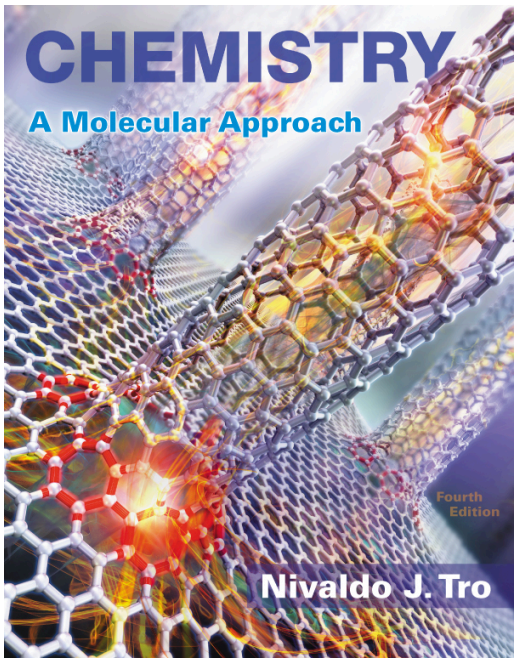


Lecture Presentation

Chapter 21

Organic Chemistry

Fragrances and Odors

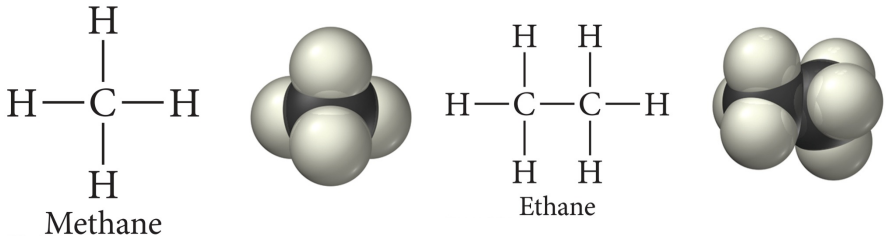
- Our sense of smell helps us identify food, people, and other organisms and alerts us to dangers such as polluted air or spoiled food.
- Odorants must be volatile, yet many volatile substances have no scent at all.
- Most common smells are caused by organic molecules.
- The study of compounds containing carbon combined with one or more of the elements hydrogen, nitrogen, oxygen, and sulfur, including their properties and their reactions, is known as **organic chemistry**.

What Is Organic Chemistry?

- Organic chemistry is a branch of chemistry that focuses on compounds that contain carbon.
  - Except CO, CO_2, carbonates, and carbides
- Even though organic compounds contain only a few elements, the unique ways carbon atoms can attach together to form molecules leads to millions of different organic compounds.

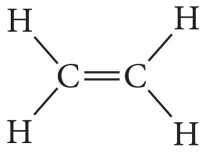
Why Carbon Is Unique

- Carbon atoms can do some unique things that other atoms cannot.
- Carbon can bond to as many as four other atoms.
- Bonds to carbon are very strong and nonreactive.

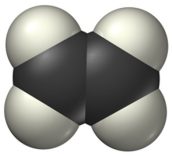


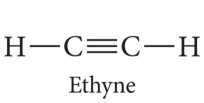
Why Carbon Is Unique

- Carbon atoms can catenate or form chains.
- Carbon atoms can form single, double, or triple bonds.
- Carbon atoms can bond together to form rings.



Ethene





Ethyne

Hydrocarbons

- Hydrocarbons contain only C and H.
  - Aliphatic or aromatic
- Insoluble in water
  - No polar bonds to attract water molecules
- Aliphatic hydrocarbons
  - Saturated or unsaturated aliphatics
    - Saturated = alkanes; unsaturated = alkenes or alkynes
  - May be chains or rings
  - Chains may be straight or branched.
- Aromatic hydrocarbons

Types of Hydrocarbons

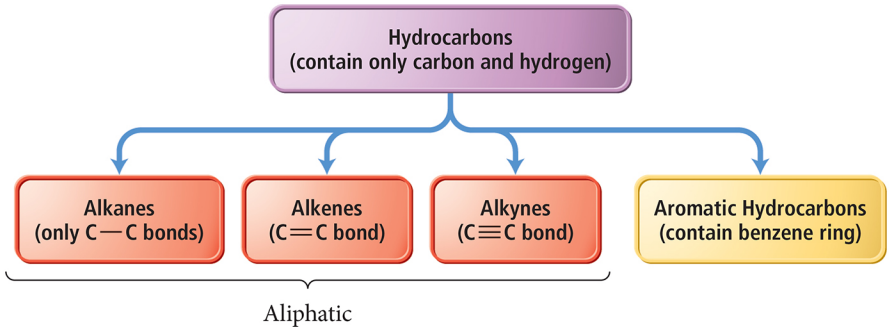
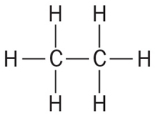
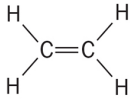
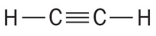


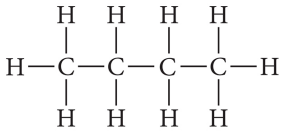
TABLE 21.1 Alkanes, Alkenes, Alkynes

Type of Hydrocarbon	Type of Bonds	Generic Formula*	Example
Alkanes	All single	C_nH_{2n+2}	 Ethane
Alkenes	One (or more) double	C_nH_{2n}	 Ethene
Alkynes	One (or more) triple	C_nH_{2n-2}	 Ethyne

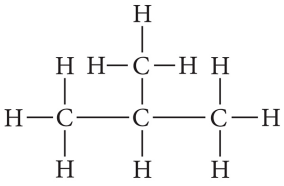
* *n* is the number of carbon atoms. These formulas apply only to noncyclic structures containing no more than one multiple bond.

Formulas

- Molecular formulas show the kinds of atoms in the molecule, but they do not show how they are attached.
- Structural formulas show you the attachment pattern in the molecule.
- Models not only show you the attachment pattern but give you an idea about the shape of the molecule.



Butane



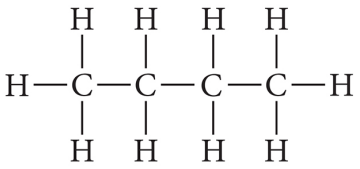
Isobutane

Structural Formulas

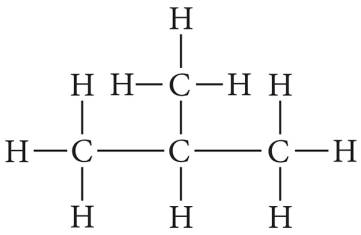
- A **structural formula** shows not only the numbers of each kind of atoms but also how the atoms are bonded.
- **Condensed structural formula** groups the hydrogen atoms with the carbon atom to which they are bonded.
- **Carbon skeleton formula**, also called a line formula, shows the carbon–carbon bonds only as lines.
- Structural formulas are two-dimensional while space-filling or ball-and-stick models are three dimensional.

Isomerism

- **Structural isomers** are different molecules with the same molecular formula.
- Below are two molecules with formula C_4H_{10}.

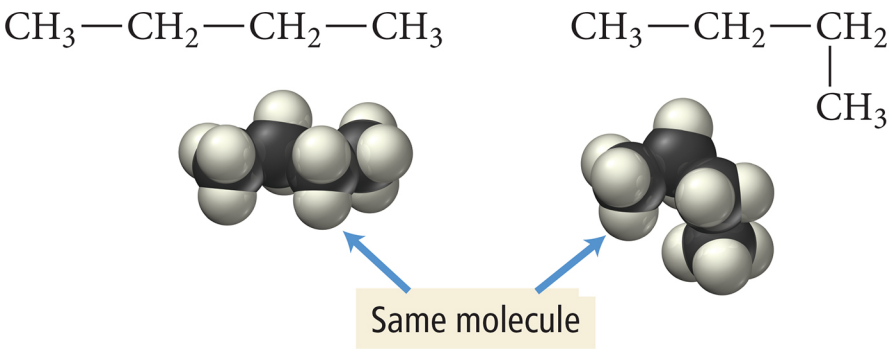


Butane



Isobutane

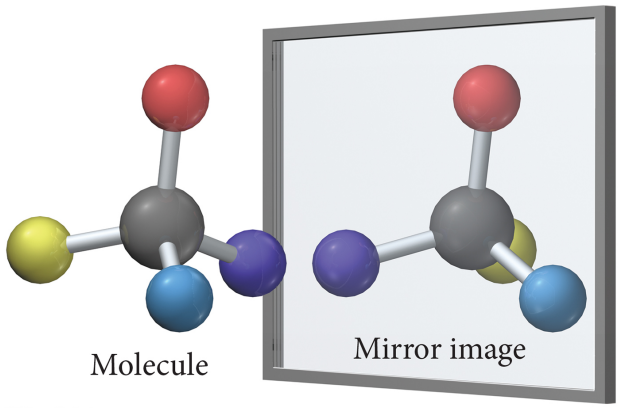
Rotation about a Bond Is Not Isomerism



Stereoisomers

- **Stereoisomers** are different molecules whose atoms are connected in the same order but with a different spatial direction.
- **Optical isomers**, also called enantiomers, are nonsuperimposable stereoisomers that are mirror images of each other.

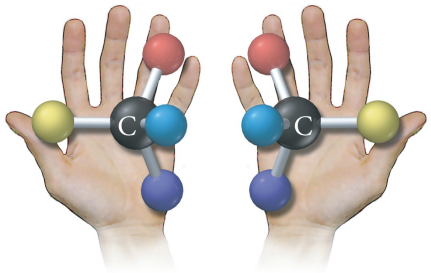
Nonsuperimposable Mirror Images



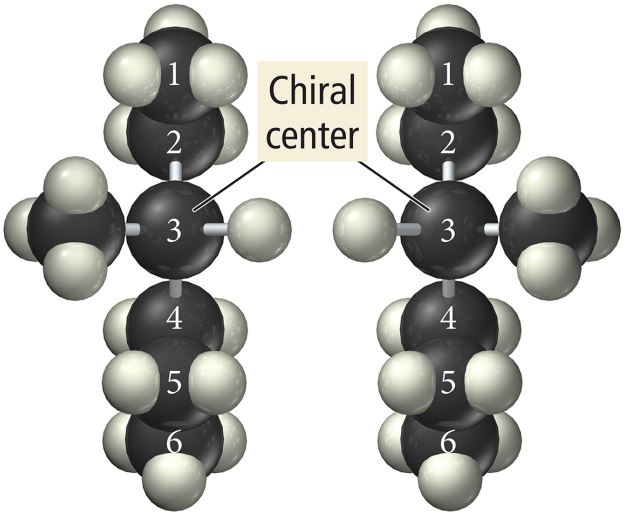
The mirror image cannot be rotated so all its atoms align with the same atoms of the original molecule.

Chirality

- Any molecule with a nonsuperimposable mirror image is said to be **chiral**.
- Any carbon with four different substituents will be a **chiral center**.
- A pair of nonsuperimposable mirror images is called a pair of **enantiomers**.



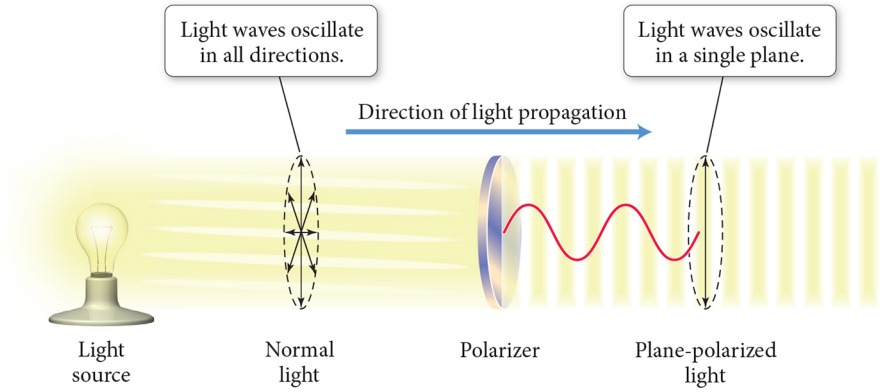
Optical Isomers of 3-Methylhexane



Optical isomers of 3-methylhexane

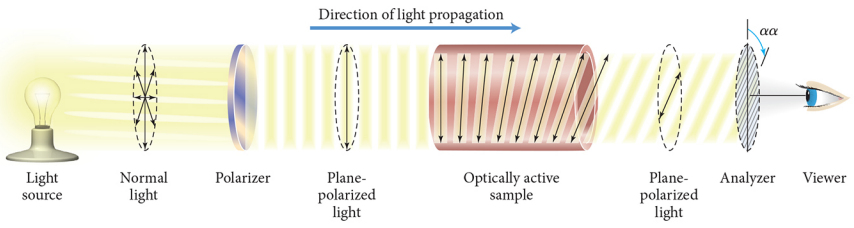
Plane-Polarized Light

- Plane-polarized light is made up of electric field waves that oscillate in only one plane.



Optical Activity

- Each of the enantiomers will rotate the plane of polarized light the same amount but in opposite directions.
- **Dextrorotatory**—rotates the plane to the right
- **Levorotatory**—rotates the plane to the left

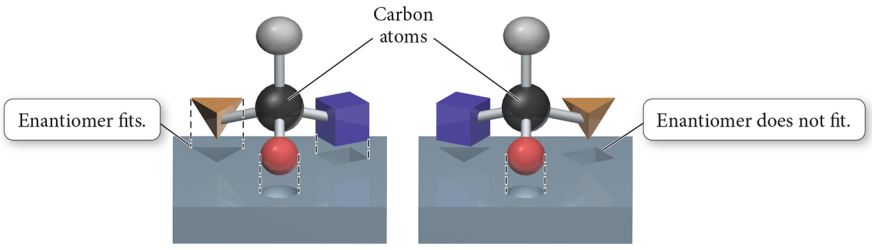


Mixtures of Enantiomers

- An equimolar mixture of a pair of enantiomers is called a **racemic mixture**.
- Because half the molecules are rotating the plane to the left and the other half are rotating it to the right, the rotations cancel, and the racemic mixture does not rotate the plane.
- If the mixture is nonracemic, the amount of rotation can be used to determine the percentages of each enantiomer in the mixture.

Chemical Behavior of Enantiomers

- A pair of enantiomers will have the same chemical reactivity in a nonchiral environment.
- But in a chiral environment, they may exhibit different behaviors.
  - Enzyme selection of one enantiomer of a pair



Saturated Hydrocarbons

- A saturated hydrocarbon has all C—C single bonds.
  - It is saturated with hydrogens.
- Saturated aliphatic hydrocarbons are called **alkanes**.
- Chain alkanes have the general formula C_nH_{2n+2}.
- Ring alkanes have all C—C single bonds but have fewer hydrogens than a chain with the same number of carbons.

Physical Properties of *n*-Alkanes

TABLE 21.2 ***n*-Alkane Boiling Points**

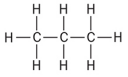
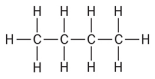
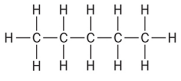
n-Alkane	Boiling Point (°C)
Methane	−161.5
Ethane	−88.6
Propane	−42.1
n-Butane	−0.5
n-Pentane	36.0
n-Hexane	68.7
n-Heptane	98.5
n-Octane	125.6

Physical Properties of Hydrocarbons

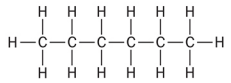
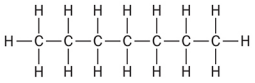
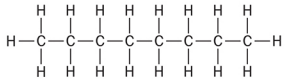
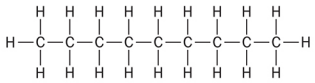
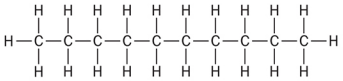
- Boiling points and melting points increase as the molar mass of the molecule increases.
  - Nonpolar molecules
  - Main attractive forces are dispersion forces
- Less dense than water

n-Alkanes

TABLE 21.3 *n*-Alkanes

n	Name	Molecular Formula C_nH_{2n+2}	Structural Formula	Condensed Structural Formula
1	Methane	CH_4		CH_4
2	Ethane	C_2H_6		CH_3CH_3
3	Propane	C_3H_8		$CH_3CH_2CH_3$
4	*n*-Butane	C_4H_{10}		$CH_3CH_2CH_2CH_3$
5	*n*-Pentane	C_5H_{12}		$CH_3CH_2CH_2CH_2CH_3$

n-Alkanes (continued)

6	*n*-Hexane	C_6H_{14}		$CH_3CH_2CH_2CH_2CH_2CH_3$
7	*n*-Heptane	C_7H_{16}		$CH_3CH_2CH_2CH_2CH_2CH_2CH_3$
8	*n*-Octane	C_8H_{18}		$CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_3$
9	*n*-Nonane	C_9H_{20}		$CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_3$
10	*n*-Decane	$C_{10}H_{22}$		$CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_3$

Uses of Hydrocarbons

TABLE 21.4 Uses of Hydrocarbons

Number of Carbon Atoms	State	Major Uses
1–4	Gas	Heating fuel, cooking fuel
5–7	Low-boiling liquids	Solvents, gasoline
6–18	Liquids	Gasoline
12–24	Liquids	Jet fuel, portable-stove fuel
18–50	High-boiling liquids	Diesel fuel, lubricants, heating oil
50+	Solids	Petroleum jelly, paraffin wax

Naming Alkanes: IUPAC

- The longest continuous carbon chain determines the base name of the compound.
- Base name prefixes for alkanes end in *–ane*.
- **Substituent** is an atom or group of atoms that have been substituted for a hydrogen atom.
- Groups of carbon atoms branching off the base chain are alkyl groups and are named as **substituents**.

Prefixes

TABLE 21.5 Prefixes for Base Names of Alkane Chains

Number of Carbon Atoms	Prefix
1	meth-
2	eth-
3	prop-
4	but-
5	pent-
6	hex-
7	hept-
8	oct-
9	non-
10	dec-

Common Alkyl Groups

TABLE 21.6 Common Alkyl Groups

Condensed Structural Formula	Name	Condensed Structural Formula	Name
$-CH_3$	Methyl	$-CHCH_3$ $\quad\quad\vert$ $\quad\quad CH_3$	Isopropyl
$-CH_2CH_3$	Ethyl	$-CH_2CHCH_3$ $\quad\quad\quad\vert$ $\quad\quad\quad CH_3$	Isobutyl
$-CH_2CH_2CH_3$	Propyl	$-CHCH_2CH_3$ $\quad\quad\vert$ $\quad\quad CH_3$	*sec*-Butyl
$-CH_2CH_2CH_2CH_3$	Butyl	CH_3 $\quad\vert$ $-CCH_3$ $\quad\vert$ CH_3	*tert*-Butyl

Naming Alkanes

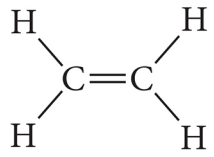
1. Identify the longest continuous carbon chain, and determine the base name of compound.
2. Name branches as **alkyl groups**. If more than one type of substituent is present, name alphabetically.
3. Number the chain from the end closest to a branch.
   - If the first branches are an equal distance, use the next substituent.
4. Write the name of the compound in the format (substituent number)-(substituent name)(base name).
5. Use a prefix if more than one of the same group is present.
   - "di-," "tri-," "tetra-"
   - Prefix does not count in alphabetizing.

Alkenes

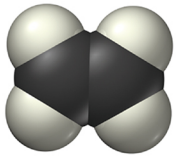
- Aliphatic, unsaturated hydrocarbons
  - C═C double bonds
- Formula for one double bond in noncylcic compound—C_nH_{2n}
  - Subtract 2 H from alkane for each double bond.
- Trigonal planar geometry around C
  - Flat
- Polyunsaturated—many double bonds

Alkenes

Ethene or ethylene



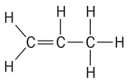
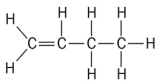
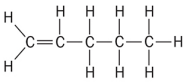
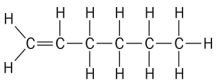
Structural formula


Space-filling model

Produced by ripening fruit

Used to make polyethylene

TABLE 21.7 Alkenes

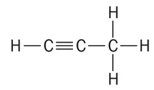
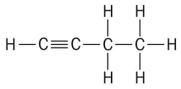
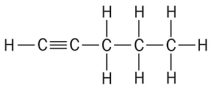
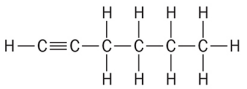
n	Name	Molecular Formula C_nH_{2n}	Structural Formula	Condensed Structural Formula
2	Ethene	C_2H_4		$CH_2{=}CH_2$
3	Propene	C_3H_6		$CH_2{=}CHCH_3$
4	1-Butene*	C_4H_8		$CH_2{=}CHCH_2CH_3$
5	1-Pentene*	C_5H_{10}		$CH_2{=}CHCH_2CH_2CH_3$
6	1-Hexene*	C_6H_{12}		$CH_2{=}CHCH_2CH_2CH_2CH_3$

* These alkenes have one or more isomers depending on the position of the double bond. The isomers shown here have the double bond in the 1 position, meaning the first carbon–carbon bond of the chain.

Alkynes

- Aliphatic, unsaturated hydrocarbons
- C≡C triple bond
- Formula of compound with one triple bond is C_nH_{2n-2}.
  - Subtract 4 H from alkane for each triple bond.
- Linear geometry

TABLE 21.8 Alkynes

n	Name	Molecular Formula C_nH_{2n-2}	Structural Formula	Condensed Structural Formula
2	Ethyne	C_2H_2	H—C≡C—H	CH≡CH
3	Propyne	C_3H_4		$CH{\equiv}CCH_3$
4	1-Butyne*	C_4H_6		$CH{\equiv}CCH_2CH_3$
5	1-Pentyne*	C_5H_8		$CH{\equiv}CCH_2CH_2CH_3$
6	1-Hexyne*	C_6H_{10}		$CH{\equiv}CCH_2CH_2CH_2CH_3$

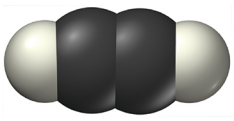
* These alkynes have one or more isomers depending on the position of the triple bond. The isomers shown here have the triple bond in the 1 position, meaning the first carbon–carbon bond of the chain.

Alkynes

Ethyne or acetylene

H—C≡C—H

Structural formula



Space-filling model

Used in welding torches

Naming Alkenes and Alkynes

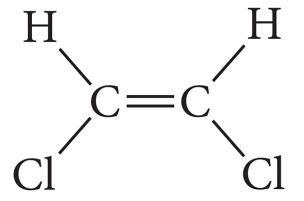
Name alkenes and alkynes the same way as alkanes except:

- The base chain is the longest continuous carbon chain that contains the double or triple bond.
- The base name ends in *–ene* for alkenes and *–yne* for alkynes.
- Number the chain from the end closest to the multiple bond.
- The number in front of the main name indicates the first carbon of the multiple bond.

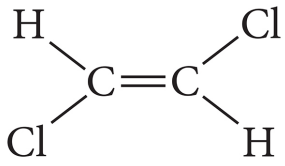
Geometric Isomerism

- Because the rotation around a double bond is highly restricted, you will have different molecules if groups have different spatial orientation about the double bond.
  - Geometric isomers
- This is often called ***cis–trans* isomerism**.
- When groups on the doubly bonded carbons are cis, they are on the same side of the double bond.
- When groups on the doubly bonded carbons are trans, they are on opposite sides.

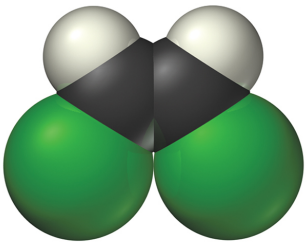
Cis–Trans Isomerism

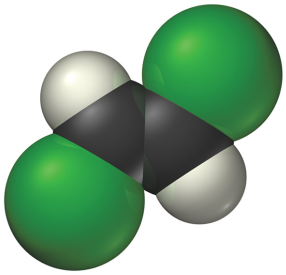


cis-1,2-Dichloroethene



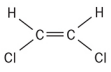
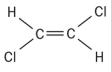
trans-1,2-Dichloroethene





Cis–Trans Isomerism

TABLE 21.9 Physical Properties of *cis*- and *trans*-1,2-Dichloroethene

Name	Structure	Space-filling Model	Density (g/mL)	Melting Point (°C)	Boiling Point (°C)
cis-1,2-Dichloroethene			1.284	−80.5	60.1
trans-1,2-Dichloroethene			1.257	−49.4	47.5

Hydrocarbon Reactions

- Combustion is one of the most common hydrocarbon reactions.
- Hydrocarbon combustion is highly exothermic.
  - About 90% of U.S. energy generated by combustion

$$CH_3CH_2CH_3(g) + 5\ O_2(g) \rightarrow 3\ CO_2(g) + 4\ H_2O(g)$$

$$CH_2{=}CHCH_2CH_3(g) + 6\ O_2(g) \rightarrow 4\ CO_2(g) + 4\ H_2O(g)$$

$$CH{\equiv}CCH_3(g) + 4\ O_2(g) \rightarrow 3\ CO_2(g) + 2\ H_2O(g)$$

Alkane Reactions

- **Halogen substitution**
  - Replace H with a halogen atom.
  - Initiated by addition of energy in the form of heat or ultraviolet light
    - To start breaking bonds
  - Methane + chlorine → chloromethane + HCl

$$\underset{\text{Methane}}{CH_4(g)} + \underset{\text{Chlorine}}{Cl_2(g)} \xrightarrow{\text{heat or light}} \underset{\text{Chloromethane}}{CH_3Cl(g)} + HCl(g)$$

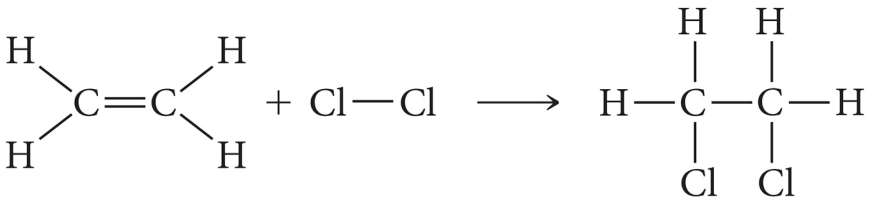
  - General form for halogen substitution

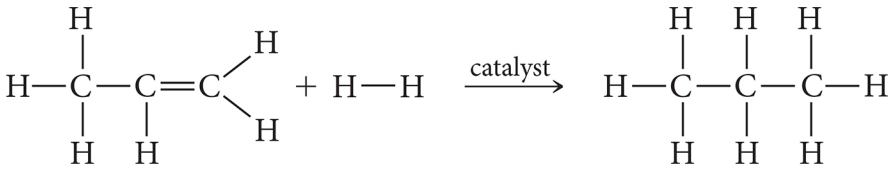
$$\underset{\text{Alkane}}{R{-}H} + \underset{\text{Halogen}}{X_2} \xrightarrow{\text{heat or light}} \underset{\text{Haloalkane}}{R{-}X} + \underset{\text{Hydrogen halide}}{HX}$$

Alkene and Alkyne Reactions: Addition

- Adding a molecule across the multiple bond
- **Hydrogenation**—adding H_2
  - Converts unsaturated molecule to saturated
  - Alkene or alkyne + $H_2 \rightarrow$ alkane
  - Generally requires a catalyst
- **Halogenation**—adding X_2
- **Hydrohalogenation**—adding HX
  - HX is polar.
  - *When adding a polar reagent to a double or triple bond, the positive end attaches to the carbon with the most Hs.*

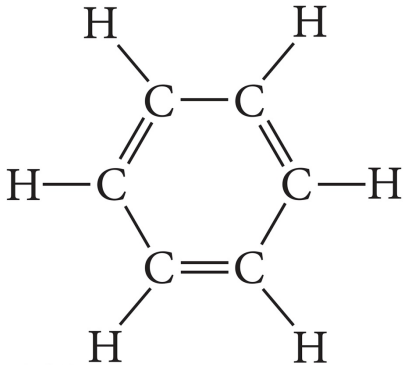
Addition Reactions





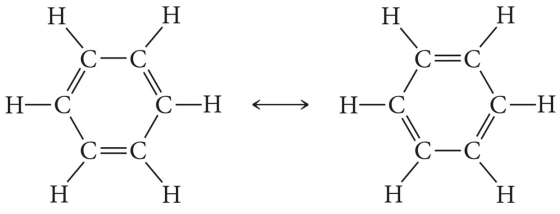
Aromatic Hydrocarbons

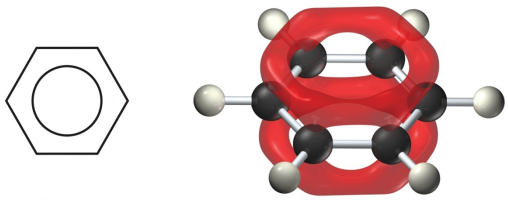
- Contain benzene ring (C_6H_6)
- Even though they are often drawn with C═C, they do not behave like alkenes.



Resonance Hybrid

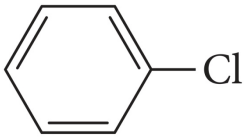
- The true structure of benzene is a resonance hybrid of two structures.





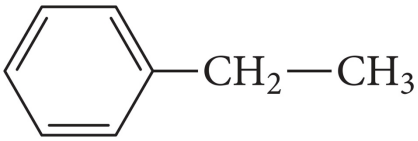
Naming Aromatic Hydrocarbons

- (Name of substituent)benzene
  - Halogen substituent = change ending to “o”

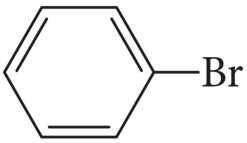


Chlorobenzene

- Or name of a common derivative



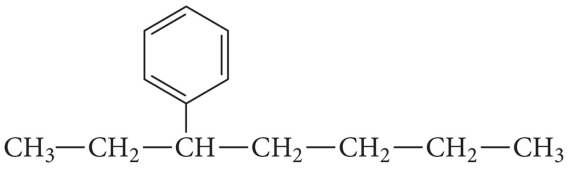
Ethylbenzene



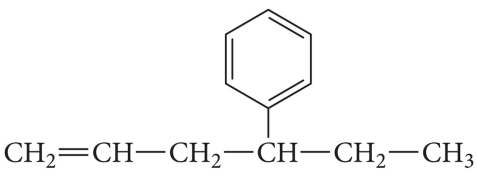
Bromobenzene

Naming Benzene as a Substituent

- When the benzene ring is not the base name, it is called a **phenyl** group.



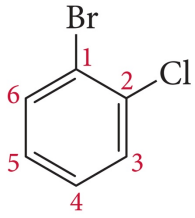
3-Phenylheptane



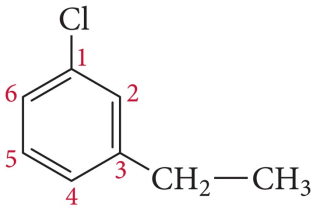
4-Phenyl-1-hexene

Naming Disubstituted Benzene Derivatives

- Number the ring starting at the attachment for the first substituent, and then move toward the second.
  - Order substituents alphabetically.
  - Use "*di-*" if both substituents are the same.



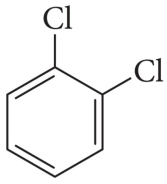
1-Bromo-2-chlorobenzene



1-Chloro-3-ethylbenzene

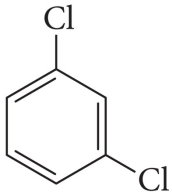
Naming Disubstituted Benzene Derivatives

- Alternatively, use a relative position prefix.
  - *Ortho-* = 1,2; *meta-* = 1,3; *para-* = 1,4



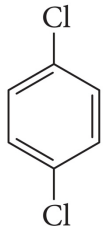
1,2-Dichlorobenzene

2-chlorotoluene
ortho-chlorotoluene
o-chlorotoluene



1,3-Dichlorobenzene

3-chlorotoluene
meta-chlorotoluene
m-chlorotoluene

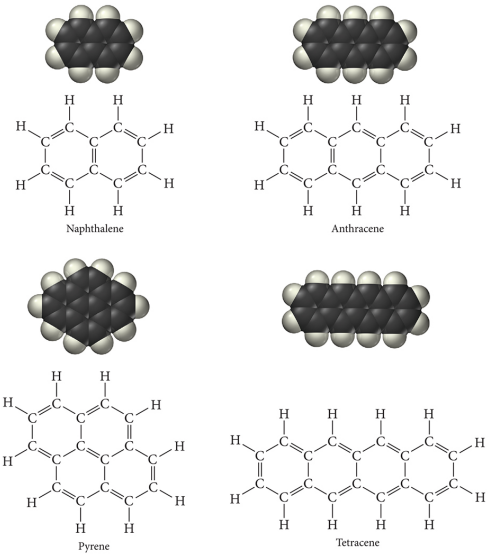


1,4-Dichlorobenzene

4-chlorotoluene
para-chlorotoluene
p-chlorotoluene

Polycyclic Aromatic Hydrocarbons

- Contain multiple benzene rings fused together via common bond



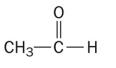
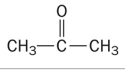
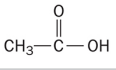
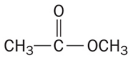
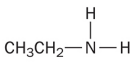
Reactions of Aromatic Compounds

- Because of electron delocalization in the benzene ring, benzene does not undergo addition reactions.
- **Substitution**—H atoms replaced with other atoms or groups of atoms

Functional Groups

- Other organic compounds are hydrocarbons in which **functional groups** have been substituted for hydrogens.
- A functional group is a group of atoms that significantly alters the properties of the molecule.
  - Generally, the reactions that a compound undergoes are determined by the functional groups it has.
  - Because the kind of hydrocarbon chain is irrelevant to the reactions, it may be indicated by the general symbol, R.

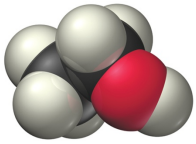
TABLE 21.10 Some Common Functional Groups

Family	General Formula*	Condensed General Formula	Example	Name
Alcohols	R—OH	ROH	CH_3CH_2OH	Ethanol (ethyl alcohol)
Ethers	R—O—R	ROR	CH_3OCH_3	Dimethyl ether
Aldehydes		RCHO		Ethanal (acetaldehyde)
Ketones		RCOR		Propanone (acetone)
Carboxylic acids		RCOOH		Ethanoic acid (acetic acid)
Esters		RCOOR		Methyl acetate
Amines		R_3N		Ethylamine

*In ethers, ketones, esters, and amines, the R groups may be the same or different.

Alcohols

- R—OH
- Ethanol—CH_3CH_2OH
  - Grain alcohol, from fermentation of sugars in grains
  - Alcoholic beverages
    - Proof number is 2 times percentage of alcohol
  - Gasohol

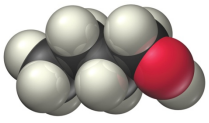


CH_3-CH_2-OH

Ethanol

Alcohols

- Isopropyl alcohol—$(CH_3)_2CHOH$
  - 2-propanol
  - Rubbing alcohol
  - Poisonous
- Methanol—CH_3OH
  - Wood alcohol = thermolysis of wood
  - Paint solvent
  - Poisonous



$CH_3-CH_2-CH_2-CH_2-OH$

1-Butanol

Naming Alcohols

- Main chain contains —OH
- Number main chain from the end closest to —OH.
- Give the base name and *-ol* ending and place the number of C on the chain, indicating where —OH attached just before the base name.

Reactions of Alcohols

Substitution

$$CH_3{-}OH + HCl \rightarrow CH_3Cl + H_2O$$

Acid-catalyzed elimination (dehydration)

$$CH_3{-}CH_2OH \xrightarrow{H_2SO_4} CH_2{=}CH_2 + H_2O$$

Reactions of Alcohols

Oxidation

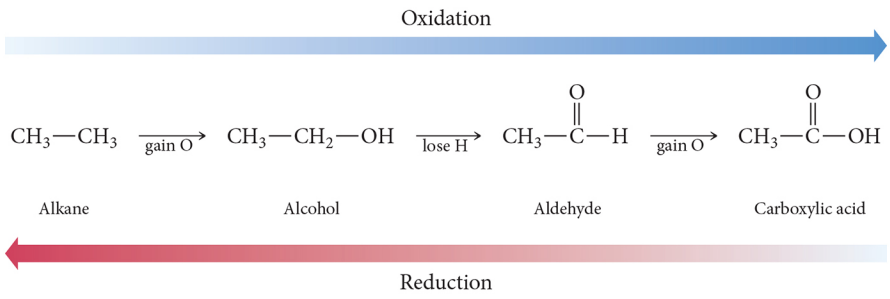
$$CH_3CH_2OH \xrightarrow{-2\ H} CH_3CHO \xrightarrow{+\ O} CH_3COOH$$

A common oxidizing agent is $Na_2Cr_2O_7$.

Alcohols with very active metals

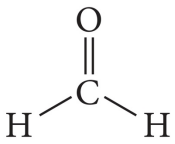
$$2\ CH_3{-}OH + 2\ K \rightarrow 2\ CH_3O^-K^+ + H_2$$

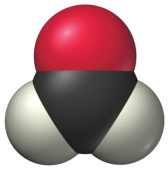
Oxidation–Reduction Reactions



Aldehydes and Ketones

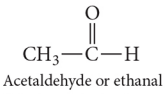
- Contain the **carbonyl** group
  - Aldehydes have at least one side H.
  - Ketones have R groups on both sides.
- Many aldehydes and ketones have pleasant tastes and aromas.
- Some are pheromones.
- Formaldehyde—$H_2C{=}O$
  - Pungent gas
  - Formalin is a preservative.
  - Wood smoke, carcinogenic
- Acetone—$CH_3C(=O)CH_3$
  - Nail polish remover



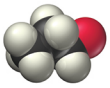


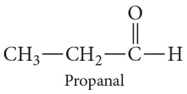
Formaldehyde or methanal

Common Aldehydes and Ketones

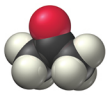


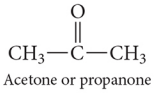
Acetaldehyde or ethanal



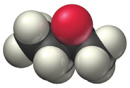


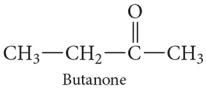
Propanal





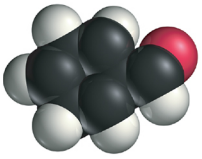
Acetone or propanone

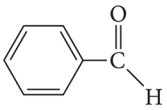




Butanone

Benzaldehydes in Almonds

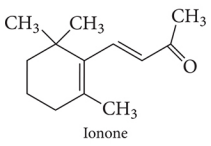




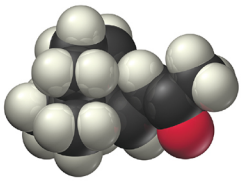
Benzaldehyde

Ketone Odors and Flavors

- Acetophenone—pistachio
- Carvone—spearmint
- Ionone—raspberries
- Muscone—musk



Ionone



Naming Aldehydes and Ketones

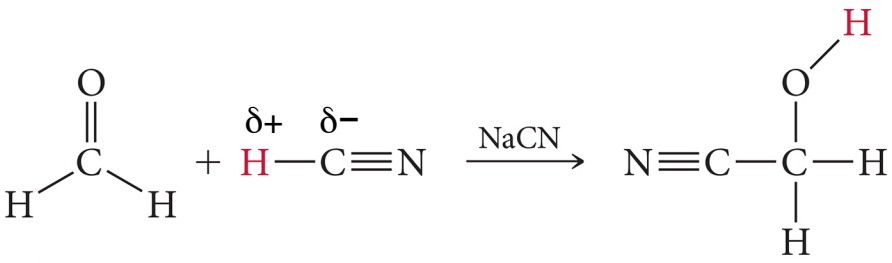
- Main chain contains C═O.
  - Unless COOH present
- Number the main chain from the end closest to C═O.
- For **aldehydes**, give the base name with an *-al* ending.
  - Always on C1
- For **ketones**, give the base name with an *-one* ending, and place the number of C on the chain where C═O attached just before the base name.

Aldehyde and Ketone Reactions

- Aldehydes and ketones are generally synthesized by the oxidation of alcohols.
- Therefore, **reduction** of an aldehyde or ketone results in an alcohol.
- **Addition** reactions occur with the C=O bond due to its polarity. The more electronegative end of the reagent bonds to C.

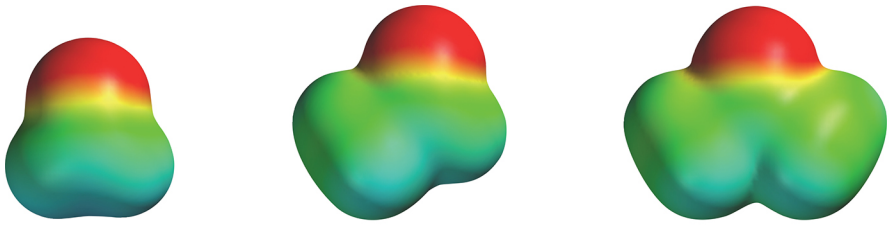
Addition to C=O

Polar molecules add across the C=O, with the positive part attaching to O.



Carbonyl Group

The C=O group is highly polar.
Many reactions involve addition across C=O, with the positive part attached to O.



Formaldehyde Acetaldehyde Acetone

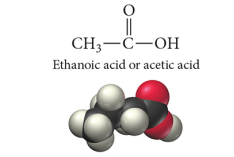
Naming Carboxylic Acids

- Carboxylic acid group always on end of main chain
  - Has highest naming precedence of functional groups
- C of group always C1
  - Position not indicated in name
- Change ending to ***-oic* acid**

Naming Esters

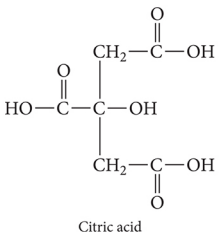
- Name an ester as if it were derived from carboxylic acid, replacing the H of the —OH group with an alkyl group.
- Begin the name with the alkyl group attached to O.
- Name the main chain with an *-oate* ending.

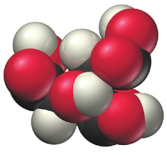
Examples of Naming Carboxylic Acids



Carboxylic Acids

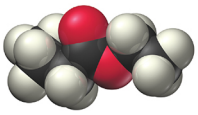
- RCOOH
- Sour tasting
- Weak acids
- Ethanoic acid, or acetic acid
  - Vinegar
- Methanoic acid, or formic acid
  - Insect bites and stings
- Citric acid
  - Found in citrus fruit

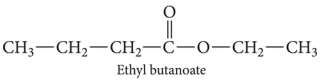




Esters

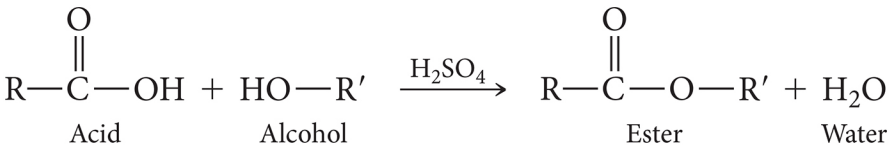
- R—COO—R
- Sweet odor



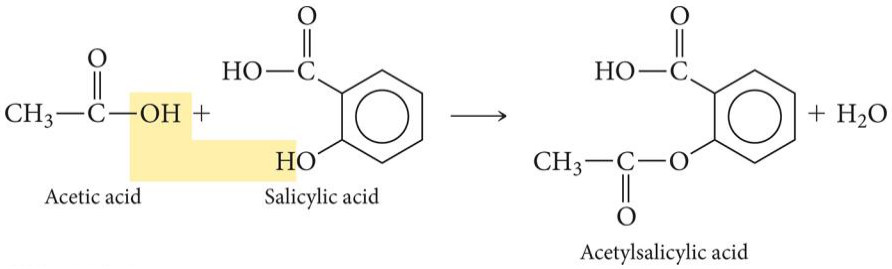


Condensation Reactions

- A condensation reaction is any organic reaction driven by the removal of a small molecule, such as water.
- Esters are made by the condensation reaction between a carboxylic acid and an alcohol.
  - The reaction is acid catalyzed.



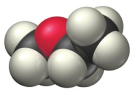
Synthesis of Aspirin (Acetylsalicylic Acid)



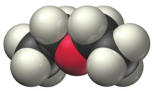
Ethers

- Ethers have the general formula ROR.
- The two R groups may be identical or different.
- Common names for ethers have the format:
  (R group 1) (R group 2) ether.

$CH_3—O—CH_3$
Dimethyl ether



$CH_3—O—CH_2—CH_3$
Ethyl methyl ether



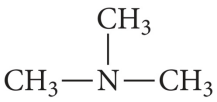
$CH_3—CH_2—O—CH_2—CH_3$
Diethyl ether

Ethers

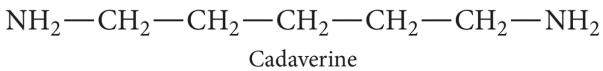
- Diethyl ether is the most common ether.
- It is useful as a laboratory solvent and can dissolve many organic compounds.
- It has a low boiling point.

Amines

- Organic molecules containing N derived from ammonia with one or more H atoms replaced with alkyl groups
- Very bad smelling
- Form when proteins decompose
- Organic bases
- Name alkyl groups attached to the N, then add -*amine* at the end.



Trimethylamine



Cadaverine

Amine Reactions

- Weak bases
  - React with strong acids to form ammonium salts

$$RNH_2 + HCl \rightarrow RNH_3^+Cl^-$$

- React with carboxylic acids in a condensation reaction to form **amides**

$$RCOOH + H—NHR' \rightarrow RCONHR' + H_2O$$