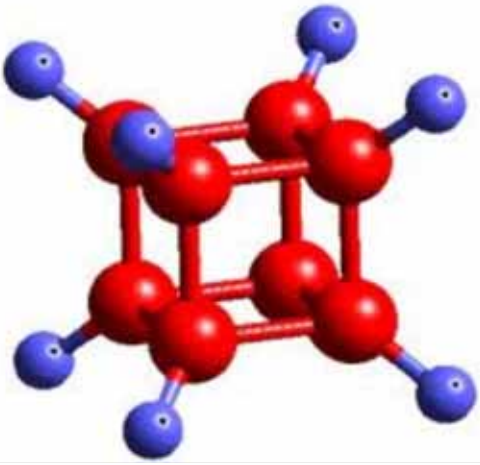
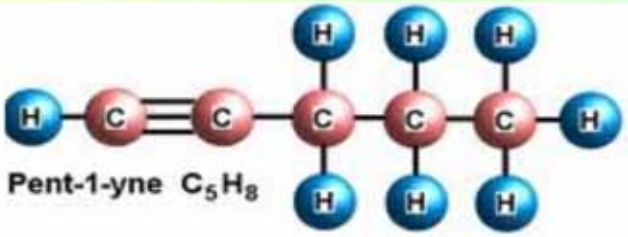
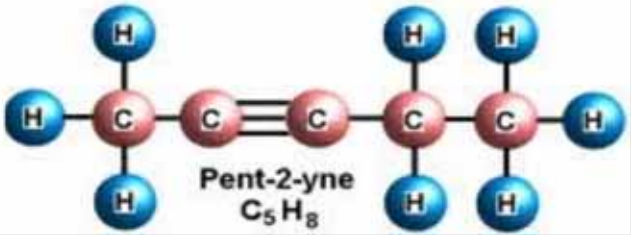
# Homologous Series And Isomerism





# Learning Outcomes:

*Students will be able to*:

1. describe homologous series and its characteristics;
2. describe isomerism and its types with examples;
3. explain chain isomerism with examples;
4. draw possible structures of butane.

# Alkanes

| | | |
|---|---|---|
| Methane | $CH_4$ | $-CH_2$ |
| Ethane | $C_2H_6$ | $-CH_2$ |
| Propane | $C_3H_8$ | $-CH_2$ |
| Butane | $C_4H_{10}$ | $-CH_2$ |
| Pentane | $C_5H_{12}$ | $-CH_2$ |

# Homologous Series:

Homology is an important feature of organic compounds. As a result of this a large number of organic compounds can be studied as families rather than as individuals.

*"A series of organic compounds that have similar structural features but differing from each other by a ($-CH_2$) group (methylene group) is known as homologous series".*

# Alkanes

$C_nH_{2n+2}$

C = 1 $\quad n = 1$

$C_1H_{2\times1+2}$

$CH_4$

$n = 10$

$C_{10}H_{2\times10+2}$

$\boxed{C_{10}H_{22}}$

# Characteristics of Homologous Series:

The characteristics of a homologous series are as following:

i. All members of the series can be represented by a general formula. Thus, the general formula for *Alkanes* is $C_nH_{2n+2}$, that of *Alkenes* is $C_nH_{2n}$ and for *Alkynes* is $C_nH_{2n-2}$.

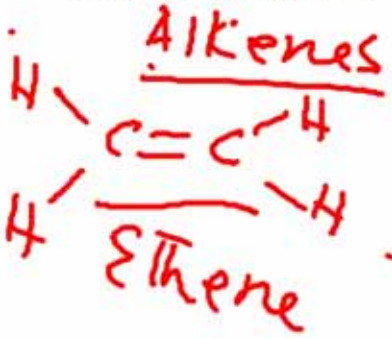
ii. All members of a series can be prepared by the same general methods.

iii. Homologues resemble in chemical properties.

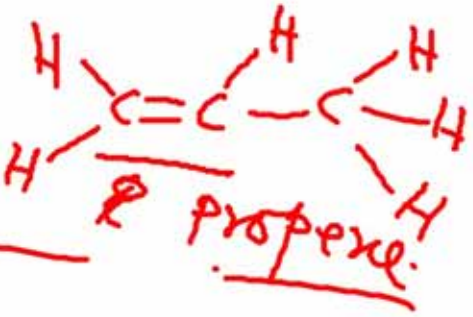
iv. Physical properties of homologues show a gradual change in the series with the increase in the molecular weight.

v. As homologues have same functional group, they have similar structures.

Alkenes



Ethene



Propene

# Homologous series of Alkanes

| Name | Molecular Formula | Condensed Structural Formula |
|---|---|---|
| Methane | $CH_4$ | $CH_4$ |
| Ethane | $C_2H_6$ | $H_3CCH_3$ |
| Propane | $C_3H_8$ | $H_3CCH_2CH_3$ |
| Butane | $C_4H_{10}$ | $H_3CCH_2CH_2CH_3$ |
| Pentane | $C_5H_{12}$ | $H_3CCH_2CH_2CH_2CH_3$ |
| Hexane | $C_6H_{14}$ | $H_3CCH_2CH_2CH_2CH_2CH_3$ |
| Heptane | $C_7H_{16}$ | $H_3CCH_2CH_2CH_2CH_2CH_2CH_3$ |
| Octane | $C_8H_{18}$ | $H_3CCH_2CH_2CH_2CH_2CH_2CH_2CH_3$ |
| Nonane | $C_9H_{20}$ | $H_3C(CH_2)_7CH_3$ |
| Decane | $C_{10}H_{22}$ | $H_3C(CH_2)_8CH_3$ |

# Homologous series of Alkenes

| Name | Molecular Formula | Condensed Structural Formula |
|---|---|---|
| Ethene | $C_2H_4$ | $H_2C{=}CH_2$ |
| Propene | $C_3H_6$ | $H_2C{=}CHCH_3$ |
| Butene | $C_4H_8$ | $H_2C{=}CHCH_2CH_3$ |
| Pentene | $C_5H_{10}$ | $H_2C{=}CHCH_2CH_2CH_3$ |
| Hexene | $C_6H_{12}$ | $H_2C{=}CHCH_2CH_2CH_2CH_3$ |
| Heptene | $C_7H_{14}$ | $H_2C{=}CHCH_2CH_2CH_2CH_2CH_3$ |
| Octene | $C_8H_{16}$ | $H_2C{=}CHCH_2CH_2CH_2CH_2CH_2CH_3$ |
| Nonene | $C_9H_{18}$ | $H_2C{=}CH(CH_2)_6CH_3$ |
| Decene | $C_{10}H_{20}$ | $H_2C{=}CH(CH_2)_7CH_3$ |

# Homologous series of Alkynes

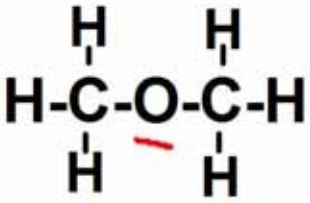
| Name | Molecular Formula | Condensed Structural Formula |
|---|---|---|
| Ethyne | $C_2H_2$ | $HC{\equiv}CH$ |
| Propyne | $C_3H_4$ | $HC{\equiv}CCH_3$ |
| Butyne | $C_4H_6$ | $HC{\equiv}CCH_2CH_3$ |
| Pentyne | $C_5H_8$ | $HC{\equiv}CCH_2CH_2CH_3$ |
| Hexyne | $C_6H_{10}$ | $HC{\equiv}CCH_2CH_2CH_2CH_3$ |
| Heptyne | $C_7H_{12}$ | $HC{\equiv}CCH_2CH_2CH_2CH_2CH_3$ |
| Octyne | $C_8H_{14}$ | $HC{\equiv}CCH_2CH_2CH_2CH_2CH_2CH_3$ |
| Nonyne | $C_9H_{16}$ | $HC{\equiv}C(CH_2)_6CH_3$ |
| Decyne | $C_{10}H_{18}$ | $HC{\equiv}C(CH_2)_7CH_3$ |

# Isomerism

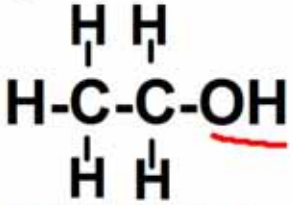
One of the reasons why organic compounds exist in a huge quantity is due to the phenomenon of isomerism.

*"Compounds having the same molecular formula but differ in structural formula are called isomers and this phenomenon is termed as Isomerism".*

For example, ethyl alcohol and dimethyl ether have the same molecular formula of $C_2H_6O$ but they differ structural formula, as given below:



*Dimethyl ether*



*Ethyl alcohol*

## Types of Structural Isomerism:

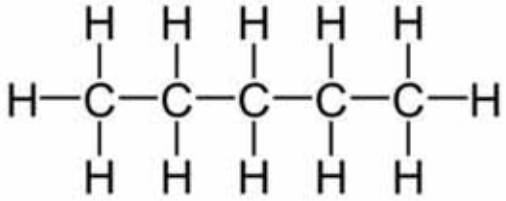
1. Chain or Skeletal Isomerism
2. Positional Isomerism
3. Functional Isomerism
4. Metamerism

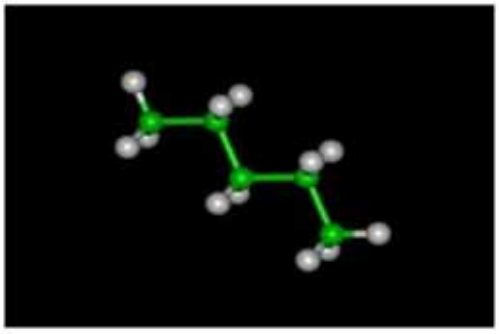
## Chain or Skeletal Isomerism:

*"Compounds having the same molecular formula but different structures of their carbon chains are called chain isomers".*

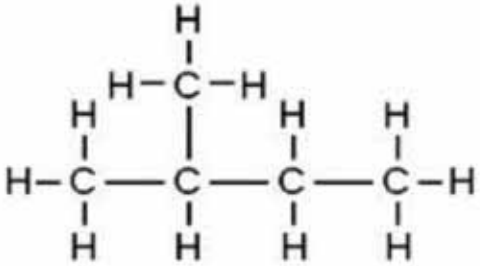
For example, the molecular formula of pentane is $C_5H_{12}$, this molecular formula represents three isomeric pentanes which differ only in the structure of their carbon chains.

**n-pentane**

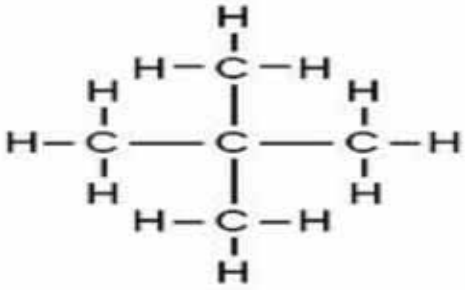


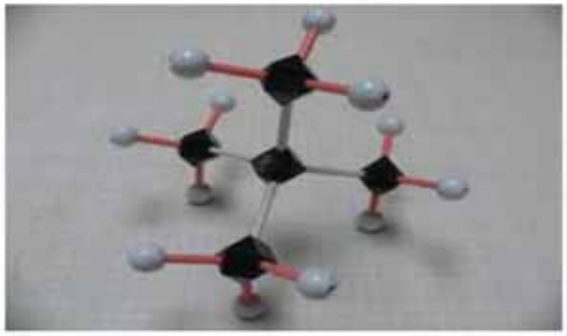


**isopentane**



**neopentane**

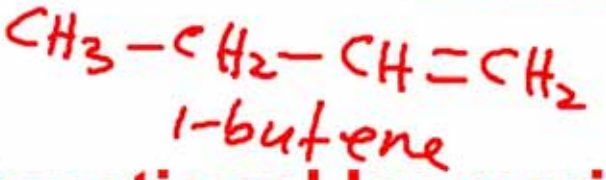




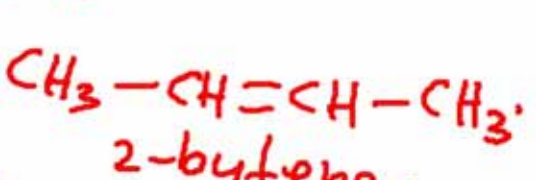
## Positional Isomerism:

Compounds having same molecular formula but different position of their functional groups.

Alkenes. Butene $C_4H_8$.



1-butene



2-butene.

## Functional Isomerism:

Compounds having same molecular formula but different functional groups.

propanone

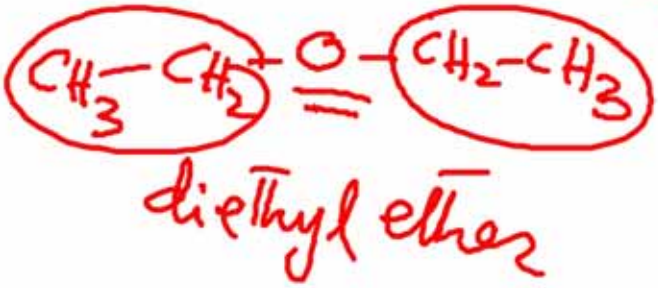
propanal.

$C_3H_6O$

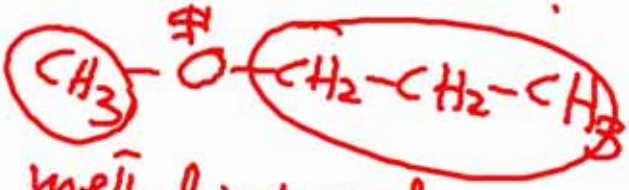
## Metamerism:

Compounds having same molecular formula but different Alkyl groups attached to the same multivalent central atom.

$C_4H_{10}O$




diethyl ether

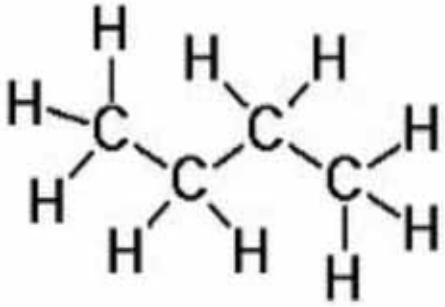


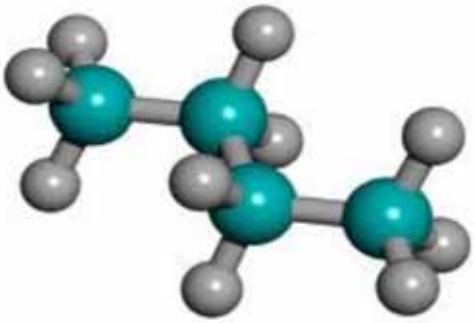

methyl-n-propyl ether

# Structures of Butane:

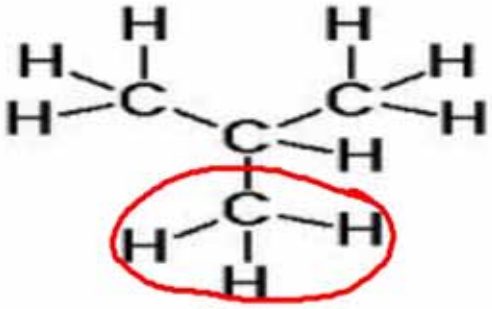
Butane is the member of the homologous series of Alkanes with a molecular formula of $C_4H_{10}$. Butane exists in two isomeric forms, which are given below:

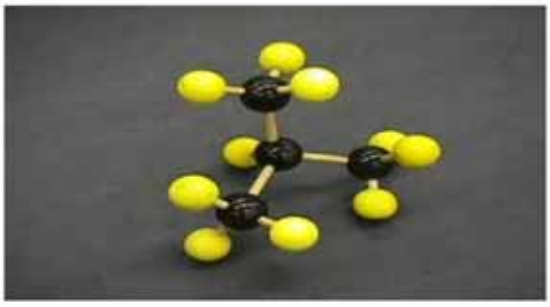
**n-butane**



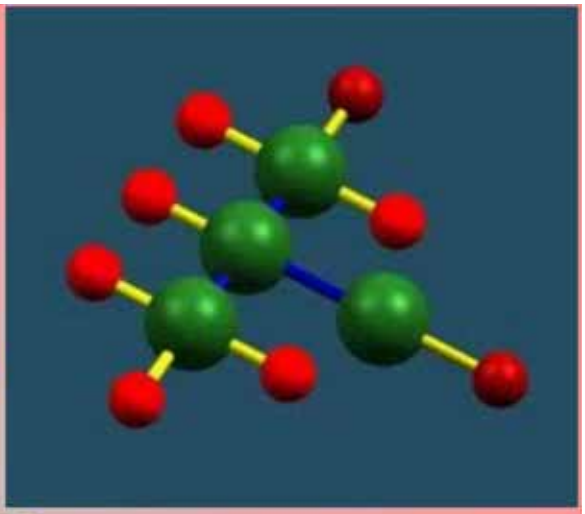


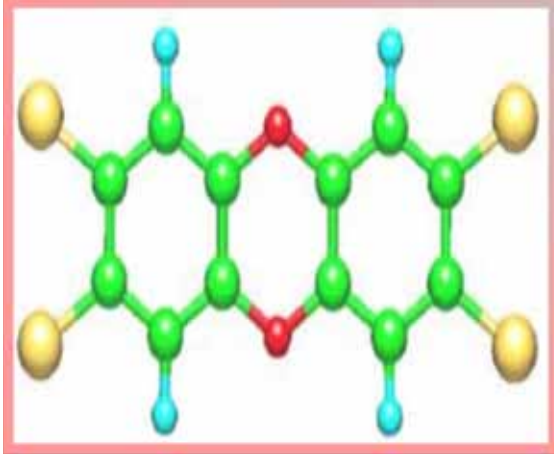
**isobutane**





# Multiple Choice Questions





1. For the given two compounds $H_3C\text{-}CH_2\text{-}CH_3$ and $H_3C\text{-}HC{=}CH_2$ which of the following statement is correct?

A. Both belong to the same homologous series.
B. Both are saturated hydrocarbons.
C. Both are isomers of each other.
D. Both possess different chemical properties.

2. Which of the following pairs of compounds belong to the same homologous series?

A. $C_4H_{10}/C_8H_{18}$
B. $C_4H_{10}/C_8H_{16}$
C. $C_4H_8/C_8H_{18}$
D. $C_4H_6/C_8H_{16}$

3. For the given two compounds

$H_3C\text{-}CH_2\text{-}CH_2\text{-}CH_3$ and $H_3C\text{-}\underset{\displaystyle CH_3}{\underset{|}{CH}}\text{-}CH_3$

which of the following statements is correct?

A. Both belong to different homologous series.
B. Both possess different molecular formula.
C. Both are isomers of each other.
D. Both possess different chemical properties.