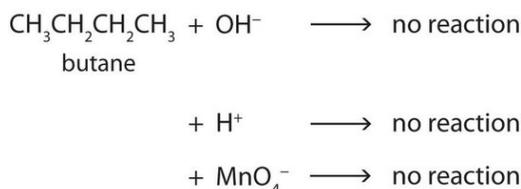


## 22.6: Hydrocarbon Reactions

### Learning Objectives

- To identify the main chemical properties of alkanes.

Alkane molecules are nonpolar and therefore generally do not react with ionic compounds such as most laboratory acids, bases, oxidizing agents, or reducing agents. Consider butane as an example:



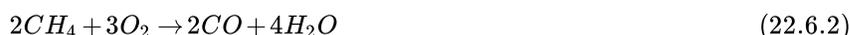
Butane plus O H superscript negative sign yields no reaction. There is also no reaction of butane with H superscript positive sign and Mn O subscript 4 superscript negative sign.

Neither positive ions nor negative ions are attracted to a nonpolar molecule. In fact, the alkanes undergo so few reactions that they are sometimes called *paraffins*, from the Latin *parum affinis*, meaning “little affinity.”

Two important reactions that the alkanes do undergo are **combustion** and **halogenation**. Nothing happens when alkanes are merely mixed with oxygen ( $O_2$ ) at room temperature, but when a flame or spark provides the activation energy, a highly exothermic combustion reaction proceeds vigorously. For methane ( $CH_4$ ), the reaction is as follows:



If the reactants are adequately mixed and there is sufficient oxygen, the only products are carbon dioxide ( $CO_2$ ), water ( $H_2O$ ), and heat—heat for cooking foods, heating homes, and drying clothes. Because conditions are rarely ideal, however, other products are frequently formed. When the oxygen supply is limited, carbon monoxide ( $CO$ ) is a by-product:



This reaction is responsible for dozens of deaths each year from unventilated or improperly adjusted gas heaters. (Similar reactions with similar results occur with kerosene heaters.)

Alkanes also react with the halogens chlorine ( $Cl_2$ ) and bromine ( $Br_2$ ) in the presence of ultraviolet light or at high temperatures to yield chlorinated and brominated alkanes. For example, chlorine reacts with excess methane ( $CH_4$ ) to give methyl chloride ( $CH_3Cl$ ).



With more chlorine, a mixture of products is obtained:  $CH_3Cl$ ,  $CH_2Cl_2$ ,  $CHCl_3$ , and  $CCl_4$ . Fluorine ( $F_2$ ), the lightest halogen, combines explosively with most hydrocarbons. Iodine ( $I_2$ ) is relatively unreactive. Fluorinated and iodinated alkanes are produced by indirect methods.

### Key Takeaway

- Alkanes react with oxygen (combustion) and with halogens (halogenation).

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