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Medical University

Introduction to organic chemistry

Senior teacher,

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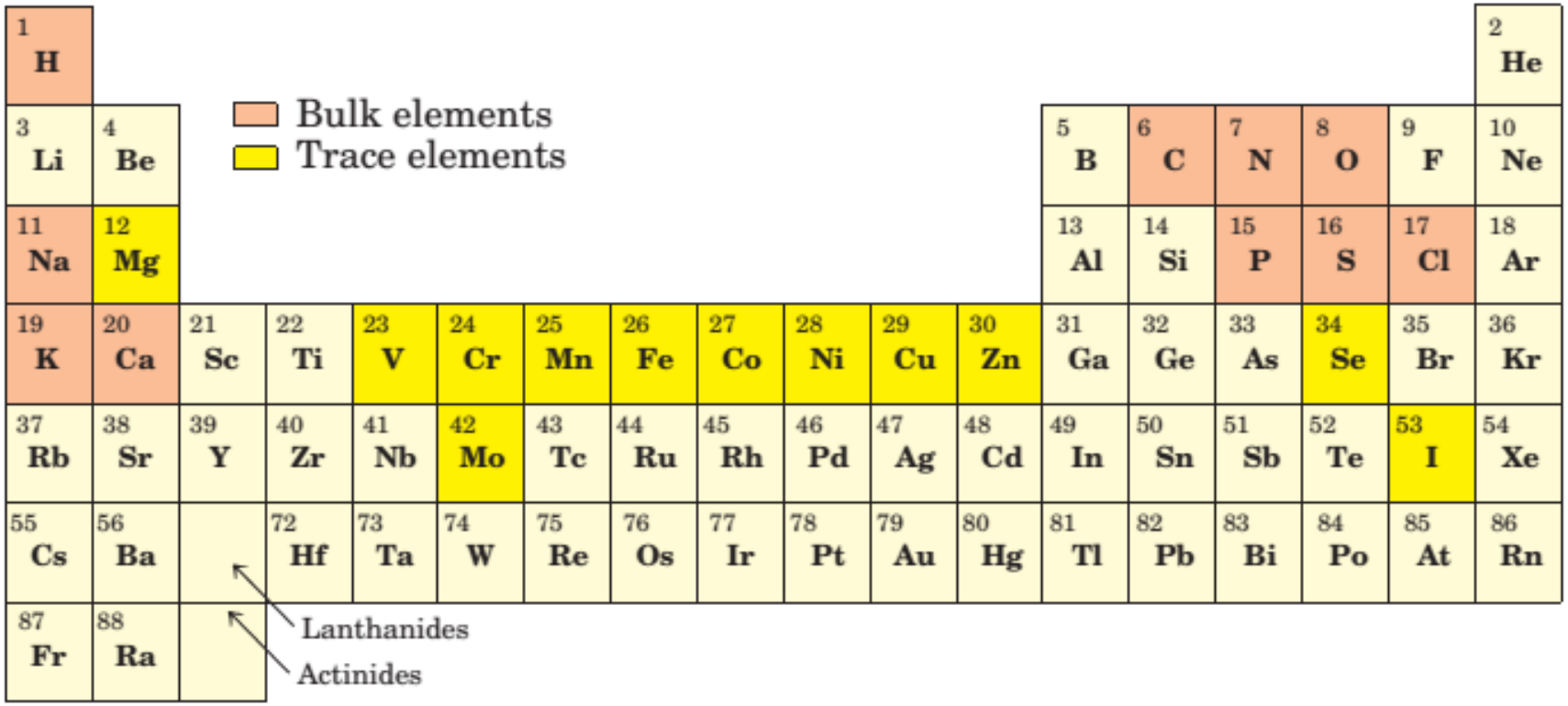
2020

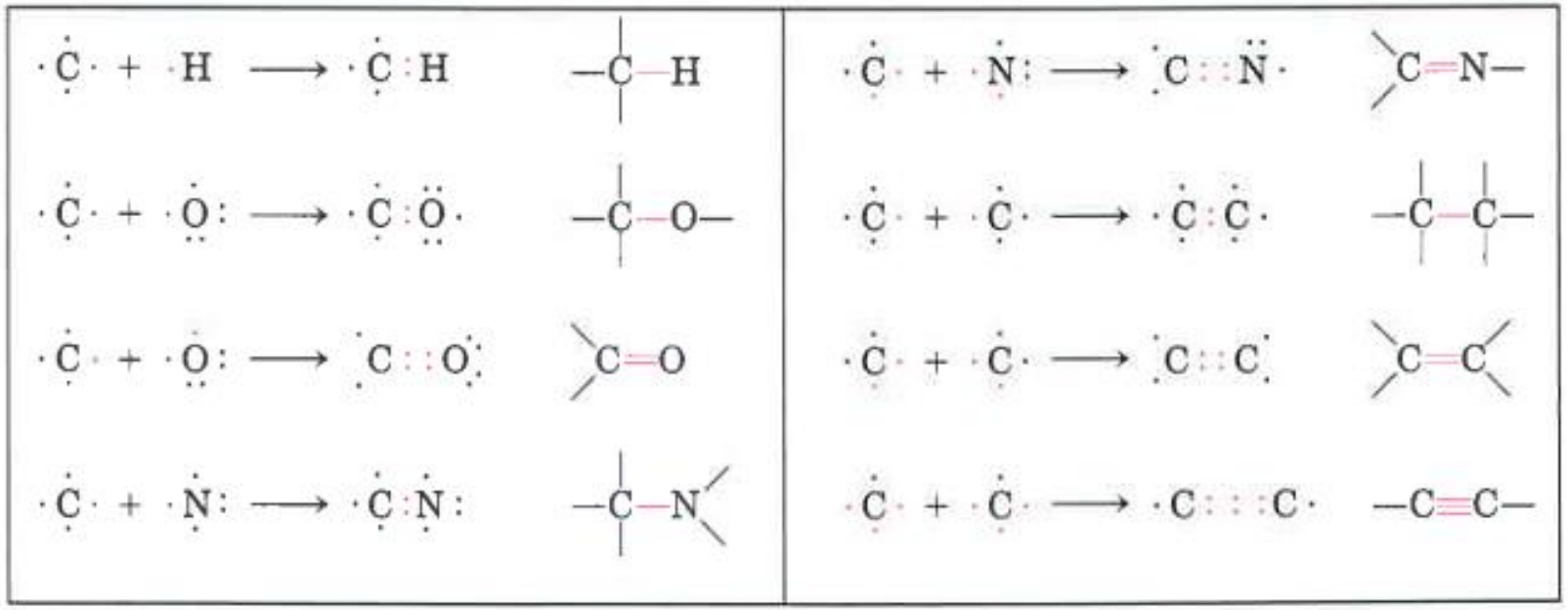
Essential chemical elements for humans



Bulk elements are structural components of cell and tissues and are required in the diet in gram quantities daily. The four basic of them are **H**, **O**, **N**, **C**.

For **trace elements**, the requirements are much smaller: a few milligrams per day.

Biomolecules are compounds of carbon with a variety of functional groups



- The chemistry of living organisms is organized around **carbon (C)**. Carbon can form single bonds with hydrogen atoms, and both single and double bonds with oxygen and nitrogen atoms.
- Also, carbon atoms can form vary stable single bonds with up to four other carbon atoms. Two carbon atoms also can share two (or three) electron pairs, thus forming double (or triple) bonds.

Some classes of organic compounds:

1) Hydrocarbons:
   - Alkanes (saturated hydrocarbons)
   - Alkenes (unsaturated hydrocarbons with double bonds)
   - Alkynes (unsaturated hydrocarbons with triple bonds)
2) Alcohols (contains one or more hydroxyl group)
3) Aldehydes (contains an aldehyde group)
4) Ketones (contains keto group)

Some classes of organic compounds:

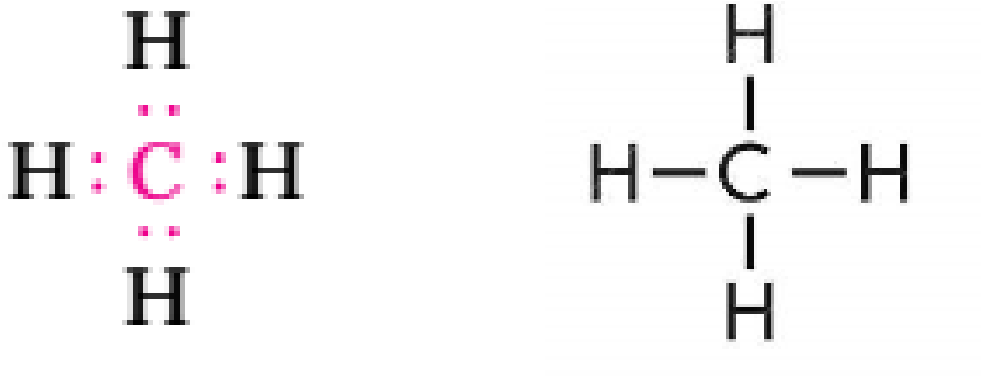
6) Carboxylic acids (contains one or more carboxylic group)
7) Amines (contains amino group)
8) Amides (contains amido group)
9) Ethers (contains an ether group)

Bioorganic compounds:

- Carbohydrates
- Lipids
- Nucleic acids
- Amino acids and proteins

Alkanes, alkenes and alkynes

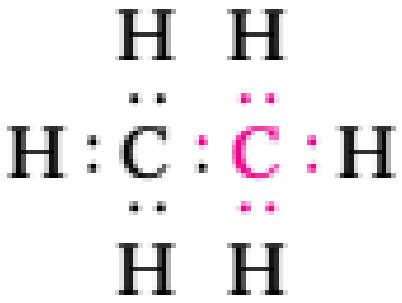
- Alkanes - saturated hydrocarbons with the general formula $\mathbf{C_nH_{2n+2}}$. Each carbon atom forms 4 strong single bonds.

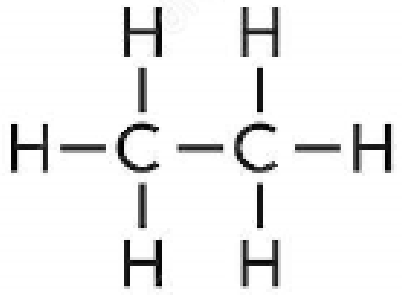


Methane (CH_4)

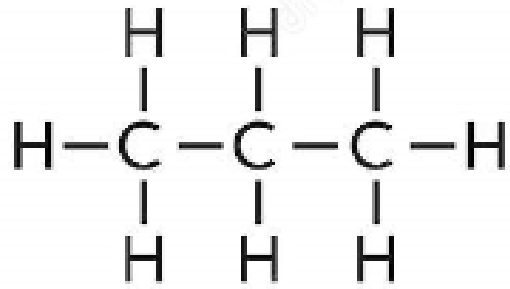
Alkanes, alkenes and alkynes

- Alkanes - saturated hydrocarbons with the general formula $\mathbf{C_nH_{2n+2}}$. Each carbon atom forms 4 strong single bonds.

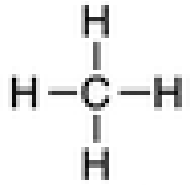
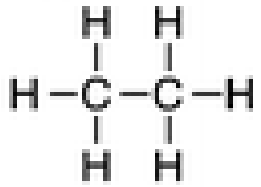
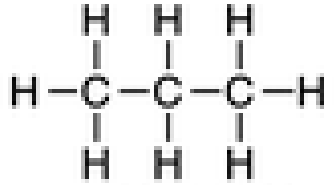
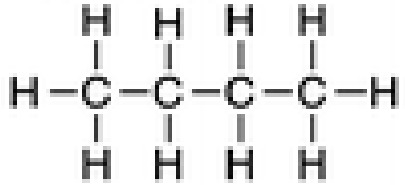
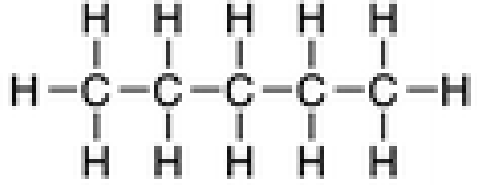
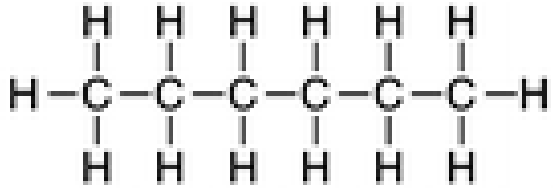
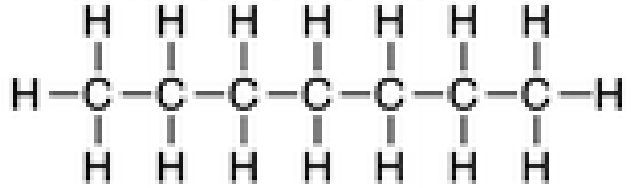
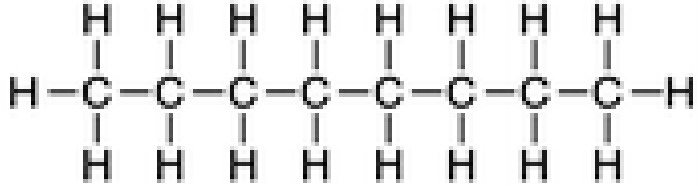
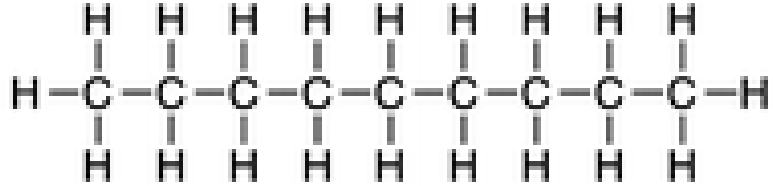
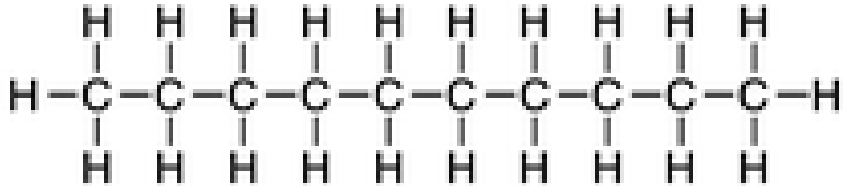




Ethane (C_2H_6)

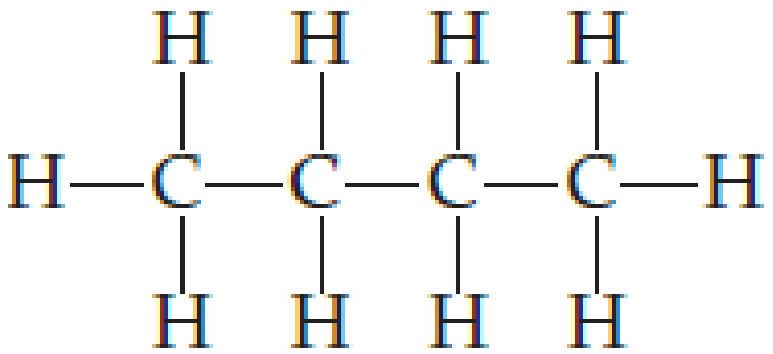


Propane (C_3H_8)

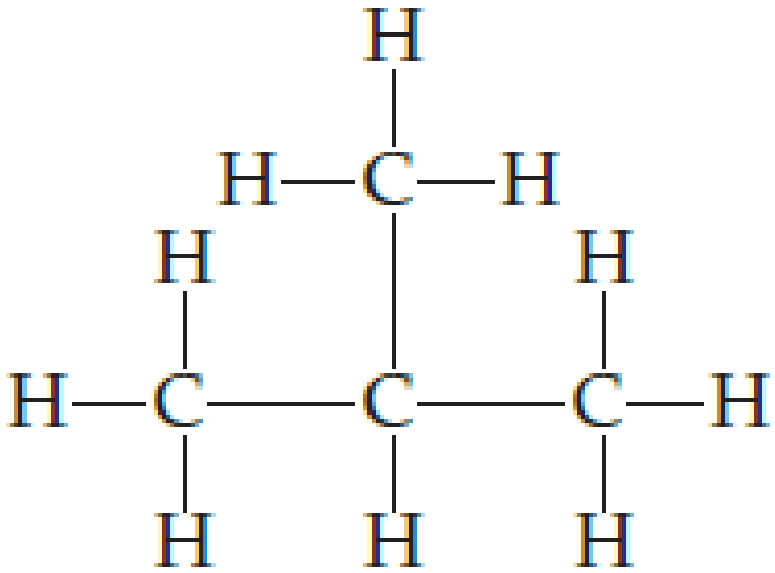
Methane	CH_4	
Ethane	C_2H_6	
Propane	C_3H_8	
Butane	C_4H_{10}	
Pentane	C_5H_{12}	
Hexane	C_6H_{14}	
Heptane	C_7H_{16}	
Octane	C_8H_{18}	
Nonane	C_9H_{20}	
Decane	$C_{10}H_{22}$	

No. of C atoms	Name of alkane	Molecular formula	Name of alkyl group	Formula
1	Methane	CH_4	Methyl	$-CH_3$
2	Ethane	C_2H_6	Ethyl	$-C_2H_5$
3	Propane	C_3H_8	Propyl	$-C_3H_7$
4	Butane	C_4H_{10}	Butyl	$-C_4H_9$
5	Pentane	C_5H_{12}	Pentyl	$-C_5H_{11}$
6	Hexane	C_6H_{14}	Hexyl	$-C_6H_{13}$
7	Heptane	C_7H_{16}	Heptyl	$-C_7H_{15}$
8	Octane	C_8H_{18}	Octyl	$-C_8H_{17}$
9	Nonane	C_9H_{20}	Nonyl	$-C_9H_{19}$
10	Decane	$C_{10}H_{22}$	Decyl	$-C_{10}H_{21}$

Branched hydrocarbons



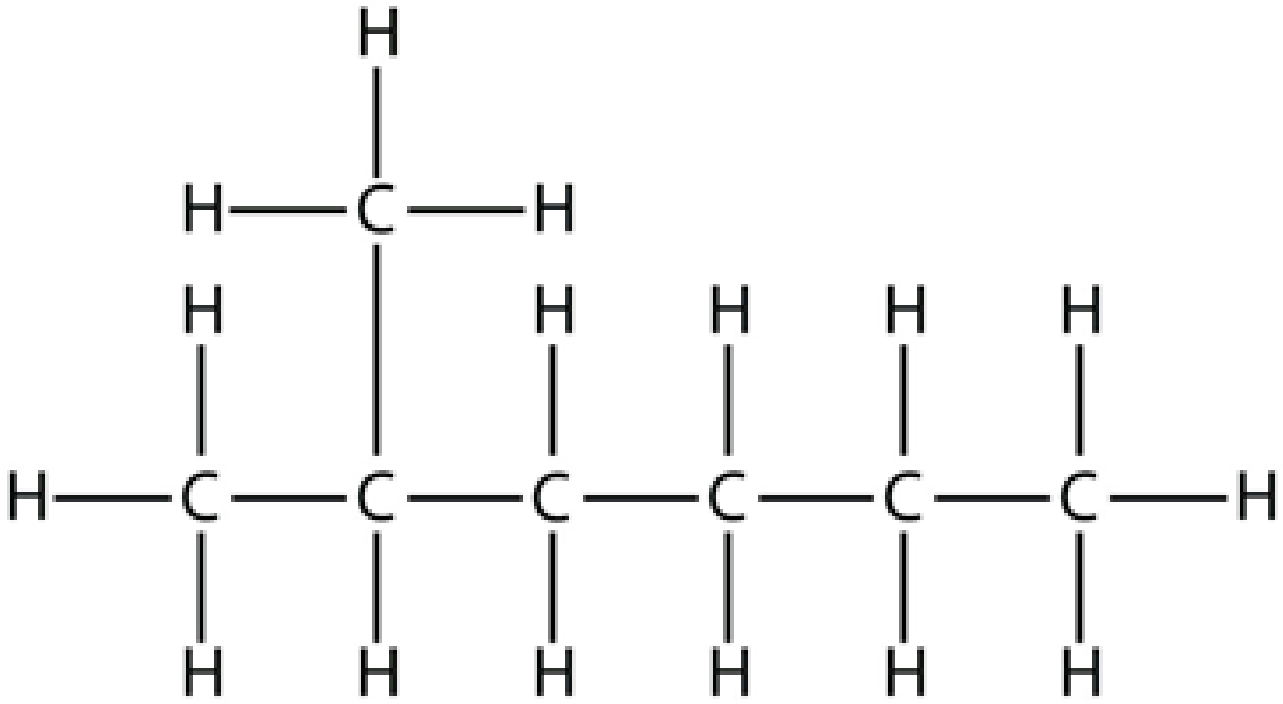
n-butane



isobutane

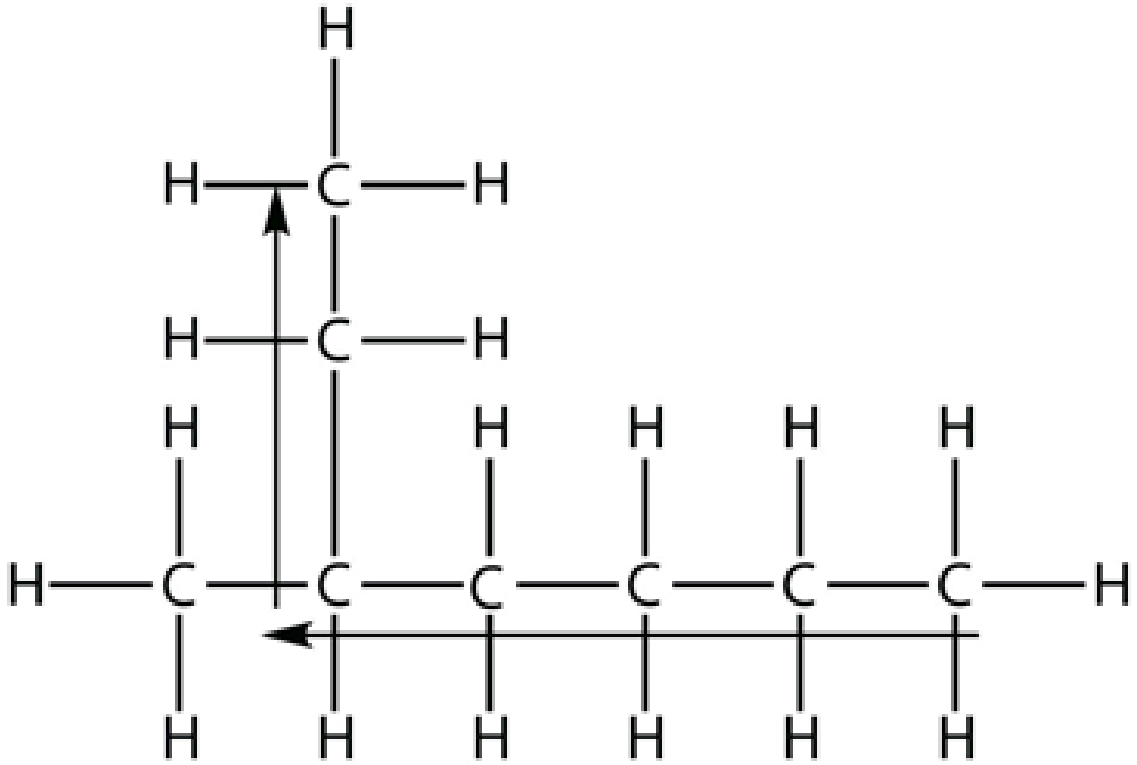
Also **methyl**propane

How can we call it?



2-methylhexane

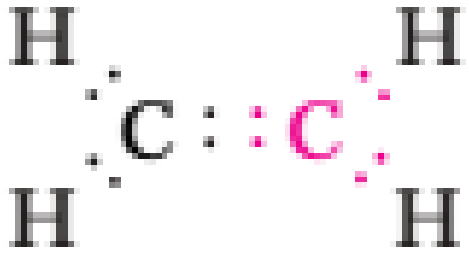
How can we call it?

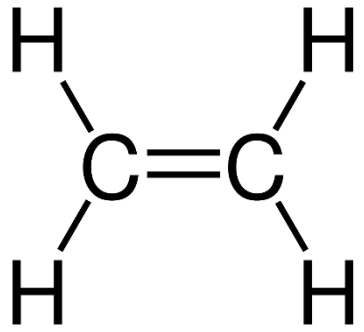


3-methylheptane

Alkenes and alkynes

- Alkenes - unsaturated hydrocarbons with the general formula $\mathbf{C_nH_{2n}}$. Compound contains one or more double bonds.



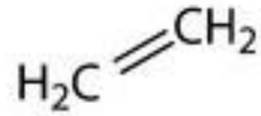


Ethene or ethylene (C_2H_4)

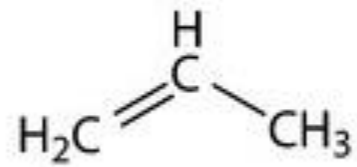
No. of C atoms	Name of alkene	Molecular formula
2	Ethene	C_2H_4
3	Propene	C_3H_6
4	Butene	C_4H_8
5	Pentene	C_5H_{10}
6	Hexene	C_6H_{12}
7	Heptene	C_7H_{14}
8	Octene	C_8H_{16}
9	Nonene	C_9H_{18}
10	Decene	$C_{10}H_{20}$

Normal Structures (Homologues & Isomers)

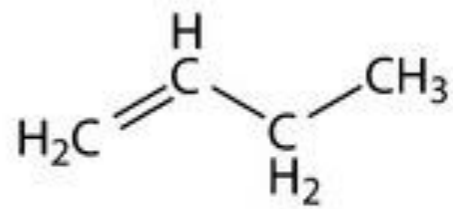
C2 Ethene (ethylene)



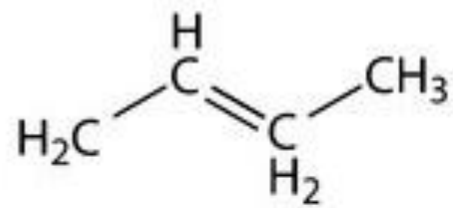
C3 Propene (propylene)



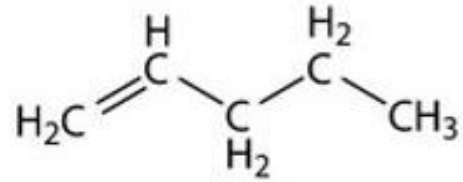
C4 Butene-1 (butylene-1)



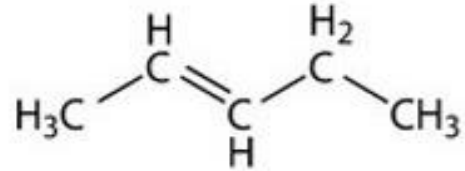
C4 Butene-2 (butylene-2)



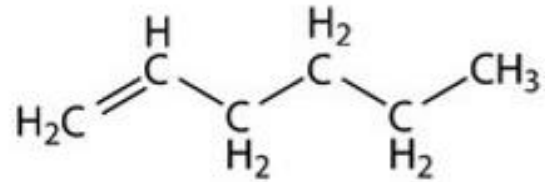
C5 Pentene-1



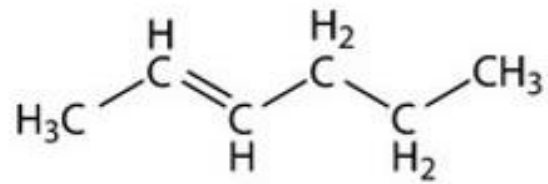
C5 Pentene-2



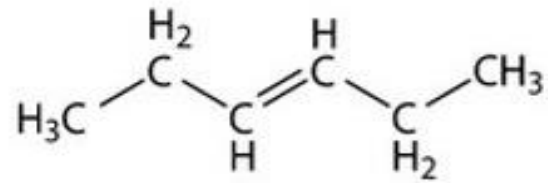
C6 Hexene-1



C6 Hexene-2

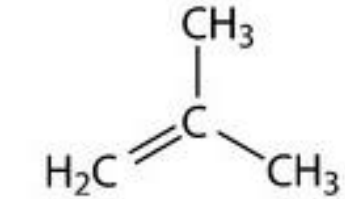


C6 Hexene-3

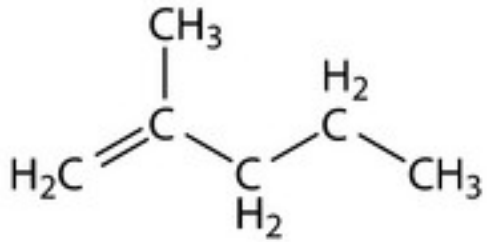


Branched Structure Samples
(Butene, Pentene and Hexene Isomers)

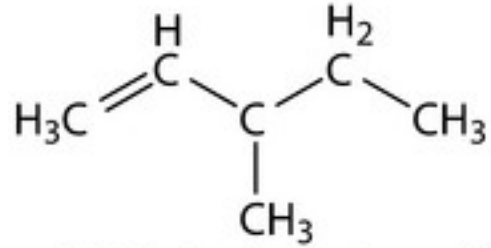
C4



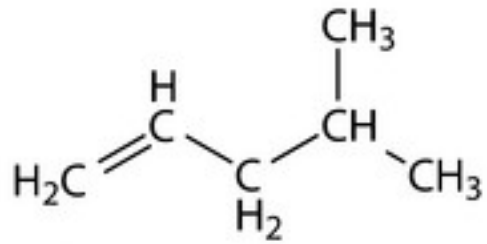
2-Methylpropene-1



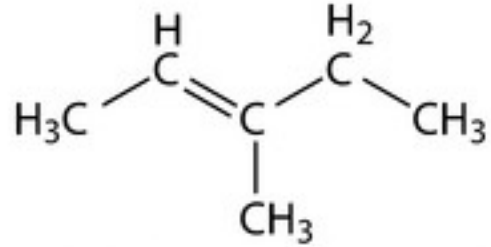
2-Methylpentene-1



3-Methylpentene-1

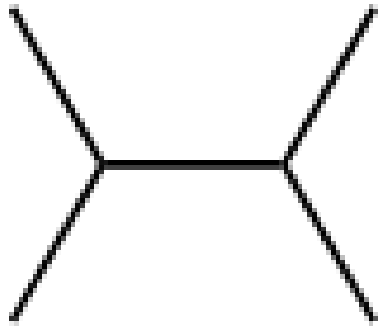


4-Methylpentene-1



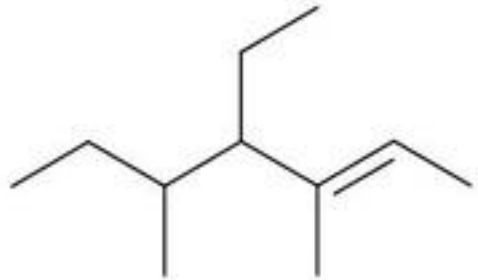
3-Methylpentene-2

Number of Same Substituent	**Numerical Prefix**
2	*di–*
3	*tri-*
4	*tetra–*
5	*penta–*
and so forth	and so forth



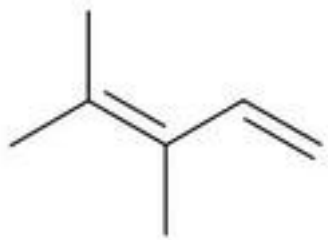
2,3- dimethylbutane

Naming Practice

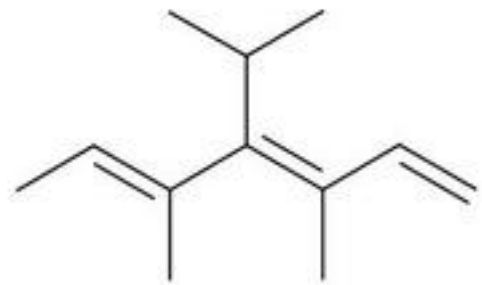


4-ethyl-3,5-dimethyl-2-heptene

2,4-hexadiene



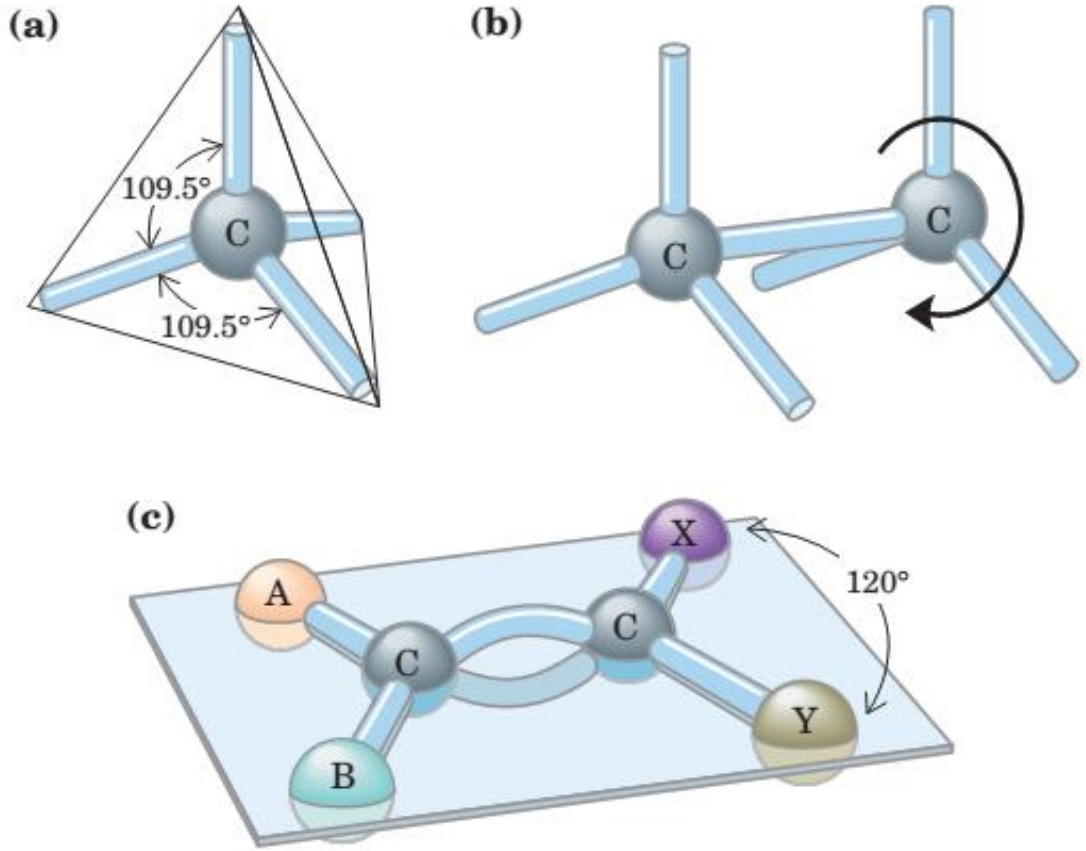
3,4-dimethyl-1,3-pentadiene

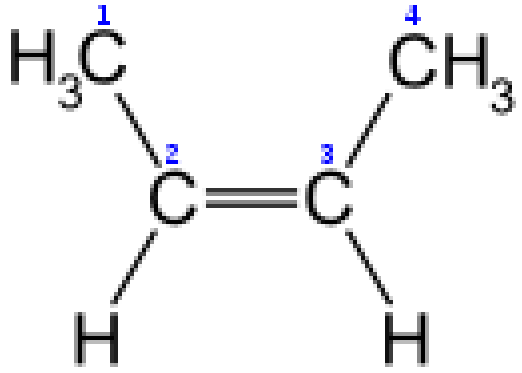


4-isopropyl-3,5-dimethyl-
1,3,5-heptatriene

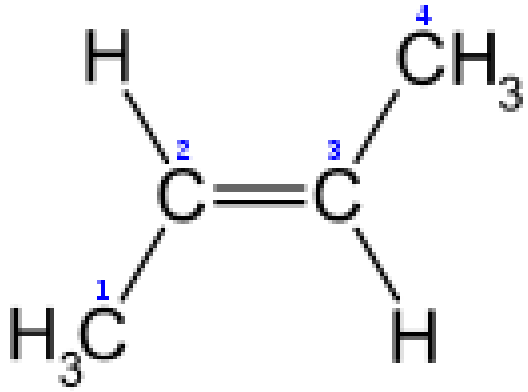
Geometry of carbon bonding

- (a) – carbon atoms have a characteristic tetrahedral arrangement of their four single bonds
- (b) – carbon-carbon single bonds have freedom of rotation, as shown for the compound ethane (CH_3-CH_3)
- (c) – double bonds are shorter and don't allow free rotation. The two doubly bonded carbons and the atoms designated A, B, X and Y all lie in the same rigid plane

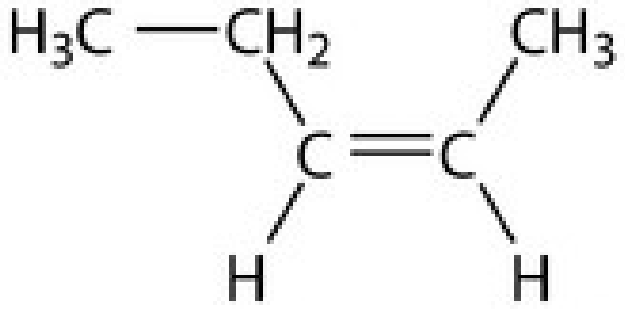




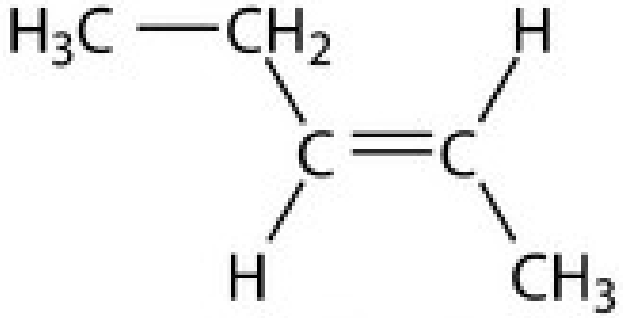
cis-but-2-ene



trans-but-2-ene



cis-Pentene-2

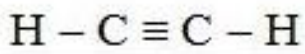
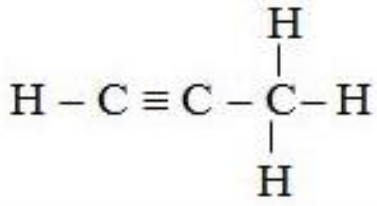
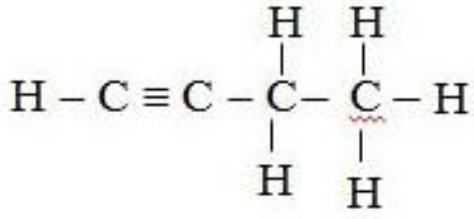
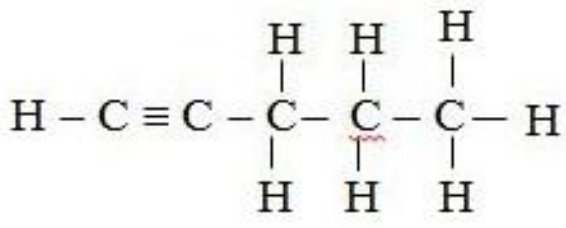
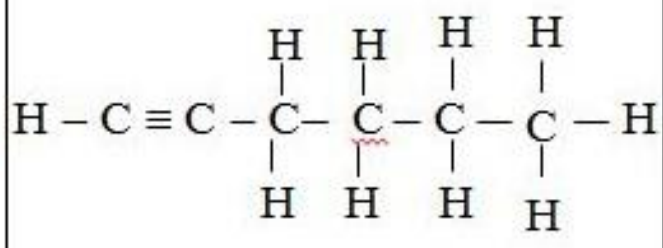


trans-Pentene-2

Alkynes

- Alkynes - unsaturated hydrocarbons with the general formula $\mathbf{C_nH_{2n-2}}$. Compounds contain one or more triple bonds.

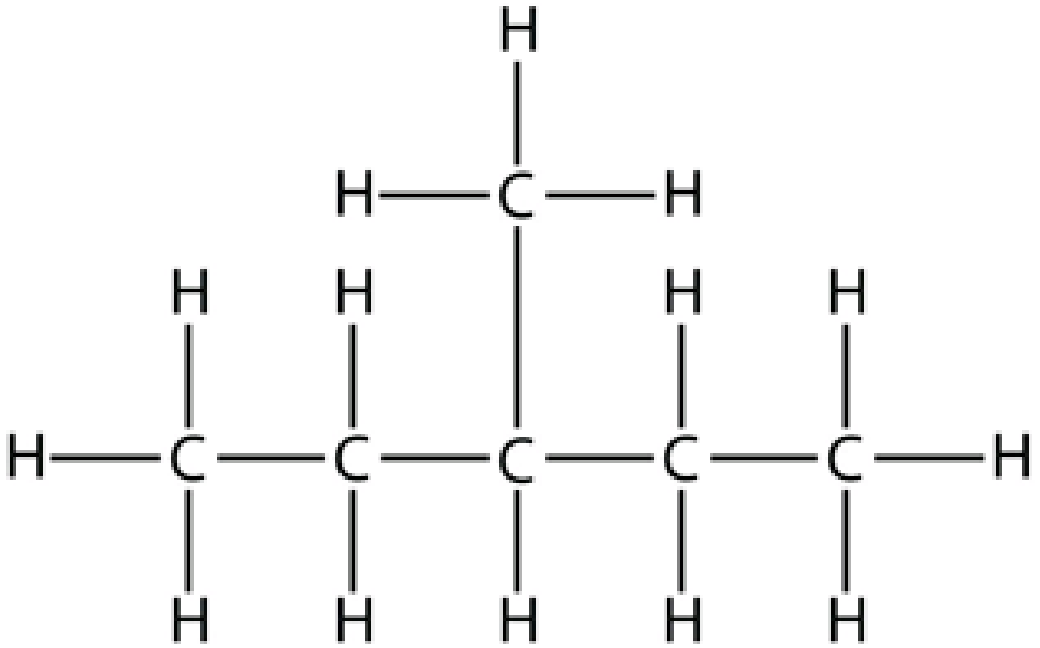
Ethyne or acetylene (C_2H_2)

Name	*Open structure*	*Condensed structure*
Ethyne		$CH{\equiv}CH$
Propyne		$CH{\equiv}C{-}CH_3$
Butyne		$CH{\equiv}C{-}CH_2{-}CH_3$
Pentyne		$CH{\equiv}C{-}CH_2{-}CH_2{-}CH_3$
Hexyne		$CH{\equiv}C{-}CH_2{-}CH_2{-}CH_2{-}CH_3$

Tasks for naming practice

How can we call it?

1)



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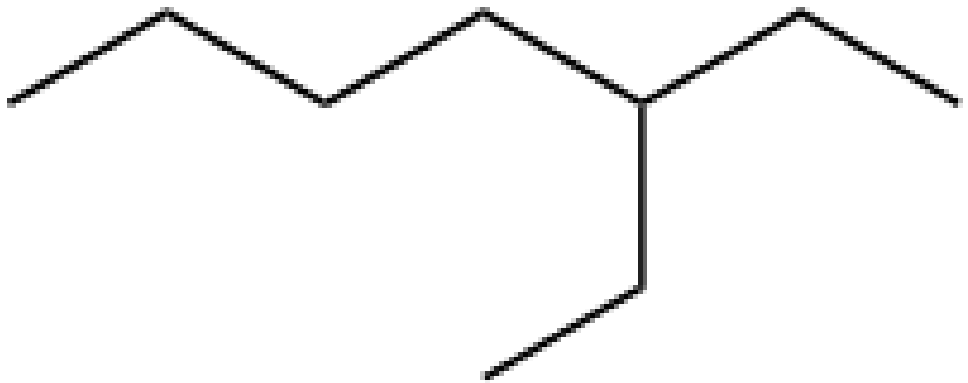
How can we call it?

2)



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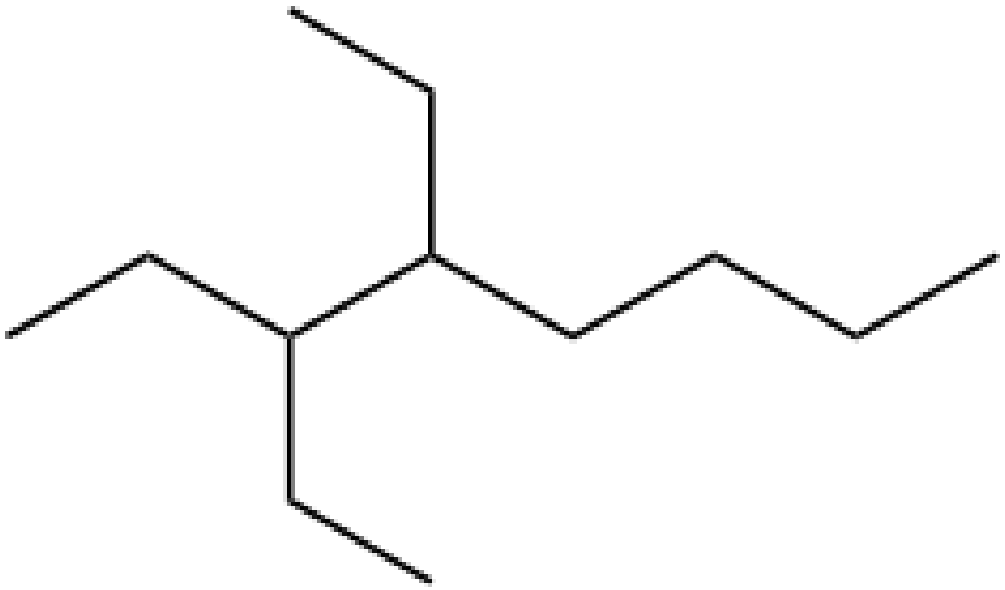
How can we call it?

3)



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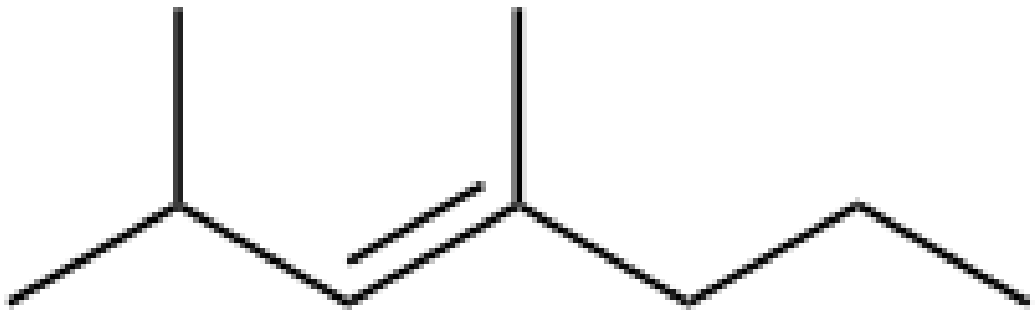
How can we call it?

4)



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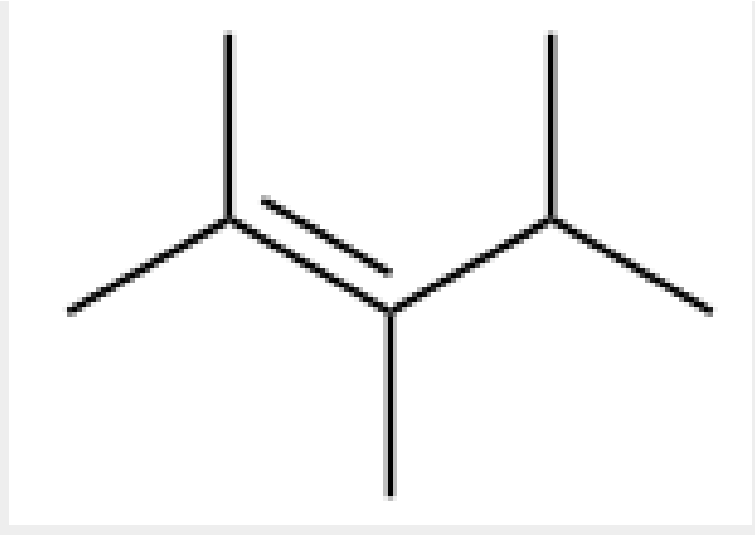
How can we call it?

5)



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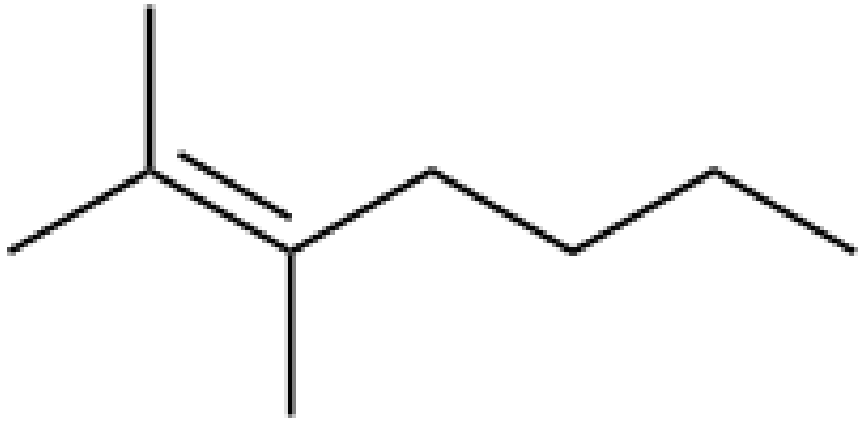
How can we call it?

6)



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How can we call it?

7)

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