

1.3 Reactions of Hydrocarbons

Symbols and Functional Groups

- alkyl group \rightarrow R, R', R''
- halogen atom (Cl) \rightarrow X
- phenyl group \rightarrow \emptyset

Combustion

- All hydrocarbons are combustible and the reaction gives off light and energy.
- complete combustion:
 $2\text{C}_2\text{H}_2 + 5\text{O}_2 \rightarrow 4\text{CO}_2 + 2\text{H}_2\text{O}$
- incomplete combustion (one possible equation)
 $4\text{C}_3\text{H}_{8(g)} + 13\text{O}_{2(g)} \rightarrow 4\text{CO}_{2(g)} + 2\text{CO}_{(g)} + 6\text{C}_{(s)} + 16\text{H}_2\text{O}_{(g)}$

Substitution Reactions (alkanes)

- The C – C bond is difficult to break therefore the primary reaction for alkanes is substitution (an H is replaced by something else).
- A typical reaction:
alkane + diatomic halide \rightarrow alkyl halide + hydrogen halide (acid)

e.g. ethane (CH_3CH_3) + bromine (Br_2) \rightarrow bromoethane ($\text{CH}_3\text{CH}_2\text{Br}$) + hydrobromic acid (HBr)

- With additional exposure additional bromine may be added to produce 1,2-dibromoethane, 1,1,2-tribromoethane, 1,1,2,2-tetrabromoethane, 1,1,1,2,2-pentabromoethane, 1,1,1,2,2,2-hexabromoethane

Addition Reactions (alkenes and alkynes)

- A double and triple bonds are highly reactive and can be easily broken and additional atoms added.
- Halogenation
ethene + bromine \rightarrow 1,2-dibromoethane

- Hydrogenation
ethyne + hydrogen \rightarrow ethane

- Hydrohalogenation
propene + hydrogen bromide \rightarrow 2-bromopropane

- Hydration
propene + water \rightarrow 2-hydroxypropane (2-propanol or isopropanol)

- Markovnikov's Rule: ("the rich get richer") When a hydrogen halide or water is added to an alkene or alkyne, the hydrogen bonds to the carbon atom within the double bond that already has more hydrogen atoms.

Substitution Reactions (aromatics):

- Similar to alkanes, hydrogen is lost and is replaced by another atom.
 - E.g. benzene + bromine \rightarrow bromobenzene
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- If the reaction is allowed to continue, the substitutions tend to alternate carbon atoms.
 - E.g. The scientist who developed the following reaction mechanism became quite rich and rewards other scientists for their work...who was it and what did he make?
toluene + nitric acid \rightarrow 2-nitrotoluene + water

2-nitrotoluene + nitric acid \rightarrow 2,4-dinitrotoluene + water

2,4-dinitrotoluene + nitric acid \rightarrow 2,4,6-trinitrotoluene + water

Homework

- Practice 1,2,3,4
- Questions 1,2,3,4