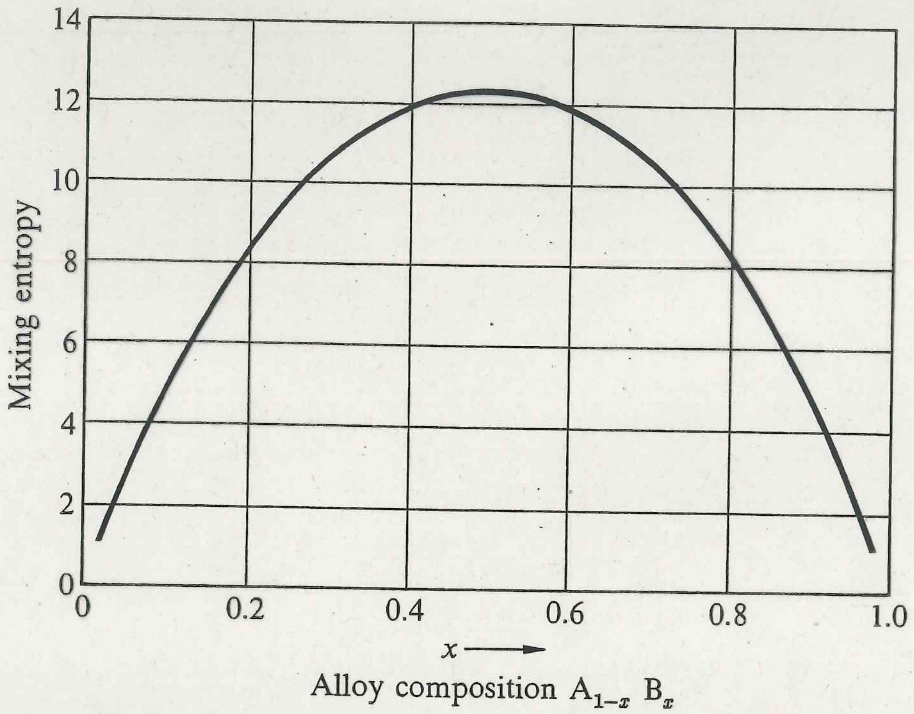

Figure 3.10 Mixing entropy of a random binary alloy as a function of the proportions of the constituent atoms A and B. The curve plotted was calculated for a total of 20 atoms. We see that this entropy is a maximum when A and B are present in equal proportions ($x = 0.5$), and the entropy is zero for pure A or pure B.

system is called the **entropy of mixing**. The result (79) may be put in a more convenient form by use of the Stirling approximation:

$$\begin{aligned}\sigma(N,t) &\simeq N\log N - N - (N-t)\log(N-t) + N - t - t\log t + t \\ &= N\log N - (N-t)\log(N-t) - t\log t \\ &= -(N-t)\log(1-t/N) - t\log(t/N)\ ,\end{aligned}$$

or, with $x \equiv t/N$,

$$\sigma(x) = -N[(1-x)\log(1-x) + x\log x]. \tag{80}$$

This result gives the entropy of mixing of an alloy $A_{1-x}B_x$ treated as a random (homogeneous) solid solution. The problem is developed in detail in Chapter 11.

We ask: Is the homogeneous solid solution the equilibrium condition of a mixture of A and B atoms, or is the equilibrium a two-phase system, such as a mixture of crystallites of pure A and crystallites of pure B? The complete answer is the basis of much of the science of metallurgy: the answer will depend on the temperature and on the interatomic interaction energies U_{AA}, U_{BB}, and U_{AB}. In the special case that the interaction energies between