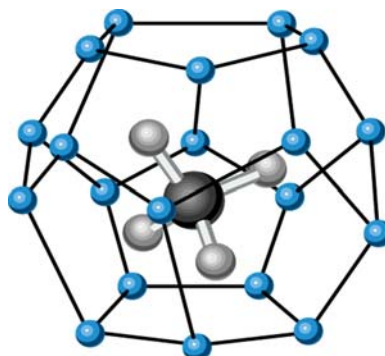


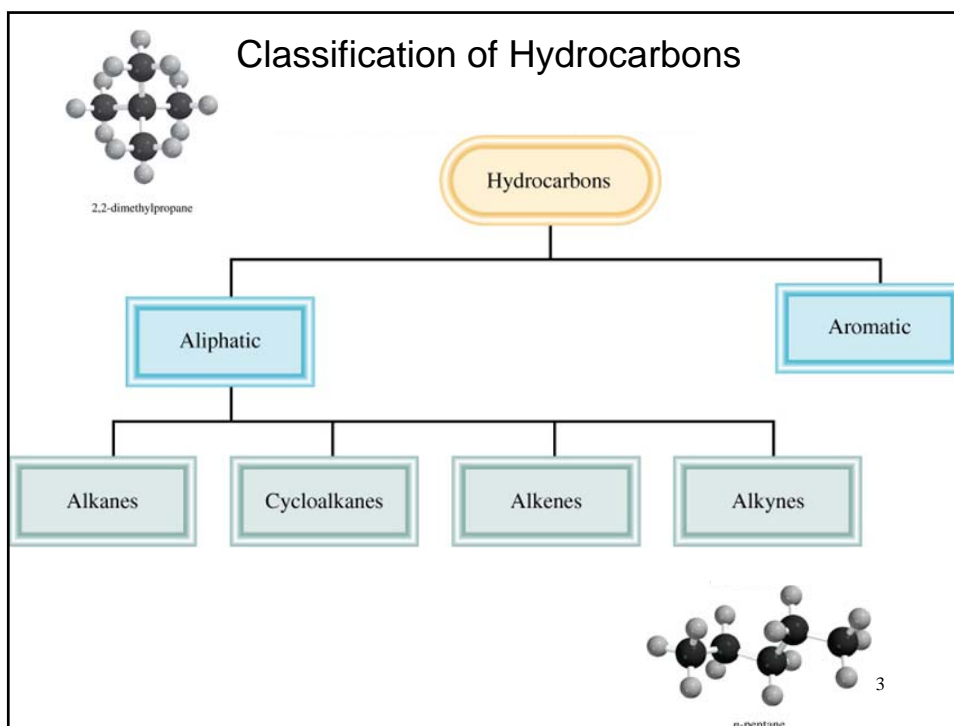
Organic Chemistry

Chapter 24



Common Elements in Organic Compounds

1A	2A	3A	4A	5A	6A	7A	8A
H		B	C	N	O	F	
			Si	P	S	Cl	
						Br	
						I	



Alkanes

Alkanes have the general formula C_nH_{2n+2} where $n = 1, 2, 3, \dots$

- only single covalent bonds
- **saturated hydrocarbons** because they contain the **maximum** number of hydrogen atoms that can bond with the number of carbon atoms in the molecule



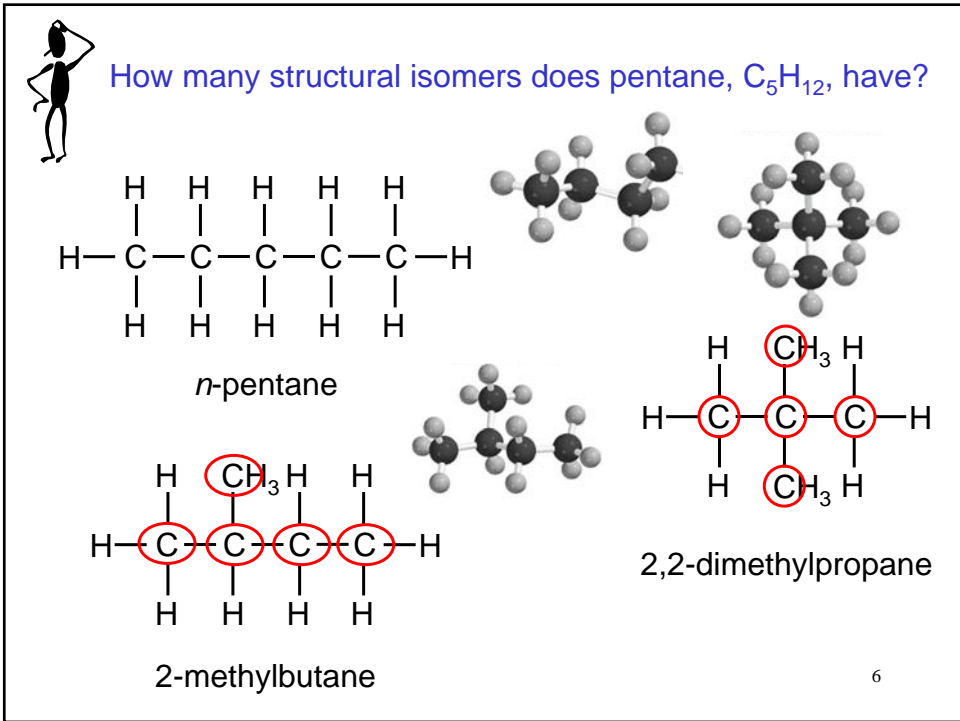
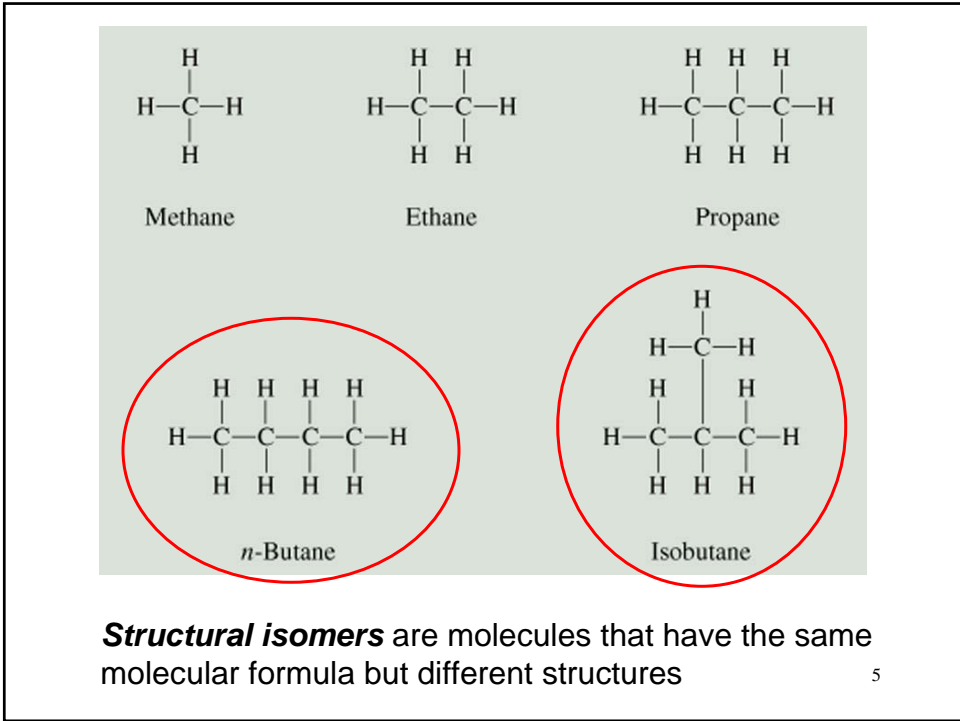
methane



ethane

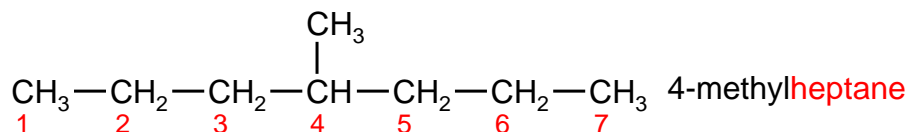


propane



Alkane Nomenclature

- The parent name of the hydrocarbon is that given to the **longest continuous** chain of carbon atoms in the molecule.



- An alkane less one hydrogen atom is an **alkyl** group.

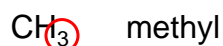
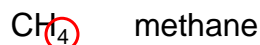


TABLE 24.2 Common Alkyl Groups

Name	Formula
Methyl	$-\text{CH}_3$
Ethyl	$-\text{CH}_2-\text{CH}_3$
<i>n</i> -Propyl	$-\text{CH}_2-\text{CH}_2-\text{CH}_3$
<i>n</i> -Butyl	$-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{CH}_3$
Isopropyl	$ \begin{array}{c} \text{CH}_3 \\ \\ -\text{C}-\text{H} \\ \\ \text{CH}_3 \end{array} $
<i>t</i> -Butyl*	$ \begin{array}{c} \text{CH}_3 \\ \\ -\text{C}-\text{CH}_3 \\ \\ \text{CH}_3 \end{array} $

*The letter *t* stands for tertiary.

7

24.2

Alkane Nomenclature

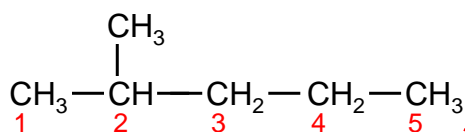
TABLE 24.1 The First 10 Straight-Chain Alkanes

Name of Hydrocarbon	Molecular Formula	Number of Carbon Atoms	Melting Point (°C)	Boiling Point (°C)
Methane	CH_4	1	-182.5	-161.6
Ethane	CH_3-CH_3	2	-183.3	-88.6
Propane	$\text{CH}_3-\text{CH}_2-\text{CH}_3$	3	-189.7	-42.1
Butane	$\text{CH}_3-(\text{CH}_2)_2-\text{CH}_3$	4	-138.3	-0.5
Pentane	$\text{CH}_3-(\text{CH}_2)_3-\text{CH}_3$	5	-129.8	36.1
Hexane	$\text{CH}_3-(\text{CH}_2)_4-\text{CH}_3$	6	-95.3	68.7
Heptane	$\text{CH}_3-(\text{CH}_2)_5-\text{CH}_3$	7	-90.6	98.4
Octane	$\text{CH}_3-(\text{CH}_2)_6-\text{CH}_3$	8	-56.8	125.7
Nonane	$\text{CH}_3-(\text{CH}_2)_7-\text{CH}_3$	9	-53.5	150.8
Decane	$\text{CH}_3-(\text{CH}_2)_8-\text{CH}_3$	10	-29.7	174.0

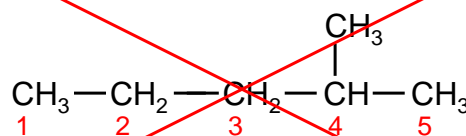
8

Alkane Nomenclature

3. When one or more hydrogen atoms are replaced by other groups, the name of the compound must indicate the locations of carbon atoms where replacements are made. Number in the direction that gives the smaller numbers for the locations of the branches.



2-methylpentane

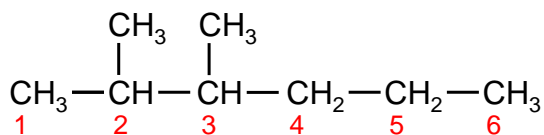


~~4-methylpentane~~

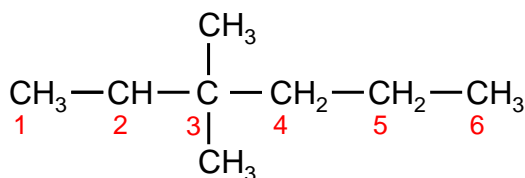
9

Alkane Nomenclature

4. Use prefixes *di-*, *tri-*, *tetra-*, when there is more than one alkyl branch of the same kind.



2,3-dimethylhexane

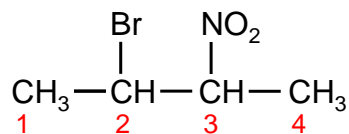


3,3-dimethylhexane

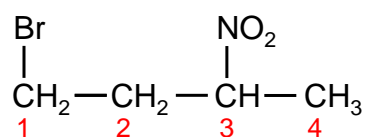
10

Alkane Nomenclature

5. Use previous rules for other types of substituents.



2-bromo-3-nitrobutane



1-bromo-3-nitrobutane

TABLE 24.3

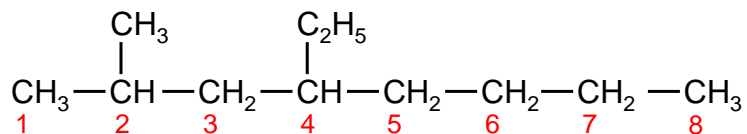
Names of Common Substituent Groups

Functional Group	Name
—NH ₂	Amino
—F	Fluoro
—Cl	Chloro
—Br	Bromo
—I	Iodo
—NO ₂	Nitro
—CH=CH ₂	Vinyl

11



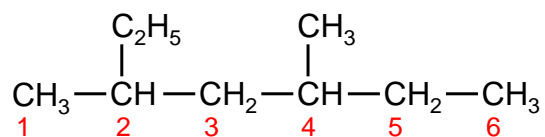
What is the IUPAC name of the following compound?



2-methyl-4-ethyloctane



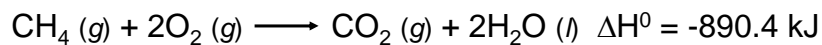
What is the structure of 2-propyl-4-methylhexane?



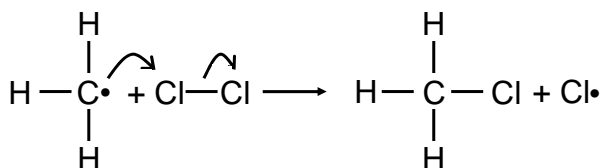
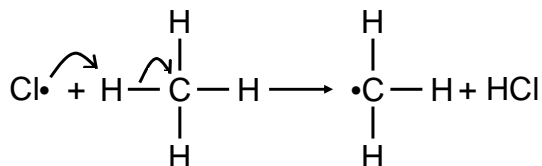
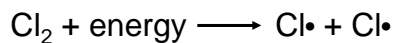
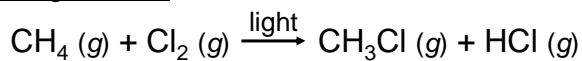
12

Alkane Reactions

Combustion



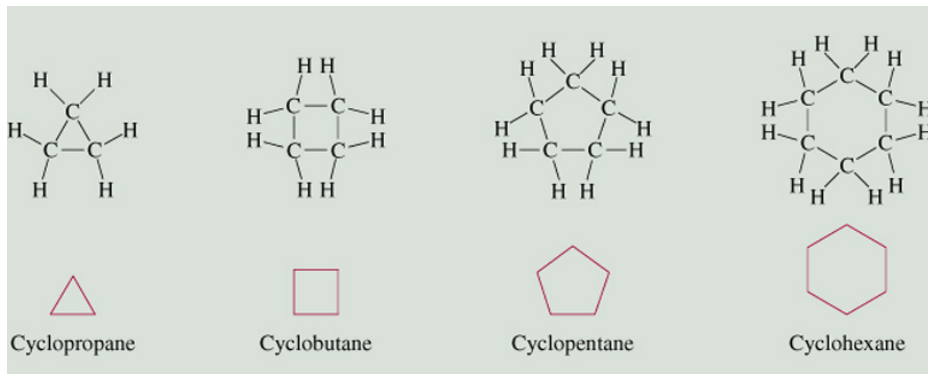
Halogenation



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Cycloalkanes

Alkanes whose carbon atoms are joined in rings are called **cycloalkanes**. They have the general formula C_nH_{2n} where $n = 3, 4, \dots$

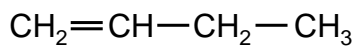


14

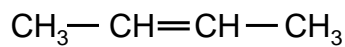
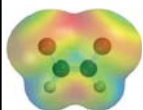
Alkenes

Alkenes have the general formula C_nH_{2n} where $n = 2, 3, \dots$

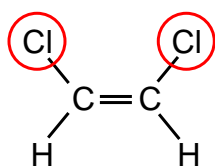
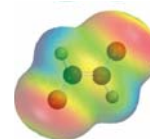
- contain at least one carbon-carbon double bond
- also called **olefins**



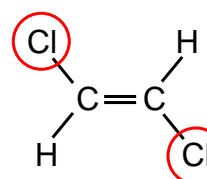
1-butene



2-butene



cis-dichloroethylene

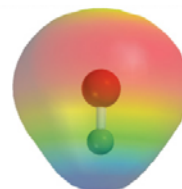
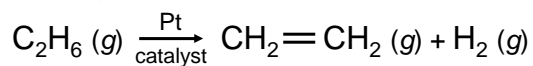


trans-dichloroethylene

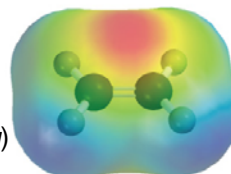
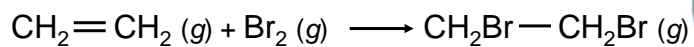
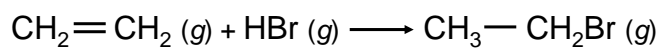
15

Alkene Reactions

Cracking



Addition Reactions

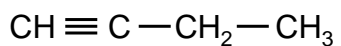


16

Alkynes

Alkynes have the general formula C_nH_{2n-2} where $n = 2, 3, 4, \dots$

- contain at least one carbon-carbon triple bond

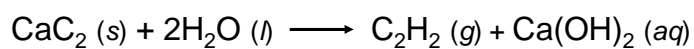


1-butyne



2-butyne

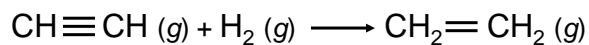
Production of acetylene



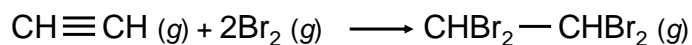
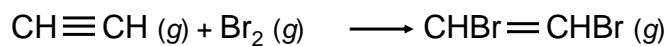
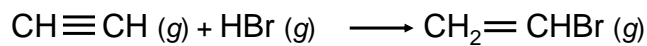
17

Alkyne Reactions

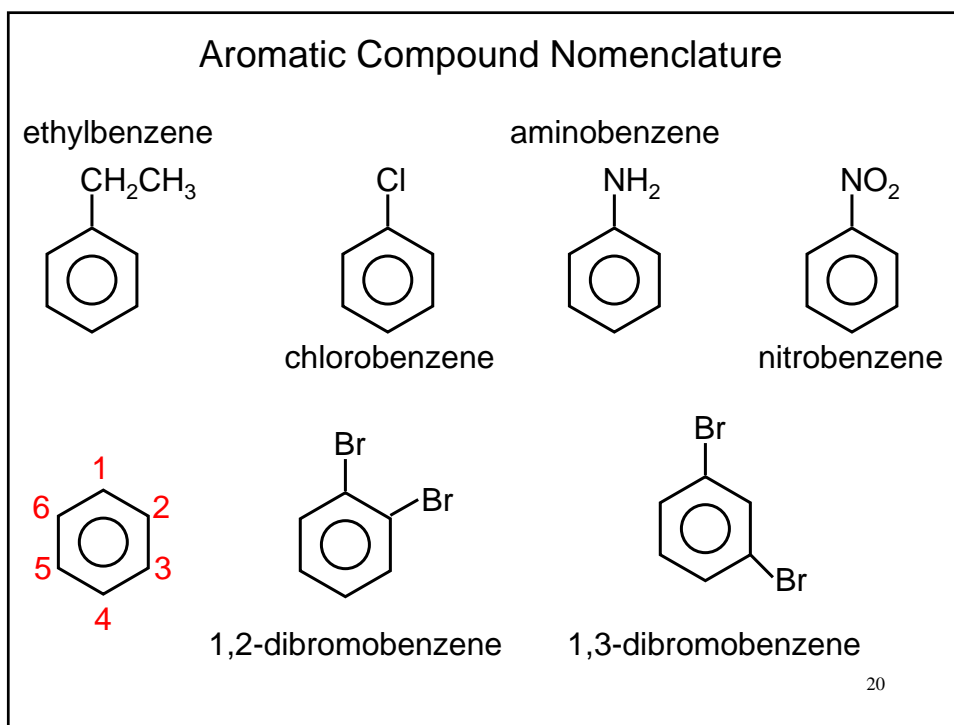
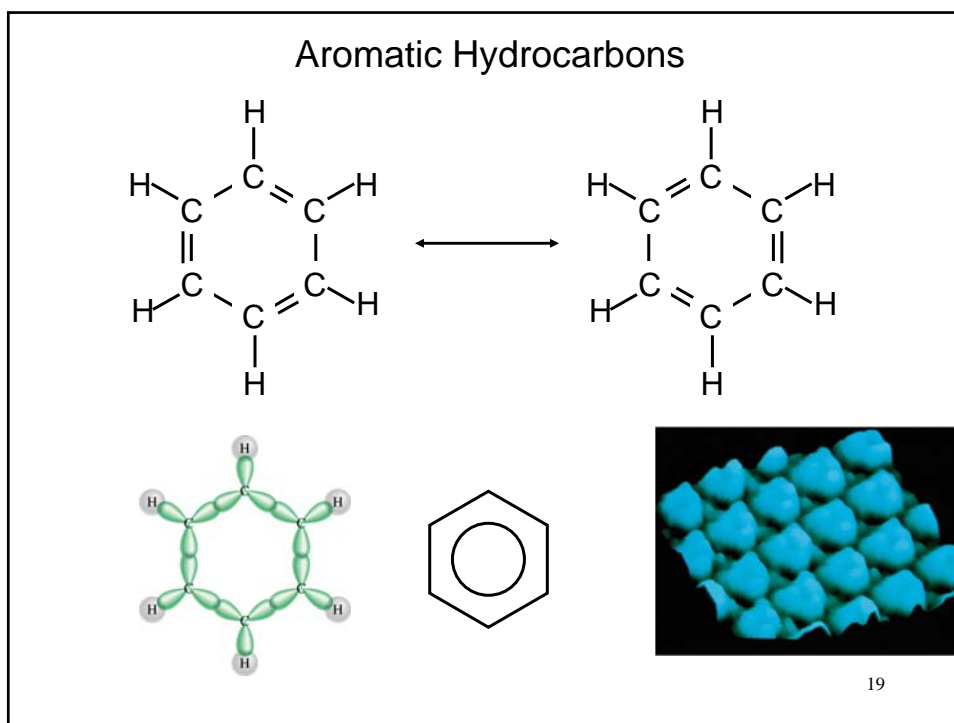
Hydrogenation



Addition Reactions

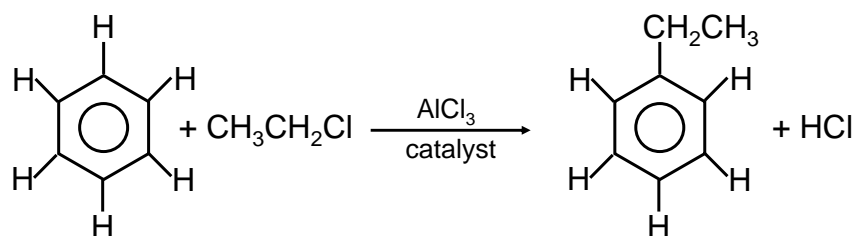
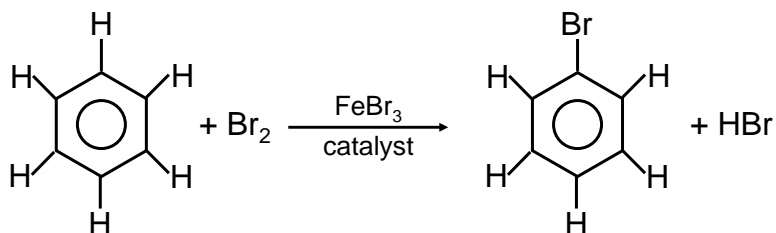


18



Aromatic Compound Reactions

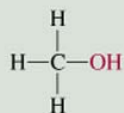
Substitution reaction



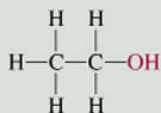
21

Functional Group Chemistry

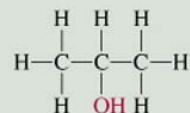
Alcohols contain the hydroxyl functional group and have the general formula R-OH.



Methanol
(methyl alcohol)



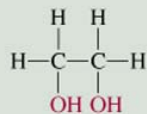
Ethanol
(ethyl alcohol)



2-Propanol
(isopropyl alcohol)



Phenol



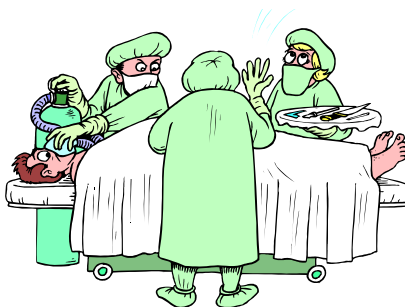
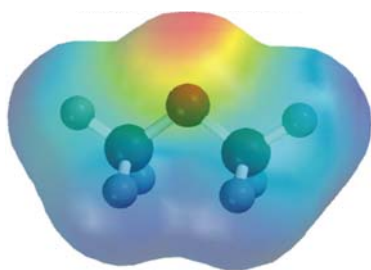
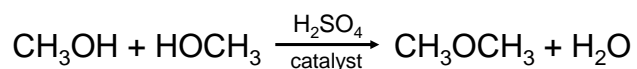
Ethylene glycol

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Functional Group Chemistry

Ethers have the general formula R-O-R'.

Condensation Reaction



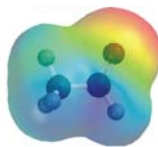
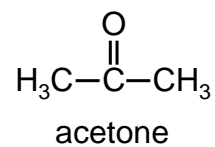
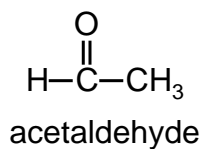
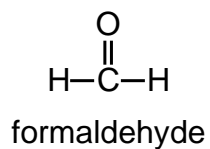
23

Functional Group Chemistry

Aldehydes and ketones contain the carbonyl ($>\text{C}=\text{O}$) functional group.

• **aldehydes** have the general formula $\text{R}-\overset{\text{O}}{\parallel}{\text{C}}-\text{H}$

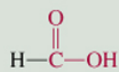
• **ketones** have the general formula $\text{R}-\overset{\text{O}}{\parallel}{\text{C}}-\text{R}'$



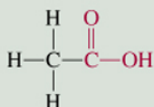
24

Functional Group Chemistry

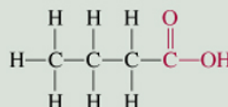
Carboxylic acids contain the carboxyl (-COOH) functional group.



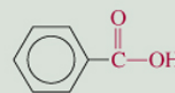
Formic acid



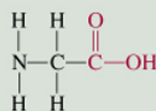
Acetic acid



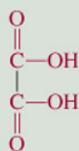
Butyric acid



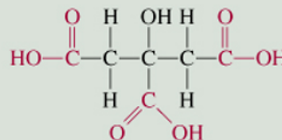
Benzoic acid



Glycine



Oxalic acid

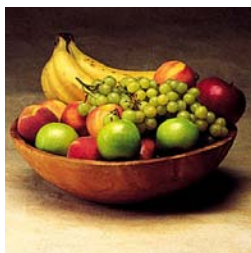
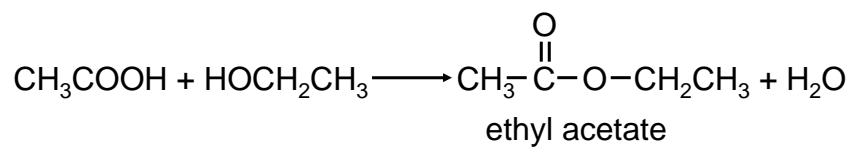


Citric acid

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Functional Group Chemistry

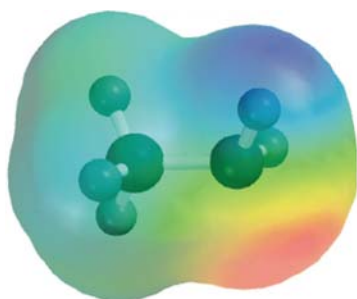
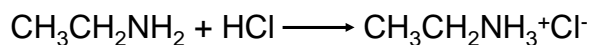
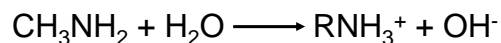
Esters have the general formula R'COOR, where R is a hydrocarbon group.



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Functional Group Chemistry

Amines are organic bases with the general formula R_3N .



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TABLE 24.4 Important Functional Groups and Their Reactions

Functional Group	Name	Typical Reactions
$\begin{array}{c} \diagup \\ \text{C}=\text{C} \\ \diagdown \end{array}$	Carbon-carbon double bond	Addition reactions with halogens, hydrogen halides, and water; hydrogenation to yield alkanes
$-\text{C}\equiv\text{C}-$	Carbon-carbon triple bond	Addition reactions with halogens, hydrogen halides; hydrogenation to yield alkenes and alkanes
$-\ddot{\text{X}}:$ (X = F, Cl, Br, I)	Halogen	Exchange reactions: $\text{CH}_3\text{CH}_2\text{Br} + \text{KI} \longrightarrow \text{CH}_3\text{CH}_2\text{I} + \text{KBr}$
$-\ddot{\text{O}}-\text{H}$	Hydroxyl	Esterification (formation of an ester) with carboxylic acids; oxidation to aldehydes, ketones, and carboxylic acids
$\begin{array}{c} \diagup \\ \text{C}=\ddot{\text{O}} \\ \diagdown \end{array}$	Carbonyl	Reduction to yield alcohols; oxidation of aldehydes to yield carboxylic acids
$\begin{array}{c} \text{:O:} \\ \parallel \\ -\text{C}-\ddot{\text{O}}-\text{H} \end{array}$	Carboxyl	Esterification with alcohols; reaction with phosphorus pentachloride to yield acid chlorides
$\begin{array}{c} \text{:O:} \\ \parallel \\ -\text{C}-\ddot{\text{O}}-\text{R} \end{array}$ (R = hydrocarbon)	Ester	Hydrolysis to yield acids and alcohols
$\begin{array}{c} \text{R} \\ \diagup \\ \text{N} \\ \diagdown \\ \text{R} \end{array}$ (R = H or hydrocarbon)	Amine	Formation of ammonium salts with acids

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