CHAPTER 1

NOMENCLATURE

1. Types of organic compounds

Organic compounds are broadly divided into four major classes:

1.1 Aliphatic compounds:

Compounds consist of open chain of carbon atoms are called aliphatic compounds, e.g. ethane, propane, butane acetic acid, n-butyl amine, etc.

Aliphatic compounds are further divided into two classes depending upon the number of single, double or triple bonds in them.

i) *Saturated Aliphatic compounds* containing only single bonds are called saturated aliphatic compounds.

ii) *Unsaturated Aliphatic compounds* containing one or more multiple bonds between pairs of atoms, e.g. between C=C or C=O or $HC{\equiv}N$, like double or triple bonds are called unsaturated compounds.

1.2 Aromatic compounds

Benzene and all other compounds which have structure and chemical properties resembling benzene are called aromatic compounds. e.g. naphthalene, aniline, etc.

1.3 Alicyclic compounds

Cyclic compounds which consist only of carbon atoms are called alicyclic or carbocyclic compounds. Actually an alicyclic compound is an organic compound which is both cyclic and aliphatic (as name shows), e.g. cyclopropane, cyclobutane, etc.

1.4 Heterocyclic compounds

Cyclic compounds which contain atoms of at least two different elements as member of their rings are called heterocyclic compounds, e.g. Oxirane, Pyridine, Quinoline, etc.

2 Nomenclature of Alkanes

2.1 Use of prefixes “n”, “iso” and “neo”

Prefix : The word used in front of the name is called prefix.

2.1.1) "*n*" Prefix "n" is used for those compounds in which all carbon atoms are in one continuous chain. "n" means normal. Chain contains no branch.

2.1.2) "*Iso*"It is used for those alkanes which have a methyl group attached to the second last carbon atom of the continuous chain. Chain contains no other branch.

2.1.3) "*neo*" This prefix is used for those alkanes which have two methyl groups attached to the second last carbon atom of the continuous chain. Chain contains no other branch.

2.2 Classification of carbon atoms

2.2.1 Primary Carbon

A carbon atom attached to no carbon atom or only one other carbon atom is called primary carbon atom designated as °1 carbon.

2.2.2 Secondary Carbon

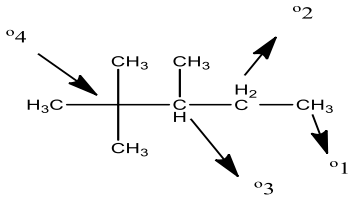
A carbon atom attached to two other carbon atoms is called secondary carbon atom designated as °2 carbon.

2.2.3 Tertiary Carbon

A carbon atom attached to three other carbon atoms is called tertiary carbon atom designated as °3 carbon.

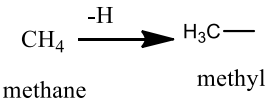
2.2.4) Quaternary Carbon

A carbon atom attached to four other carbon atoms is called quaternary carbon atom designated as °4 carbon.

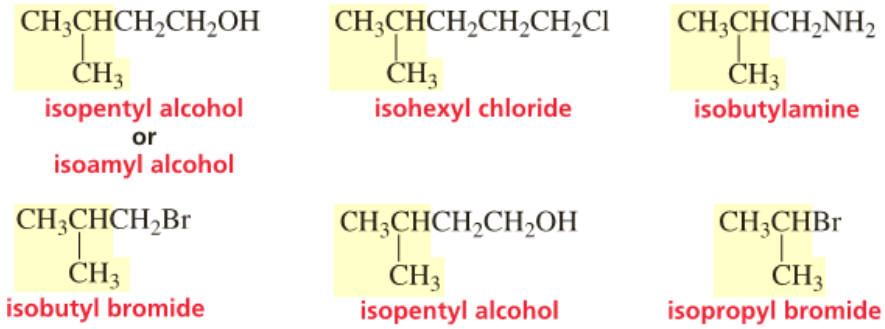


Alkyl group:

An alkyl group is formed by removing one hydrogen atom from one alkane



Notice that an *iso* group has a methyl group on the next-to-the-last carbon in the chain. Notice also that all *iso* alkyl compounds have the substituent (OH, Cl, NH2 , etc.) on a primary carbon, except for isopropyl, which has the substituent on a secondary carbon. The *isopropyl group could have been called a sec-propyl group.* Either name would have been appropriate because the group has an *iso* structural unit and a hydrogen has been removed from a secondary carbon. Chemists decided to call it *isopropyl*, however, which means that "sec" is used only for sec-butyl.



2.3 Rules for naming alkanes

i) Select the longest continuous chain.

ii) Name the longest chain. This will be the parent name and will come at the end of the name.

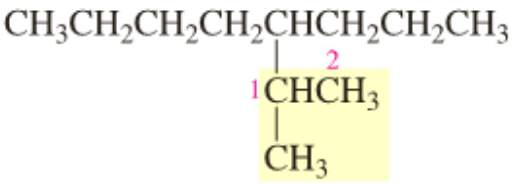
iii) Number the longest chain to give the substituents as the least possible number.

iv) Prefix the position number and the name of the substituent onto the parent name. The whole name is written in one word. There will be a hyphen between the number and the word and the two numbers are separated by a comma.

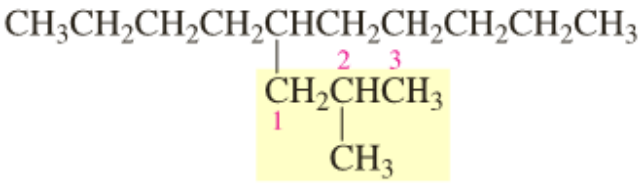
v) The names of two or more different substituents are arranged alphabetically. Number is given for each substituent separately.

vi) Names such as "isopropyl," "sec-butyl," and "tert-butyl" are acceptable sub- stituent names in the IUPAC system of nomenclature, but systematic substituent names are preferable. Systematic substituent names are

obtained by numbering the alkyl substituent starting at the carbon that is attached to the parent hydrocarbon. This means that the carbon that is attached to the parent hydrocarbon is always the number 1 carbon of the substituent. In a compound such as 4-(1-methylethyl)octane, the substituent name is in parentheses; the number inside the parentheses indicates a position on the substituent, whereas the number outside the parentheses indicates a position on the parent hydrocarbon.

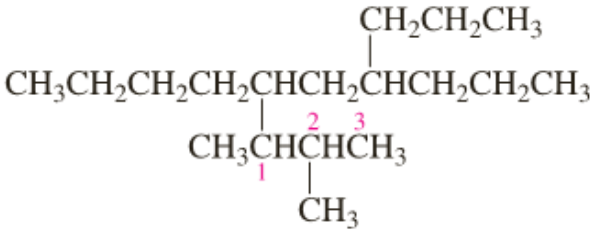


4-isopropyloctane
or
4-(1-methylethyl)octane

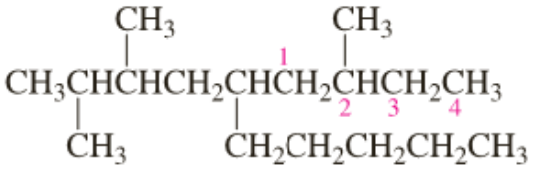


5-isobutyldecane
or
5-(2-methylpropyl)decane

Some substituents have only a systematic name.



6-(1,2-dimethylpropyl)-4-propyldecane

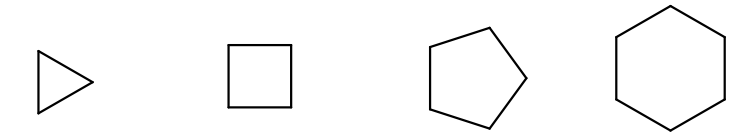


2,3-dimethyl-5-(2-methylbutyl)decane

3 Cycloalkanes

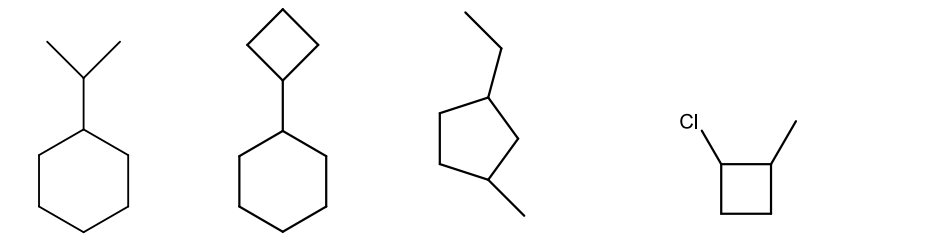
These are the alkanes in which carbon atoms are arranged in a ring.

General name for this class is **"Cycloalkanes"**. They are named by attaching a prefix "**cyclo**" to the name of alkane having the same number of carbon atoms.



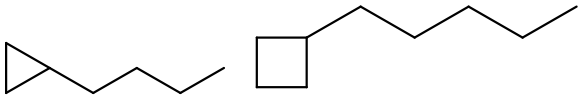
Cyclopropane Cyclobutane Cyclopentane Cyclohexane

Substituted cycloalkanes are named as "**Alkylcycloalkanes**". If more than one substituents are attached, then the substituents are named and their position is indicated by number. Numbering is given alphabetically.



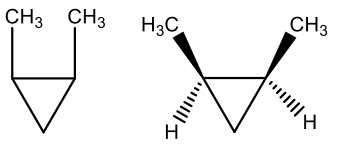
Isopropylcyclohexane Cyclobutylcyclohexane 1-ethyl-3-methylcyclopentane 1-chloro-2-methylcyclobutane

If the alkane chain attached to a ring have more number of carbon atoms than the ring, then alkane chain will be a parent name and ring is designated as a substituent on the alkane chain.

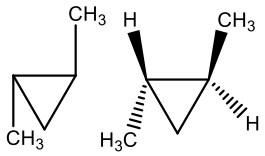


1-cyclopropylbutane 1-Cyclobutylpentane

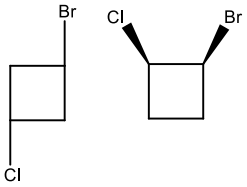
If the two substituents are located on the adjacent carbon atoms on the same side or face of the ring then they are called *cis* (Latin, on the same side) with respect to each other. Those on opposite sides are called *trans*.



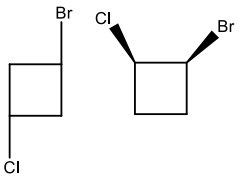
cis-1,2-dimethylcyclopropane



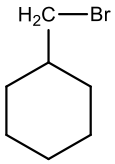
trans-1,2-dimethylcyclopropane



cis-1-bromo-3-chlorocyclobutane



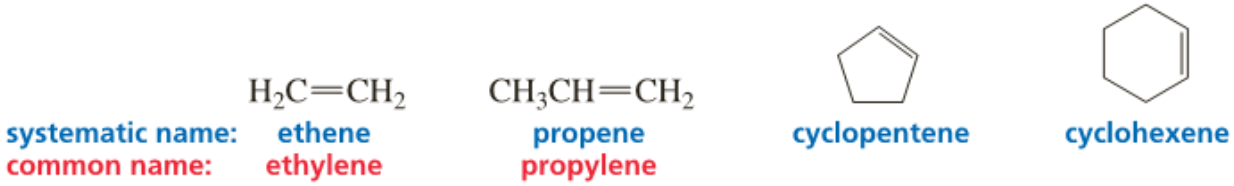
trans-1-bromo-3-chlorocyclobutane



(bromomethyl)cyclohexane

4) Alkenes

The systematic (IUPAC) name of an alkene is obtained by replacing the "ane" ending of the corresponding alkane with "ene." For example, a two-carbon alkene is called ethene and a three-carbon alkene is called propene. Ethene also is frequently called by its common name: ethylene.



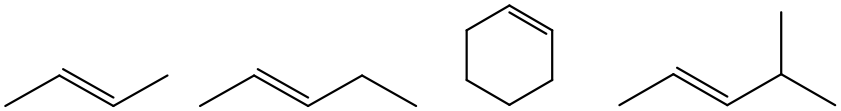
Most alkene names need a number to indicate the position of the double bond. (The four names above do not, because there is no ambiguity.) The IUPAC rules you learned for alkanes apply to alkenes as well:

i) Select the longest continuous chain and name it.

ii) Number the chain to give the double bonded carbon as the lowest possible number.

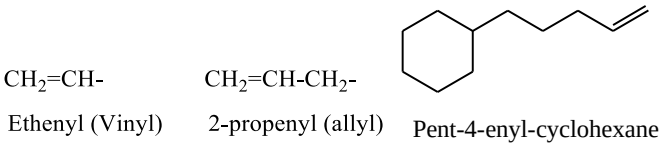
ii) Write the name of the alkene and indicate the number of double bond carbon.

iv) Alkyl groups and other substituents are numbered, named and placed as prefixes in alphabetical order.



2-butene 2-pentene cyclohexene 4-methyl-2-pentene

v) Common name for Substituents containing a double bond is alkenyl. e.g. ethenyl (vinyl), 2-propenyl (allyl), etc.

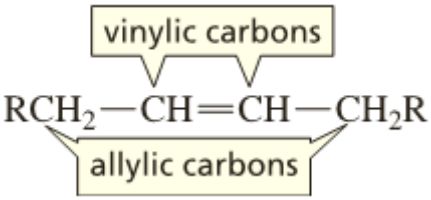


CH_2=CH- Ethenyl (Vinyl)

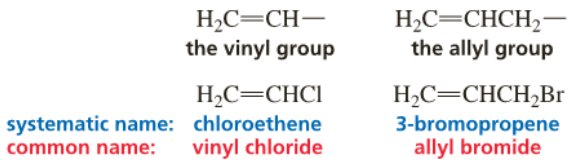
CH_2=CH-CH_2- 2-propenyl (allyl)

Pent-4-enyl-cyclohexane

The sp^2 carbons of an alkene are called vinylic carbons. An sp^3 carbon that is adjacent to a vinylic carbon is called an allylic carbon.

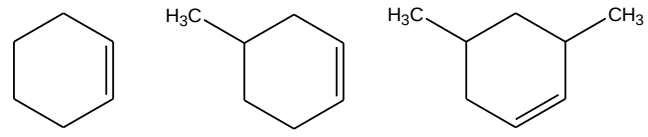


vi) Two groups containing a carbon–carbon double bond are used in common names— the vinyl group and the allyl group. The vinyl group is the smallest possible group that contains a vinylic carbon; the allyl group is the smallest possible group that contains an allylic carbon. When “allyl” is used in nomenclature, the substituent must be attached to the allylic carbon.



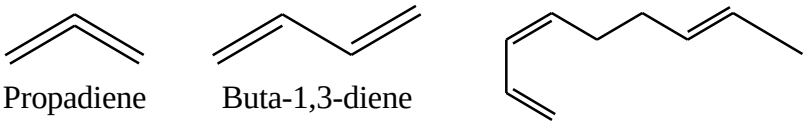
4.1 Cycloalkenes

vii) In cycloalkenes, double bonded carbons are numbered 1 and 2. Direction of numbering is so that the substituent get the lowest number. Position of double bond is not indicated.



Cyclohexene 4-Methylcyclohexene 3,5-Dimethylcyclohexene

viii)Alkenes containing more than one double bonds are called alkadienes, alkatrienes and so on. E.g.,



Propadiene Buta-1,3-diene

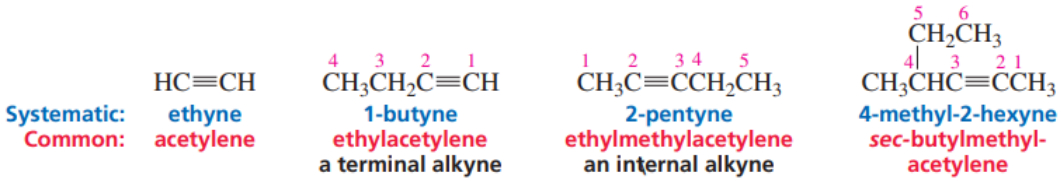
Nona-1,3,7-triene

5 Alkynes

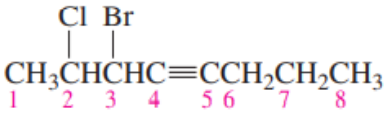
Common name of alkynes is "alkyne. Similar to the other functional groups,

i) the longest continuous chain containing the carbon–carbon triple bond is numbered in the direction that gives the alkyne functional group suffix as low a number as possible.

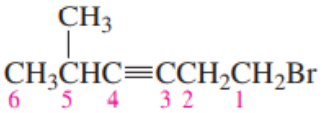
ii) If the triple bond is at the end of the chain, the alkyne is classified as a terminal alkyne. Alkynes with triple bonds located elsewhere along the chain are called internal alkynes. For example, 1-butyne is a terminal alkyne, whereas 2-pentyne is an internal alkyne.



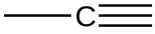
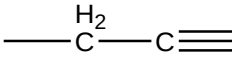
iii) If the same number for the alkyne functional group suffix is obtained counting from either direction along the carbon chain, the correct systematic name is the one that contains the lowest substituent number. If the compound contains more than one substituent, the substituents are listed in alphabetical order.

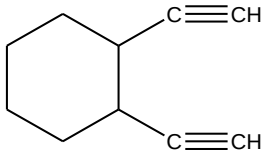


3-bromo-2-chloro-4-octyne
***not* 6-bromo-7-chloro-4-octyne**
because 2 < 6

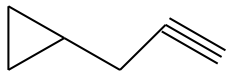


1-bromo-5-methyl-3-hexyne
***not* 6-bromo-2-methyl-3-hexyne**
because 1 < 2

iv) When alkynes are used as substituents, their common name is alkynyl. E.g.,  is called ethynyl,  is called propynyl.



1,2-Diethynylcyclohexane



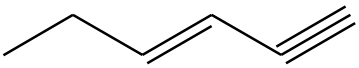
2-Propynylcyclopropane

5.1 Both alkene and alkynes

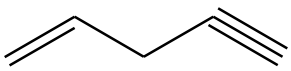
i)Common name for compound containing both alkene and alkynes is "alkenyne". The number before the name shows the double bond number and the number before -yne shows the triple number.

ii)The number starts from alkene or alkynes whichever ca have the lowest number.

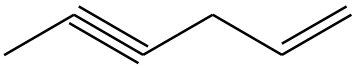
iii)However if both double and triple bond are at equivalent distance, then the lowest number must be given to the double bond.



3-Hexen-1-yne



1-Penten-4-yne

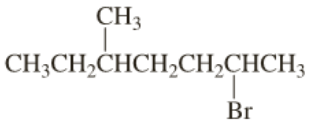


1-Hexen-4-yne

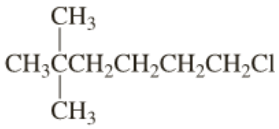
6 Nomenclature of Alkyl Halides

i)The common name for alkyl halide is alkyl halide. But the general IUPAC name for alkyl halide is **halo alkanes**.

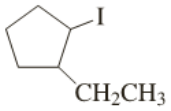
ii) A halogen is treated as an alkyl group with no priority. The longest alkane chain is numbered so as to give the first substituent, from either end, the lowest number. All substituents are ordered alphabetically.



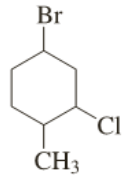
2-bromo-5-methylheptane



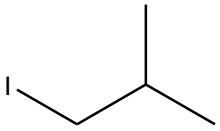
1-chloro-5,5-dimethylhexane



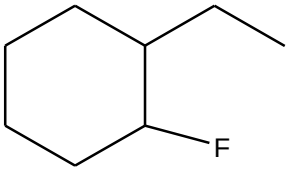
1-ethyl-2-iodocyclopentane



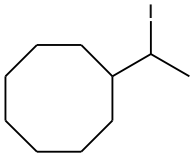
4-bromo-2-chloro-1-methylcyclohexane



1-Iodo-2-methyl-propane



1-Ethyl-2-fluoro-cyclohexane

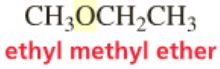


(1-Iodo-ethyl)-cyclooctane

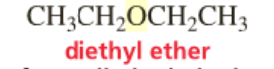
6 Nomenclature of Ethers

Ethers are compounds in which an oxygen is bonded to two alkyl substituents. If the alkyl substituents are identical, the ether is a symmetrical ether. If the substituents are different, the ether is an unsymmetrical ether

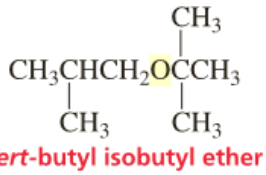
i) The common name of an ether consists of the names of the two alkyl substituents (in alphabetical order), followed by the word "ether." The smallest ethers are almost always named by their common names.



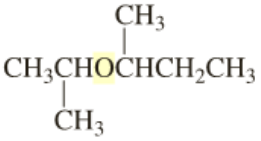
ethyl methyl ether



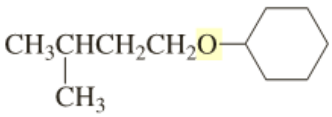
diethyl ether
often called ethyl ether



tert-butyl isobutyl ether

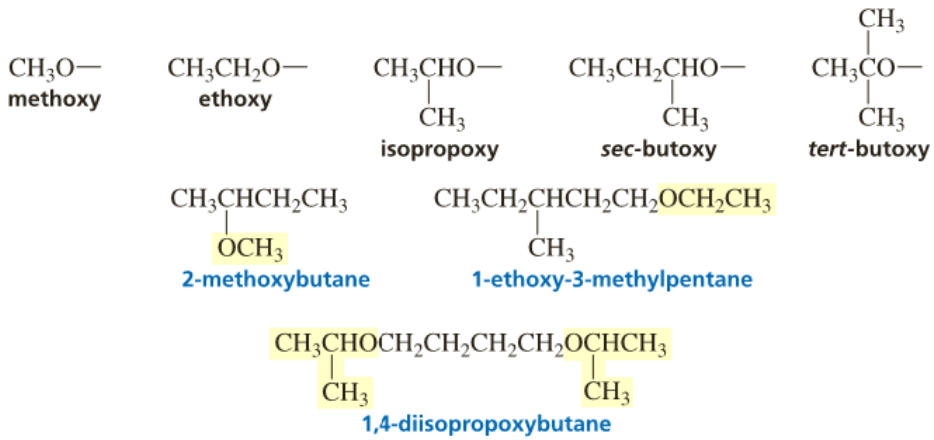


sec-butyl isopropyl ether



cyclohexyl isopentyl ether

ii) The General IUPAC name for ethers is "Alkoxyalkane". The longest alkyl group is selected as a parent name as alkane. The smallest group is taken as first name with replacing "yl" of the alkyl group with "oxy".

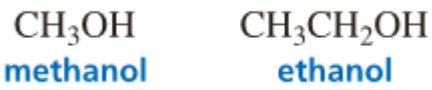


7 Nomenclature of Alcohols

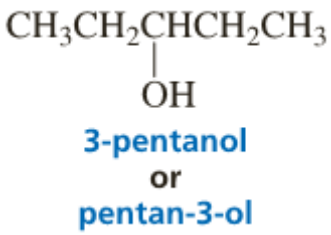
Alcohols are compounds in which a hydrogen of an alkane has been replaced by an OH group. Alcohols are classified as primary, secondary, or tertiary, depending whether the OH group is bonded to a primary, secondary, or tertiary carbon—the same way alkyl halides are classified.

The common name of an alcohol consists of the name of the alkyl group to which the OH group is attached, followed by the word “alcohol.”

The general IUPAC name of alcohol is “alkanol”. The systematic name of an alcohol, for example, is obtained by replacing the “e” at the end of the name of the parent hydrocarbon with the suffix “ol.”



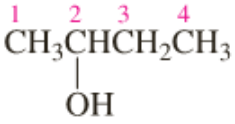
When necessary, the position of the functional group is indicated by a number immediately preceding the name of the alcohol or immediately preceding the suffix. The most recently approved IUPAC names are those with the number immediately preceding the suffix. However, names with the number preceding the name of the alcohol have been in use for a long time, so those are the ones most likely to appear in the literature and are acceptable.



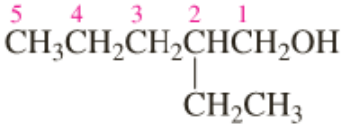
The following rules are used to name a compound that has a functional group suffix:

1. The parent hydrocarbon is the longest continuous chain containing the functional group.

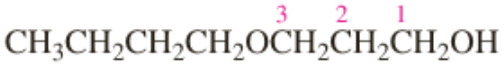
2. The parent hydrocarbon is numbered in the direction that gives the functional group suffix the lowest possible number.



2-butanol
or
butan-2-ol

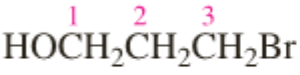


2-ethyl-1-pentanol
or
2-ethylpentan-1-ol

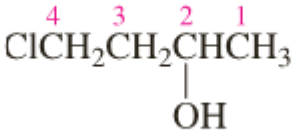


3-butoxy-1-propanol
or
3-butoxypropan-1-ol

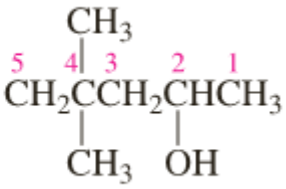
3. If there is a functional group suffix and a substituent, the functional group suffix gets the lowest possible number.



3-bromo-1-propanol



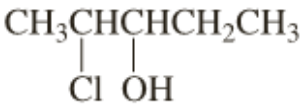
4-chloro-2-butanol



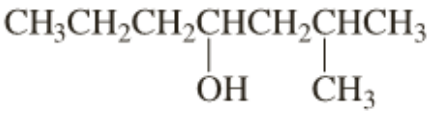
4,4-dimethyl-2-pentanol

4. If the same number for the functional group suffix is obtained in both directions, the chain is numbered in the direction that gives a substituent the lowest possible number.

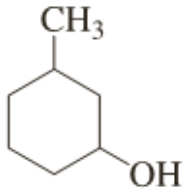
Cyclic alcohols are named as cycloalkanols. Notice that a number is not needed to designate the position of a functional group suffix in a cyclic compound, because it is assumed to be at the 1-position.



2-chloro-3-pentanol
not
4-chloro-3-pentanol

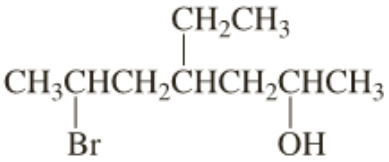


2-methyl-4-heptanol
not
6-methyl-4-heptanol

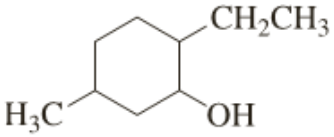


3-methylcyclohexanol
not
5-methylcyclohexanol

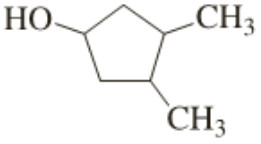
5. If there is more than one substituent, the substituents are cited in alphabetical order.



6-bromo-4-ethyl-2-heptanol



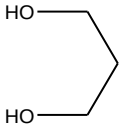
2-ethyl-5-methylcyclohexanol



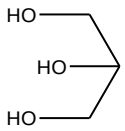
3,4-dimethylcyclopentanol

Remember that the name of a substituent is stated before the name of the parent hydrocarbon, and the functional group suffix is stated after the name of the parent hydrocarbon. [substituent] [parent hydrocarbon] [functional group suffix].

6. Alcohols containing two or three -OH groups are named as alkanediols and alkanetriols.



Propane-1,3-diol



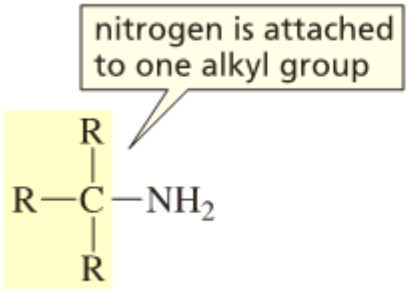
Propane-1,2,3-triol

8 Nomenclature of Amines

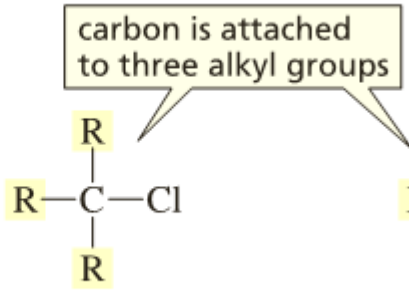
Amines are compounds in which one or more of the hydrogens of ammonia have been replaced by alkyl groups. Smaller amines are characterized by their fishy odors.

There are primary amines, secondary amines, and tertiary amines. The classification depends on how many alkyl groups are bonded to the nitrogen. Primary amines have one alkyl group bonded to the nitrogen, secondary amines have two, and tertiary amines have three.

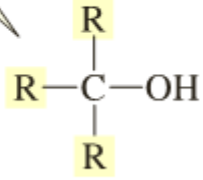
Notice that the number of alkyl groups attached to the nitrogen determines whether an amine is primary, secondary, or tertiary. For an alkyl halide or an alcohol, on the other hand, the number of alkyl groups attached to the carbon to which the halogen or the OH is bonded determines the classification.



a primary amine



a tertiary alkyl chloride

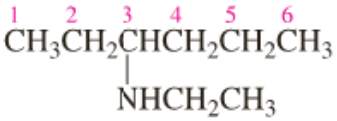


a tertiary alcohol

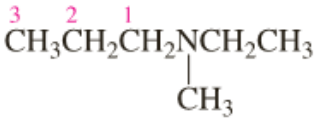
The common name of an amine consists of the names of the alkyl groups bonded to the nitrogen, in alphabetical order, followed by "amine." The entire name is written as one word (unlike the common names of alcohols, ethers, and alkyl halides, in which "alcohol," "ether," and "halide" are separate words).

In IUPAC system the general name for amine is "**alkylalkanamine"**. The IUPAC system uses a suffix to denote the amine functional group. The "e" at the end of the name of the parent hydrocarbon is replaced by "amine"—similar to the way in which alcohols are named. A number identifies the carbon to which the nitrogen is attached. The number can appear before the name of the parent hydrocarbon or before "amine." The name of any alkyl group bonded to nitrogen is preceded by an "N" (in italics) to indicate that the group is bonded to a nitrogen rather than to a carbon.

1-butanamine
or
butan-1-amine

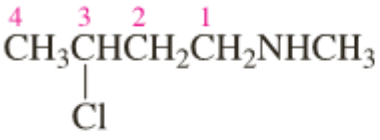


N-ethyl-3-hexanamine
or
N-ethylhexan-3-amine

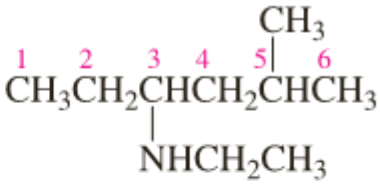


N-ethyl-*N*-methyl-1-propanamine
or
N-ethyl-*N*-methylpropan-1-amine

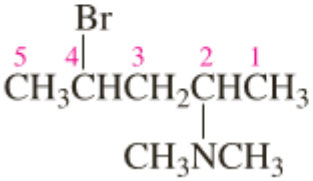
The substituents—regardless of whether they are attached to the nitrogen or to the parent hydrocarbon—are listed in alphabetical order, and then a number or an "N" is assigned to each one. The chain is numbered in the direction that gives the functional group suffix the lowest possible number.



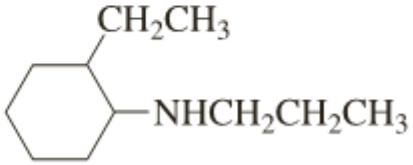
3-chloro-*N*-methyl-1-butanamine



N-ethyl-5-methyl-3-hexanamine

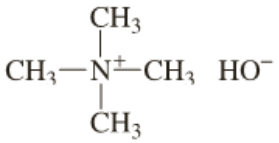


4-bromo-*N*,*N*-dimethyl-2-pentanamine

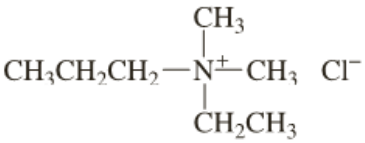


2-ethyl-*N*-propylcyclohexanamine

Nitrogen compounds with four alkyl groups bonded to the nitrogen—thereby giving the nitrogen a positive formal charge—are called quaternary ammonium salts. Their names consist of the names of the alkyl groups in alphabetical order, followed by "ammonium" (all in one word), and then the name of the counterion as a separate word.



tetramethylammonium hydroxide

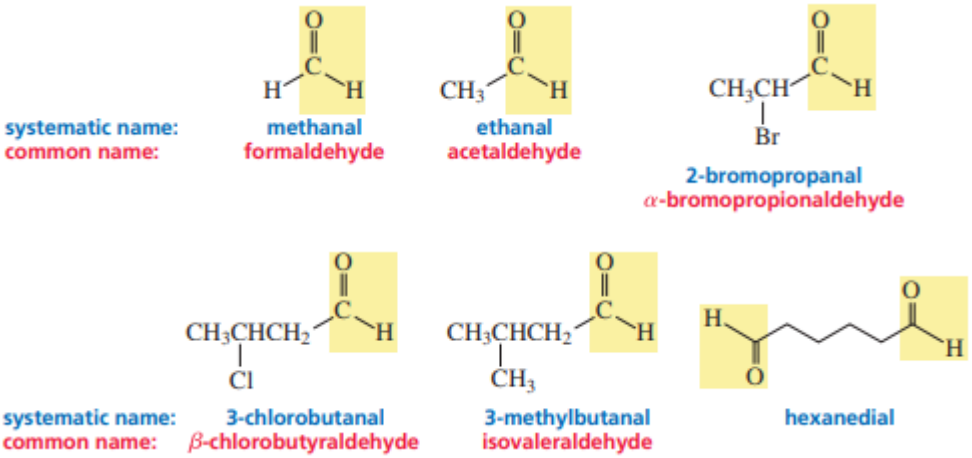


ethyldimethylpropylammonium chloride

9 Aldehydes

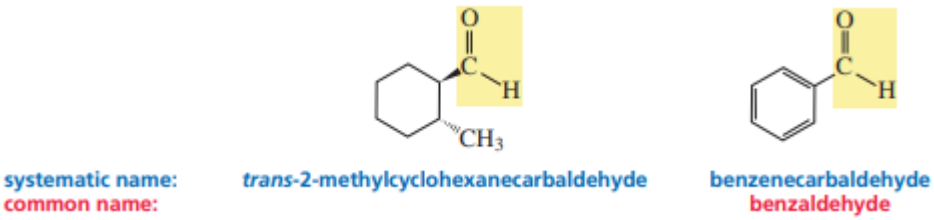
1) The IUPAC name of an aldehyde is obtained by replacing the terminal "e" from the name of the parent hydrocarbon with "al." (**Alkanal)** For example, a one-carbon aldehyde is methanal; a two-carbon aldehyde is ethanal. The position of the carbonyl carbon does not have to be designated, because it is always at the end of the parent hydrocarbon and therefore always has the 1-position.

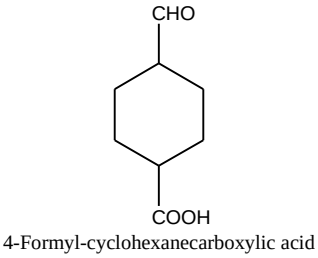
2) The common name of an aldehyde is the same as the common name of the corresponding carboxylic acid (Section 17.1), except that "aldehyde" is substituted for "ic acid" (or "oic acid"). When common names are used, the position of a substituent is designated by a lowercase Greek letter. The carbonyl carbon is not designated; the carbon adjacent to the carbonyl carbon is the alpha carbon.



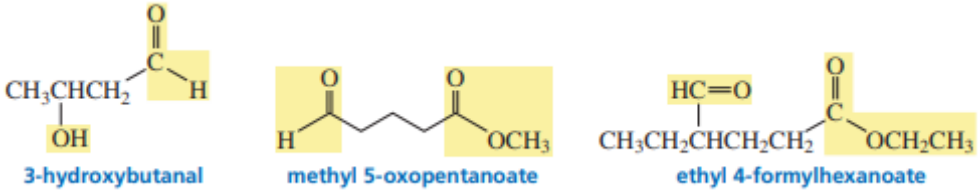
3) The aldehyde containing two aldehydic groups are called as alkanedial. Notice that the terminal "e" is not removed in hexanedial; the "e" is removed only to avoid two successive vowels.

4) If the aldehyde group is attached to a ring, the aldehyde is named by adding "carbaldehyde" to the name of the cyclic compound. When aldehyde group is present on the ring with some other group as a substituent, then it is named as formyl.

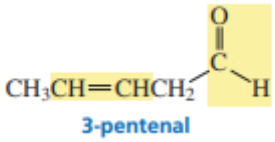




4-Formyl-cyclohexanecarboxylic acid



5) If the compound has both an alkene and an aldehyde functional group, the alkene is cited first, with the "e" ending omitted to avoid two successive vowels.

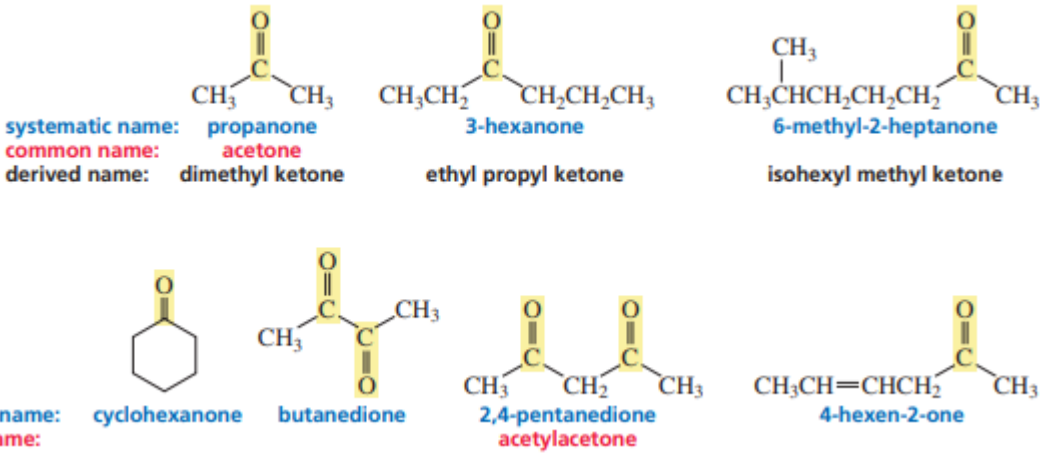


10 Ketones

1) The IUPAC name of a ketone is obtained by removing the "e" from the name of the parent hydrocarbon and adding "one" (**Alkanone**). The chain is numbered in the direction that gives the carbonyl carbon the smaller number.

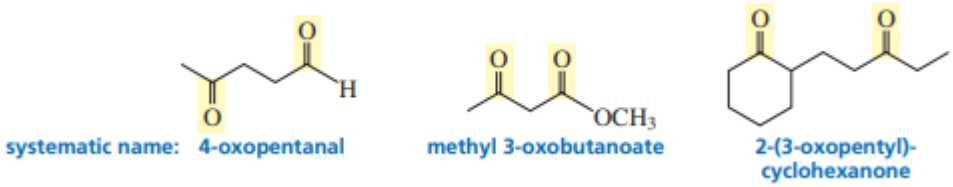
2) In the case of cyclic ketones, the IUPAC general name is **cycloalkanone** and a number is not necessary because the carbonyl carbon is assumed to be at the 1-position.

Derived Common names are used for ketones—the substituents attached to the carbonyl group are cited in alphabetical order, followed by "ketone."



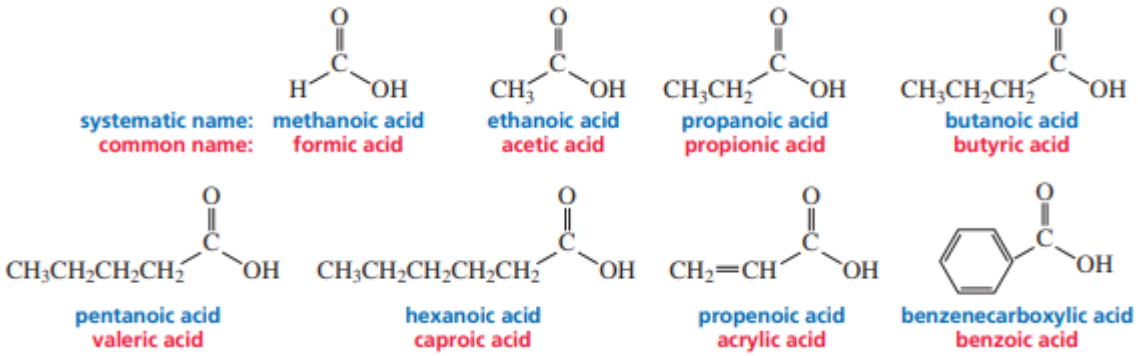
Only a few ketones have common names. The smallest ketone, propanone, is usually referred to by its common name, acetone. Acetone is a common laboratory solvent.

3) If the ketone has a second functional group of higher naming priority, the ketone oxygen is indicated by the prefix "oxo."



11 Carboxylic Acids

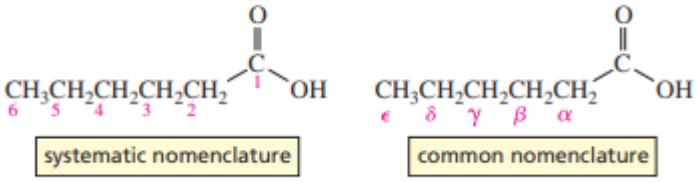
1) In IUPAC nomenclature, a carboxylic acid is named by replacing the terminal "e" of the alkane name with "oic acid." (**Alkanoic Acid)** For example, the one-carbon alkane is methane, so the one-carbon carboxylic acid is methanoic acid.



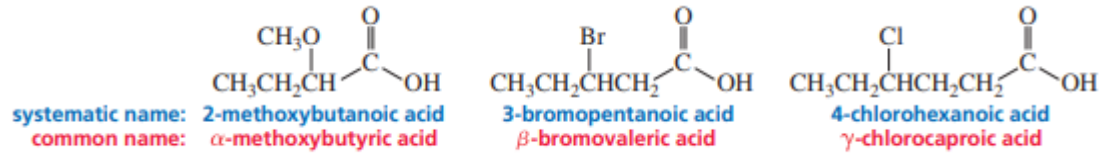
2) Carboxylic acids containing six or fewer carbons are frequently called by their common names. These names were chosen by early chemists to describe some feature of the compound, usually its origin. For example, **formic acid is found in ants**, bees, and other stinging insects; its name

comes from formica, which is Latin for "ant." **Acetic acid—contained in vinegar**—got its name from acetum, the Latin word for "vinegar." **Propionic acid is the smallest acid that shows some of the characteristics of the larger fatty acids**; its name comes from the Greek words pro ("the first") and pion ("fat"). **Butyric acid is found in rancid butter**; the Latin word for "butter" is butyrum. **Valeric acid is found in valeric plant roots**. **Caproic acid is found in goat's milk,** and if you have the occasion to smell both a goat and caproic acid, you will find that they have similar odors. Caper is the Latin word for "goat."

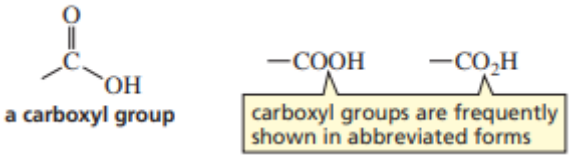
3) In IUPAC nomenclature, the position of a substituent is designated by a number. The carbonyl carbon of a carboxylic acid is always the C-1 carbon.
4) In common nomenclature, the position of a substituent is designated by a lowercase Greek letter, and the carbonyl carbon is not given a designation. The carbon adjacent to the carbonyl carbon is the Alpha Carbon, the carbon adjacent to the Alpha is the Beta Carbon and so on.



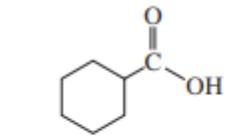
5) Take a careful look at the following examples to make sure that you understand the difference between systematic (IUPAC) and common nomenclature:



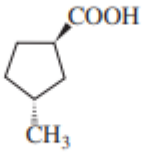
6) The functional group of a carboxylic acid is called a carboxyl group.



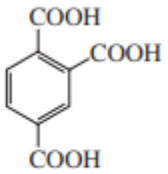
7) Carboxylic acids in which a carboxyl group is attached to a ring are named by adding "carboxylic acid" to the name of the cyclic compound.



cyclohexanecarboxylic acid



trans-3-methylcyclopentanecarboxylic acid



1,2,4-benzenetricarboxylic acid

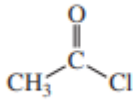
Acyl

Derivatives of Carboxylic Acids

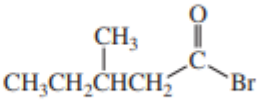
11.1 Acyl Halides

1) Acyl halides are compounds that have a halogen atom in place of the OH group of a carboxylic acid. The most common acyl halides are acyl chlorides and acyl bromides. Their general IUPAC name is **Alkanoyl halide.**

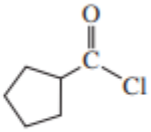
2) Acyl halides are named by using the acid name and replacing "ic acid" with "yl chloride" (or "yl bromide"). For acids ending with "carboxylic acid," "carboxylic acid" is replaced with "carbonyl chloride" (or "bromide").



systematic name: ethanoyl chloride
common name: acetyl chloride



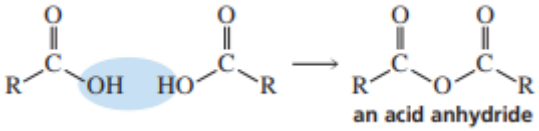
3-methylpentanoyl bromide
β-methylvaleryl bromide



cyclopentanecarbonyl chloride

11.2 Acid Anhydrides

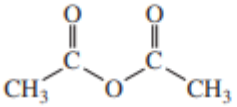
1) Loss of water from two molecules of a carboxylic acid results in an acid anhydride. "Anhydride" means "without water."



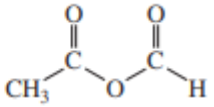
an acid anhydride

2) If the two carboxylic acid molecules forming the acid anhydride are the same, the anhydride is a symmetrical anhydride. If the two carboxylic acid molecules are different, the anhydride is a mixed anhydride.

3) Symmetrical anhydrides are named by using the acid name and replacing "acid" with "anhydride." Mixed anhydrides are named by stating the names of both acids in alphabetical order, followed by "anhydride."



systematic name: ethanoic anhydride
common name: acetic anhydride
a symmetrical anhydride

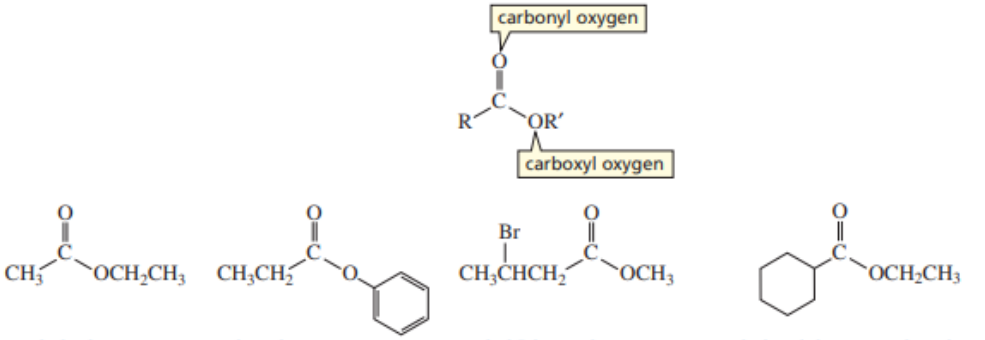


ethanoic methanoic anhydride
acetic formic anhydride
a mixed anhydride

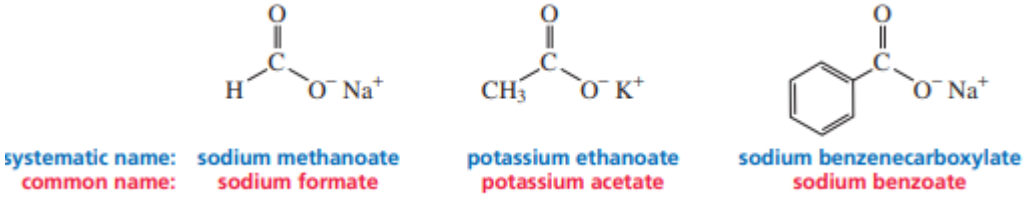
11.3 Esters

1) An ester is a compound that has an OR group in place of the OH group of a carboxylic acid. Its IUPAC general name is **alkylalkanotae** and consists of two words.

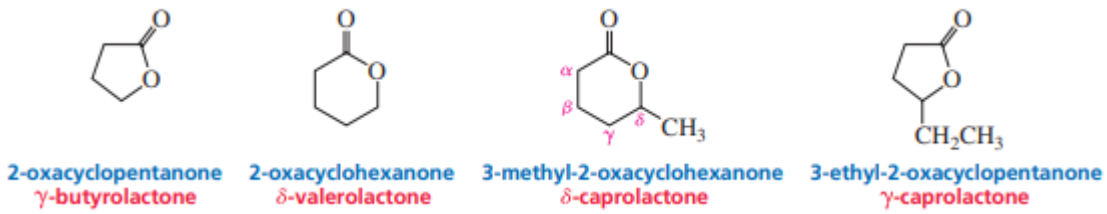
2) In naming an ester, the name of the group attached to the carboxyl oxygen is stated first, followed by the name of the acid, with "ic acid" replaced by "ate."



3) Salts of carboxylic acids are named in the same way. The cation is named first, followed by the name of the acid, again with "ic acid" replaced by "ate.

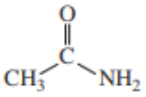


4) Cyclic esters are called lactones. In systematic nomenclature, they are named as "2-oxacycloalkanones." Their common names are derived from the common name of the carboxylic acid, which designates the length of the carbon chain, and a Greek letter to indicate the carbon to which the carboxyl oxygen is attached. Thus, four-membered ring lactones are Beta lactone (the carboxyl oxygen is on the Beta Carbon), five-membered ring lactones are gamma lactones and six-membered ring are delta lactones.

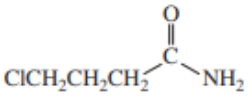


11.4 Amides

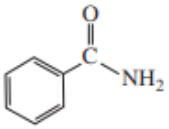
1) An amide has an NH_2, NHR, or NR_2 group in place of the OH group of a carboxylic acid. Their IUPAC name is **N-alkylalkanamide**. Amides are named by using the acid name, replacing "oic acid" or "ic acid" with "amide." For acids ending with "carboxylic acid," "ylic acid" is replaced with "amide."



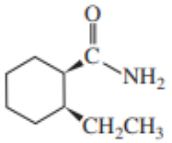
systematic name: ethanamide
common name: acetamide



4-chlorobutanamide
γ-chlorobutyramide

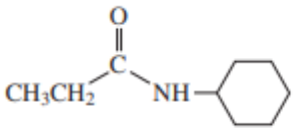


benzenecarboxamide
benzamide

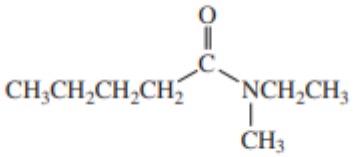


cis-2-ethylcyclohexanecarboxamide

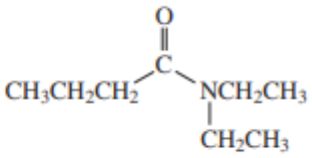
2) If a substituent is bonded to the nitrogen, the name of the substituent is stated first (if there is more than one substituent bonded to the nitrogen, they are stated alphabetically), followed by the name of the amide. The name of each substituent is preceded by a capital N to indicate that the substituent is bonded to a nitrogen.



N-cyclohexylpropanamide

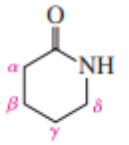


N-ethyl-*N*-methylpentanamide

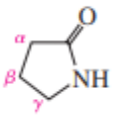


N,*N*-diethylbutanamide

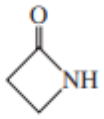
3) Cyclic amides are called lactams. Their nomenclature is similar to that of lactones. They are named as "2-azacycloalkanones" in systematic nomenclature ("aza" is used to designate the nitrogen atom). In their common names, the length of the carbon chain is indicated by the common name of the carboxylic acid, and a Greek letter indicates the carbon to which the nitrogen is attached.



2-azacyclohexanone
δ-valerolactam



2-azacyclopentanone
γ-butyrolactam



2-azacyclobutanone
β-propiolactam

11.5 Nitriles

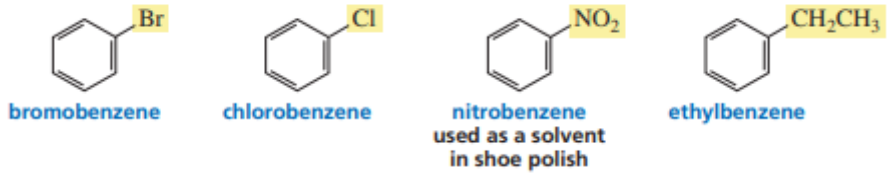
1) Nitriles are compounds that contain a functional group. Nitriles are considered carboxylic acid derivatives because they react with water to form carboxylic acids. In systematic nomenclature, nitriles are named by adding "nitrile" to the parent alkane name **Alkanenitrile**.

2) Notice that the triple bonded carbon of the nitrile group is counted in the number of carbons in the longest continuous chain.

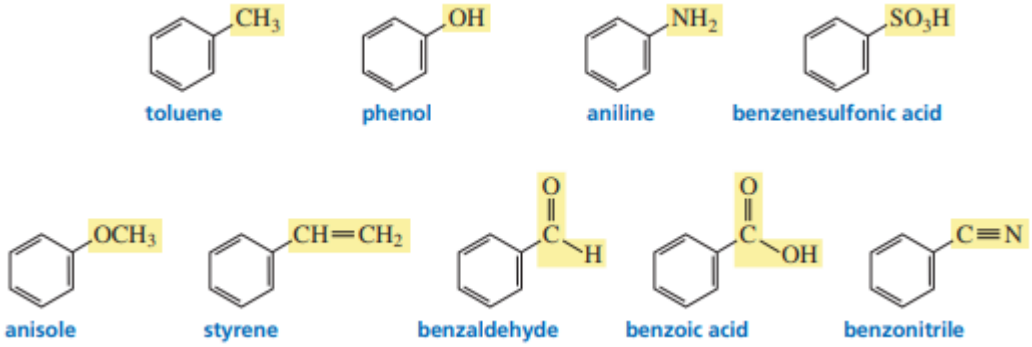
3) In common nomenclature, nitriles are named by replacing "ic acid" of the carboxylic acid name with "onitrile." They can also be named as alkyl cyanides—stating the name of the alkyl group that is attached to the group.

12. Nomenclature of Monosubstituted Benzenes

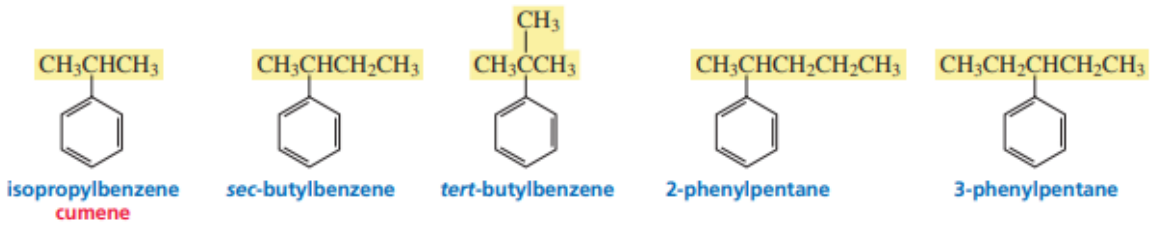
1) Some monosubstituted benzenes are named simply by stating the name of the substituent, followed by the word "benzene."



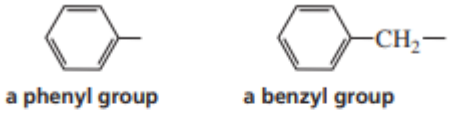
2) Some monosubstituted benzenes have names that incorporate the name of the substituent. Unfortunately, such names have to be memorized.

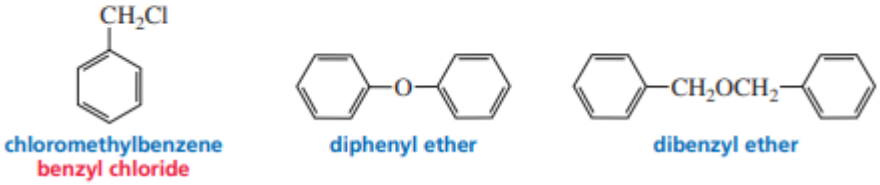


3) With the exception of toluene, benzene rings with an alkyl substituent are named as alkyl-substituted benzenes or as phenyl-substituted alkanes.

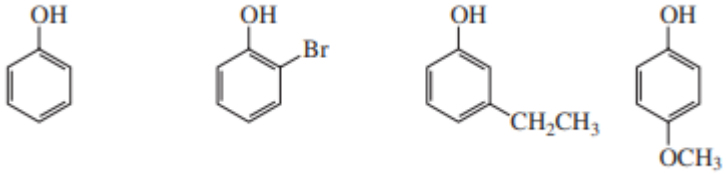


4) When a benzene ring is a substituent, it is called a phenyl group. A benzene ring with a methylene group is called a benzyl group.





5) An aryl group (Ar) is the general term for either a phenyl group or a substituted phenyl group, just as an alkyl group (R) is the general term for a group derived from an alkane. In other words, ArOH could be used to designate any of the following phenols:



13. Polyfunctional compounds

When a compound contains more than one functional group, then the main functional group with higher priority will act as principal functional group. The other functional groups are considered as substituents. For example carboxylic acid functional group will always act as principal one.

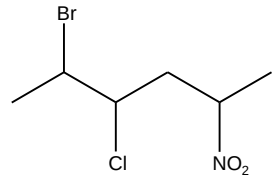
The IUPAC has established the priority of functional groups for deciding the principal and substituent functional groups in poly functional compounds. The priority table is given below in decreasing order of the priority for citation of principal functional group.

Priority list for principal functional group in decreasing order	
Functional group	**FORMULA**
Carboxylic acid	-COOH
Sulphonic acid	-SO3H
Ester	-COOR
Acid chloride	-COCl
Acid amides	-CONH2
Nitrile	-CN
Aldehyde	-CHO

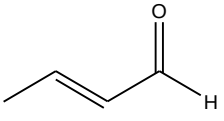
Ketone	>C=O
Alcohol	-OH
Phenol	-C6H6O
Thiols	-SH
Amines	0
Ether	-OR
Alkene	>C=C<
Alkyne	-C≡C-

Name for secondary functional groups	
SECONDARY FUNCTIONAL GROUP	**PREFIX**
-X (F,Cl,Br,I)	Halo (fluoro, chloro, bromo, iodo)
-OH	Hydroxy
-SH	Mercapto
-OR	Alkoxy
NH2	Amino
-CHO	Formyl or Carbaldehyde
-C=O	oxo
NO2	Nitro
-CN	Cyano
NO	Nitroso

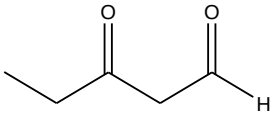
Halo and alkyl groups are always named a substituent.



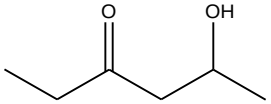
2-Bromo-3-chloro-5-nitro-hexane



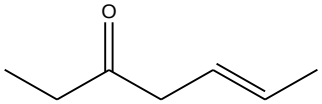
2-Butenal



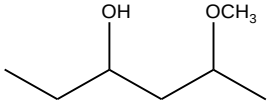
3-Oxo-pentanal



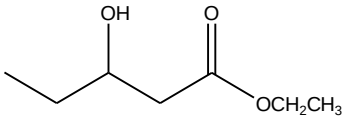
5-Hydroxy-3-hexanone



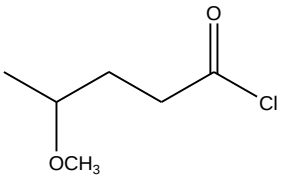
Hept-5-en-3-one



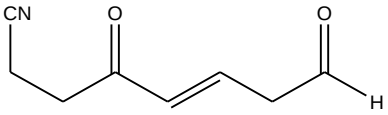
5-Methoxy-hexan-3-ol



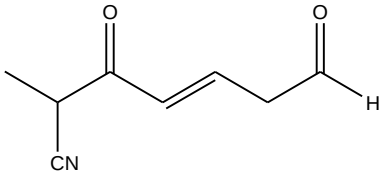
Ethyl-3-hydroxypentanoate



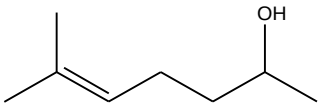
4-Methoxy-pentanoyl chloride



4,8-Dioxo-oct-5-enenitrile



6-Cyano-5-oxo-3-heptenal



6-Methyl-hept-5-en-2-ol

14. Polycyclic alkanes

Two or more rings can be joined into bicyclic or polycyclic systems. There are three ways that two rings may be joined.

14.1 Bicylo alkanes, in which two rings share two carbon atoms. There are further two types.

a) Fused rings are most common in which two adjacent carbon atoms are part of each ring.
b) Bridged rings are also common which share two non-adjacent carbon atoms.

14.2 Spirocyclic compounds in which the two rings share only one carbon atom. They are very rare.

14.1 Bicycloalkanes

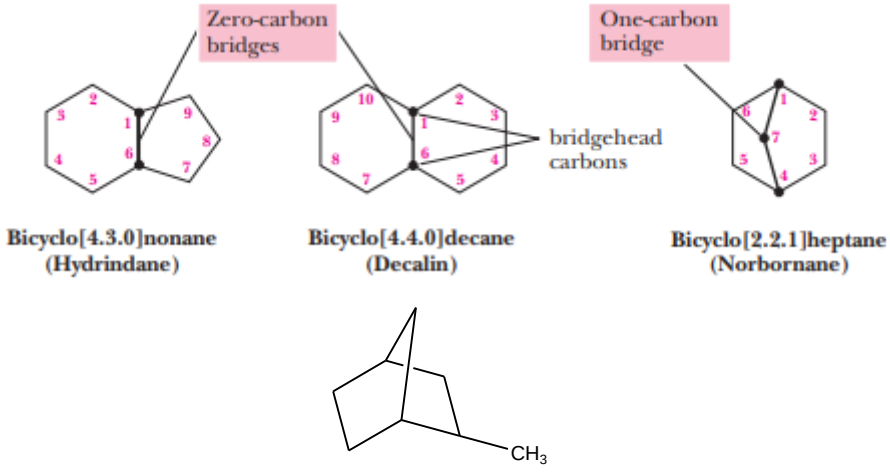
An alkane that contains two rings that share two carbon atoms in common is classified as a bicycloalkane.

1)The shared carbon atoms are called bridgehead carbons, and the carbon chain connecting them is called a bridge. The general formula of a bicycloalkane is CnH2n-2.

2)The numbers are assigned to the carbon atoms by beginning at a bridgehead carbon and moving along the bridges. The longest chain is numbered first, the second longest next and so on. Examples of bicycloalkanes along with the IUPAC and common name of each are given below.

3)Suffixes such as bicyclo, tricyclo indicate the number of rings.

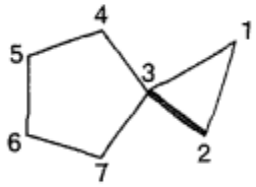
4) The numbers in the brackets indicate the number of carbons in longest chain, shortest chain and in the bridge in order of decreasing size.



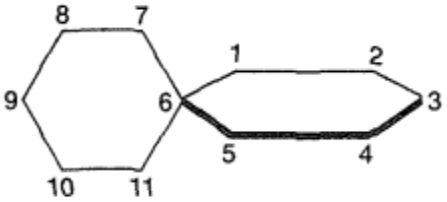
2-Methylbicyclo[2.2.1]heptane

14.2 Spiroalkanes

When the hydrocarbon rings have only one carbon in common, they are called spiranes and are given systematic names in accord with the following examples :



spiro[4.2]heptane



spiro[5.5]undecane

1)Notice that for spiranes the numbering starts next to the junction point (spiro carbon) in the smaller ring. The naming of tricyclo alkanes follows the same general system.

15 Heterocyclic compounds

Ring compounds containing nitrogen, oxygen, sulfur, or other elements as ring atoms generally are known as heterocyclic compounds, and the ring atoms other than carbon are the hetero atoms.

Unfortunately, several competing systems have been developed for naming heterocyles. We prefer the simplest procedure, which is to name the simple

heterocycles as oxa, aza, and thia-derivatives of cycloalkanes. However, this procedure has not been accepted (or adopted) universally.

We summarize here the rules of the so-called Hantzsch-Widman nomenclature system for heterocycles,

1- The IUPAC name of any heterocycle consists of one or more numbers and three parts.

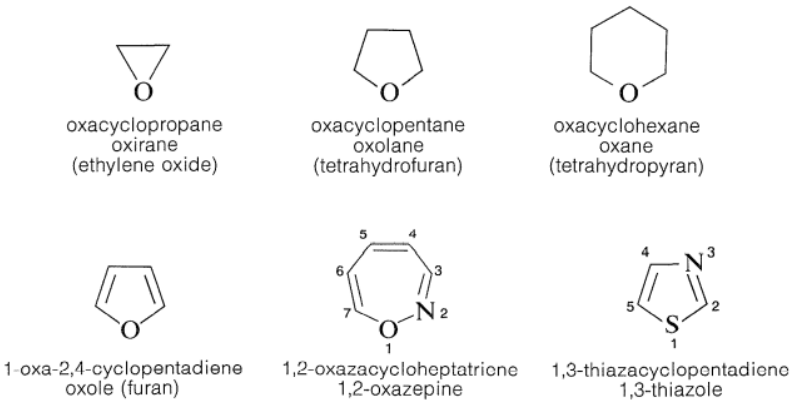
A)Prefix: The prefix shows the kind of heteroatom present in the ring. prefix, oxa, thia, or aza are used for oxygen, sulfur, or nitrogen, respectively; the prefixes dioxa, dithia, or diaza denote two oxygen, sulfur, or nitrogen atoms.

When two or more different hetero atoms are present, they are cited in order of preference: oxygen before sulfur before nitrogen, as in the prefixes oxaza for one oxygen and one nitrogen, and thiaza for one sulfur and one nitrogen.

B) Stem: Second Part of name consists of a stem depending upon the number of atoms in a ring. Ring size is denoted by the stem, ir, et, ol, in, ep, oc, on, or ec for 3-, 4-, 5-, 6-, 7-, 8-, 9-, or 10-membered rings, respectively.

c)Suffix: Third part of name consists of suffix showing saturation or unsaturation. A list of appropriate suffixes and their stems according to ring sizes is given in Table below. Notice that the suffix changes slightly according to whether the ring contains nitrogen.

2. Numbering of the ring starts with the hetero atom and proceeds around the ring so as to give substituents (or other hetero atoms) the lowest numbered positions. When two or more different hetero atoms are present, oxygen takes precedence over sulfur and sulfur over nitrogen for the number one position. Examples follow to illustrate both the heterocycloalkane and the Hantzsch-Widman systems. Trivial names also are included.



Stems, Suffix, and Ring Size of Heterocyclic Compounds

		Stem + suffix			
		Ring contains nitrogen		Ring contains no nitrogen	
Ring size	Stem	Unsaturated[a]	Saturated	Unsaturated[a]	Saturated
3	-ir-	-irine	-iridine	-irene	-irane
4	-et-	-ete	-etidine	-ete	-etane
5	-ol-	-ole	-olidine	-ole	-olane
6	-in-	-ine	*b*	-in	-ane
7	-ep-	-epine	*b*	-epin	-epane
8	-oc-	-ocine	*b*	-ocin	-ocane
9	-on-	-onine	*b*	-onin	-onane
10	-ec-	-ecine	*b*	-ecin	-ecane

[a]Corresponding to maximum number of double bonds, excluding cumulative double bonds.
[b]The prefix "perhydro" is attached to the stem and suffix of the parent unsaturated compound.