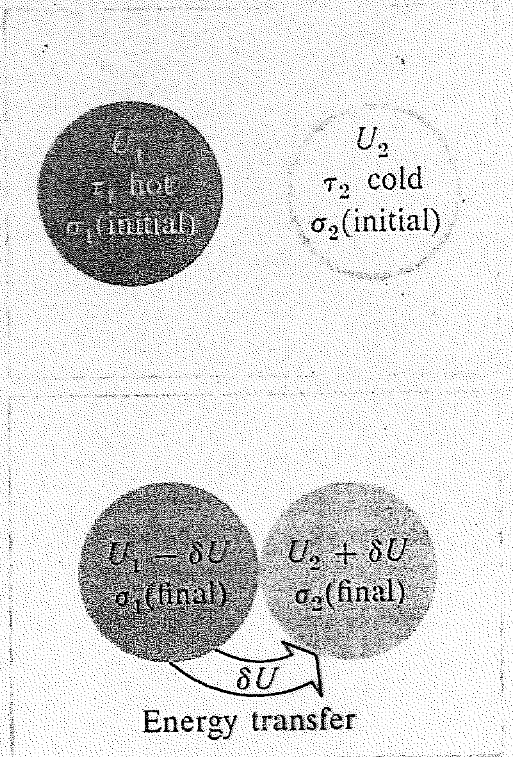

$\sigma_1(\text{final}) + \sigma_2(\text{final}) > \sigma_1(\text{initial}) + \sigma_2(\text{initial})$

Figure 2.7 If the temperature τ_1 is higher than τ_2, the transfer of a positive amount of energy δU from system 1 to system 2 will increase the total entropy $\sigma_1 + \sigma_2$ of the combined systems over the initial value $\sigma_1(\text{initial}) + \sigma_2(\text{initial})$. In other words, the final system will be in a more probable condition if energy flows from the warmer body to the cooler body when thermal contact is established. This is an example of the law of increasing entropy.

As a consequence of (24), we see that S and σ are connected by a scale factor:

$$\boxed{S = k_B\sigma.} \tag{30}$$

We will call S the conventional entropy.

The more states that are accessible, the greater the entropy. In the definition of $\sigma(N,U)$ we have indicated a functional dependence of the entropy on the number of particles in the system and on the energy of the system. The entropy may depend on additional independent variables: the entropy of a gas (Chapter 3) depends on the volume.

In the early history of thermal physics the physical significance of the entropy was not known. Thus the author of the article on thermodynamics in the *Encyclopaedia Britannica*, 11th ed. (1905), wrote: "The utility of the conception of entropy . . . is limited by the fact that it does not correspond directly to any directly measurable physical property, but is merely a mathematical function of the definition of absolute temperature." We now know what absolute physical property the entropy measures. An example of the comparison of the experimental determination and theoretical calculation of the entropy is discussed in Chapter 6.

Consider the total entropy change $\Delta\sigma$ when we remove a positive amount of energy ΔU from 1 and add the same amount of energy to 2, as in Figure 2.7.