



FIGURE 11.12

The form of some wave functions for a harmonic oscillator. Some probability density functions for a harmonic oscillator. The corresponding classical functions shown as dashed lines.

the quantum-mechanical behavior are very striking. For $v = 0$, for example, we see that the highest probability according to the quantum-mechanical treatment is when the system is passing through its equilibrium position ($x = 0$). In classical mechanics, on the other hand, the probability is *lowest* at the equilibrium position, since the system has its highest velocity at this position and therefore passes through it rapidly; the vibrational motion is slowest at the extremities of the vibration, and the probability is therefore the highest at these extremities. As the vibrational quantum number increases, however, the quantum-mechanical probabilities become closer to the classical ones, and the highest probabilities are close to the turning points of the vibrations.

Another important difference between the quantum-mechanical and classical probabilities is that the quantum-mechanical treatment gives a finite probability that the bond is extended to a greater extent than the value permitted by classical theory. In a classical vibration the extension is restricted to a certain fixed value, but the quantum-mechanical curves in Figure 11.12b show that there is a certain