



MINISTRY OF EDUCATION,
YOUTH AND SPORTS

INVESTICE DO ROZVOJE VZDĚLÁVÁNÍ



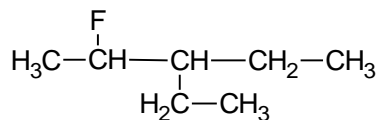
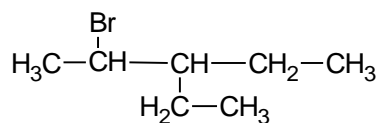
ORGANIC HALOGEN COMPOUNDS

= derivatives of hydrocarbons, one or more hydrogen atoms are substituted by an atom or atoms of halogens.

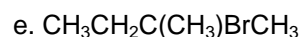
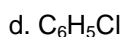
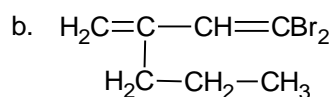
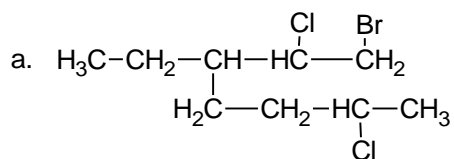
Naming:

1. Write the structures of all isomers of the molecular formula $C_4H_8Cl_2$ and name them. (9)

2. Name these two compounds:



3. Give the names or formulae for:



f. 1-bromo-3-iodocyclopentane

g. 1,1,3-trichloro-2-iodo-2-methylbutane

h. perfluorocyclohexane

i. ethyl iodide

j. *cis*-1,2-dichloroethene

k. 2-bromotoluene

l. 2,4-dibromo- 3-chloro-1,3-difluoro-4-methyl-hex-1-ene

Classification of monosubstituted (one halogen atom) halogenoalkanes: R-X, X =

- Primary: a halogen atom bonded on a carbon which carries two hydrogen atoms, e.g
CH₃CH₂Cl
- Secondary: a halogen atom bonded on a carbon which carrieshydrogen atom, e.g
CH₃CHClCH₃
- Tertiary: a halogen atom bonded on a carbon which carries hydrogen atom, e.g

4. Find in the questions 2 and 3 all monosubstituted halogenoalkanes and classify them as primary, secondary or tertiary.

Physical properties

5. Put CH₃F, CH₃Cl, CH₃Br, CH₃I in order with respect to increasing polarity of the molecules.
6. Put CH₃F, CH₃Cl, CH₃Br, CH₃I in order with respect to increasing van de Waals' forces.
7. Use the table of boiling points to state what has a bigger effect on boiling points of halogenoalkanes.

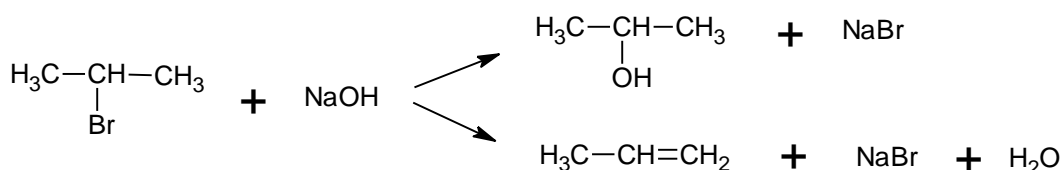
halogenoalkane	CH ₃ F	CH ₃ Cl	CH ₃ Br	CH ₃ I
boiling point /°C	-78.4	-24.2	4.5	42.2

However the bonds between carbon atom and halogens are, it doesn't affect the overall polarity of the molecule. That's why halogenoalkanes are mostly *soluble/insoluble* in water and they are *volatile/involatile*.

Chemical properties

8. Put the bonds C-F, C-Cl, C-Br, C-I in order with respect to:
- increasing bond length
 - increasing bond energy
9. Put C₂H₅F, C₂H₅Cl, C₂H₅Br and C₂H₅I in order with respect to increasing reactivity.

1. Reactions of halogenoalkanes with OH⁻





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10. State the reaction mechanisms of the above reactions.

The ratio between the amount of alcohol and an alkene made depends on:

- The type of halogenoalkane: primary → alcohol, tertiary → alkene
- The conditions: NaOH(aq) → alcohol, NaOH(EtOH) → alkene, higher t → alkene, high concentration of hydroxide → alkene

2. Other substitution reactions:

11. Identify the nucleophiles in the following reactions and write the formulae of the organic products:

- With water: $C_2H_5Br + H_2O \rightarrow$
- With ammonia: $CH_3CH_2CH_2Cl + NH_3 \rightarrow$
- With cyanides: $(CH_3)_2CH-I + KCN \rightarrow$
- With alkoxides: $CH_3CH(CH_3)CH_2Br + CH_3ONa \rightarrow$
- With salts of carboxylic acids: $CH_3CH_2I + CH_3COOK \rightarrow$

Reactivity of halogenoalkenes and halogenoarenes

Due to a conjugation, i.e. an interaction of lone electron pairs of a halogen atom with the π -electrons of either alkenes or arenes, the carbon – halogen bond gets *shorter/longer* → *higher/lower* bond energy needed to break the bond → halogenoalkenes and halogenoarenes are *more/less* reactive than halogenoalkanes.

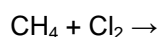
E.g. conversion of chlorobenzene to phenol takes place at extreme conditions only: $t = 300-350^\circ C$, $p = 15-20$ MPa.

12. Write down an equation of this reaction.

13. A byproduct of this reaction is a substance made by a reaction between chlorobenzene and sodium phenoxide (C_6H_5ONa). Write its formula.

Manufacture and preparation

1. From alkanes:



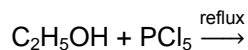
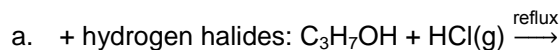
14. What is the reaction mechanism, necessary condition and the steps of halogenation of alkanes?

2. From alkenes

- $CH_2=CH_2 + Br_2 \rightarrow$
- $CH_2=CH_2 + HBr \rightarrow$

15. Write down an equation for the reaction between but-1-ene and hydrogen chloride.

3. From alcohols



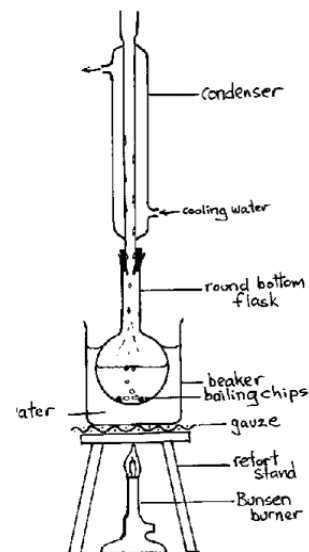
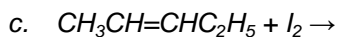
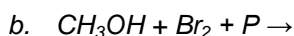
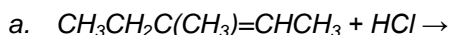
16. Write down the structures and names of alcohols that may be used for the preparation of :

- 2-chloropropane
- 1-bromobutane

4. From arenes

17. What are the reagents and catalysts for making chlorobenzene and bromobenzene?

18. Finish equations, name the products and state the reaction mechanisms:



Uses of organic halogen compounds

19. Prepare presentations:

- Anaesthetics – chloroform, halothane = 2-bromo-2-chloro-1,1,1-trifluoroethane
- Plastics- PVC, Teflon
- Solvents (*polar/nonpolar*)
- Freons
- Pesticides – DDT
- PCB = polychlorinated biphenyls