



Biological and Bioorganic Chemistry


Some useful web-materials

Kharkov V. N. Karazin National University
Institute for Chemistry

Department of Physical Organic Chemistry

HOME GROUP MEMBERS RESEARCH PUBLICATIONS TEACHING CONTACT US

Teaching



Biological and Bioorganic Chemistry (Faculty of Medicine)

Lecturer: Dr. Denis Svecikarev

A semester-long introduction to organic, bioorganic and biological chemistry for first-year foreign students of the Faculty of Medicine is fully taught in English. The course comprises a small series of lectures, 10 seminars and 5 practice sessions and gives 2 credits according to ECTS.

- Lectures download [PPT]
- Material for seminars download [PDF]
- Calendar working plan [PDF]
- Rules and grading criteria for students [PDF]

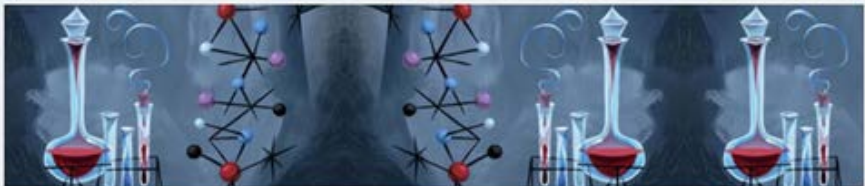
© 2009-2011 Institute for Chemistry, Kharkov V. N. Karazin National University. All rights reserved. Website Administrator - Denis Svecikarev.

I CAN GENERALCHEM

Search... SEARCH

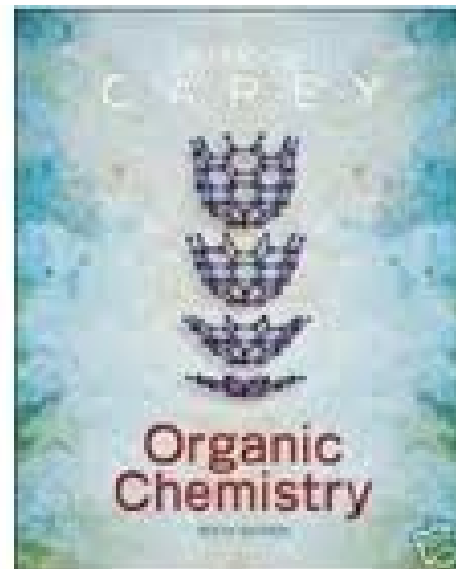
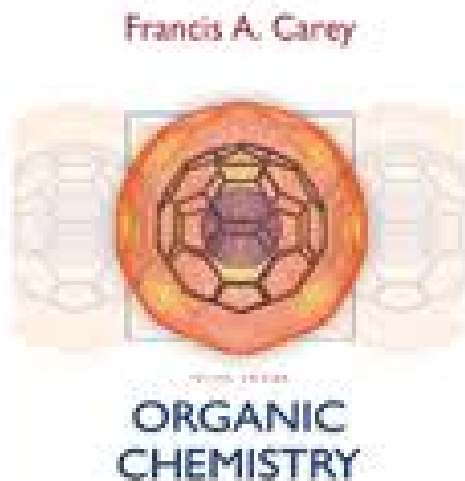
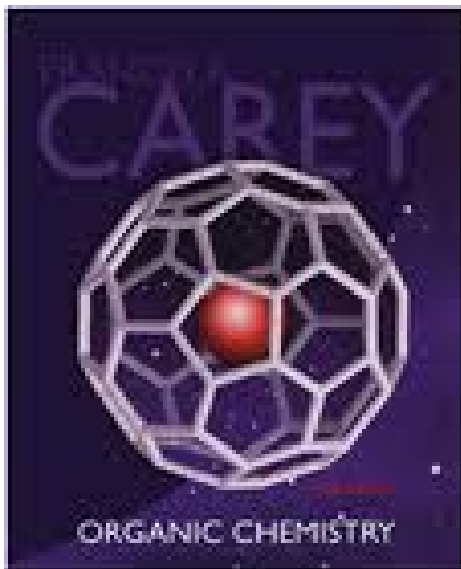
CHEMLABA

HOME TEACHING MATERIALS STUDY PLAN FACULTY OF CHEMISTRY SITEMAP RSS



will be announced ...

Some useful web-materials



F. A. Carey. Organic Chemistry, 5th Edition, The McGraw-Hill, 2004. P. 211.
(<http://www.chem.ucalgary.ca/courses/350/Carey5th/Carey.html>)

What shall we do?



Feb 19

Introduction to organic and biological chemistry. Classes and nomenclature of organic compounds. Saturated and unsaturated hydrocarbons. S_R and Ad_E reactions.

Mar 4

Aromatic hydrocarbons. Orientation in the aromatic ring. Halogen derivatives of hydrocarbons. S_N reactions. Alcohols, ethers. Polyhydric alcohols.

Mar 18

Carbonyl compounds – aldehydes and ketones. Carbohydrates.

Apr 1

Carboxylic acids and their derivatives: amides, nitriles, anhydrides. Esters, fats.

Apr 15

Amines, aminoacids, peptides. Heterocyclic compounds and their biological activity.

A black and white photograph of a desk with an open notebook, a cup, and a calculator, with a central text overlay. The notebook is open to a page with handwritten notes and diagrams. A white cup is on the desk. A calculator is visible in the lower right. The text overlay is a semi-transparent box with a black border containing the text "Main principles of organic chemistry" in a bold, black, sans-serif font.

Main principles of organic chemistry

Organic vs. Inorganic

Comparison of Inorganic vs. Organic compounds:

Inorganic

Ionic Bonding, hence:

High melting point

High boiling point

Non-volatile

Soluble in water

Insoluble in organic solvents

Electrical conductors in aqueous solutions when melted

Have fast reactions

Ex. salts
water
oxides
carbonates

Organic

Covalent/van der waals

Low melting point

Low boiling point

Volatile

Insoluble in water

Soluble in organic solvents

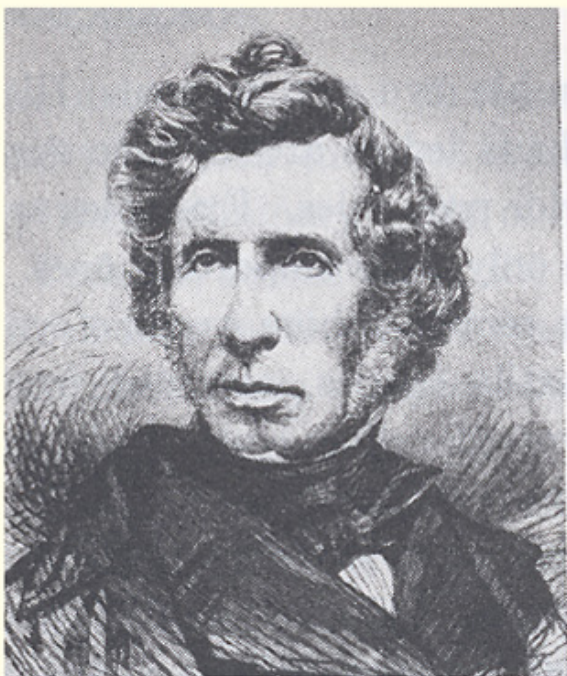
Electrical insulators in solutions when melted

Have slow reactions

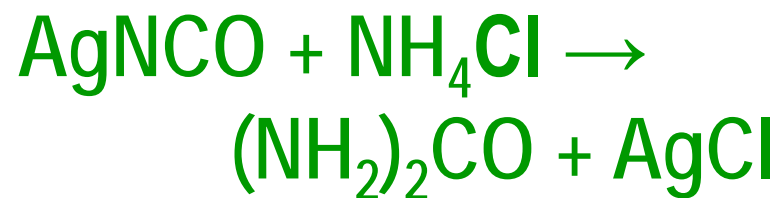
Ex. wax
butter
alcohols
gasoline
sugar

Power of life and vitalism

Friedrich Woller
1800-1882



Made the first organic compound from non-living substances. Shot down the *Vital Force* idea of organic substances.



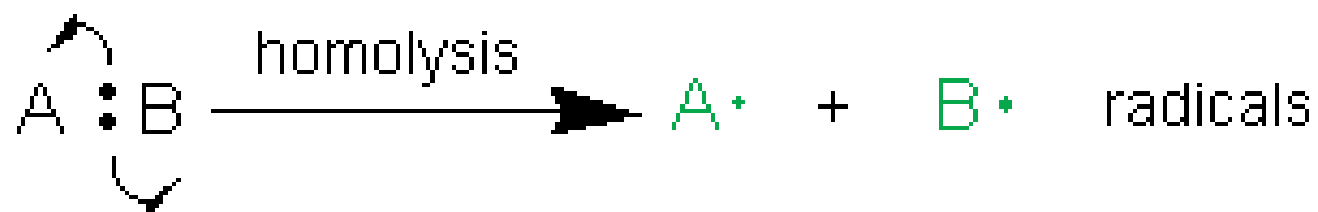
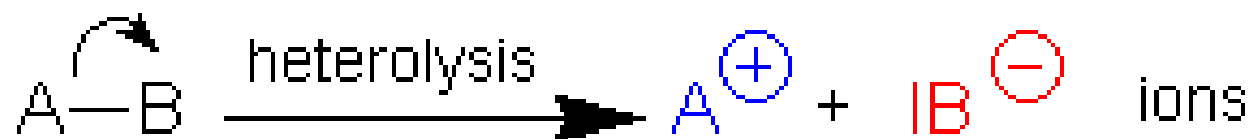
Theory of chemical structure



Alexander Butlerov

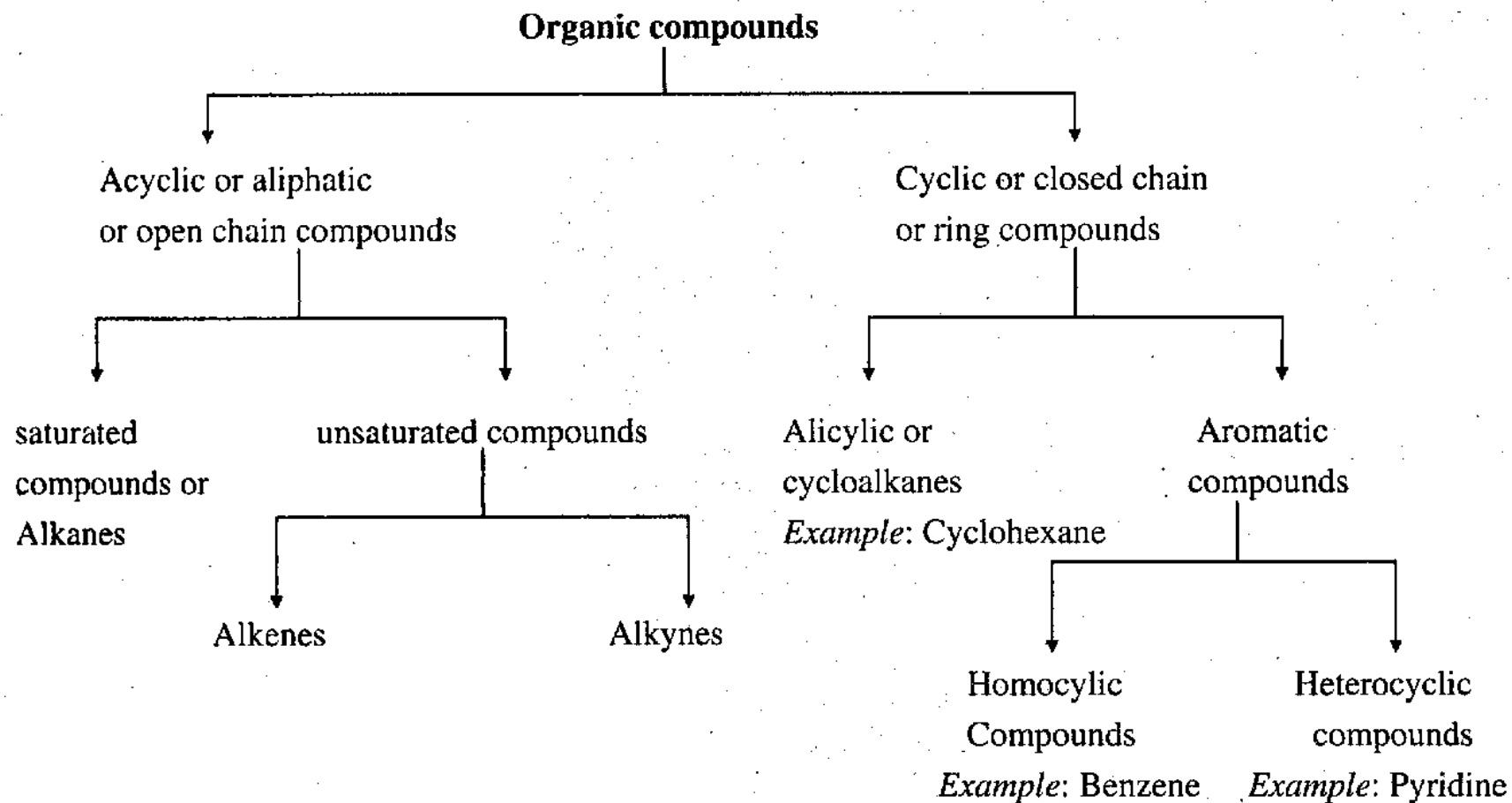
Eminent Russian chemist, one of the founders of the theory of chemical structure. First scientist to introduce double bonds in structural formulae.

Intermediate particles

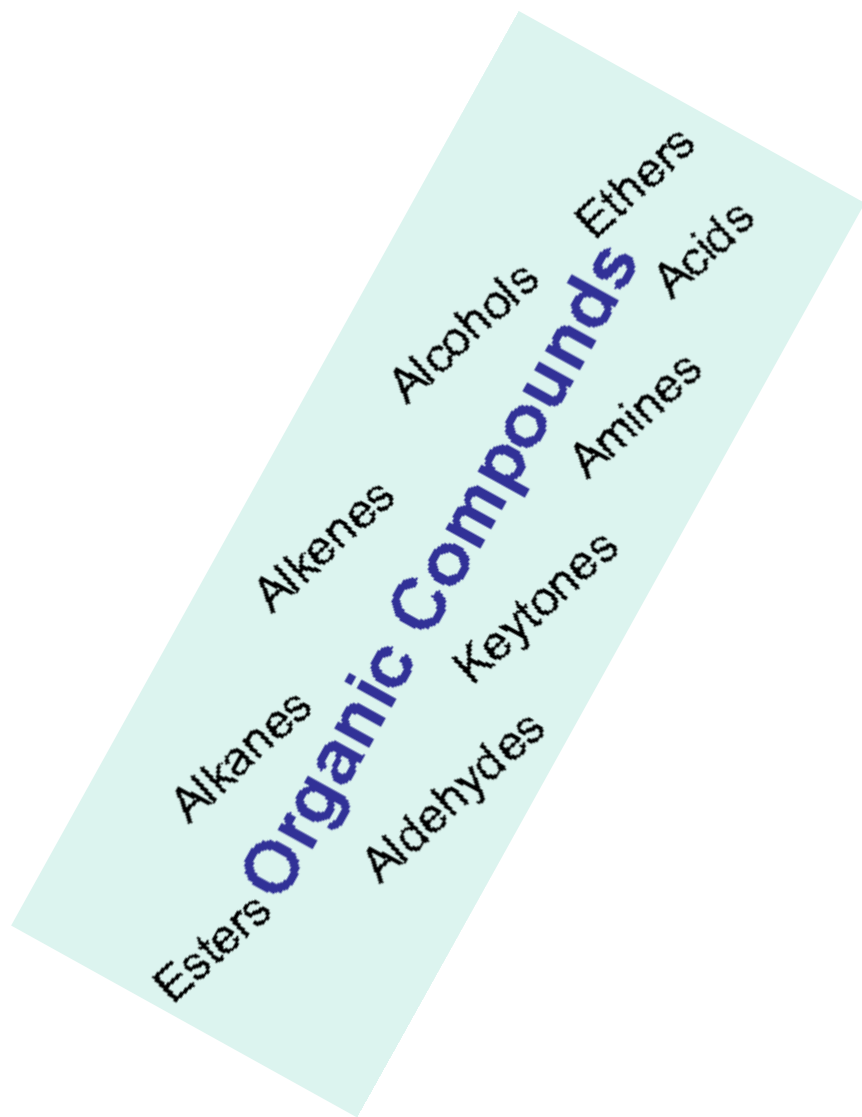


Classification of organic compounds

Schematic representation for the classification of organic compounds



Classification of organic compounds



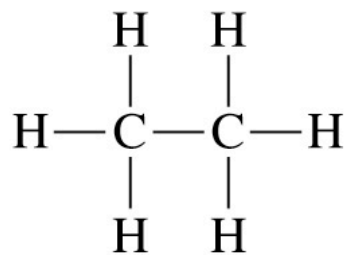
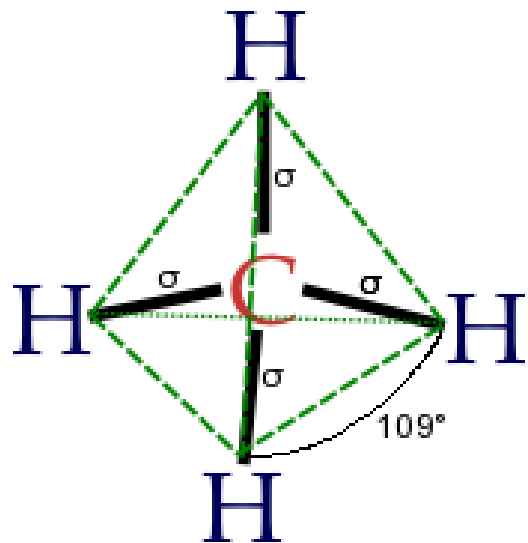
- ♦ Halogen derivatives
- ♦ Oxygen-containing:
 - ♦ Alcohols & ethers
 - ♦ Aldehydes & ketones
 - ♦ Carboxylic acids & esters
- ♦ Nitrogen-containing:
 - ♦ Amines
 - ♦ Nitriles
- ♦ Mixed:
 - ♦ Aminoacids
 - ♦ Peptides
 - ♦ Nitro compounds
- ♦ ...

Alkanes

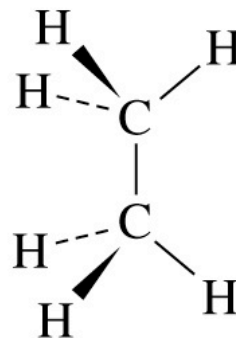


Alkanes

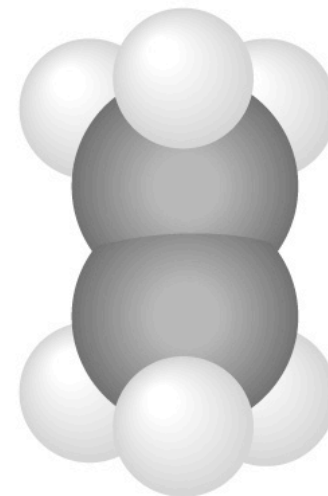
Structure and formulae



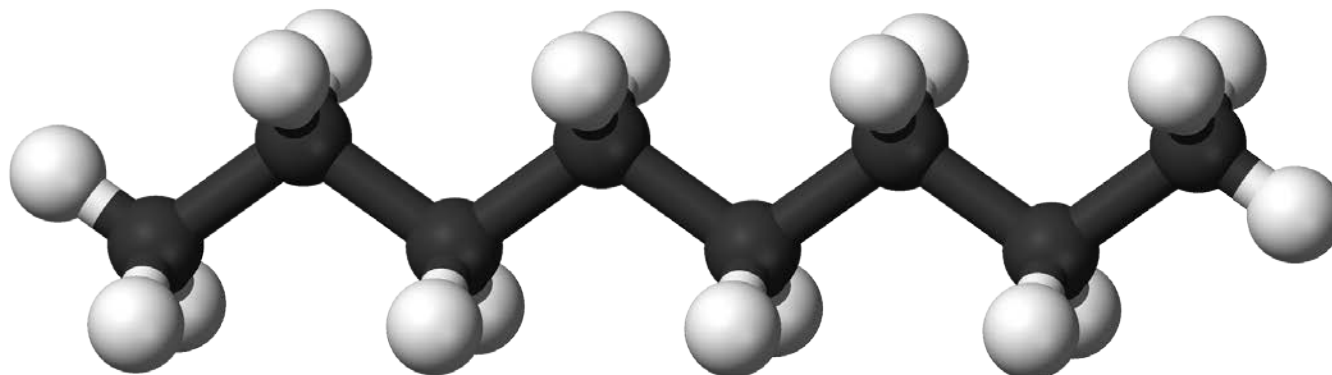
(a)



(b)

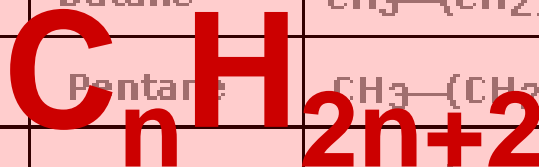


(c)

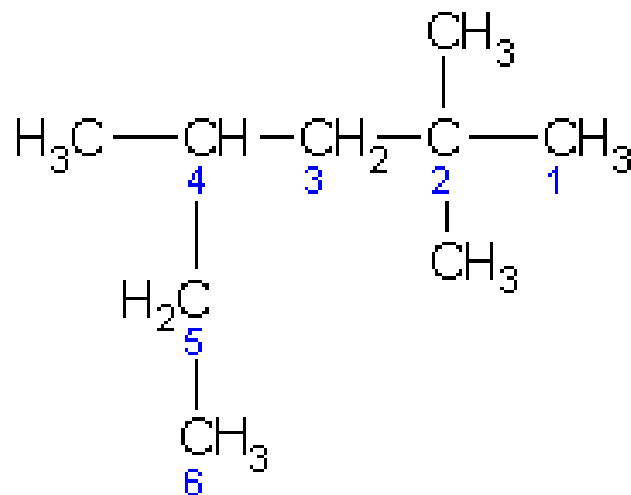
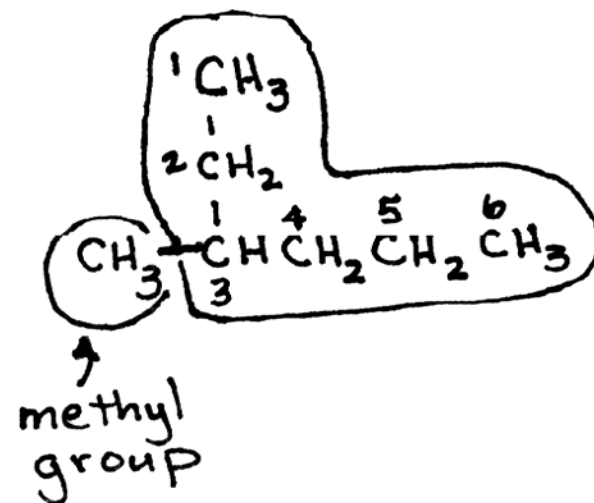
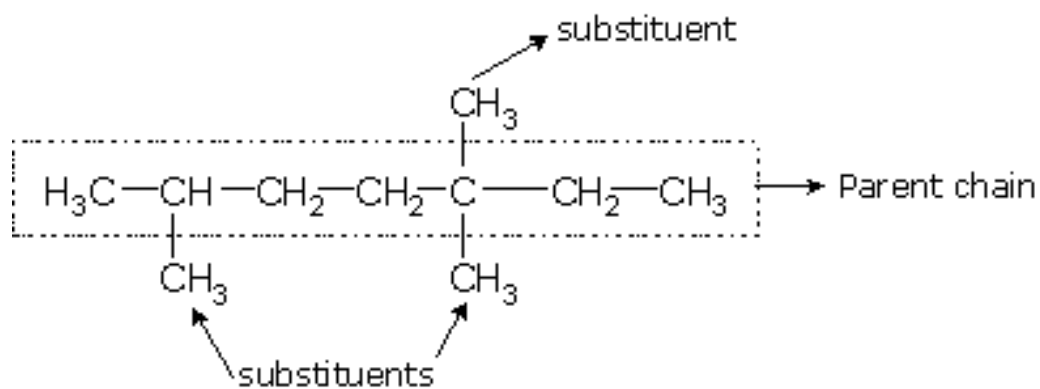


Naming alkanes

| Number of 'C' atoms | Word root | IUPAC name | Structure | Molecular formula |
|---------------------|-----------|------------|---|---------------------------------|
| 1 | Meth | Methane | CH ₄ | CH ₄ |
| 2 | Eth | Ethane | CH ₃ —CH ₃ | C ₂ H ₆ |
| 3 | Prop | Propane | CH ₃ —CH ₂ —CH ₃ | C ₃ H ₈ |
| 4 | But | Butane | CH ₃ —(CH ₂) ₂ —CH ₃ | C ₄ H ₁₀ |
| 5 | Pent | Pentane | CH ₃ —(CH ₂) ₃ —CH ₃ | C ₅ H ₁₂ |
| 6 | Hex | Hexane | CH ₃ —(CH ₂) ₄ —CH ₃ | C ₆ H ₁₄ |
| 7 | Hept | Heptane | CH ₃ —(CH ₂) ₅ —CH ₃ | C ₇ H ₁₆ |
| 8 | Oct | Octane | CH ₃ —(CH ₂) ₆ —CH ₃ | C ₈ H ₁₈ |
| 9 | Non | Nonane | CH ₃ —(CH ₂) ₇ —CH ₃ | C ₉ H ₂₀ |
| 10 | Dec | Decane | CH ₃ —(CH ₂) ₈ —CH ₃ | C ₁₀ H ₂₂ |

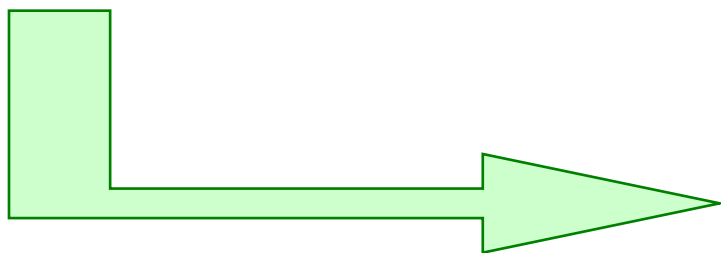
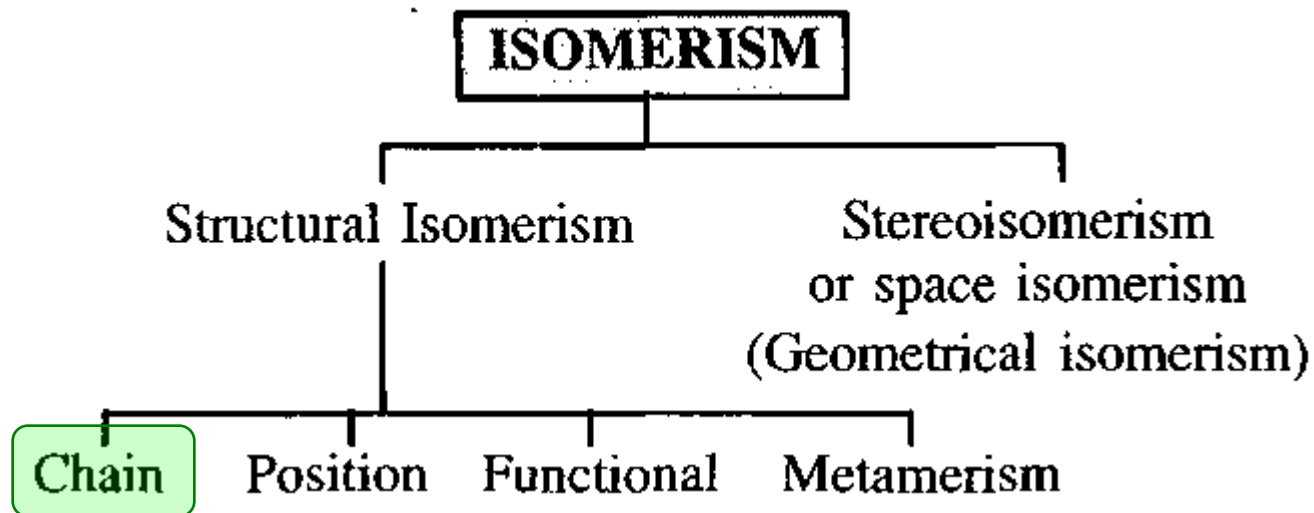


Naming branched-chain alkanes

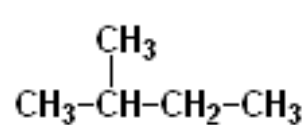


2,2,4-trimethylhexane

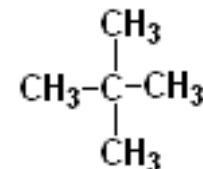
Isomerism of alkanes



pentane
(*n*-pentane)



methylbutane
(isopentane)



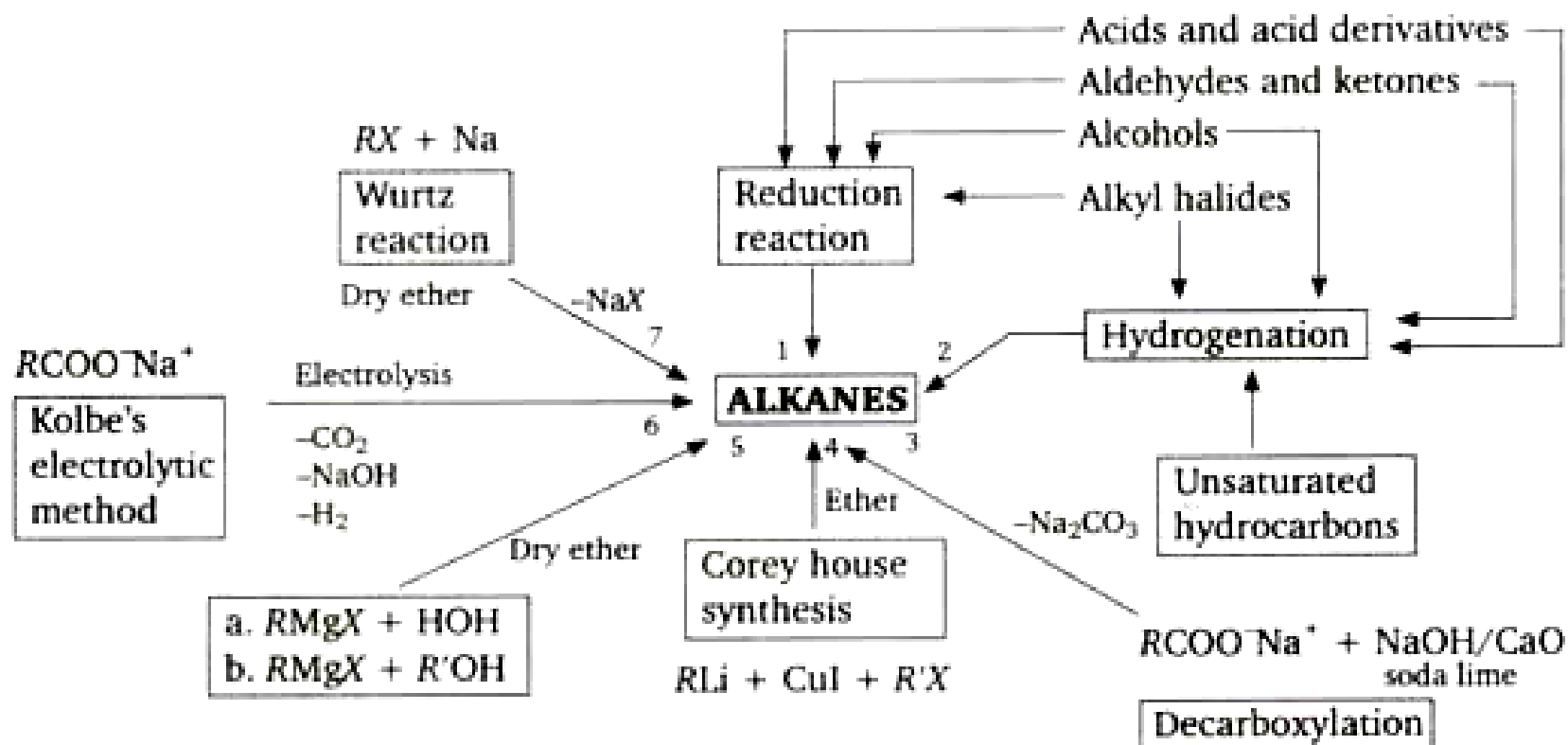
dimethylpropane
(neopentane)

Alkanes

Physical Properties:

| <u>Name</u> | <u>Formula</u> | <u>MP (°C)</u> | <u>BP (°C)</u> | <u>Density (g/mL)</u> |
|-------------|---------------------------------|----------------|----------------|-----------------------|
| Methane | CH ₄ | -182 | -164 | -- |
| Ethane | C ₂ H ₆ | -183 | -89 | -- |
| Propane | C ₃ H ₈ | -190 | -42 | -- |
| Butane | C ₄ H ₁₀ | -138 | -1 | -- |
| Pentane | C ₅ H ₁₂ | -130 | 36 | 0.63 |
| Hexane | C ₆ H ₁₄ | -95 | 69 | 0.66 |
| Heptane | C ₇ H ₁₆ | -91 | 98 | 0.68 |
| Octane | C ₈ H ₁₈ | -57 | 125 | 0.70 |
| Nonane | C ₉ H ₂₀ | -51 | 151 | 0.72 |
| Decane | C ₁₀ H ₂₂ | -30 | 174 | 0.73 |

How to obtain alkanes

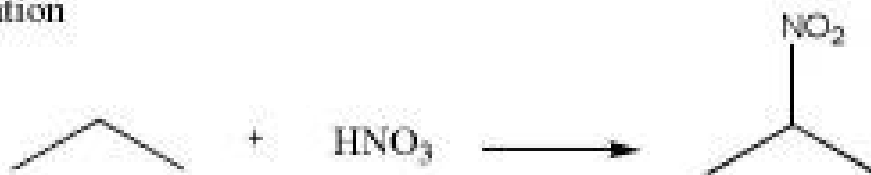


Chemical properties of alkanes

Halogenation



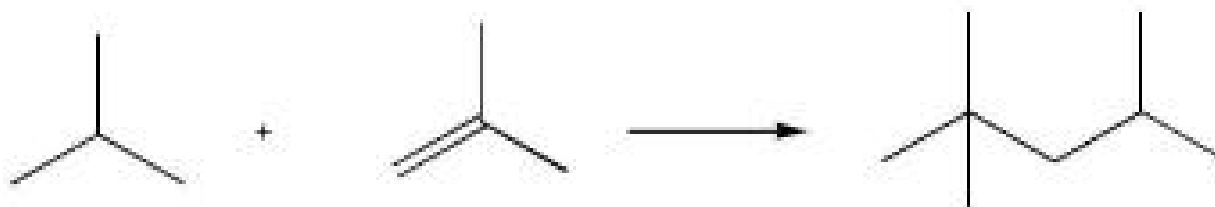
Nitration



Sulphonation



Alkylation

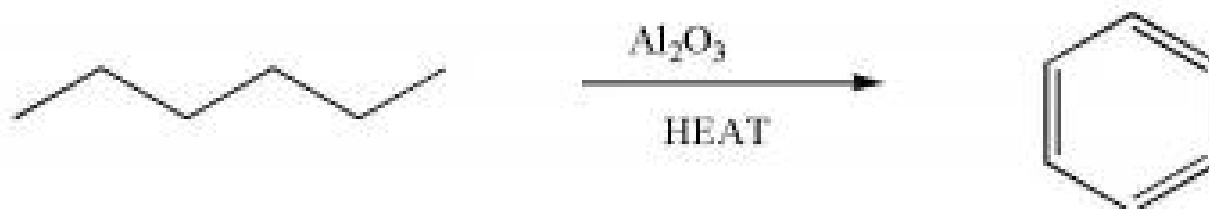


Chemical properties of alkanes

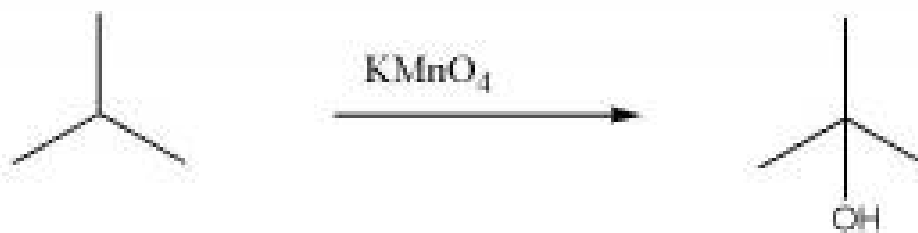
Isomerisation



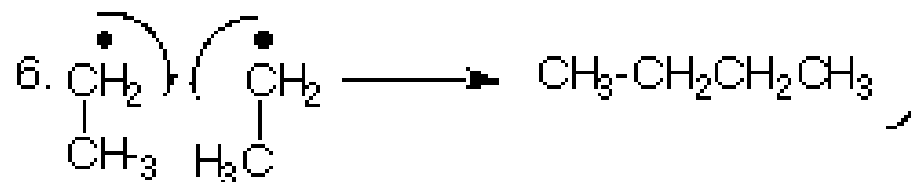
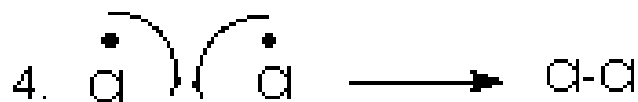
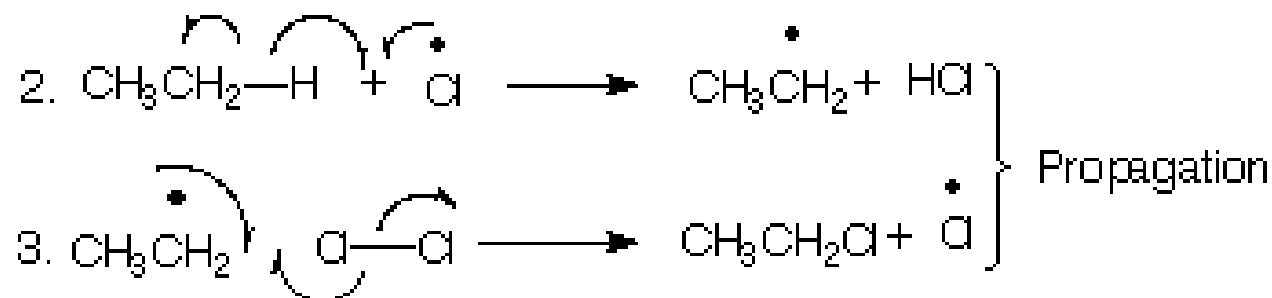
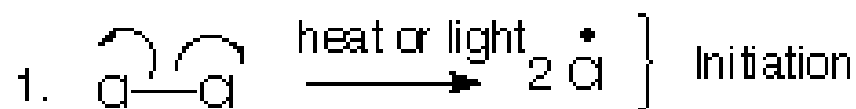
Aromatisation



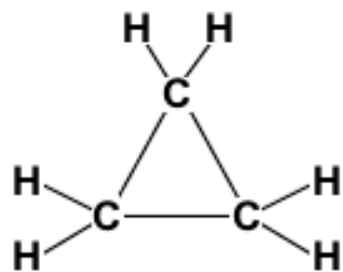
Oxidation



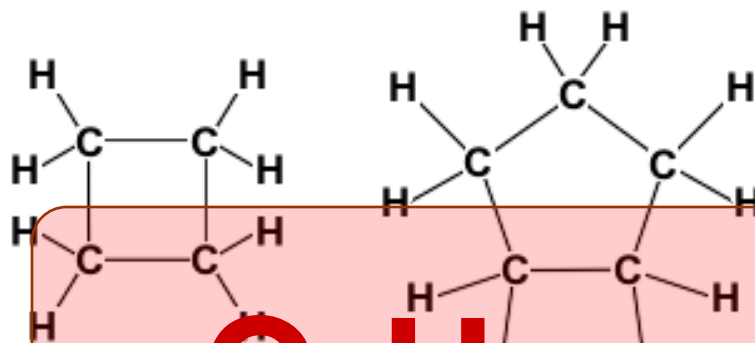
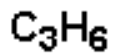
Radical substitution - S_R



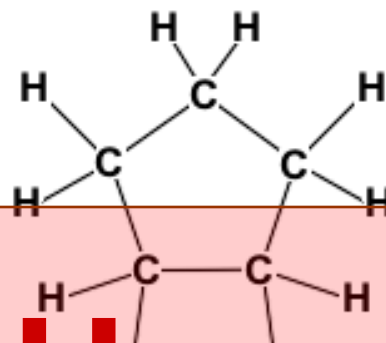
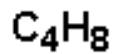
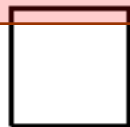
Cycloalkanes



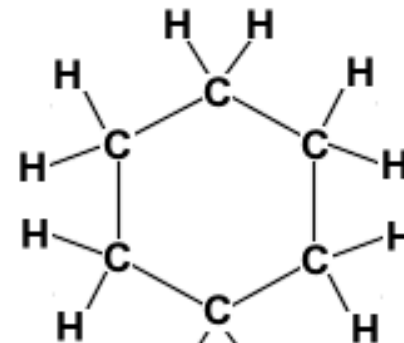
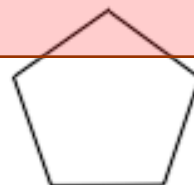
Cyclopropane



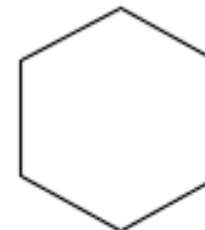
Cyclobutane



Cyclopentane

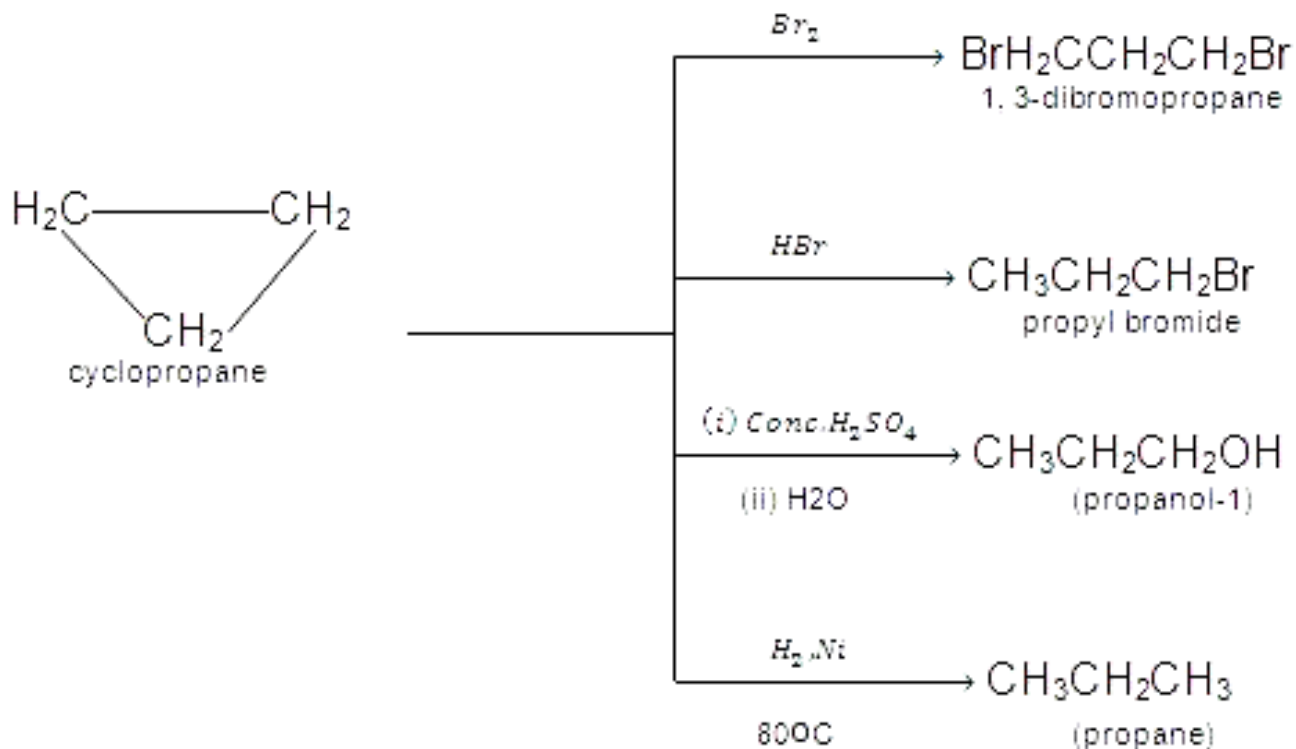


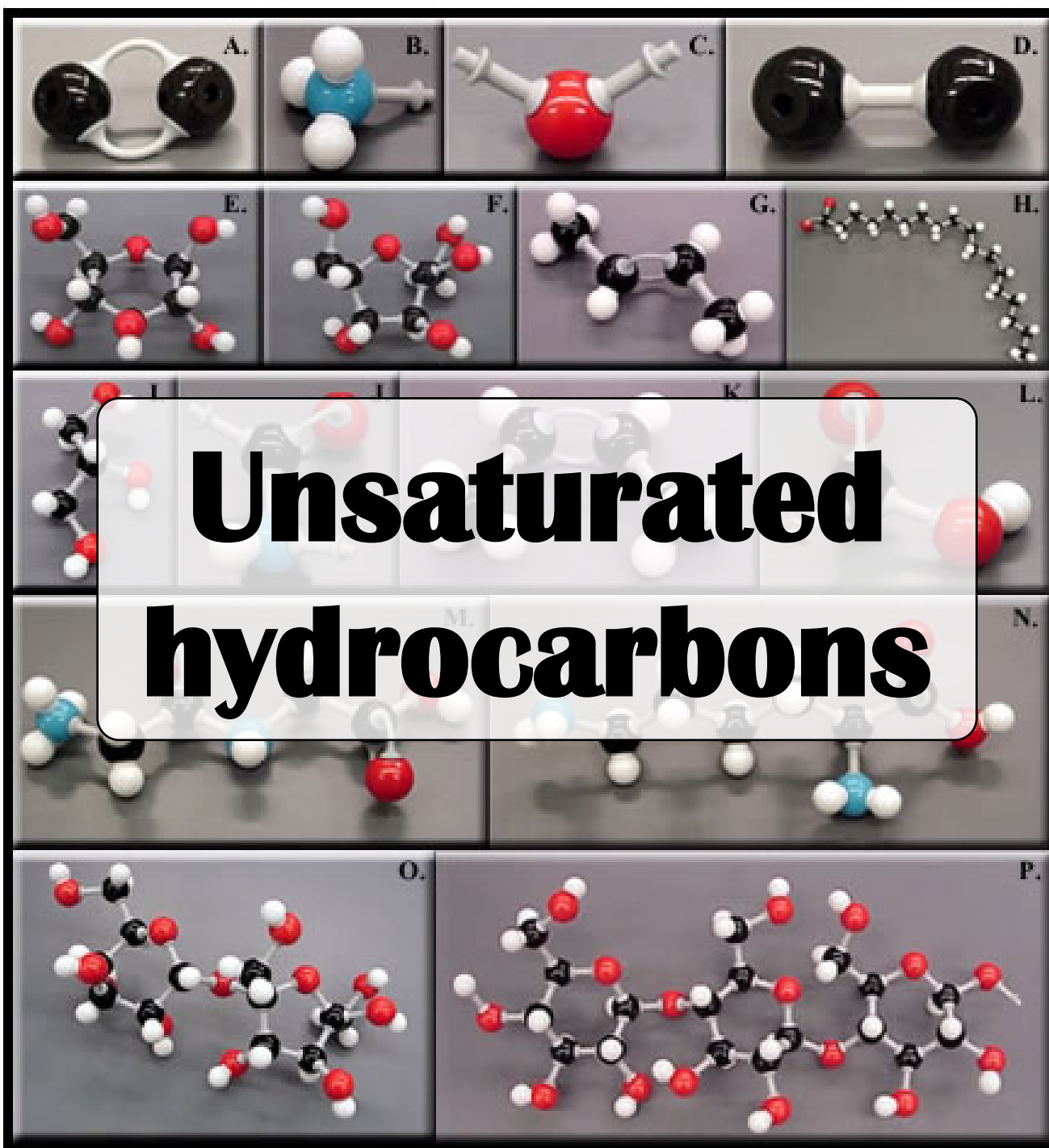
Cyclohexane



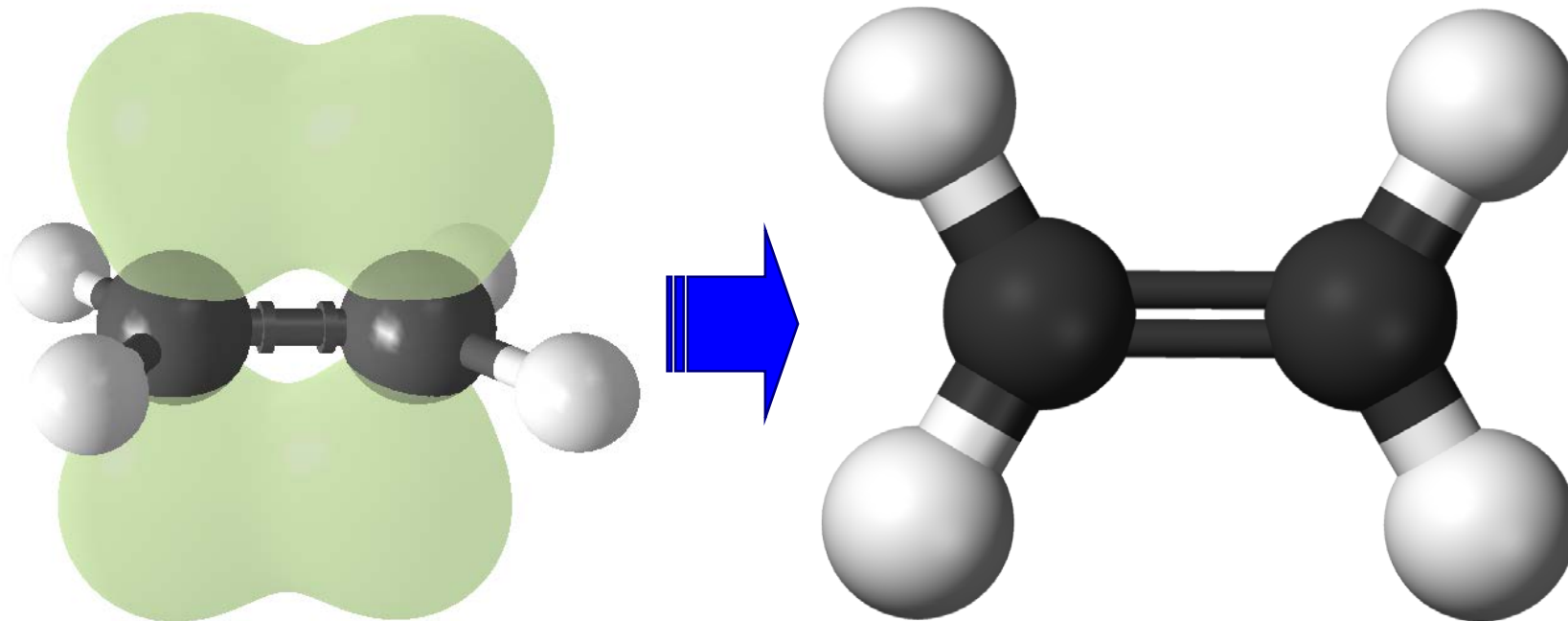
Chemical properties of cycloalkanes

Small cycles show some particular properties:





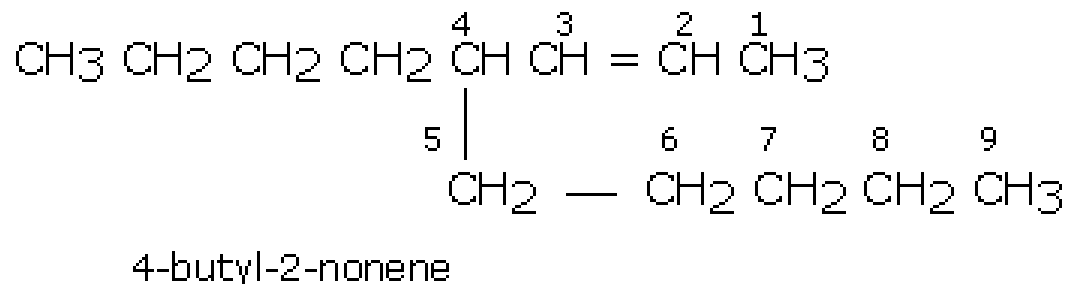
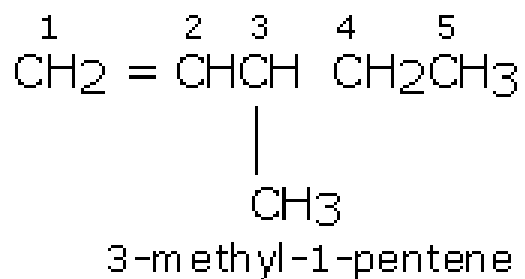
Structure of alkenes: σ - and π -bonds



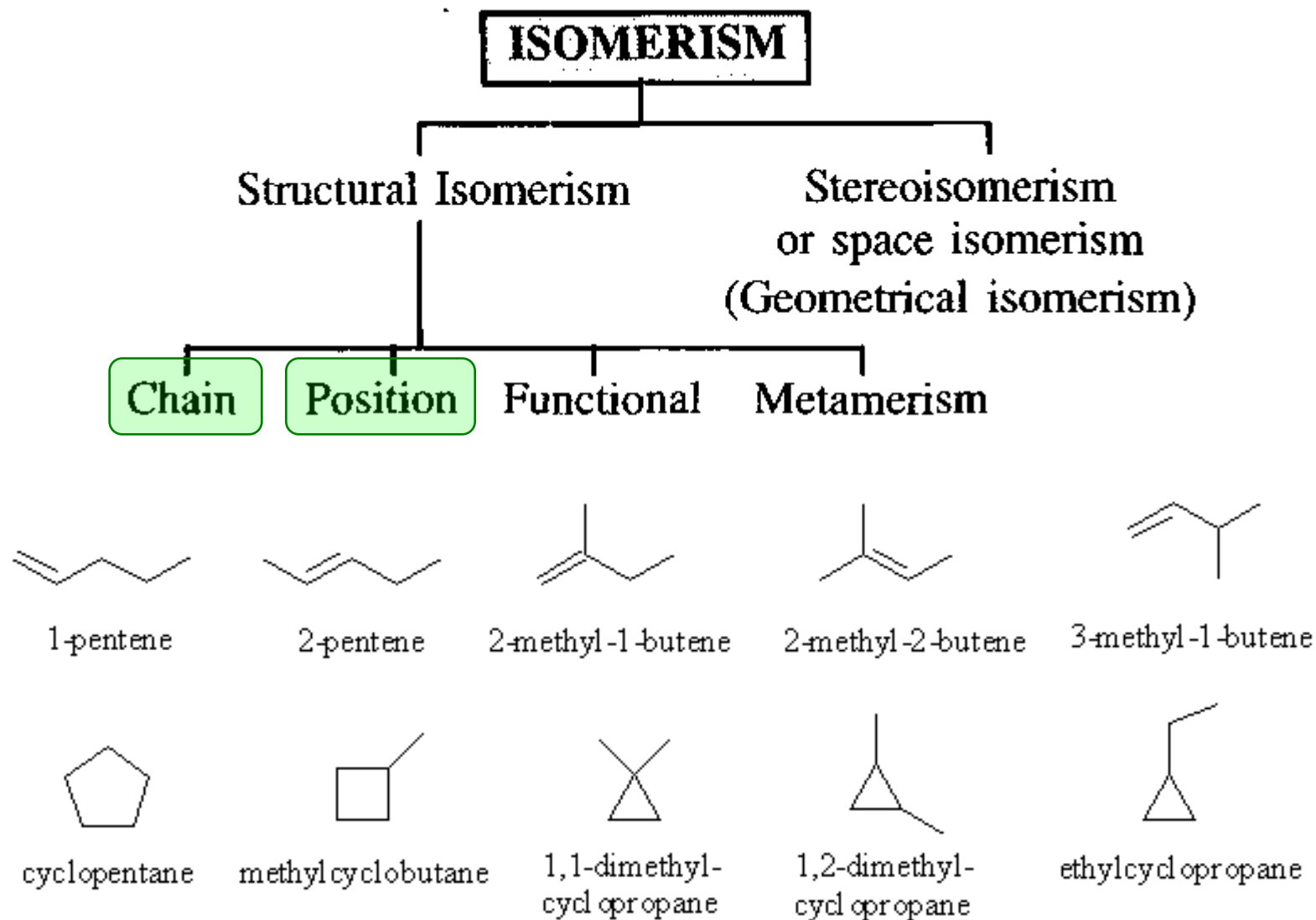
Naming alkenes

| Formula | Common name | IUPAC name |
|-------------------|--------------------|------------|
| C_nH_{2n} | Alkylene or olefin | Alkene |
| 1. C_2H_4 | Ethylene | Ethene |
| 2. C_3H_6 | Propylene | Propene |
| 3. C_4H_8 | Butylene | Butene |
| 4. C_5H_{10} | - | Pentene |
| 5. $C_{10}H_{20}$ | - | Decene |

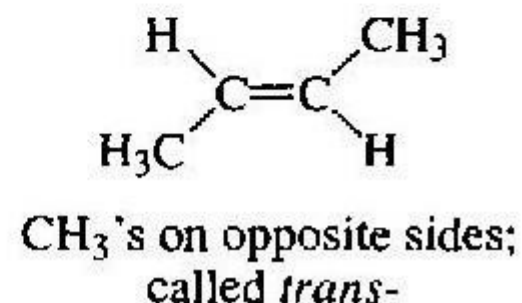
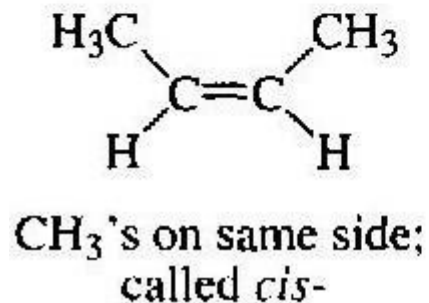
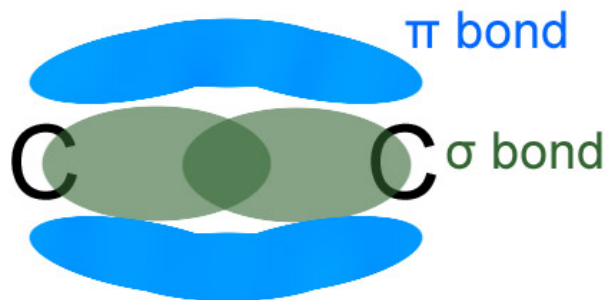
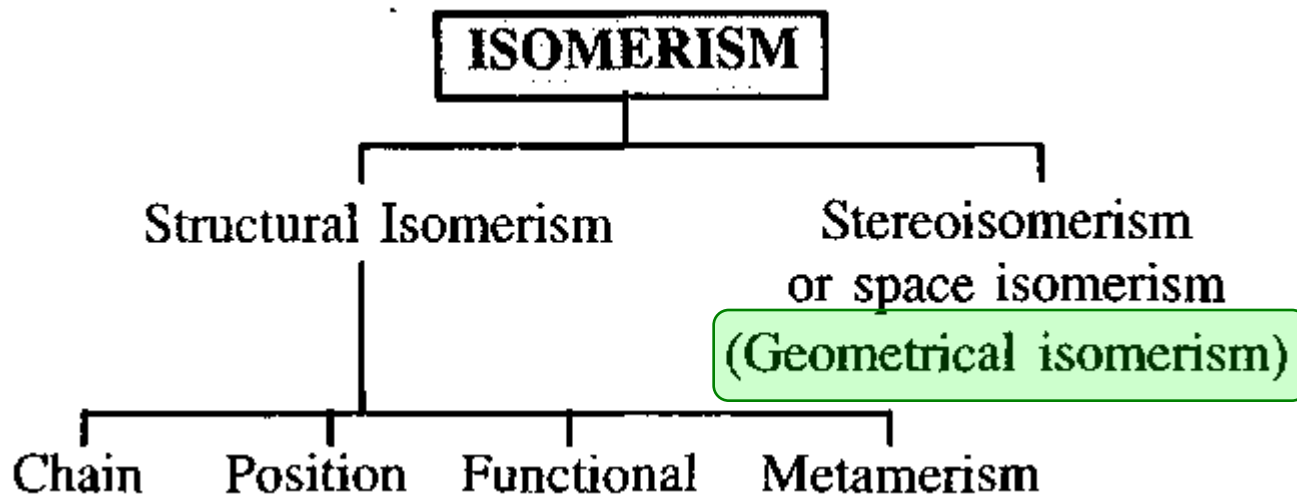
Naming branched-chain alkenes



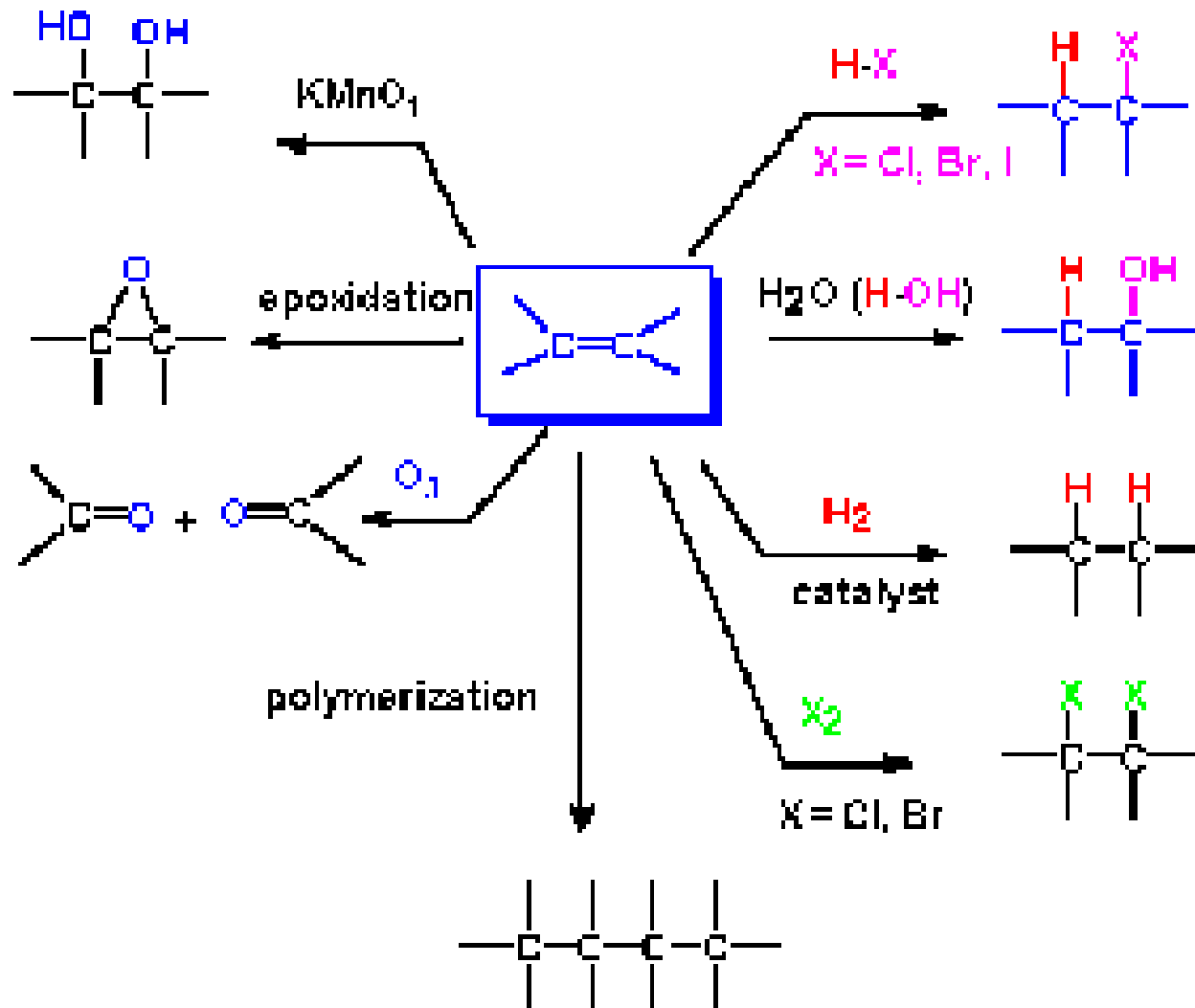
Isomerism of alkenes



Isomerism of alkenes



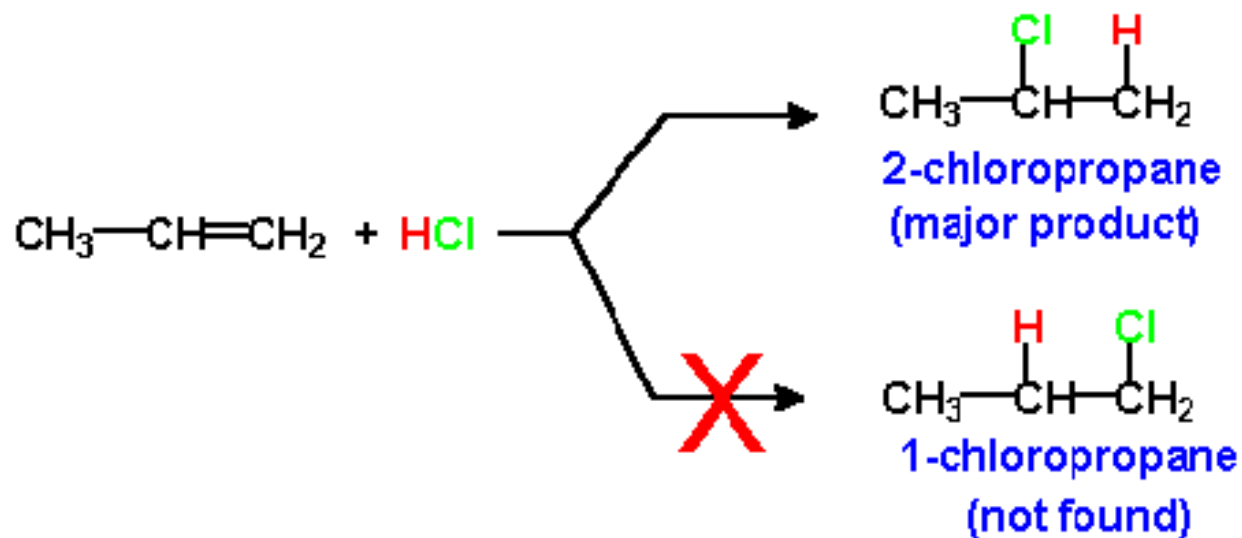
Reactions of Alkenes



Addition to the double bond – Ad_E reactions

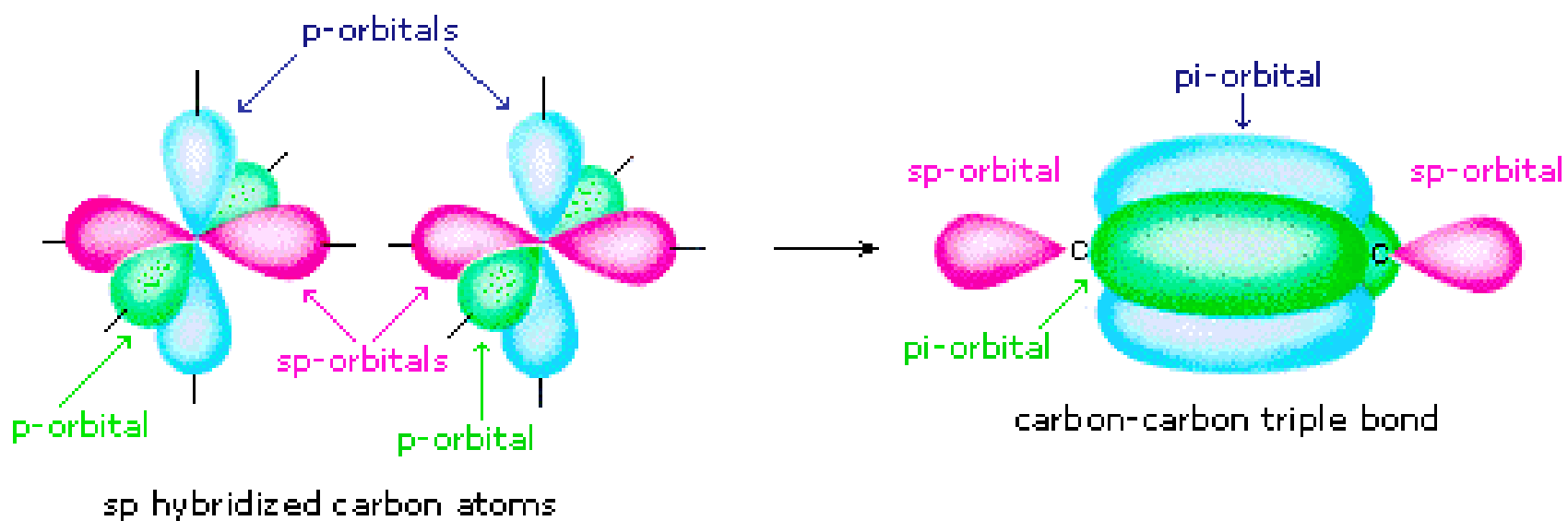
Addition of HX to Alkenes

HX = HCl or HBr



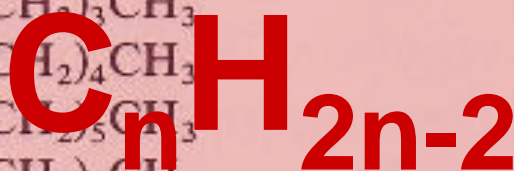
Markovnikov rule

Structure of alkynes: σ - and π -bonds



Naming and properties of alkynes

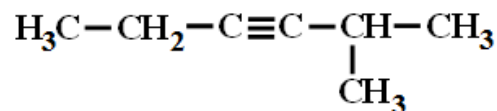
| Name | Formula | M.p. °C | B.p. °C |
|-----------|--|------------|------------|
| Acetylene | $\text{HC}\equiv\text{CH}$ | -82 | -75 |
| Propyne | $\text{HC}\equiv\text{CCH}_3$ | -101.5 | -23 |
| 1-Butyne | $\text{HC}\equiv\text{CCH}_2\text{CH}_3$ | -122 | 9 |
| 1-Pentyne | $\text{HC}\equiv\text{C}(\text{CH}_2)_2\text{CH}_3$ | -98 | 40 |
| 1-Hexyne | $\text{HC}\equiv\text{C}(\text{CH}_2)_3\text{CH}_3$ | -124 | 72 |
| 1-Heptyne | $\text{HC}\equiv\text{C}(\text{CH}_2)_4\text{CH}_3$ | -80 | 100 |
| 1-Octyne | $\text{HC}\equiv\text{C}(\text{CH}_2)_5\text{CH}_3$ | -70 | 126 |
| 1-Nonyne | $\text{HC}\equiv\text{C}(\text{CH}_2)_6\text{CH}_3$ | -65 | 151 |
| 1-Decyne | $\text{HC}\equiv\text{C}(\text{CH}_2)_7\text{CH}_3$ | -36 | 182 |
| 2-Butyne | $\text{CH}_3\text{C}\equiv\text{CCH}_3$ | -24 | 27 |
| 2-Pentyne | $\text{CH}_3\text{C}\equiv\text{CCH}_2\text{CH}_3$ | -101 | 55 |
| 2-Hexyne | $\text{CH}_3\text{C}\equiv\text{C}(\text{CH}_2)_2\text{CH}_3$ | -92 | 84 |
| 3-Hexyne | $\text{CH}_3\text{CH}_2\text{C}\equiv\text{CCH}_2\text{CH}_3$ | -51 | 81 |
| 4-Octyne | $\text{CH}_3(\text{CH}_2)_2\text{C}\equiv\text{C}(\text{CH}_2)_2\text{CH}_3$ | | 131 |
| 5-Decyne | $\text{CH}_3(\text{CH}_2)_3\text{C}\equiv\text{C}(\text{CH}_2)_3\text{CH}_3$ | | 175 |



Naming branched-chain alkynes

Example 2.10.

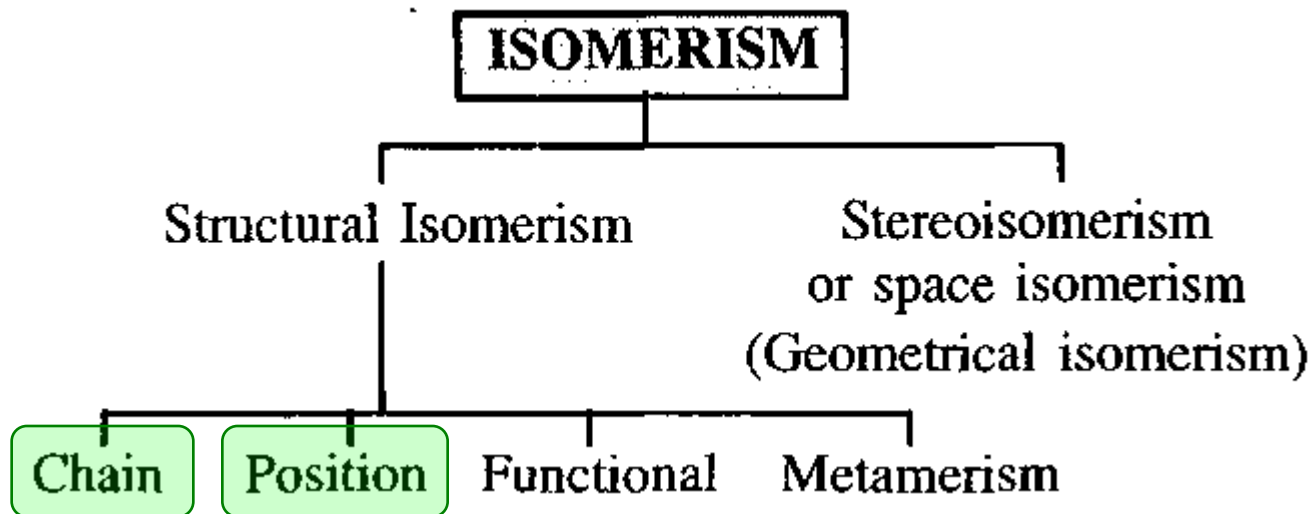
The structural formula is:



E2.10.1

| | |
|---|---|
| <p>Steps 1 and 2. Choose the main chain and name it.</p> | <p>The longest chain contains 6 carbon atoms; its name is <u>hex-</u>.</p> |
| <p>Step 3. Number carbon atoms in the chain.</p> | <p>The main chain is symmetrical. According to the rules mentioned above (see <i>F.3</i>) the numbering is following:</p> $\begin{array}{ccccccc} \leftarrow & & & & & & \\ 6 & 5 & 4 & 3 & 2 & 1 & \\ \text{H}_3\text{C} & -\text{CH}_2 & -\text{C}\equiv\text{C} & -\underset{\text{CH}_3}{\text{CH}} & -\text{CH}_3 & & \end{array}$ |
| <p>Step 4 and 5. Determine quantity and positions of π-bonds.</p> | <p>There is <u>two</u> π-bonds in <u>one</u> triple bond, which “begins” at atom 3. The suffix will be <u>yne</u>.</p> |
| <p>Step 6. Determine types, quantities and positions of substituents.</p> | <p>There is <u>one</u> substituent, it is methyl group. Methyl group is connected to the main chain at atom 2. The prefix is <u>2-methyl-</u>.</p> |
| <p>Step 7. Compose the name.</p> | <p>prefix + chain name + suffix 2-METHYL-3-HEXYNE</p> |

Isomerism of alkynes



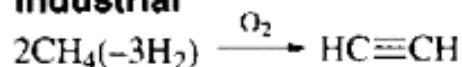
- ♦ triple bond position in alkyne molecule
- ♦ carbon skeleton branching
- ♦ interclass isomerism:
 - ♦ alkadienes
 - ♦ cycloalkenes

Synthesis and reactions of alkynes

SUMMARY OF ALKYNE CHEMISTRY

PREPARATION

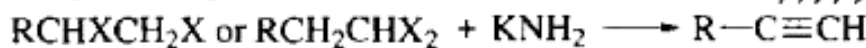
1. Industrial



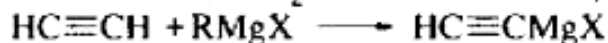
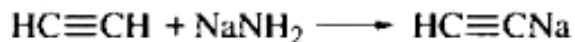
2. Laboratory

(a) Triple-Bond Formation

Dehydrohalogenation

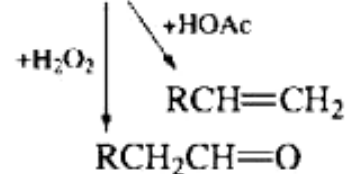
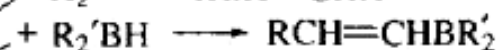
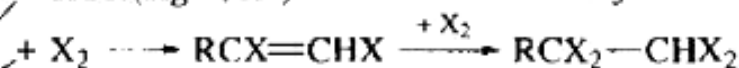
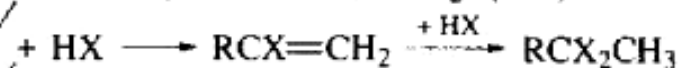
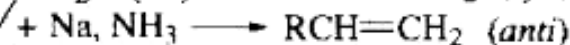
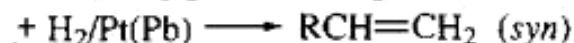
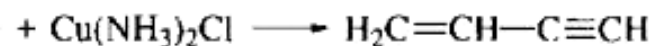


(b) Alkylation of Acetylene



PROPERTIES

1. Addition Reactions



2. Replacement of Acidic Hydrogen



What shall we do?



Feb 19

Introduction to organic and biological chemistry. Classes and nomenclature of organic compounds. Saturated and unsaturated hydrocarbons. S_R and Ad_E reactions.

Mar 4

Aromatic hydrocarbons. Orientation in the aromatic ring. Halogen derivatives of hydrocarbons. S_N reactions. Alcohols, ethers. Polyhydric alcohols.

Mar 18

Carbonyl compounds – aldehydes and ketones. Carbohydrates.

Apr 1

Carboxylic acids and their derivatives: amides, nitriles, anhydrides. Esters, fats.

Apr 15

Amines, aminoacids, peptides. Heterocyclic compounds and their biological activity.