To make comparisons meaningful, enthalpies of formation are given for the standard states of reactants and products—these are the states found at atmospheric pressure and, usually, room temperature (298.15 K). Thus, the standard state of water is liquid, not gas or solid. The standard state of iron is solid, not a molten liquid. To signify that a value represents measurements on substances in their standard states, a ^{0} sign is added to the enthalpy symbol, giving ΔH^0 for the standard enthalpy of a reaction. Adding a subscript *f*, as in ΔH_f^0, further indicates a standard enthalpy of formation.

Some standard enthalpies of formation are given in Appendix Table A-14. Each entry in the table is the enthalpy of formation for the synthesis of *one mole* of the compound listed from its elements in their standard states. The thermochemical equation to accompany each enthalpy of formation shows the formation of one mole of the compound from its elements in their standard states.

Stability and Enthalpy of Formation

If a large amount of energy as heat is released when a compound is formed, the compound has a large negative enthalpy of formation. Such compounds are very stable.

Elements in their standard states are *defined* as having $\Delta H_f^0 = 0$. The ΔH_f^0 of carbon dioxide is –393.5 kJ/mol of gas produced. Therefore, carbon dioxide is more stable than the elements from which it was formed. You can see in Appendix Table A-14 that the majority of the enthalpies of formation are negative.

Compounds with relatively positive values of enthalpies of formation, or only slightly negative values, are typically unstable. For example, hydrogen iodide, HI, is a colorless gas that decomposes somewhat when stored at room temperature. It has a relatively high positive enthalpy of formation of +26.5 kJ/mol. As it decomposes, violet iodine vapor, I_2, becomes visible throughout the container of the gas.

Compounds with a high positive enthalpy of formation are sometimes very unstable and may react or decompose violently. For example, ethyne (acetylene), C_2H_2 (ΔH_f^0 = +226.7 kJ/mol), reacts violently with oxygen and must be stored in cylinders as a solution in acetone. Mercury fulminate, $HgC_2N_2O_2$, has a very large enthalpy of formation of +270 kJ/mol. Its instability makes it useful as a detonator for explosives.

Enthalpy of Combustion

Combustion reactions produce a considerable amount of energy in the form of light and heat when a substance is combined with oxygen. The enthalpy change that occurs during the complete combustion of one mole of a substance is call the **enthalpy of combustion** of the substance.