Key

Organic Chemistry

- **Organic chemistry** is defined as the chemistry of carbon compounds.
- Why is organic chemistry so important? A partial answer is found by looking at the organic compounds below.

C_8H_{18}	=	iso–octane (the chief ingredient in gasoline)
CH_4	=	methane ("natural gas")
$C_{18}H_{21}NO_3$	=	codeine (pain reliever)
$C_{22}H_{25}NO_6$	=	colchicine (anti–leukemia drug)
$C_8H_6O_3Cl_2$	=	2,4–D (a herbicide)
$C_{14}H_9Cl_5$	=	DDT (a banned pesticide)
$C_{10}H_{19}O_6S_2P$	=	malathion (an insecticide)
$C_{19}H_{28}O_2$	=	testosterone (a male sex hormone)
$C_{17}H_{21}NO_4$	=	cocaine
$C_{10}H_{14}N_2$	=	nicotine
$C_6H_{12}O_6$	=	glucose (a sugar)
C_2H_4	=	ethene (a plant hormone which causes ripening of fruit)
$C_{20}H_{12}$	=	1,2–benzpyrene (a cancer–causing ingredient of cigarette smoke)
$C_{40}H_{56}$	=	beta–carotene (the yellow colour in carrots; used as the colouring agent in margarine)
$[C_2H_4]_x$	=	polyethylene (plastic) ["x" implies a multiply–repeated unit]
$[C_2F_4]_x$	=	Teflon

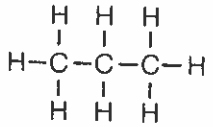
- **Hydrocarbons** are compounds that contain only hydrogen and carbon.

- **Alkanes** are carbon atoms that are connected by single bonds. The names of alkanes end in "ane". The alkane is also called "**Saturated**" because each carbon is bonded to the maximum number of atoms.

- Carbon can bond to four other atoms since it has a valence of 4.
- There is more than one way to represent a hydrocarbon formula depending on how compact one want to write the formula. Look at the example below:

The structure of propane, C_3H_8, can be shown in three ways.

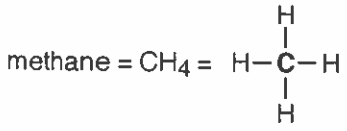
full structure:

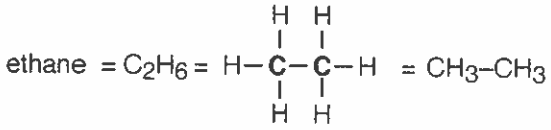


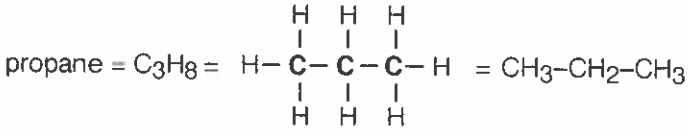
or condensed structure: $CH_3–CH_2–CH_3$ (or even $CH_3CH_2CH_3$)

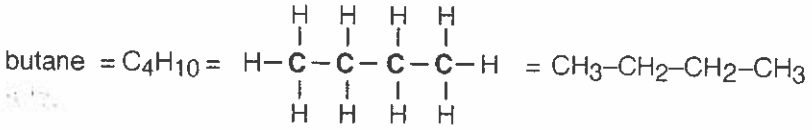
or molecular formula: C_3H_8

❖ In the following sequence of hydrocarbons, each molecule differs in the number of carbon atoms linked to one another to form a "carbon chain". These are "straight-chain" hydrocarbons.









pentane = C_5H_{12} = CH_3–CH_2–CH_2–CH_2–CH_3

hexane = C_6H_{14} = CH_3–CH_2–CH_2–CH_2–CH_2–CH_3

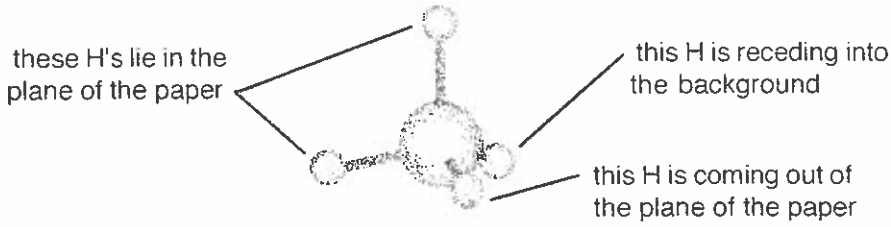
heptane = C_7H_{16} = CH_3–CH_2–CH_2–CH_2–CH_2–CH_2–CH_3

octane = C_8H_{18} = CH_3–CH_2–CH_2–CH_2–CH_2–CH_2–CH_2–CH_3

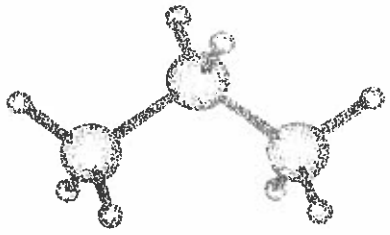
nonane = C_9H_{20} = CH_3–CH_2–CH_2–CH_2–CH_2–CH_2–CH_2–CH_2–CH_3

decane = $C_{10}H_{22}$ = CH_3–CH_2–CH_2–CH_2–CH_2–CH_2–CH_2–CH_2–CH_2–CH_3

❖ Although the bonds of a carbon atom are usually drawn lying flat on a page the bonds are actually arranged in the shape of a 4 cornered pyramid called a "Tetrahedron" as shown below:



Therefore the actual shape of the propane molecule can be shown as



- A hydrocarbon can have "side branches" which are also hydrocarbon chains. These groups are called **Alkyl Groups**

- Definition: An alkyl group is an alkane which has lost one hydrogen atom.

- **Rule: An alkyl group is named by changing the "ane" ending of the original hydrocarbon to "yl".**

- Examples:

Original hydrocarbon	Alkyl group
methane = CH_4	methyl = CH_3–
ethane = CH_3–CH_3	ethyl = CH_3–CH_2–
propane = CH_3–CH_2–CH_3	propyl = CH_3–CH_2–CH_2–
butane = CH_3–CH_2–CH_2–CH_3	butyl = CH_3–CH_2–CH_2–CH_2–

- Rule: A substituted hydrocarbon is named by writing the following one after another:
  1. The carbon number to which the alkyl group is attached
  2. A dash
  3. The name of the alkyl group
  4. The name of the longest or "parent" hydrocarbon chain, to which the alkyl group is attached.

- Note; The carbon atoms in the parent hydrocarbon are numbered consecutively from the end of the hydrocarbon which gives the lowest possible set of numbers to the attached groups.

- Note: If more than one alkyl groups are attached to a hydrocarbon, then list the alkyl groups alphabetically, precede each alkyl group by its number, and put a dash between each alkyl group and its number.

① - Name the following hydrocarbons:

(a) CH_3–CH_2–$\underset{\displaystyle CH_3}{\underset{|}{CH}}$–$CH_2$–$CH_2$–$CH_3$

3-methylhexane

(b) CH_3–CH_2–CH_2–$\underset{\displaystyle CH_3–CH_2}{\underset{|}{CH}}$–$CH_2$–$CH_2$–$CH_3$

4-ethylheptane

(c) CH_3–CH_2–$\underset{\displaystyle CH_2–CH_3}{\underset{|}{CH}}$–$CH_2$–$CH_2$–$CH_2$–$CH_2$–$CH_3$

3-ethyloctane

(d) CH_3–$\underset{\displaystyle CH_3}{\underset{|}{CH}}$–$CH_2$–$CH_2$–$CH_2$–$CH_3$

2-methylhexane

(2) Draw the following hydrocarbons. Include all hydrogens.
(a) 3–methylhexane (c) 2–methylpentane

$CH_3-CH_2-\underset{\displaystyle CH_3}{\underset{|}{CH}}-CH_2-CH_2-CH_3$

$CH_3-\underset{\displaystyle CH_3}{\underset{|}{CH}}-CH_2-CH_2-CH_3$

(3) Name the following molecules.

(a) $CH_3-CH(CH_3)-CH(CH_3)-CH_2-CH_2-CH_3$

3,4-dimethylheptane

(b) $CH_3-CH_2-CH(CH_2-CH_3)-C(CH_2-CH_3)(CH_2-CH_3)-CH_2-CH_3$

3,4,4,5-tetraethyl heptane

(c) $CH_3-C(CH_3)_2-CH_2-CH_2-CH_2-CH_2-C(CH_3)_2-CH_3$

2,2,7,7-tetramethyloctane

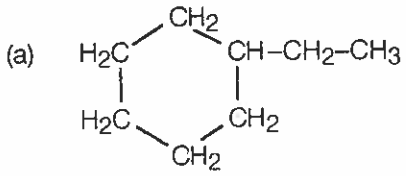
(d) $CH_3-CH(CH_3)-CH(CH_2-CH_3)-CH(CH_2-CH_3)-CH_2-CH_3$

5-ethyl-3,4-dimethylheptane

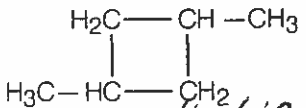
❖ **Cycloalkanes** are hydrocarbon chains which connect in head-to tail "circle.

❖ When naming substituted cycloalkanes, follow the same rules as straight-chain alkanes, except that is there is only a single substituent then a number to indicate position is not used. If there is more than one substituent, the first substituent is assumed to be in the "1"position.

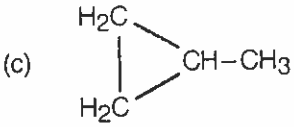
(4) ❖ Name the following cycloakanes.

(a) 

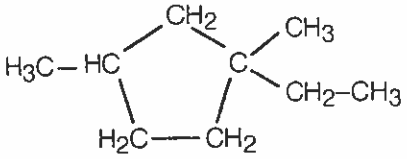
ethylcyclohexane

(b) 

1,3-dimethylcyclobutane

(c) 

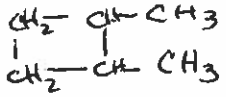
methylcyclopropane

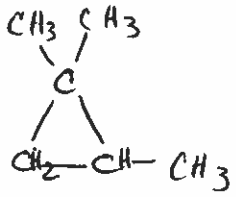
(d) 

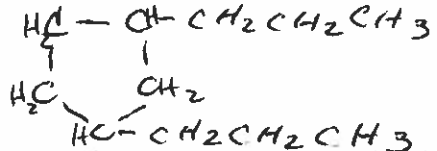
1-ethyl-1,3-dimethylcyclopentane

(5) DRAW THE FOLLOWING

(a) 1,2–dimethylcyclobutane
(b) 1,1,2–trimethylcyclopropane
(c) 1,3–dipropylcyclopentane

a) 

b) 

c) 

Definition: **STRUCTURAL ISOMERS** are compounds which have the same molecular formula but a different arrangement of atoms.

EXAMPLE: C_4H_{10} can refer to either $CH_3-CH_2-CH_2-CH_3$ or $CH_3-\underset{\displaystyle CH_3}{\underset{|}{CH}}-CH_3$