For an adiabatic process, this becomes

$$\Big[dS\Big]_{\text{adiabatic}} \geq 0.$$

Thus we have proved that if we start with the Clausius statement we obtain the mathematical inequality of the second law introduced at the beginning of this chapter.

NOTE

Carnot Cycle and the "Work Value" of Heat

From an end-user perspective we can understand that heat and work are not equivalent in the
sense that work more highly valued than heat. Suppose we are given an amount of heat Q at
temperature T. How much work can we extract from that amount? If we have access to a reser-
is voir at lower temperature T_0 (and the surroundings are always a convenient choice), then we can
build a cycle between T and T_0 and feed the amount Q into it to produce work. In this sense,
the temperature difference is equivalent to a voltage difference in an electric circuit, or elevation
difference in a gravitational system (a river flowing to sea level from a mountain spring), and
provides an opportunity to produce work. If the power cycle is reversible, the fraction of heat
that is converted into work is the Carnot efficiency, $1 - T_0/T$. The balance will appear as heat
that is rejected at T_0; this amount can no longer be converted into work unless a reservoir at

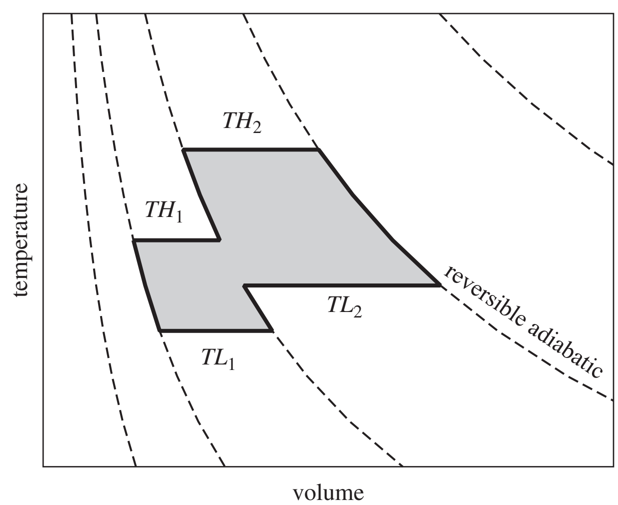

Figure 4-6: A cycle composed of two interconnected Carnot cycles. Using enough reversible adiabatic paths close to each other, any reversible closed path can be represented by a series of Carnot cycles. Along such closed path, the integral of dQ_{rev}/T is zero (see Example 4.14).