Ķīmi 2028 PART II
Organic compounds

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Requirements

- 4 Laboratory reports and tests
- 2 successfully passed tests
- Examination Part1 and part 2

* print out lab report in paper form, Exercise 1, 2, 3

1st seminar: Test.

2nd Test: 4th of December

Textbooks

- Fundamentals of general, organic, and biological chemistry / J. McMurry., 7th ed. Pearson Education, 2013. p. 970 (e-book)

http://www.biblioteka.lu.lv/e-resursi/nozaru-e-gramatas/kimija/

- Foundations of organic chemistry : unity and diversity of structures, pathways, and reactions / by David R. Dalton., Wiley, [2011], p.1414 . (e-book. *large*)

Textbooks

3. Groundwater P.W. , TaylorG.A. Organic Chemistry, 1998, Longman.

4. Brown W., Foote C., Organic Chemistry, , Harcoutr College Publishers, 2002.

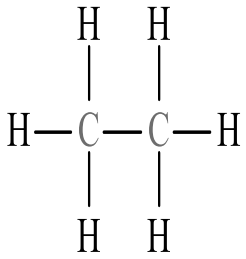
5. Organic Chemistry (Mc.Murry, Solomons T.W.G. , Bruice etc.)

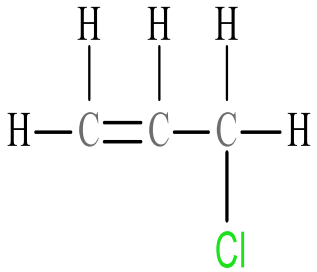
6. Organic chemistry : a brief course / David J. Hart .[u.c.]., 13th. ed., Brooks/Cole Cengage Learning, 2012., p.580.

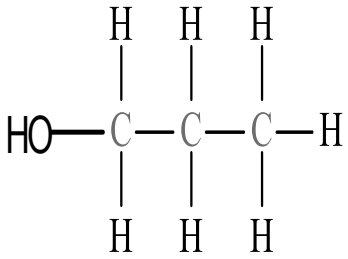
Organic compounds

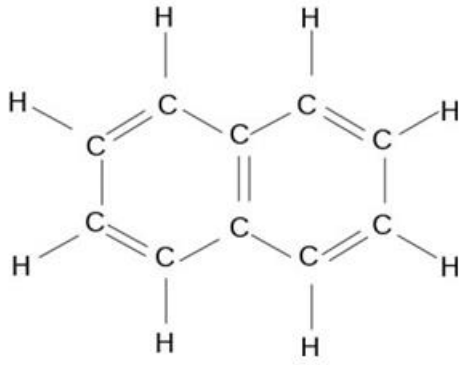
Organic chemistry is chemistry of carbon compounds.

Carbon atoms are linked together or linked with H, O, Hal, N and also P.









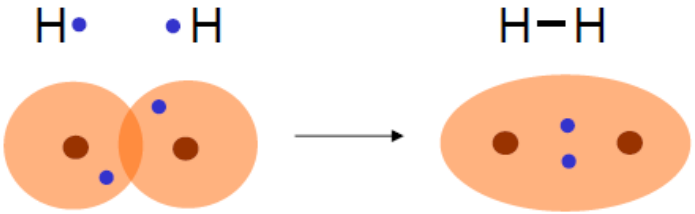
Chemical bonds in organic compounds

• Carbon typically *engages in a total of four bonds* in a compound. These bonds can be distributed in several ways, *four* single bonds, one double bond and two single bonds, two double bonds or one triple bond and one single bond.

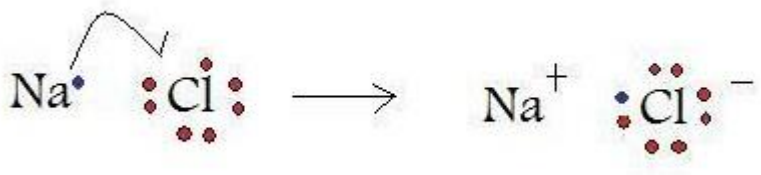
• Only valence electrons are used in chemical bonding in organic molecules.

The two extreme cases of chemical bonds

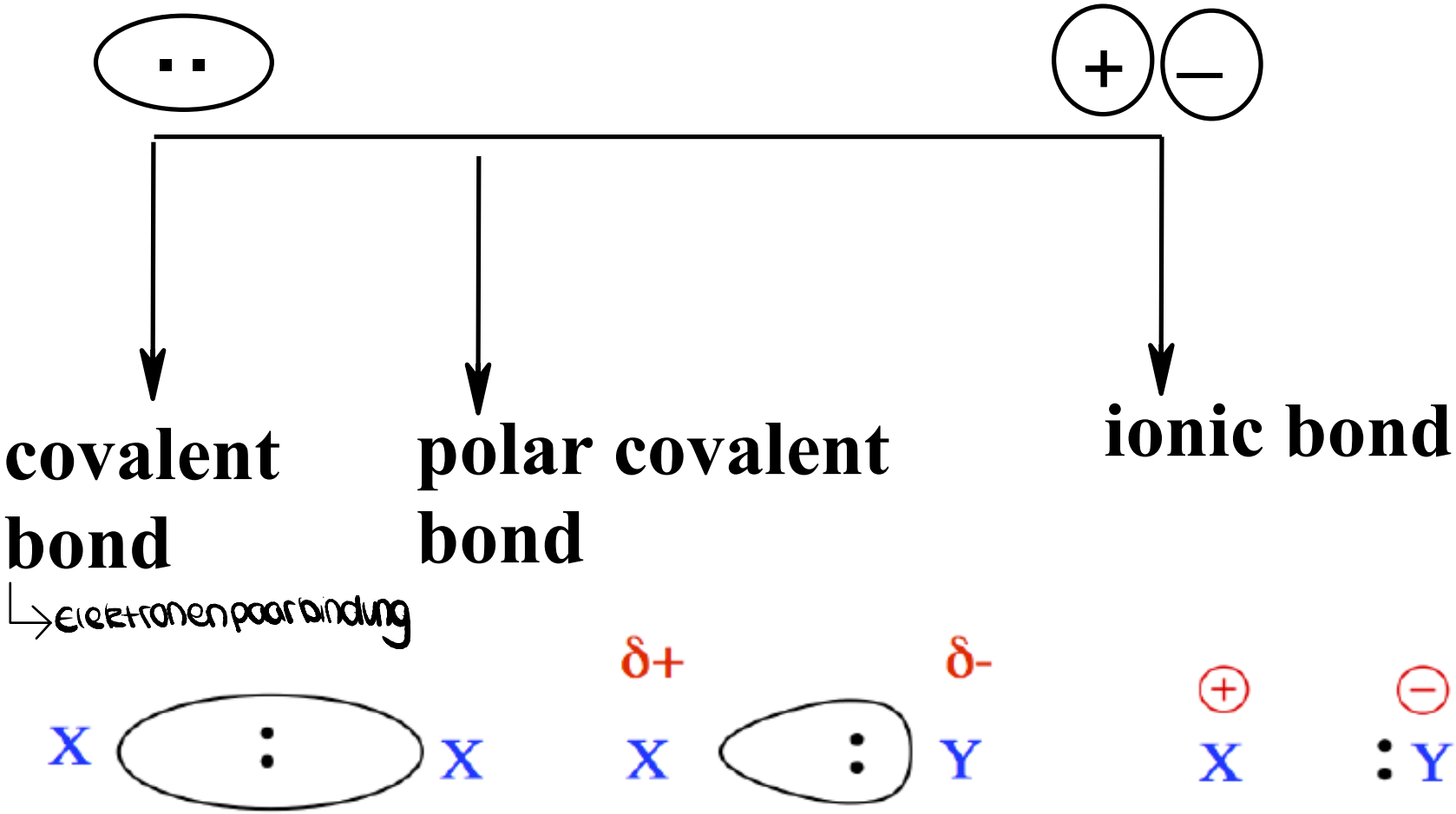
Covalent bond - in which one or more pairs of electrons are shared by two atoms.



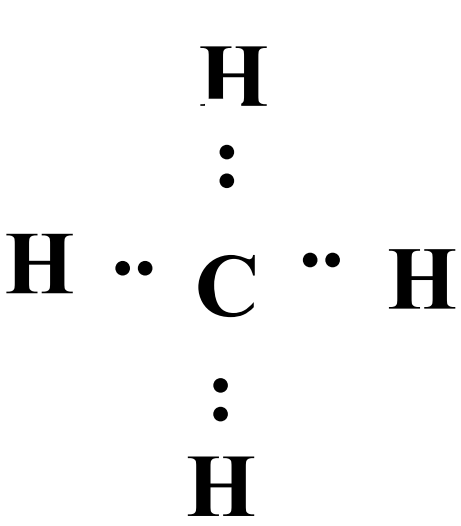
Ionic bond - bond in which one or more electrons from one atom are removed and attached to another atom, resulting in positive and negative ions which attract each other.

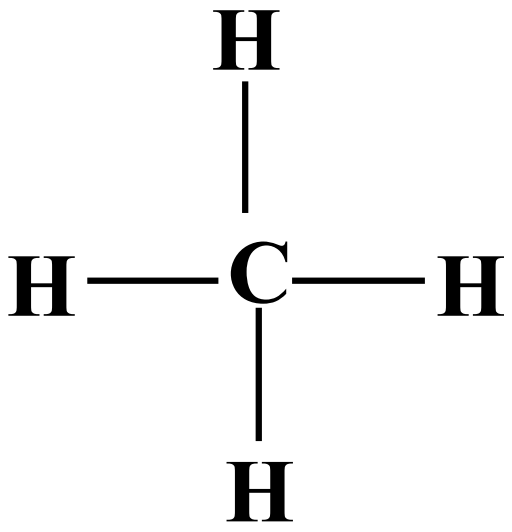


Principles of bond formation



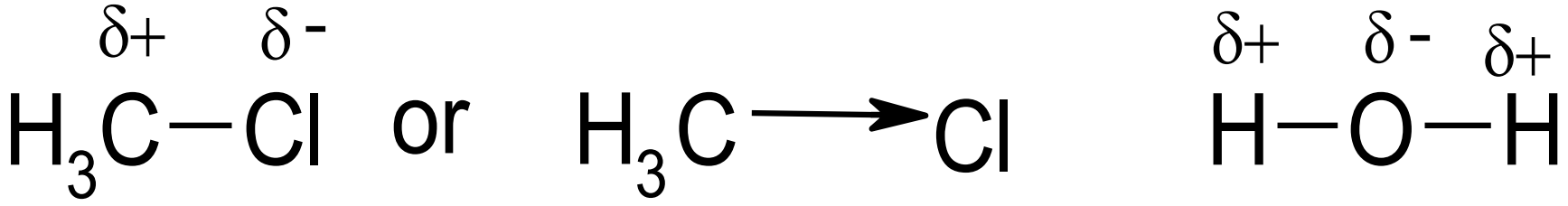
Covalent bonds of methane





Polar covalent bonds

Covalent bonds in which the sharing of the electron pair is unequal, are called polar covalent bonds.



In such a bond there is a charge separation with one atom being slightly more positive and the other more negative.

The ability of an atom to attract electrons in the presence of another atom is a measurable property called *electronegativity*:

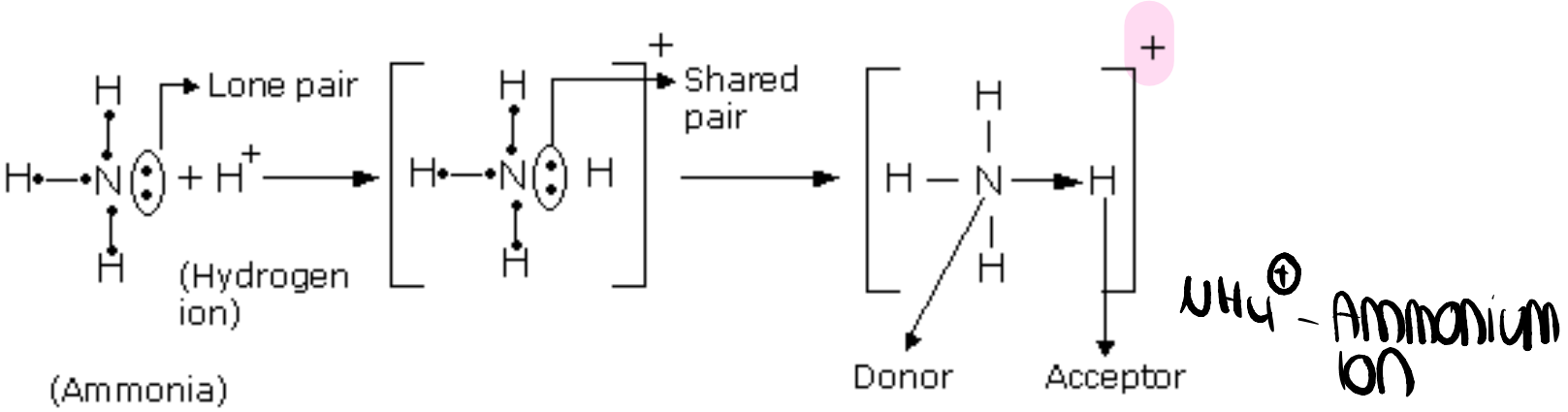
H – 2,1, C – 2,5, N – 3,0, Cl – 3,0.

Donor- acceptor bond

- The donor-acceptor bond is formed by a pair of electrons from one atom (the donor) and a free (unfilled) orbital from another (the acceptor). The difference can be expressed schematically:

Covalent bond A + B->A:B

Donor-acceptor bond A: + B->A:B



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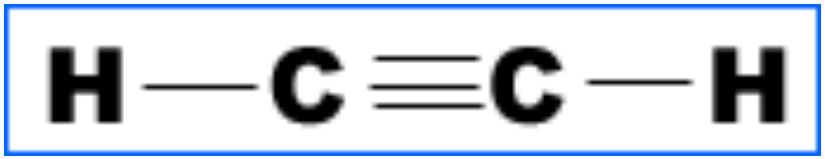
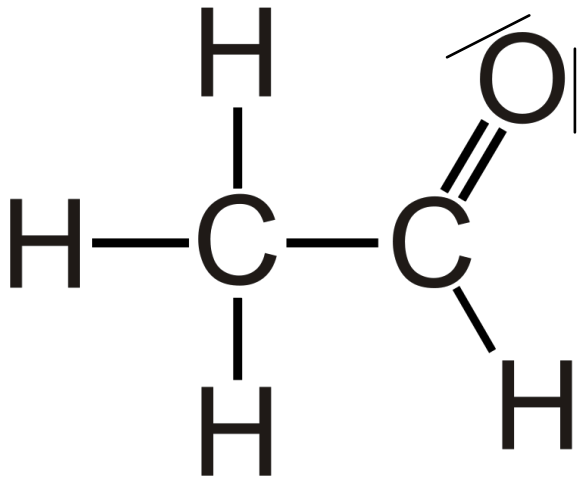
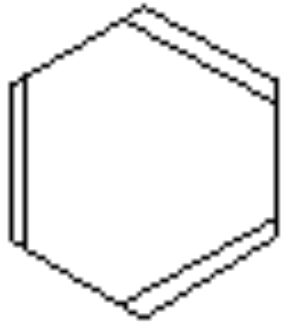
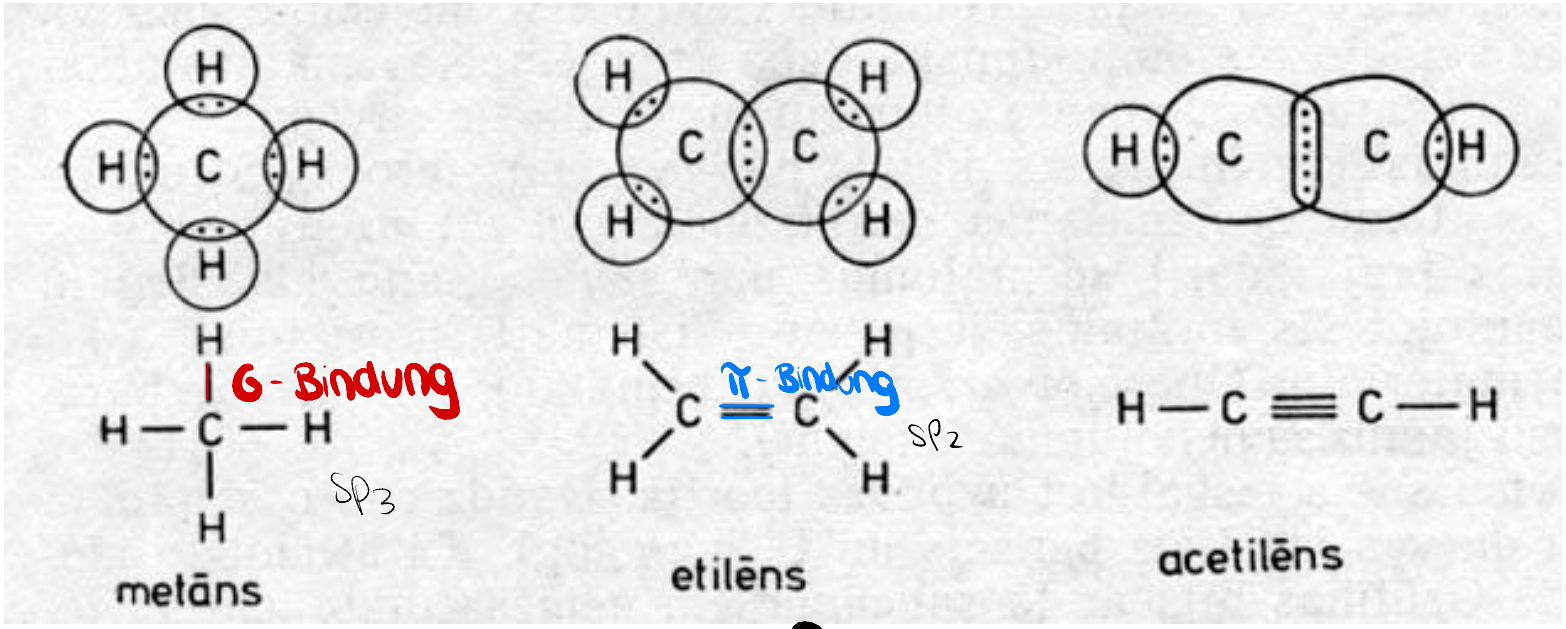

H—C≡C—H


H
O
H
C
C
H
H

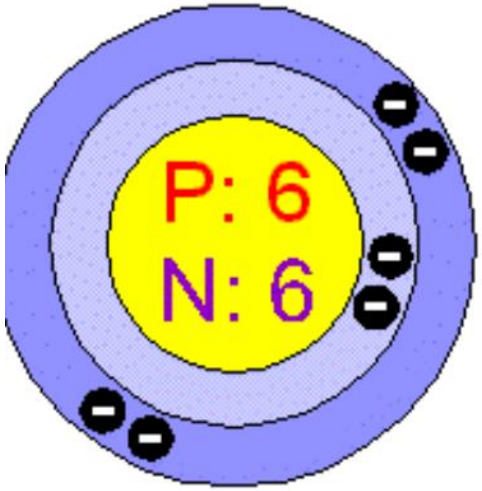


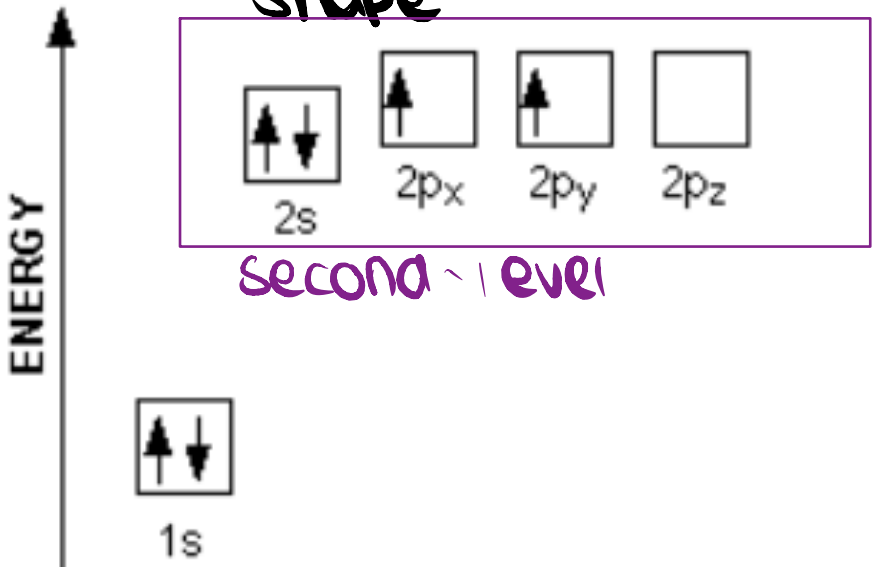
Types of covalent bonds

- single bond,(σ)
- double bonds,(σ,π)
- triple bonds (σ π, π)



Carbon atom





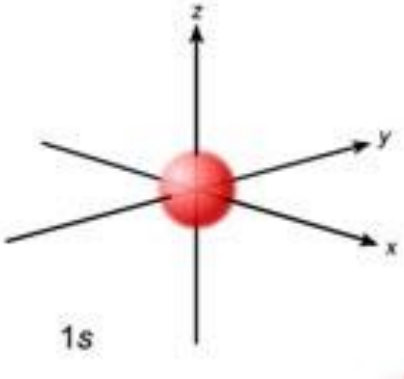
electrons have different shape

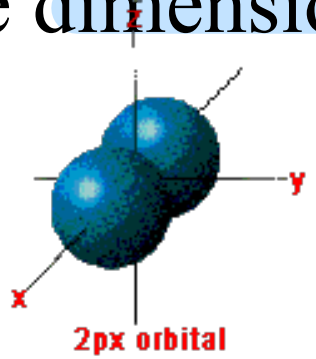
second level

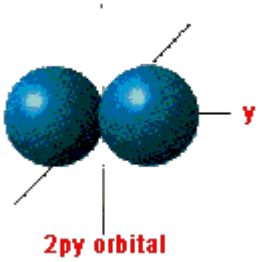
Number of Energy Levels: **2** closer to the nucleus
First Energy Level: **2 s electrons**
Second Energy Level: **2s electrons and 4 p valence electrons.**
Electrons of s and p orbitals have different «shape».

s and p orbitals

- An orbital is a region of space in which there is a 99% probability of finding an electron with a specific quantity of energy.
- The 's' orbital is spherical about the nucleus and the 'p' orbitals are like double headed balloons arranged along the axis of (imaginary) three dimensional coordinates.



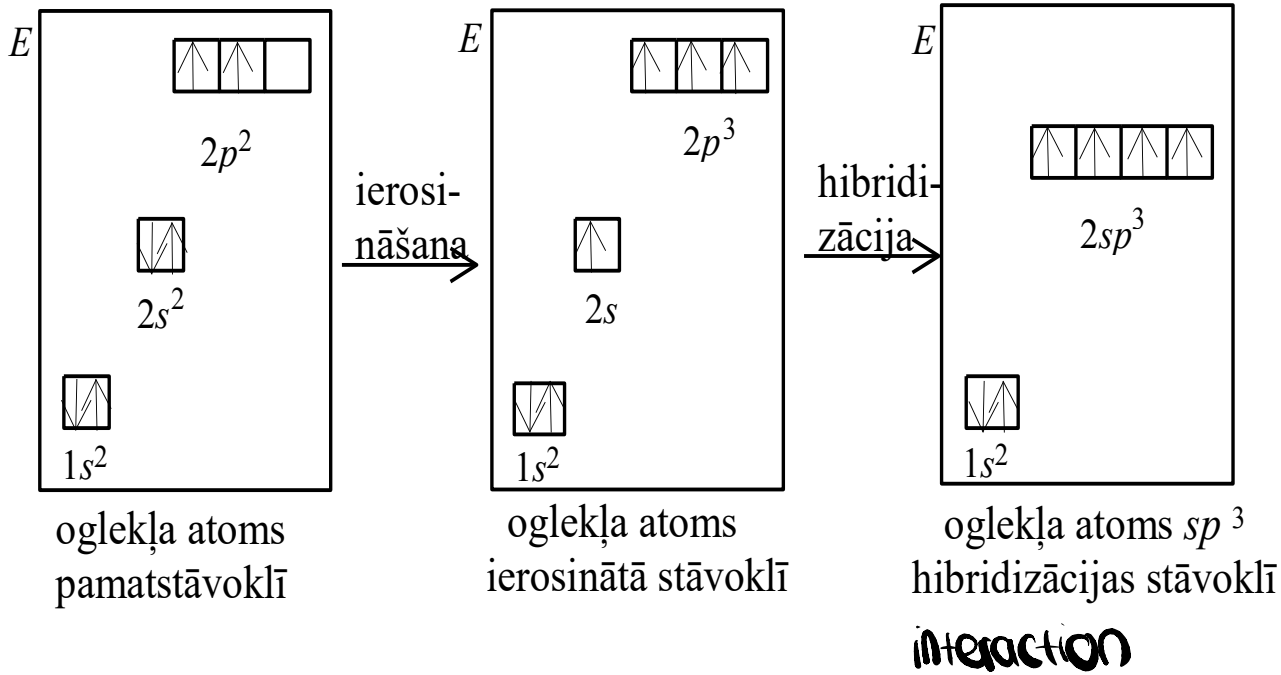




Valence electrons of carbon

1.sp3 hybridisation

'p' orbitals



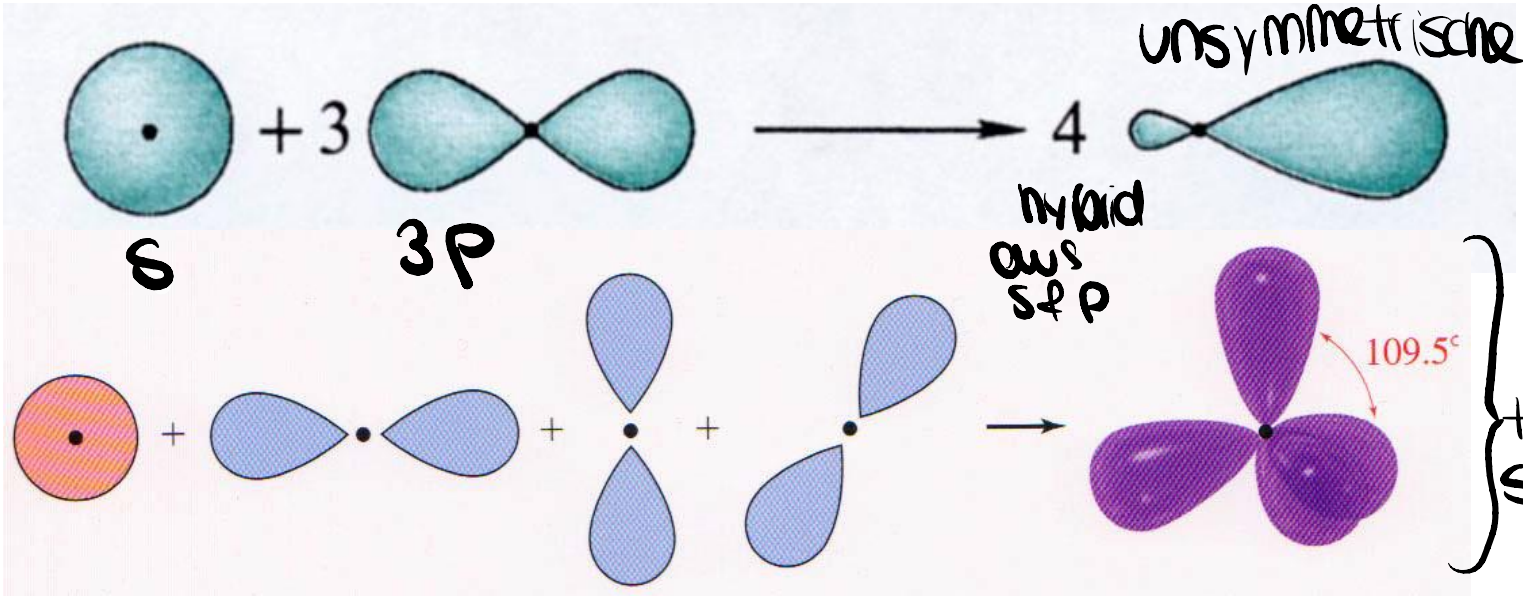
oglekļa atoms pamatstāvoklī

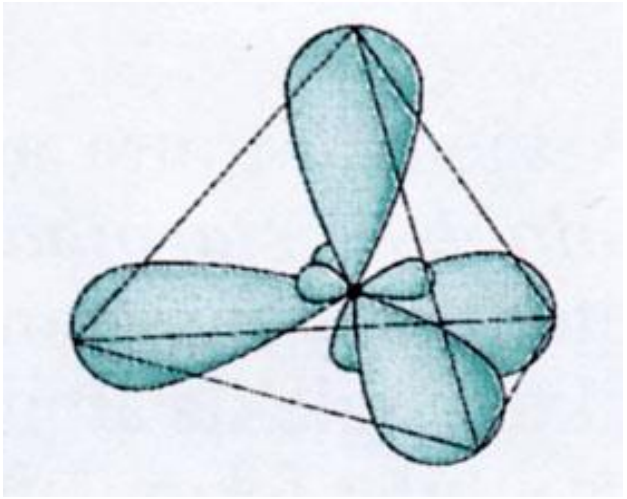
oglekļa atoms ierosinātā stāvoklī

oglekļa atoms sp^3 hibridizācijas stāvoklī

interaction

sp3 hybridisation



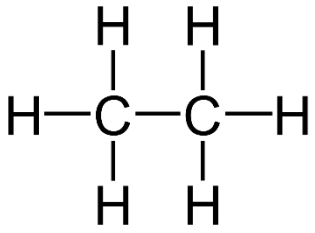


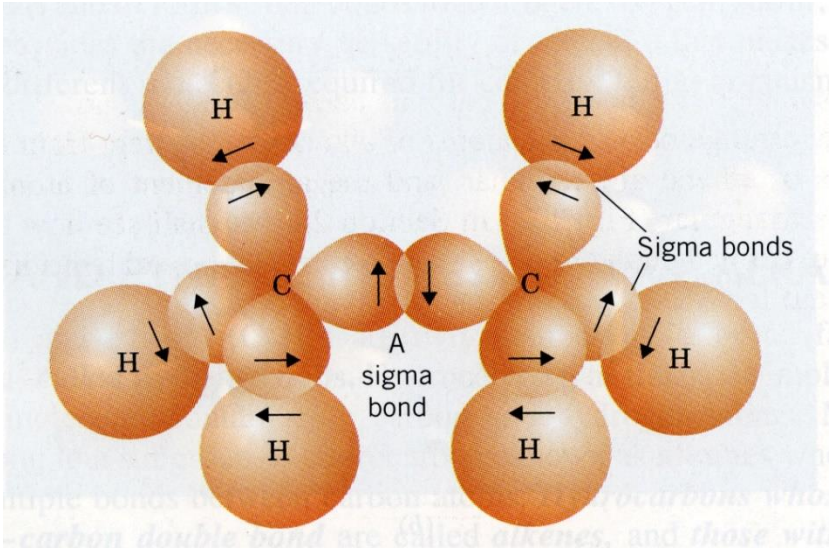
Methane
Ethane

Alkanes in allen Alkanen

Angle 109,28

Alkanes - Ethane

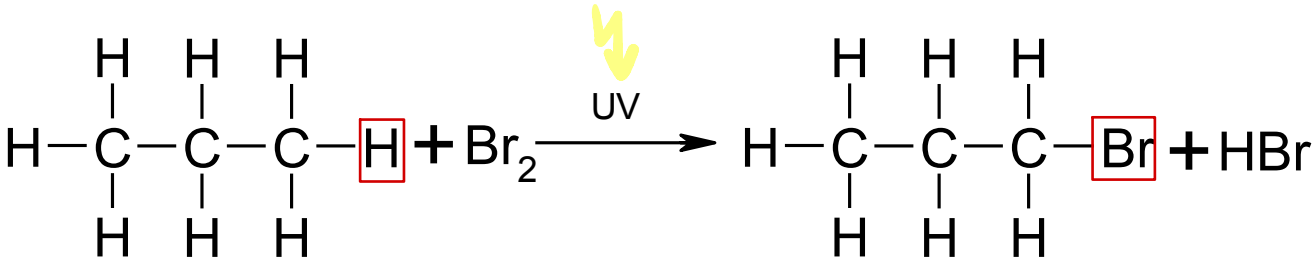




2 C atoms sp3,

7 σ bonds C-C, C-H

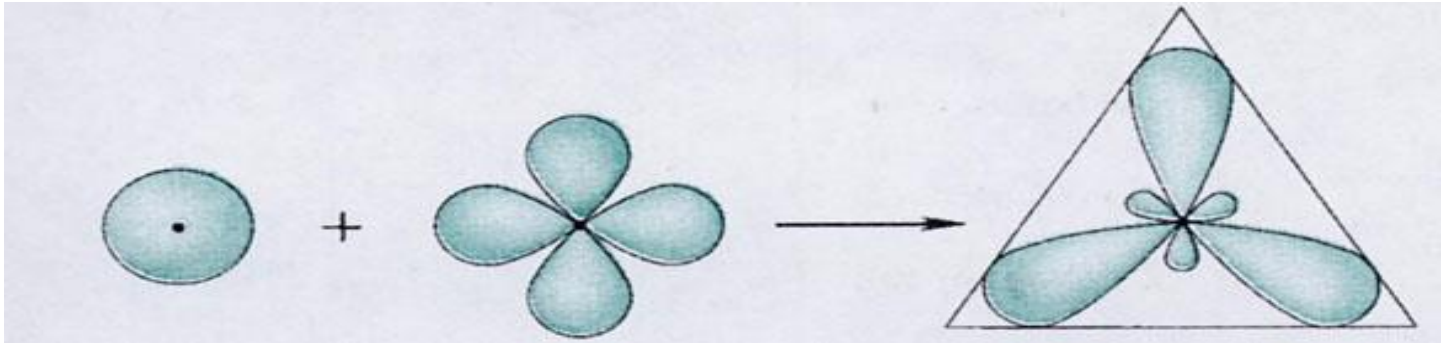
Propane 3 C atomi sp3, 10 σ bonds

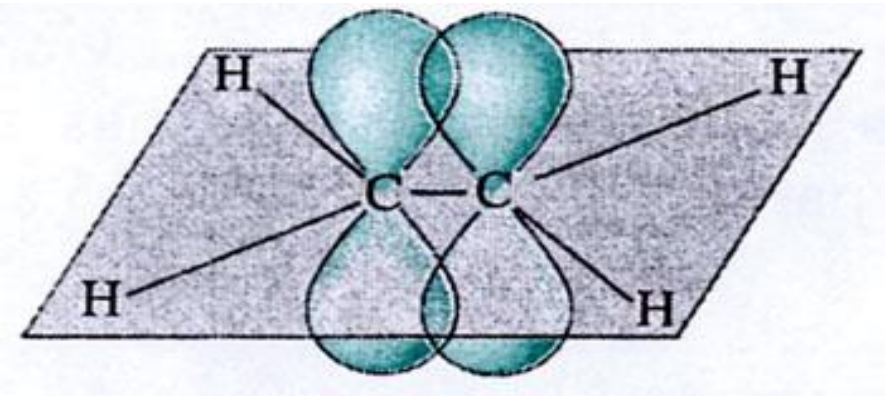


SUBSTITUTION !

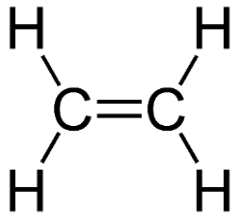
Reaction of substitution → austausch der Atome

sp2 hybridisation

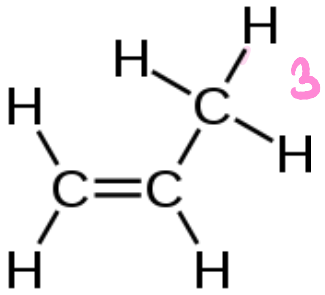




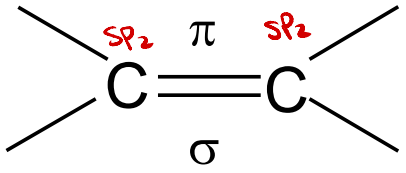
Ethene (alkene)
5 σ bonds are in one plane, angles 120^{o}
π –bond is in the perpendicular plane



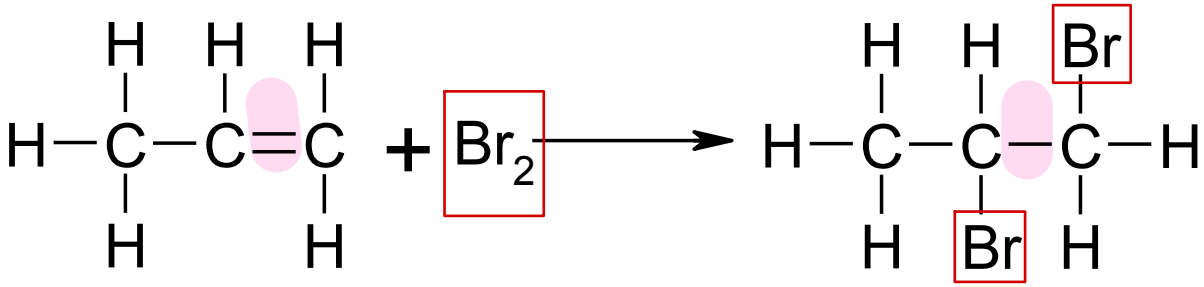
Alkene - propene 1- Doppelbindung



3 6 - Bonds



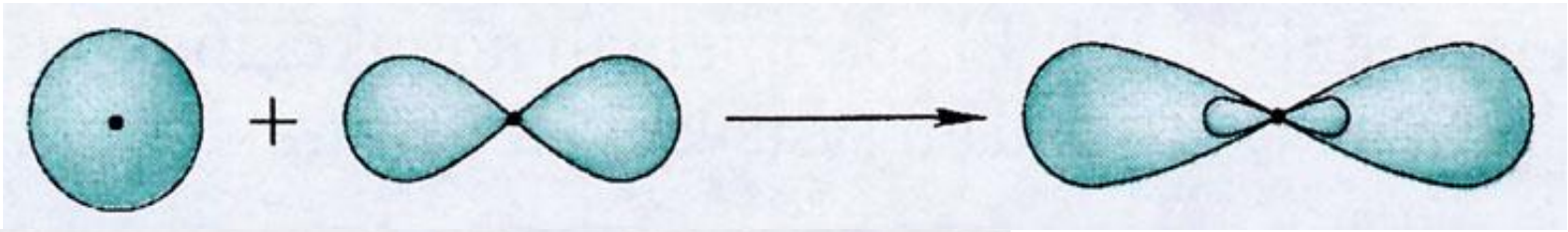
2C atoms are in Sp2 un 1C atom in sp3 hybridisation
8 σ bonds (C-C, C-H) and 1 π bond

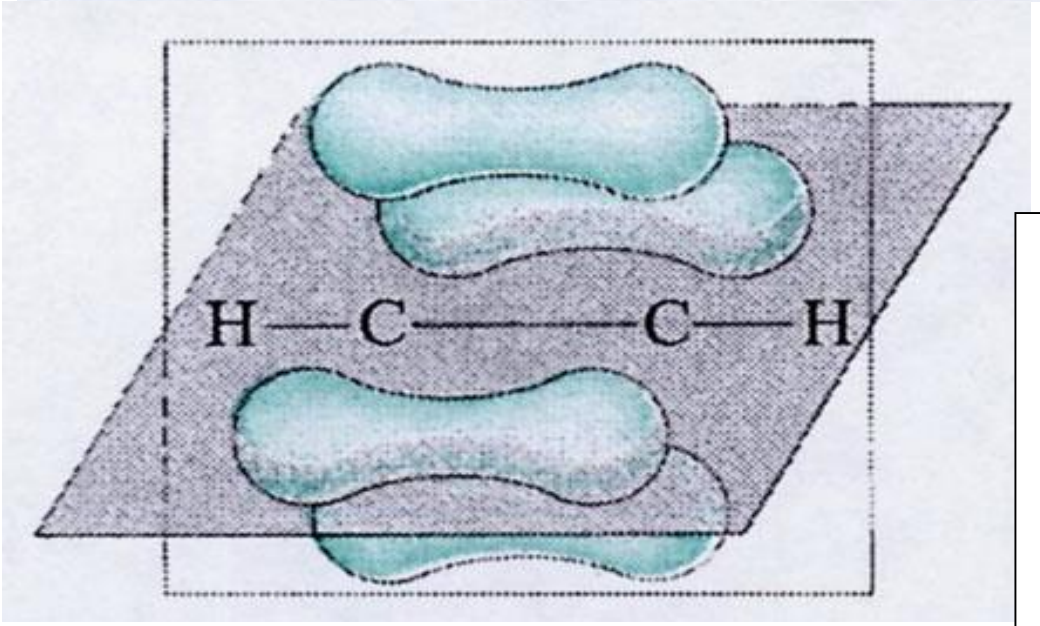


Reaction of addition to double bond

addition !

sp hybridisation



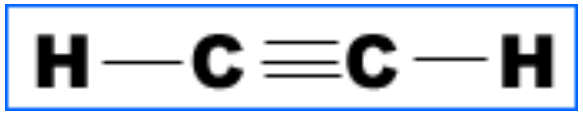


Alkynes

Triple bond:

σ and 2 π

Angle 180°



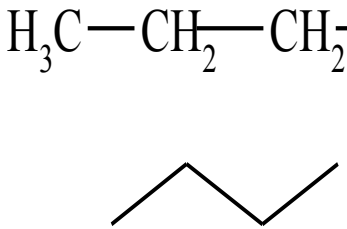
ethyne

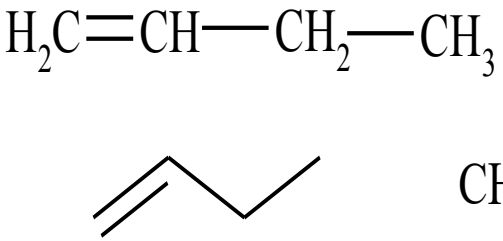
2. Writing Structures

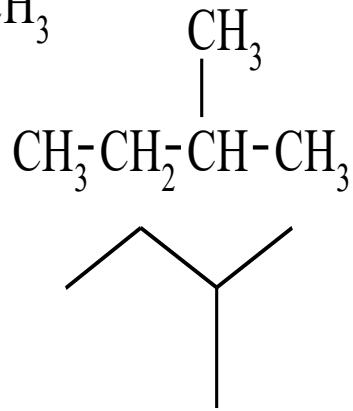
- Molecular formulas

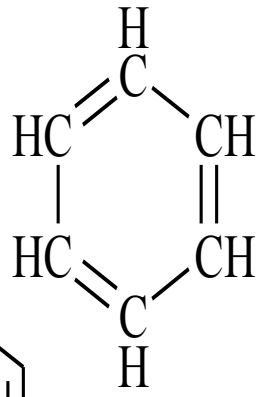
$C_6H_{12}O_6$ glucose

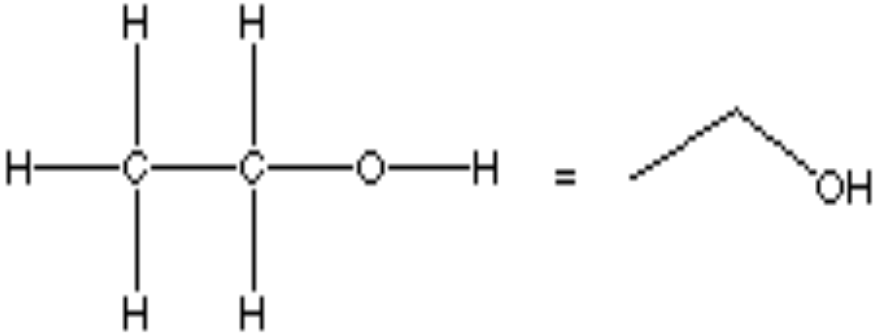
- Structure formulas **-** *Line structures* are used for both linear and cyclic structures. **In these structures** it is understood that there is **a carbon atom at each "bend" and that each carbon atom** is attached to as many hydrogen atoms as are needed to complete its valence of four.

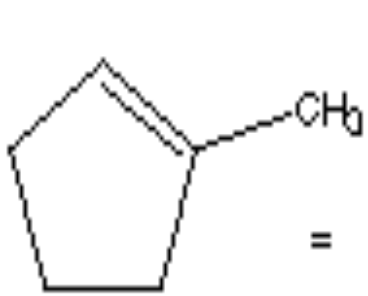


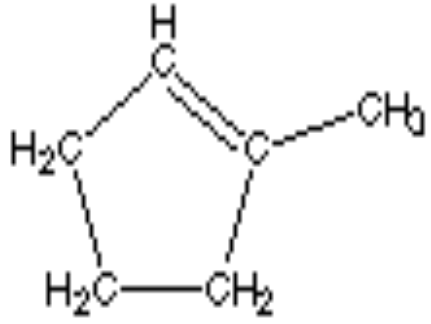








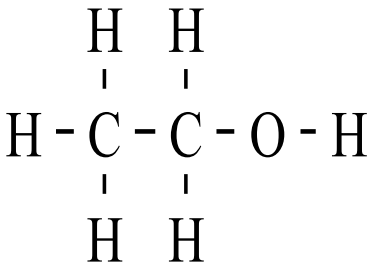




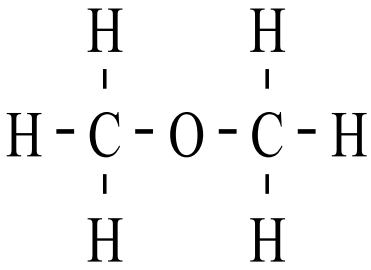
2.1.Isomers

Isomers - two or more compounds that have the same formula but different structures.

Structure isomers and stereoisomers



ethanol
(b. temp. 78 °C)



dimethylether
(b. temp. 24 °C)

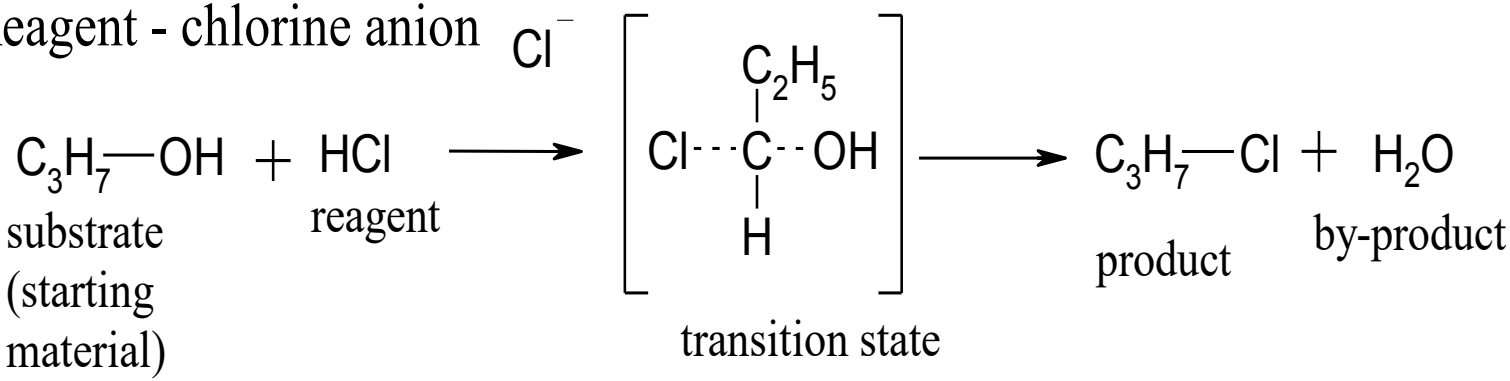
Moleculformula

C_2H_6O

3. Reactions of organic compounds

Reaction of nucleophilic substitution S_N

Reagent - chlorine anion Cl^-



Classification of organic reactions is based on reaction mechanisms.

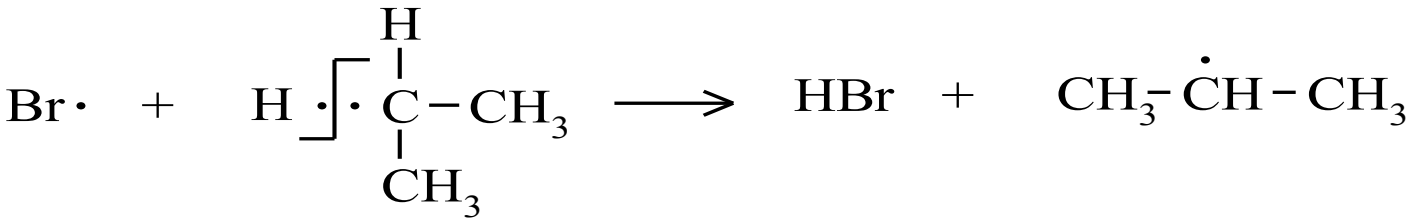
3.1.Classification of organic reaction based on the type of reagent

- ***radical reactions,***
- ***ionic reactions-***
- ***electrophilic reactions,***
- ***nucleophilic reactions***

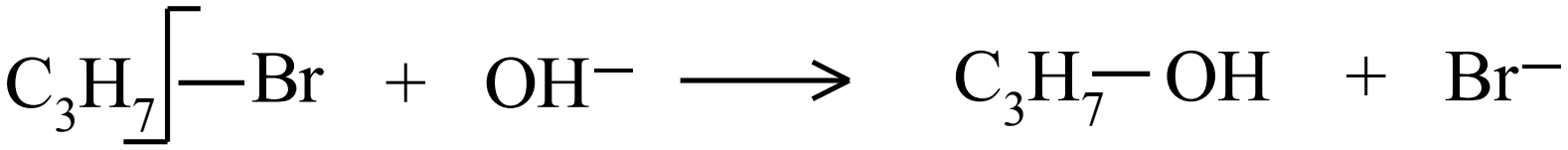
4.2. Examples of bond breaking

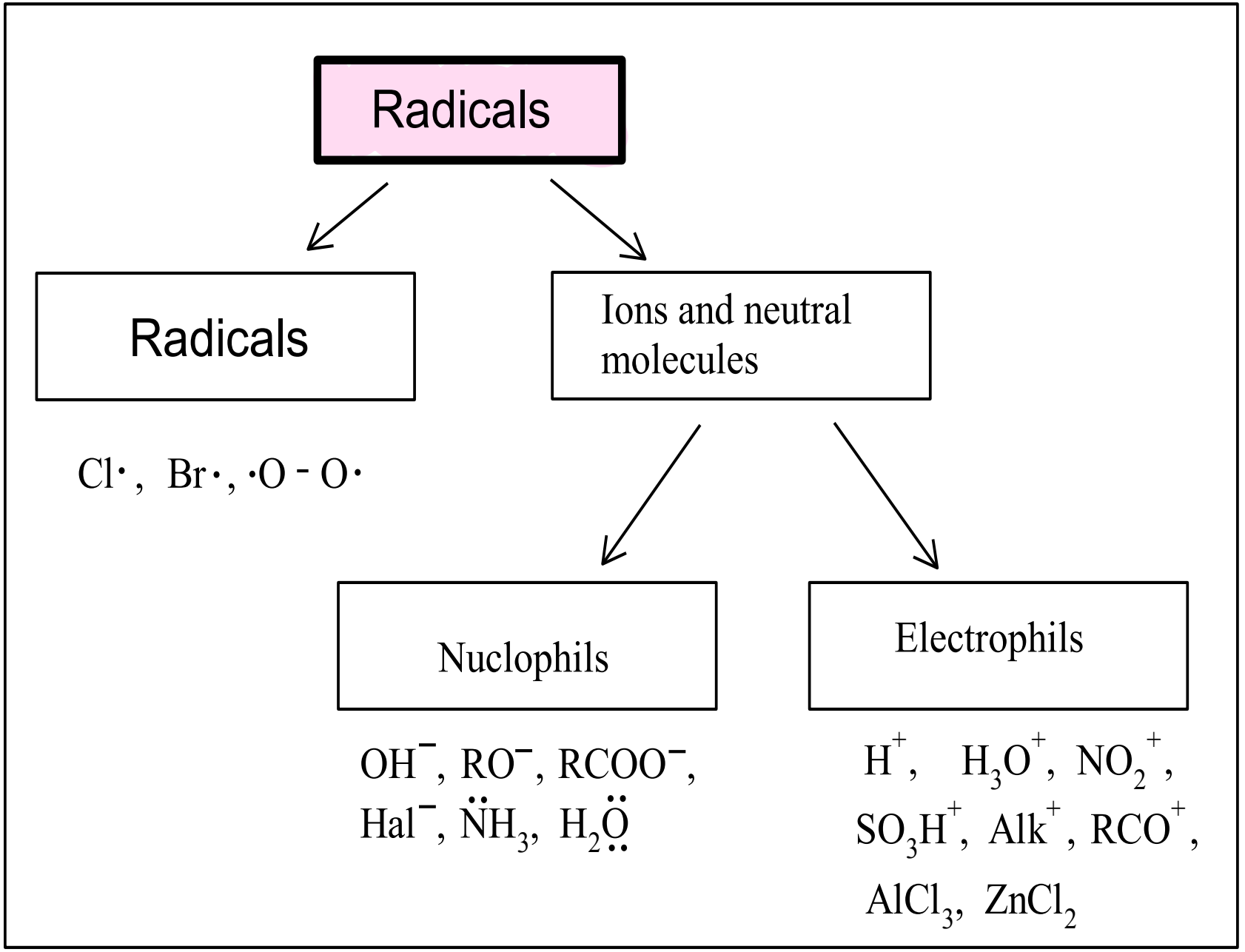
Radical reaction

Brom-Radikale werden unter UV-Licht gemacht



Ionic reaction




Radicals
Radicals
Ions and neutral molecules
Cl·, Br·, ·O - O·
Nuclophils
Electrophils
OH⁻, RO⁻, RCOO⁻,
Hal⁻, NH3, H2O
H+, H3O+, NO2+,
SO3H+, Alk+, RCO+,
AlCl3, ZnCl2

4.3. Main types of organic reactions

- **substition**

$$CH_4 + Br_2 \rightarrow CH_3Br + HBr$$

!

- **addition (to double of triple bond)**

$$CH_2=CH-CH_2-CH_3 + Cl_2 \longrightarrow CH_2(Cl)-CH(Cl)-CH_2-CH_3$$

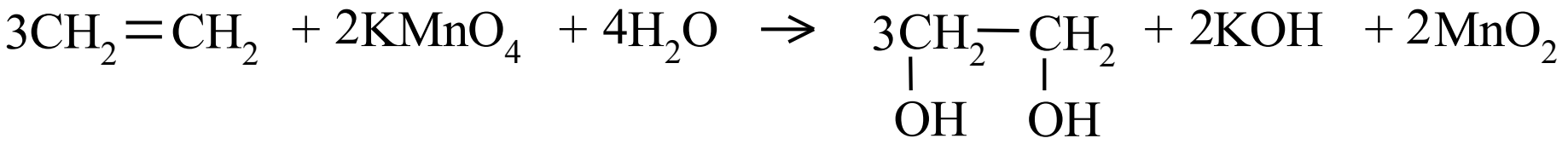
!

1,2-dichlorobutane

- **elimination** (Umreorreaction)

$$CH_3-\underset{\underset{OH}{|}}{CH}-CH_3 \xrightarrow{H_2SO_4} CH_3-CH=CH_2 + H_2O$$

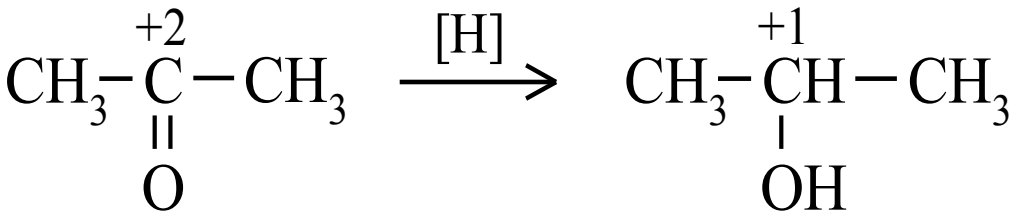
➢ oxydation (O2, KMnO4, etc.)



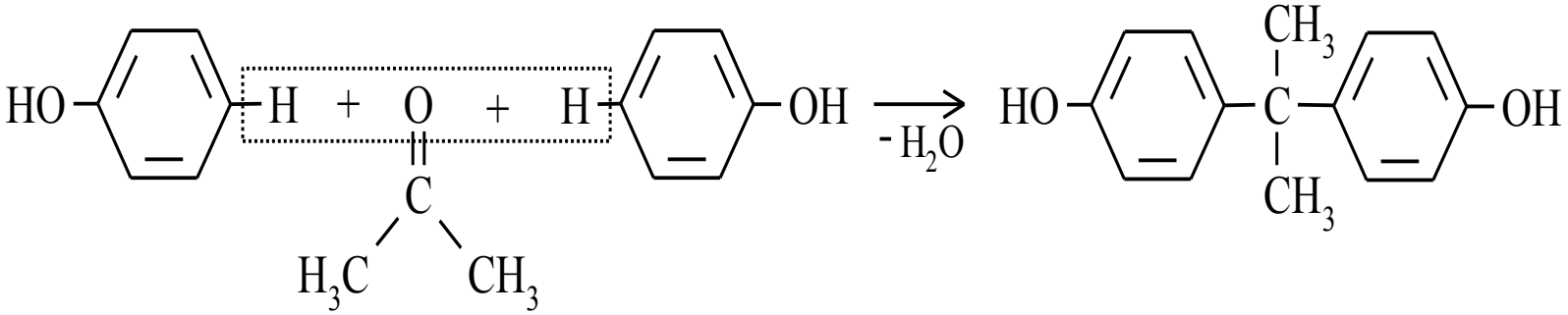
➢ reduction (H2, NaBH4, LiAlH4)

[H] = H_2 $NaBH_4$ $LiAlH_4$

[O] = O_2 $KMnO_4$ $K_2Cr_2O_7$



➢ condensation



Thank you !

single : sp_3

double + single : sp_2

triple + single = sp