Chemical Properties of Hydrocarbons

1. Addition

As alkenes are unsaturated, they have the capacity to bond to more atoms. They are therefore more reactive than alkanes and readily undergo addition reactions.

Use condensed structural formula to show the addition reactions for:

a) Pent-1-ene + hydrogen
b) Pent-1-ene + fluorine
c) Pent-1-ene + Hydrogen chloride

a) $CH_2CHCH_2CH_2CH_3 + H_2 \rightarrow CH_3CH_2CH_2CH_2CH_3$
pentane

b) $CH_2CHCH_2CH_2CH_3 + F_2 \rightarrow CH_2FCHFCH_2CH_2CH_3$
1,2-difluoropentane

c) $CH_2CHCH_2CH_2CH_3 + HCl \rightarrow CH_3CHClCH_2CH_2CH_3$
2-chloropentane (use Markovnikov's rule)

2. Substitution

Substitution reactions occur when an alkane or benzene is combined with another element. The C-H bond breaks and the hydrogen is substituted with another element which requires one bond, for example a halogen.

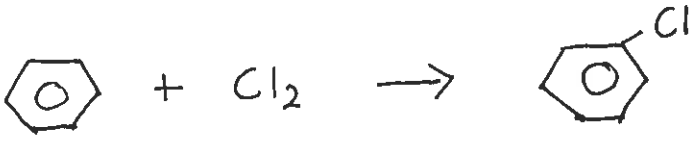
The reactions tend to be slow with one substitution at a time and they require UV light as a catalyst.

Use condensed structural formula to show the substitution reactions for:

a) Ethane + bromine (first substitution)
b) Methane + chlorine (complete substitution)
c) Benzene + Cl_2

a) $CH_3CH_3 + Br_2 \rightarrow CH_2BrCH_3 + HBr$

b) $CH_4 + 4Cl_2 \rightarrow CCl_4 + 4HCl$

c)  $+ HCl$

3. Combustion

Hydrocarbons are excellent fuels. When ignited in excess air (O_2) they produce carbon dioxide and water vapour and also release considerable amounts of heat energy. This is called complete combustion.

Use molecular formula to write balanced chemical equations for the following combustion reactions (assume complete combustion):

a) Methane in air
b) Butane in air

a) $CH_{4(g)} + 2O_{2(g)} \rightarrow CO_{2(g)} + 2H_2O_{(g)}$

b) $2C_4H_{10(g)} + 13O_{2(g)} \rightarrow 8CO_{2(g)} + 10H_2O_{(g)}$

Incomplete combustion will occur if the air (O_2) supply is limited. Carbon monoxide and even soot (solid carbon) can be produced.

Use molecular formula to write balanced chemical equations for the following reactions where incomplete combustion occurs:

a) Methane in limited oxygen
b) Butane in limited oxygen

a) $2CH_{4(g)} + 3O_{2(g)\ \text{limited}} \rightarrow 2CO_{(g)} + 4H_2O_{(g)}$

b) $2C_4H_{10(g)} + 9O_{2(g)\ \text{limited}} \rightarrow 8CO_{(g)} + 10H_2O_{(g)}$

Bibliography

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