In a reaction between organic molecules, it is *only* the functional groups that participate in the reaction.

Example: $\mathrm{R\text{-}C(=O)OH} + \mathrm{R'OH} \longrightarrow \mathrm{R\text{-}C(=O)OR'} + \mathrm{H_2O}$

Carboxylic acid Alcohol Ester Water

In this reaction, the hydroxide from the alcohol and the hydrogen from the acid will react, forming water. This will leave the alkyl with a free radical from the alcohol to bond to the O_2CR from the carboxylic acid. This yields an ester.

1 Reaction Mechanisms of Alkanes

There are two ways in which an alkane can react,

1. Combustion
2. Free radical substitution

1.1 Combustion

There are two types of alkane combustion, complete and incomplete. In combustion, all bonds are broken and then reformed.

1.1.1 Complete Combustion

Complete combustion requires excess air/oxygen.

$\mathrm{R} + \mathrm{O_2} \longrightarrow \mathrm{H_2O} + \mathrm{CO_2}$

A specific example would be:

$\mathrm{C_2H_6} + 7\,\mathrm{O_2} \longrightarrow 6\,\mathrm{H_2O} + 4\,\mathrm{CO_2}$

Ethane Oxygen Water Carbon Dioxide

1.1.2 Incomplete Combustion

Incomplete combustion is when air/oxygen is not in excess.

$\mathrm{R} + \mathrm{O_2} \longrightarrow \mathrm{H_2O} + \mathrm{CO}$

and

$\mathrm{R} + \mathrm{O_2} \longrightarrow \mathrm{H_2O} + \mathrm{C}$

A more specific example would be the incomplete combustion of ethane:

$\mathrm{C_2H_6} + 5\,\mathrm{O_2} \longrightarrow 6\,\mathrm{H_2O} + 4\,\mathrm{CO}$

This reaction yields carbon monoxide, a very dangerous gas. The second reaction in the incomplete combustion of ethane is:

$$C_2H_6 + 3\,O_2 \longrightarrow 6\,H_2O + 4\,C$$

This reaction yields carbon, or soot.

1.2 Free Radical Substitution

$$\text{Alkane} + \text{Halogen} \xrightarrow[\text{Light}]{\text{UV}} \text{Halogenoalkane} + \text{Hydrochloric Acid}$$

1.2.1 Mechanism of Reaction

Initiation The halogen is broken apart by homolytic fission, yielding two free radicals.

$$Cl\text{–}Cl \xrightarrow[\text{Light}]{\text{UV}} Cl\cdot + Cl\cdot$$

Propogation The halogen free radicals react with the other compounds present in the reaction mixture in some of the following ways:

$$CH_4 + Cl\cdot \longrightarrow CH_3\cdot + HCl$$
$$CH_3\cdot + Cl_2 \longrightarrow CH_3Cl + Cl\cdot$$
$$Cl\cdot + CH_3Cl \longrightarrow CHCl_2\cdot + HCl$$
$$CH_2Cl\cdot + Cl_2 \longrightarrow CH_2Cl_2 + Cl\cdot$$
$$Cl\cdot + CH_2Cl_2 \longrightarrow CHCl_2\cdot + HCl$$
$$CHCl_2\cdot + Cl_2 \longrightarrow CHCl_3 + Cl\cdot$$
$$Cl\cdot + CHCl_3 \longrightarrow CCl_3\cdot + HCl$$
$$CCl_3\cdot + Cl_2 \longrightarrow CCl_4 + Cl\cdot$$ [1]

Termination Radicals combine to create stable compounds, ending the chain reaction.

$$Cl\cdot + CH_3\cdot \longrightarrow CH_3Cl$$
$$Cl\cdot + Cl\cdot \longrightarrow Cl_2$$
$$CH_3\cdot + CH_3\cdot \longrightarrow C_2H_6$$

The reaction also has the byproducts of all the propogation steps.

[1] CCl_4 is very very bad for you