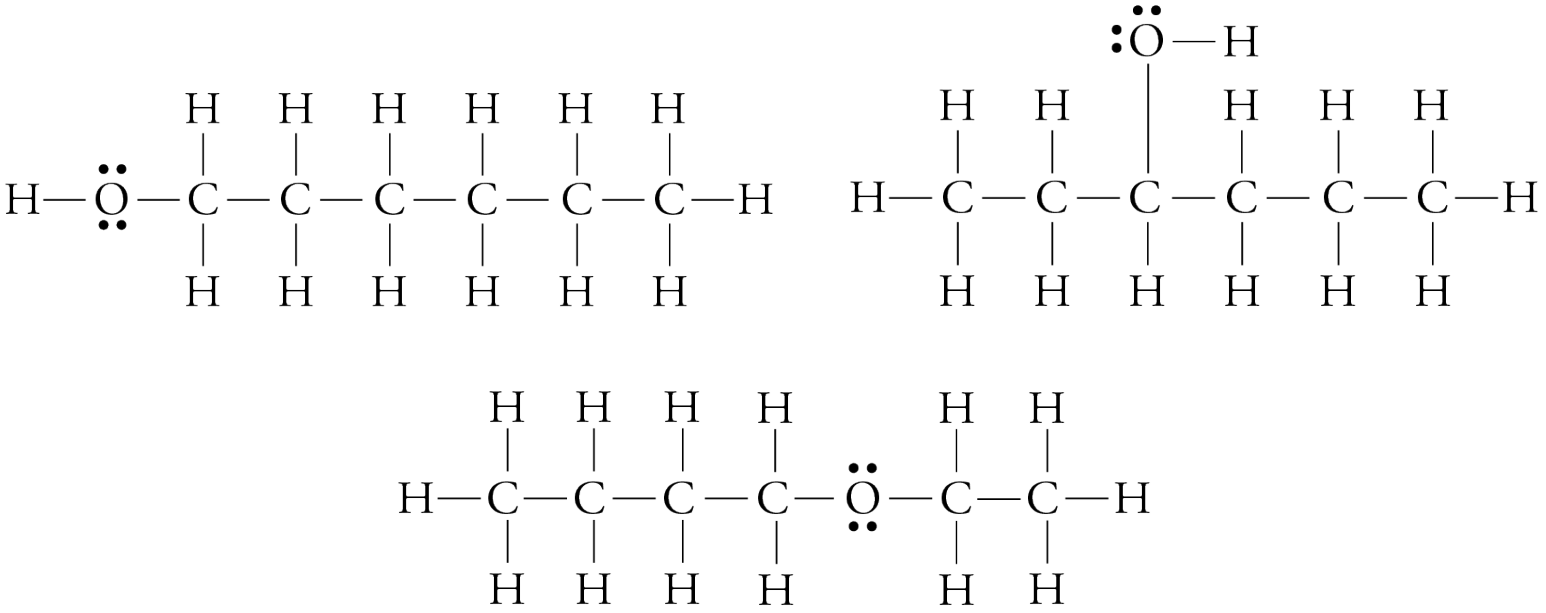
Organic Chemistry

- **Organic chemistry** is the chemistry of carbon-based compounds.
- There are two reasons why there are millions of organic chemicals.
  - Carbon atoms can form strong bonds to other carbon atoms and still form bonds to atoms of other elements.
  - There are many different ways to arrange the same atoms in carbon-based compounds.

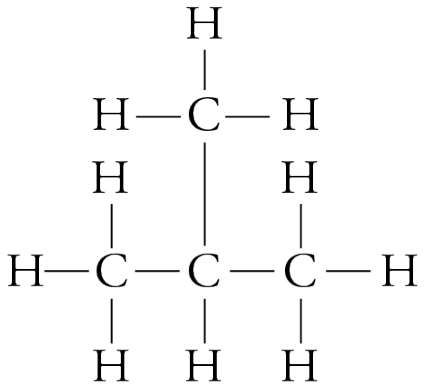
Isomers



- **Isomers** are molecules with the same atoms (same molecular formula) but a different arrangement of the atoms in space (different structural formula).

Ways to Describe Organic Compounds (Methylpropane)

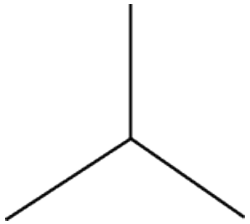
- Lewis structures



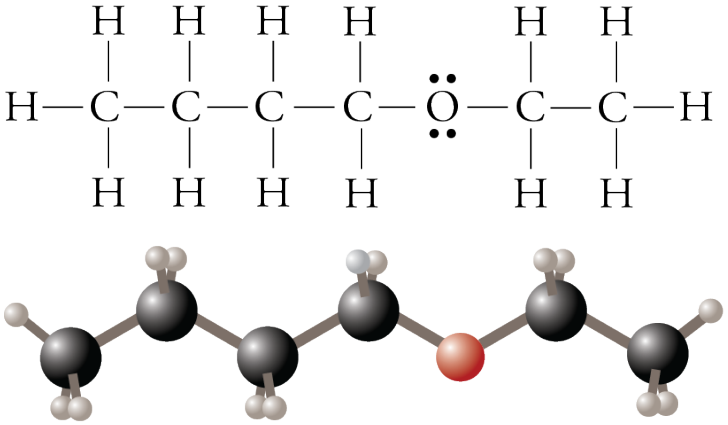
- Condensed formulas

$CH_3CH(CH_3)CH_3$

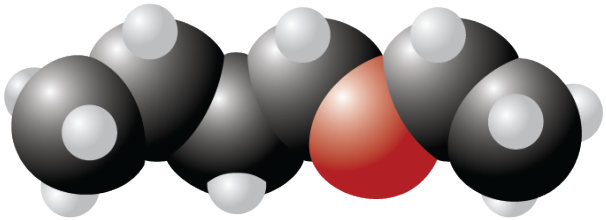
- Line drawings

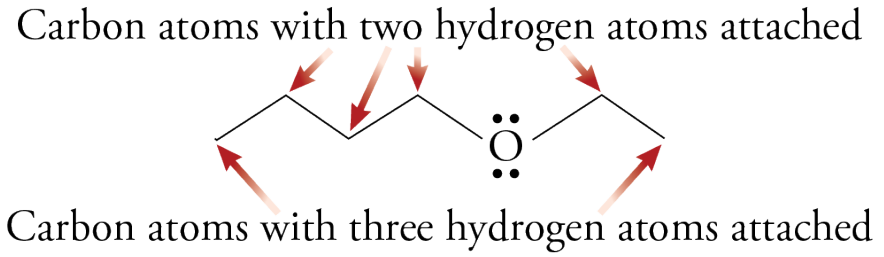


Ways to Describe Organic Compounds (butyl ethyl ether)

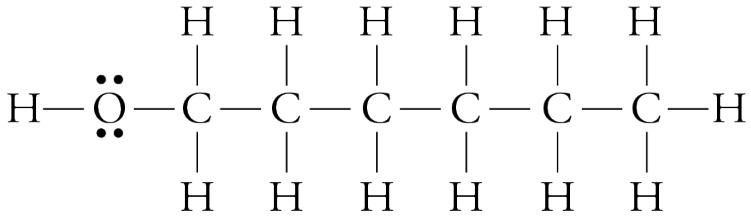


$CH_3CH_2CH_2CH_2OCH_2CH_3$ or $CH_3(CH_2)_3OCH_2CH_3$

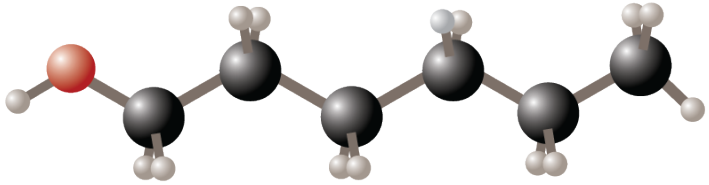


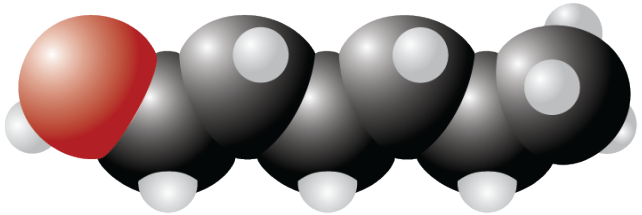


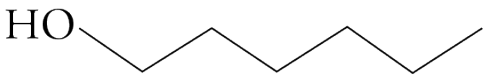
Ways to Describe Organic Compounds (1-hexanol)



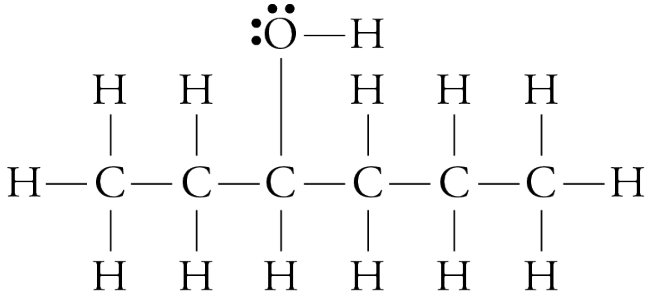
$HOCH_2CH_2CH_2CH_2CH_2CH_3$ or $HOCH_2(CH_2)_4CH_3$

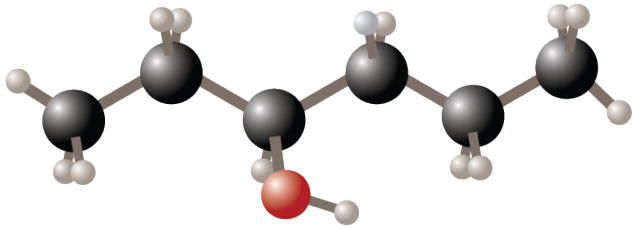




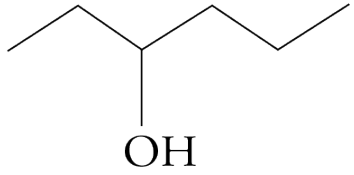


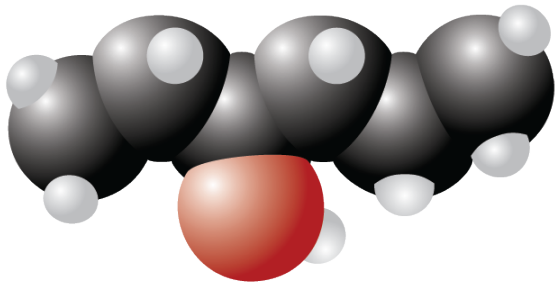
Ways to Describe Organic Compounds (3-hexanol)





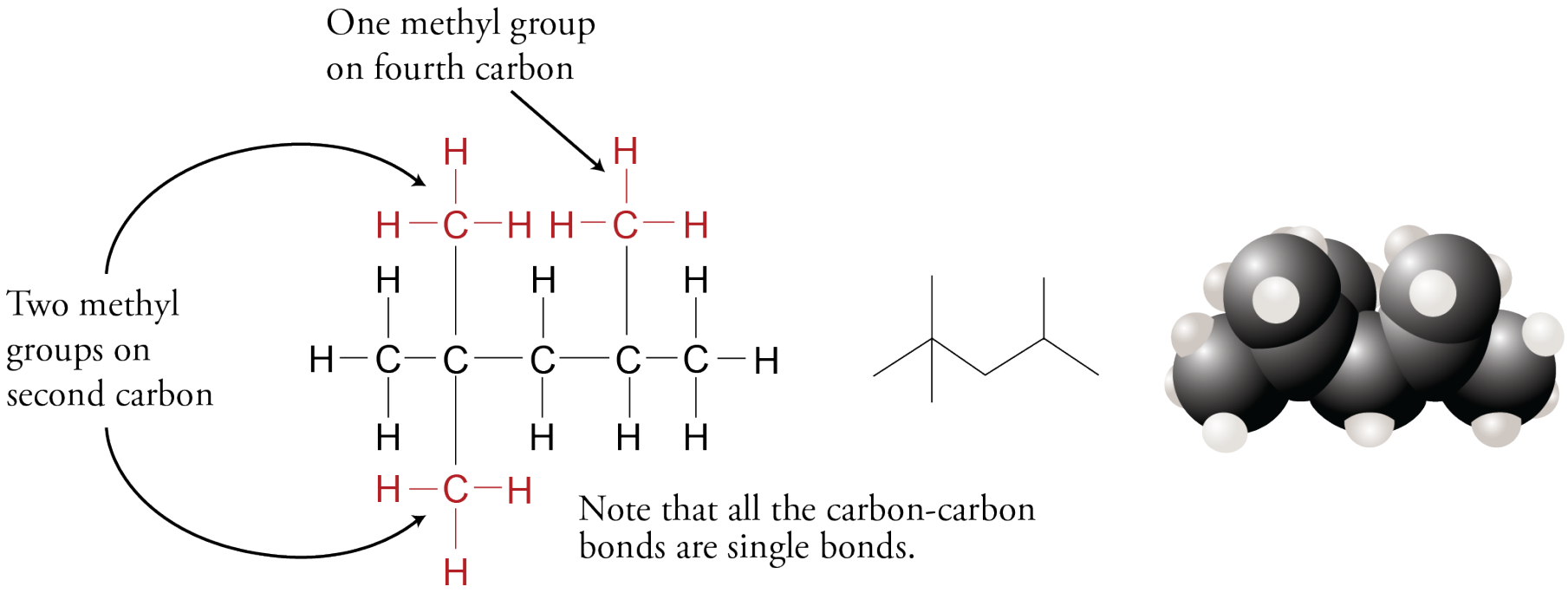
$CH_3CH_2CH(OH)CH_2CH_2CH_3$



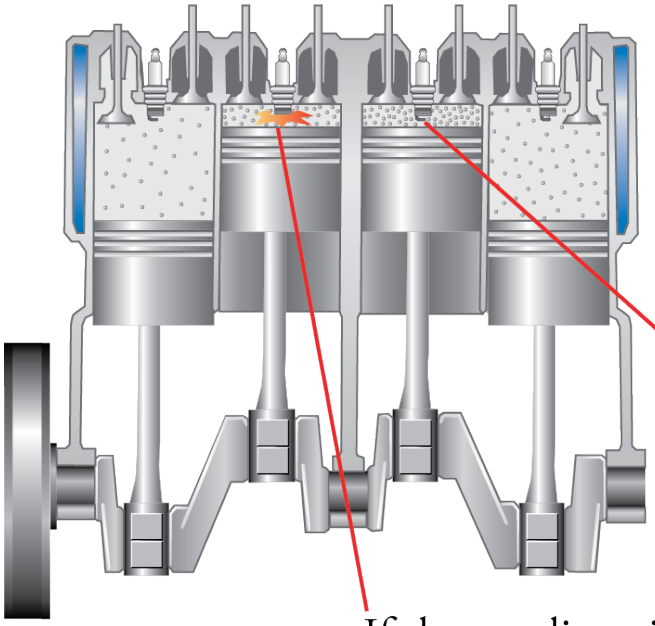


Alkanes

Hydrocarbons (compounds composed of carbon and hydrogen) in which all of the carbon-carbon bonds are single bonds



2,2,4-trimethylpentane, $CH_3C(CH_3)_2CH_2CH(CH_3)CH_3$



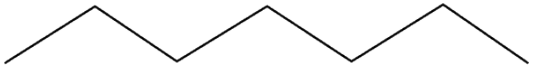
Pre-ignition Knock and Octane Rating

If the gasoline-air mixture reacts too soon, before the peak of the stroke of the piston, the piston pushes the crankshaft in the opposite direction, causing a vibration or "pre-ignition knock".

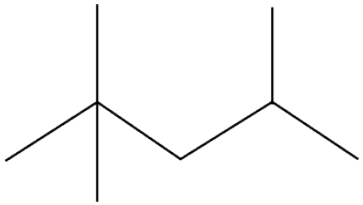
If the gasoline-air mixture ignites at (or just past) the peak of the stroke of the piston, the crankshaft is turned, which ultimately turns the wheels.

Straight-chain hydrocarbons, such as heptane, are more likely to react early, so a gasoline that has a higher percentage of straight-chain hydrocarbons has a greater tendency toward pre-ignition knock.

Branched-chain hydrocarbons, such as 2,2,4-trimethylpentane, are less likely to react early, so a gasoline that has a higher percentage of branched-chain hydrocarbons has a lower tendency toward pre-ignition knock.



Heptane



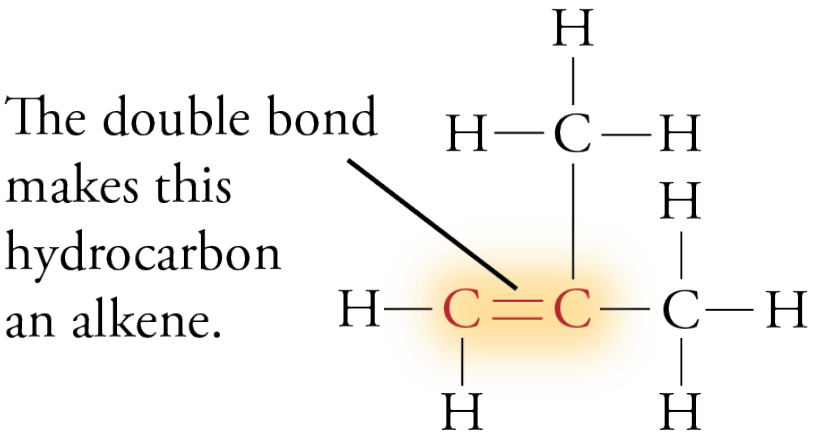
2,2,4-trimethylpentane

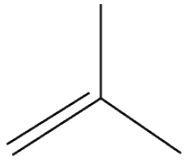
Steps to Octane Rating

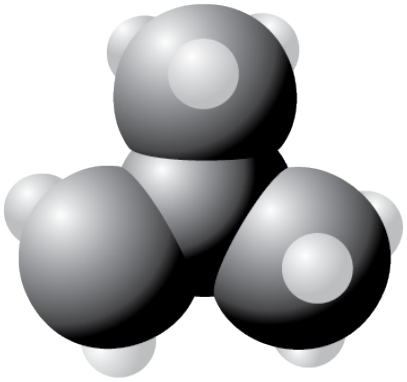
- Measure efficiency and degree of vibration for a test engine running on various percentages of heptane (a straight-chain hydrocarbon) and 2,2,4-trimethylpentane (a branched-chain hydrocarbon).
- Run the same test engine with the gasoline to be tested, and measure its efficiency and degree of vibration.
- Assign an octane rating to the gasoline based on comparison of the efficiency and degree of vibration of the test engine with the gasoline and the various percentages of 2,2,4-trimethylpentane (octane or isooctane) and heptane. For example, if the gasoline runs the test engine as efficiently as 91% 2,2,4-trimethylpentane (octane or isooctane) and 9% heptane, it gets an octane rating of 91.

Alkenes

Hydrocarbons that have one or more carbon-carbon double bonds





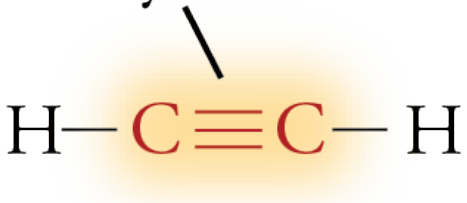


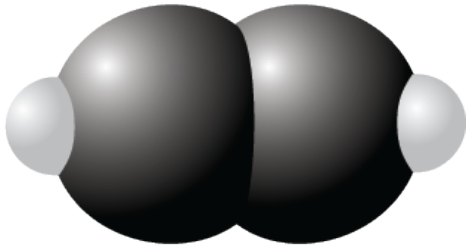
2-methylpropene (isobutene), $CH_2C(CH_3)CH_3$

Alkynes

Hydrocarbons that have one or more carbon-carbon triple bonds

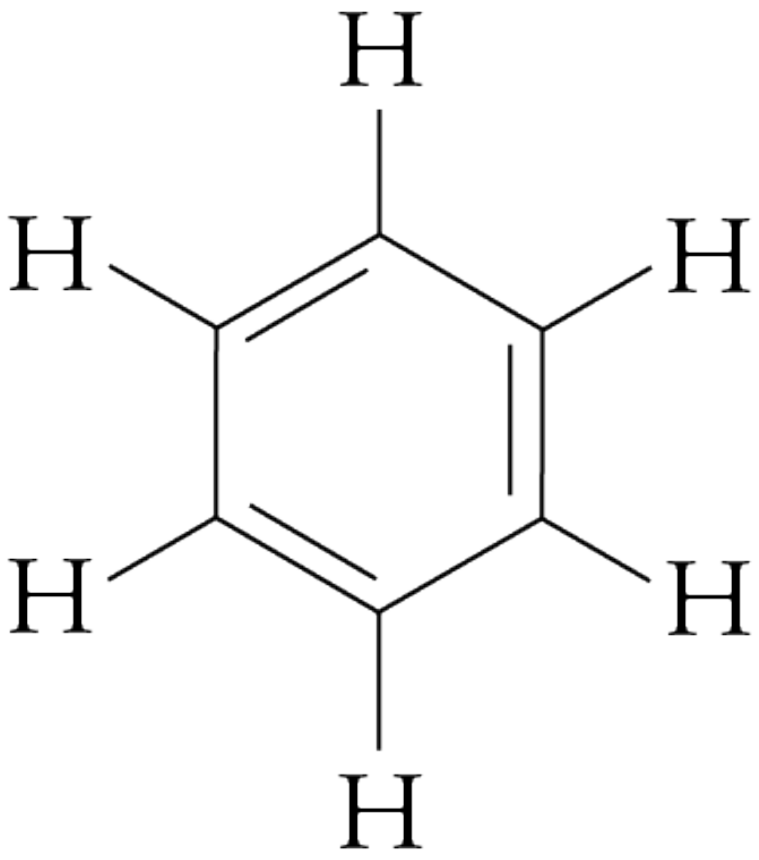
The triple bond makes this hydrocarbon an alkyne.



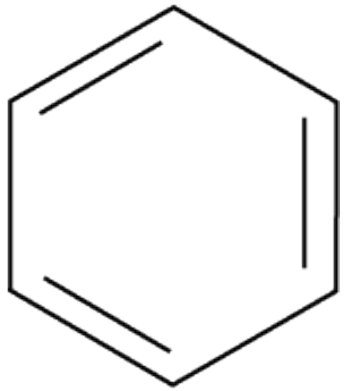


Ethyne (acetylene), HCCH

Benzene

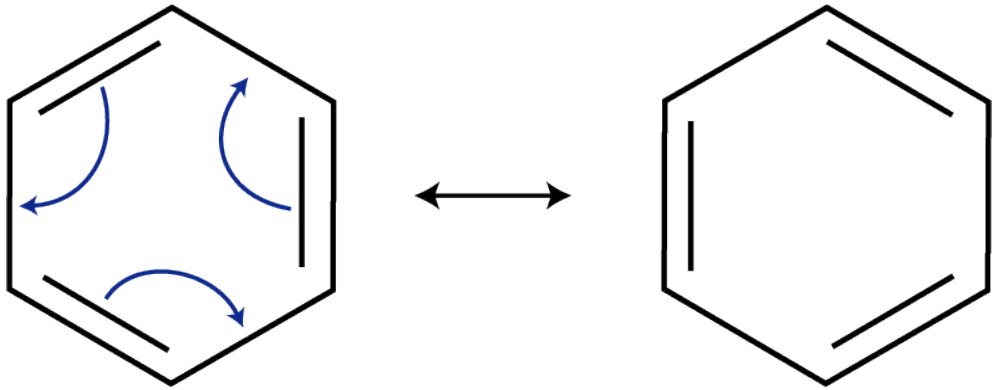


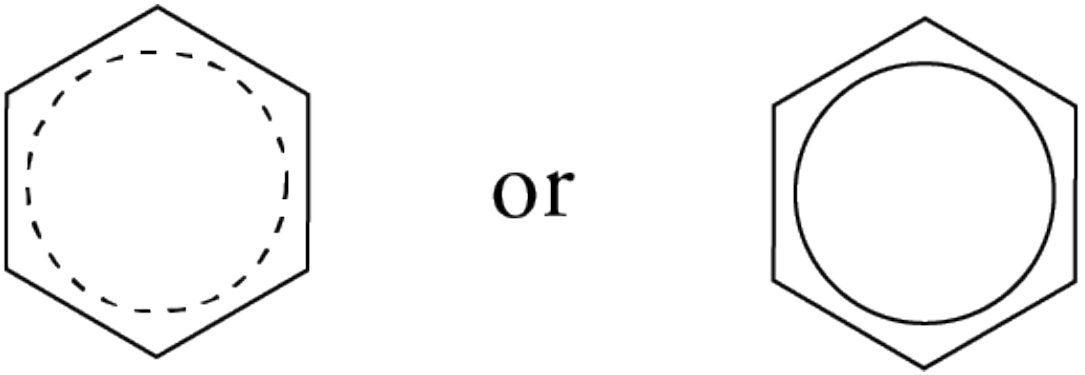
or



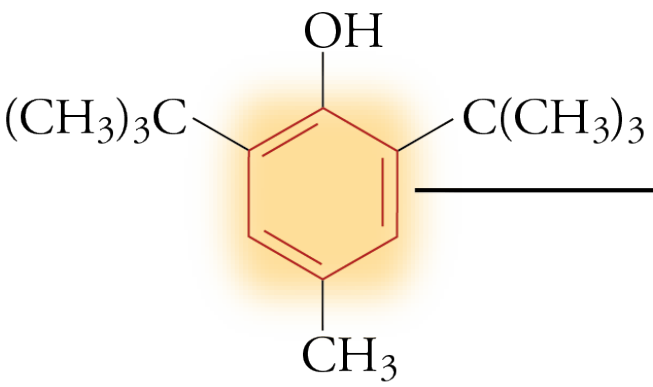
Benzene

Benzene



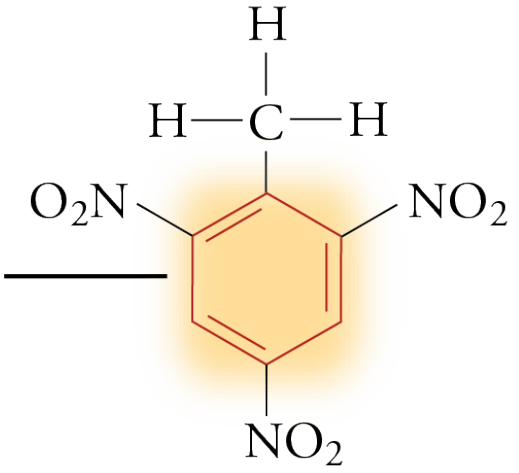


Arenes (or Aromatics) - Compounds that contain the benzene ring

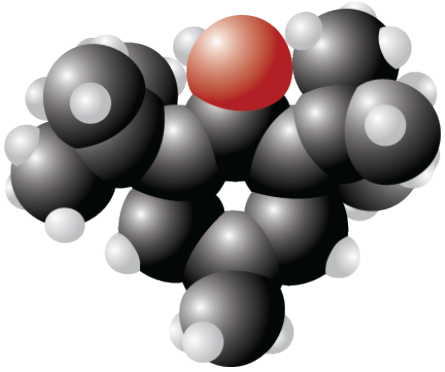


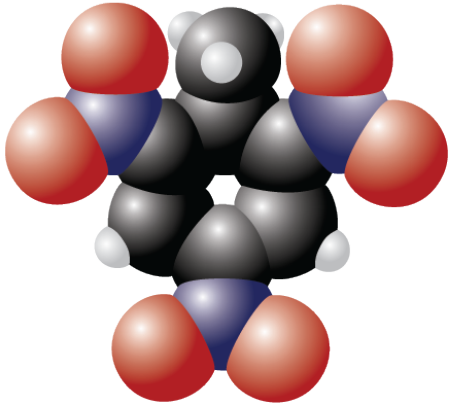
BHT

Benzene rings make these compounds arenes.



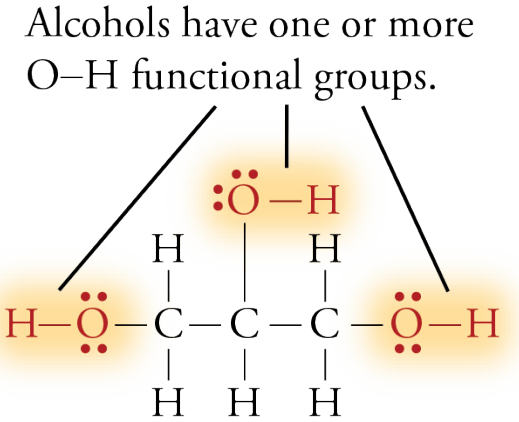
TNT

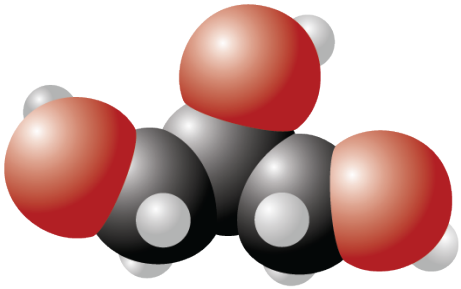


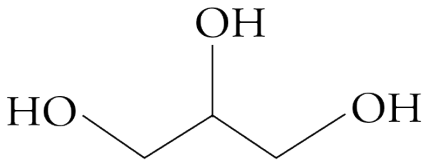


Alcohols

Compounds with one or more -OH groups attached to a hydrocarbon group

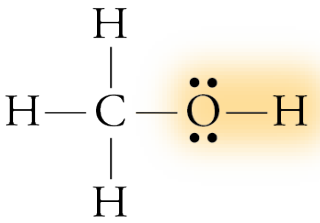




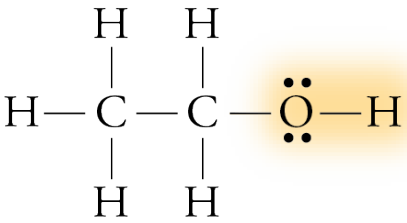


Glycerol, $HOCH_2CH(OH)CH_2OH$

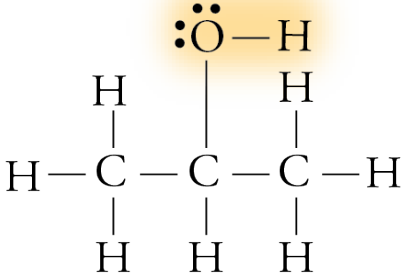
Other Common Alcohols



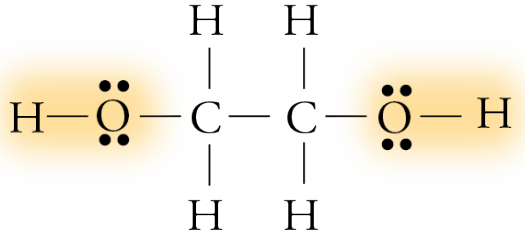
Methanol



Ethanol

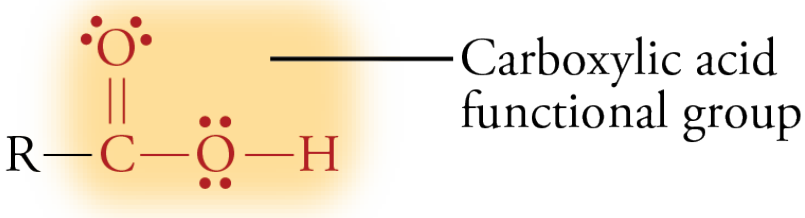


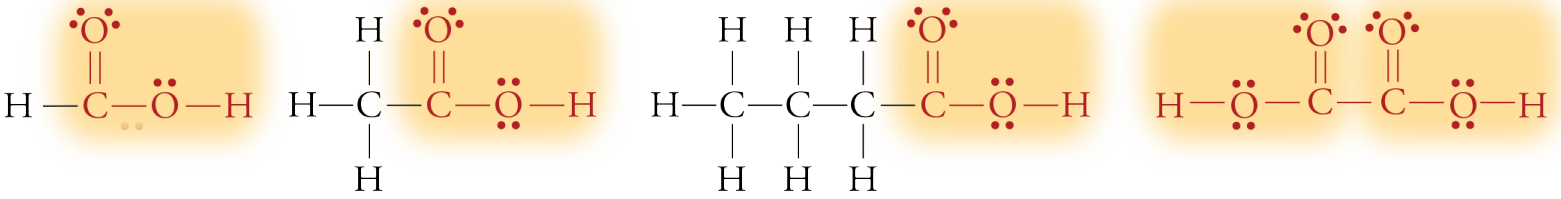
2-Propanol



Ethylene glycol

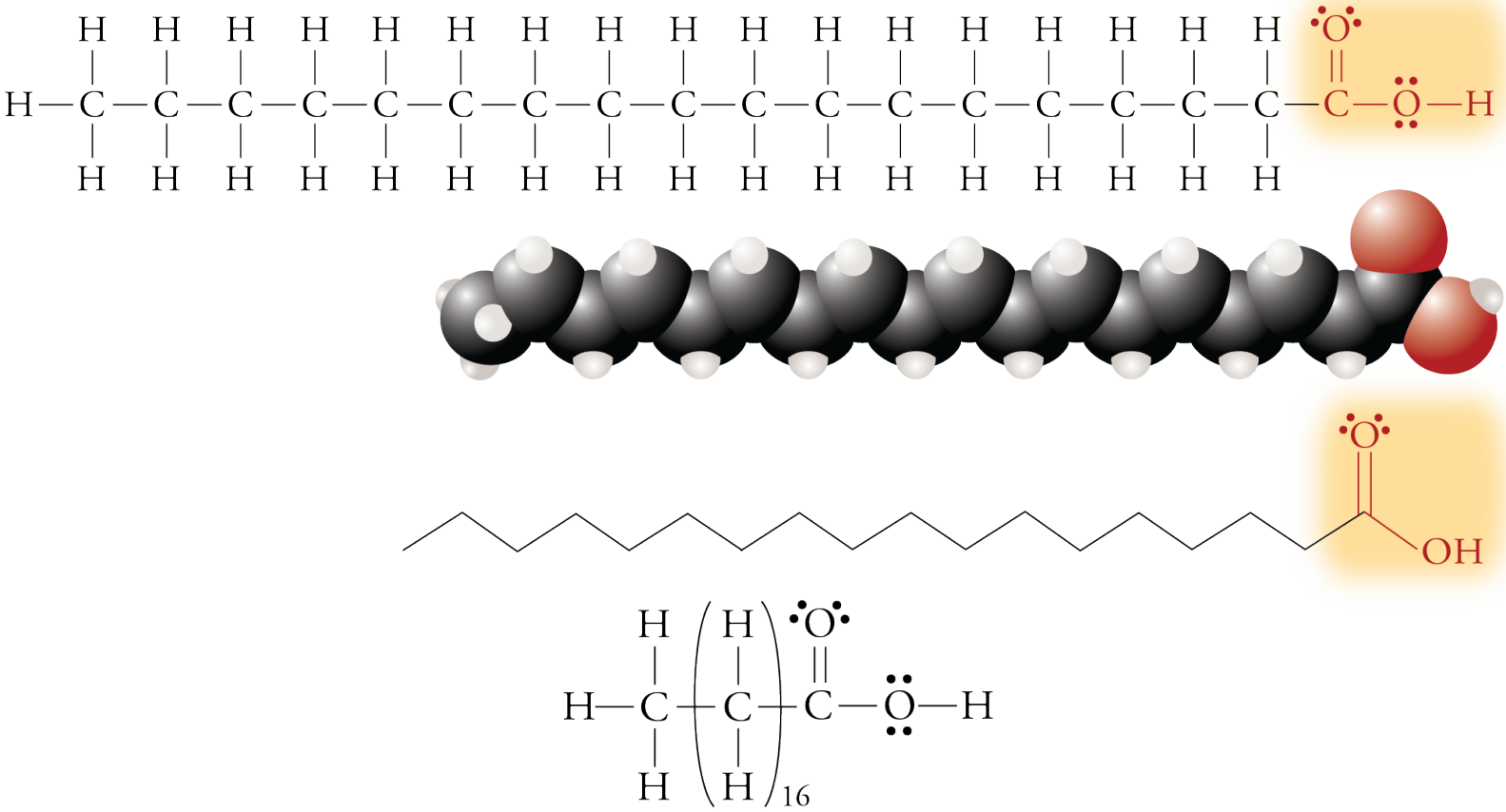
Carboxylic Acids





Formic acid Acetic acid Butanoic acid Oxalic acid

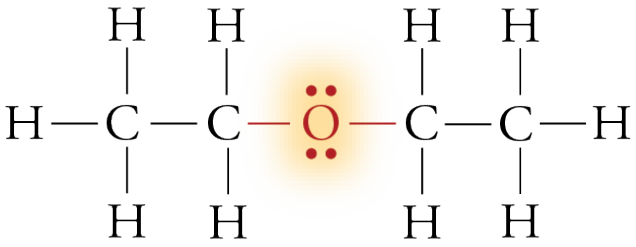
Fatty Acids

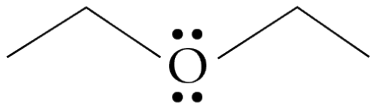


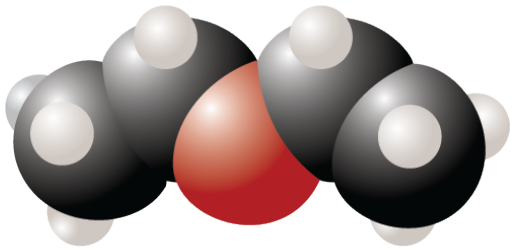
Stearic acid, $CH_3(CH_2)_{16}CO_2H$

Ethers

Two hydrocarbon groups surrounding an oxygen atom

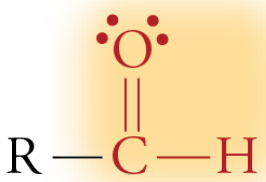




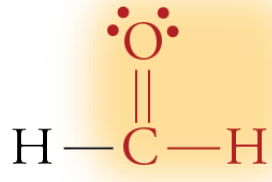


Diethyl ether, $CH_3CH_2OCH_2CH_3$

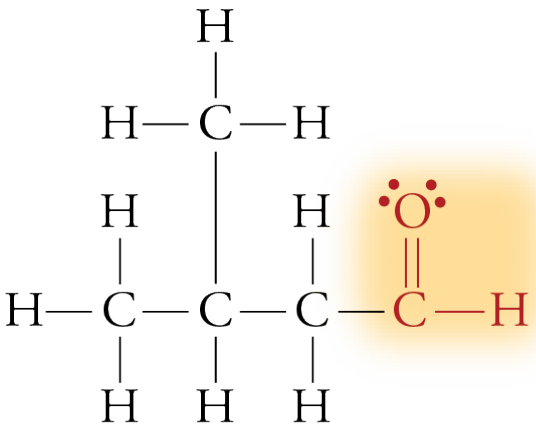
Aldehyde

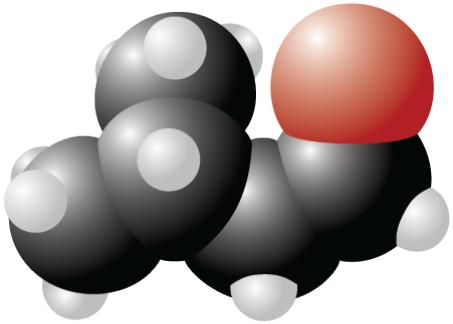


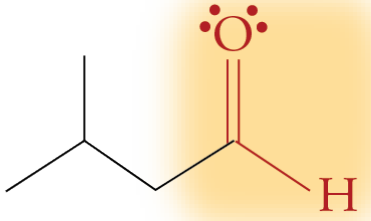
Aldehyde



Formaldehyde



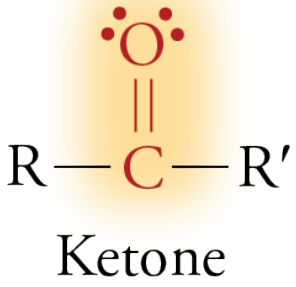




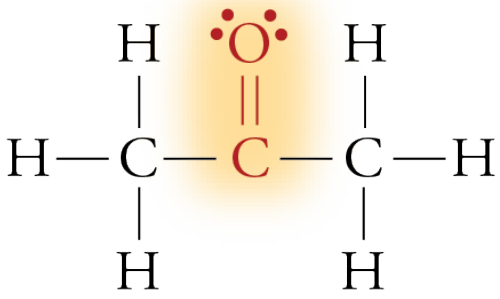
2-methylbutanal, $CH_3CH(CH_3)CH_2CHO$

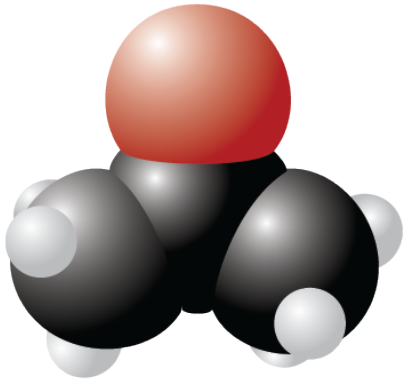
Ketones

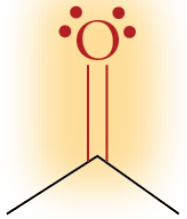
The R's must be hydrocarbon groups. They cannot be hydrogen atoms.



Ketone

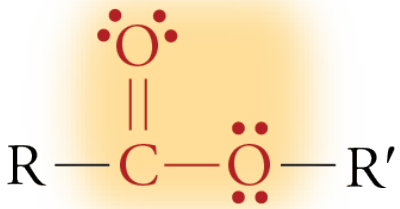






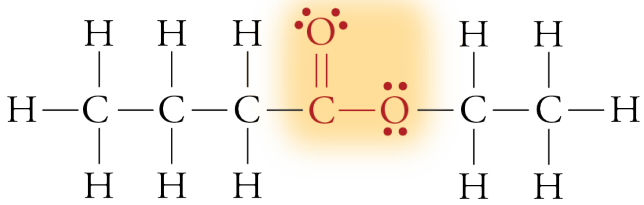
2-propanone (acetone), CH_3COCH_3

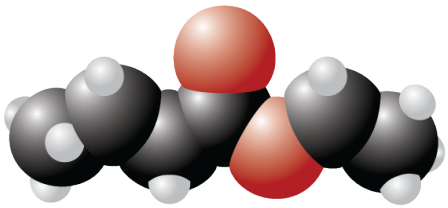
Esters

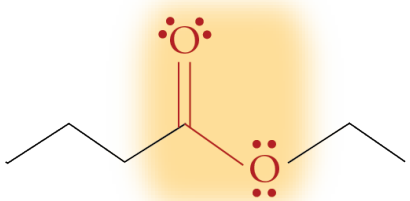


Ester

The R’ must be a hydrocarbon group. It cannot be a hydrogen atom.

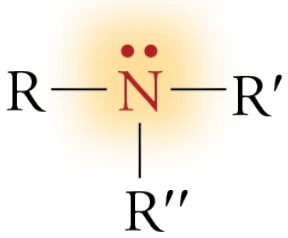




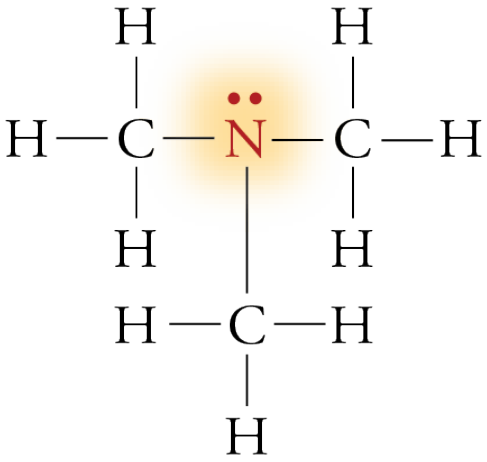


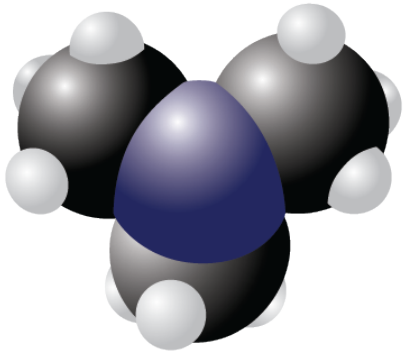
Ethyl butanoate, $CH_3CH_2CH_2CO_2CH_2CH_3$

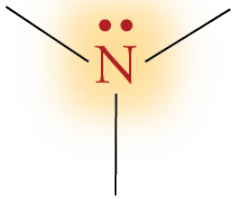
Amine



Amine

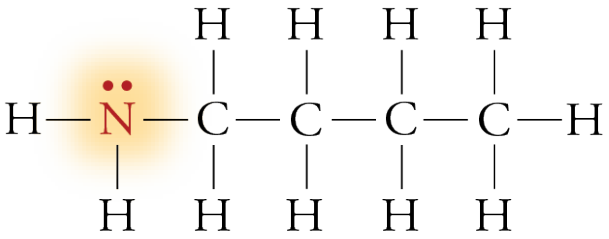




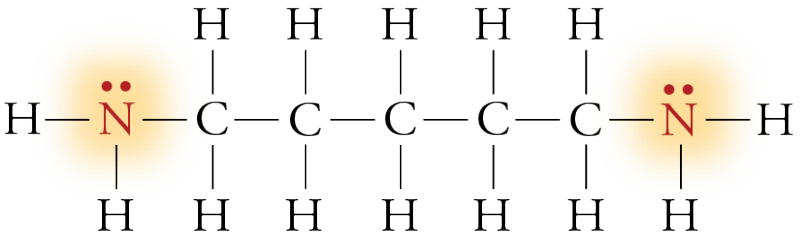


Trimethylamine, $(CH_3)_3N$

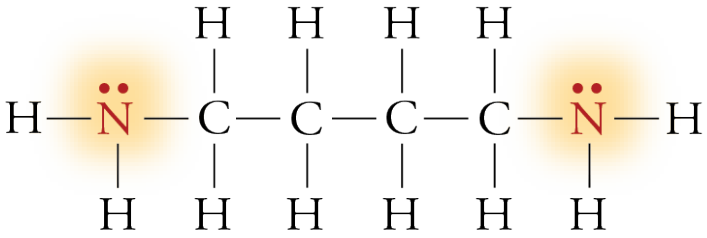
More Amines



1-Aminobutane

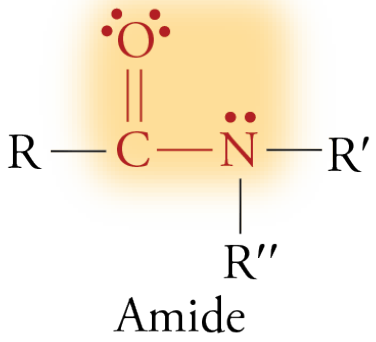


Cadaverine

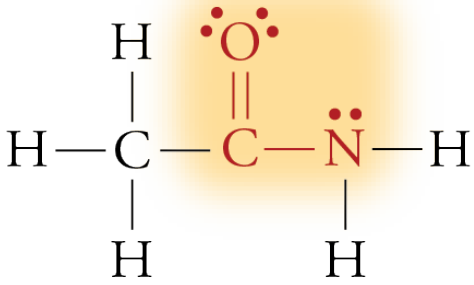


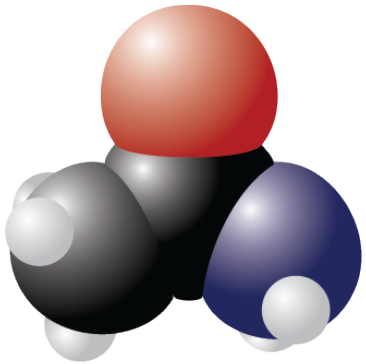
Putresine

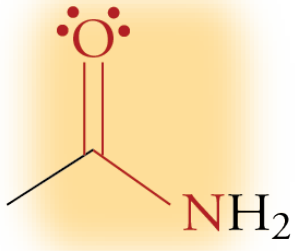
Amides



Amide

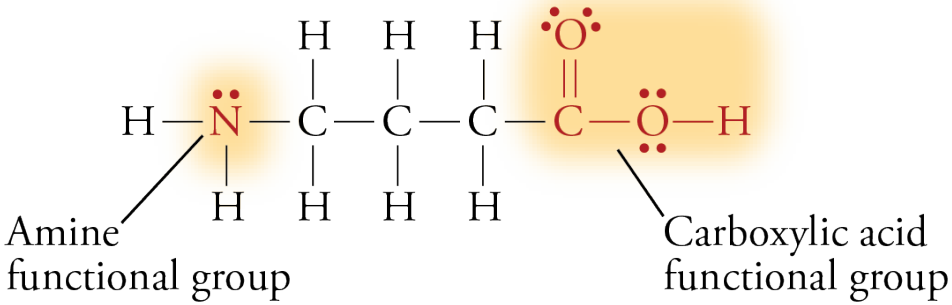


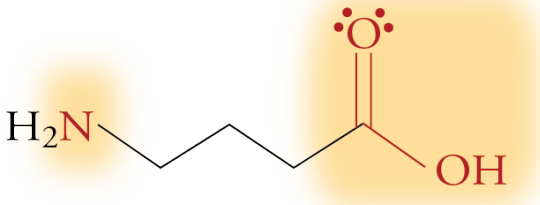


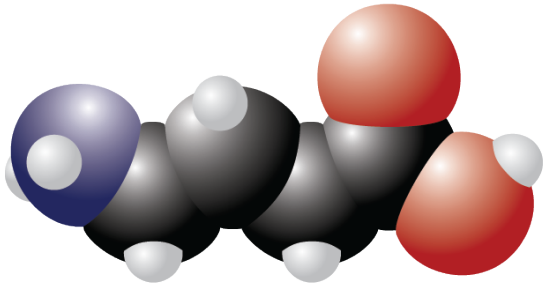


Ethanamide (acetamide), CH_3CONH_2

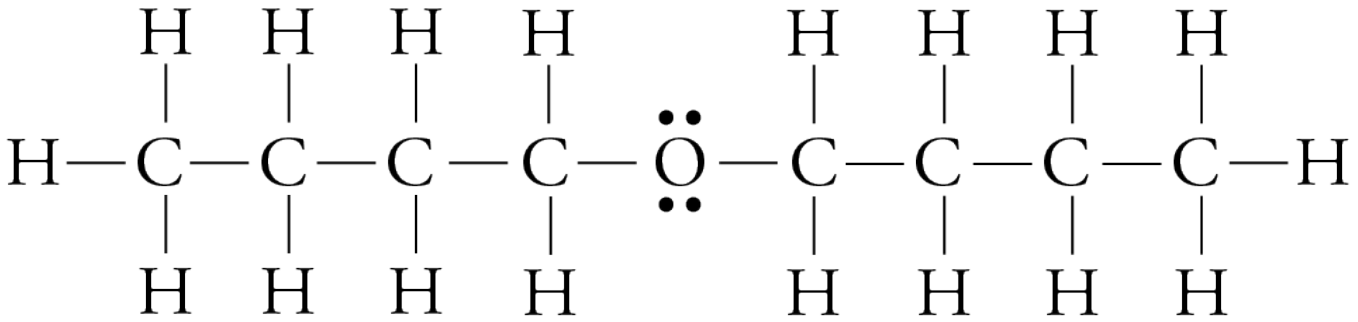
Difunctional Compounds - GABA





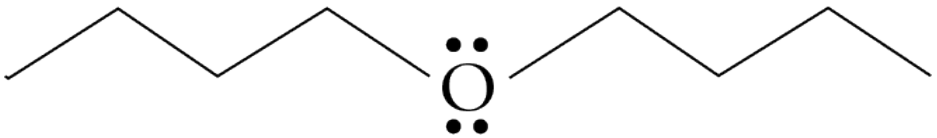


Example 1

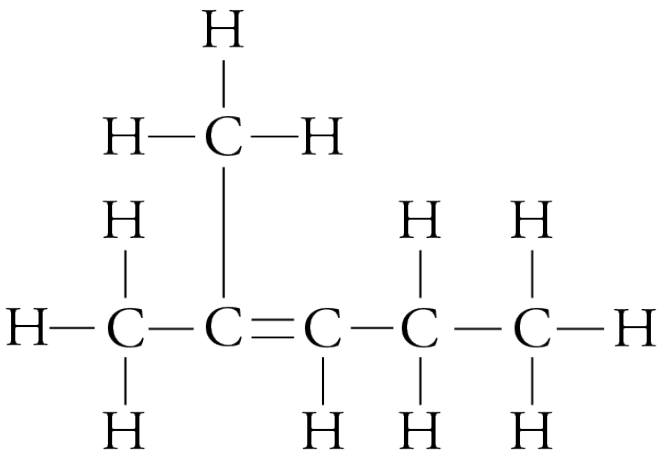


$CH_3CH_2CH_2CH_2OCH_2CH_2CH_2CH_3$

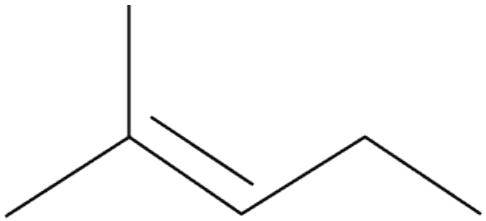
or $CH_3(CH_2)_3O(CH_2)_3CH_3$



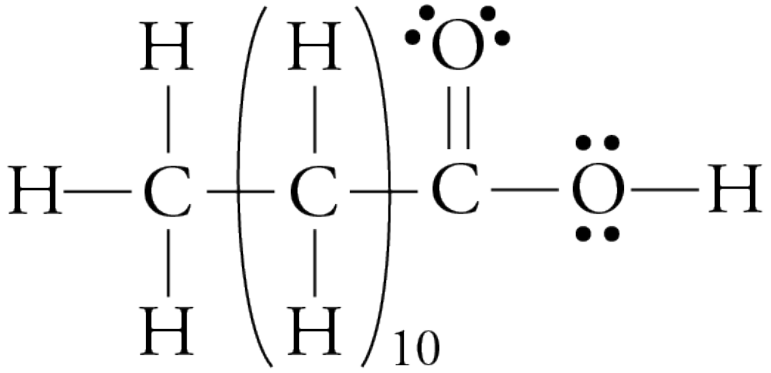
Example 2



$CH_3C(CH_3)CHCH_2CH_3$



Example 3

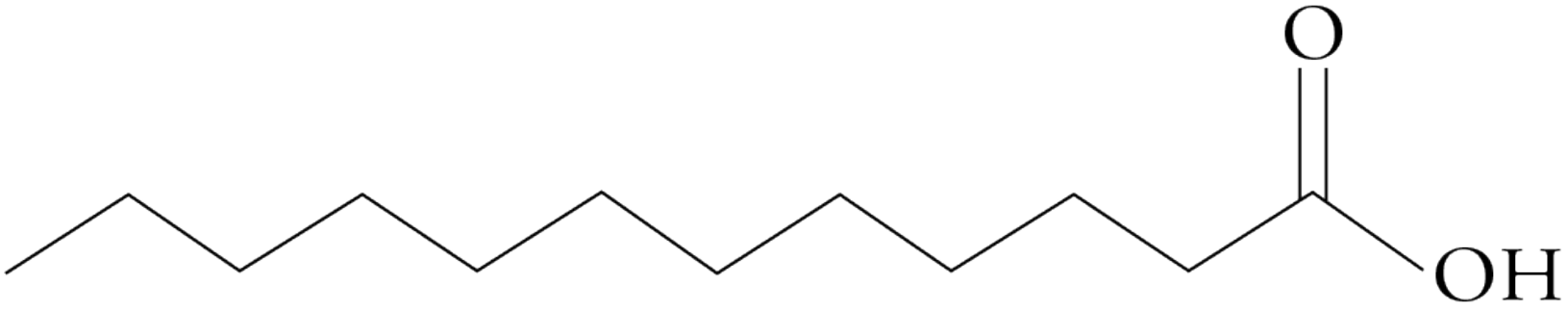


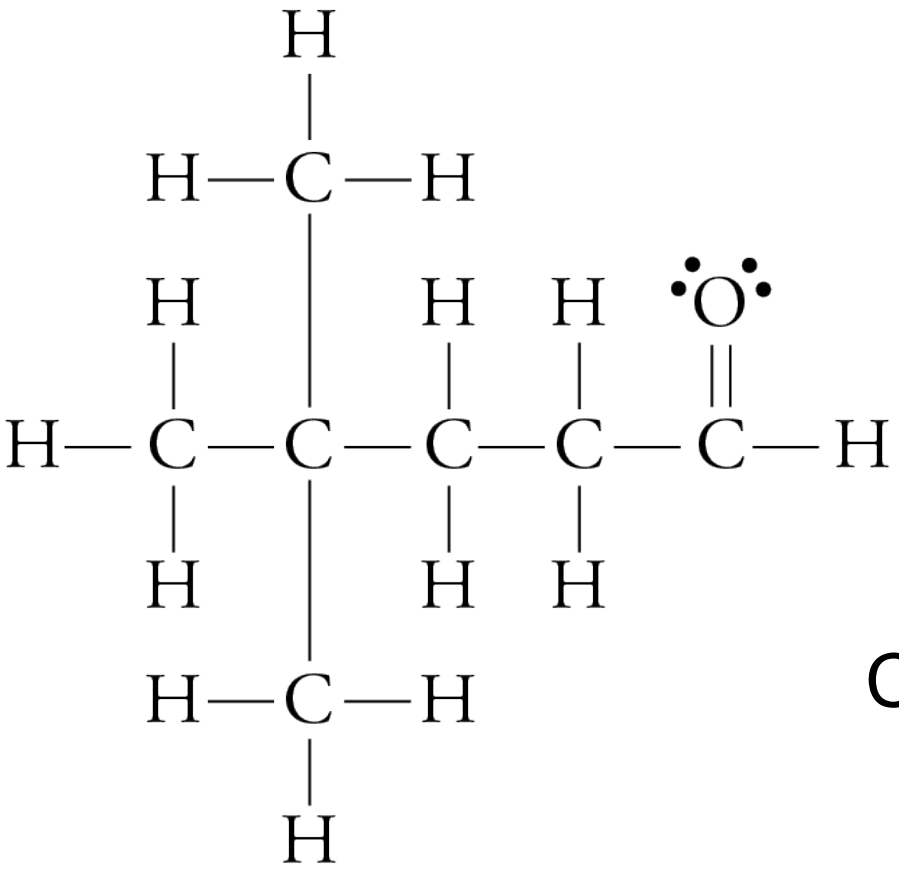
$CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CO_2H$

or $CH_3(CH_2)_{10}CO_2H$

$CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2COOH$

or $CH_3(CH_2)_{10}COOH$





Example 4

$CH_3C(CH_3)_2CH_2CH_2CHO$