1.3 Reactions of Hydrocarbons

Symbols and Functional Groups

- alkyl group → R, R', R"
- halogen atom (ex.Cl) → X
- phenyl group (benzene ring) → Ø

Combustion

- All hydrocarbons are combustible and the reaction gives off light and energy.
- complete combustion:
  $2C_2H_2 + 5O_2 \rightarrow 4CO_2 + 2H_2O$
- incomplete combustion (<u>one</u> possible equation of many)
  $4C_3H_{8(g)} + 13O_{2(g)} \rightarrow 4CO_{2(g)} + 2CO_{(g)} + 6C_{(s)} + 16H_2O_{(g)}$

Substitution Reactions (alkanes)

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

  e.g. ethane (CH_3CH_3) + bromine (Br_2) → bromoethane (CH_3CH_2Br) + hydrobromic acid (HBr)

- With additional exposure additional bromine may be added to produce 1,2-dibromoethane, 1,1,2-tribromoethane, 1,1,2,2-tetrabromo ethane, 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 → 1,2-dibromoethane

- Hydrogenation
  ethyne + hydrogen → ethane

- Hydrohalogenation
  propene + hydrogen bromide → 2-bromopropane

- Hydration
  propene + water → 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 → bromobenzene

- 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 → 2-nitrotoluene + water

  2-nitrotoluene + nitric acid → 2,4-dinitrotoluene + water

  2,4-dinitrotoluene + nitric acid → 2,4,6-trinitrotoluene + water

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