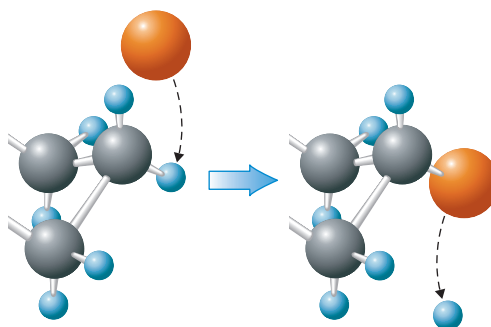


Figure 12.14 In an alkane substitution reaction, an incoming atom or group of atoms (represented by the orange sphere) replaces a hydrogen atom in the alkane molecule.

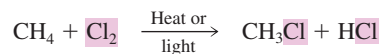


(The symbol R is used frequently in organic chemistry and will be encountered in numerous generalized formulas in subsequent chapters; it always represents a generalized organic group in a structural formula. An R group can be an alkyl group—methyl, ethyl, propyl, etc.—or any number of other organic groups. Consider the symbol R to represent the Rest of an organic molecule, which is not specifically specified because it is not the focal point of the discussion occurring at that time.)

In halogenation of an alkane, the alkane is said to undergo *fluorination*, *chlorination*, *bromination*, or *iodination*, depending on the identity of the halogen reactant. Chlorination and bromination are the two widely used alkane halogenation reactions. Fluorination reactions generally proceed too quickly to be useful, and iodination reactions go too slowly.

Halogenation usually results in the formation of a mixture of products rather than a single product. More than one product results because more than one hydrogen atom on an alkane can be replaced with halogen atoms. To illustrate this concept, let us consider the chlorination of methane, the simplest alkane.

Methane and chlorine, when heated to a high temperature or in the presence of light, react as follows:



CHEMISTRY AT A GLANCE

Properties of Alkanes and Cycloalkanes

ALKANES AND CYCLOALKANES				
PHYSICAL PROPERTIES			CHEMICAL PROPERTIES	
Solubility	Density	Boiling Points	Combustion	Halogenation
<ul style="list-style-type: none"> Insoluble in water Soluble in nonpolar solvents 	<ul style="list-style-type: none"> Less dense than water Float on top of water 	<ul style="list-style-type: none"> Increase as carbon chain length increases Decrease with increase in degree of branching 	<ul style="list-style-type: none"> All alkanes and cycloalkanes are flammable Combustion products are CO_2 and H_2O 	<ul style="list-style-type: none"> Hydrogen atoms are replaced with halogen atoms (a substitution reaction) Requires the presence of heat or light
			$2\text{C}_5\text{H}_{10} + 15\text{O}_2 \rightarrow 10\text{CO}_2 + 10\text{H}_2\text{O}$ $\text{Alkane} + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}$	
			$\text{C}_5\text{H}_{10} + \text{Cl}_2 \xrightarrow{\text{Heat or light}} \text{C}_5\text{H}_9\text{Cl} + \text{HCl}$ $\text{R}-\text{H} + \text{X}_2 \xrightarrow{\text{Heat or light}} \text{R}-\text{X} + \text{H}-\text{X}$	