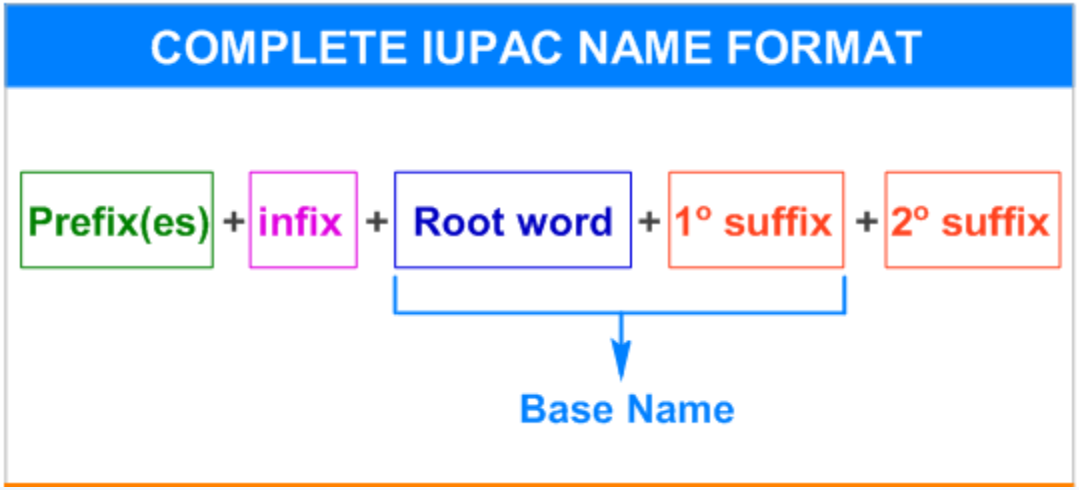
IUPAC Nomenclature

Nomenclature of organic compounds: alkanes, alkenes, alkynes, haloalkanes, alcohols, ethers, aldehydes, ketones, carboxylic acids, carboxylic acid derivatives (acid halides, esters, anhydrides, amides), nitro compounds, nitriles and amines; including their cyclic analogues.

IUPAC system: (International Union of Pure and Applied Chemistry)

- By using this system one can name any complex organic compound easily. The name assigned to an organic compound on the basis of latest IUPAC rules is known as systematic name.

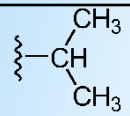
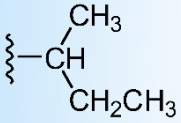
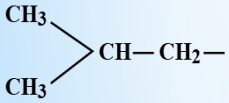
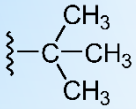


Prefix:

1) Secondary- The prefix is used to indicate the side chains, substituents and low priority functional groups (which are considered as substituents). The prefix may precede the word root or the infix of IUPAC name. (examples provided in table)
2) Primary or Infix- The infixes, like cyclo, spiro, bicyclo, are added between the prefix(es) and root word in the IUPAC name to indicate the nature of parent chain.

* The "Cyclo" infix is used to indicate the cyclic nature of the parent chain.
* The "Spiro" infix is used to indicate the spiro compound.
* The "Bicyclo" infix is used to indicate the bicyclic nature of the parent chain.

Secondary prefix

Side chain or Substituent	Prefix
$-CH_3$	methyl-
$-CH_2CH_3$ (or) $-C_2H_5$	ethyl-
$-CH_2CH_2CH_3$	propyl-
	isopropyl-
$-CH_2CH_2CH_2CH_3$	butyl
	sec-butyl (or) (1-methyl)propyl
	isobutyl (or) (2-methyl)propyl
	tert-butyl (or) (1,1-dimethyl)ethyl
-X	halo-
-OR	alkoxy-
$-NO_2$	-nitro

Word Root

The Word root of IUPAC name indicates the number of carbon atoms in the longest possible continuous carbon chain also known as parent chain including the functional group and based upon the common names of alkanes chosen by a set of rules. It is the basic unit of the name. It denotes the number of carbon atoms present in the principal chain of the organic molecules.

Number of carbon atoms in the parent chain	Root word
1	Meth
2	Eth
3	Prop
4	But
5	Pent
6	Hex
7	Hept
8	Oct
9	Non
10	Dec
11	Undec
12	Dodec
13	Tridec
14	Tetradec
15	Pentadec
16	Hexadec
17	Heptadec
18	Octadec
19	Nonadec
20	Icos

Suffix:

It is again divided into two types.

i.Primary suffix and

ii.Secondary suffix

i) Primary suffix:

It is used to indicate the degree of saturation or unsaturation in the main chain. It is added immediately after the word root of IUPAC name.

Type of carbon chain	Primary suffix
Saturated (all C-C bonds)	-ane
Unsaturated: one C=C	-ene
Unsaturated: two C=C	-diene
Unsaturated: one C≡C	-yne
Unsaturated: two C≡C	-diyne
Unsaturated: one C=C & one C≡C	-enyne

ii) Secondary suffix:

It is used to indicate the main functional group in the organic compound and is added immediately after the 1^{o} suffix in the IUPAC name.

Note: If there are two or more functional groups in a compound, the functional group with higher priority is to be selected as main functional group, which must be indicated by a secondary suffix. The remaining functional groups with lower priority are treated as substituents and are indicated by prefixes.

The suffixes as well as prefixes used for some important functional groups are shown in the following table in the decreasing order of their priority.

Also note that different suffix is used when carbon atom of the functional group is not part of the main chain.

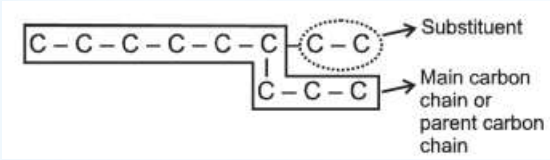
Name of Functional group	Representation	Suffix When carbon of the functional group is part of the parent chain	Suffix When carbon of the functional group is NOT part of the parent chain	Prefix
carboxylic acid	-COOH	-oic acid	-carboxylic acid	carboxy-
Acid anhydride		-oic anyhydride	-carboxylic anhydride	-
Ester	-COOR	alkyl -oate	alkyl -carboxylate	alkoxycarbonyl-
Acid halide	-COX	-oyl halide	-carbonyl halide	halocarbonyl-
Acid amide	$-CONH_2$	-amide	-carboxamide	carbamoyl-
Nitrile	-CN	-nitrile	-carbonitrile	cyano-
Aldehyde	-CHO	-al	-carbaldehyde	oxo-
Ketone	-CO-	-one	-	oxo-
Alcohol	-OH	-ol	-	hydroxy
Thiol	-SH	-thiol	-	mercapto
Amine	$-NH_2$	-amine	-	amino-
Imine	=NH	-imine	-	imino-
Alkene	C=C	-ene	-	-
Alkyne	C≡C	-yne	-	-

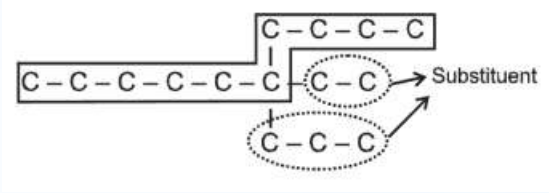
Nomenclature of Alkane

Steps in IUPAC Naming
- (A) Selection of parent chain
- (B) Numbering at parent chain

Rule-1 :

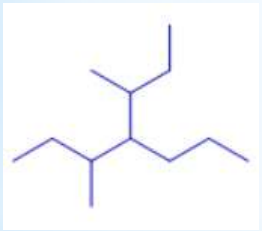
- Select the longest carbon chain containing maximum number of carbon and this longest carbon chain is also called parent carbon chain (PCC).
- Longest carbon chain not always straight.

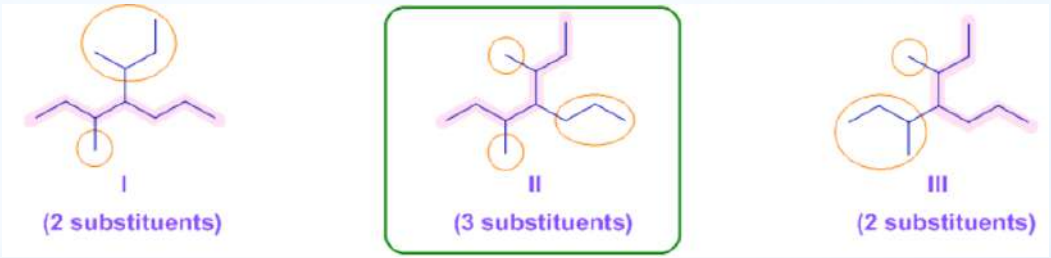




Rule-2 :

- If two or more carbon chain contains same number of carbon then PCC is considered which has more number of substituents.



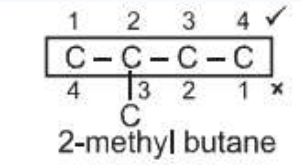


- *The double bonds and triple bonds have more priority than the alkyl side chains and some other substituents like halo, nitro, alkoxy etc. Hence, whenever there are two or more chains with equal number of carbons, the chain that contains double or triple bond is to be selected as the parent chain irrespective of other chain containing more number of substituents.*

- However, the longest chain must be selected as parent chain irrespective of whether it contains multiple bonds or not.

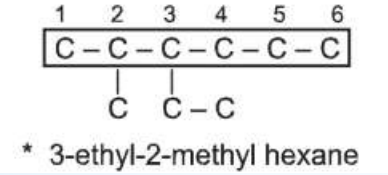
Rule-3 :

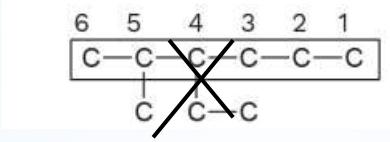
- Numbering of parent carbon chain is done by lowest locant rule.
- Lowest Locant Rule : According to this rule numbering is done in such a way so that substituent will get lowest number



Rule-4 :

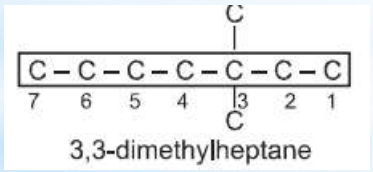
- If two or more different substituents are present at parent carbon chain then numbering is done according to lowest locant rule while writing IUPAC name follow alphabetical order.

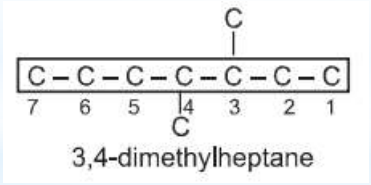


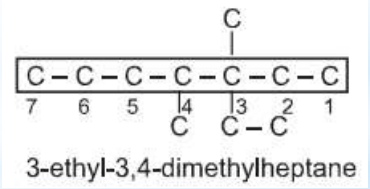


Rule-5 :

- If two or more similar substituents are present on parent carbon chain then use di, tri, tetra etc. before 2° prefix while writing IUPAC name but di, tri, tetra, etc. are not considered alphabetically

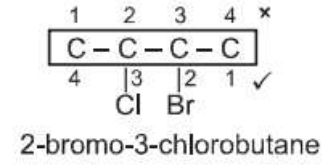




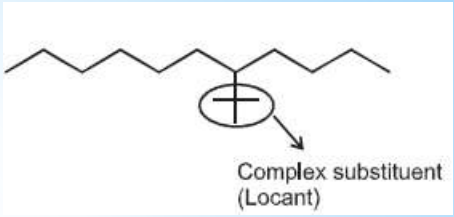


Rule-6 :

If two or more substituents are present on parent carbon chain and they get same number from either side during numbering then numbering is done by alphabetical order.



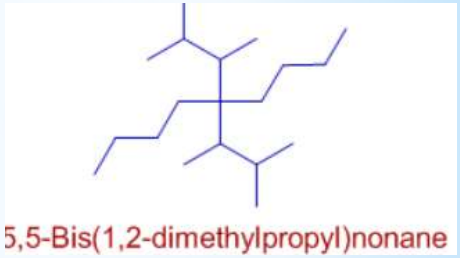
Nomenclature of complex locant



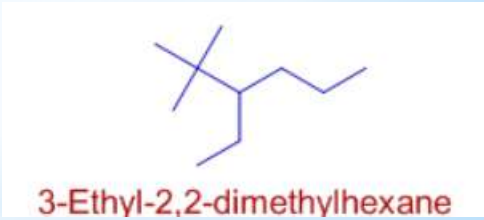
Complex locant is defined as which consist of substituent in substituent.

- If there are two or more same type of simple substituents they should be prefixed by di, tri, tetra, penta etc.

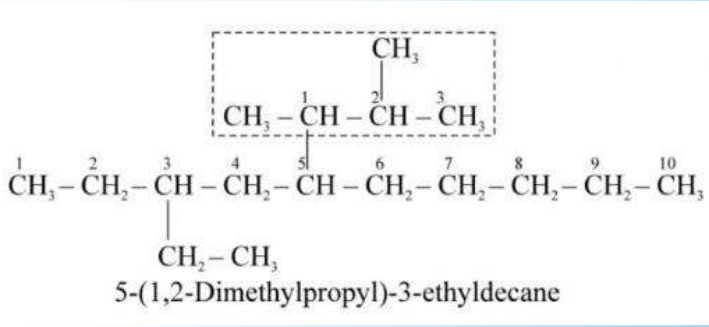
- If the side chains themselves contain terms like di, tri, tetra etc., the multiplying prefixes like bis, tris, tetrakis etc., should be used. For Ex.-The two 1,2-dimethylpropyl groups are indicated by the prefix "bis" as shown below.



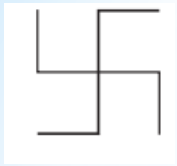
- If two or more side chains of different nature are present, they are cited in alphabetical order. E.g. In the following molecule, the ethyl group is written first since the letter 'e' precedes the letter 'm' of methyl in the alphabetical order. We should not compare 'e' in the word 'ethyl' and 'd' in the word 'dimethyl'

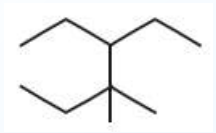


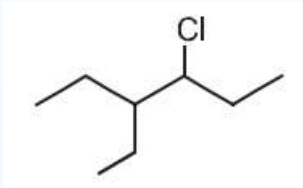
- However the name of a complex radical is considered to begin with the first letter of its complete name. E.g. In the following case, “dimethylpropyl” is considered as a complete single substituent and is alphabetized under "d“.

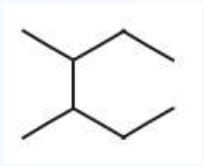


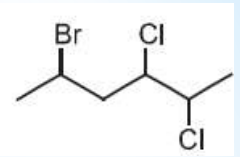
Practice Examples:

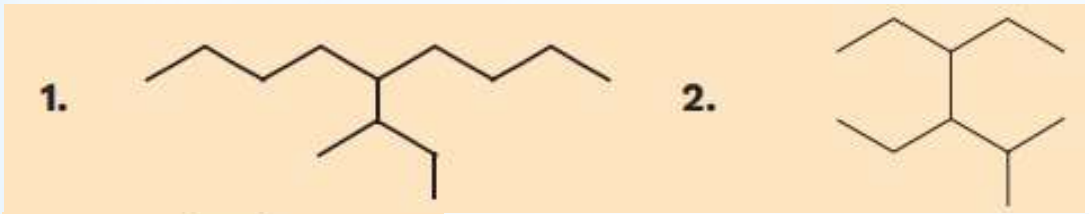


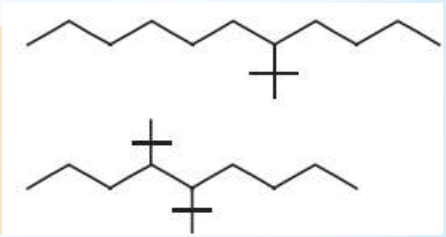


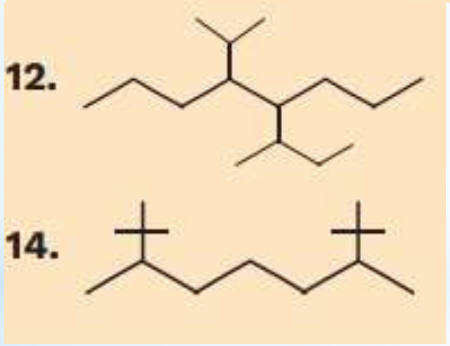


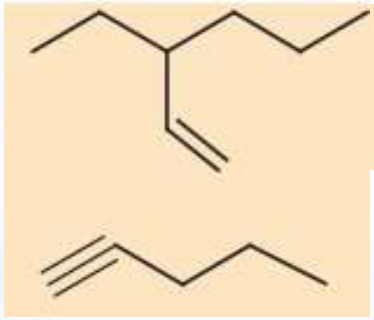


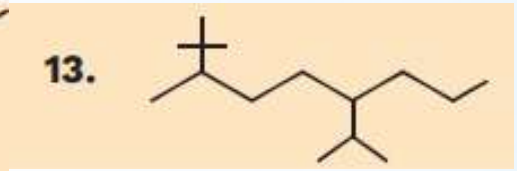




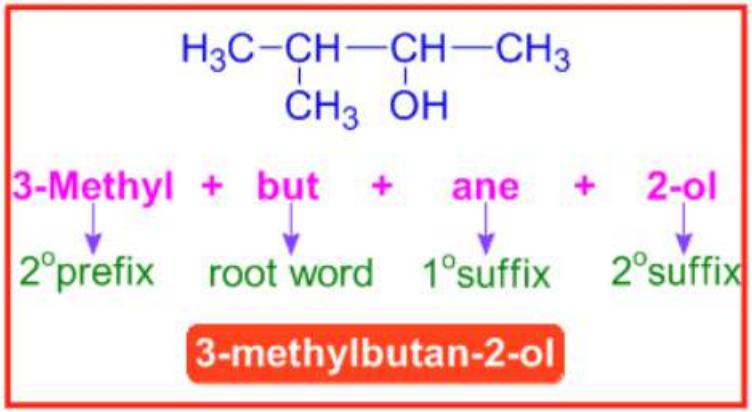








1) The first step in giving IUPAC name to an organic compound is to select the parent chain and assign a word root.
2) Next, the appropriate primary suffix(es) must be added to the root word to indicate the saturation or unsaturation.
3) If the molecule contains functional group or groups, a secondary suffix must be added to indicate the main functional group. This is optional and not necessary if the molecule contains **no** functional group.
4) Prefix the root word with the infix "cyclo" if the parent chain is cyclic; or with the infix "spiro" if it is a spiro compound; or with the infix "bicyclo" if the compound is bicyclic.
5) Finally add prefix(es) to the IUPAC name, if there are side chains or substituents on the parent chain.

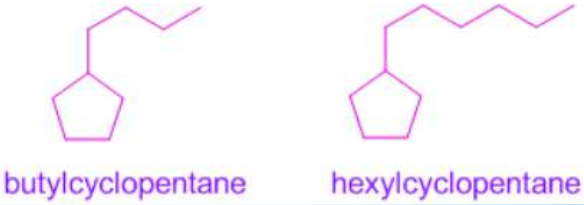


Step-1	How many carbons are there in the parent chain?	4	Root word = "but"
Step-2	Saturated or Unsaturated?	Saturated	1°suffix = "ane"
Step-3	Is there any functional group?	Yes. There is an alcohol group on 2nd carbon.	2°suffix = "2-ol"
Step-4	Are there any side chains or substituents?	Yes. There is a methyl group on 3rd carbon.	2°prefix = "3-methyl"

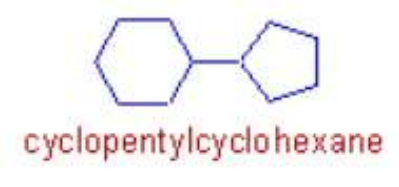
Nomenclature of cyclic Alkane

- *The IUPAC name of an alicyclic compound is prefixed with "cyclo".*
  Example, Cyclohexane, Cyclopentane.

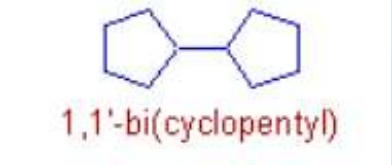
Rule1: Cycles are seniors to acyclics, Hence when cyclic nucleus is attached to the non cyclic chain, it is always named as the derivative of the cyclic hydrocarbon irrespective of the length of the non cyclic chain. This is a very new IUPAC recommendation.



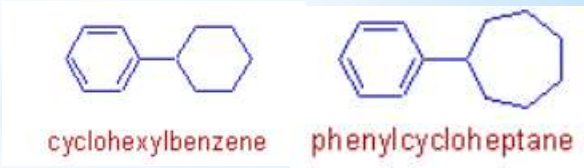
Rule 2: When two non-aromatic rings (alicyclic) are connected to each other, the compound is considered as the derivative of larger ring. The root word is derived from the larger ring. Whereas the smaller ring is indicated by the prefix.



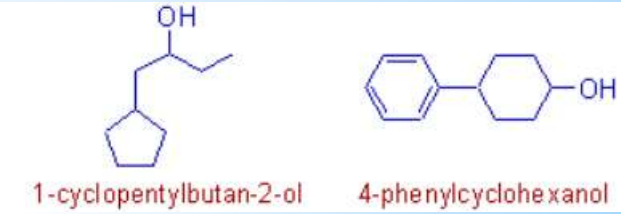
Rule 3: However if two alicyclic rings of same size are connected to each other, they are named as x,x'-bi(cycloalkyl).



Rule 4: The aromatic rings have more preference over the non-aromatic rings, when the sizes of both the rings are same. However the larger ring has more priority irrespective of its nature (whether it is aromatic or not).



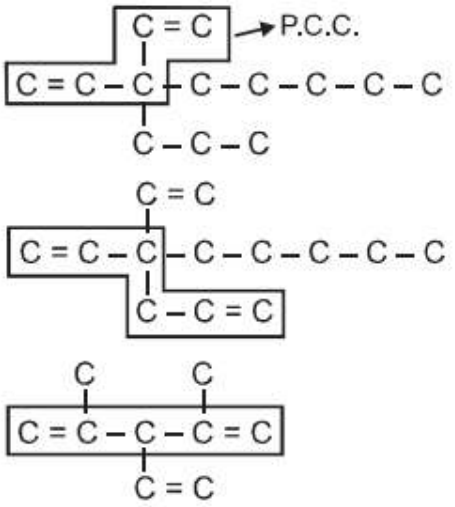
Rule 5: Nevertheless, the functional group is always the king. It will decide the root word of the IUPAC name when present in the compound.



Nomenclature of Alkene and alkynes

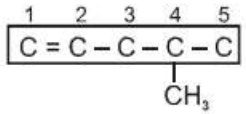
Rule-1 : Parent carbon chain selection :

- Select the longest carbon chain containing maximum number of multiple bonds.
- If two chains having same number of multiple bonds then check maximum number of carbons to select parent carbon chain.
- If multiple bonds & carbon both are same then see maximum number of substituent to select parent carbon chain.
- Number of multiple bond > Number of carbon > Number of substituent (priority order)

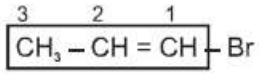


Rule-2 : Numbering of parent carbon chain :

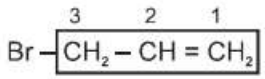
- While doing numbering in alkene and alkyne minimum number should be given to multiple bond.
- If multiple bond getting same number from either side then give minimum number to substituent.
- For numbering multiple bond priority is high compare to substituent



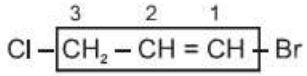
4-methylpent-1-ene
2° prefix | Word root | 1° suffix



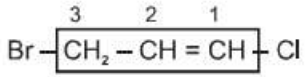
1-bromoprop-1-ene



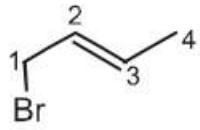
3-bromoprop-1-ene



1-bromo-3-chloroprop-1-ene

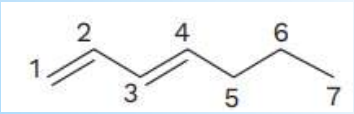


3-bromo-1-chloroprop-1-ene

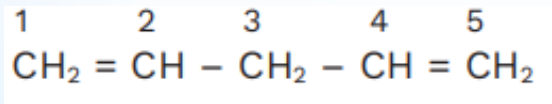


1-bromobut-2-ene

Rule 3: If two or more similar multiple bonds are present on PCC then use di, tri, tetra etc. before 1° suffix and before this di, tri, tetra etc. 'a' should be written.



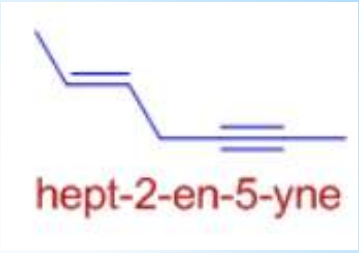
Hepta-1,3-diene

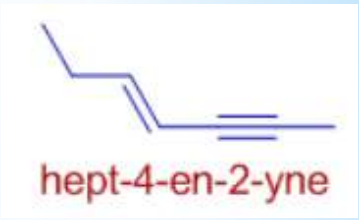


Penta-1,4-diene

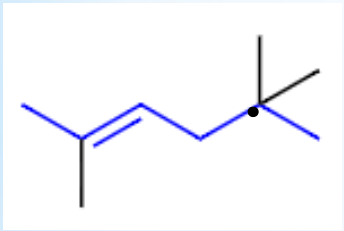
Rule 4:

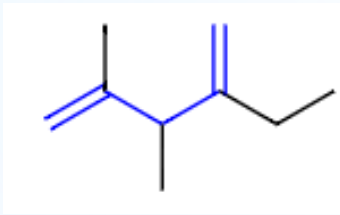
- If in parent carbon chain alkene and alkyne both are present and they are getting same number from either side i.e. in between alkene and alkyne) then numbering is done from alkene side because alphabetically ene > yne.
- The double bond is preferred over the triple bond since it is to be cited first in the name.
- *However,* if the double and triple bonds are not at equivalent positions, then the positions are decided by the rule of first point of difference.

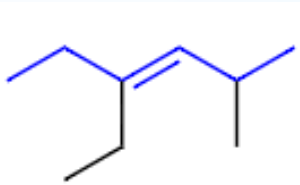


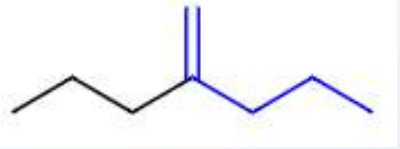


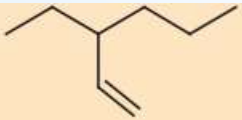
Practice Examples:

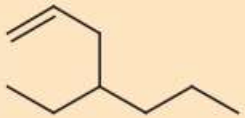






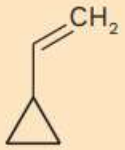


1. 

2. 

3. 

4. 

5. 

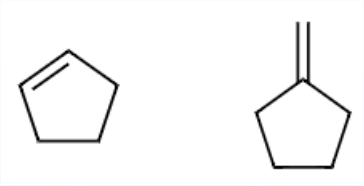
6. $Br - C \equiv C - CH_2 - CH_3$

7. $CH_3 - C \equiv C - CH_2 - CH = CH_2$

Don't forget to solve NCERTs examples! Class 11th Part I Unit 13th

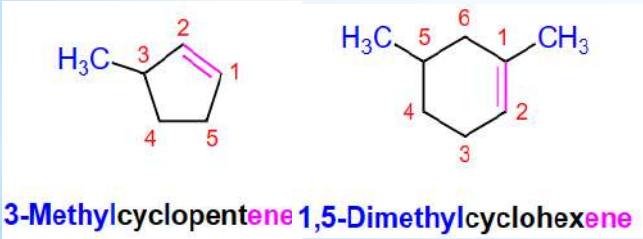
Nomenclature of cyclic Alkene and Alkynes

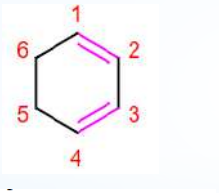
Types: Endocyclic double bonds have both carbons in the ring and exocyclic double bonds have only one carbon as part of the ring.

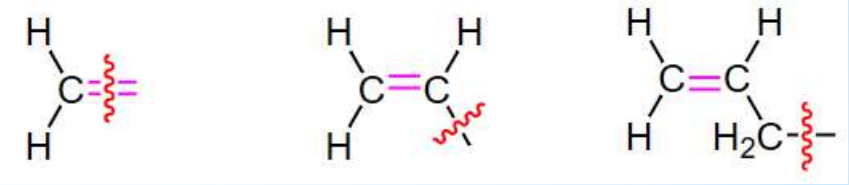


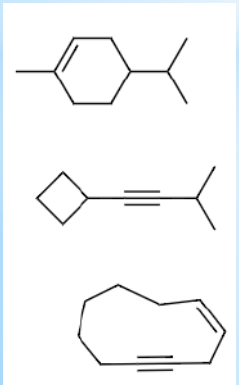
Rule:

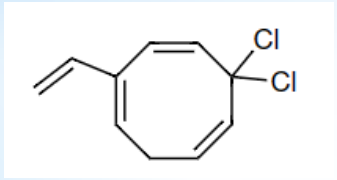
- All rules are similar to alkene & alkyne but during numbering 1 number is always given to alkene.
- Because there are no chain ends in cycloalkenes, the double bond is assumed to numbered C1 and C2 and its location number is not required in the name.
- The direction of the numbering is determined by which will give the substituent closest to the double bond the lowest number.
- If multiple double bonds are present, it may be necessary to include their location numbers in the name. One of the double bonds will be number C1 and C2 and the numbering direction is determined by which gives the remaining double bonds the lowest possible number.

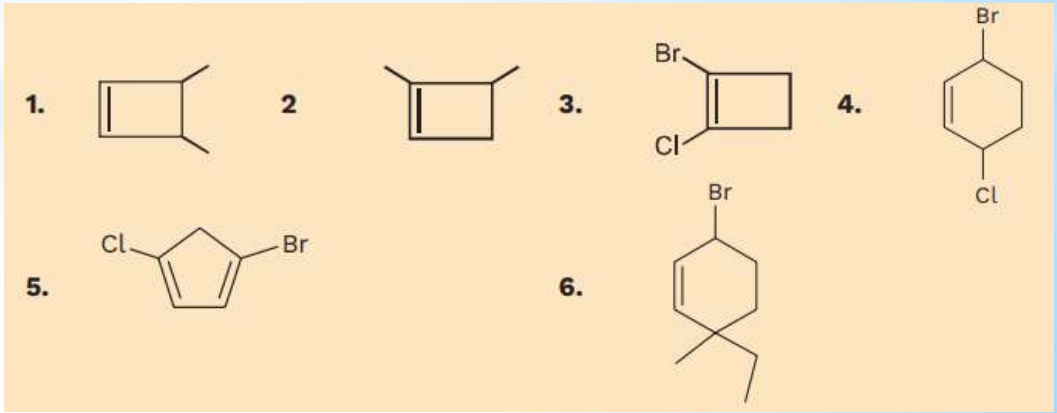










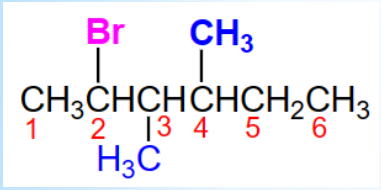


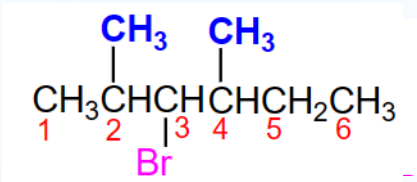
IUPAC Naming of Functional Groups

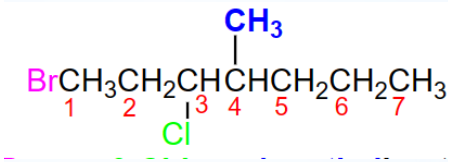
Haloalkanes represented as R-X, X= F, Cl, Br and I as Fluro, Chloro, Bromo and Iodo

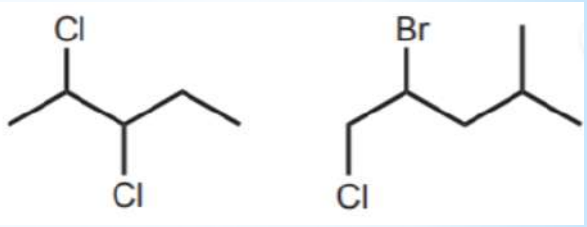
IUPAC Name Format: locator # + halo prefix + parent alkane

- Find and name the longest carbon chain and name it as the parent.
- Number the parent chain consecutively, starting at the end nearest a substituent group. Then assign each substituent a number. The name of a halogen is preceded by a number indicating the substituent's location on the parent chain. If multiple bonds (double or triple bonds) are present, then it is given the preference in numbering the carbon chain.

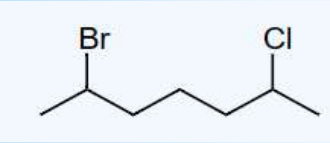




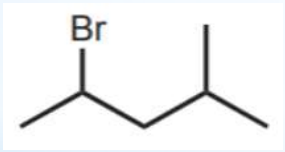




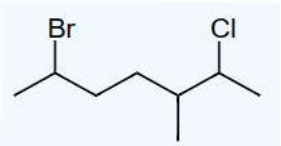
- If there is an ambiguity in numbering the parent chain, begin on the end which is closer to the substituent which comes first alphabetically.



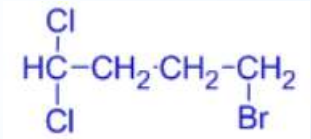
2-bromo-6-chlorooctane



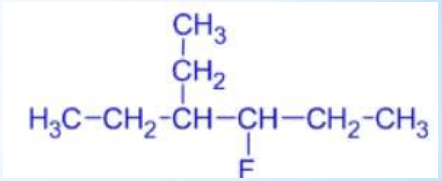
2-bromo-4-methylpentane



6-bromo-2-chloro-3-methyloctane

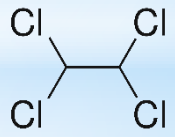


4-bromo-1,1-dichlorobutane

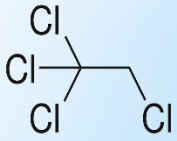


3-ethyl-4-flurohexane

- Multiple halogen atoms are labelled with the Greek numerical prefixes such as di(for two halogen atoms), tri(for three halogen atoms), and tetra(for four halogen atoms) to denote the number of identical halogen atoms attached to a carbon atom. If more than one halogen atom is attached to the same carbon atom, then the numeral is repeated for that much time.



1,1,2,2-tetrachloroethane

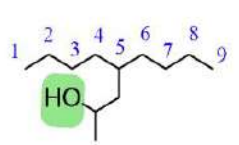


1,1,1,2-tetrachloroethane

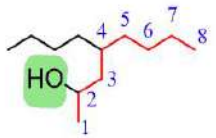
Alcohols represented as R-OH, with a hydroxyl (OH) functional group, *suffix-ol.*

1. Find the longest chain containing the hydroxy group (OH). If there is a chain with more carbons than the one containing the OH group, it will be named as a substituent.

1) **The parent chain must contain the carbon bonded to the OH group**



Parent chain - nonane
OH is not part of the chain
Incorrect

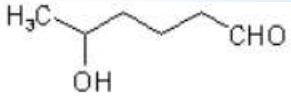


Parent chain - octane
OH is part of the chain
Correct

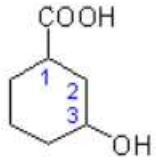
Despite being shorter, octane is the parent chain since it contains the OH group while nonane does not.

2)

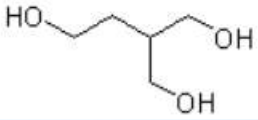
5-Hydroxyhexanal



3-Hydroxy-1-cyclohexanecarboxylic acid

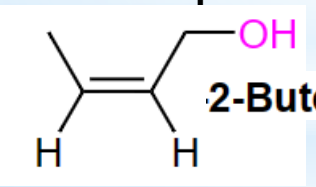


2-Hydroxymethyl-1,4-butanediol

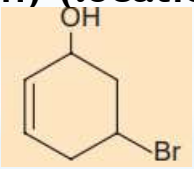


2. Place the OH on the lowest possible number for the chain. With the exception of carbonyl groups such as ketones and aldehydes in which Hydroxyl groups are indicated by the prefix "hydroxy-".

3. When an alkene and alcohol are present in a molecule it is named as follows **(location of the alkene)-(prefix for the parent chain + en)-(location of the hydroxyl)-ol**

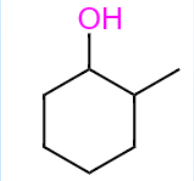


2-Buten-1-ol

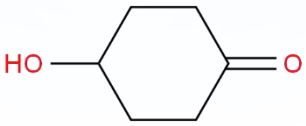


5-bromo-cyclohex-
2-ene-1-ol

4. When naming a cyclic structure, the -OH is assumed to be on the first carbon unless the carbonyl group is present, in which case the later will get priority at the first carbon.

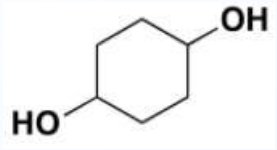


2-Methylcyclohexanol

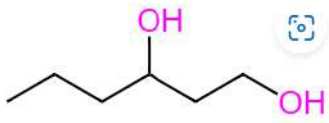


4-hydroxy-cyclohexanone
Not
4-carbonyl-cyclohexanol

5. When multiple -OH groups are on the cyclic structure, number the carbons on which the -OH groups reside. When multiple alcohols are present use **di, tri,** et.c before the **ol,** after the parent name. Also, when a prefix is used the **-e** is not removed from the parent chain name ex. 1,3-hexanediol.

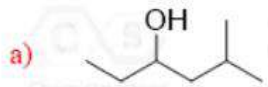


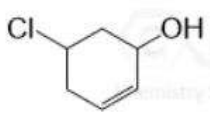
cyclohexane-1,4-diol

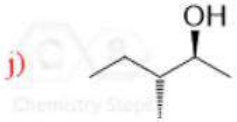


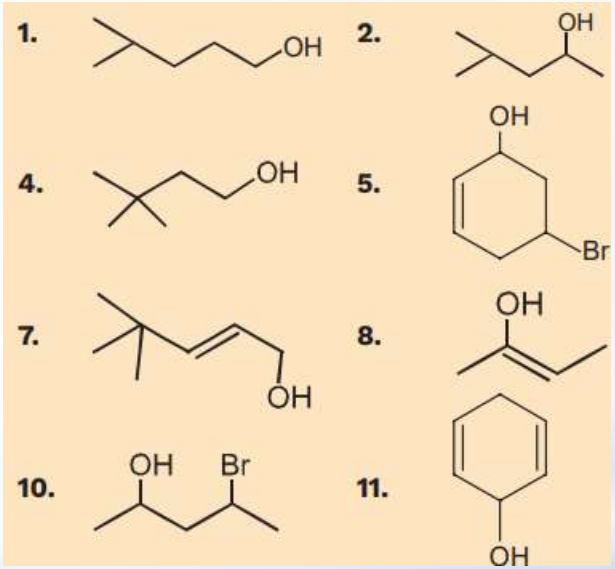
1,3-Hexanediol
(Hexane-1,3-diol)

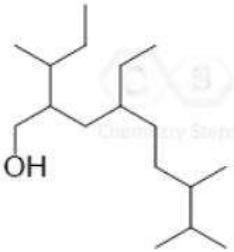
Some examples

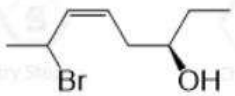


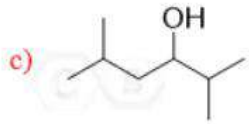


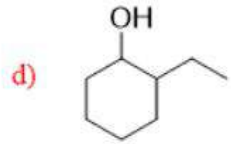


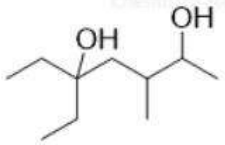


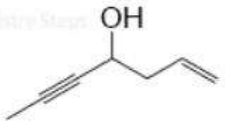


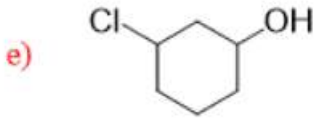


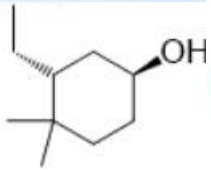


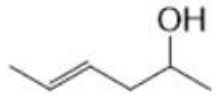




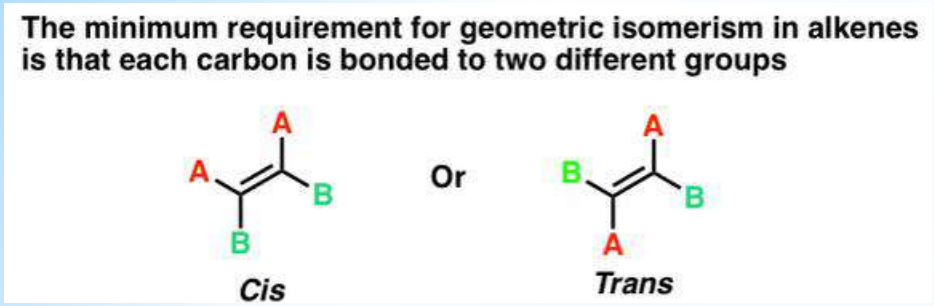


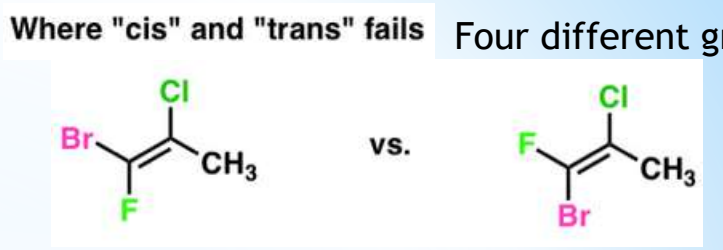






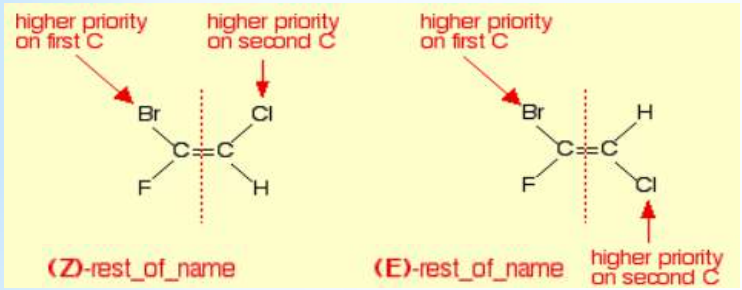
E and Z nomenclature system for Alkene





The *E(Entagen means opposite)* and *Z(Zusameen means together)* Notation For Alkenes

- In the example above, at the left-hand end of the bond, it turns out that bromine has a higher priority (based on atomic number) than fluorine. And on the right-hand end, it turns out that chlorine has a higher priority than hydrogen

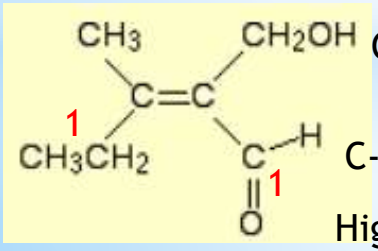


Summary

•(E)- : the higher priority groups are on opposite sides of the double bond.

•(Z)- : the higher priority groups are on the same side of the double bond.

- If two atom directly attached to carbon has similar atomic number then subsequent atom attached to that particular atom d decides the priority.

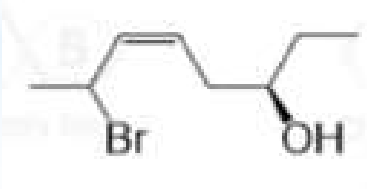


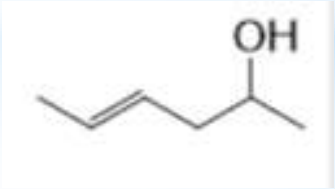
CH_2-O-H

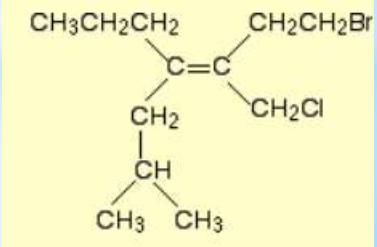
C-O-O-H

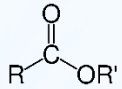
Highest priority is on same side therefore (Z)

IUPAC Name:
(Z)-2-hydroxymethyl-3-methyl-pent-2-en-1-al



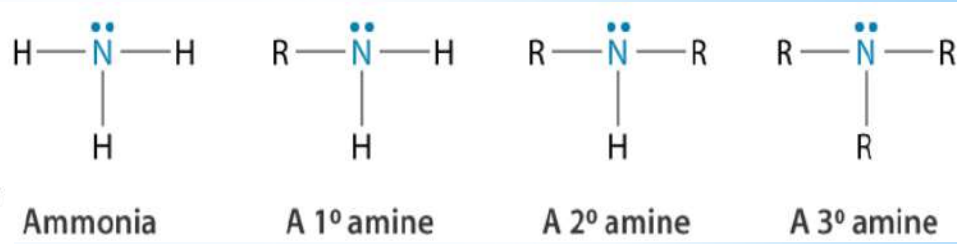




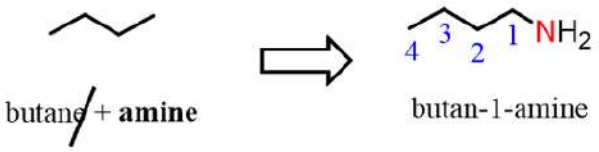
Name of Functional group	Representation	Suffix When carbon of the functional group is part of the parent chain	Suffix When carbon of the functional group is NOT part of the parent chain	Prefix
carboxylic acid	-COOH	-oic acid	-carboxylic acid	carboxy-
sulphonic acid	– SO_3H	sulphonic acid	sulphonic acid	Sulpho
Acid anhydride		-oic anyhydride	-carboxylic anhydride	-
Ester	-COOR	alkyl -oate	alkyl -carboxylate	alkoxycarbonyl-
Acid halide	-COX	-oyl halide	-carbonyl halide	halocarbonyl-
Acid amide	$-CONH_2$	-amide	-carboxamide	carbamoyl-
Nitrile	-CN	-nitrile	-carbonitrile	cyano-
Aldehyde	-CHO	-al	-carbaldehyde	oxo-
Ketone	-CO-	-one	-	oxo-
Alcohol	-OH	-ol	-	hydroxy
Thiol	-SH	-thiol	-	mercapto
Amine	$-NH_2$	-amine	-	amino-
Imine	=NH	-imine	-	imino-
Alkene	C=C	-ene	-	-
Alkyne	C≡C	-yne	-	-

Nomenclature of Amine

Amines are the derivatives of **ammonia**. Replacing one hydrogen of ammonia with an alkyl group forms an amine with a general formula of R-NH_2:



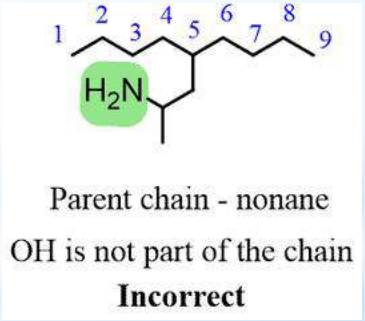
Drop the "e", change the suffix to "amine"

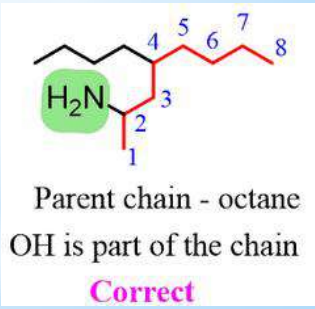


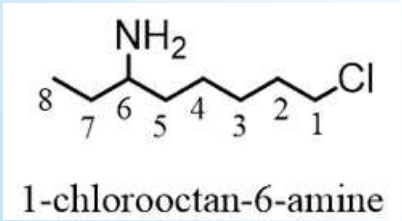
Step 1. Identify the longest carbon chain bonded to the amine nitrogen.
Step 2. Identify the substituents.
Step 3. Number the parent chain giving the amine the lowest locant
Step 4. Put everything together having the substituents **in alphabetical order.**

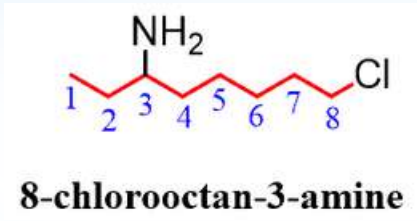
➢ How to Name a Compound with Multiple Functional Groups

- The **parent chain** is chosen such that it is the **longest carbon chain containing the carbon atom connected to the NH_2 group even if there is a longer chain without the NH_2 group.**
- The amino group has a higher priority than alkyl groups and halides, and therefore, changes the numbering of the parent chain.







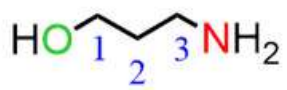


➢ Naming a Compound Where the Amino group is Not the Highest Priority

- If we put an **alcohol and amine** on the periphery of a carbon chain, the **alcohol gets the priority**, therefore it is assigned with a **suffix**, while the **amine is assigned a prefix** (like the alkyl substitutes). This also indicates that we need to start numbering the carbon chain from the OH group

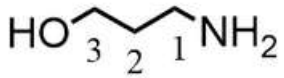
(substituent) **Prefix**-**Parent chain**-**Suffix** (principal group)

lowert priority ***highest priority***



3-aminopropan-1-ol

NOT

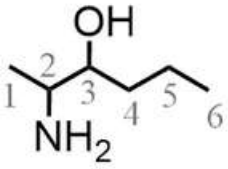


3-hydroxypropan-1-amine

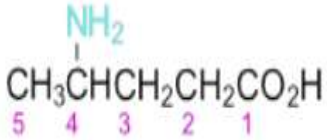
Remember the suffix and prefix of the amino group; "**amine**" and "**amino**" respectively.

2-aminohexan-3-ol

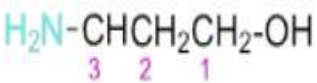
NOT



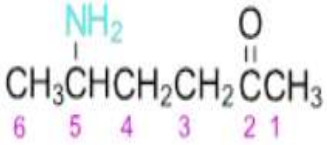
3-hydroxynexan-2-amine



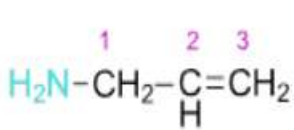
4-Aminopentanoic Acid



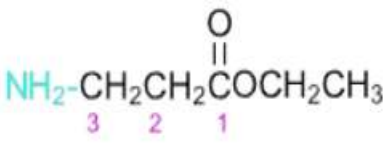
3-Amino-1-propanol



4-Amino-2-Butanone



2-Propen-1-amine
(NH_2 Has Priority)

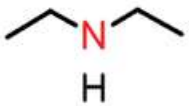


Ethyl 3-aminopropionate

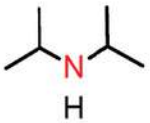
➢ Naming Secondary and Tertiary Amines

- When the alkyl groups are identical, they are listed with a prefix "**di**" or "**tri**".

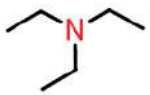
trimethylamine



diethylamine



diisopropylamine



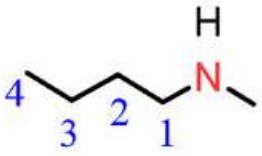
triethylamine

- If the secondary or a tertiary amine has more than one type of alkyl group, then it is named as a primary amine. The parent chain is the longest chain bonded to the amine, and the other groups are named as substituents connected to the nitrogen and preceded by an "***N***" (in italics). This emphasizes that they are bonded to the nitrogen rather than to a carbon.

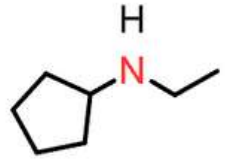
Step 1. Find the parent chain - longest carbon chain bonded to N.

Step 2. Name the other groups as alkyls preceded by an "*N*".

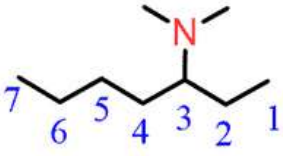
Step 3. Write the substituents followed by the parent chain with "amine".



***N*-methylbutan-1-amine**

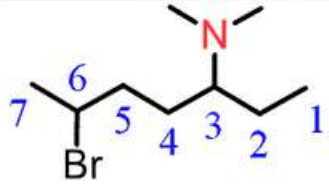


***N*-ethylcyclopentanamine**

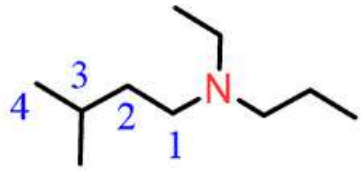


***N*,*N*-dimethylheptan-3-amine**

- The substituents are listed in alphabetical order regardless of whether they are connected to the nitrogen or to the parent chain.



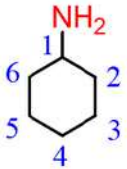
6-bromo-*N*,*N*-dimethylheptan-3-amine



***N*-ethyl-3-methyl-*N*-propylbutan-1-amine**

➢ Naming of Cyclic Amines

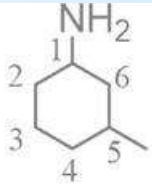
- When the **amine is connected to a ring**, we start numbering from **the carbon connected to the NH_2 group. This rule always puts the NH_2 group at C1,** therefore, the "1" is usually omitted from the name.



cyclohexanamine

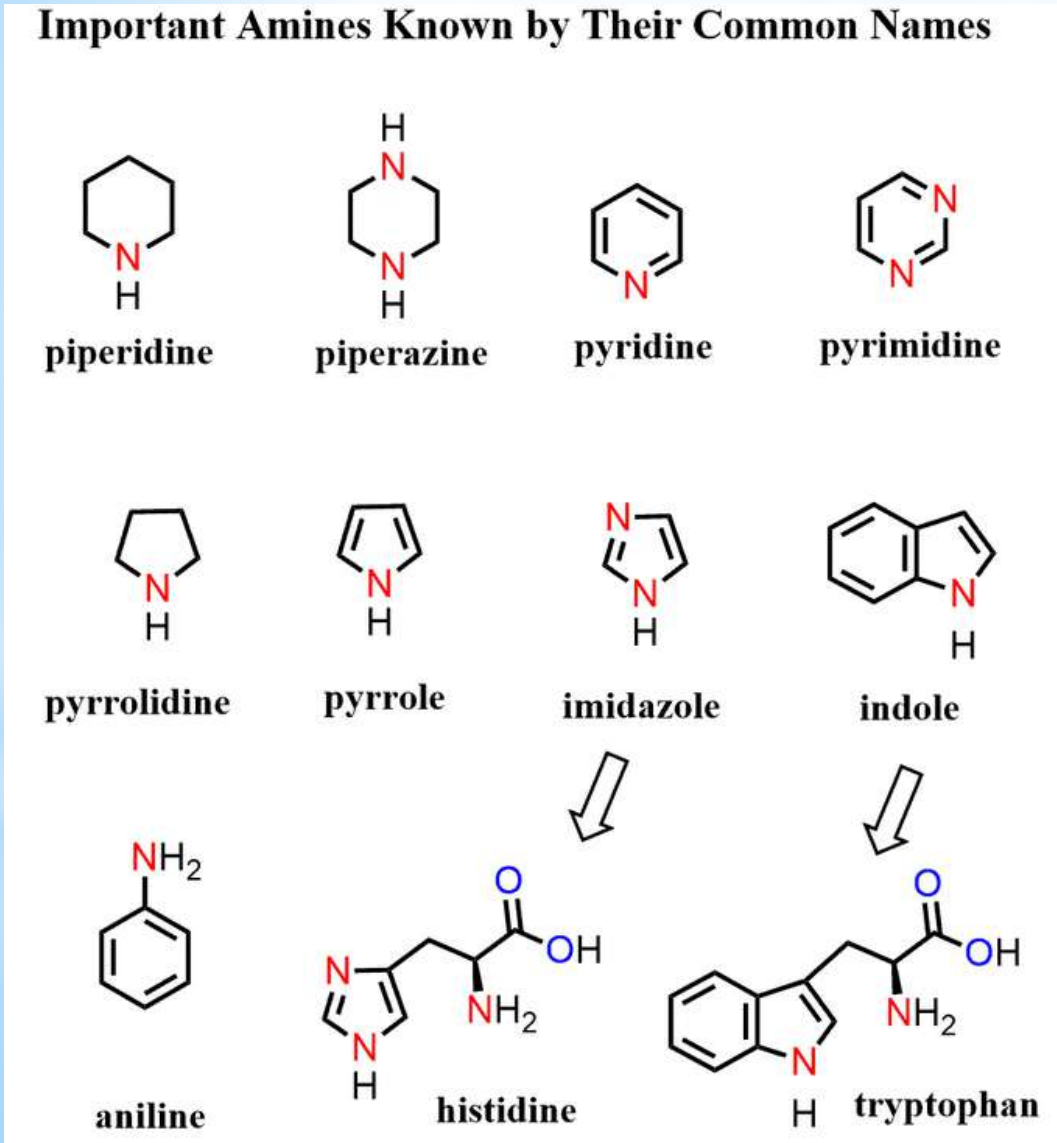
3-methylcyclohexan-1-amine

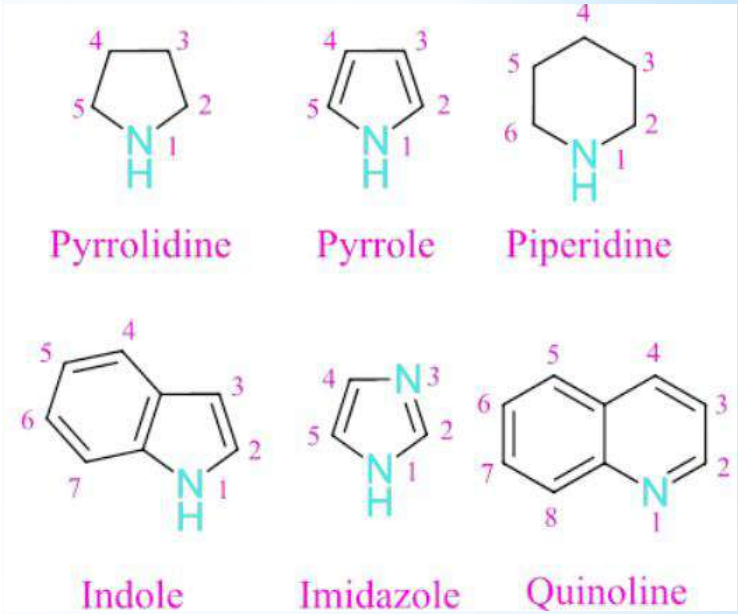
NOT

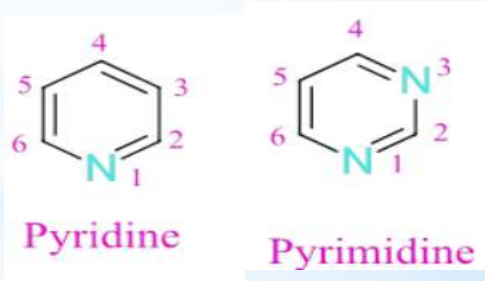


5-methylcyclohexan-1-amine

Heterocyclic amine have one or more nitrogens as part of the ring and can be aliphatic or aromatic. Most heterocyclic amine ring systems have a common name and are numbered such that a nitrogen always gets position 1. An amine attached to a heterocyclic ring is named as an amino substituent

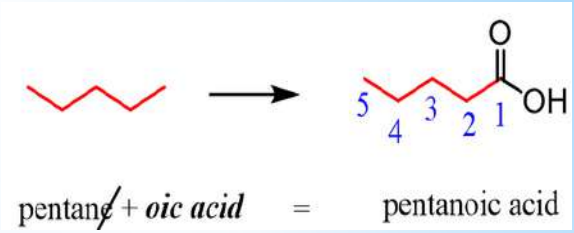




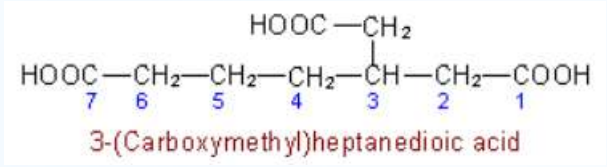


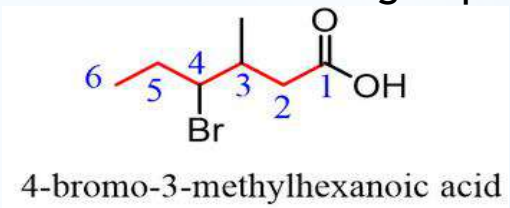
Nomenclature of Carboxylic Acid

- Carboxylic acids are named by adding a suffix to the parent name of the longest chain. If the parent chain is noncyclic, you need to first find the **longest carbon chain containing the -COOH** group and **change the suffix** from "ane" to "**oic acid**" dropping the "e" and the locant "1" in the final name:



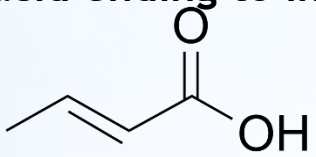
- The substituents are numbered based on the position of the COOH group and placed **in alphabetical order.**





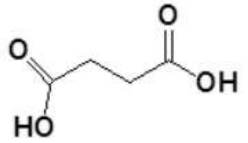
- When carboxylic acids are included with an alkene the following order is followed:

(Location number of the alkene)-(Prefix name for the longest carbon chain minus the -ane ending)-(an -enoic acid ending to indicate the presence of an alkene and carboxylic acid).

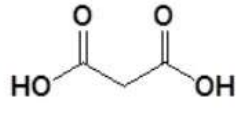


2-Butenoic acid

- Naming Dicarboxylic acid: The location numbers for both carboxyl groups are omitted because both functional groups are expected to occupy the ends of the parent chain. The ending **-dioic acid** is added to the end of the parent chain.

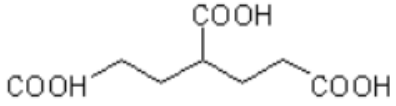


Butanedioic acid



Propanedioic acid

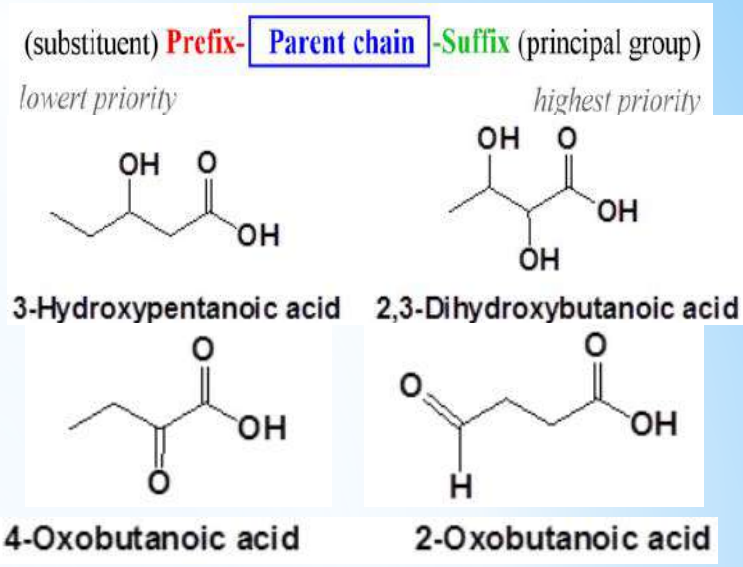
- If an unbranched chain is directly linked to more than two carboxy groups, these carboxy groups are named by omitting carboxylic carbon and use of a suffix such as "-tricarboxylic acid"



Pentane-1,3,5-tricarboxylic acid
(**not** 4-Carboxyheptanedioic acid)

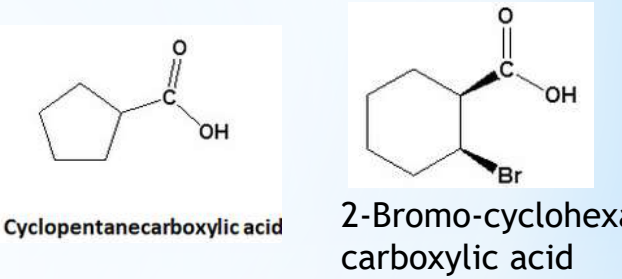
➢ Naming Carboxylic Acids with Functional Groups

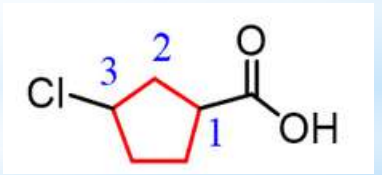
- Carboxylic acids have higher priority than all the other functional groups and therefore, they define the parent chain and give the corresponding *suffix* to the compound's name. All the other groups standing below in the functional group priority table are added as a ***prefix***
- In the case of molecules containing a carboxylic acid and aldehydes and/or ketones functional groups the carbonyl is named as a "Oxo" substituent. If Amine group then "Amino".

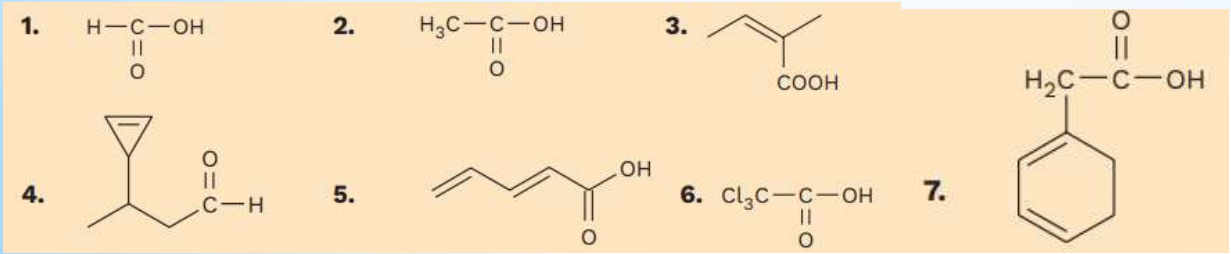


➢ Naming Carboxylic Acids on a Ring

- When a carboxyl group is added to a ring the suffix **-carboxylic acid** is added to the name of the cyclic compound. The ring carbon attached to the carboxyl group is given the #1 location number.
- If substituents are also present, the **numbering starts from the carbon connected to the COOH group** and goes in the direction that **minimizes the numbering** of the substituents

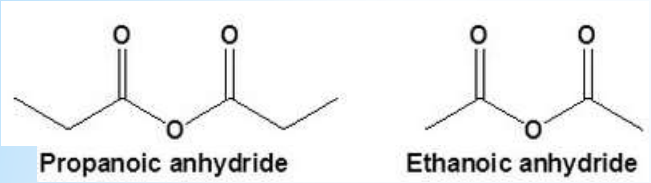


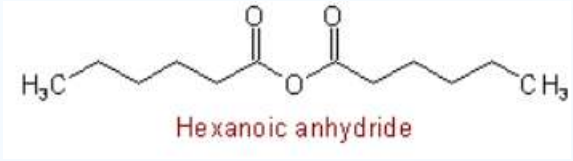


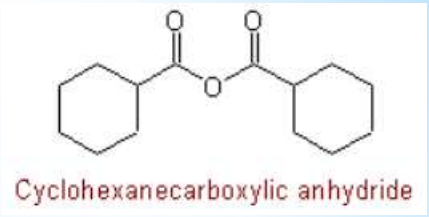


Carboxylic acid derivatives: Acid anhydride:

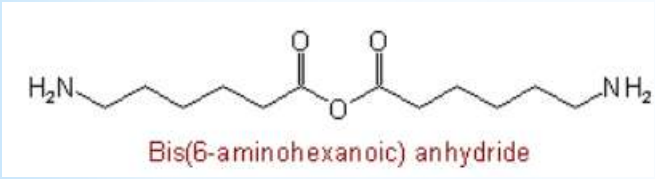
- The acid anhydride functional group results when two carboxylic acids combine and lose water (anhydride = without water). Symmetrical acid anhydrides are named like carboxylic acids except the ending **-acid** is replaced with **-anhydride**.

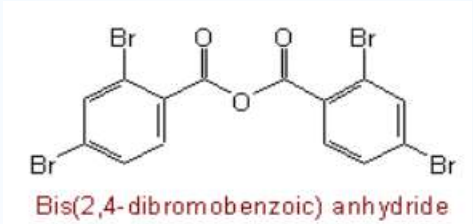


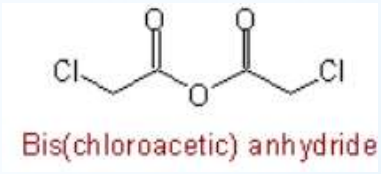




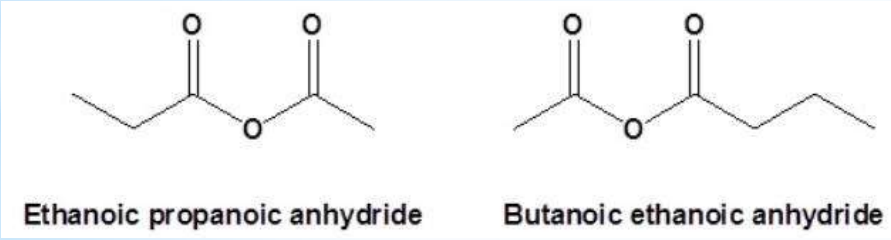
- **Symmetrical anhydrides:** Anhydrides of substituted monocarboxylic acids, if symmetrically substituted, are named by prefixing "bis-" to the name of the acid and replacing the word "acid" by "anhydride". The "bis" may, however, be omitted.

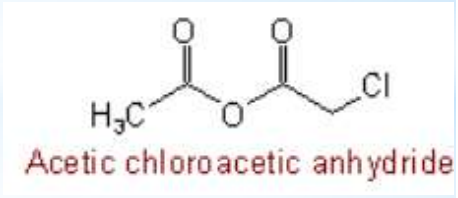


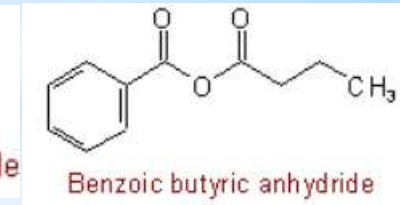




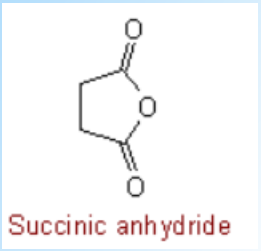
- Unsymmetrical acid anhydrides are named by first naming each component carboxylic acid alphabetically arranged (without the word acid) followed by spaces and then the word anhydride.



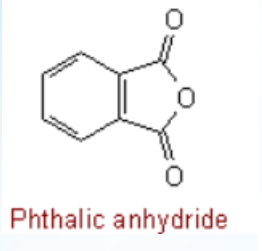




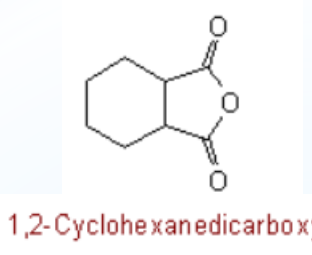
- Cyclic anhydrides of polycarboxylic acids, although possessing a heterocyclic structure, are preferably named as acid anhydrides.



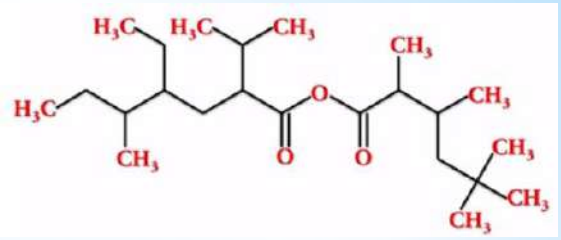
Succinic anhydride

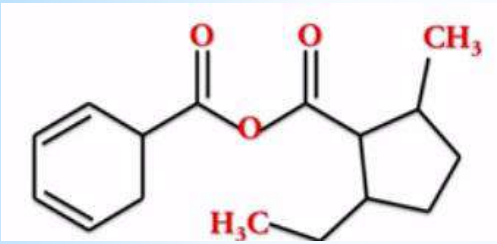


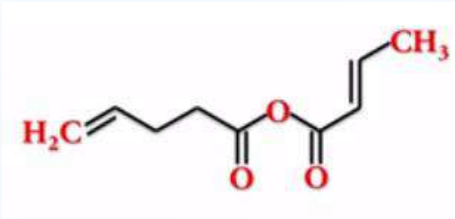
Phthalic anhydride

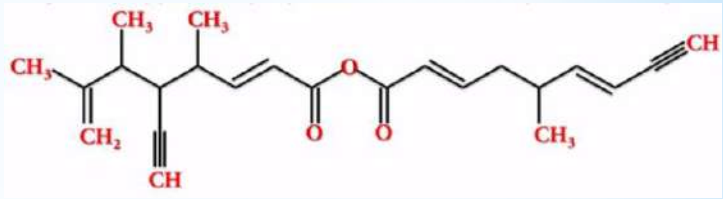


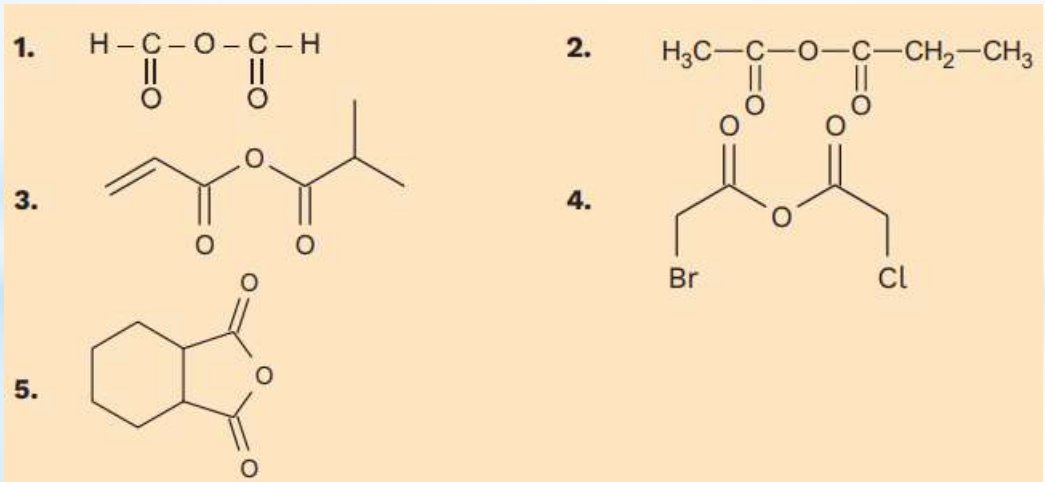
1,2-Cyclohexanedicarboxylic anhydride







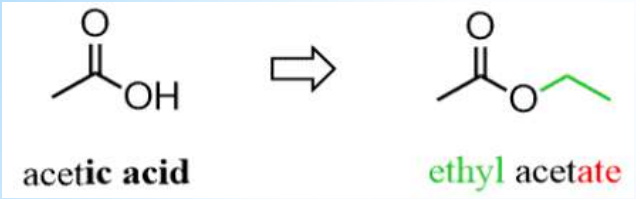


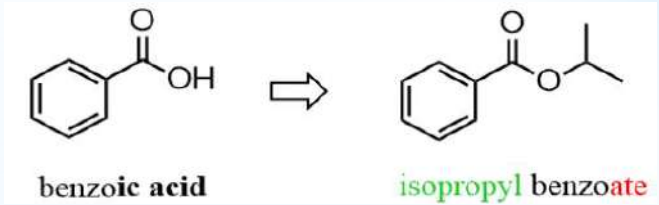


For more such examples: https://www.acdlabs.com/iupac/nomenclature/79/r79_363.htm

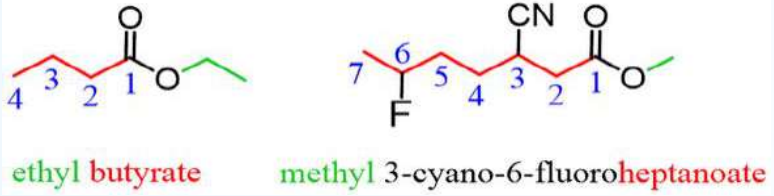
Esters: “oic acid” with “ate”

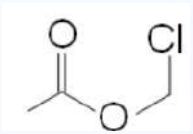
Name of alkyl group attached to oxygen followed by Prefix + W.R + ate

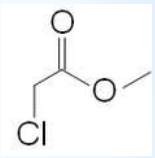




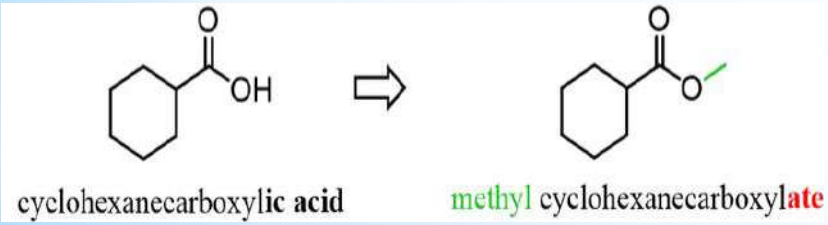
- The substituents are numbered based on the position of the COOR group and placed **in alphabetical order:**

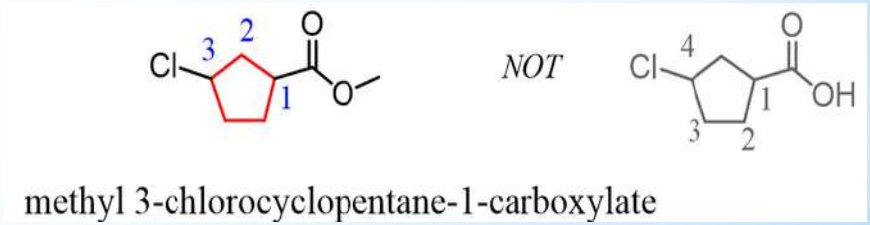




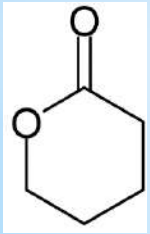


Naming Esters on a Ring: To name an ester on a ring, we need to refer to the corresponding carboxylic acid. For example, the suffix of cyclopentanecarboxylic acid is changed to carboxy”***late***” and the alkyl group is added at the beginning:

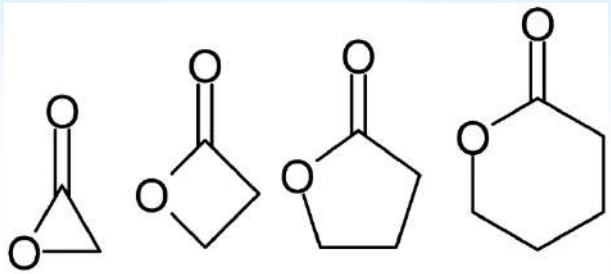




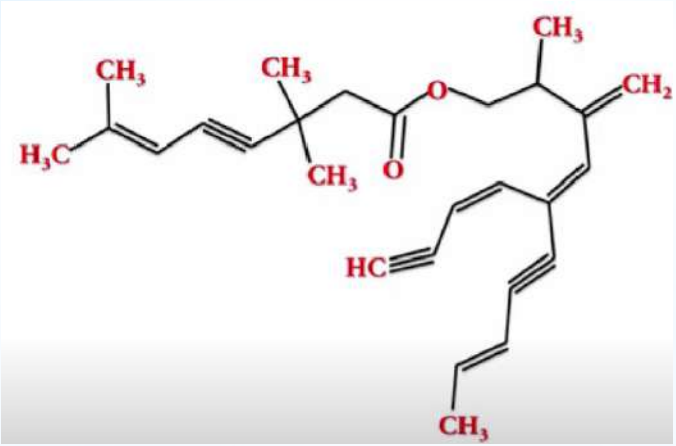
- **Lactones** are cyclic carboxylic esters and they name by giving carbonyl group #1 and oxygen (called oxa) as #2 followed by ring type. If there are substituents on the ring, then they have to write following the rules.



2-Oxacyclohexanone



α-acetolactone, ß-propiolactone, γ-butyrolactone, and δ-valerolactone respectively

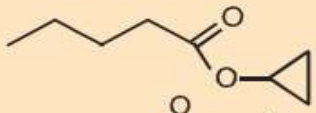


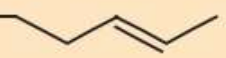
1. $H_3C - CH_2 - \underset{\underset{O}{\|}}{C} - O - CH_2 - CH_3$

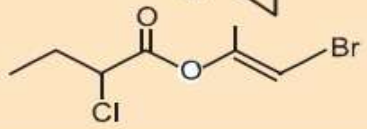
2. $CH_3 - \underset{\underset{Br}{|}}{CH} - \underset{\underset{O}{\|}}{C} - O - CH_2 - CH_3$

3. $H - \underset{\underset{O}{\|}}{C} - O - CH_3$

4. 

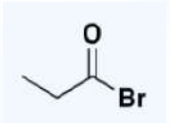
5. 

6. $CH_3 - \underset{\underset{O}{\|}}{C} - O$ 

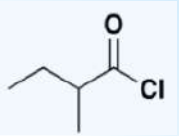
7. 

Acyl Halide (-ioc acid to -oyl haloide)

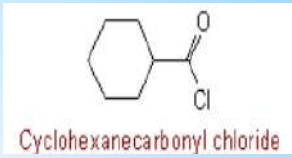
- The carbonyl carbon is given the #1 location number. It is not necessary to include the location number in the name because it is assumed that the functional group will be on the end of the parent chain.



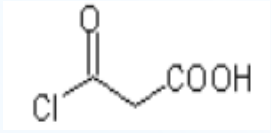
Propanoyl Bromide



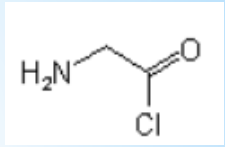
2-Methylbutanoyl chloride



- When another group is present that has priority over acyl halide for citation as principal group, or when the acyl halide group is attached to a side chain, the prefix "fluoroformyl-", "chloroformyl-", "bromoformyl-", or "iodoformyl-" is used.

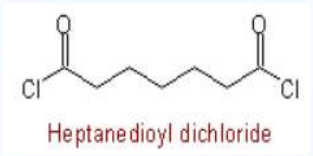


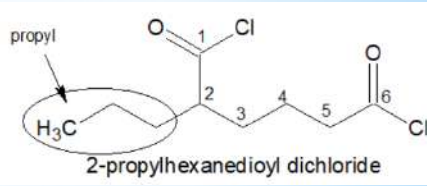
(Chloroformyl)acetic acid

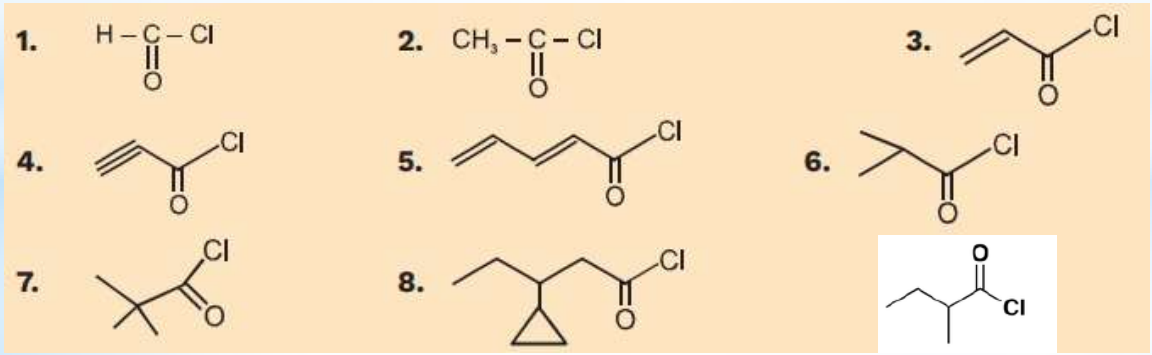


Aminoacetyl chloride

- If two groups are present then always keep them at the terminal of chain irrespective of chain length. If three groups are present then the longest chain holding two terminal acyl halide group is considered as parent chain.
- Prefix for Acyl halide is “halocarbonyl”

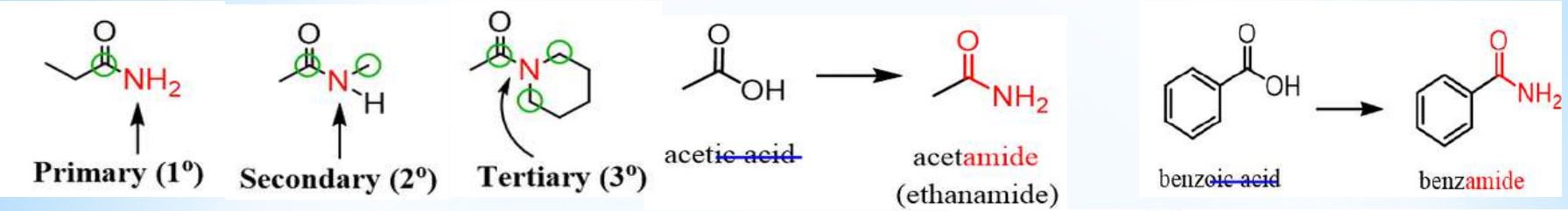




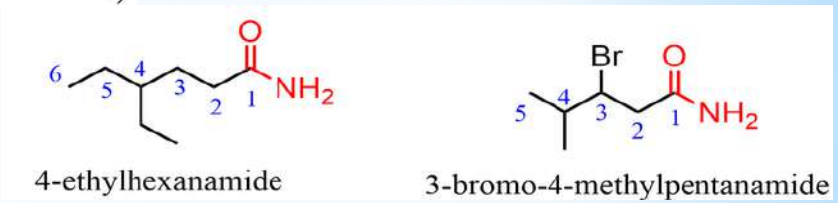


Amide: “oic acid” with “amide”

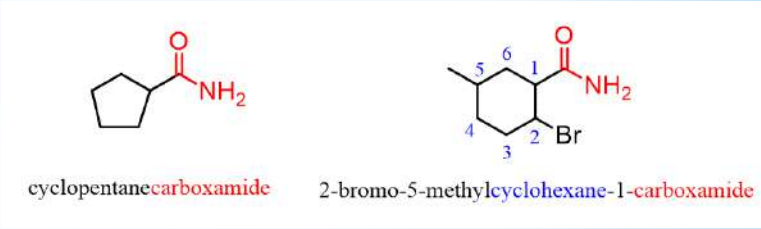
- Amides are derivatives of carboxylic acids and all you need to do is replace the ***-ic acid***, or ***-oic acid*** ending with the suffix “**amide**



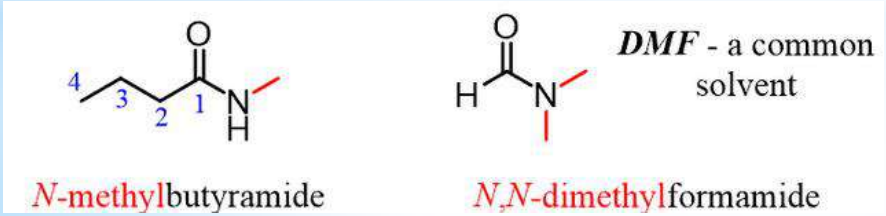
- All the substituents are numbered by starting from the amide carbon (unless a higher priority group is present) and placed alphabetically just like for naming any other functional group



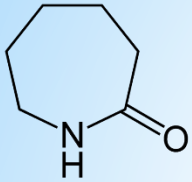
- When the amide group is connected to a ring, the suffix “carboxylic acid” is replaced with “**carboxamide**”.



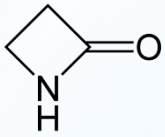
- **Naming Secondary and Tertiary Amides:** Secondary and tertiary amides bear **alkyl group(s) on the nitrogen** and just like other substituents, these are placed at the beginning of the name. However, these alkyl groups are also specifically indicated with the **letter “*N* ”**.



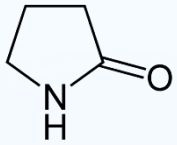
- **A lactam** is a cyclic amide, formally derived from an amino alkanoic acid through cyclization reactions.
- Naming is similar to Lactones, here nitrogen gets the #2 and called as Aza.



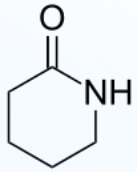
2-Azacycloheptanone
Or Azepan-2-one



2-Azetidinone



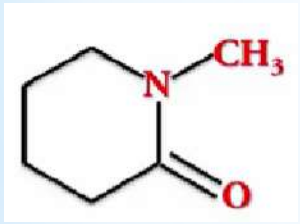
Pyrrolidin-2-one



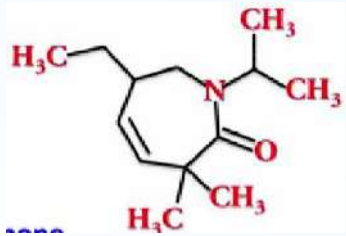
Piperidin-2-one

Their common names are ß-propiolactam, γ-butyrolactam, δ-valerolactam, and ε-caprolactam.

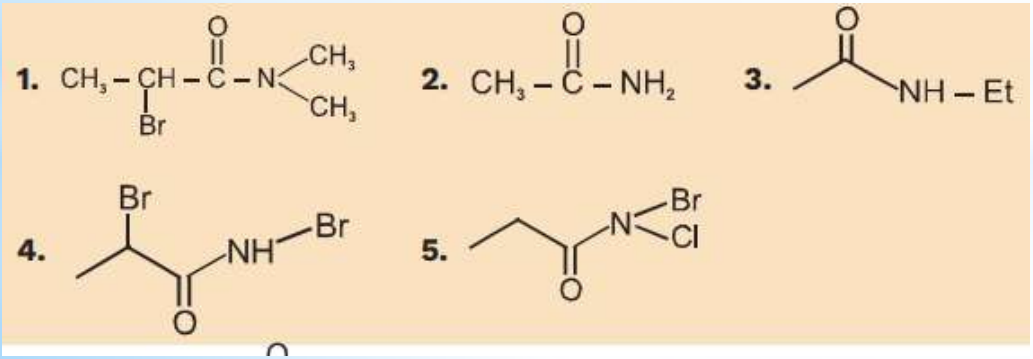
- If substituents are present on nitrogen, name them first followed by the ring size.

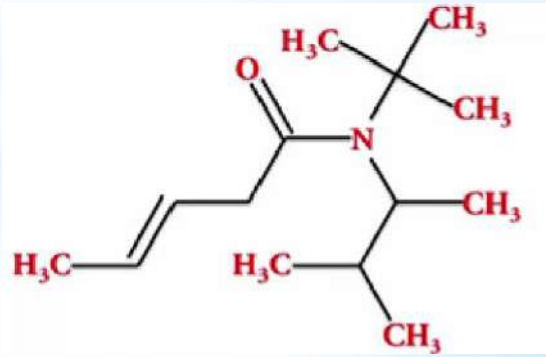


N-methyl-2-azacyclohexanone



N-Isopropyl-4-ethyl-7,7dimethyl-2-azacyclohept2enone





For more examples: https://www.acdlabs.com/iupac/nomenclature/93/r93_543.htm

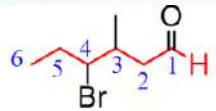
Aldehydes Compounds

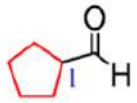
- The IUPAC system of nomenclature assigns a characteristic suffix ***-al*** to aldehydes. For example, $H_2C{=}O$ is methan**al**.
- When the -CHO functional group is attached to a ring the suffix ***-carbaldehyde*** is added, and the carbon attached to that group is C1.

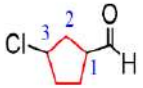
(substituent) **Prefix-** **Parent chain** **-Suffix** (principal group)

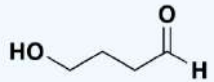
lowert priority *highest priority*

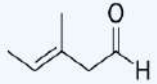

pentanal

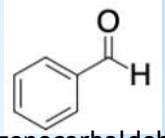

4-bromo-3-methylhexanal


cyclopentanecarbaldehyde

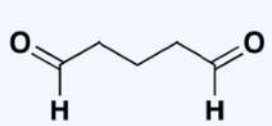

3-chlorocyclopentane-1-carbaldehyde

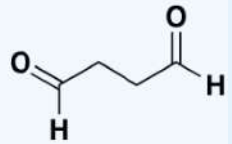

4-hydroxybutanal


(*E*)-3-methyl-3-pentenal

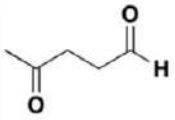

Benzenecarbaldehyde

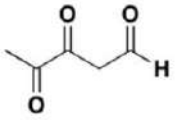
- For dialdehydes, The ending **-dial** is added to the end of the parent chain name

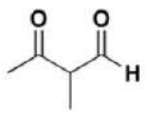

pentanedial


butanedial

- Naming Aldehydes and Ketones in the Same Molecule, As being a lowest priority group ketone is named as an "oxo" substituent.

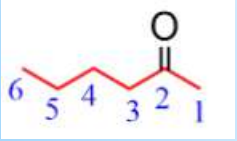

4-oxopentanal

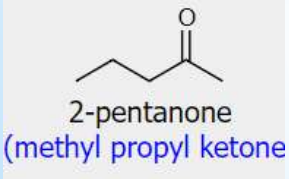

3,4-dioxopentanal

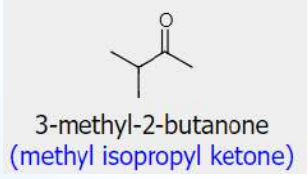

2-methyl-3-oxo-butanal

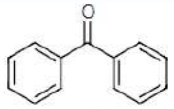
Ketones Compounds

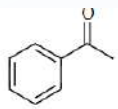
- The IUPAC system of nomenclature assigns a characteristic suffix of **-one** to ketones.
- we need to choose the **parent chain** such that it is the **longest carbon chain contains the C=O group.**
- **If highest priority group is attached to the molecule, then named as "Oxo"**

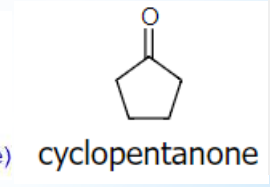

hexan-2-one

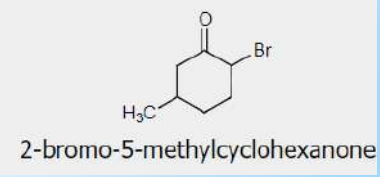

2-pentanone
(methyl propyl ketone


3-methyl-2-butanone
(methyl isopropyl ketone)

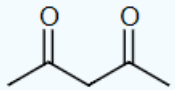

benzophenone
(diphenyl ketone)

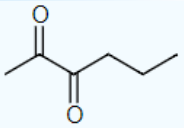

acetophenone
(methyl phenyl ketone)

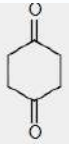

cyclopentanone

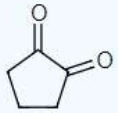

2-bromo-5-methylcyclohexanone

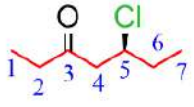
- Diketone using -dione suffix and substituents follows from giving carbonyl carbon the minimum number and name of substituents follow the alphabetical order.

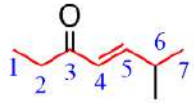

2,4-pentanedione

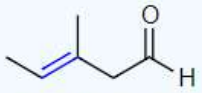

2,3-hexanedione

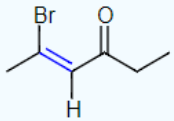

1,4-cyclohexanedione


1,2-cyclopentanedione

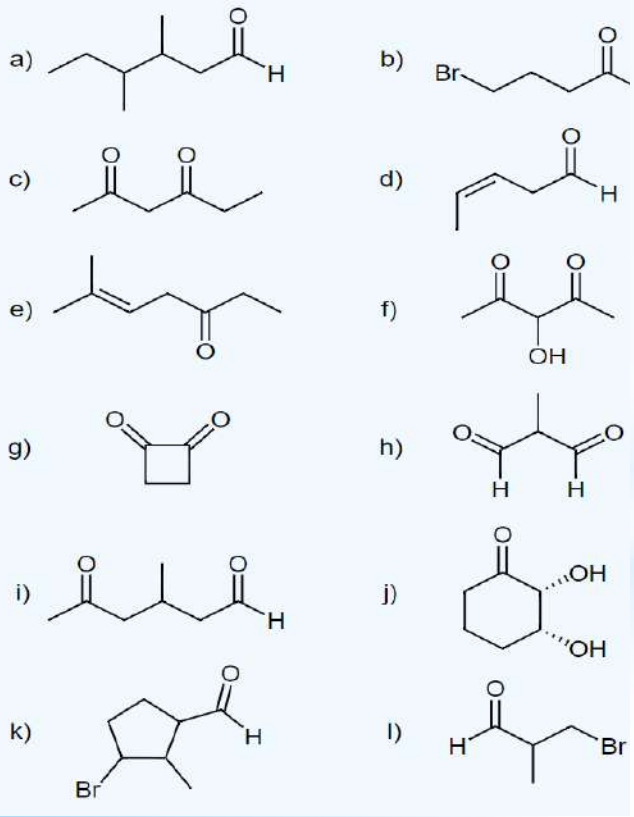

(*S*)-5-chloroheptan-3-one

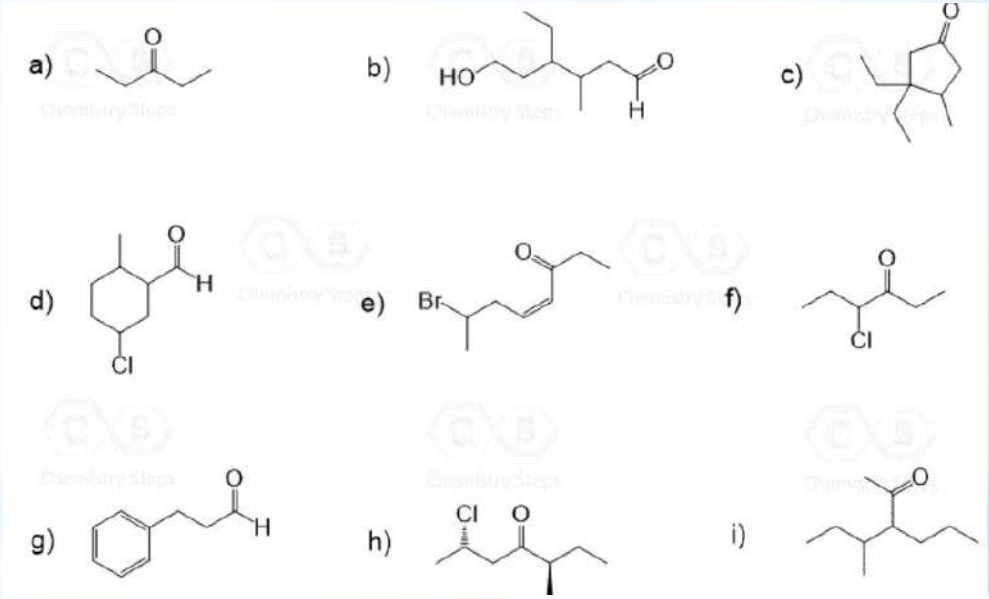

(*E*)-6-methylhept-4-en-3-one


(*E*)-3-methyl-3-pentenal


(*Z*)-5-bromo-4-hexen-3-one

Examples





A) butanal

B) 2-hydroxycyclopentanone

C) 2,3-pentanedione

D) 1,3-cyclohexanedione

E) 4-hydoxy-3-methyl-2-butanone

F) (*E*) 3-methyl-2-hepten-4-one

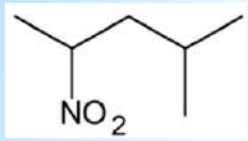
G) 3-oxobutanal

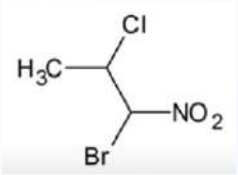
H) *cis*-3-bromocyclohexanecarboaldehyde

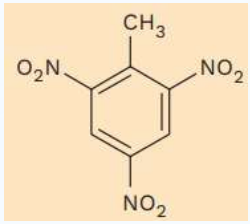
I) butanedial

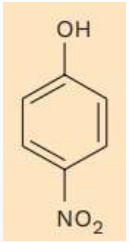
Nitro Compounds

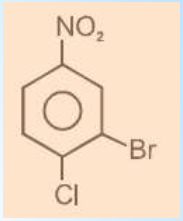
- Compounds containing a -NO_2 group are named only as a substituents by means of a prefix "nitro-".





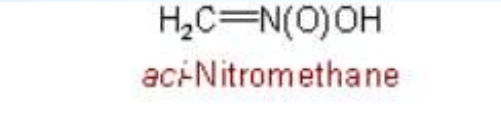


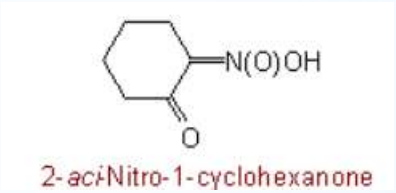




1-Methyl-4-nitropentane

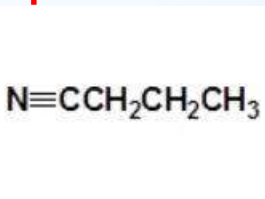
- Compounds containing the group X=N(O)OH are named by adding the prefix "*aci*-nitro-" to the name of the parent compound XH_2.



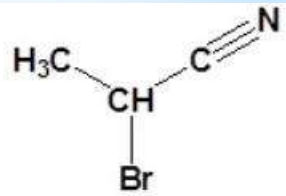


Nitrile (Cyno if substituents) Compounds

- Open chain nitriles are named with the word **-nitrile** after the name of the parent alkane name. Remember to include the carbon atom of the nitrile as part of the parent chain. For example, CH_3CN has two carbons including the nitrile carbon, therefore it is ethanenitrile.

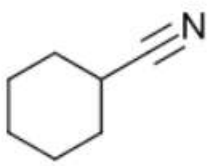


Butane nitrile

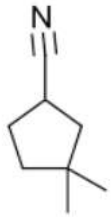


2-Bromopropane nitrile

- When a nitrile is the highest priority functional group attached to a cycloalkane, the name of the parent cycloalkane is followed by the word **-carbonitrile**. The ring carbon attached to the nitrile is numbered C1 and the nitrile is not given a number in the name.

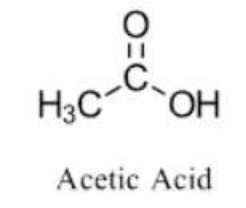


Cyclohexanecarbonitril

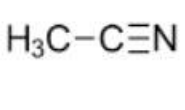


3,3-Dimethylcyclopentanecarbonitrile

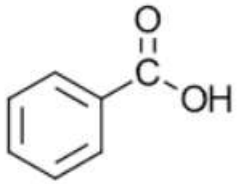
- Name of nitrile group is given based on the parent carboxylic acids.



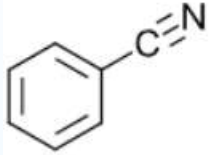
Acetic Acid



Acetonitrile

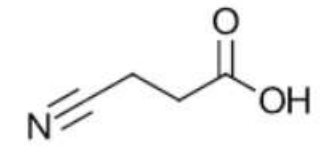


Benzoic Acid



Benzonitrile

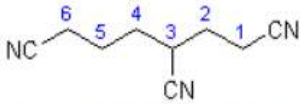
- In the case of molecules containing a carboxylic acid and nitrile functional group, the nitrile is named as a "cyano" substituent. Note! The carbon in the nitrile is not counted as part of the parent chain when named as a cyano substituent.



3-Cyanopropanoic Acid

- If two group, count the number of cyno carbon and If more than two group, don't count the number of cyno carbon

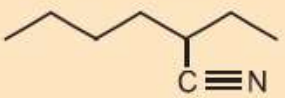
Hexanedinitrile

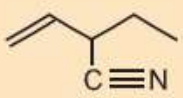


1,3,6-Hexanetricarbonitrile

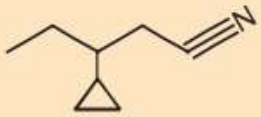
1. $CH_3 - C \equiv N$

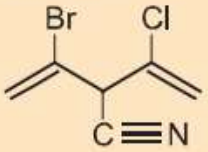
2. 

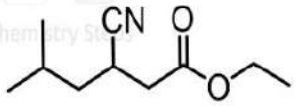
3. 

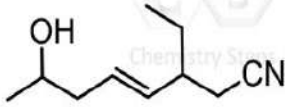
4. 

5. $CH_2=CH-CN$

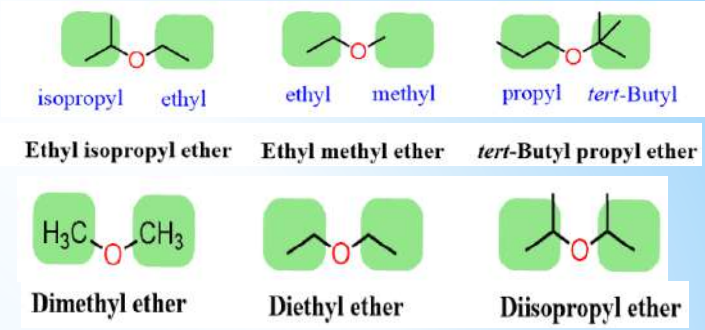
6. 

7. 

b) 

g) 

Ether Compounds

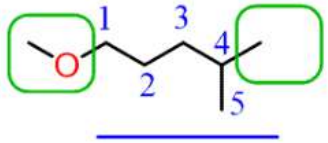


- Just like halide, nitro and alkyl group, ether can act as substituents.They can be name by both common and systematic IUPAC nomenclature. we **first identify the alkyl groups** and arrange them in **alphabetical order** followed by the word **"ether".**

➢ By IUPAC,

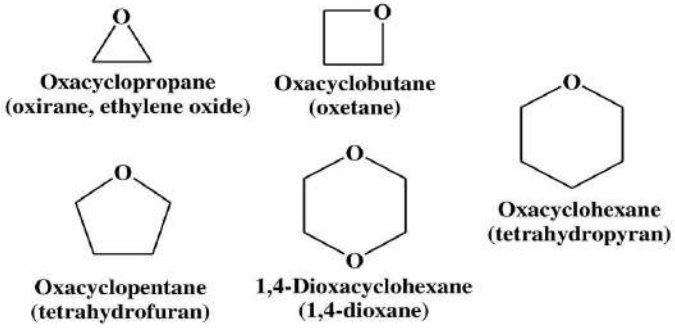
- The alkoxy groups with shorter carbon chain is a substituent.
- The longest carbon chain is the parent chain.
- The substituents are places alphabetically.

1-ethoxybutane



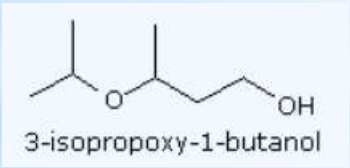
1-methoxy-4-methylpentane

Naming Cyclic Ethers

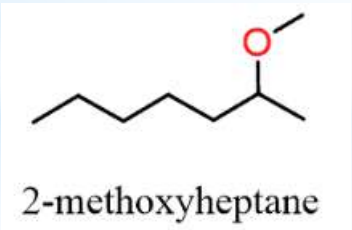


- **Can Use Replacement Nomenclature (oxa → O replaces CH_2)**
- **Also Many Common Name (Acceptable to Use)**

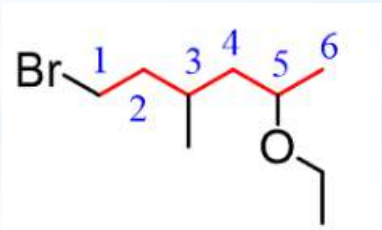
- Ether do not have any priority hence they are only treated as substituents

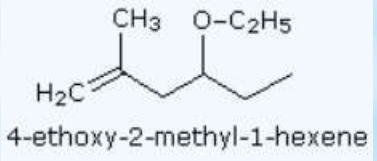


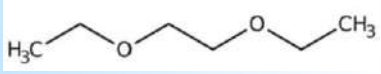
3-isopropoxy-1-butanol

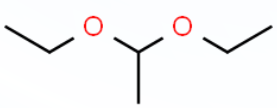


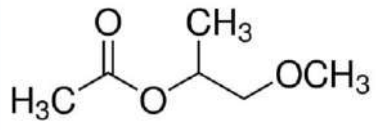
2-methoxyheptane

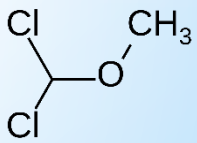












END of Nomenclature