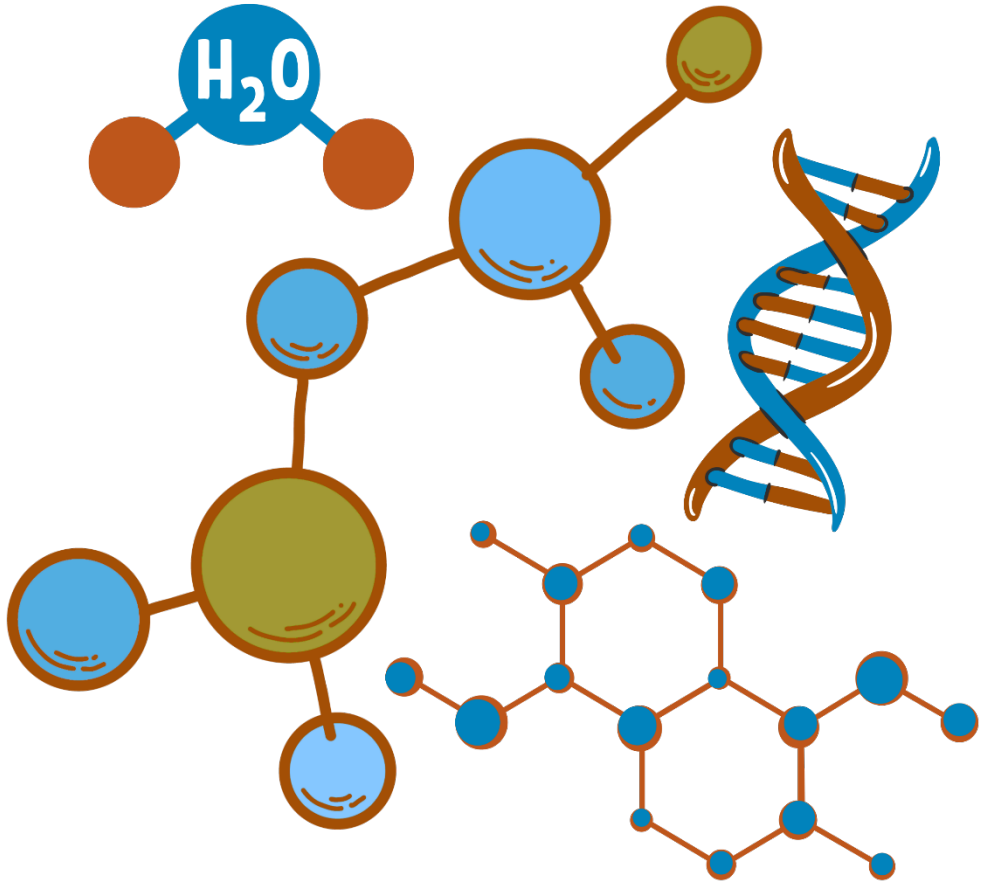
Introduction to Organic Chemistry
CHEM 108

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Chapter 3: Nomenclature of Organic Compounds

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- The older unsystematic names, (*Common names*).
- Systematic nomenclature developed and updated by the International Union of Pure and Applied Chemistry (IUPAC).

1. Nomenclature of Alkanes and Cycloalkanes

- **The names for some unbranched alkanes are listed in Table 3.1.**
- **The ending for all of the names of alkanes is *-ane*.**
- **The stems of the names of most of the alkanes (above C4) are of Greek and Latin origin. Thus, one, two, three, four, and five become meth-, eth-, prop-, but-, and pent-.**

Table 3-1 The Unbranched alkanes

Name	Number of Carbon Atoms	Structure	Name	Number of Carbon Atoms	Structure
Methane	1	CH_4	Hexane	6	$CH_3(CH_2)_4CH_3$
Ethane	2	CH_3CH_3	Heptane	7	$CH_3(CH_2)_5CH_3$
Propane	3	$CH_3CH_2CH_3$	Octane	8	$CH_3(CH_2)_6CH_3$
Butane	4	$CH_3(CH_2)_2CH_3$	Nonane	9	$CH_3(CH_2)_7CH_3$
Pentane	5	$CH_3(CH_2)_3CH_3$	Decane	10	$CH_3(CH_2)_8CH_3$

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1. Nomenclature of Alkanes and Cycloalkanes

1.1. How to Name Alkyl Groups

- **If we remove one terminal hydrogen atom from an alkane, we obtain what is called an alkyl group.**
- **These alkyl groups have names that end in *-yl*.**

Alkane ⟹ Alkyl

- **Example;**

$CH_3—H$

Methane

$CH_3—$

Methyl

Me-



$CH_3CH_2—H$

Ethane

$CH_3CH_2—$

Ethyl

Et-



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1. Nomenclature of Alkanes and Cycloalkanes

1.1. How to Name Alkyl Groups

- For alkanes with more than two carbon atoms, more than one derived group is possible.
- For example;

  Two groups can be derived from propane,

  the propyl group is derived by removal of a terminal hydrogen, and

  the isopropyl (common name) is derived by removal of a hydrogen from the central carbon.

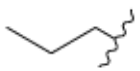
Three-Carbon Groups

$CH_3CH_2CH_3$

Propane

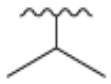
$CH_3CH_2CH_2$—

Propyl (or Pr)



CH_3CHCH_3

Isopropyl (or i-Pr)



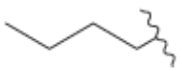
Four-Carbon Groups

$CH_3CH_2CH_2CH_3$

Butane

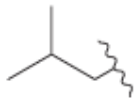
$CH_3CH_2CH_2CH_2$—

Butyl (or Bu)



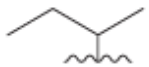
CH_3
CH_3CHCH_2—

Isobutyl



$CH_3CH_2CHCH_3$
CH_3

***sec*-Butyl**



$(CH_3)_3C$ —

***tert*-Butyl (or *t*-Bu)**



- The common names isopropyl, isobutyl, *sec*-butyl, and *tert*-butyl are approved by IUPAC for the unsubstituted groups, and they are still very frequently used.

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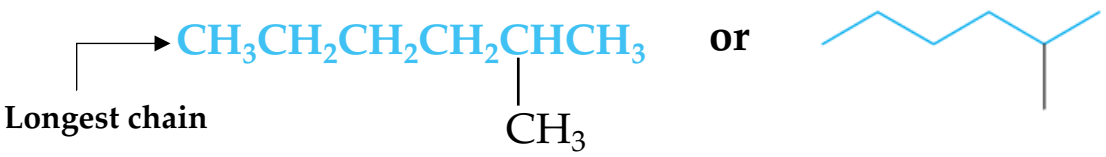
1. Nomenclature of Alkanes and Cycloalkanes

1.2. How to Name Alkanes

- **Branched-chain alkanes are named according to the following rules:**

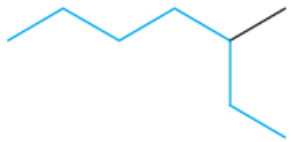
1. Locate the longest continuous chain of carbon atoms; this chain determines the parent's name for the alkane.

The longest continuous chain may not always be obvious from the way the formula is written.



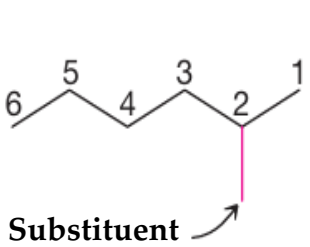
or

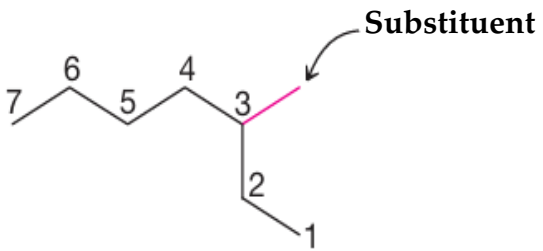
Hexane
Because the longest continuous chain contains six carbon atoms



Heptane
Because the longest chain contains seven carbon atoms

2. Number the longest chain beginning with the end of the chain nearer the substituent.





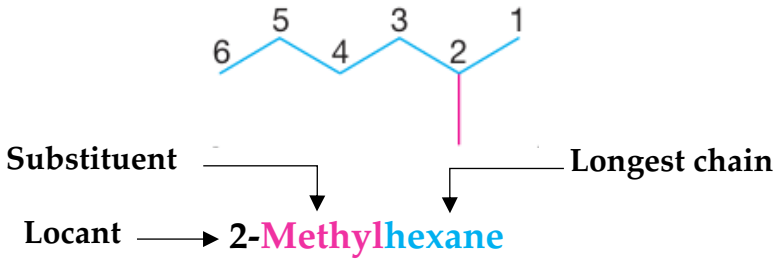
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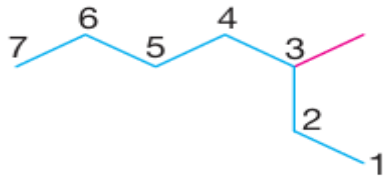
1. Nomenclature of Alkanes and Cycloalkanes

1.2. How to Name Alkanes

3. Use the numbers obtained by application of rule 2 to designate the location of the substituent group.

The parent's name is placed last, and the substituent group, preceded by the number designating its location on the chain, is placed first. Numbers are separated from words by a hyphen (-).

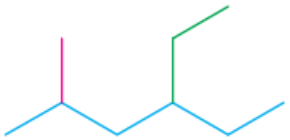




4. When two or more substituents are present, give each substituent a number corresponding to its location on the longest chain.

The substituent groups should be listed alphabetically (i.e., ethyl before methyl).

In deciding on alphabetical order, disregard multiplying prefixes such as "di" and "tri".



4-Ethyl-2-methylhexane

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1. Nomenclature of Alkanes and Cycloalkanes

1.2. How to Name Alkanes

5. When two substituents are present on the same carbon atom, use that number repeated twice.



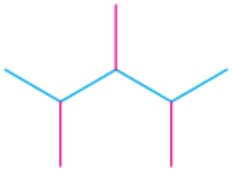
3-Ethyl-3-methylhexane

6. When two or more substituents are identical, indicate this by the use of the prefixes di-, tri-, tetra-, and so on.

Then, make sure that each substituent is assigned a number. Commas (,) are used to separate numbers from each other.



2,3-Dimthylbutane



2,3,4-Trimthylpentane



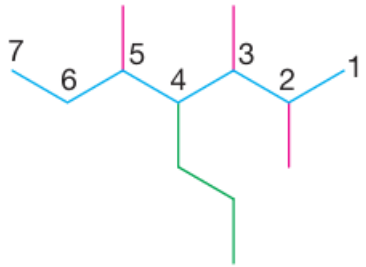
2,2,4,4-Tetramthylpentane

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1. Nomenclature of Alkanes and Cycloalkanes

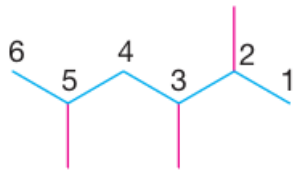
1.2. How to Name Alkanes

7. **When two chains of equal length compete for selection as the parent chain, choose the chain with the greater number of substituents.**



2,3,5-Trimthyl-4-propylheptane
(four substituent)

8. **When branching first occurs at an equal distance from either end of the longest chain, choose the name that gives the lower number at the first point of difference.**



2,3,5-Trimthylhexane
(*not* 2,4,5-Trimthylhexane)

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1. Nomenclature of Alkanes and Cycloalkanes

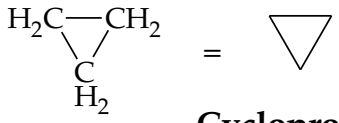
1.3. How to Name Monocyclic Cycloalkanes

- **Cycloalkanes are named by adding "*cyclo*" before the parent's name.**

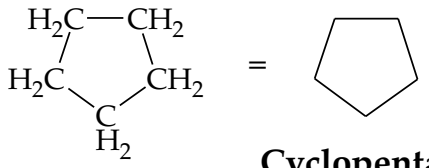
1. Cycloalkanes with one ring and no substituents:

Count the number of carbon atoms in the ring, then add "*cyclo*" to the beginning of the name of the alkane with that number of carbons.

Example; cyclopropane has three carbons and cyclopentane has five carbons.



Cyclopropane

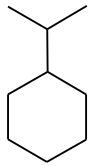


Cyclopentane

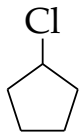
2. Cycloalkanes with one ring and one substituent:

Add the name of the substituent to the beginning of the parent's name.

For compounds with only one substituent, it is not necessary to specify a number (locant) for the carbon bearing the substituent.



Isopropylcyclohexane



Chlorocyclopentane

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1. Nomenclature of Alkanes and Cycloalkanes

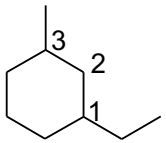
1.3. How to Name Monocyclic Cycloalkanes

3. Cycloalkanes with one ring and two or more substituents:

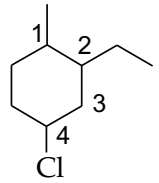
For a ring with two substituents, begin by numbering the carbons in the ring, starting at the carbon with the substituent that is first in the alphabet and number in the direction that gives the next substituent the lower number possible.

When there are three or more substituents, begin at the substituent that leads to the lowest set of numbers (locants).

The substituents are listed in alphabetical order, not according to the number of their carbon atom.

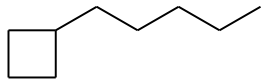


1-Ethyl-3-methylcyclohexane
(*not* 1-ethyl-5-methylcyclohexane)

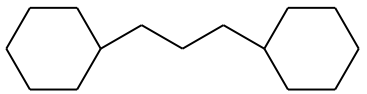


4-Chloro-2-ethyl-1-methylcyclohexane
(*not* 1-Chloro-3-ethyl-4-methylcyclohexane

4. When a single ring system is attached to a single chain with a greater number of carbon atoms, or when more than one ring system is attached to a single chain, then it is appropriate to name the compounds as cycloalkylalkanes.



1-Cyclobutylpentane



1,3-Dicyclohexylpropane

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2. Nomenclature of Alkenes and Cycloalkenes

2.1. How to Name Alkenes

- **The IUPAC rules for naming alkenes are similar in many respects to those for naming alkanes:**

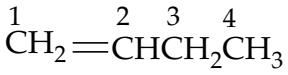
1. **Determine the parent's name by selecting the longest chain that contains the double bond and change the ending of the name of the alkane of identical length from *-ane* to *-ene*.**

IUPAC name	Ethene	Propene	2-Methylpropene
Common name	Ethylene	Propylene	Isobutylene

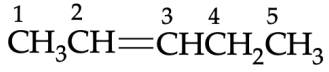
2. **Number the chain from the end nearest the double bond, ensuring that both double-bonded carbon atoms are included in the parent chain.**

   Designate the location of the double bond by using the number of the first atom of the double bond as a prefix. The locant for the alkene suffix may precede the parent's name or be placed immediately before the suffix.

3. **Indicate the locations of the substituent groups by the numbers of the carbon atoms to which they are attached.**



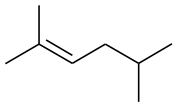
1-Butene
(*not* 3-butene)



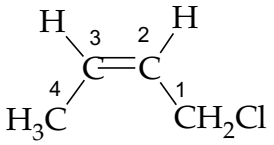
2-Pentene
(*not* 3-Pentene)



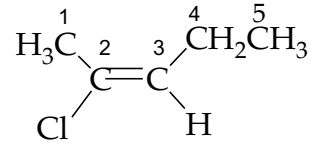
2-Methyl-2-butene
or 2-Methylbut-2-ene



2,5-Dimethyl-2-hexene
or 2,5-Dimethylhex-2-ene



***(Z)*-1-Chloro-2-butene**



***(E)*-2-Chloro-2-pentene**

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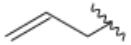
2. Nomenclature of Alkenes and Cycloalkenes

2.1. How to Name Alkenes

4. Two frequently encountered alkenyl groups are the vinyl group and the allyl group.

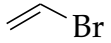


The vinyl group

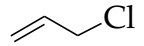


The allyl group

IUPAC name	Bromoethene	Ethenylcyclopropane	3-Chloropropene
Common name	Vinyl bromide	Vinylcyclopropane	Allyl chloride



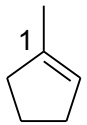




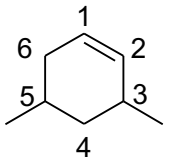
2.2. How to Name Cycloalkenes

Number substituted cycloalkenes in the way that gives the carbon atoms of the double bond the 1 and 2 positions and that also gives the substituent groups the lower numbers at the first point of difference.

With substituted cycloalkenes it is not necessary to specify the position of the double bond since it will always begin with C1 and C2.



1-Methylcyclopentene
(*not* 2-methylcyclopentene)



3,5-Dimethylcyclohexene
(*not* 4,6-Dimethylcyclohexene)

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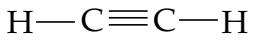
3. Nomenclature of Alkyne

3.1. How to Name Alkyne

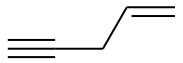
- **Alkynes are named in much the same way as alkenes.**
- **Alkynes, are named by replacing the *-ane* of the name of the corresponding alkane with the ending *-yne*.**

  The chain is numbered to give the carbon atoms of the triple bond the lower possible numbers. The lower number of the two carbon atoms of the triple bond is used to designate the location of the triple bond.
- **When double and triple bonds are present, the direction of numbering is chosen so as to give the lowest overall set of locants. In the face of equivalent options, then preference is given to assigning lowest numbers to the double bonds.**
- **The locations of substituent groups of branched alkynes and substituted alkynes are also indicated with numbers.**

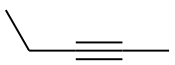
IUPAC name
Common name



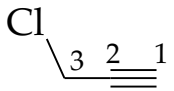
Ethyne
Acetylene



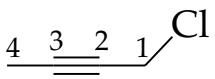
1-Penten-4-yne
or Pent-1-en-4-yne



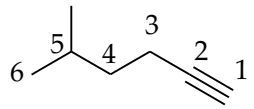
2-Pentyne



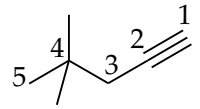
3-Chloropropyne



1-Chloro-2-but-yne
or 1-Chlorobut-2-yne



5-Methyl-1-hexyne
or 5-Methylhex-1-yne



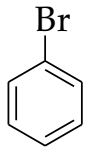
4,4-Dimethyl-1-pentyne
or 4,4-Dimethylpent-1-yne

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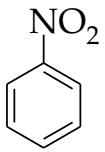
4. Nomenclature of Aromatic Compounds

4.1. How to Name Monosubstituted Benzene

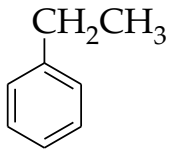
- **Benzene is the simplest aromatic compound, and the simple monosubstituted ring is named as derivative of benzene.**



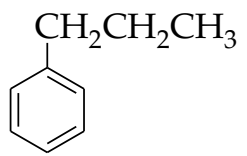
Bromobenzene



Nitrobenzene

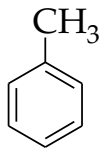


Ethylbenzene

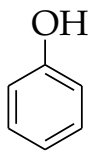


Propylbenzene

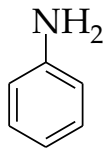
- **Common names are accepted by IUPAC as parent compounds.**



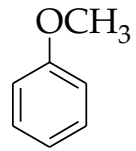
Toluene



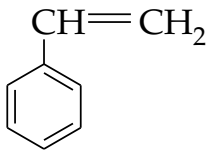
Phenol



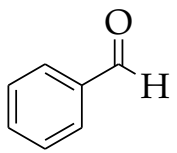
Aniline



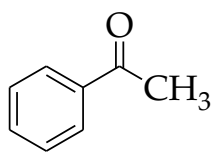
Anisole



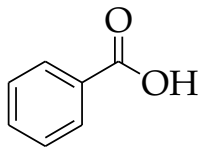
Styrene



Benzaldehyde



Acetophenone



Benzoic acid

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4. Nomenclature of Aromatic Compounds

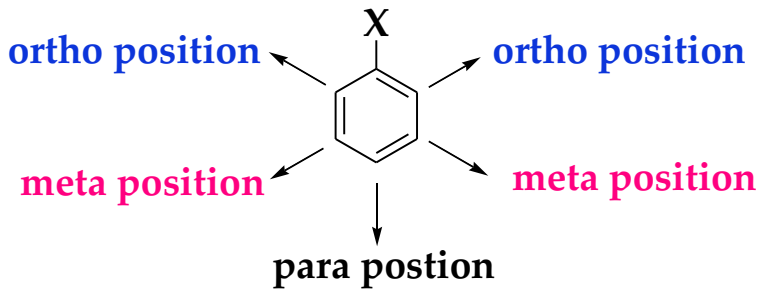
4.2. How to Name Disubstituted Benzene

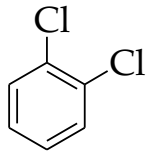
- When two substituents are present, their relative positions are indicated by the prefixes *ortho-*, *meta-*, and *para-* (abbreviated *o-*, *m-*, and *p-*) or using numbers.
- If substituent X is attached to carbon 1;

  o- groups are on carbons 2 and 6;

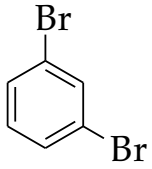
  m- groups are on carbons 3 and 5, and

  p- groups are on carbon 4.

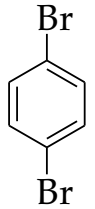




1,2-Dichlorobenzene
(*o*-Dichlorobenzene)



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



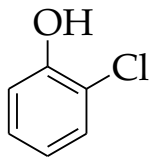
1,4-Dibromobenzene
(*p*-Dibromobenzene)

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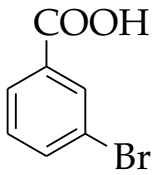
4. Nomenclature of Aromatic Compounds

4.2. How to Name Disubstituted Benzene

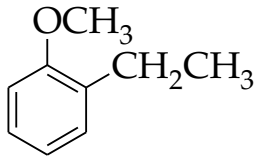
- **If a substituent have a special name, it could be used as the parent's name with the possible lowest number .**
- **Some disubstituted benzene derivatives have a common names.**



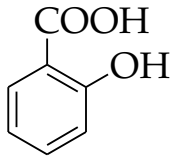
2-Chlorophenol
(*o*-Chlorophenol)



3-Bromobenzoic acid
(*m*-Bromobenzoic acid)

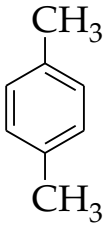


2-Ethylanisole
(*o*-Ethylanisole)



IUPAC name
Common name

2-Hydroxybenzoic acid
Salicylic acid



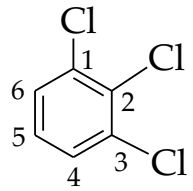
1,4-Dimethylbenzene

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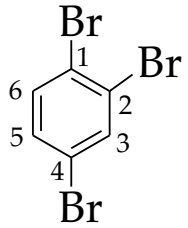
4. Nomenclature of Aromatic Compounds

4.3. How to Name Polysubstituted Benzene

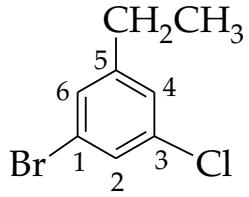
- **If more than two groups are present on the benzene ring, their positions must be indicated using numbers only.**
- **The benzene ring is numbered so as to give the lowest possible numbers to the substituents.**



1,2,3-Trichlorobenzene

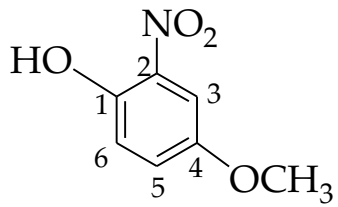


1,2,4-Tribromobenzene

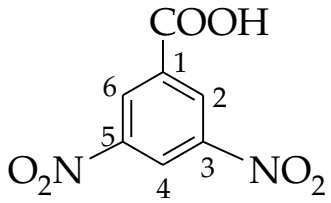


1-Bromo-3-chloro-5 ethylbenzene

- **When a substituent is one that together with the benzene ring gives a new base name, that substituent is assumed to be in position 1 and the new parent's name is used.**



4-Methoxy-2-nitro-phenol



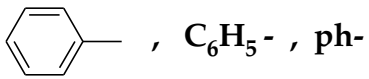
3,5-Dinitrobenzoic acid

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4. Nomenclature of Aromatic Compounds

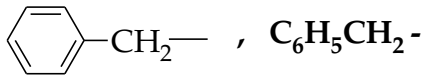
4.4. How to Name Aryl Groups

- When the C_6H_5– group is named as a substituent, it is called a phenyl group (Ph–).
- Benzyl group ($C_6H_5CH_2$-) is an alternative name for the phenylmethyl group.



, C_6H_5- , ph-

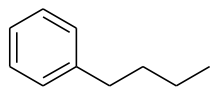
Phenyl group



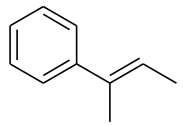
, $C_6H_5CH_2$-

Benzyl group

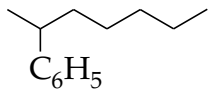
- A hydrocarbon composed of one saturated chain and one benzene ring is usually named as a derivative of the larger structural unit.



Butylbenzene

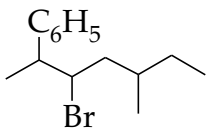


(*E*)-2-Phenyl-2-butene

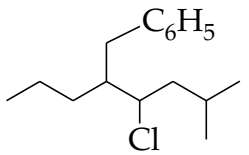


2-Phenylheptane

- If the chain is unsaturated, the compound may be named as a derivative of that chain, regardless of ring size.



3-Bromo-5-methyl-2-phenylheptane



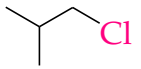
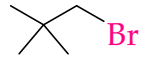
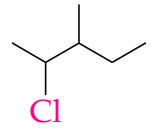
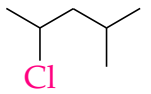
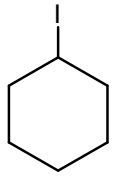
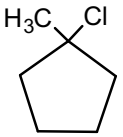
5-Benzyl-4-chloro-2-methyloctane

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5. Nomenclature of Halogen Compounds

5.1. How to Name Alkyl and Cycloalkyl Halides

- Alkanes bearing halogen substituents are named in the IUPAC substitutive system as haloalkanes.
- Common nomenclature system, called functional class nomenclature, haloalkanes are named as alkyl halides.
- When the parent chain has both a halo and an alkyl substituent attached to it, number the chain from the end nearer the first substituent, regardless of whether it is halo or alkyl.
- If two substituents are at equal distance from the end of the chain, then number the chain from the end nearer the substituent that has alphabetical precedence.
- Cycloalkyl halides are organic halides in which a halogen atom is attached directly to a carbon atom of a cycloalkane ring.

	CH_3CH_2Cl	$CH_3CH_2CH_2F$	$CH_3CHBrCH_3$
IUPAC name Common name	Chloroethane Ethyl chloride	1-Fluoropropane Propyl fluoride	2-Bromopropane Isopropyl bromide
			
IUPAC name Common name	1-Chloro-2-methylpropane Isobutyl chloride	2-Bromo-2-methylpropane *tert*-Butyl bromide	
			
IUPAC name Common name	1-Bromo-2,2-dimethyl-propane Neopentyl bromide		
			
IUPAC name	2-Chloro-3-methylpentane	2-Chloro-4-methylpentane	
			
Common name IUPAC name	Cyclohexyl iodide Iodocyclohexane	Methylcyclopentyl chloride 1-Chloro-1-methylcyclopentane	

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5. Nomenclature of Halogen Compounds

5.2. How to Name Vinylic halides

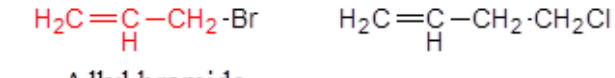
- **Vinylic halides** are organic halides in which a halogen atom is attached directly to a carbon atom of a C=C double bond.



Vinyl chloride — 1-Chlorocycolbutene

5.3. How to Name Allylic halides

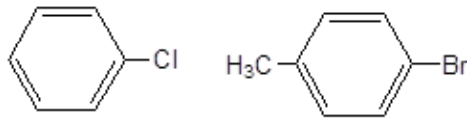
- **Allylic halides** are organic halides in which a halogen atom is attached to a carbon atom adjacent to a C=C double bond.



Common name	Allyl bromide		
IUPAC name	3-Bromo-1-propene	4-Chloro-1-butene	3-Chlorocyclopentene

5.4. How to Name Aryl halides

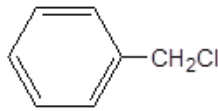
- **Aryl halides (Ar–X)** are organic halides in which a halogen atom is attached directly to a carbon atom of an aromatic ring.



Chlorobenzene — *p*-Bromotoulene

5.5. How to Name Benzylic halides

- **Benzylic halides (Ar–C–X)** are organic halides in which a halogen atom is attached to a carbon atom adjacent to an aromatic ring.



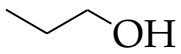
Benzyl chloride

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6. Nomenclature of Alcohols, Phenols and Thiols

6.1. How to Name Alcohols

- The common names for the simplest alcohols consist of alkyl group attached to the hydroxyl function followed by the word alcohol: Alkyl alcohol .
- In the IUPAC system, the following procedure should be followed:
  1. Select the longest continuous carbon chain to which the hydroxyl is directly attached. Change the name of the alkane corresponding to this chain by dropping the final –e and adding the suffix –ol: Alkanol.

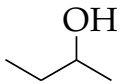
	CH_3OH	CH_3CH_2OH	
IUPAC name	Methanol	Ethanol	1-propanol
Common name	Methyl alcohol	Ethyl alcohol	Propyl alcohol

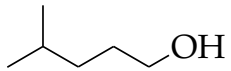
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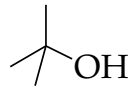
6. Nomenclature of Alcohols, Phenols and Thiols

6.1. How to Name Alcohols

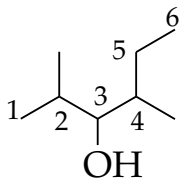
2. Number the longest continuous carbon chain so as to give the carbon atom bearing the hydroxyl group the lower number.



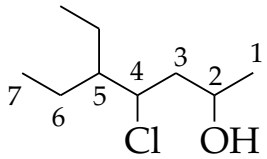




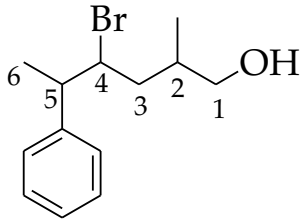
IUPAC name	**2-Butanol**	**4-Methyl-1-pentanol**	**2-Methyl-2-propanol**
Common name	**sec-Butyl alcohol**	**Isohexyl alcohol**	**tert-Butyl alcohol**



2,4-Dimethyl-3-hexanol
or 2,4-Dimethylhexan-3-ol



4-Chloro-5-ethyl-2-heptanol
or 4-Chloro-5-ethylheptan-2-ol



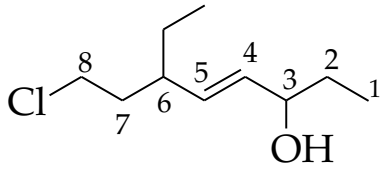
4-Bromo-2-methyl-5-phenyl-1-hexanol
or 4-Bromo-2-methyl-5-phenylhexan-1-ol

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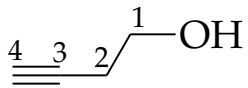
6. Nomenclature of Alcohols, Phenols and Thiols

6.1. How to Name Alcohols

3. The hydroxyl group has precedence over double bonds and triple bonds in deciding which functional group to name as the suffix.

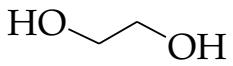
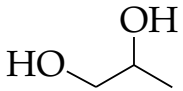
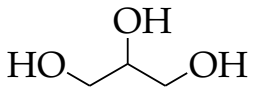


8-Chloro-6-ethyl-4-octen-3-ol
or 8-Chloro-6-ethyloct-4-en-3-ol



3-Butyn-1-ol
or But-3-yn-1-ol

4. If more than one hydroxyl group is present, use the prefix diol (commonly called glycol) , triol (commonly called glycerol) , etc.

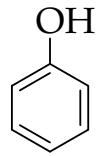
			
IUPAC name	**1,2-Ethanediol** **or Ethane-1,2-diol**	**1,2-Propanediol** **or Propane-1,2-diol**	**1,2,3-Propanetriol** **or Propane-1,2,3-triol**
Common name	**Ethylene glycol**	**Propylene glycol**	**glycerol**

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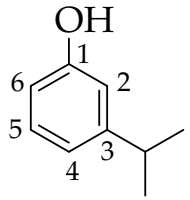
6. Nomenclature of Alcohols, Phenols and Thiols

6.2. How to Name Phenols

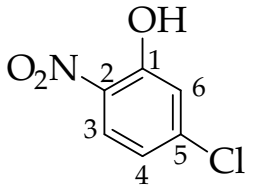
- **Phenols are usually named as derivatives of the parent compounds; phenol itself could be named as hydroxybenzene.**



Phenol

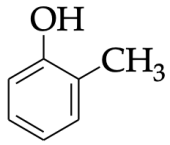


3-Isopropylphenol

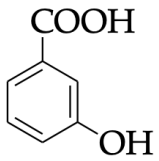


5-Chloro-2-nitrophenol

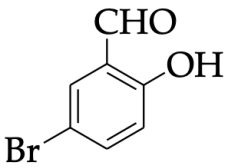
- **The hydroxyl group is named as a substituent when it occurs in the same molecule with carboxylic acid, aldehyde, or ketone functionalities, which have priority in naming.**



2-Methylphenol



3-Hydroxybenzoic acid



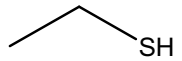
5-Bromo-2-hydroxybenzaldehyde

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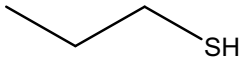
6. Nomenclature of Alcohols, Phenols and Thiols

6.3. How to Name Thiols

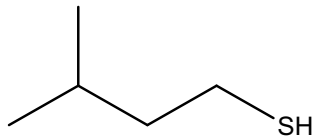
- The sulfur analog of an alcohol is called a thiol, in which the hydroxyl group (–OH) is replaced by a sulfhydryl group (–SH). Thiols are also commonly known as mercaptans.
- The common names for simple thiols consist of the alkyl group attached to the sulfhydryl group followed by the word mercaptan: Alkyl mercaptan.
- In the IUPAC system, thiols are named using the same general rules as alcohols, but the suffix –thiol is used instead of –ol. The following procedure should be followed:
  1. Select the longest continuous carbon chain containing the carbon atom bonded to the sulfhydryl group (–SH). Name the corresponding alkane and replace the ending with the suffix –thiol: Alkanethiol.
  2. Number the longest continuous carbon chain to give the carbon atom bearing the sulfhydryl group the lower number.
  3. When both a sulfhydryl group (–SH) and a double bond are present, the chain is numbered to give the –SH group the lowest possible number. The position of the double bond is then indicated in the name.



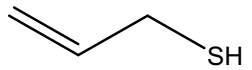
Ethanethiol



Propane-1-thiol



3-Methylbutane-1-thiol



Prop-2-ene-1-thiol

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7. Nomenclature of Ethers and Epoxides

7.1. How to Name Ethers

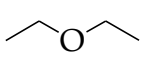
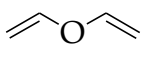
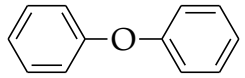
- **Common names, simple ethers are frequently given common functional class names.**

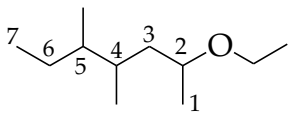
  One simply lists (in alphabetical order) both groups that are attached to the oxygen atom and adds the word, Ether.

- **In the IUPAC style, ethers are named as alkoxyalkanes. The –OR group is an alkoxy group.**

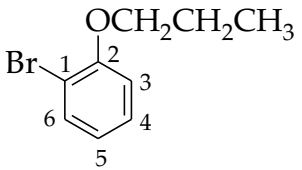
  Choose the longest chain as the parent alkane and then name as usual.

	$H_3C-O-CH_3$	$H_3C-O-CH_2CH_3$	$(H_3C)_3C-O-CH_3$
IUPAC name	Methoxymethane	Methoxy-ethane	2-Methoxy-2-methylpropane
Common name	Dimethyl ether	Ethyl methyl ether	*tert*-Butyl methyl ether

			
IUPAC name	Ethoxyethane	Vinyloxy-ethene	Phenoxybenzene
Common name	Diethyl ether	Divinyl ether	Diphenyl ether



2-Ethoxy-4,5-dimethylheptane



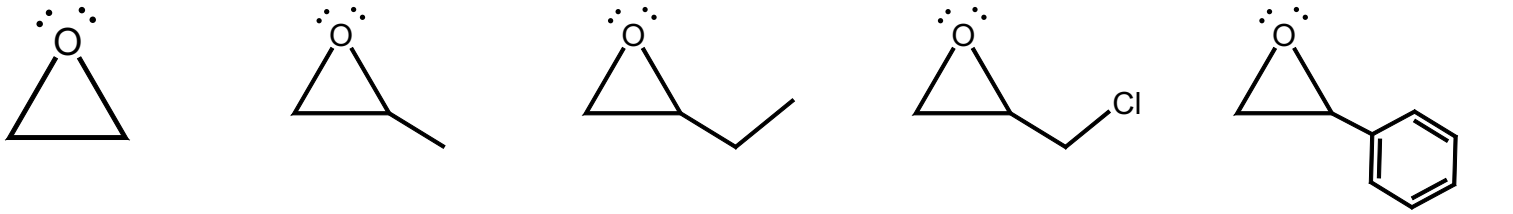
1-Bromo-2-propoxybenzene

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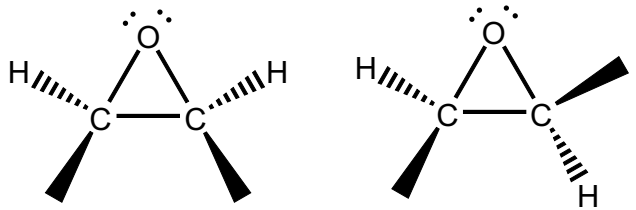
7. Nomenclature of Ethers and Epoxides

7.2. How to Name Epoxides

- **Common names, epoxides are commonly named as alkene oxides, using the name of the corresponding alkene followed by the word oxide.** Common name = Alkene name + oxide
- **In the IUPAC system, epoxides are named as oxiranes. The oxygen atom is assigned position 1, and the two carbon atoms are numbered 2 and 3.** IUPAC name = Oxirane system
- **Substituents attached to the oxirane ring are named as prefixes and numbered to give the lowest possible numbers.**
- **For disubstituted oxiranes, *cis* and *trans* may be used to indicate the relative positions of the substituents.**



IUPAC name Common name	Oxirane Ethylene oxide	2-methyloxirane Propylene oxide	2-ethyloxirane Butylene oxide	2-(chloromethyl)oxirane	2-phenyloxirane



IUPAC name	*cis*-2,3-Dimethyloxirane	*Trans*-2,3-Dimethyloxirane

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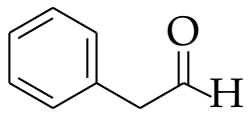
8. Nomenclature of Aldehydes and Ketones

8.1. How to Name Aldehydes

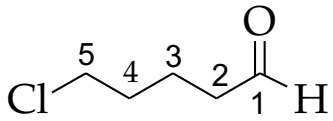
- **The common names are derived from the common names for the corresponding carboxylic acids.**
- **In the IUPAC System, Aliphatic aldehydes are named substitutively by replacing the final -e of the name of the corresponding alkane with –al, Alkanal.**
- **Since the aldehyde group must be at the end of the carbon chain, there is no need to indicate its position.**
- **When other substituents are present, the carbonyl group carbon is assigned position 1.**

Carbon atoms	Formula	Common name	IUPAC name
1	HCHO	Formaldehyde	Methanal
2	CH_3CHO	Acetaldehyde	Ethanal
3	CH_3CH_2CHO	Propionaldehyde	Propanal
4	$CH_3(CH_2)_2CHO$	Butyraldehyde	Butanal
5	$CH_3(CH_2)_3CHO$	Valeraldehyde	Pentanal

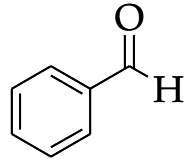
- **Aromatic aldehydes are usually named as derivatives of the parent compound benzaldehyde.**



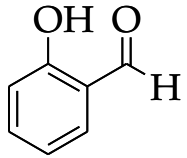
2-Phenylethanal



5-Chloropentanal



Benzaldehyde



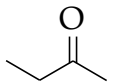
2-Hydroxybenzaldehyde

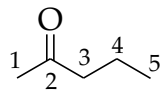
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8. Nomenclature of Aldehydes and Ketones

8.2. How to Name Ketones

- Common functional group names for ketones are obtained simply by separately naming the two groups attached to the carbonyl group and adding the word ketone as a separate word, Alkyl ketone.
- In the IUPAC System, Aliphatic ketones are named substitutively by replacing the final -e of the name of the corresponding alkane with –one, Alkanone.
- The chain is then numbered in the way that gives the carbonyl carbon atom the lower possible number, and this number is used to designate its position.



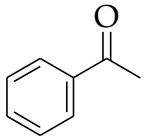


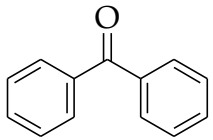
IUPAC name
Common name

2-Butanone
Ethyl methyl ketone

2-Pentanone
Methyl propyl ketone







IUPAC name
Common name

2-Propanone
Acetone

1-Phenylethanone
Acetophenone

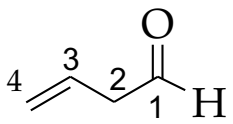
Diphenylmethanone
Diphenyl ketone

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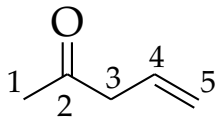
8. Nomenclature of Aldehydes and Ketones

8.3. How to Name Aldehydes and Ketones with Unsaturated Bonds and Aryl Groups

- **The carbonyl group has precedence over double bonds and triple bonds in deciding which functional group to name as the suffix.**

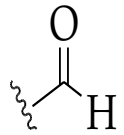


3-Butenal

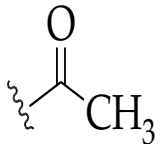


4-Penten-2-one
(*not* 1-penten-4-one)

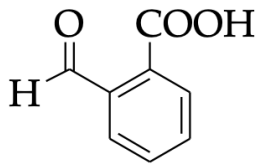
- **When it is necessary to name (-CHO and CH_3CO-) as a prefix, it is called the formyl group and acetyl group, respectively.**



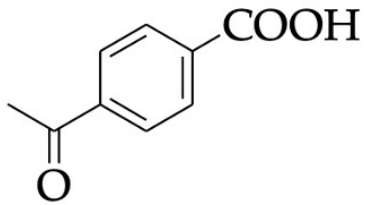
formyl group



acetyl group



2-Formylbenzoic acid



4-Acetylbenzoic acid

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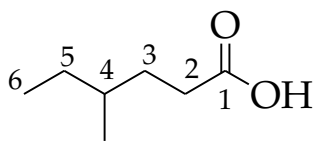
9. Nomenclature of Carboxylic acid and Their Derivatives

9.1. How to Name Carboxylic Acids

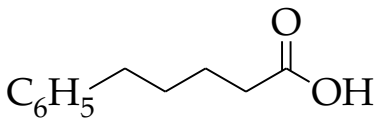
- Many carboxylic acids have common names that are derived from Latin or Greek words that indicate one of their natural sources.

Carbon atoms	Formula	Source	Common name	IUPAC name
1	HCOOH	formica, Latin: ant	Formic acid	Methanoic acid
2	CH_3COOH	acetum, Latin: vinegar	Acetic acid	Ethanoic acid
3	CH_3CH_2COOH	Milk, Greek: protos pion, first fat	Propionic acid	Propanoic acid
4	$CH_3(CH_2)_2COOH$	butyrum, Latin: butter	Butyric acid	Butanoic acid
5	$CH_3(CH_2)_3COOH$	valerian, a perennial herb	Valeric acid	Pentanoic acid

- In the IUPAC System, carboxylic acids are named by dropping the final -e of the name of the alkane corresponding to the longest chain in the acid and by adding -oic acid, alkanoic acids. The carboxyl carbon atom is assigned number 1.



4-Methylhexanoic acid



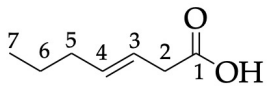
5-Phenylpentanoic acid

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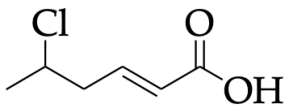
9. Nomenclature of Carboxylic acid and Their Derivatives

9.1. How to Name Carboxylic Acids

- The carboxyl group has precedence over double bonds and triple bonds in deciding which functional group to name as the suffix.



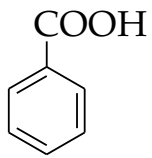
3-Heptenoic acid
or Hept-3-enoic acid



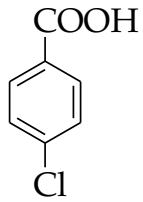
5-Chloro-2-hexenoic acid
or 5-Chlorohex-2-enoic acid

9.2. How to Name Aromatic Acids

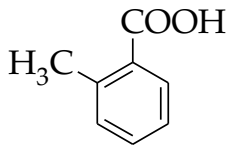
- Aromatic acids are named by attaching the suffix -oic acid to an appropriate prefix derived from the aromatic hydrocarbon.



Benzoic acid



4-Chlorobenzoic acid



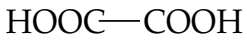
2-Methylbenzoic acid

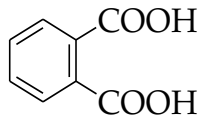
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9. Nomenclature of Carboxylic acid and Their Derivatives

9.3. How to Name Dicarboxylic Acids

- **Dicarboxylic acids are named as alkanedioic acids in the IUPAC systematic or substitutive system.**
- **Most simple dicarboxylic acids have common names.**

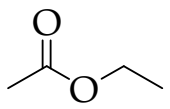




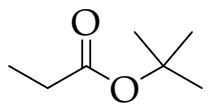
IUPAC name	Ethanedioic acid	1,2-Benzenedicarboxylic acid
Common name	Oxalic acid	Phthalic acid

8.4. How to Name Esters

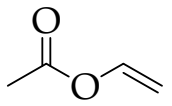
- **The names of esters are derived from the names of the alcohol (with the ending -yl) and the acid (with the ending -ate or -oate).**
- **The portion of the name derived from the alcohol comes first.**



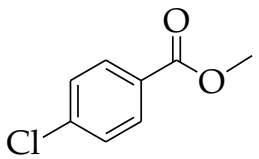
Ethyl ethanoate



***tert*-Butyl propanoate**



Vinyl ethanoate



Methyl *p*-chlorobenzoate

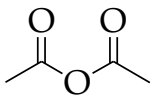
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9. Nomenclature of Carboxylic acid and Their Derivatives

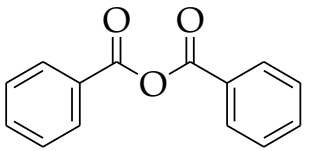
9.5. How to Name Carboxylic Anhydrides

- **Most anhydrides are named by dropping the word acid from the name of the carboxylic acid and then adding the word anhydride.**

IUPAC name
Common name

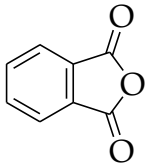


Ethanoic anhydride
Acetic anhydride

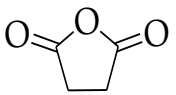


Benzoic anhydride

IUPAC name
Common name



1,2-Benzenedicarboxylic anhydride
Phthalic anhydride



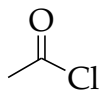
Butanedioic anhydride

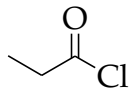
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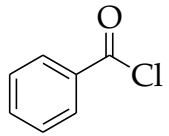
9. Nomenclature of Carboxylic acid and Their Derivatives

9.6. How to Name Acyl Chlorides

- **Acyl chlorides are also called acid chlorides. They are named by dropping -ic acid from the name of the acid and then adding -yl chloride.**



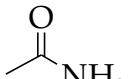


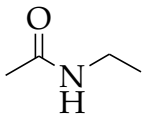


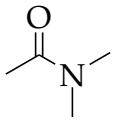
IUPAC name	Ethanoyl chloride	Propanoyl chloride	Benzoyl chloride
Common name	Acetyl chloride		

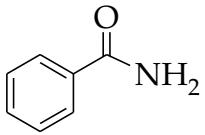
9.7. How to Name Amides

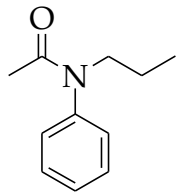
- **Amides that have no substituent on nitrogen are named by dropping -oic acid from the name and then adding -amide.**
- **Alkyl groups on the nitrogen atom of amides are named as substituents, and the named substituent is prefaced by *N*- or *N,N*-.**











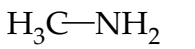
IUPAC name	Ethanamide	*N*-Ethylethanamide	*N,N*-Dimethylethanamide	Benzamide	*N*-Phenyl-*N*-propylethanamide
Common name	Acetamide				

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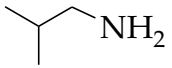
10. Nomenclature of Amines

10.1. How to Name Amines

- **In common nomenclature, most primary amines are named as alkylamines.**
- **In systematic nomenclature, they are named by adding the suffix -amine to the name of the chain or ring system to which the NH_2 group is attached, with replacement of the final -e.**



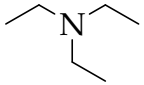




IUPAC name: **Methanamine** | **Ethanamine** | **2-Methyl-1-propanamine**
Common name: **Methylamine** | **Ethylamine** | **Isobutylamine**





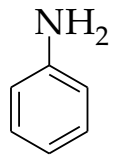


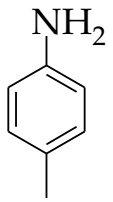


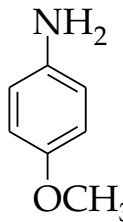
IUPAC name: ***N*-Methylethanamine** | ***N*-Ethylethanamine** | **N,N-Diethylethanamine** | ***N*-Ethyl-*N*-methyl-1-propanamine**
Common name: **Ethylmethylamine** | **Diethylamine** | **Triethylamine** | **Ethylmethylpropylamine**

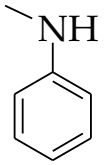
10.2. How to Aromatic Amines

- **Aromatic amines are usually named as derivatives of the parent compound aniline.**







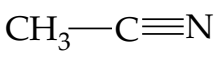


Aniline | **4-Methylaniline** | **4-Methoxyaniline** | ***N*-Methylaniline**

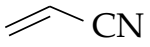
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11. Nomenclature of Nitriles

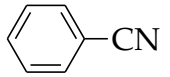
- In IUPAC substitutive nomenclature, acyclic nitriles are named by adding the suffix -nitrile to the name of the corresponding hydrocarbon, Alkanenitrile.
- The carbon atom of the –C≡N group is assigned number 1.



Ethanenitrile



Prop-2-enenitrile



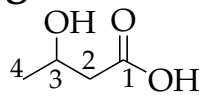
Benzonitrile

12. Priority of Functional Groups in IUPAC Nomenclature

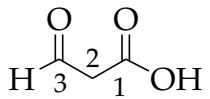
- The functional group priority order in nomenclature system is as following:

Increasing priority

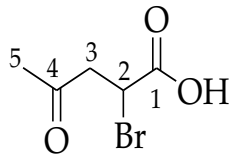
Class	Suffix name	Prefix name
Carboxylic acid	-oic acid	-
Ester	-oate	Alkoxycarbonyl
Amide	-amide	Amido
Aldehyde	-al	Oxo
Ketone	-one	Oxo
Alcohol	-ol	Hydroxy
Amine	-amine	Amino
Alkene	-ene	Alkenyl
Alkyne	-yne	Alkynyl
Alkane	-ane	Alkyl
Ether	-	Alkoxyl



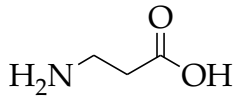
3-Hydroxybutanoic acid



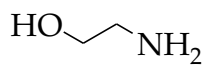
3-Oxopropanoic acid



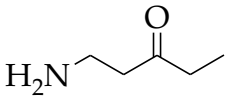
2-Bromo-4-oxopentanoic acid



3-Aminopropanoic acid



2-Aminoethanol

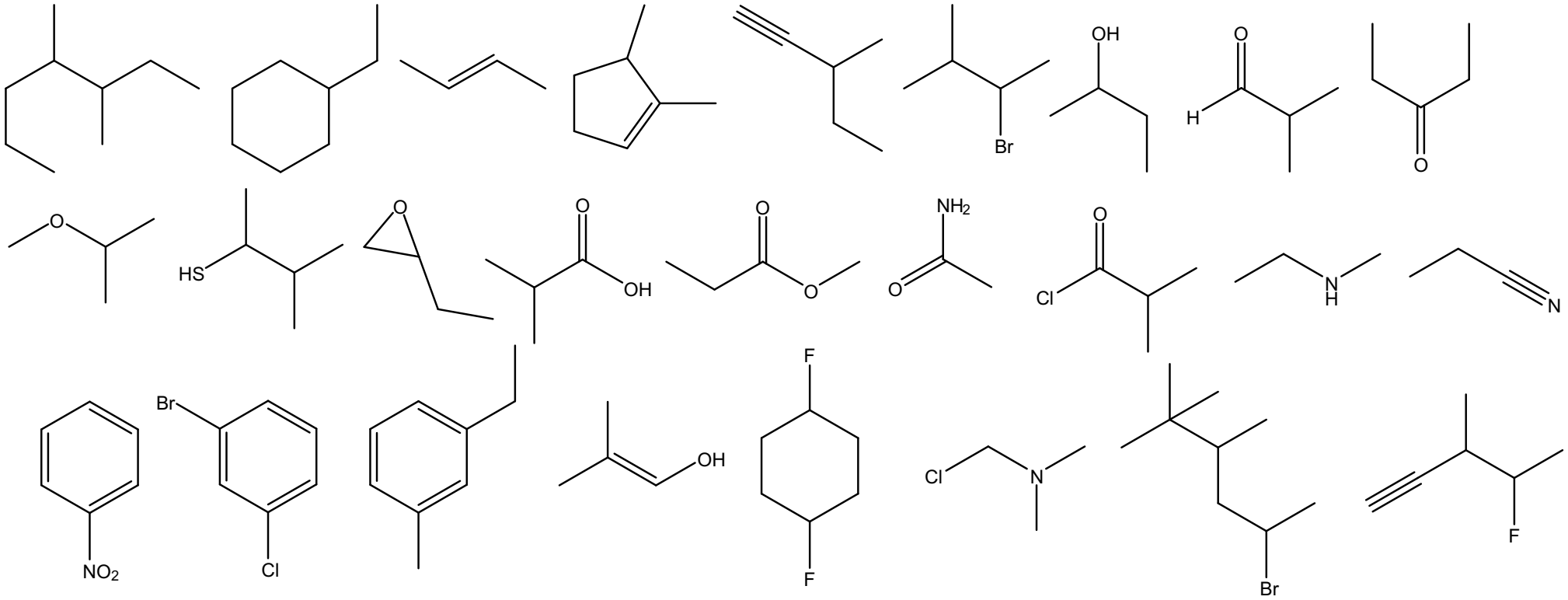


1-Amino-3-pentanone

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11. Practice Problems

1) Give the IUPAC name of each of the following compounds



2) Give the common name of each of the following compounds

