

Chapter 35 Problem 27 †

Given

$$m = 1.0 \text{ g} = 1.0 \times 10^{-3} \text{ kg}$$

$$k = 80 \text{ N/m}$$

Solution

Find the separation between the energy levels for a harmonic oscillator, which is a mass on a spring.

The angular frequency of the mass on a spring oscillator is given by the formula

$$\omega = \sqrt{\frac{k}{m}} = \sqrt{\frac{80 \text{ N/m}}{1.0 \times 10^{-3} \text{ kg}}} = 283 \text{ rad/s}$$

The frequency of this oscillator is

$$f = \frac{\omega}{2\pi} = \frac{283 \text{ rad/s}}{2\pi} = 45.0 \text{ Hz}$$

The allowed energy levels of a harmonic oscillator are

$$E_n = hf(n + \frac{1}{2})$$

Therefore, the difference between adjacent energy levels is

$$\Delta E = hf$$

Therefore, the energy difference is

$$\Delta E = (6.63 \times 10^{-34} \text{ J} \cdot \text{s})(45.0 \text{ Hz}) = 2.98 \times 10^{-32} \text{ J}$$

†Problem from Essential University Physics, Wolfson