Introduction to Organic Chemistry
CHEM 109

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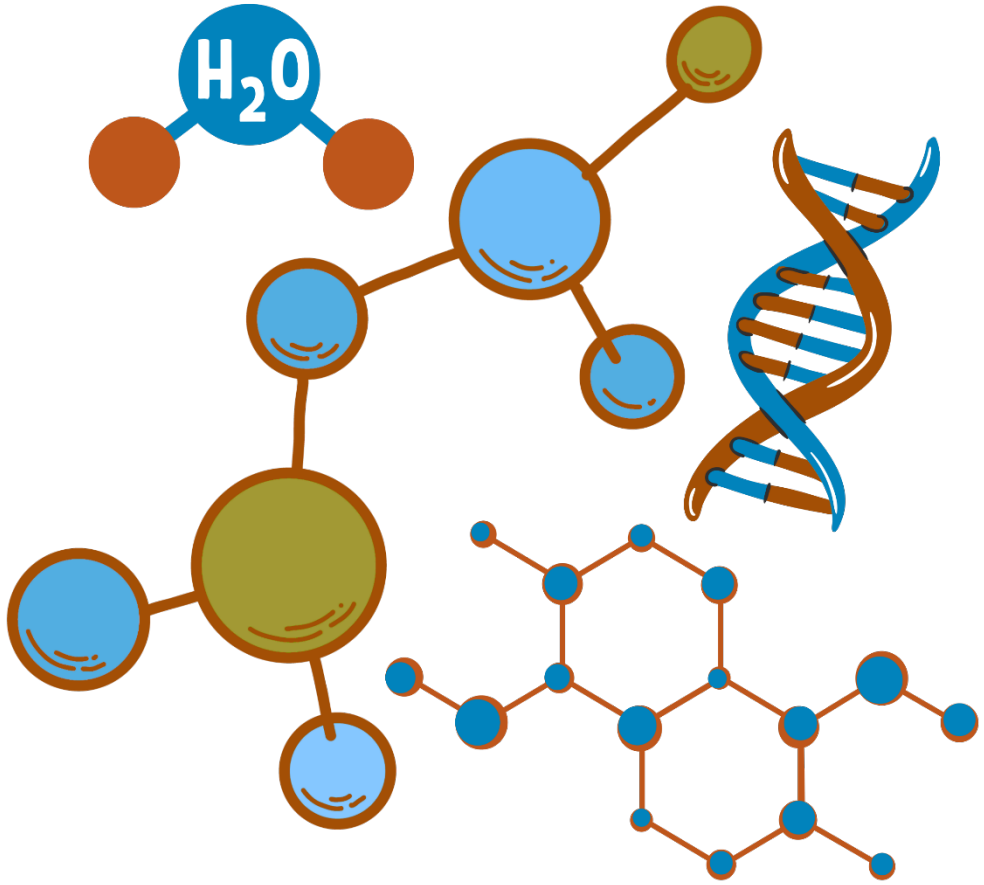

Chapter 3: Nomenclature of Organic Compounds

Chapter 3: Nomenclature of Organic Compounds

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1. How to Name Alkanes and Alkyl halides: the IUPAC system

- Chemists use a systematic nomenclature developed and updated by the International Union of Pure and Applied Chemistry (IUPAC).
- Underlying the IUPAC system is a fundamental principle: each different compound should have a different and unambiguous name.
- The names for several of the 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. Learning the stems is like learning to count in organic chemistry. 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. How to Name Alkanes and Alkyl halides: the IUPAC system

1.1 How To Name Unbranched 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

$CH_3—H$

Methane

$CH_3—$

Methyl

Me-

$CH_3CH_2—H$

Ethane

$CH_3CH_2—$

Ethyl

Et-

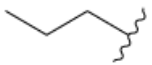
$CH_3CH_2CH_2—H$

Propane

$CH_3CH_2CH_2—$

Propyl

Pr-



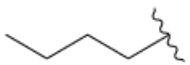
$CH_3CH_2CH_2CH_2—H$

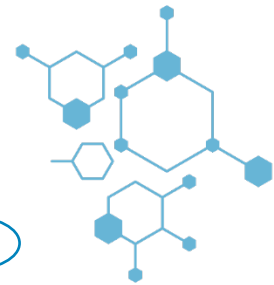
Butane

$CH_3CH_2CH_2CH_2—$

Butyl

Bu-





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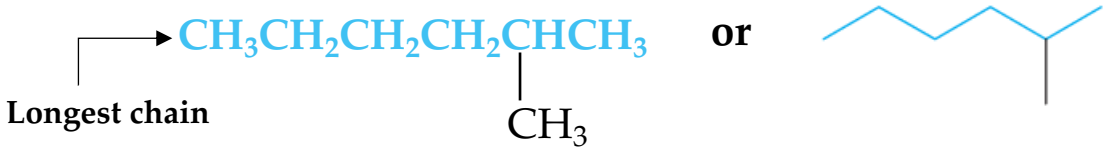
1. How to Name Alkanes and Alkyl halides: the IUPAC system

1.2 How To Name Branched-Chain 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 name for the alkane.**

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



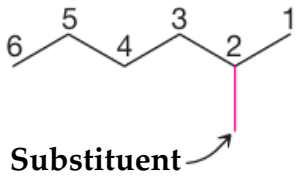
Hexane

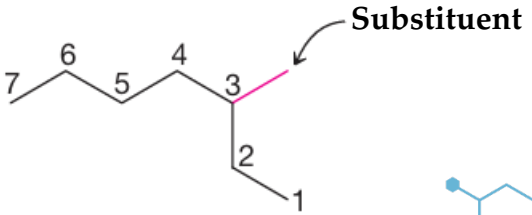
Because the longest continuous chain contains six carbon atoms

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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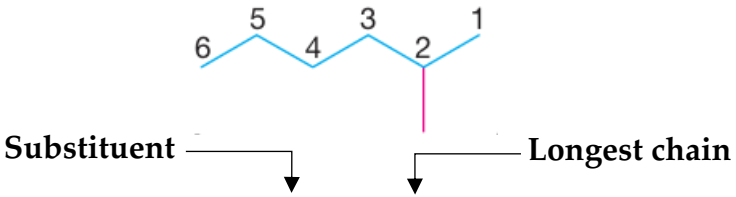
1.2 How To Name Branched-Chain Alkanes

3. Use the numbers obtained by application of rule 2 to designate the location of the substituent group. The parent 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 i.e: - .

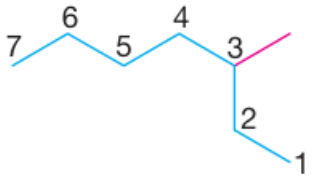
4. When two or more substituents are present, give each substituent a number corresponding to its location on the longest chain.

   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".

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



2-Methylhexane



3-Methylheptane

4-Ethyl-2-methylhexane

3-Ethyl-3-methylhexane

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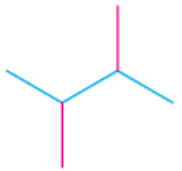
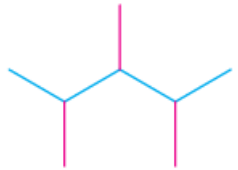
1. How to Name Alkanes and Alkyl halides: the IUPAC system

1.2 How To Name Branched-Chain Alkanes

6. **When two or more substituents are identical, indicate this by the use of the prefixes di-, tri-, tetra-, and so on. Then make certain that each and every substituent has a number. Commas are used to separate numbers from each other.**



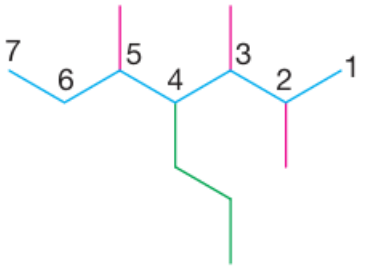
2,3-Dimthylbutane



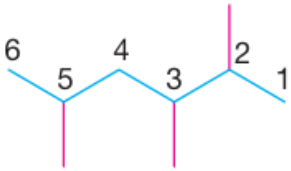
2,3,4-Trimthylpentane

2,2,4,4-Tetramthylpentane

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)



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

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.**

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1. How to Name Alkanes and Alkyl halides: the IUPAC system

1.3 How To Name Branched Alkyl Groups

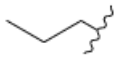
- For alkanes with more than two carbon atoms, more than one derived group is possible.
- Two groups can be derived from propane, for example; the propyl group is derived by removal of a terminal hydrogen, and the 1-methylethyl (systematic name) isopropyl (common name) is derived by removal of a hydrogen from the central carbon.

- 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.

Three-Carbon Groups

$CH_3CH_2CH_3$
Propane

$CH_3CH_2CH_2—$
Propyl (or Pr)

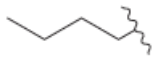


CH_3CHCH_3
|
Isopropyl (or i-Pr)

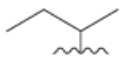
Four-Carbon Groups

$CH_3CH_2CH_2CH_3$
Butane

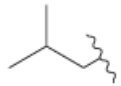
$CH_3CH_2CH_2CH_2—$
Butyl (or Bu)



$CH_3CH_2CHCH_3$
|
sec-Butyl



CH_3
|
$CH_3CH_2CH_2—$
Isobutyl



$(CH_3)_3C—$
tert-Butyl (or *t*-Bu)

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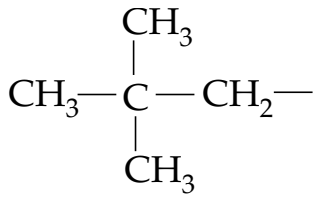
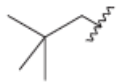
1. How to Name Alkanes and Alkyl halides: the IUPAC system

1.3 How To Name Branched Alkyl Groups

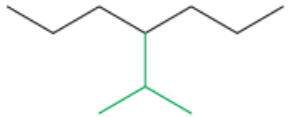
- There is one five-carbon group with an IUPAC approved common name that you should also know: the 2,2-dimethylpropyl group, commonly called the neopentyl group.



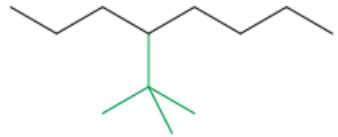
Neopentyl or 2,2-dimethypropyl



- The following examples show how the names of these groups are employed.



4-isopropylheptane
or
4-(1-Methylethyl)heptane



4-tert-butyloctane
or
4-(1,1-Dimethylethyl)octane

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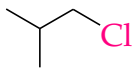
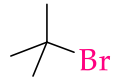
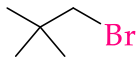
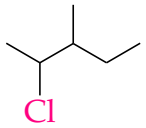
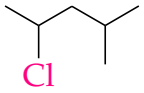
1. How to Name Alkanes and Alkyl halides: the IUPAC system

1.4 How To Name Alkyl 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.

IUPAC name Common name	CH_3CH_2Cl Chloroethane Ethyl chloride	$CH_3CH_2CH_2F$ 1-Fluoropropane Propyl fluoride	$CH_3CHBrCH_3$ 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	

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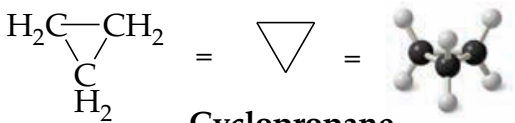
2. How to Name Cycloalkanes

2.1 How to Name Monocyclic Cycloalkanes

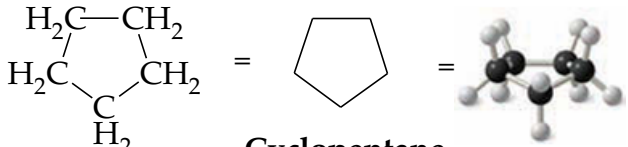
- **Cycloalkanes are named by adding "cyclo" before the parent name.**

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. For example, cyclopropane has three carbons and cyclopentane has five carbons.



Cyclopropane

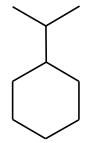


Cyclopentane

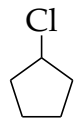
2. Cycloalkanes with one ring and one substituent:

Add the name of the substituent to the beginning of the parent 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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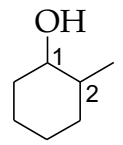
2. How to Name Cycloalkanes

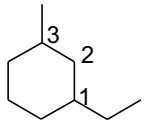
2.1 How to Name Monocyclic Cycloalkanes

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

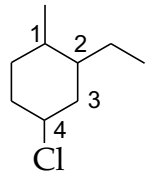
For a ring with two substituents, begin by numbering the carbons in the ring, starting at the carbon with the substituent that is first in the alphabet and number in the direction that gives the next substituent the lower number possible. When there are three or more substituents, begin at the substituent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



2-Methylcyclohexanol

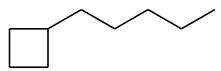


1-Ethyl-3-methylcyclohexane
(*not*1-ethyl-5-methylcyclohexane)

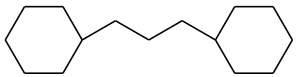


4-Chloro-2-ethyl-1-methylcyclohexane
(*not* 1-Chloro-3-ethyl-4-methylcyclohexane

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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3. How to Name Alkenes and Cyclohexenes

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

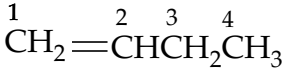
1. Determine the parent name by selecting the longest chain that contains the double bond and change the ending of the name of the alkane of identical length from -ane to -ene.
2. Number the chain so as to include both carbon atoms of the double bond, and begin numbering at the end of the chain nearer the double bond. Designate the location of the double bond by using the number of the first atom 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 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.

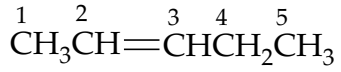
IUPAC name
Common name

Ethene
Ethylene

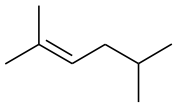

Propene
Propylene

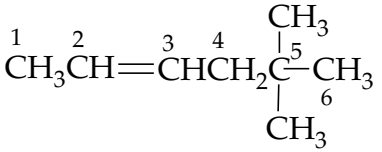

2-Methylpropene
Isobutylene

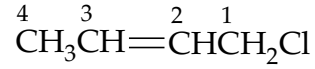

1-Butene
(*not* 3-butene)


2-Hexene
(*not* 4-hexene)


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


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


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


1-Chloro-2-butene
or 1-Chlorobut-2-ene

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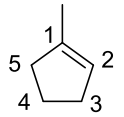
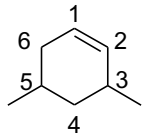
3. How to Name Alkenes and Cyclohexenes

4. 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.

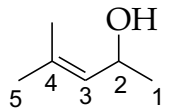
5. Name compounds containing a double bond and an alcohol group as alkenols (or cycloalkenols) and give the alcohol carbon the lower number.



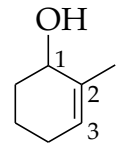
1-Methylcyclopentene
(*not* 2-methylcyclopentene)



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



4-Methyl-3-penten-2-ol
or 4-Methyl-pent-3-en-2-ol



2-Methyl-2-cyclohexen-1-ol
or 2-Methylcyclohex-2-en-1-ol

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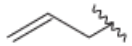
3.How to Name Alkenes and Cyclohexenes

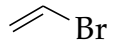
6. Two frequently encountered alkenyl groups are the vinyl group and the allyl group.

- Using substitutive nomenclature, the vinyl and allyl groups are called ethenyl and prop-2-en-1-yl, respectively.

The vinyl group

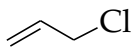


The allyl group

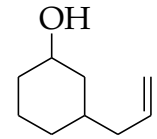


IUPAC name: Bromoethene
Common name: Vinyl bromide

IUPAC name: Ethenylcyclopropane
Common name: Vinylcyclopropane

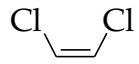


IUPAC name: 3-Chloropropene
Common name: Allyl chloride

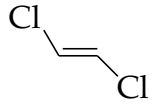


IUPAC name: 3-(Prop-2-en-1-yl)cyclohexan-1-ol
Common name: 3-Allylcyclohexanol

7. If two identical or substantial groups are on the same side of the double bond, the compound can be designated *cis* ; if they are on opposite sides it can be designated *trans*.



cis-1,2-Dichloroethene



trans-1,2-Dichloroethene

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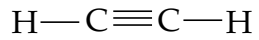
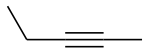
4. How to Name Alkyne

- **Alkynes are named in much the same way as alkenes.**
- **Unbranched alkynes, for example, 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.**
- **An –OH group has priority over the triple bond when numbering the chain of an alkynol.**

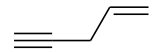
IUPAC name
Common name



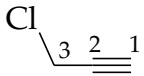
Ethyne
Acetylene



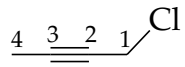
2-Pentyne



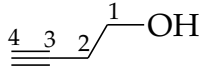
1-Penten-4-yne
or Pent-1-en-4-yne



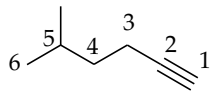
3-Chloropropyne



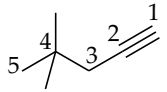
1-Chloro-2-but-yne
or 1-Chlorobut-2-yne



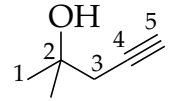
3-Butyn-1-ol
or But-3-yn-1-ol



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



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



2-Methyl-4-pentyn-2-ol
or 2-Methylpent-4-yn-2-ol

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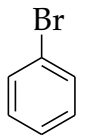
5. How to name aromatic compounds

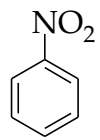
5.1 Monosubstituted:

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

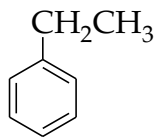
- **Common names are accepted by IUPAC as parent compounds.**



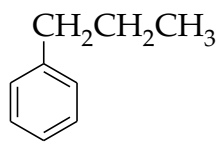
Bromobenzene



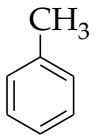
Nitrobenzene



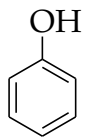
Ethylbenzene



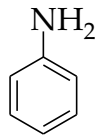
Propylbenzene



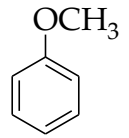
Toluene



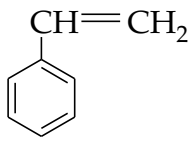
Phenol



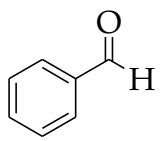
Aniline



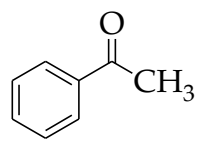
Anisole



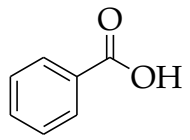
Styrene



Benzaldehyde



Acetophenone



Benzoic acid

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5. How to name aromatic compounds

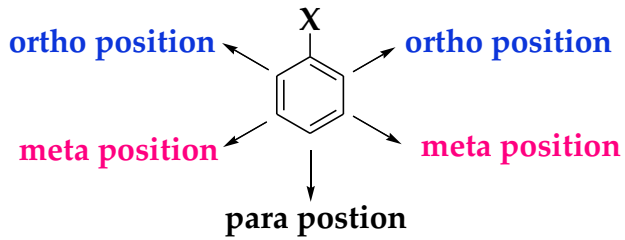
5.2 Disubstituted

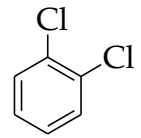
- When two substituents are present, their relative positions are indicated by the prefixes *ortho-*, *meta-*, and *para-* (abbreviated *o-*, *m-*, and *p-*) or by the use of numbers.

- 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.

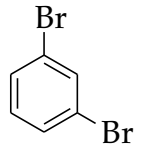
- If a substituent have a special name, it could be used as the parent name with the possible lowest number .

- Some disubstituted benzene derivatives have a common names.

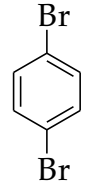




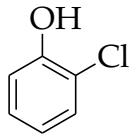
1,2-Dichlorobenzene
(*o*-Dichlorobenzene)



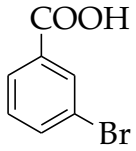
1,3-Dibromobenzene
(*m*-Dibromobenzene)



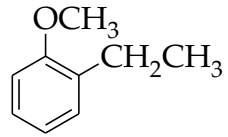
1,4-Dibromobenzene
(*p*-Dibromobenzene)



2-Chlorophenol
(*o*-Chlorophenol)

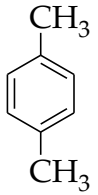


3-Bromobenzoic acid
(*m*-Bromobenzoic acid)

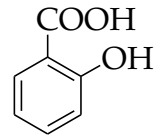


2-Ethylanisole
(*o*-Ethylanisole)

IUPAC name
Common name



1,4-Dimethylbenzene
p-Xylene



2-Hydroxybenzoic acid
Salicylic acid

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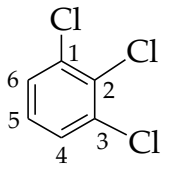
5. How to name aromatic compounds

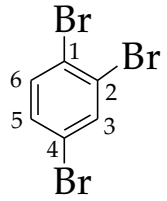
5.3 Polysubstituted

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

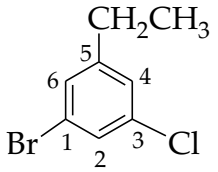
- When a substituent is one that together with the benzene ring gives a new base name, that substituent is assumed to be in position 1 and the new parent name is used.



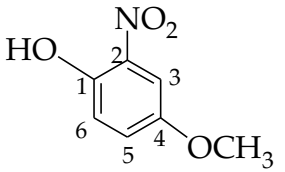
1,2,3-Trichlorobenzene



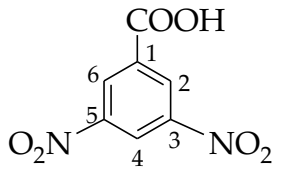
1,2,4-Tribromobenzene



1-Bromo-3-chloro-5 ethylbenzene



4-Methoxy-2-nitro-phenol



3,5-Dinitrobenzoic acid

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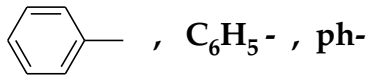
5. How to name aromatic compounds

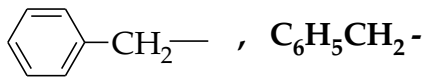
5.3 Polysubstituted

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



, C_6H_5- , ph-

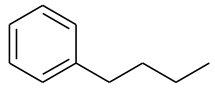
Phenyl group



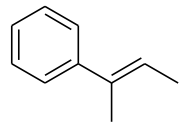
, $C_6H_5CH_2$-

Benzyl group

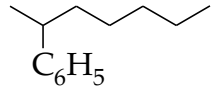
- A hydrocarbon composed of one saturated chain and one benzene ring is usually named as a derivative of the larger structural unit.
- If the chain is unsaturated, the compound may be named as a derivative of that chain, regardless of ring size.



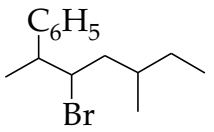
Butylbenzene



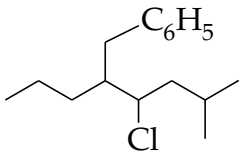
(*E*)-2-Phenyl-2-butene



2-Phenylheptane



3-Bromo-5-methyl-2-phenylheptane



5-Benzyl-4-chloro-2-methyloctane

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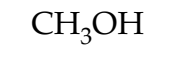
6. How to Name Alcohols, Phenols and Ethers

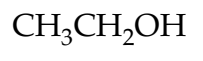
6.1 Nomenclature of Alcohols

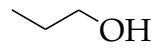
- The common names for the simplest alcohols consist of alkyl group attached to the hydroxyl function followed by the word alcohol: Alkyl alcohol .

- In the IUPAC system, the following procedure should be followed:

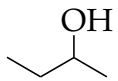
1. Select the longest continuous carbon chain to which the hydroxyl is directly attached. Change the name of the alkane corresponding to this chain by dropping the final –e and adding the suffix -ol.
2. Number the longest continuous carbon chain so as to give the carbon atom bearing the hydroxyl group the lower number.

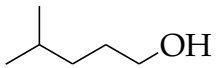


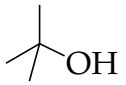




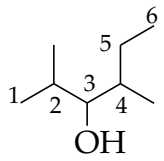
IUPAC name: Methanol | Ethanol | 1-propanol
Common name: Methyl alcohol | Ethyl alcohol | Propyl alcohol



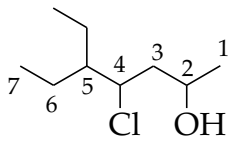




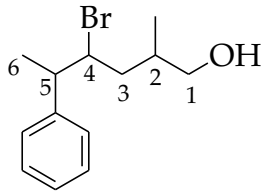
IUPAC name: 2-Butanol | 4-Methyl-1-pentanol | 2-Methyl-2-propanol
Common name: sec-Butyl alcohol | Isohexanol | tert-Butyl alcohol



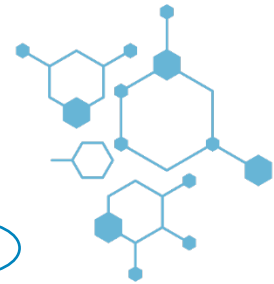
2,4-Dimethyl-3-hexanol
or 2,4-Dimethylhexan-3-ol



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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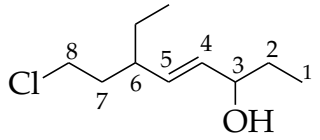
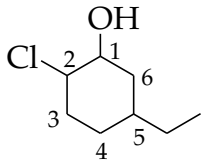
6. How to Name Alcohols, Phenols and Ethers

6.1 Nomenclature of Alcohols

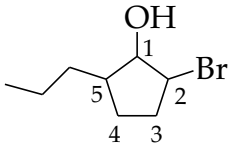
3. **The hydroxyl group has precedence over double bonds and triple bonds in deciding which functional group to name as the suffix.**



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

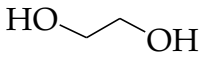


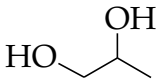
2-Chloro-5-ethylcyclohexanol



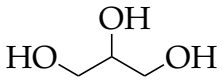
2-Bromo-5-propylcyclopentanol

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**
Common name	**Ethylene glycol**	**Propylene glycol**



IUPAC name	**1,2,3-Propanetriol or Propane-1,2,3-triol**
Common name	**glycerol**

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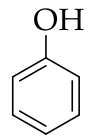
6. How to Name Alcohols, Phenols and Ethers

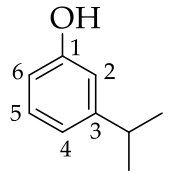
6.2 Nomenclature of Phenols

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

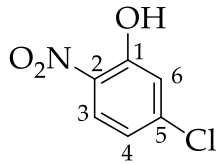
- **The hydroxyl group is named as a substituent when it occurs in the same molecule with carboxylic acid, aldehyde, or ketone functionalities, which have priority in naming.**



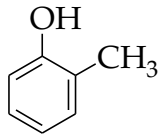
Phenol



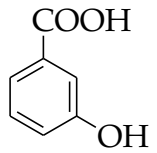
3-Isopropylphenol



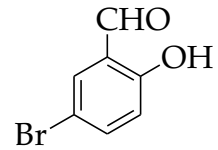
5-Chloro-2-nitrophenol



2-Methylphenol



3-Hydroxybenzoic acid



2-Hydroxy-5-bromobenzaldehyde

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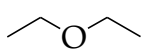
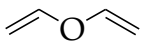
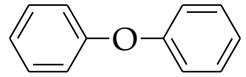
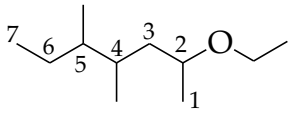
6. How to Name Alcohols, Phenols and Ethers

6.3 Nomenclature of Ethers

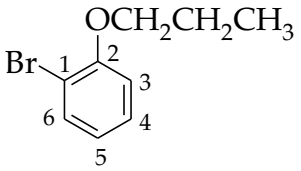
- **Simple ethers** are frequently given **common** functional class names. One simply lists (in alphabetical order) both groups that are attached to the oxygen atom and adds the word **Ether.**
- **In the IUPAC style**, ethers are named as **alkoxyalkanes**. The **–OR** group is an **alkoxy group**.
- Choose the longest chain as the parent alkane, and then name as usual.
- **Cyclic ethers** can be named in several ways. One simple way is to use **replacement nomenclature**, in which we relate the cyclic ether to the corresponding **hydrocarbon ring** system and use the prefix **oxa-** to indicate that an oxygen atom replaces a CH_2 group. Several simple cyclic ethers also have common names.

	$H_3C-O-CH_3$	$H_3C-O-CH_2CH_3$	$(H_3C)_3-O-CH_3$
IUPAC name	Methoxymethane	Methoxy-ethane	2-Methoxy-2-methylpropane
Common name	Dimethyl ether	Ethyl methyl ether	*tert*-Butyl methyl ether

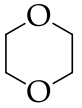
			
IUPAC name	Ethoxyethane	Vinyloxy-ethene	Phenoxybenzene
Common name	Diethyl ether	Divinyl ether	Phenyl ether



2-Ethoxy-4,5-dimethylheptane



1-Bromo-2-propoxybenzene

			
IUPAC name	Oxacyclopropane	Oxacyclopentane	1,4-Dioxacyclohexane
Common name	Ethylene oxide	Tetrahydrofuran	1,4-Dioxane

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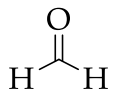
7. How to Name Aldehydes and Ketones

7.1 Nomenclature of Aldehydes

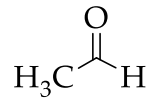
- The common names are derived from the common names for the corresponding carboxylic acids.

Formula	Carboxylic acid	Formula	Aldehyde
HCOOH	Formic acid	HCHO	Formaldehyde
CH_3COOH	Acetic acid	CH_3CHO	Acetaldehyde
CH_3CH_2COOH	Propionic acid	CH_3CH_2CHO	Propionaldehyde
$CH_3(CH_2)_2COOH$	Butyric acid	$CH_3(CH_2)_2CHO$	Butyraldehyde
$CH_3(CH_2)_3COOH$	Valeric acid	$CH_3(CH_2)_3CHO$	Valeraldehyde

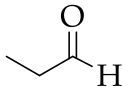
- In the IUPAC System, Aliphatic aldehydes are named substitutively by replacing the final -e of the name of the corresponding alkane with -al.
- Since the aldehyde group must be at the end of the carbon chain, there is no need to indicate its position.
- When other substituents are present, the carbonyl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



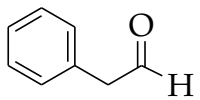
IUPAC name: Methanal
Common name: Formaldehyde



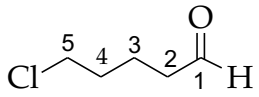
IUPAC name: Ethanal
Common name: Acetaldehyde



IUPAC name: Propanal
Common name: Propionaldehyde



IUPAC name: Phenylethanal
Common name: phenylacetaldehyde



5-Chloropentanal

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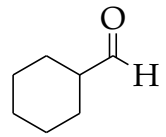
7. How to Name Aldehydes and Ketones

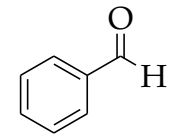
7.1 Nomenclature of Aldehydes

- **Cyclic and aromatic aldehyde:** Aldehydes in which the –CHO group is attached to a ring system are named substitutively by adding the suffix carbaldehyde.

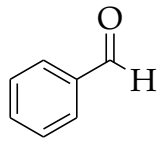
- The common name benzaldehyde is far more frequently used than benzenecarbaldehyde for C_6H_5CHO, and it is the name we shall use in this course.



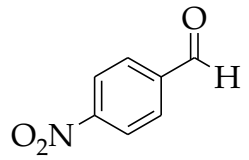
Cyclohexanecarbaldehyde



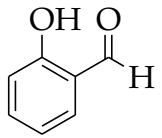
Benzenecarbaldehyde
Benzaldehyde



Benzaldehyde



4-Nitrobenzaldehyde



2-Hydroxybenzaldehyde

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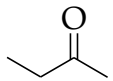
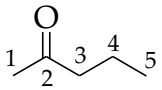
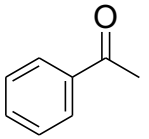
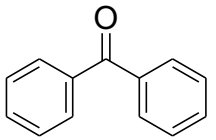
7. How to Name Aldehydes and Ketones

7.2 Nomenclature of 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.**

- **In the IUPAC System, Aliphatic ketones are named substitutively by replacing the final -e of the name of the corresponding alkane with -one. 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	 Butanone	 2-Pentanone
Common name	Ethyl methyl ketone	Methyl propyl ketone

IUPAC name	 Acetone	 Acetophenone	 Benzophenone
Common name	Propanone	1-Phenylethanone Methyl phenyl ketone	Diphenylmethanone Diphenyl ketone

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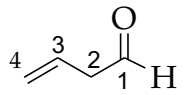
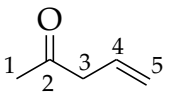
7. How to name Aldehydes and Ketones

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

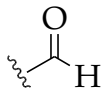
- When it is necessary to name (-CHO and -CH_3CHO) as a prefix, it is called the methanoyl (or formyl group) and ethanoyl (or acetyl group).



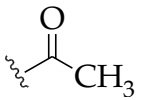
3-Butenal



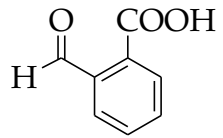
4-Penten-2-one
(*not* 1-penten-4-one)
Allyl methyl ketone



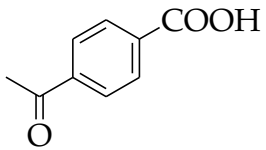
methanoyl group
or formyl group



Ethanoyl
or acetyl group



2-Methanoylbenzoic acid
or *o*-formylbenzoic acid



4-Ethanoylbenzoic acid
or *p*-acetylbenzoic acid

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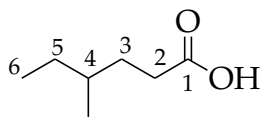
8. How to Name Carboxylic acid and their Derivatives

8.1 Nomenclature of Carboxylic Acids

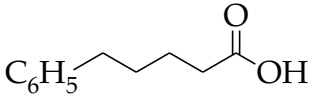
- Many carboxylic acids have common names that are derived from Latin or Greek words that indicate one of their natural sources.
- Most of these common names have been used for a long time and some are likely to remain in common usage, so it is helpful to be familiar with them.

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,

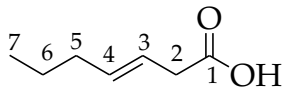
- In the IUPAC System, carboxylic acids are named by dropping the final -e of the name of the alkane corresponding to the longest chain in the acid and by adding -oic acid. The carboxyl carbon atom is assigned number 1.



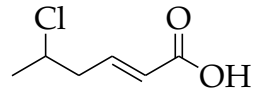
4-Methylhexanoic acid



5-Phenylpentanoic acid



3-Heptenoic acid
or Hept-3-enoic acid



5-Chloro-2-hexenoic acid
or Hept-3-enoic acid

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8. How to Name Carboxylic acid and their Derivatives

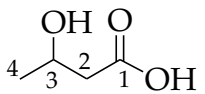
8.1 Nomenclature of Carboxylic Acids

- The carboxyl group has priority over alcohol, aldehyde, or ketone functionality in naming.

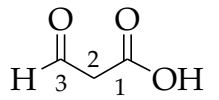
- The functional group priority order in nomenclature system is as following:

Increasing priority

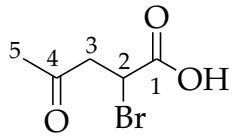
Class	Suffix name	Prefix name
Carboxylic acid	-oic acid	-
Ester	-oate	Alkoxycarbonyl
Amide	-amide	Amido
Aldehyde	-al	Oxo
Ketone	-one	Oxo
Alcohol	-ol	Hydroxy
Amine	-amine	Amino
Alkene	-ene	Alkenyl
Alkyne	-yne	Alkynyl
Alkane	-ane	Alkyl
Ether	-	Alkoxyl



3-Hydroxybutanoic acid



3-Oxopropanoic acid



2-Bromo-4-oxopentanoic acid

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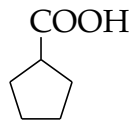
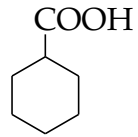
8. How to Name Carboxylic acid and their Derivatives

8.1 Nomenclature of Carboxylic Acids

- When the carboxyl group is attached to a ring, the ending -carboxylic acid is added to the name of the parent cycloalkane.

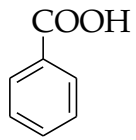


Cyclopentanecarboxylic acid

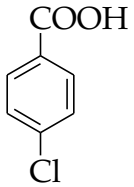


Cyclohexanecarboxylic acid

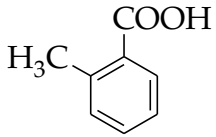
- Aromatic acids are named by attaching the suffix -oic acid or -ic acid to an appropriate prefix derived from the aromatic hydrocarbon.



Benzenecarboxylic acid
Benzoic acid



4-Chlorobenzoic acid



2-Methylbenzoic acid

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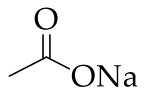
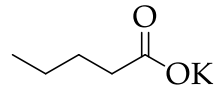
8. How to Name Carboxylic acid and their Derivatives

8.2 Nomenclature of Carboxylate Salts

- **Salts of carboxylic acids are named as -ates; in both common and systematic names, -ate replaces -ic acid. The name of the cation precedes that of the carboxylate anion.**

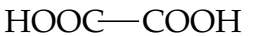


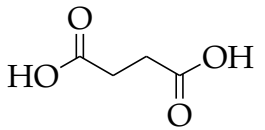


IUPAC name	Sodium ethanoate	Potassium pentnoate
Common name	Sodium acetate	

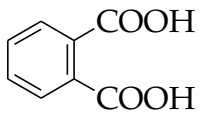
8.3 Nomenclature of Dicarboxylic Acids

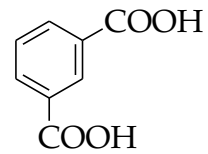
- **Dicarboxylic acids are named as alkanedioic acids in the IUPAC systematic or substitutive system.**
- **Most simple dicarboxylic acids have common names.**





IUPAC name	Ethanedioic acid	Propanedioic acid	Butanedioic acid
Common name	Oxalic acid	Malonic acid	Succinic acid





IUPAC name	1,2-Benzenedicarboxylic acid	1,3-Benzenedicarboxylic acid
Common name	Phthalic acid	Isophthalic acid

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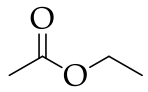
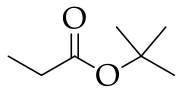
8. How to Name Carboxylic acid and their Derivatives

8.4 Nomenclature of Esters

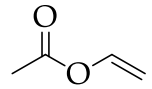
- The names of esters are derived from the names of the alcohol (with the ending -yl) and the acid (with the ending -ate or -oate). The portion of the name derived from the alcohol comes first.



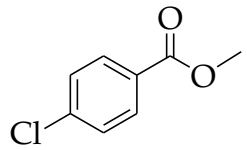
Ethyl ethanoate



tert-Butyl propanoate



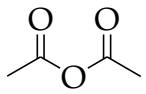
Vinyl ethanoate



Methyl *p*-chlorobenzoate

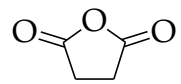
8.5 Nomenclature of Carboxylic Anhydrides

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

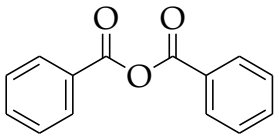


IUPAC name
Common name

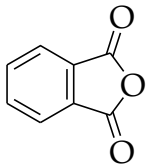
Ethanoic anhydride
Acetic anhydride



Butandioic anhydride
Succinic anhydride



Benzoic anhydride



1,2-Benzenedicarboxylic anhydride
Phthalic anhydride

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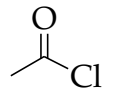
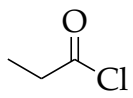
8. How to Name Carboxylic acid and their Derivatives

8.6 Nomenclature of Acyl Chlorides

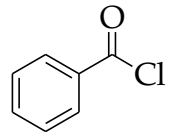
- **Acyl chlorides are also called acid chlorides. They are named by dropping -ic acid from the name of the acid and then adding -yl chloride.**



IUPAC name
Common name
Ethanoyl chloride
Acetyl chloride



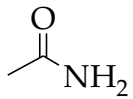
Propanoyl chloride



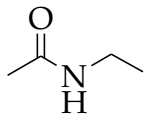
Benzoyl chloride

8.7 Nomenclature of Amides

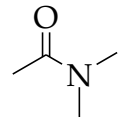
- **Amides that have no substituent on nitrogen are named by dropping -ic acid from the common name of the acid (or -oic acid from the substitutive name) and then adding -amide.**
- **Alkyl groups on the nitrogen atom of amides are named as substituents, and the named substituent is prefaced by *N-*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



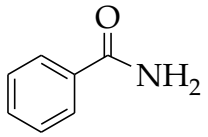
IUPAC name
Common name
Ethanamide
Acetamide



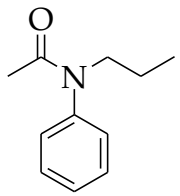
***N*-Ethylethanamide**



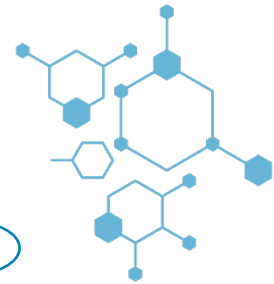
***N,N*-Dimethylethanamide**



Benzamide



***N*-Phenyl-*N*-propylethanamide**



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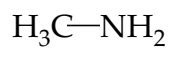
9. How to Name Amines

9.1 Nomenclature of Aliphatic Amines

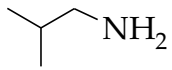
- In common nomenclature, most primary amines are named as alkylamines.

- 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.

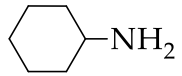


IUPAC name: Methanamine
Common name: Methylamine

IUPAC name: Ethanamine
Common name: Ethylamine

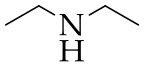


IUPAC name: 2-Methyl-1-propanamine
Common name: Isobutylamine

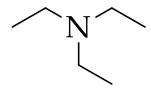


IUPAC name: Cyclohexanamine
Common name: Cyclohexylamine

IUPAC name: *N*-Methylethanamine
Common name: Ethylmethylamine

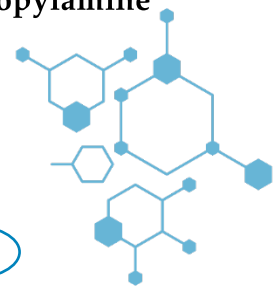


IUPAC name: *N*-Ethylethanamine
Common name: Diethylamine



IUPAC name: N,N-Diethylethanamine
Common name: Triethylamine

IUPAC name: *N*-Ethyl-*N*-methyl-1-propanamine
Common name: Ethylmethylpropylamine



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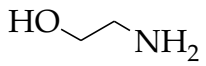
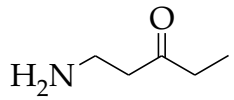
9. How to Name Amines

9.1 Nomenclature of Aliphatic Amines

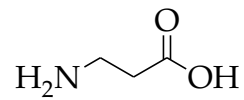
- In the IUPAC system, the substituent $-NH_2$ is called the amino group. We often use this system for naming amines containing an OH group or a CO_2H group.



2-Aminoethanol



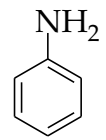
1-Amino-3-pentanone



3-Aminopropanoic acid

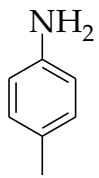
9.2 Nomenclature of Arylamines

- Aromatic amines are named as derivatives of aniline.
- In the CA system, aniline is called benzenamine.

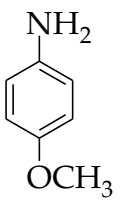


Aniline
Benzenamine

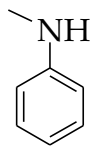
IUPAC name
Common name



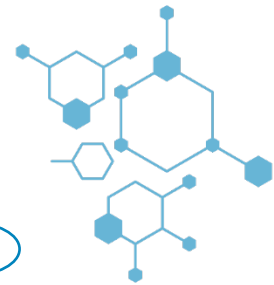
4-Methylaniline
p-Toluidine



4-Methoxyaniline
p-Anisidine



N-Methylaniline



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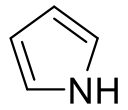
9. How to Name Amines

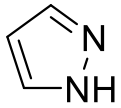
9.3 Nomenclature of Heterocyclic Amines

- **The important heterocyclic amines all have common names. Such as Pyrrole (five membered ring with one N-atom); pyridine (six membered ring one N-atom); Pyrazole (five membered ring with two N-atoms); Pyridazine (six membered ring with two N-atoms); and fused rings such as indole and quinoline.**

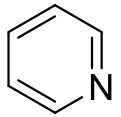
Some Common names



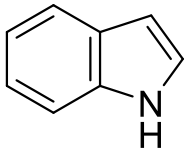
Pyrrole



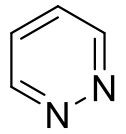
Pyrazole



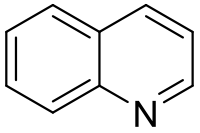
Pyridine



Indole



Pyridazine



Quinoline

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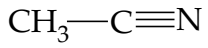
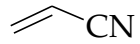
10. How to Name Nitriles

- **Carboxylic acids can be converted to nitriles and vice versa.**
- **In IUPAC substitutive nomenclature, acyclic nitriles are named by adding the suffix -nitrile to the name of the corresponding hydrocarbon.**
- **The carbon atom of the –C≡N group is assigned number 1.**

		
IUPAC name	Ethanenitrile	Propenenitrile
Common name	Acetonitrile	Acrylonitrile