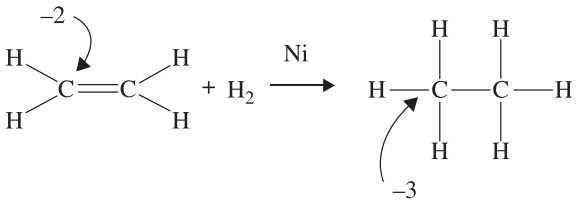
There is no change in the number of valence electrons in any of the atoms in this reaction. Both before and after the reaction, each carbon atom shares a total of eight valence electrons, and each hydrogen atom shares two electrons. Instead of electrons, this reaction involves the transfer of atoms—in this case, the hydrogen atoms. There are so many atom-transfer reactions that chemists developed the concept of *oxidation number* to extend the idea of oxidation and reduction to reactions in which electrons are not necessarily gained or lost. Oxidation involves an increase in the oxidation number of an atom, whereas reduction occurs when the oxidation number of an atom decreases.

During the transformation of ethene into ethane, there is a *decrease* in the oxidation number of the carbon atom. This reaction therefore involves the *reduction* of ethene to ethane.



(8.11)

Reactions in which none of the atoms undergo a change in oxidation number are called *metathesis reactions*. Consider the reaction between a carboxylic acid and an amine, for example.

$$CH_3CO_2H + CH_3NH_2 \longrightarrow CH_3CO_2^- + CH_3NH_3^+ \tag{8.12}$$

Or the reaction between an alcohol and hydrogen bromide.

$$CH_3CH_2OH + HBr \longrightarrow CH_3CH_2Br + H_2O \tag{8.13}$$

These are metathesis reactions, because there is no change in the oxidation number of any atom in either reaction.

The oxidation numbers of the carbon atoms in a variety of compounds are given in Table 8.3.

The oxidation numbers given in Table 8.3 can be used to classify organic reactions as either oxidation–reduction reactions or metathesis reactions. Because electrons are neither created nor destroyed, oxidation cannot occur in the absence of reduction, or vice versa. It is often useful, however, to focus attention on one component of the reaction and ask: Is that substance oxidized or reduced? Assigning oxidation numbers to the individual carbon atoms in a complex molecule can be difficult. Fortunately, there is another way to recognize oxidation–reduction reactions in organic chemistry.

Oxidation occurs when hydrogen atoms are removed from a carbon atom or when an oxygen atom is added to a carbon atom. Reduction occurs when hydrogen atoms are added to a carbon atom or when an oxygen atom is removed from a carbon atom.