

Introduction to Physical Science

Hydrocarbons
Presented by Robert Wagner

Organic Compounds

- Based on the chemistry of carbon atoms
 - Carbon can form multiple strong bonds with other atoms
- Hydrocarbons
 - Simplest organic compounds
 - Composed of carbon and hydrogen
 - Often used as fuels and in plastics

Alkanes

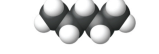
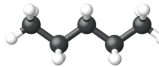
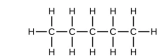
- Alkanes are saturated hydrocarbons
 - Have one, single, covalent bond between each carbon atom
- General formula:
 -
- Properties vary predictably as the number of atoms changes



methane
CH₄



ethane
CH₃CH₃ or C₂H₆



pentane
CH₃CH₂CH₂CH₂CH₃ or C₅H₁₂

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Properties of Some Alkanes³

Alkane	Molecular Formula	Melting Point (°C)	Boiling Point (°C)	Phase at STP ¹	Number of Structural Isomers
methane	CH ₄	-182.5	-161.5	gas	1
ethane	C ₂ H ₆	-183.3	-88.6	gas	1
propane	C ₃ H ₈	-187.7	-42.1	gas	1
butane	C ₄ H ₁₀	-138.3	-0.5	gas	2
pentane	C ₅ H ₁₂	-129.7	36.1	liquid	3
hexane	C ₆ H ₁₄	-95.3	68.7	liquid	5
heptane	C ₇ H ₁₆	-90.6	98.4	liquid	9
octane	C ₈ H ₁₈	-56.8	125.7	liquid	18
nonane	C ₉ H ₂₀	-53.6	150.8	liquid	35
decane	C ₁₀ H ₂₂	-29.7	174.0	liquid	75
tetradecane	C ₁₄ H ₃₀	5.9	253.5	solid	1958
octadecane	C ₁₈ H ₃₈	28.2	316.1	solid	60,523

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Isomers

- Isomers

- Hydrocarbons that have the same formula but different structures
- n-Butane (normal)
 - Unbranched chain - no carbon atoms are bonded to more than two other carbon atoms
- Isobutane (2-methylpropane) has a branched chain

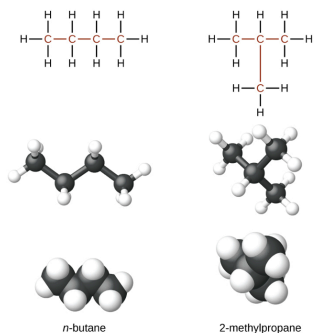


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Naming Alkanes

- Identify the longest chain of carbon atoms in the structure
 - 2 = ethane
 - 3 = propane
 - 4 = butane
 - 5 = pentane
 - 6 = hexane ; 7 = heptane ; 8 = octane, etc.
- Use a prefix to indicate the position and name of the substituent(s)

Naming Alkanes - Examples

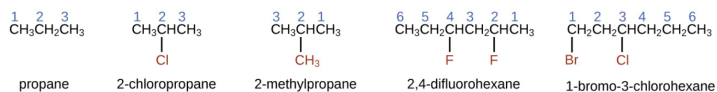
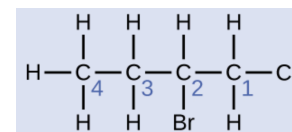
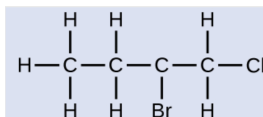


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Example

- Name this molecule



Chlorine attached to carbon #1
Bromine attached to carbon #2

2-bromo-1-chlorobutane

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Fossil Fuels

- Different liquid alkane fuels have different boiling points
 - Gasoline, kerosene, fuel oil
 - Separated by heating crude oil

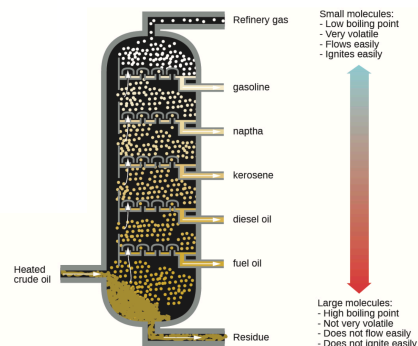


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Alkenes

- Alkenes are unsaturated hydrocarbons
 - Molecules contain one or more double bonds between carbon atoms
 - Ethene - simplest alkene

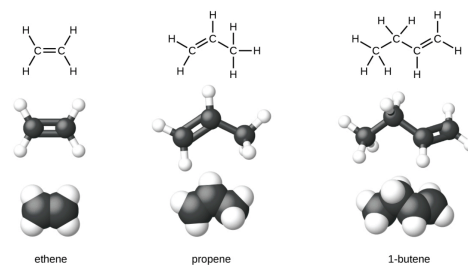
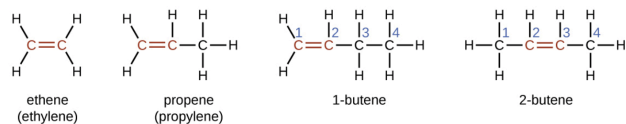


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Naming Alkenes



- Alkenes are named based on the name of the alkane with the same number of carbon atoms
 - ane suffix is replaced by -ene

Image Credit: OpenStax Chemistry Chapter 20.1 Figure

Alkene Isomers

- Structural isomers
 - Different arrangement of atoms
- Geometric isomers
 - Double bonds are more rigid than single bonds
- Isomers can have different physical properties such as boiling points

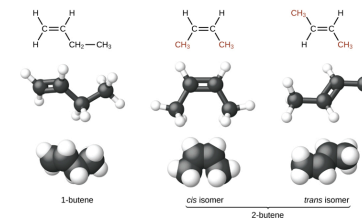


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Alkynes

- Alkynes are hydrocarbons with one or more triple bonds between carbon atoms
 - Simplest alkyne: ethyne (acetylene)
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- -yne is used as the suffix instead of -ane or -ene

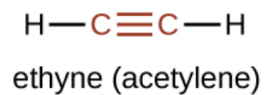


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Aromatic Hydrocarbons

- Hydrocarbons with a ring structure
 - Simplest aromatic hydrocarbon: Benzene
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 - Bonding structures are very complex and not just simple single and double bonds

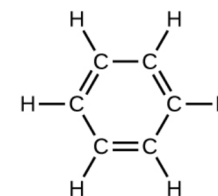


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Summary

- Alkanes are saturated hydrocarbons with only single bonds between each carbon atom
- Alkenes are unsaturated hydrocarbons with one or more double bonds between carbon atoms
- Alkynes are unsaturated hydrocarbons with one or more triple bonds between carbon atoms