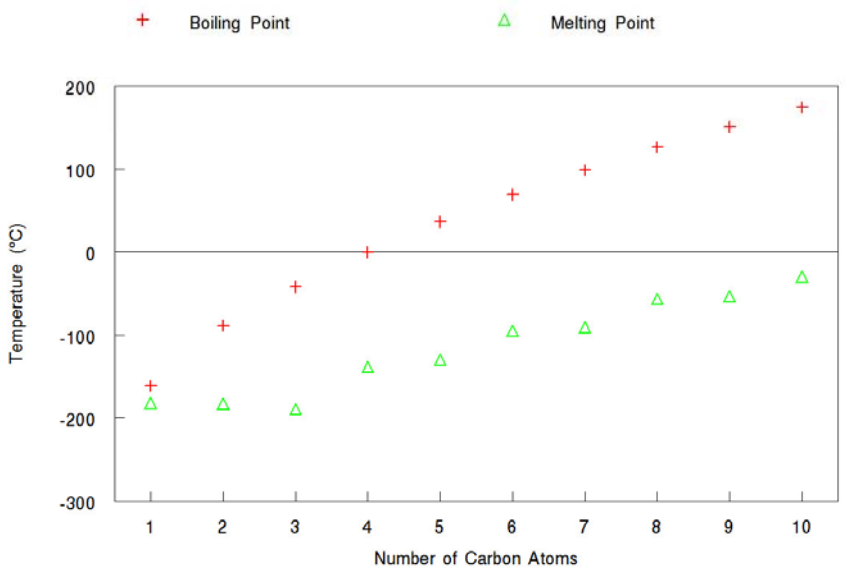
Alkanes, Alkenes, Alkynes

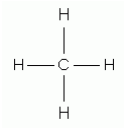
Alkanes

- Single bonds between carbon atoms
- General formula: $C_nH_{(2n+2)}$
- The maximum amount of hydrogen atoms are bonded so alkanes are referred to as saturated

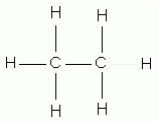
IUPAC name	Molecular Formula	Structural Formula	Boiling Point (°C)	Melting Point (°C)	Density (g/ml, 20°C)
Methane	CH_4	CH_4	-161.5	-182.5	
Ethane	C_2H_6	CH_3CH_3	-88.6	-183.3	
Propane	C_3H_8	$CH_3CH_2CH_3$	-42.1	-189.7	
Butane	C_4H_{10}	$CH_3(CH_2)_2CH_3$	-0.5	-138.4	
Pentane	C_5H_{12}	$CH_3(CH_2)_3CH_3$	36.1	-129.7	0.626
Hexane	C_6H_{14}	$CH_3(CH_2)_4CH_3$	68.7	-95.3	0.659
Heptane	C_7H_{16}	$CH_3(CH_2)_5CH_3$	98.4	-90.6	0.684
Octane	C_8H_{18}	$CH_3(CH_2)_6CH_3$	125.7	-56.8	0.703
Nonane	C_9H_{20}	$CH_3(CH_2)_7CH_3$	150.8	-53.5	0.718
Decane	$C_{10}H_{22}$	$CH_3(CH_2)_8CH_3$	174.1	-29.7	0.730



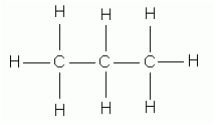
Structural Formulas



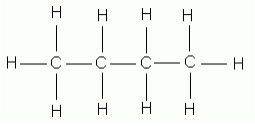
Methane



Ethane



Propane



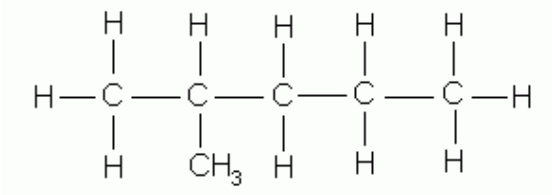
Butane

Simplified Structural Formulas

Methane	CH_4	CH_4	CH_4
Ethane	CH_3-CH_3	CH_3CH_3	CH_3CH_3
Propane	CH_3-CH_2-CH_3	$CH_3CH_2CH_3$	$CH_3CH_2CH_3$
Butane	CH_3-CH_2-CH_2-CH_3	$CH_3CH_2CH_2CH_3$	$CH_3(CH_2)_2CH_3$
Petane	CH_3-CH_2-CH_2-CH_2-CH_3	$CH_3CH_2CH_2CH_2CH_3$	$CH_3(CH_2)_3CH_3$

Substituent Groups

- A group, known as an alkyl group, may be bonded to a carbon instead of a hydrogen
- Some examples of substituent groups
  - Methyl: CH_3-
  - Ethyl: CH_3-CH_2-

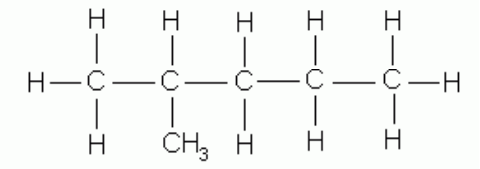


Naming Alkanes

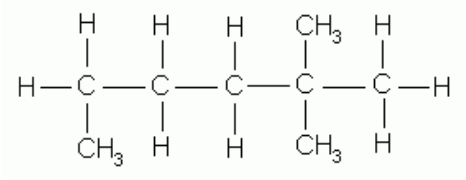
- Find and name the longest continuous carbon chain
- Identify and name groups attached to this chain
- Number the chain consecutively, starting at the end nearest a substituent group
- Designate the location of each substituent by an appropriate number and name

- Assemble the name, listing groups in alphabetical order
  - The prefixes di, tri, tetra, etc., used to designate several groups of the same kind, are not considered when alphabetizing

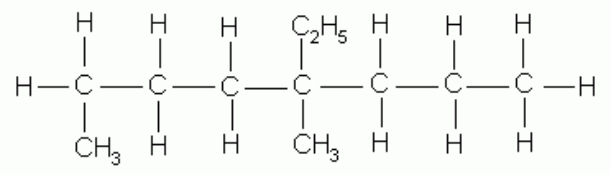
Examples



2-methylpentane



2,2-dimethylhexane



4-ethyl-4-methyloctane

Alkenes

- Have a double bond between a pair of carbons
- General formula: C_nH_{2n}
- Considered unsaturated because the maximum amount of hydrogens are not bonded to carbons
- Simplest alkene contains two carbons
  - Ethene, $CH_2=CH_2$

Dehydrogenation

- Dehydrogenation is the removal of two hydrogen atoms from an organic molecule
- Thermal dehydrogenation of alkanes of fewer than six carbon atoms can be accomplished with metal oxide catalysts
- Location of the double bond(s) in open chain molecules is not easily controlled, and the product is usually a mixture of alkenes.

- Larger alkanes undergo thermal dehydrogenation with degradation
  - Breaking of larger chains into smaller ones

Hydrogenation

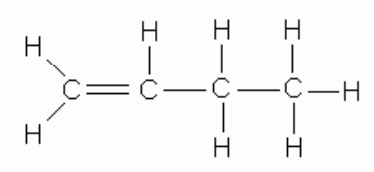
- Hydrogenation is the chemical reaction that results from the addition of hydrogen
- The process is usually employed to reduce or saturate organic compounds
- This process also uses catalysts like nickel, platinum or palladium

Naming Alkenes

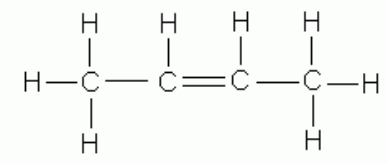
- The **ene** suffix (ending) indicates an alkene
- The longest chain chosen for the root name must include both carbon atoms of the double bond
- The root chain must be numbered from the end nearest a double bond carbon atom
  - If the double bond is in the center of the chain, the nearest substituent rule is used to determine the end where numbering starts.

- The smaller of the two numbers designating the carbon atoms of the double bond is used as the double bond locator
  - If more than one double bond is present the compound is named as a diene, triene or equivalent prefix indicating the number of double bonds, and each double bond is assigned a locator number

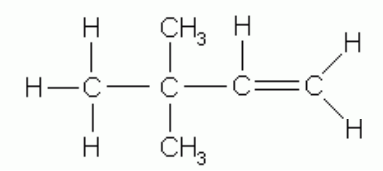
Examples



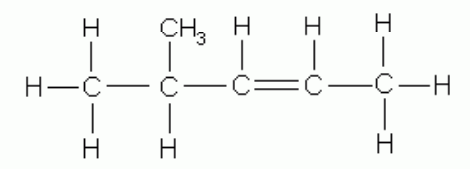
but-1-ene



but-2-ene



3,3-dimethylbut-1-ene



4-methylpent-2-ene

Alkynes

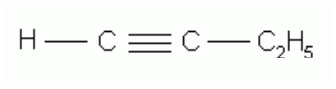
- Have a triple bond between a pair of carbons
- General formula: C_nH_{2n-2}
- Considered unsaturated because the maximum amount of hydrogens are not bonded to carbons
- Simplest alkyne contains two carbons
  - Ethyne, CH≡CH

Naming Alkynes

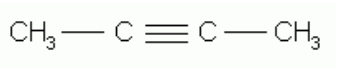
- The **yne** suffix (ending) indicates an alkyne
- The longest chain chosen for the root name must include both carbon atoms of the triple bond.
- The root chain must be numbered from the end nearest a triple bond carbon atom
  - If the triple bond is in the center of the chain, the nearest substituent rule is used to determine the end where numbering starts.

- The smaller of the two numbers designating the carbon atoms of the triple bond is used as the triple bond locator
- If several multiple bonds are present, each must be assigned a locator number
  - Double bonds precede triple bonds in the IUPAC name, but the chain is numbered from the end nearest a multiple bond, regardless of its nature.

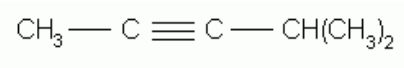
Examples



but-1-yne



but-2-yne



4-methylpent-2-yne