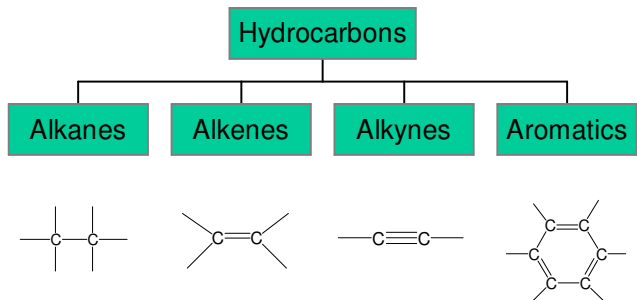


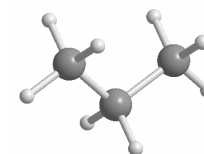
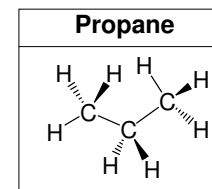
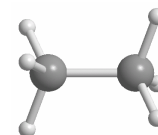
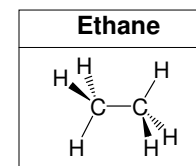
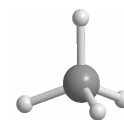
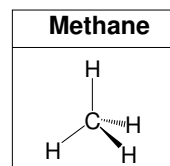
## Hydrocarbons

- Contain “only” carbon and hydrogen



## Alkanes

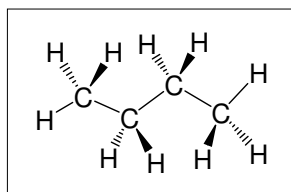
- General formula  $C_nH_{2n+2}$
- Each carbon is  $sp^3$  hybridized
  - Bond angles are  $\approx 109.5^\circ$



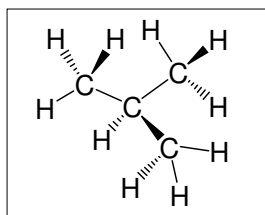
## Butane Isomers

- Four carbon atoms,  $C_4H_{10}$ 
  - Can exist in two structural forms or **isomers**

Straight chain isomer

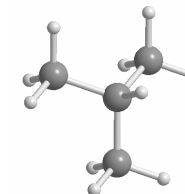
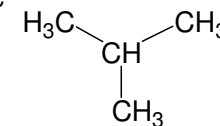
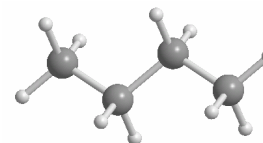
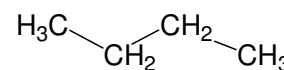


Branched isomer



## Structural Isomers

- Butane  $C_4H_{10}$  has two structural isomers
- Straight chain isomer and a branched isomer
- Isomers have different physical properties
  - Straight chain isomer boils at  $-0.5^\circ C$
  - Branched isomer boils at  $-12^\circ C$



## Structural Isomers

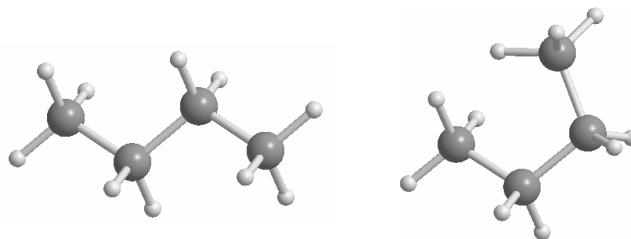
### ➤ Structural isomers

- Share same chemical formula
- Possess different arrangement of atoms
- Number of isomers increases rapidly with increasing number of carbon atoms

Molecular Formula	Number of possible structural isomers
$C_4H_{10}$	2
$C_5H_{12}$	3
$C_6H_{14}$	5
$C_{10}H_{22}$	75
$C_{20}H_{42}$	366,319
$C_{30}H_{62}$	4,111,847,763

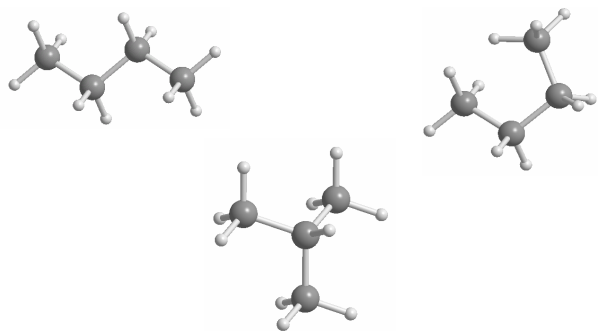
## Conformations

- Two of several possible butane **conformations** are shown below
- Convert one **conformation** into the other by pivoting about the central C-C bond



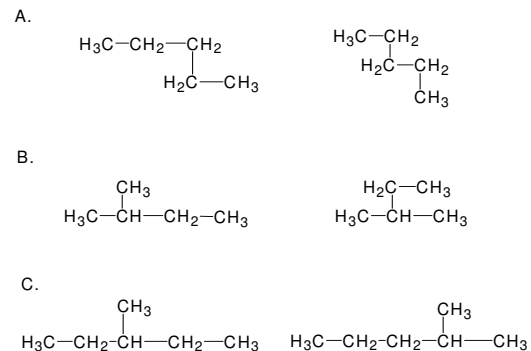
## Conformations

- **Conformations** are not structural isomers
- **Structural isomers** require the breaking and making of covalent bonds to convert one isomer into the other



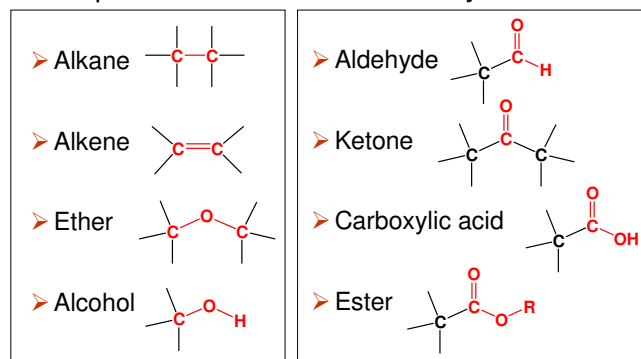
## Isomers or Conformers?

- Which of the following pairs are structural isomers?



## Functional Groups

- Functional group – atom or group of atoms with specific structure and reactivity



## Nomenclature

Prefix — Root — Ending

- The root specifies the number of carbon atoms in the longest continuous chain

Root	Number of Carbon atoms (Chain length)
meth-	1
eth-	2
prop-	3
but-	4
pent-	5
hex-	6

## Nomenclature

Prefix — Root — Ending

- The ending specifies the functional group present in the molecule

Functional Group	Ending
Alkanes	<i>ane</i>
Double bond	<i>ene</i>
Triple bond	<i>yne</i>
Alcohol	<i>anol</i>
Ether	<i>ether</i>
Aldehyde	<i>anal</i>
Ketone	<i>anone</i>

## Alkane Nomenclature

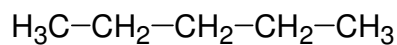
- IUPAC names for alkanes

Number of carbon atoms	Name	Molecular formula	Structure of the normal isomer
1	methane	CH <sub>4</sub>	CH <sub>4</sub>
2	ethane	C <sub>2</sub> H <sub>6</sub>	CH <sub>3</sub> CH <sub>3</sub>
3	propane	C <sub>3</sub> H <sub>8</sub>	CH <sub>3</sub> CH <sub>2</sub> CH <sub>3</sub>
4	butane	C <sub>4</sub> H <sub>10</sub>	CH <sub>3</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>3</sub>
5	pentane	C <sub>5</sub> H <sub>12</sub>	CH <sub>3</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>3</sub>
6	hexane	C <sub>6</sub> H <sub>14</sub>	CH <sub>3</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>3</sub>
7	heptane	C <sub>7</sub> H <sub>16</sub>	CH <sub>3</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>3</sub>
8	octane	C <sub>8</sub> H <sub>18</sub>	CH <sub>3</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>3</sub>
10	decane	C <sub>10</sub> H <sub>22</sub>	CH <sub>3</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>3</sub>

## Alkane Nomenclature



- Prefix specifies the identity, number and location of atoms or groups of atoms that are attached to the longest chain
  - If no groups are attached, no prefix is required
- Correct IUPAC name for ...



... is **pentane**

## Alkane Nomenclature



- Most organic compounds contain groups attached to the main chain (**side groups**)
- The prefix names for saturated hydrocarbon side groups are derived from the name of the parent alkane
  - Groups are the alkanes minus one hydrogen
  - *ane* ending of the alkane is changed to *yl*
    - $\text{CH}_3-$  = methyl                       $(\text{CH}_3)_2\text{CH}-$  = isopropyl
    - $\text{CH}_3\text{CH}_2-$  = ethyl
    - $\text{CH}_3\text{CH}_2\text{CH}_2-$  = propyl

## Alkane Nomenclature



- Prefix names for common non-alkyl groups

Group	Name
-F	Fluoro
-Cl	Chloro
-Br	Bromo
-I	Iodo
-NO <sub>2</sub>	Nitro
-NH <sub>2</sub>	Amino

## Alkane Nomenclature

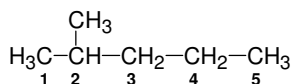


- If more than one group of the same type is present, prefixes are used to indicate the number of groups
  - 2 = *Di*
  - 3 = *Tri*
  - 4 = *Tetra*
  - 5 = *Penta*
  - 6 = *Hexa*

## Alkane Nomenclature

Prefix — Root — Ending

- Point of attachment is indicated by a number

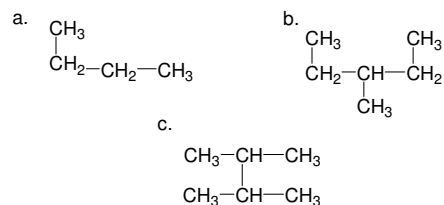


- The methyl group (CH<sub>3</sub>) is attached to the second carbon atom
- The longest chain contains five carbon atoms
- The proper name is 2-methylpentane
  - 2-methyl is the prefix
  - "pent" is the root for a five carbon chain
  - "ane" is the ending for an alkane

## Alkane Nomenclature

Prefix — Root — Ending

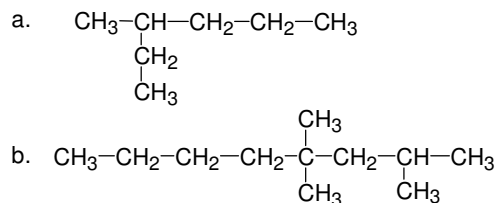
- General procedure for naming
  - Identify the longest chain
  - Assign a name to this longest chain
- Identify the longest chain in the following:



## Alkane Nomenclature

Prefix — Root — Ending

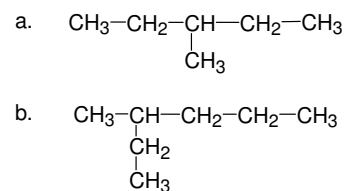
- Number the longest chain so that the number assigned to the first point of attachment is as low as possible



## Alkane Nomenclature

Prefix — Root — Ending

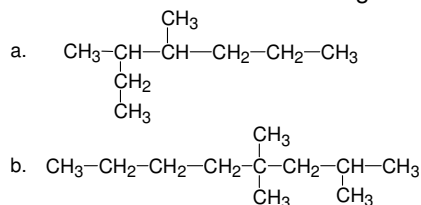
- Locate and name the attached side groups
  - The position number and name of the side group are combined (separated by a hyphen) and placed just before the name of the longest chain – then finish off with *ane*



## Alkane Nomenclature

Prefix — Root — Ending

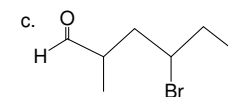
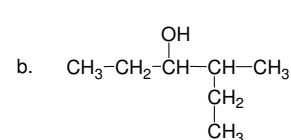
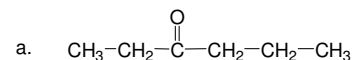
- Use prefixes (di, tri, tetra) if more than one of the same group is present
  - Combine position numbers and side group names (separated by commas and a hyphen) and place just before the name of the longest chain



## Nomenclature

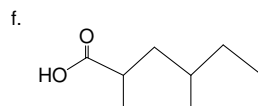
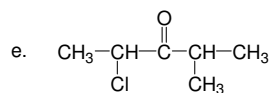
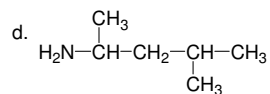
Prefix — Root — Ending

- For other functional groups, name the compound with the functional group on the lowest number carbon atom



## Nomenclature

Prefix — Root — Ending



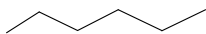
## Cycloalkanes

- In addition to straight and branched chain structures, alkanes can form cyclic or ring structures
- Cyclic alkanes have the general formula  $\text{C}_n\text{H}_{2n}$
- Compounds are named by placing **cyclo** in front of the name of the alkane with the same number of carbons
  - Straight chain with six carbon atoms is **hexane**
  - Ring structure with six carbon atoms is **cyclohexane**
    - Cyclohexane has molecular formula  $\text{C}_6\text{H}_{12}$

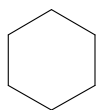
## Cycloalkanes

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- Rather than continually writing each carbon with its full complement of hydrogen, we often abbreviate the structural formula using stick figures
- Each corner or bend represents a carbon atom
- Each  $sp^3$  carbon is bonded to four other atoms
  - The other atoms are assumed to be hydrogen if nothing else is present



hexane

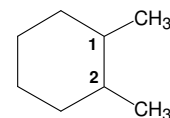


cyclohexane

## Cycloalkanes

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- More on naming cyclic compounds
  - Identify the parent ring structure
  - Assign points of attachment so that the numbers are as low as possible



**1,2-dimethylcyclohexane**  
**not**  
**1,6-dimethylcyclohexane**