2-ethoxyheptane.

Remember always that only terminal position cannot be assumed for alkoxy group, it can be placed with any C–atom of the chain, e.g.



1-methoxypropane

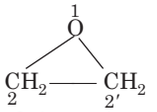


2-methoxypropane

Methoxy group

Oxiranes

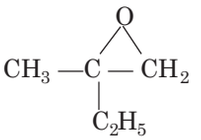
These are cyclic ethers in which ethereal oxygen is a part of three membered oxirane ring. This ring seems as



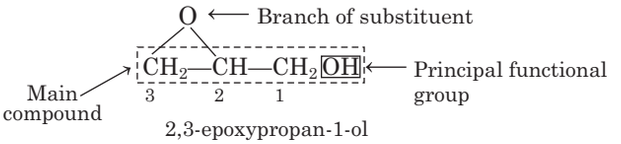
Oxirane ring

Here, oxygen of the ring is given number 1 and both the C-atoms as 2 by IUPAC.

These cyclic ethers are placed at the lowest preference in the preferential order and normally written as prefixes when any functional group is present in the compound except alkyl group. The prefix of this group is **epoxy**, e.g.



2-ethyl-2-methyl oxirane

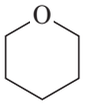


2,3-epoxypropan-1-ol

Oxiranes are also called **epoxides.** As they are readily prepared from alkenes, they are commonly called **alkene oxides.**

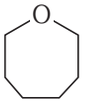
IUPAC name of the some of the oxiranes are as,

oxirane



oxane

oxetane



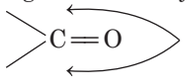
oxepane

oxolane

oxetene

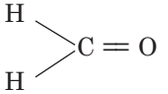
Aldehydes

These are the compounds in which carbonyl group [>C=O] is bonded to at least one hydrogen (alongwith one alkyl group.

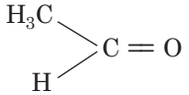


At least one hydrogen atom should be attached to either of these valencies.

Their common names are related to those of carboxylic acids, e.g.



Formaldehyde
(Related to formic acid)



Acetaldehyde
(Related to acetic acid)

- Their IUPAC names are obtained by dropping final –e from the name of corresponding alkane and adding the ending -al, i.e.

$$\boxed{\text{alkane} - \text{e} + \text{al} = \text{alkanal}}$$

e.g. $\underset{\text{Methanal}}{HCHO}$ $\underset{\text{Ethanal}}{CH_3CHO}$ $\underset{\text{Propanal}}{CH_3CH_2CHO}$

As per 1993, recommandations one more suffix "carbaldehyde" is used for aldehydes under such conditions when C-atom of —CHO is not counted in the longest possible chain due to any unconventional reason. The illustration of such a usage is given in carboxylic acids.

Ketones

These are the compounds in which carbonyl group $[\rangle C = O]$ is bonded to two alkyl groups.

In the IUPAC system, ketones are named as alkanones, i.e.

$$\boxed{\text{alkane} - \text{e} + \text{one} = \text{alkanone}}$$

e.g. $\underset{\text{Propan-2-one}}{\overset{1}{C}H_3\overset{2}{C}O\overset{3}{C}H_3}$ $\underset{\text{Butan-2-one}}{\overset{1}{C}H_3\overset{2}{C}O\overset{3}{C}H_2\overset{4}{C}H_3}$

Carboxylic Acids

These are the compounds which contain $-\overset{\overset{O}{\|}}{C}-OH$ group.

In IUPAC system these are named as alkanoic acid, i.e.

$$\boxed{\text{alkane} - \text{e} + \text{oic acid} = \text{alkanoic acid}}$$

e.g. $\underset{\text{Methanoic acid}}{HCOOH}$ $\underset{\text{Ethanoic acid}}{CH_3COOH}$ $\underset{\text{Propanoic acid}}{CH_3CH_2COOH}$

Special conditions for functional groups containing C-atoms.

For all those functional groups which contain C-atom in them, following two conditions are also applicable.

Two suffixes are alloted to these functional groups according to 1993 recommendations. (see table)
Out of these two, one - *oic acid* can be used normally while other one, i.e. *carboxylic acid* is used only when it is difficult to count the C-atom of functional group in the main chain, e.g

$\underset{\text{Propanoic acid}}{CH_3CH_2COOH}$ $\underset{\text{Butane-1,4-dioic acid}}{\begin{matrix}CH_2CH_2\,COOH\\ |\\ COOH\end{matrix}}$

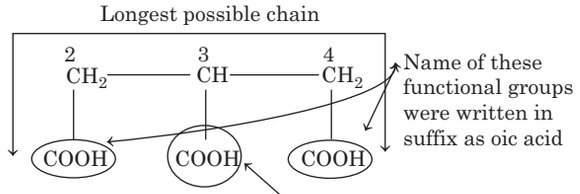
But when another carboxylic group is attached to the main chain directly as,

$$\begin{matrix}CH_2 & --- & CH & --- & CH_2\\ | & & | & & |\\ COOH & & COOH & & COOH\end{matrix}$$

Here, problem lies in the fact that all the functional groups cannot be taken in the main chain simultaneously.

1979 Recommendations

This situation was not so clear in 1979 recommendations where the middle —COOH attached to centralised C-atom was written in prefix while rest two —COOH groups attached at terminals were written in suffix as,



The name of the compound according to 1979 recommendations was **3-carboxy pentane-1,5 dioic acid**

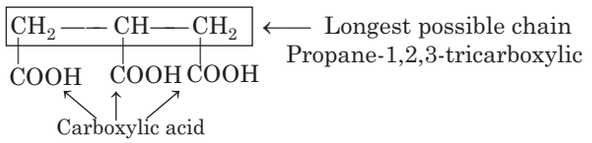
Name of this functional group was written in prefix as- carboxy

1993 Recommendations

In its recommendations of 1993, IUPAC cleared the situation for such cases and mentioned,

"If an unbranched chain is directly linked to more than two carboxy groups, these carboxy groups are named from the parent hydride by substitutive use of a suffix like carboxylic acid".

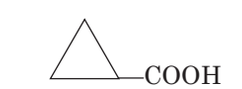
So, the name of the above written compound according to 1993 recommendations is written as,



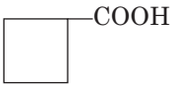
← Longest possible chain
Propane-1,2,3-tricarboxylic

Remember Here, the C-atom of all the three —COOH groups is not included in the longest possible chain.

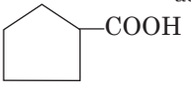
- Such a situation is also applicable to the cases written below,



Cyclopropane carboxylic acid



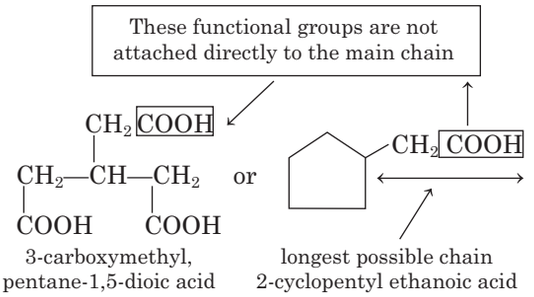
Cyclobutane carboxylic acid



Cyclopentane carboxylic acid

- In all the above cases due to the presence of cyclic hydrocarbon difficulty lies in inclusion of C-atom of functional group within the longest possible chain.Hence, here also the suffix used is carboxylic acid and not the —oic acid which is normally used.

- However, the suffix carboxylic acid cannot be used in situations like,



Carboxylic Acid Derivatives

These are the compounds in which the —OH part of —C(=O)— OH group is replaced by various other groups.

These derivatives are

1. Acid Chlorides

In these compounds —OH group of acid is replaced by —Cl group.

The group —C(=O)— Cl is commonly called as **acyl chloride**. Their IUPAC name can be written as,

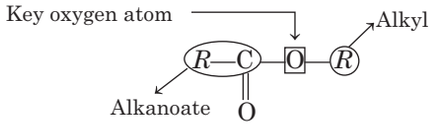
alkanoic acid – ic acid + yl chloride = alkanoyl chloride

e.g. CH_3COCl (Ethanoyl chloride) CH_3CH_2COCl (Propanoyl chloride)

Suffix **'carbonyl chloride'** is also assigned in case where C-atom of this group is not counted with the main chain.

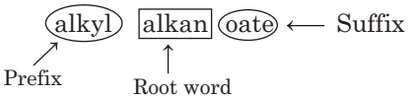
2. Esters

In esters —OH group of acid is replaced by —O*R* group. Their IUPAC names are written as alkyl alkanoate as,



Here, key oxygen is the oxygen of alcohol. Alkyl group present after key oxygen is written as alkyl and rest all the C-atoms before key oxygen are written as alkanoate.

Remember in alkyl alkanoate,



e.g. CH_3COOCH_3 Methyl ethanoate $CH_3COOC_2H_5$ Ethyl ethanoate

Suffix **'carboxylate'** can also be assigned if C-atom of this group is not counted in the longest possible chain.

3. Acid Anhydrides

In these compounds, —OH group of acid is replaced by —O—C(=O)—*R*. So, they are named as

alkanoic acid – acid + anhydride = alkanoic anhydride

e.g. $(CH_3CO)_2O$ Ethanoic anhydride; $CH_3CO-O-COCH_2CH_3$ Ethanoic propanoic anhydride

4. Amides

In Amides, —OH of carboxylic acid is replaced by —NH_2 group. They are named as

alkanoic acid – oic acid + amide = alkanamide

e.g. CH_3CONH_2 Ethanamide $HCONH_2$ Methanamide

Suffix '**carboxamide**' is used if C-atom of —$CONH_2$ group is not counted in the longest possible chain.

Alkyl group can also be attached to the nitrogen of —NH_2 group in place of hydrogen. In such cases the names of amides can be written as N—substituted amides.

e.g. $CH_3CON(H)-CH_3$ N-methyl ethanamide; $CH_3CH_2CON(H)-CH_3$ N-methylpropanamide

$CH_3CH_2CON(CH_3)CH_2CH_3$ N-methyl-N-ethylpropanamide

Remember Never treat the $>C=O$ and —NH_2 groups of an amide as separate entities.

Sulphonic Acid

These compounds contain —SO_3H group. Their IUPAC names are written as,

alkane + sulphonic acid = alkane sulphonic acid

e.g. CH_3SO_3H Methane sulphonic acid $CH_3CH_2SO_3H$ Ethane sulphonic acid

Nitro Compounds

These are the compounds which contain —NO_2 group in them. Their IUPAC names are obtained by adding the prefix 'nitro' to the name of alkane.

nitro + alkane = nitroalkane

e.g. CH_3NO_2 Nitromethane $CH_3CH_2NO_2$ Nitroethane $CH_3CH_2CH_2NO_2$ Nitropropane

Cyanides or Nitriles

The compounds which contain —CN group are named as alkane nitriles in IUPAC system, i.e.

alkane + nitrile ⟶ alkane nitrile

e.g. $\overset{4}{C}H_3\overset{3}{C}H_2\overset{2}{C}H_2\overset{1}{C}N$ Butane nitrile; CH_3CN Ethane nitrile; CH_3CH_2CN Propane nitrile; HCN Methane nitrile

Like acids and others, cyanides also have two suffix, i.e. **carbonitrile** and nitrile.

Amines

These are the derivatives of ammonia in which one or more hydrogen atoms have been replaced by alkyl or aryl groups. In the common system they are classified as *primary* (1°), *secondary* (2°) or *tertiary* (3°) depending upon the number of valencies of nitrogen atom satisfied by carbon atoms. eg

CH_3NH_2 Methyl amine (primary); $CH_3—NH—CH_3$ Dimethyl amine (secondary); $CH_3—N(CH_3)—CH_3$ Trimethyl amine (tertiary)

In the IUPAC system, primary amines are named by replacing the final –e of the parent alkane by amine, i.e.

alkane –e + amine = alkanamine

The inclusion of a numeral to indicate the position of $—NH_2$ group is also necessary except the situation when $—NH_2$ group is attached at terminal position eg.

$CH_3CH_2NH_2$ Ethanamine; $CH_3\overset{2}{C}H(NH_2)\overset{3}{C}H_3$ Propan-2-amine; $\overset{1}{C}H_3—\overset{2}{C}H(NH_2)—\overset{3}{C}H_2\overset{4}{C}H_3$ Butan-2-amine

The secondary and tertiary amine are named as N-substituted and N,N-disubstituted amines. In those cases, the largest of the alkyl groups attached to nitrogen is chosen as the alkyl group of primary amine.

Remember IUPAC does not considers secondary and tertiary amines as main compounds. According to IUPAC these are the substitution derivatives of primary amine. e.g.

$CH_3—N(H)—CH_3$ N-methyl methanamine; $CH_3—N(CH_3)—CH_2CH_3$ (Longest possible chain) N,N-dimethyl ethanamine

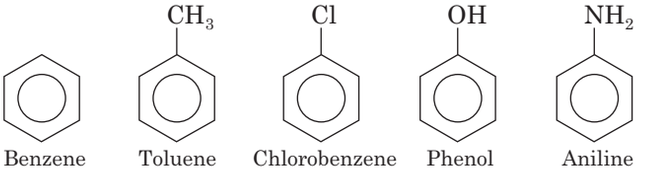
$CH_3—N(CH_2CH_3)—CH_2CH_3$ (Longest possible chain) N-ethyl-N-methyl ethanamine

Nomenclature of Cyclic Compounds

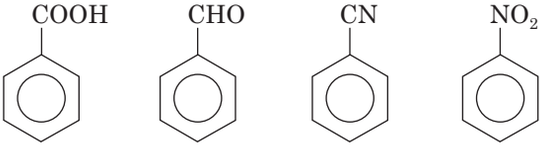
Naming of cyclic compounds can be studied under following sub categories

Naming the Aromatic Compounds

All common trivial names of aromatic compounds are accepted by IUPAC. So, usually they do not have separate IUPAC names. Thus, their some examples are

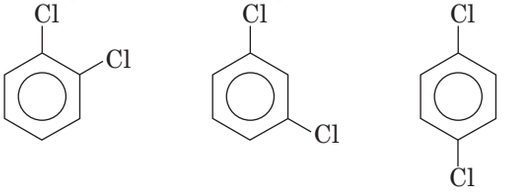


Benzene; Toluene; Chlorobenzene; Phenol; Aniline



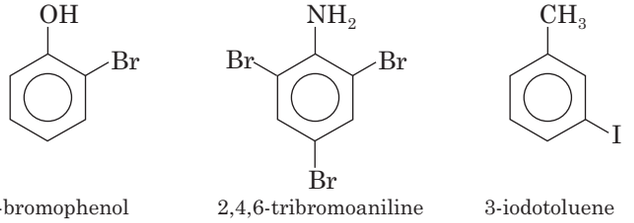
Benzoic acid; Benzaldehyde; Benzonitrile; Nitrobenzene

However, the use of *ortho* (*o*-), *meta* (*m*-), or *para* (*p*-) is avoided in IUPAC names. So, these are called 1,2 ; 1,3 and 1,4 compounds. For example,



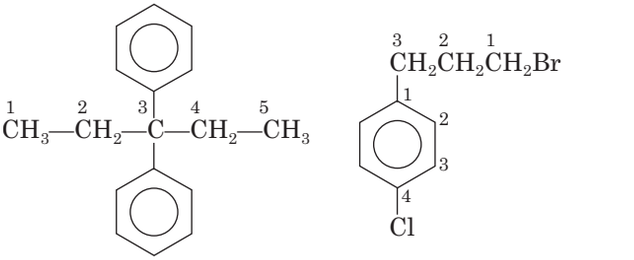
1,2-dichlorobenzene 1,3-dichlorobenzene 1,4-dichlorobenzene

If two different groups are attached to the benzene ring then the main or principal group is treated as the base compound. Thus,



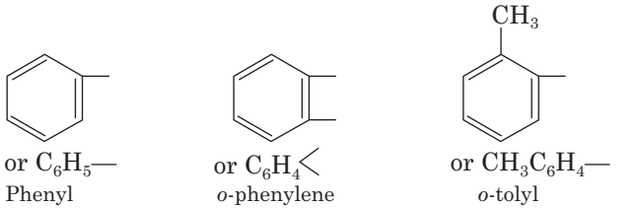
2-bromophenol 2,4,6-tribromoaniline 3-iodotoluene

If the aromatic compound has an open chain attached to benzene then this chain gets the longest possible chain status and the ring is treated as substituent. Thus,



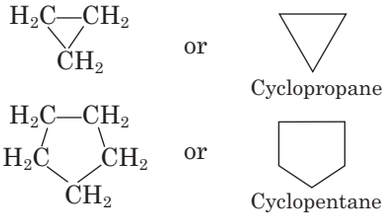
3,3-biphenyl pentane 1-bromo-3-(4-chlorophenyl)propane

The following names are given to certain aromatic hydrocarbon residues formed by the loss of one or more hydrogen atoms from the parent hydrocarbon



Naming the Alicyclic (Monocyclic) Compounds

The alkanes in which carbon atoms are arranged in a ring are called **cycloalkanes.** They are named by attaching the prefix **'cyclo'** to the name of the alkane having the same number of carbons as in the ring, e.g.



Cycloalkanes are often represented by simple geometrical figures. It is understood that their each corner represents —CH_2 groups. Remember that their

Cyclopropane is represented by a **triangle**.

Cyclobutane is represented by a **square**.

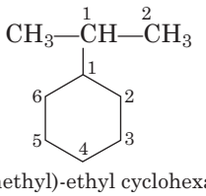
Cyclopentane is represented by a **pentagon**.

Cyclohexane is represented by a **hexagon**.

Rules for Naming Alicylic Compounds

Following rules are considered while naming the alicyclic compounds

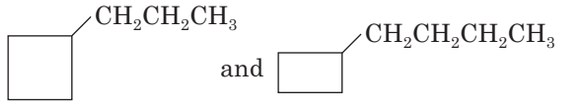
I. Substituted cycloalkanes are named as alkylcycloalkanes. The substituents on the ring are named, accordingly and their positions are indicated by number.



1-(1-methyl)-ethyl cyclohexane

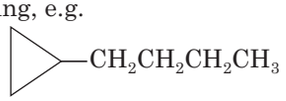
Remember, the C-atom of main chain which is attached to the ring is always given Ist number, as shown above.

II. The alkyl group is designated as a substituent if the alkyl chain contains a lesser or equal number of C-atoms than the ring, e.g.



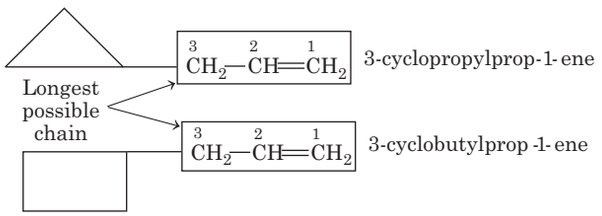
Propylcyclobutane Butylcyclobutane

III. The ring is designated as a substituent if the alkyl chain contains a greater number of C-atoms than the ring, e.g.



Cyclopropylbutane

VI. However, if the side chain contains a multiple bond or a functional group, the ring is treated as a substituent irrespective of the size of ring.

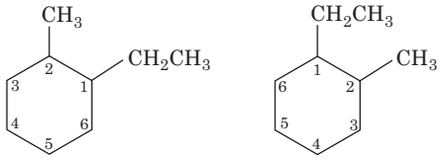


Such an exception is due to the rule "the multiple bond/functional group if present in the compound should be included in the longest possible chain".

V. In case more than one substituent are attached to the ring then, while numbering the C-atoms of the ring, the substituent which comes first in alphabetical order is given the lowest number provided that it does not violate the lowest sum rule.

Remember there is no restriction in going clockwise or anticlockwise for numbering the C-atoms of ring.

e.g.

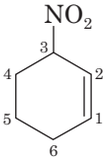


1-ethyl-2-methylcyclohexane

Since, 1-ethyl-2-methyl cyclohexane can have both of above written structures, therefore the above **written structures are similar.**

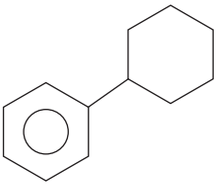
VI. If multiple bond and some other substituents are present in the ring, then the numbering should

be done in such a manner so that the multiple bond gets the least possible number, e.g.

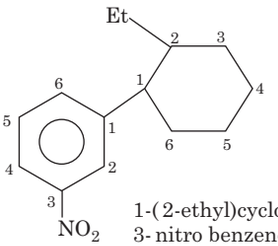


3-nitrocyclohex-1-ene

VII. If a compound contains an alicyclic ring directly linked to the benzene ring, it is named as the derivative of benzene, i.e. the compound having lowest state of hydrogenation, e.g.

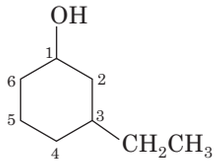


Cyclohexyl benzene

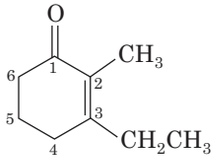


1-(2-ethyl)cyclohexyl 3- nitro benzene

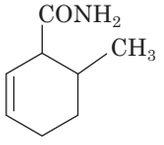
VIII. If some functional group along with other substituent groups are present in the ring, it is indicated by some appropriate prefix or suffix and its position is indicated by numbering the carbon atoms of the ring in such a way that the functional group gets the least possible number, e.g.



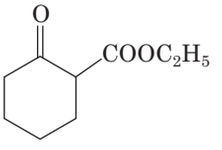
3-ethylcyclohexan-1- ol



3-ethyl-2-methyl cyclohex-2-en-1- one

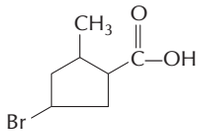


6-methylcyclohex -2-en-1-carboxamide



Ethyl (2-oxo) cyclohexane 1-carboxylate

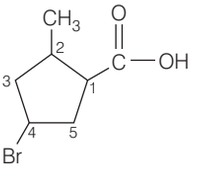
Example 2. *The* IUPAC *name of the following compound is*



(JEE Main 2020)

(a) 3-bromo-5-methylcyclopentane carboxylic acid
(b) 3-bromo-5-methylcyclopentanoic acid
(c) 5-bromo-3-methylcyclopentanoic acid
(d) 4-bromo-2-methylcyclopentane carboxylic acid

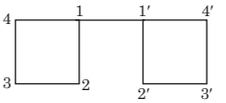
Sol. (*d*) The IUPAC name of the given compound.is



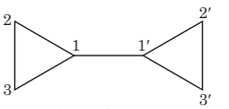
4-bromo-2-methylcyclopentane carboxylic acid.

Naming the Bi and Polycyclic Compounds

(i) **Unbranched Assemblies Consisting of Two Identical Ring Systems** These assemblies are named by placing numerical prefix bi before the name of parent hydride, e.g.



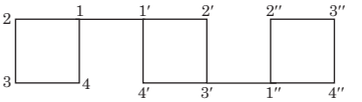
1,1′-bicyclo butane



1,1′-bicyclo propane

Such assemblies can be identified by counting the C-atoms in them. The total number of C-atoms in such assemblies will be exactly double of the number of C-atoms present in a single ring.

(ii) **Unbranched assemblies consisting of three or more identical ring systems** These are named by placing an appropriate numerical prefix like *ter, quater, quinique* etc., before the name of parent hydride corresponding to the repetitive unit, e.g.

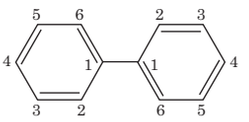


1,1′,3′,1″-tercyclobutane

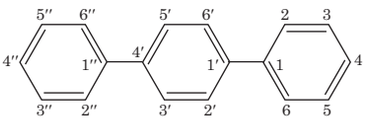
The following multiplying prefixes are used in names for unbranched assemblies of three or more identical repeating units :

3-ter-, 4-quater-, 5-quiniques-, 6-sexi-, 7-septi-, 8-octi-, 9-novi-, 10-deci-

As exceptions, unbranched assemblies consisting of benzene rings are named by using the appropriate numerical prefix with the substituent prefix name phenyl, e.g.



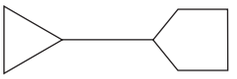
Biphenyl



1,1′4′,1″-terphenyl (preferred to p-terphenyl)

In the numbers of all such assemblies ' and " are used to signify similar atoms.

(iii) **Unbranched assemblies containing unidentical rings** In these assemblies the smaller ring will be considered as substituent (written as cycloalkyl) while larger cycle will be considered as main chain, e.g.



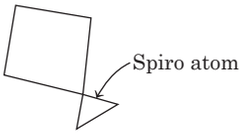
Cyclopropyl cyclopentane

(iv) **Spiro parent hydrides** A 'spiro union' is a linkage between two rings consisting of a single atom common to both. The common atom is designated as the '**spiro atom**'.

According to the number of spiro atoms present, the compounds are distinguished as *monospiro, dispiro, trispiro*, etc., ring systems. The following recommendations apply only to the naming of parent hydrides containing free spiro unions.

Monospiro parent hydrides are the hydrides consisting of two homogeneous saturated monocyclic rings and are named by placing 'spiro' before the name of the acyclic parent hydride with the same total number of skeletal atoms.

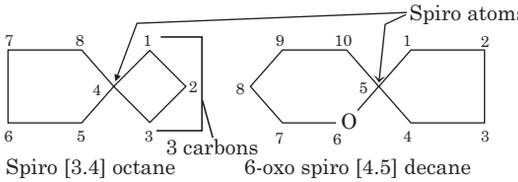
The numbers of skeletal atoms linked to the spiro atom in each ring are indicated by arabic numbers separated by a full stop, cited in ascending order and enclosed in square brackets. This descriptor is placed between the spiro prefix and the name of the parent hydride. e.g.



Spiro [2.3] Hexane

Numbering of Spiro Compounds

Numbering starts with a ring atom next to the spiro atom and proceeds first through the smaller ring and then through the spiro atom and around the second ring at the last. e.g.



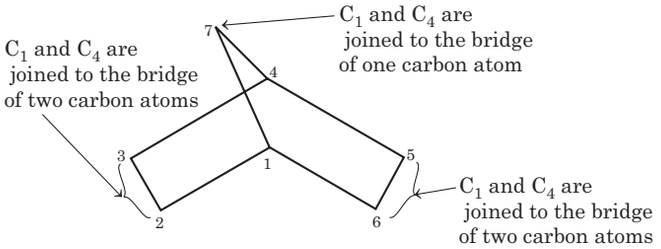
Spiro [3.4] octane 6-oxo spiro [4.5] decane

Emphasis on ascending order of numerals was given in 1993 recommondations although it was not there according to 1979 recommondations of IUPAC.

Polycyclic Ring Systems

Saturated homogeneous bicyclic systems having two or more atoms in common, are named by prefixing 'bi/tri/cyclo-' to the name of the acyclic parent hydride that has the same total number of skeletal atoms.

The number of the acyclic atoms (bridges) connecting the common atoms (bridg-heads) is given by arabic numbers cited in descending numerical order separated by full stops and enclosed in square brackets. e.g.



Bicyclo [2.2.1] Heptane

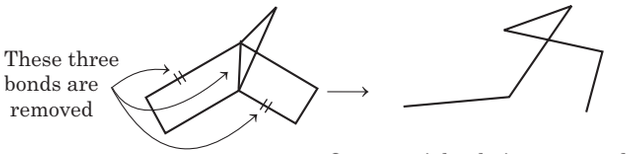
Identification of Number of Cycles in the Assembly

In these cases number of cycles can be guessed by practically observing minimum number of bonds removed so that the compound is converted into a continuous open chain compound.

Practically, the minimum number of bonds removed = Number of cycles present in the compound, e.g.

In the compound removing these two bonds will give

Hence, the above written compound is **bicyclo** (two bonds removed),



Open straight chain compound

Hence, the above written compound is **tricyclo** (3 bonds have to be removed).

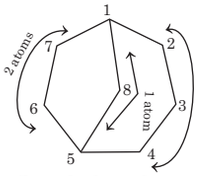
Numbering in Polycylic Ring System

The numbering in system begins with one of the bridgeheads and proceeding through the longest bridge to the second bridgehead, continuing back to the first bridgehead by means of the longer unnumbered bridge.

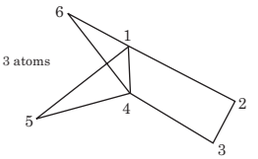
These two bridges constitute the 'main ring' of the system.

Numbering is completed by numbering the remaining bridge (the shortest) beginning with the atom next to the first bridgehead.

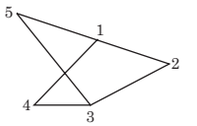
e.g.



Bicyclo [3.2.1] octane



Bicyclo [2.1.1] hexane



Bicyclo [1.1.1] pentane

Compounds Containing Bivalent Bridges

Sometimes it is difficult to name a compound which looks like simple but show a small deviation from a normal rule.

e.g. The compound  can be named as 1,1′ -bicyclo butane, but it is difficult to name:  as a bivalent bridge is present in it.

To name this compound we must know the name of bivalent bridges. In its 1993 recommondations, IUPAC provided the guidelines for such naming also.

According to IUPAC the above compound can be named as "methano-1,1′-bicyclobutane". IUPAC gave the guidelines for usage of such simple bivalent bridges as **"such a bridge is named as a prefix derived from the hydrocarbon name by changing the final 'e' to 'o'**.

The locant of a double bond, if present, is indicated in square brackets between the hydrocarbon prefix and the ending '—eno' —'dieno' etc. Some of such bridges can be named as,

—CH_2— methano
—CH_2 — CH_2 — ethano
—CH_2 — CH_2 — CH_2 — propano
—CH_2 — CH_2 — CH_2 — CH_2 — butano
—CH ═CH — etheno
—CH═CH — CH_2 — prop[1] eno
—CH═CH — CH_2 — CH_2 — but[1] eno
—CH_2— CH ═CH — CH_2 — but[2] eno
—CH ═CH—CH═CH — buta[1, 3] dieno

Terms and Punctuations Used in IUPAC System of Nomenclature

While writing IUPAC name, one should remember the following

(i) **Locants** (numerals and/or letters) are placed immediately before the part of the name of which they relate, except in the case of traditional contracted forms. e.g.

Hex-2-ene (formerly, 2-hexene)

Cyclohex-2-en-1-ol (formerly 2-cyclohexen-1-ol)

(ii) **Commas** are used to separate locants that refer to the same part of a name, i.e. locants of a series in names of fused ring systems, e.g. 1, 2-dichloroethane.

(iii) **Full stops** (periods) separate numerical ring size indicators in names, constructed according to the von Baeyer system and in certain spiro names, e.g. bicyclo [3.2.1] octane.

(iv) **Colons** separate related sets of locants; if a higher level of separation is required, semicolons are employed, e.g. 1, 4, 5, 8-tetrahydro-1, 5 : 5, 8-dimethanoanthracene

(v) **Hyphens** separate

- Locants from the words of syllables of a name.
- Adjacent locants referring to different parts of the name (but preferably parentheses should be inserted).
- The two parts of the designation for a primary fusion site in a name for a fused ring system.
- A stereodescript or / and the name, e.g.

N-acetyl-N-(2-naphthyl) benzamide

(preferred to N-acetyl-N-2-naphthyl-benzamide)

(vi) **Numerical** (multiplicative) **prefixes** are derived from Greek and Latin number names and are the principal method for describing a multiplicity of identical features of a structure in chemical nomenclature.

- **The simple numerical prefixes** di-, tri-, tetra-, etc., are of Greek derivation (except for nona- and undeca-, which are derived from Latin) and are used to indicate a multiplicity of substituent suffixes, e.g.

–diol	ditetradecane-1, 4-diyl-
–dicarboxylic acid	tetra-2-naphthyl-
–tricyclohexyl-	dioxime
—diamidodiaza	ethylenedimino

- **The numerical prefixes** 'bis-', 'tris-', 'tetrakis-', etc., which, except for 'bis-' and 'tris-', are derived by adding 'kis-' to the simple numerical prefixes. These are used to indicate a multiplicity of substituted prefixes or functional modification terms, e.g. *bis* (2-aminoethyl).

  Such prefixes are also used when the use of 'di-', 'tri-', etc., is (or could be) ambiguous; this usually happens when an analogue of the term being multiplied beginss with a simple numerical prefix.

- **The numerical prefixes** 'bi-', 'ter-', 'quater-' etc., are derived from Latin number names and are used mainly in identical ring assembly names, e.g. biphenyl, 2, 2' : 6', 2" : 6", 2" -quaterpyridine.

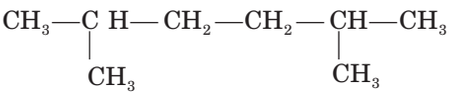
Practice Exercise

ROUND I Topically Divided Problems

Introduction to Organic Chemistry

1. The number of σ-and π-bonds in *o*-xylene are
(a) 12 σ and 3π
(b) 18 σ and 3π
(c) 9 σ and 3π
(d) 15 σ and 3π

2. The number of secondary C-atoms in the following compound are



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

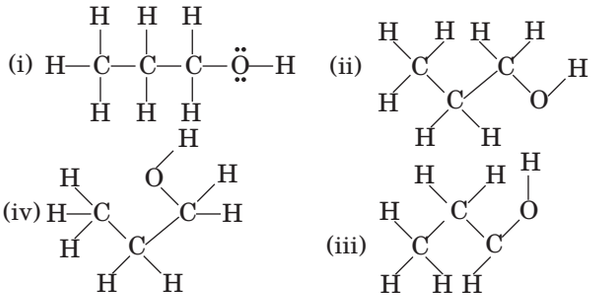
3. The carbon-carbon bond lengths of the following molecules follow the order
(a) $C_2H_6 > C_2H_4 > C_6H_6 > C_2H_2$
(b) $C_2H_4 > C_6H_6 > C_2H_2 > C_6H_6$
(c) $C_2H_6 > C_2H_2 > C_6H_6 > C_2H_4$
(d) $C_2H_2 < C_2H_4 < C_6H_6 < C_2H_6$

4. Which of the following molecules has the shortest carbon-carbon bond?
(a) Acetylene
(b) Ethane
(c) Benzene
(d) Diamond

5. Among the molecules of ethane, ethylene and acetylene, the C — H bond energy is the
(a) highest in ethane
(b) highest in ethylene
(c) highest in acetylene
(d) same in all the three

6. Which of the following in incorrect about homologous?
(a) They have a difference of —CH_2 group between any two successive members.
(b) They can be prepared by general methods of preparation.
(c) They are all unbranched compounds.
(d) They contain the same functional group.

7. Which of the following is the correct dash formula for *n*-propyl alcohol?

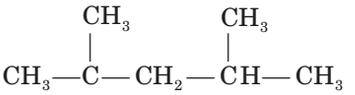


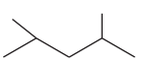
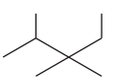
(a) only (i) (b) (i), (ii)
(c) (i), (iv) (d) (i), (ii), (iii), (iv)

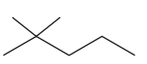
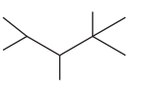
8. The condensed formula for *iso*-propyl alcohol can be written in ..... different ways.
(a) just one (b) four (c) two (d) three

9. Which of the following is not correct regarding the wedge-and-dashed representation?
(a) Bonds that project upward out of the plane of the paper are indicated by a wedge (◄).
(b) Bond that lie behind the plane are indicated with a dashed wedge (┈┈).
(c) Bonds that lie in the plane of the page are indicated by a line (—).
(d) For tetrahedral C-atoms, we draw the two bonds that are in the plane of the page with an angle of approximately 111° between them.

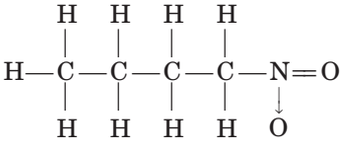
10. The correct bond notation of the compound which is shown below



(a)  (b) 

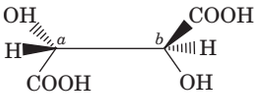
(c)  (d) 

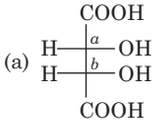
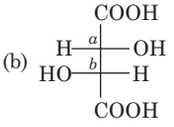
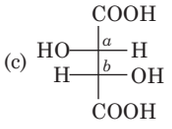
11. Convert the following complete structure formula into condensed formula.



(a) $CH_2(CH_3)_3NO_2$ (b) $CH_3(CH_2)_3NO_2$
(c) $CH_3(CH_2)_3NO$ (d) $NO_2CH(OH_3)_2$

12. Which of these is the correct Fischer projection for the wedge and dash formula given below?

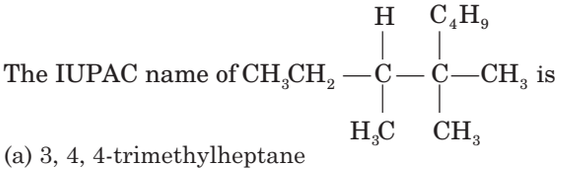


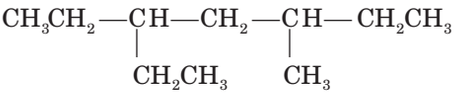
(a) 
(b) 
(c) 
(d) All of these

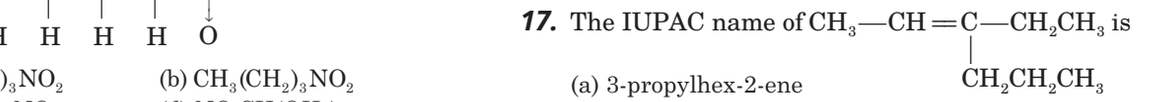
IUPAC Nomenclature of Hydrocarbons

13. The compound with molecular formula, C_6H_{14} has two tertiary carbons. Its IUPAC name is
(a) *n*-hexane
(b) 2-methylpentane
(c) 2, 3-dimethylbutane
(d) 2, 3-dimethylpentane

14. Which one of the following IUPAC names is not correct?
(a) 3, 4, 7-trimethyloctane
(b) 3-ethyl-5-methylheptane
(c) 2, 2, 4-trimethylpentane
(d) 3-ethyl-4, 4-dimethylheptane

15. The IUPAC name of  is
(a) 3, 4, 4-trimethylheptane
(b) 3, 4, 4-trimthyloctane
(c) 2-butyl-2-methyl-3-ethylbutane
(d) 2-ethyl-3, 3-dimethylheptane

16. The IUPAC name of the following compound

(a) 3-ethyl-5-methylheptane
(b) 5-ethyl-3-methylheptane
(c) 3, 5-diethylhexane
(d) 1, 1-diethyl-1-methylpentane
(e) 1, 3-diethyl-1-methylpentane

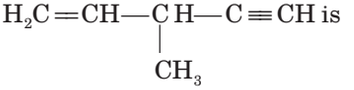
17. The IUPAC name of  is
(a) 3-propylhex-2-ene
(b) 3-propylhex-3-ene
(c) 4-ethylhex-4-ene
(d) 3-ethylhex-2-ene

18. The IUPAC nomenclature of $(CH_3)_3C—CH=C(CH_3)_2$ is
(a) 2, 4, 4-trimethylpent-3-ene
(b) 2, 4, 4-trimethypent-2-ene
(c) 2, 2, 4-trimethylpent-3-ene
(d) 2, 2, 4-trimethylpent-2-ene

19. The IUPAC name of the compound, $CH_3CH=CHC\equiv CH$ is
(a) pent-4-yn-2-ene
(b) pent-3-en-1-yne
(c) pent-2-en-4-yne
(d) pent-1-yn-3-ene

20. The IUPAC name of the compound having the formula $HC\equiv C—\ CH=CH_2$ is
(a) but-1-yn-3-ene (b) but-1-yne-3-ene
(c) but-1-ene-3-yne (d) but-3-ene-1-yne

21. The correct IUPAC name of the following compound $HC\equiv C—\ CH=CH—\ CH=CH_2$ is
(a) 4-ethynyl-1, 3-butadiene
(b) hexa-1, 3-diene-5-yne
(c) 4-ethenyl but-3-en-1-yne
(d) 1-ethynyl buta-1, 3-diene

22. The correct IUPAC name of

(a) 3-methylpent-4-en-1-yne
(b) 3-methylpent-1-en-4-yne
(c) 3-ethenylbut-1-yne
(d) 3-ethynylbut-1-ne

23. The IUPAC name for *tert*-butyl iodine is
(a) 4-iodobutane
(b) 2-iodobutane
(c) 1-iodo-3-methylpropane
(d) 2-iodo-2-methylpropane

24. The IUPAC name of *neo*-pentyl group is
(a) 2-methylbutyl (b) 3-methylbutyl
(c) 2-methylbutyl (d) 2, 2-dimethylpropyl

25. IUPAC name of the allyl group is
(a) 3-propenyl (b) 1-propenyl
(c) 2-propenyl (d) 4-propenyl

26. The maximum number of alkyl groups that can be derived from *iso*-pentane is
(a) two (b) three (c) four (d) five

27. The number of primary secondary, tertiary and quaternary carbons in neopentane are respectively
(a) 4, 3, 2, 1 (b) 5, 0, 0, 1
(c) 4, 0, 0, 1 (d) 4, 0, 1, 1

28. The compound having only primary hydrogen atoms is
(a) *iso*-butene (b) 2, 3-dimethyl-2-butene
(c) cyclohexane (d) propyne

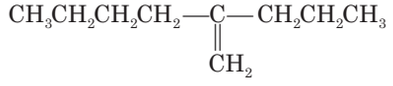
29. The IUPAC name of an alkane containing only one methyl, one ethyl and one *n*-propyl group is
(a) 2, 3-dimethylpentane
(b) 3-methylhexane
(c) 2, 3-dimethylbutane
(d) 3-ethyl-4-methylheptane

30. The lowest molecular mass alkane which has ethyl group as the substituent, has the IUPAC name as
(a) 2-ethylpropane (b) 2-ethylbutane
(c) 2-ethylpentane (d) 3-ethylpentane

IUPAC Nomenclature of Monofunctional Organic Compound

31. The correct structure of 4-bromo-3-methylbut-1-ene is
(a) $BrCH = C(CH_3)_2$
(b) $CH_2 = CH—CH(CH_3)—CH_2Br$
(c) $CH_2 = C(CH_3)CH_2CH_2Br$
(d) $CH_3—C(CH_3) = CHCH_2Br$

32. The IUPAC name for the following compound

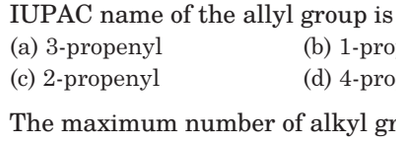


(a) 2-propylhex-1-ene (b) 2-butylpent-1-ene
(c) 2-propyl-2-butylene (d) propyl-1-butylene

33. The name of

to IUPAC nomenclature system is
(a) 2, 3-dibromo-1, 4-dichlorobut-2-ene
(b) 1, 4-dichloro-2, 3-dibromobutene-2
(c) dichloro-2, 3-dibromobutene
(d) dichlorodibromobutene

34. The IUPAC name of

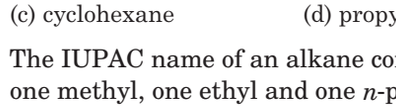


(a) 4-bromo-3-ethyl-1, 4-pentadiene
(b) 2-bromo-3-ethyl-1, 4-pentadiene
(c) 2-bromo-3-ethyl-1, 5-pentadiene
(d) none of these

35. The correct IUPAC name of the following compound is

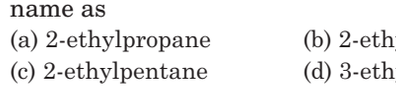
(a) 3-methyl-6-octanol (b) 6-methyloctan-3-ol
(c) 1, 4-diethylpentan-1-ol (d) 6-ethylheptan-3-ol

36. The correct IUPAC name of the organic compound



(a) 4-chloro-2, 3-dimethylpentan-1-ol
(b) 2-chloro-3, 4-dimethylpentan-5-ol
(c) 2, 3-dimethylpentan-1-ol
(d) 2-chloro-3, 4-dimethyl-*n*-pentyl alcohol
(e) 2, 3-dimethyl-4-chloro-*n*-pentyl alcohol

37. The IUPAC name of the compound,



(a) 2-ethylprop-2-en-1-ol
(b) 2-hydroxymethylbutan-1-ol
(c) 2-methylenebutan-1-ol
(d) 2-ethyl-3-hydroxyprop-1ene

38. Structure of vinyl carbinol is
(a) $HO—CH_2—CH=CH_2$
(b) $CH_3CH(OH)=CH_2$
(c) $CH_3—CH=CH—OH$
(d) $CH_3—C(CH_2OH)=CH_2$

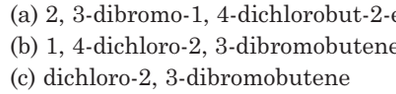
39. The IUPAC name of the following compound $CH_2=CH—CH_2OH$ is
(a) allyl alcohol (b) vinyl alcohol
(c) 3-hydroxyprop-1-ene (d) prop-2-en-1-ol

40. Names of some compounds are given. Which one is not correct according to IUPAC system?

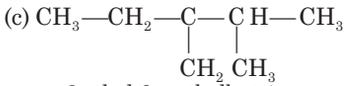
(a)

3-methyl-4-ethylheptane

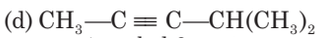
(b)



3-methylbutan-2-ol

(c) 

2-ethyl-3-methylbut-1-ene

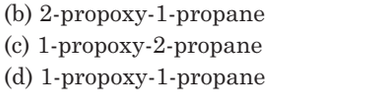
(d) 

4-methyl-2- pentyne

41. The IUPAC name of $(CH_3)_2CH—O—CH(CH_3)_2$ is

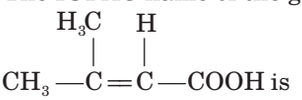
(a) 2-propoxy-2-propane
(b) 2-propoxy-1-propane
(c) 1-propoxy-2-propane
(d) 1-propoxy-1-propane

42. The IUPAC name of



(a) 3-oxo-2-heptyne (b) hept-3-yn-4-one
(c) hept-4-yn-3-one (d) hept-3-en-4-one

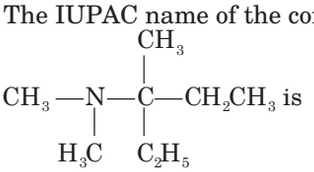
43. The IUPAC name of the given compound



is

(a) 2-methylbut-2-enoic acid
(b) 3-methylbut-2-enoic acid
(c) 3-methylbut-3-enoic acid
(d) 2-methylbut-3-enoic acid

44. The IUPAC name of the compound,



is

(a) 3-(N, N-dimethylamino)-3-methylpentane
(b) 3-methyl-3-N, N-dimethyl-3-pentanamine
(c) N, N, 3-trimethyl-3-pentanamine
(d) 2-ethyl-2-(N, N-dimethylamino) butane

IUPAC Nomenclature of Polyfunctional Organic Compound

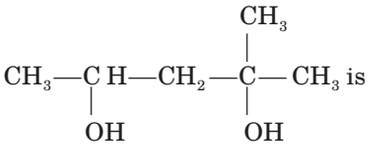
45. The correct decreasing order of priority for the functional groups of organic compounds in the IUPAC system of nomenclature is

(a) $—CONH_2$, —CHO, $—SO_3H$, —COOH
(b) —COOH, $—SO_3H$, $—CONH_2$, —CHO
(c) $—SO_3H$, —COOH, $—CONH_2$, —CHO
(d) —CHO, —COOH, $—SO_3H$, —COOH, $—CONH_2$

46. The IUPAC name of $CH_3CHOHCH_2—O—CH_2CH_3$ is

(a) 1-ethoxypropan-2-ol
(b) 3-ethoxypropan-2-ol
(c) 1-ethoxy-2-hydroxypropane
(d) None of the above

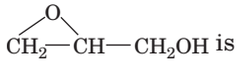
47. The IUPAC name of the compound



is

(a) 1, 1-dimethylbutane-1, 3-diol
(b) 1, 3, 3-trimethylpropane-1, 3-diol
(c) 2-methylpentane-2, 4-diol
(d) 1, 3, 3-trimethyl-1-3-propanediol

48. The IUPAC name for the compound



is

(a) 1, 2-epoxy-3-prapanol
(b) 1, 2-oxo-3-propanol
(c) 2, 3-epoxy-1-propanol
(d) 2, 3-epoxyallylalcohol

49. Mesityl oxide is a common name of *(JEE Main 2021)*

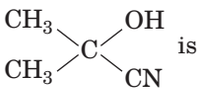
(a) 1, 4-dimethyl pentan-3-one
(b) 3-methyl cyclohexane carbaldehyde
(c) 2-methyl cyclohexane
(d) 4-methyl pent-3-en-2-one

50. The IUPAC name of 

is

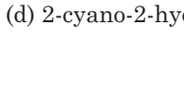
(a) 1-hydroxy-4-methylpentan-3-one
(b) 2-methyl-5-hydroxypentan-3-one
(c) 4-methyl-3-oxopentan-1-ol
(d) hexan-1-ol-3-one

51. Give the IUPAC of the compound



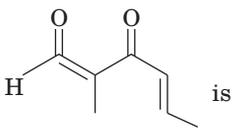
is

(a) acetone cyanohydrin
(b) 2-cyano-2-propanol
(c) 2-hyroxy-2-methylpropanenitrile
(d) 2-cyano-2-hydroxypropane

52. The correct IUPAC name of 

(a) formylmethanal (b) 1, 2-ethanedione
(c) 2-oxoethanal (d) 1, 2-ethanedial

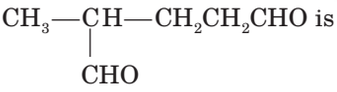
53. The IUPAC name of the compound



is

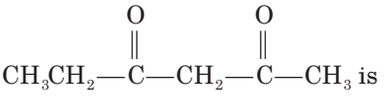
(a) 5-formylhex-2-en-3-one
(b) 5-methyl-4-oxohex-2-en-5-al
(c) 3-keto-2-methylhex-5-enal
(d) 3-keto-2-methylhex-4-enal

54. The IUPAC name of the compound



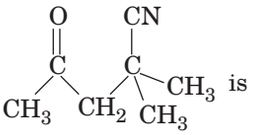
(a) 2-formylpentanal (b) 1, 3-diformylbutane
(c) 2, 4-diformylbutane (d) 2-methylpentanedial

55. The IUPAC name of the following compound



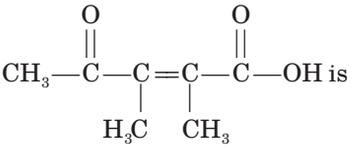
(a) 5-oxohexan-3-one (b) 4-oxohexan-2-one
(c) 2, 4-hexan-dione (d) hexane-2, 4-dione

56. The correct IUPAC name of the following compound



(a) 4-cyano-4-methyl-2-oxopentane
(b) 2-cyano-2-methyl-4-oxopentane
(c) 2, 2-dimethyl-4-oxopentanenitrile
(d) 4-cyano-4-methyl-2-pentanone

57. IUPAC name of the molecule



(a) 4-oxo-2, 3-dimethylpent-2-en-1-oic acid
(b) 3-carboxy-3-methylpent-2-en-3-one
(c) 4-carboxy-3-methylpent-3-en-2-one
(d) 2, 3-dimethyl-4-oxopent-2-ene-1-oic acid

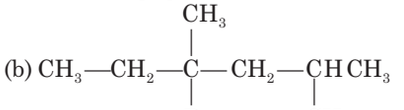
58. The IUPAC name of $NC—CH_2CH_2—COOH$ is

(a) 4-cyanobutanoic acid
(b) 3-cyanopropanoic acid
(c) 3-carboxypropanenitrile
(d) 2-cyanomethylethanoic acid

59. Which nomenclature is not according to IUPAC system ?

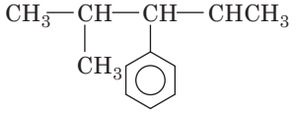
(a) $Br—CH_2—CH=CH$
1-bromoprop-2-ene

(b)

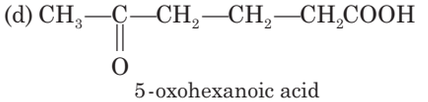


4-bromo, 2, 4-dimethylhexane

(c)

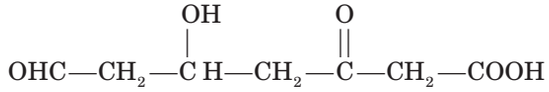


(d)



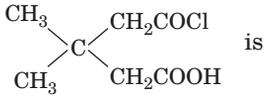
5-oxohexanoic acid

60. Which of the following is correct IUPAC name of the given compound ?



(a) 6-formyl-5-hydroxy-3-oxohexan-1-oic acid
(b) 3-hydroxy-5-oxo-1-formylheptan-7-oic acid
(c) 1-formly-3-hydroxy-5-oxohexan-1-oic acid
(d) 5-hydroxy-3, 7-dioxoheptan-1-oic-acid

61. The IUPAC name of the following compound

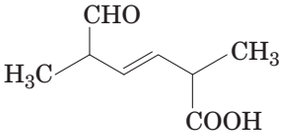


is

(a) 3, 3-dimethyl-5-carboxypentanoyl chloride
(b) 5-carboxy-3, 3-dimethylpentanoyl chloride
(c) 5-chloroformyl-3, 3-dimethylpentanoic acid
(d) 4-chloroformyl-3, 3-dimethylpentanoic acid

62. Give the IUPAC name of the following compound
$BrCH_2(CONH_2)CHCOCH_2CH_3$
(a) 3-(bromethyl)-3-oxopentanamidc
(b) 2-(bromoethyl)-3-ketopentanamide
(c) 2-(bromomethyl)-3-oxopentanamide-1
(d) 2-(bromomethyl)-3-oxopentanamide

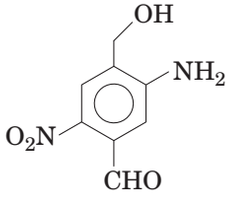
63. The IUPAC name for the following compound is



(JEE Main 2020)

(a) 6-formyl-2-methyl-hex-3-enoic acid
(b) 2, 5-dimethyl-6-oxo-hex-3-enoic acid
(c) 2, 5-dimethyl-6-carboxy-hex-3-enal
(d) 2, 5-dimethyl-5-carboxy-hex-3-enal

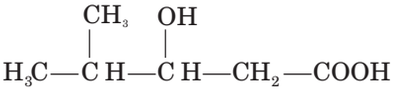
64. The IUPAC name of the following compounds is



(JEE Main 2020)

(a) 2-nitro-4-hydroxymethyl-5-amino benzaldehyde
(b) 3-amino-4-hydroxymethyl-1-5- nitrobenzaldehyde
(c) 5-amino-4-hydroxymethyl 1-2-nitrobenzaldehyde
(d) 4-amino-2-formyl-5-hydroxymethyl -nitrobenzene

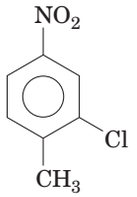
65. The IUPAC name of the following compound is



(JEE Main 2019)

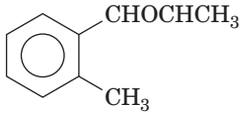
(a) 4,4 - dimethyl -3-hydroxybutanoic acid
(b) 2-methyl-3-hydroxypentan-5-oic acid
(c) 3- hydroxy -4- methylpentanoic acid
(d) 4-methyl-3-hydroxypentanoic acid

66. The correct IUPAC name of the following compound is *(JEE Main 2019)*

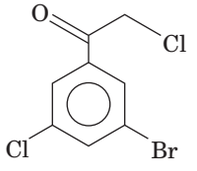


(a) 2-methyl-5-nitro-1-chlorobenzene
(b) 3-chloro-1-methyl-1-nitrobenzene
(c) 2-chloro-1-methyl-4-nitrobenzene
(d) 5-chloro-4-methyl 1-1-nitrobenzene

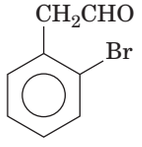
IUPAC Nomenclature of cyclic compounds

67. The IUPAC name of  is

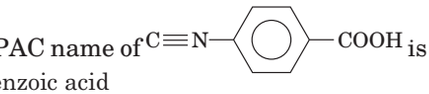
(a) 1-hydroxyethyl-2-methylbenzene
(b) 2-(2-methylphenyl) ethanol
(c) 1-(2-methylphenyl) ethanol
(d) *o*-toylmethylcarbinol

68. IUPAC name of  is

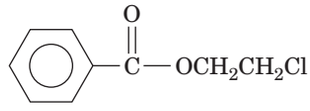
(a) 3-bromo-5-chlorophenacyl chloride
(b) 5-bromo-3-chlorophenacyl chloride
(c) 1-(5-bromo-3-chlorophenyl)-2-chloroethanone
(d) 1-(3-bromo-5-chlorophenyl)-2-chloroethanone

69. The IUPAC name of the compound  is

(a) 2-(*o*-bromophenyl) ethanal
(b) 2-(2-bromophenyl) ethanal
(c) 2-bromo-1-(2-oxoethyl) benzene
(d) 2-bromo-1-(1-oxoethyl) benzene

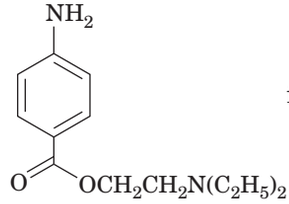
70. The correct IUPAC name of  is

(a) 4-*iso*cyanobenzoic acid
(b) 4-*iso*nitrilebenzoic acid
(c) 4-carboxyphenylcarbylamine
(d) All of the above

71. The IUPAC name of  is

(a) 2-chloroethyl benzoyl ether
(b) 2-benzoyloxy-1-chloroethane
(c) 1-chloro-2-benzoyloxyethane
(d) 2-chloroethyl benzoate

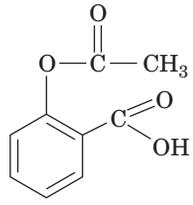
72. The correct IUPAC name of the following compound



is

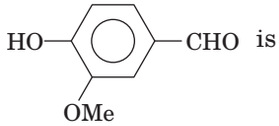
(a) N, N-diethylaminoethylaniline
(b) N, N-diethylaminoethyl-4-aminobenzoate
(c) N, N-diethylaminoethyl *p*-aminobenzoate
(d) N, N-diethylaminoethoxycarbonyl 4-aminobenzene

73. The IUPAC name of the popular analgesic cum antipyretic having the following structure is



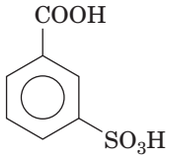
(a) acetylsalicylic acid
(b) 2-acetoxybenzoic acid
(c) 2-acetylbonzoic acid
(d) 2-carboxyphenyl-ethanoic acid

74. The IUPAC name of the flavouring agent vanillin used in the manufacture of biscuits having the following structure

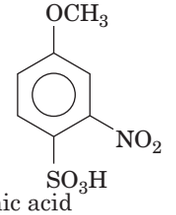


is

(a) *p*-hydroxy-*m*-methoxybenzaldehyde
(b) *m*-hydroxy-*p*-methoxybenzaldehyde
(c) 4-hydroxy-3-methoxybenzaldehyde
(d) 3-hydroxy-4-methoxybenzaldehyde

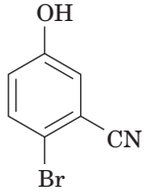
75. The IUPAC name of  is

(a) 3-carboxybenzenesulphonic acid
(b) 3-sulphobenzoic acid
(c) 1-carboxy-3-sulphobenzene
(d) 3-carboxy-1-sulphobenzene

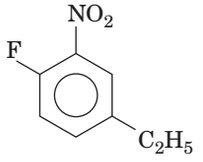
76. The IUPAC name of the compound  is

(a) 4-methoxy-2-nitrobenzenesulphonic acid
(b) 3-nitro-4-sulphoanisole
(c) 6-nitro-4-methoxybenzenesulphonic acid
(d) 6-nitro-4-sulphoanisole

77. The IUPAC name of the following compound

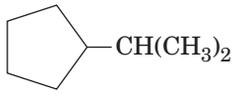
 is

(a) 4-bromo-3-cyanophenol
(b) 2-bromo-5-hydroxybenzonitrile
(c) 2-cyano-4-hydroxybromobenzene
(d) 6-bromo-3-hydroxybenzonitrile

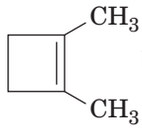
78. The IUPAC name for the compound  is

(a) 1-fluoro-4-ethyl-2-nitrobenzene
(b) 4-fluoro-1-ethyl-3-nitrobenzene
(c) 4-ethyl-1-fluoro-2-nitrobenzene
(d) 2-fluoro-5-ethyl-1-nitrobenzene

79. The IUPAC name of

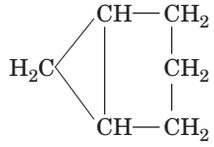


(a) 2-cyclopentyl propane
(b) 1,1-dimethyl-1-cyclopentyl methane
(c) 1-(1-methyl) ethyl cyclopentane
(d) None of the above

80.  having the IUPAC name as

(a) 1,2-dimethyl cyclobutane
(b) 2,3-dimethyl cyclobutene
(c) 2,3-dimethyl butene
(d) 1,2-dimethyl cyclobut-1-ene

81. The IUPAC name of the compound



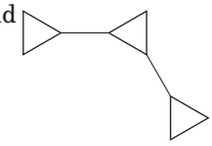
(a) bicyclo [3,0,1] hexane (b) bicyclo [3,1,0] hexane
(c) bicyclo [3,1,1] hexane (d) bicyclo [1,3,1] hexane

81. Choose the IUPAC name of 

(a) dicyclobutane
(b) bicyclo [2.2.0] hexane
(c) bicyclo [2.2.1] hexane
(d) None of the above

83. *A* ; *A* is named as

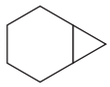
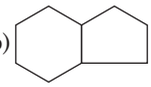
(a) bicyclo (2,2,1) heptane (b) bicyclo (2,2,2) hexane
(c) bicyclo (2,2,1) hexane (d) bicyclo (2,1,0) hexane

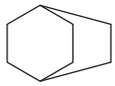
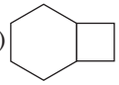
84. The compound 

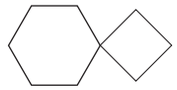
have IUPAC name as

(a) tricyclopropyl (b) tricylopropane
(c) 1,1′, 2′, 1″-tercyclo propane (d) None of these

85. Structure of bicyclo (2,2,2) is

(a)  (b) 

(c)  (d) 

86. The IUPAC name of  is

(a) bicyclo [5.5.0] nonane
(b) biphenyl
(c) cyclopropyl cyclohexane
(d) spiro [3.5] nonane

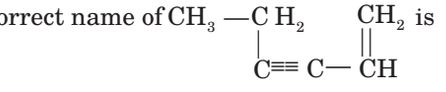
ROUND II Mixed Bag

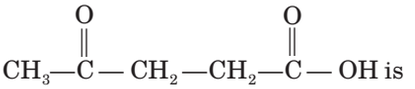
1. The incorrect statement for IUPAC system of nomenclature is
(a) in an organic compound, the longest carbon chain is always selected for assigning the root word
(b) there is no compound with the name 3-ethylpentane
(c) out of $—NH_2$ and —OH groups present in an organic compound, $—NH_2$ is treated as substituent
(d) different alkyl groups are written alphabetically while writing the IUPAC name

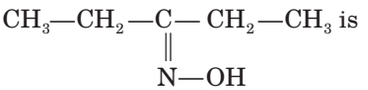
2. Which one is not correct for homologous series?
(a) All members are represented by same general formula
(b) All members have same chemical properties
(c) All members have same physical properties
(d) All members have same functional group

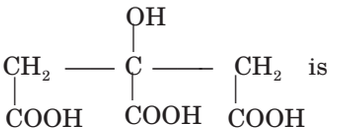
3. The correct statement related to IUPAC nomenclature is
(a) if two or more chains of equal length are seen in the compound then the chain with minimum number of side chains will be preferred
(b) if double and triple bonds are at symmetrical positions in a compound then triple bond gets lower preference
(c) correct IUPAC name of $CH_3COC_2H_5$ is ethyl methyl ketone
(d) as far as possible, the IUPAC name of a compound is written as a single word

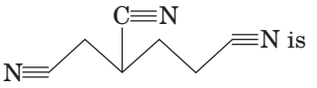
4. Choose the option which show correct preferential order of groups among the following
(a) — COOH, — CHO, — OH, — NH_2
(b) $—NH_2$, —OH, — CHO, — COOH
(c) — COOH, — OH, — NH_2, — CHO
(d) — COOH, — NH_2, — CHO, — OH

5. The correct name of  is
(a) hex-3-yn-5-ene (b) hex-5-en-3-yne
(c) hex-3-yn-1-ene (d) hex-1-en-3-yne

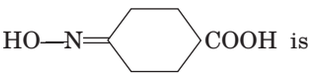
6. The IUPAC name for

(a) 1-hydroxypentane-1,4-dione *[NCERT Exemplar]*
(b) 1, 4-dioxopentanol
(c) 1-carboxybutan-3-one
(d) 4-oxopentanoic acid

7. The IUPAC name of the compound

(a) N-hydroxy-3-aminopentane
(b) N-hydroxyaminopentane
(c) N-hydroxy-3-iminopentane
(d) None of the above

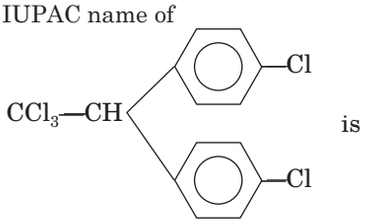
8. The correct IUPAC name of
 is
(a) 2-hydroxypropane-1, 2, 3-tricarboxylic acid
(b) 3-carboxy-3-hydroxypentane-1,5-dioic acid
(c) 2-carboxy-4 hydroxypentane-1,5-dioic acid
(d) 3-carboxy-3-hydroxyhexane-1,6-dioic acid

9. The IUPAC name of compound
 is
(a) hexane-1,2,5-tricarbonitrile
(b) hexane-1,3,6-tricarbonitrile
(c) butane-1,2,4-tricarbonitrile
(d) butane-1,3,4-tricarbonitrile

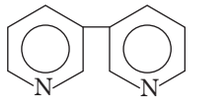
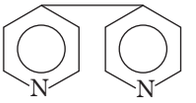
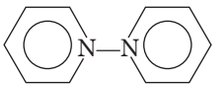
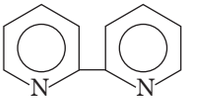
10. The IUPAC name of the compound  is
(a) butane-2-aldehyde (b) 2-methylbutanal
(c) 2-ethylpropanal (d) None of these

11. The IUPAC name of
 is
a) 4-hydroxy amino benzene carboxylic acid
(b) 4-(N-hydroxy) imino benzene carboxylic acid
(c) 4-hydroxy imino cyclohexanoic acid
(d) 4-(N-hydroxy) imino cyclohexane-1-carboxylic acid

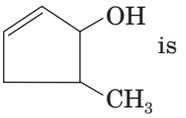
12. The correct IUPAC name of tartaric acid is
(a) 1,4-dicarboxy-2,3-dihydroxyethane
(b) α, α′-dihydroxybutane-1,4-dioic acid
(c) 1,4-dihydroxybutane-2,3-dioic acid
(d) 2,3-dihydroxybutane-1,4-dioic acid

13. Correct IUPAC name of

is
(a) gammexane
(b) dichloro diphenyl trichloroethane
(c) diparachlorophenyl trichloroethane
(d) 1,1,1-trichloro-2,2-*bis* (4-chlorophenyl) ethane

14. The compound 2,2′-bipyridine has the structure

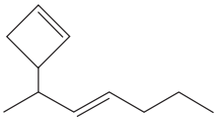
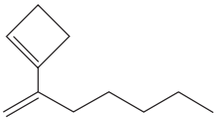
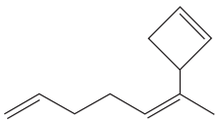
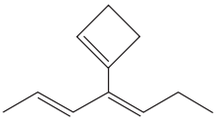
(a) 
(b) 
(c) 
(d) 

15. The IUPAC name of the compound

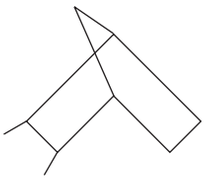

is

(a) 4-methylcyclopent-1-en-3-ol
(b) 5-methylcyclopent-2-en-1-ol
(c) 2-methylcyclopent-4-en-1-ol
(d) 3-methylcyclopent-1-en-2-ol

16. Which is the structure of compound 2-(1-cyclobutenyl)-1-hexene?

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

17. Write the IUPAC name of the compound

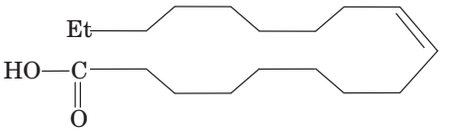


(a) 5,6-dimethyl bicyclo [2.2.1] heptane
(b) 2,3-dimethyl bicyclo [2.2.1] heptane
(c) 2,3-dimethyl bicyclo[1.2.2] heptane
(d) 3,4-dimethyl bicyclo [2.1.2] heptane

18. The IUPAC name of following compound is

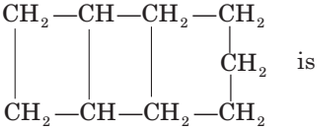
(a) N,N-dimethyl- 3-methylpentan-3-amine
(b) 3-N,N-dimethyl, 3-methyl pentanamine
(c) 3-methyl-3-N,N-dimethyl pentane
(d) 3-methyl-3-N,N-dimethyl butane

19. The compound



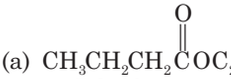
have its IUPAC name as
(a) octa dec-9-enoic acid
(b) oleic acid
(c) ethyl hexadec-9-enoic acid
(d) All of the above

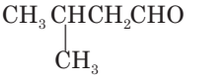
20. The IUPAC name of the compound

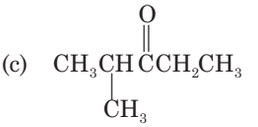

is

(a) bicyclo [2.5.0] nonane (b) bicyclo [5.0.2] nonane
(c) bicyclo [5.2.0] nonane (d) bicyclo [0.2.5] nonane

21. Which of the following compounds has incorrect IUPAC nomenclature?

(a) 
Ethyl butanoate

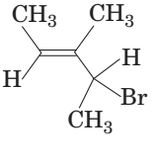
(b) 
3-methyl butanal

(c) 
2-methyl-3- pentanone

(d) 
2-methyl-3- butanol

22. The IUPAC name of $CH_3COCH(CH_3)_2$ is
(a) *iso*-propylmethyl ketone
(b) 2-methyl-3-butanone
(c) 4-methyl *iso*-propyl ketone
(d) 3-methyl-2-butanone

23. What is the IUPAC name of the following compound ?



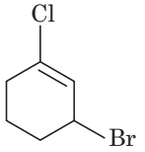
(JEE Main 2019)

(a) 3-bromo-3-methyl-1,2-dimethylprop-1-ene
(b) 3-bromo-1,2-dimethylbut-1-ene
(c) 2-bromo-3-methylpent-3-ene
(d) 4-bromo-3-methylpent-2-ene

24. The IUPAC name of *neo*-pentane is *[AIEEE 2009]*

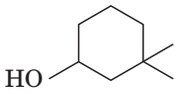
(a) 2-methylbutane
(b) 2,2-dimethylpropane
(c) 2-methylpropane
(d) 2,2-dimethylbutane

25. The IUPAC name of the compound shown below is *[AIEEE 2006]*



(a) 2-bromo-6-chlorocyclohex-1-ene
(b) 6-bromo-2-chlorocyclohexene
(c) 3-bromo-1-chlorocyclohexene
(d) 1-bromo-3-chlorocyclohexene

26. The IUPAC name of the compound is



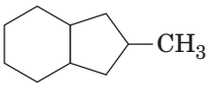
[AIEEE 2004]

(a) 3, 3-dimethyl-1-hydroxy cyclohexane
(b) 1, 1-dimethyl-3-hydroxy cyclohexane
(c) 3, 3-dimethyl-1-cyclohexanol
(d) 1, 1-dimethyl-3-cyclohexanol

27. The IUPAC name of $CH_3COCH(CH_3)_2$ is *(AIEEE 2003)*

(a) *iso*-propylmethyl ketone
(b) 2-methyl-3-butanone
(c) 4-methyl-iso-propyl ketone
(d) 3-methyl-2-butanone

28. IUPAC name of the following cycloalkane is

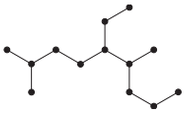


(a) 8-methyl bicylo (4,3,0) nonane
(b) 1-methyl bicyclo (4,3,0) nonane
(c) 3-methyl bicyclo (4,3,0) nonane
(d) 4-methyl bicyclo (4,3,0) nonane

Numeric Value Questions

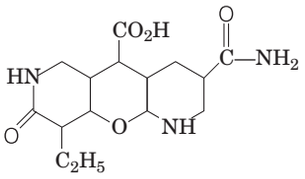
29. How many 1° carbon atom will be present in simplest hydrocarbon having two 3° and one 2° carbon atom?

30.



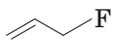
How many methyl —CH_3 groups are present in given alkene?

31.



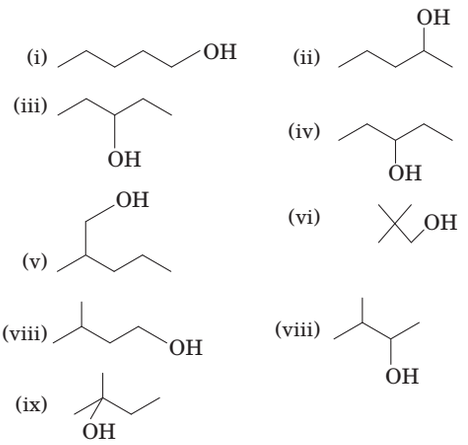
Number of functional group in the above compound is …… .

32.

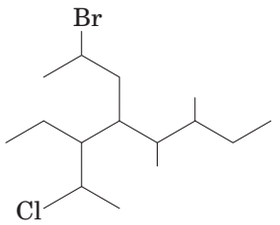


When IUPAC name of following compound is given, then double bond and substituent gets respectively (x and y) number so the sum of ($x + y$) will be …… .

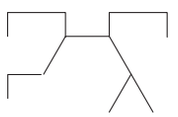
33. How many number of compounds, which have same IUPAC name ?



34. How many total number of substituent are present in the following compound?



35. How many carbon atoms are present in parent carbon chain the following compound?



Answers

Round I

1. (b)	**2.** (b)	**3.** (d)	**4.** (a)	**5.** (c)	**6.** (c)	**7.** (d)	**8.** (b)	**9.** (d)	**10.** (a)
11. (b)	**12.** (a)	**13.** (c)	**14.** (a)	**15.** (b)	**16.** (a)	**17.** (d)	**18.** (b)	**19.** (b)	**20.** (c)
21. (b)	**22.** (b)	**23.** (d)	**24.** (d)	**25.** (c)	**26.** (c)	**27.** (c)	**28.** (b)	**29.** (b)	**30.** (d)
31. (b)	**32.** (a)	**33.** (a)	**34.** (b)	**35.** (b)	**36.** (a)	**37.** (a)	**38.** (a)	**39.** (d)	**40.** (a)
41. (a)	**42.** (c)	**43.** (b)	**44.** (c)	**45.** (b)	**46.** (a)	**47.** (c)	**48.** (c)	**49.** (d)	**50.** (a)
51. (c)	**52.** (d)	**53.** (d)	**54.** (d)	**55.** (d)	**56.** (c)	**57.** (d)	**58.** (b)	**59.** (a)	**60.** (a)
61. (c)	**62.** (d)	**63.** (b)	**64.** (c)	**65.** (c)	**66.** (c)	**67.** (c)	**68.** (d)	**69.** (b)	**70.** (a)
71. (d)	**72.** (b)	**73.** (b)	**74.** (c)	**75.** (b)	**76.** (a)	**77.** (b)	**78.** (c)	**79.** (c)	**80.** (d)
81. (b)	**82.** (b)	**83.** (a)	**84.** (c)	**85.** (c)	**86.** (d)				

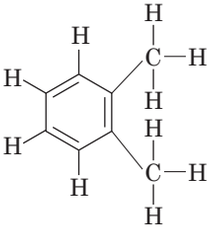
Round II

1. (b)	**2.** (c)	**3.** (d)	**4.** (a)	**5.** (d)	**6.** (d)	**7.** (c)	**8.** (a)	**9.** (c)	**10.** (b)
11. (d)	**12.** (d)	**13.** (d)	**14.** (d)	**15.** (b)	**16.** (b)	**17.** (b)	**18.** (a)	**19.** (a)	**20.** (c)
21. (d)	**22.** (d)	**23.** (d)	**24.** (b)	**25.** (c)	**26.** (c)	**27.** (d)	**28.** (a)	**29.** (4)	**30.** (2)
31. (5)	**32.** (4)	**33.** (0)	**34.** (4)	**35.** (8)					

Solutions

Round I

1.



[Every single bond is a σ-bond while every double bond has one σ bond and one π-bond.]

3. The carbon-carbon bond length follows the order

Single bond > Double bond > Triple bond

4. Acetylene has triple bond, benzene has double character, while bond ethane and diamond have C—C single bonds.

5. $CH \equiv \overset{sp}{C}—H > CH_2 = \overset{sp^2}{C}H > CH_3\overset{sp^3}{C}H_2—H$

7. All the given structures are correct dash formula for *n*-propyl alcohol. The atoms joined by single bonds can rotate relatively free with respect to one another.

8. $CH_3\underset{\underset{OH}{|}}{CH}CH_3$ (i), $CH_3CH(OH)CH_3$ (ii),

$CH_3CHOHCH_3$ (iii), $(CH_3)_2CHOH$ (iv)

9. For tetrahedral carbon atom-A carbon atom with four attachments and bond angles of approximately 109.5°.

13. $CH_3—\overset{3°}{C}H—\overset{3°}{C}H—CH_3$ 2, 3-dimethylbutane has two tertiary carbon atoms marked as 3°.

14. $\overset{8}{C}H_3\overset{7}{C}H_2—\overset{6}{C}H—\overset{5}{C}H—\overset{4}{C}H_2\overset{3}{C}H_2—\overset{2}{C}H—\overset{1}{C}H_3$

2, 5, 6-trimethyloctane (lowest locant rule)

All other names are correct.

15. $\overset{1}{C}H_3\overset{2}{C}H_2—\overset{3}{C}(H)(CH_3)—\overset{4}{C}(CH_3)—\overset{5}{C}H_2\overset{6}{C}H_2\overset{7}{C}H_2\overset{8}{C}H_3$

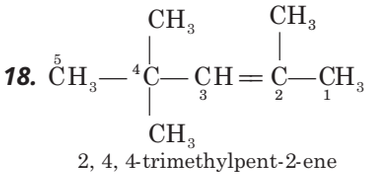
3, 4, 4-trimethyloctane

16. $\overset{1}{C}H_3\overset{2}{C}H_2—\overset{3}{C}H(CH_2CH_3)—\overset{4}{C}H_2—\overset{5}{C}H(CH_3)—\overset{6}{C}H_2\overset{7}{C}H_3$

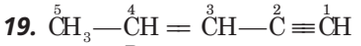
3-ethyl-5-methylheptane

17. $\overset{1}{C}H_3—\overset{2}{C}H=\overset{3}{C}(CH_2CH_3)—\overset{4}{C}H_2\overset{5}{C}H_2\overset{6}{C}H_3$

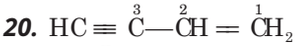
3-ethylhex-2-ene

18. 

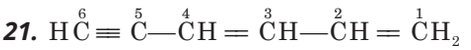
2, 4, 4-trimethylpent-2-ene

19. 

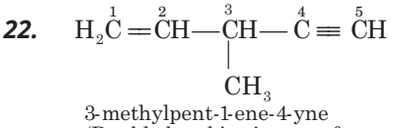
Pent-3-en-1-yne

20. 

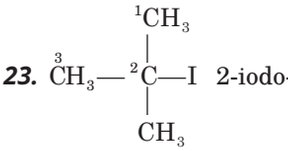
But-1-en-3-yne

21. 

Hexa-1, 3-dien-5-yne
(double bond is given preference over the triple bond)

22. 

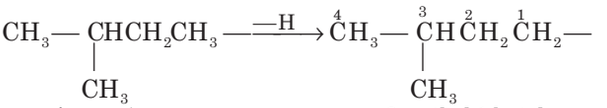
3-methylpent-1-ene-4-yne
(Double bond is given preference)

23. 

2-iodo-2-methylpropane

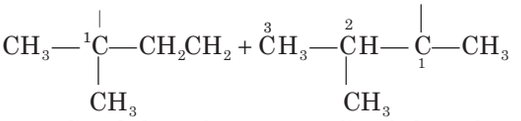
24. The IUPAC name of neopentyl group is 2, 2-dimethylpropyl.

25. The IUPAC name of allyl group ($—\overset{1}{C}H_2—\overset{2}{C}H=\overset{3}{C}H_2$) is 2-propenyl.

26. 

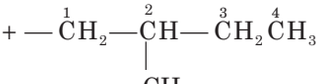
iso- pentane

3-methyl-1-butyl
(*iso*- pentyl)

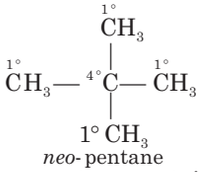


1, 1-dimethylpropyl

1, 2-dimethylpropyl

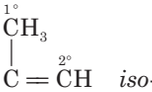


2-methyl-1-butyl

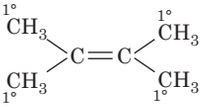
27. 

neo- pentane

neo-pentane contains four 1° and one 4° carbons but no 2° and 3° carbons. Thus, option (c) is correct.

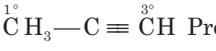
28. 

iso-butene has only 1° and 2° hydrogens.



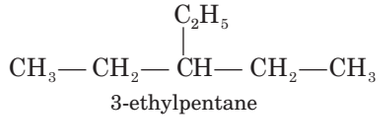
2, 3-dimethyl-2-butane has only 1° hydrogens

Cyclohexane only 2° hydrogen

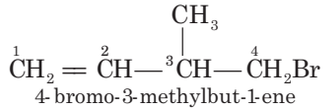


Propyne has 1° and 3° hydrogens.

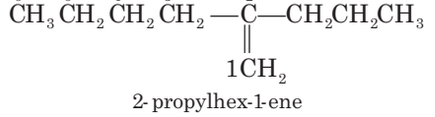
Hence, option (b) is correct.

30. 

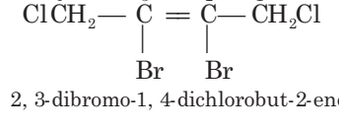
3-ethylpentane

31. 

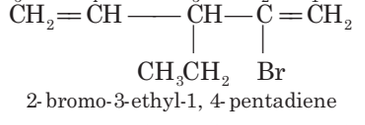
4-bromo-3-methylbut-1-ene

32. 

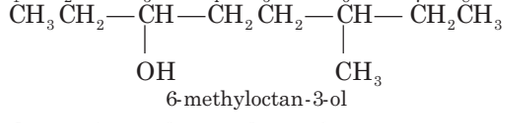
2-propylhex-1-ene

33. 

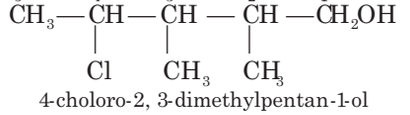
2, 3-dibromo-1, 4-dichlorobut-2-ene

34. 

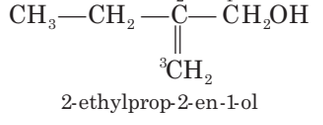
2-bromo-3-ethyl-1, 4-pentadiene

35. 

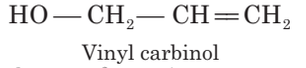
6-methyloctan-3-ol

36. 

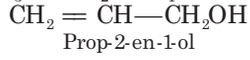
4-choloro-2, 3-dimethylpentan-1-ol

37. 

2-ethylprop-2-en-1-ol

38. 

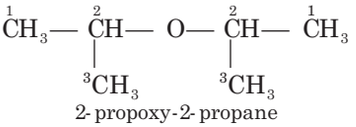
Vinyl carbinol

39. 

Prop-2-en-1-ol

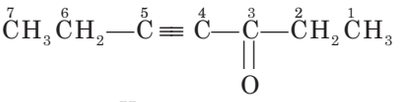
40. Option (a) is the incorrect IUPAC naming. The correct name will be : 4-ethyl-3-methylheptane (alphabetical order). All other names are correct.

41.



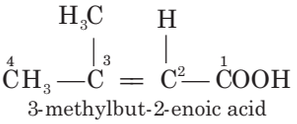
2- propoxy-2- propane

42.



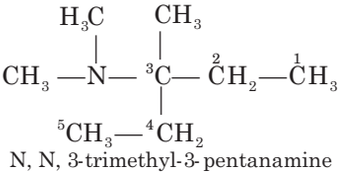
Hept-4-yn-3-one

43.



3-methylbut-2-enoic acid

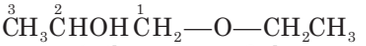
44.



N, N, 3-trimethyl-3- pentanamine

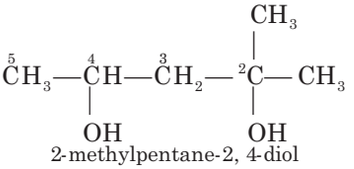
(Alphabets are given preference over arabic numerals)

46.



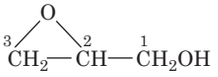
1-ethoxypropane-2-ol

47.



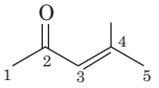
2-methylpentane-2, 4-diol

48.



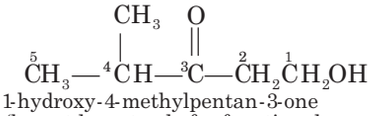
2, 3-epoxy-1-propanol

49.



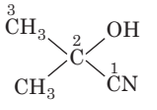
4-methylpent-3-en-2-one

50.



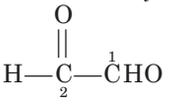
1-hydroxy-4-methylpentan-3-one
(lowest locant rule for fucntional groups)

51.



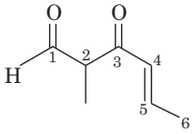
2-hydroxy-2-methylpropanenitrile

52.



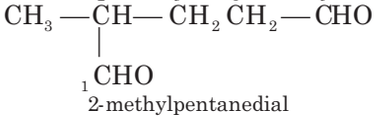
1, 2-ethanedial

53.



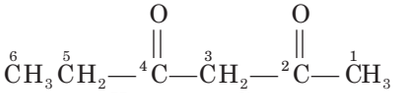
3-keto-2-methylhex-4-enal

54.



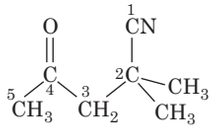
2-methylpentanedial

55.



Hexane-2, 4-dione

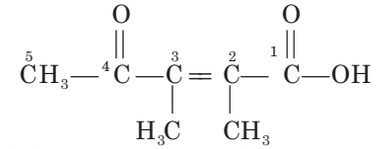
56.



2, 2-dimethyl-4-oxopentanenitrile

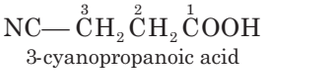
(CN gets preference over C═O group)

57.



2, 3-dimethyl-4-oxopent-2-ene-1-oic acid

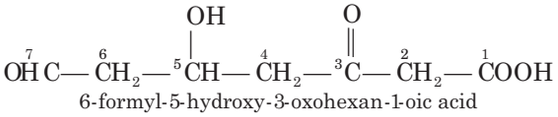
58.



3-cyanopropanoic acid

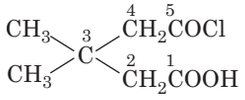
59. The correct name of $BrCH_2CH=CH_2$ is 3-bromoprop-1-ene since double bond is given preference over the substituent (i.e. Br). All other names are correct.

60.



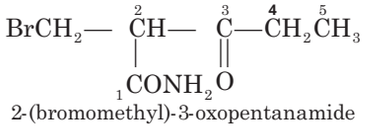
6-formyl-5-hydroxy-3-oxohexan-1-oic acid

61.



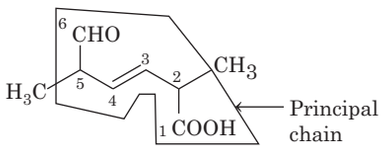
5-chloroformyl-3, 3-dimethylpentanoic acid

62.



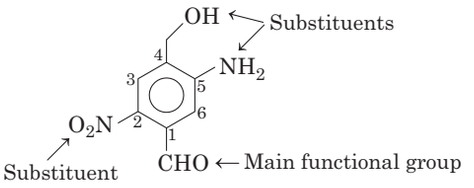
2-(bromomethyl)-3-oxopentanamide

63.



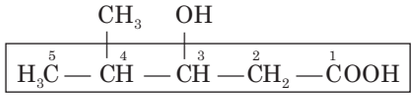
IUPAC name is 2, 5-dimetyl-6-oxo-hex-3-enoic acid.

64.



5-amino-4-hydroxymethyl-1-2-nitrobenzaldehyde

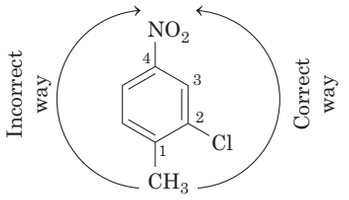
65. The IUPAC name of the given compound is 3-hydroxy-4-methylpentanoic acid.



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.

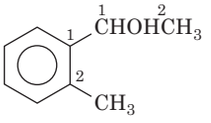
66. The IUPAC name of the given compound is



2- chloro-1-methyl-4-nitrobenzene

Here, the given compound contains two or more functional groups. So, the numbering is done in such a way that the sum of the locants is the lowest.

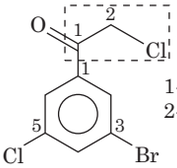
67.



1-(2-methylphenylethanol)

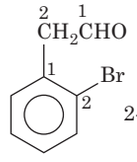
There is no functional group in the benzene ring, therefore, it is named as a derivative of the side chain.

68.



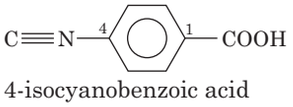
1-(3-bromo-5-chlorophenyl)-2-chloroethanone

69.



2-(2-bromophenyl) ethanal

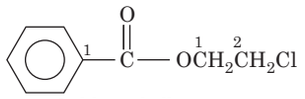
70.



4-isocyanobenzoic acid

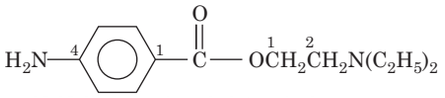
Prefix for NC is isocyano and not isonitrile or carbylamine.

71.



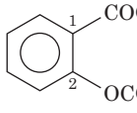
2-chloroethylbenzoate

72.



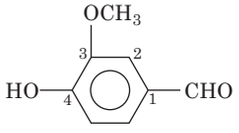
N, N-diethylaminoethyl-4-amionbenzoate

73.



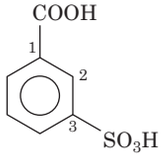
(commonly known as aspirin)
2-acetoxybenzoic acid

74.



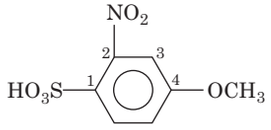
4-hydroxy-3-methoxy-benzaldehyde

75.



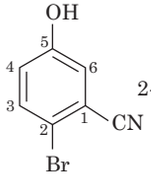
3-sulphobenzoic acid
(COOH gets preference over SO_3H)

76.



4- methoxy-2-nitrobenzenesulphonic acid

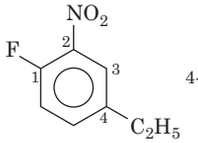
77.



2-bromo-5-hydroxybenzonitrile

(∵ CN is the principal functional group while OH and Br are the substituent groups.)

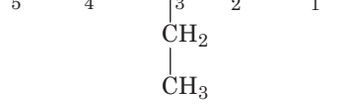
78.



4-ethyl-1-fluoro-2-nitrobenzene

Round II

1.

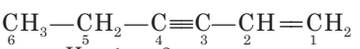


3-ethyl pentane

This compound exists.

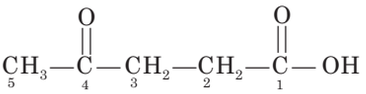
4. The choice of principal functional group is made on the basis of the following order

Carboxylic acid > sulphonic acid > anhydride > esters > acid halide > acid amide > nitrile > aldehyde > ketone > alcohol > amine

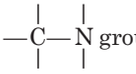
5. 

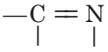
Hex-1-en-3-yne

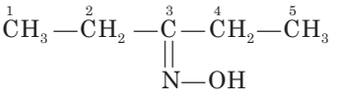
[∴ Double bond is preferred over ≡ bond while naming.]

6. 

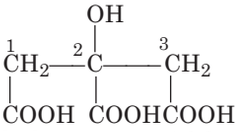
4-oxo pentanoic acid

7.  group is called amino

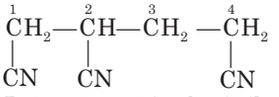
while  group is called imino.



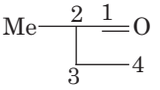
N-hydroxy-3-iminopentane

8. 

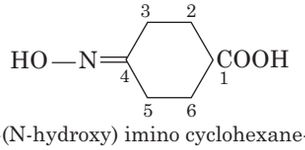
2-hydroxypropane-1,2,3-tricarboxylic acid

9. 

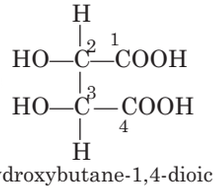
Butane-1,2,4-tricarbonitrile

10. 

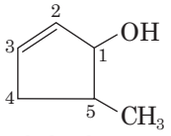
2-methylbutanal

11. 

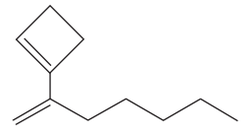
4-(N-hydroxy) imino cyclohexane-1-carboxylic acid

12. Tartaric acid is 

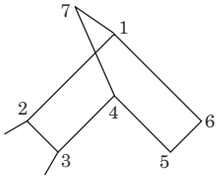
2,3-dihydroxybutane-1,4-dioic acid

15. 

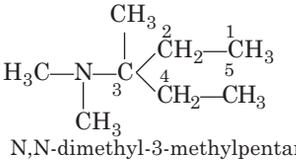
5-methylcyclopent-2-en-1-ol

16. 

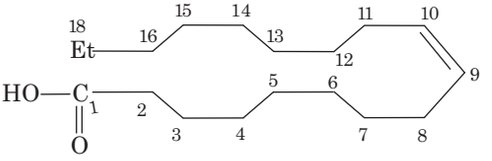
2-(1-cyclobutenyl)-1-hexene

17. 

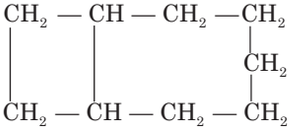
2,3-dimethyl bicyclo [2.2.1] heptane

18. 

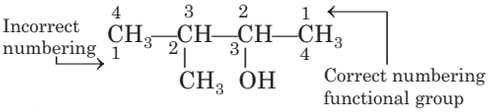
N,N-dimethyl-3-methylpentan-3-amine

19. 

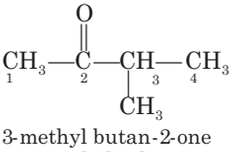
Octa dec-9-enoic acid

20. 

This compound contains 9 carbon atoms thus, corresponding alkane is nonane. Three bridges contain 5, 2 and 0 carbon atoms respectively.
Therefore, the name of the compound is bicyclo [5.2.0] nonane.

21. 

Correct name 3-methyl butan-2-ol or 3-methyl-2-butanol

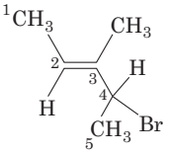
22. 

3-methyl butan-2-one
or 3-methyl-2- butanone

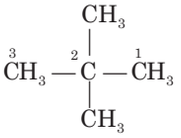
 keto (—C—) functional group is given priority.

23. While naming the compound, alkene gets priority over functional group (—Br) and numbering starts from alkene side.

Hence, **IUPAC** name: 4-bromo-3-methylpent-2-ene

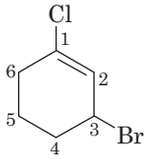


24. Structure of the *neo*-pentane

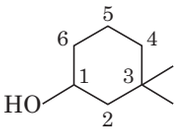


IUPAC name : 2,2-dimethyl propane

25. Unsaturation (double bond) is given priority over halogen. So, the correct IUPAC name is 3-bromo-1-chlorocyclohexene.

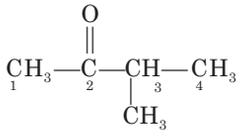


26.



Carbon with — OH group is given C_1, thus it is 3, 3-dimethyl-1-cyclohexanol.

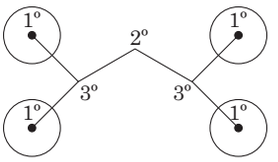
27.



3-methyl butan-2-one
or 3 -methyl-2- butanone

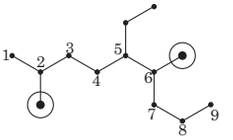
keto (—C—) functional group is given priority.

29.



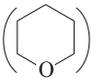
Four 1° carbon as shown in circle.

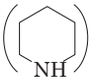
30.

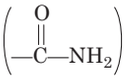


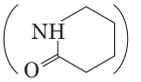
Only two —CH_3 groups present at 2 position and 6 position.

31. 1. Acid (—COOH)

2. Cyclic ether 

3. Cyclic 2° amine 

4. Amide 

5  Lactum (cyclic imide)

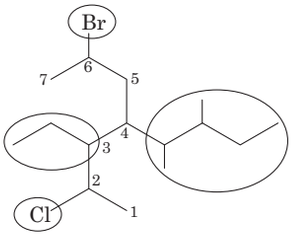
32. Double bond is in 1 position, $\because x = 1$

Substituent (—F group) is present at 3-position, $\therefore y = 3$

$\therefore \quad x + y = 1 + 3 = 4$

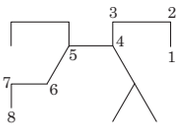
33. All have different IUPAC name.

34.



Four substituents as shown in circle.

35.



Eight carbon atoms are present in parent chain.