4. The textbook notes (in the discussion immediately after Eq. 16-7) that the acceleration amplitude is $a_m = \omega^2 x_m$, where ω is the angular frequency ($\omega = 2\pi f$ since there are 2π radians in one cycle). Therefore, in this circumstance, we obtain

$$a_m = (2\pi(6.60\,\mathrm{Hz}))^2\,(0.0220\,\mathrm{m}) = 37.8\ \mathrm{m/s^2}\ .$$

8. (a) The acceleration amplitude is related to the maximum force by Newton's second law: $F_{\text{max}} = ma_m$. The textbook notes (in the discussion immediately after Eq. 16-7) that the acceleration amplitude is $a_m = \omega^2 x_m$, where ω is the angular frequency ($\omega = 2\pi f$ since there are 2π radians in one cycle). The frequency is the reciprocal of the period: $f = 1/T = 1/0.20 = 5.0$ Hz, so the angular frequency is $\omega = 10\pi$ (understood to be valid to two significant figures). Therefore,

$$F_{\text{max}} = m\omega^2 x_m = (0.12\,\text{kg})(10\pi\,\text{rad/s})^2(0.085\,\text{m}) = 10\text{ N} .$$

(b) Using Eq. 16-12, we obtain

$$\omega = \sqrt{\frac{k}{m}} \implies k = (0.12\,\text{kg})(10\pi\,\text{rad/s})^2 = 1.2 \times 10^2\text{ N/m} .$$

9. (a) The amplitude is half the range of the displacement, or $x_m = 1.0\,\text{mm}$.

(b) The maximum speed v_m is related to the amplitude x_m by $v_m = \omega x_m$, where ω is the angular frequency. Since $\omega = 2\pi f$, where f is the frequency,

$$v_m = 2\pi f x_m = 2\pi(120\,\text{Hz})\left(1.0 \times 10^{-3}\,\text{m}\right) = 0.75 \text{ m/s} .$$

(c) The maximum acceleration is

$$a_m = \omega^2 x_m = (2\pi f)^2 x_m = (2\pi(120\,\text{Hz}))^2\left(1.0 \times 10^{-3}\,\text{m}\right) = 570 \text{ m/s}^2 .$$

10. (a) The problem gives the frequency $f = 440$ Hz, where the SI unit abbreviation Hz stands for Hertz, which means a cycle-per-second. The angular frequency ω is similar to frequency except that ω is in radians-per-second. Recalling that 2π radians are equivalent to a cycle, we have $\omega = 2\pi f \approx 2800$ rad/s.

(b) In the discussion immediately after Eq. 16-6, the book introduces the velocity amplitude $v_m = \omega x_m$. With $x_m = 0.00075$ m and the above value for ω, this expression yields $v_m = 2.1$ m/s.

(c) In the discussion immediately after Eq. 16-7, the book introduces the acceleration amplitude $a_m = \omega^2 x_m$, which (if the more precise value $\omega = 2765$ rad/s is used) yields $a_m = 5.7$ km/s.

32. (a) The energy at the turning point is all potential energy: $E = \frac{1}{2}kx_m^2$ where $E = 1.00$ J and $x_m = 0.100$ m. Thus,

$$k = \frac{2E}{x_m^2} = 200 \text{ N/m} .$$

(b) The energy as the block passes through the equilibrium position (with speed $v_m = 1.20$ m/s)is purely kinetic:

$$E = \frac{1}{2}mv_m^2 \implies m = \frac{2E}{v_m^2} = 1.39 \text{ kg} .$$

(c) Eq. 16-12 (divided by 2π) yields

$$f = \frac{1}{2\pi}\sqrt{\frac{k}{m}} = 1.91 \text{ Hz} .$$

55. (a) The frequency for small amplitude oscillations is $f = (1/2\pi)\sqrt{g/L}$, where L is the length of the pendulum. This gives $f = (1/2\pi)\sqrt{(9.80\,\text{m/s}^2)/(2.0\,\text{m})} = 0.35\,\text{Hz}$.

(b) The forces acting on the pendulum are the tension force $\vec{T}$ of the rod and the force of gravity $m\vec{g}$. Newton's second law yields $\vec{T} + m\vec{g} = m\vec{a}$, where m is the mass and $\vec{a}$ is the acceleration of the pendulum. Let $\vec{a} = \vec{a}_e + \vec{a}'$, where $\vec{a}_e$ is the acceleration of the elevator and $\vec{a}'$ is the acceleration of the pendulum relative to the elevator. Newton's second law can then be written $m(\vec{g}-\vec{a}_e)+\vec{T} = m\vec{a}'$. Relative to the elevator the motion is exactly the same as it would be in an inertial frame where the acceleration due to gravity is $\vec{g} - \vec{a}_e$. Since $\vec{g}$ and $\vec{a}_e$ are along the same line and in opposite directions we can find the frequency for small amplitude oscillations by replacing g with $g + a_e$ in the expression $f = (1/2\pi)\sqrt{g/L}$. Thus

$$f = \frac{1}{2\pi}\sqrt{\frac{g + a_e}{L}} = \frac{1}{2\pi}\sqrt{\frac{9.8\,\text{m/s}^2 + 2.0\,\text{m/s}^2}{2.0\,\text{m}}} = 0.39\ \text{Hz}\ .$$

(c) Now the acceleration due to gravity and the acceleration of the elevator are in the same direction and have the same magnitude. That is, $\vec{g} - \vec{a}_e = 0$. To find the frequency for small amplitude oscillations, replace g with zero in $f = (1/2\pi)\sqrt{g/L}$. The result is zero. The pendulum does not oscillate.