Homework Solutions
10/9/2007

Conceptual

9. Nothing would happen to the period of a pendulum if water leaked out of the bob because mass has no effect on the period or frequency.

10. The length of the grandfather clock's pendulum should be decreased to shorten the time between ticks and tocks.

11. The clock will run slow because the period will increase making the time between "ticks" and "tocks" longer than a second.

Problems

28. a.

$$k = \frac{F}{x} = \frac{7.50N}{0.03m} = 250\frac{N}{m}$$

b.

$$T = 2\pi\sqrt{\frac{m}{k}} = 2\pi\sqrt{\frac{0.500kg}{250\frac{N}{m}}} = 0.281s$$

$$f = \frac{1}{T} = \frac{1}{0.281s} = 3.56Hz$$

$$f = \frac{\omega}{2\pi}$$

$$\omega = 2\pi f = 2\pi(3.56Hz) = 22.4\frac{rad}{s}$$

c.

$$TE = U_g + U_s + KE$$

$$TE = \frac{1}{2}kx^2 = \frac{1}{2}\left(250\frac{N}{m}\right)(0.0500m)^2 = 0.313J$$

d. The amplitude is the amount the spring is stretched, or 5 cm.

e.

$$U_{g,i} + U_{s,i} + KE_i = U_{g,f} + U_{s,f} + KE_f$$

$$U_{s,i} = \frac{1}{2}mv^2$$

$$v = \sqrt{\frac{2\left(U_{s,i}\right)}{m}} = \sqrt{\frac{2\left(0.313J\right)}{0.500kg}} = 1.12\frac{m}{s}$$

$$a = \frac{\Sigma F}{m} = \frac{kx}{m} = \frac{\left(250\frac{N}{m}\right)\left(0.0500m\right)}{0.500kg} = 25.0\frac{m}{s^2}$$

f.

$$x(t) = A\cos\left(\omega t\right) = \left(5.00cm\right)\cos\left(22.4 \bullet 0.500s\right) = 0.919cm$$

34. a.

$$T = 2\pi\sqrt{\frac{L}{g}} = 2\pi\sqrt{\frac{5.00m}{14.8\frac{m}{s^2}}} = 3.65s$$

b.

$$T = 2\pi\sqrt{\frac{L}{g}} = 2\pi\sqrt{\frac{5.00m}{4.80\frac{m}{s^2}}} = 6.41s$$

35. Using the Pythagorean theorem to find the total acceleration:

$$g_{effective} = \sqrt{\left(5.00\frac{m}{s^2}\right)^2 + \left(9.80\frac{m}{s^2}\right)^2} = 11.0\frac{m}{s^2}$$

$$T = 2\pi\sqrt{\frac{L}{g}} = 2\pi\sqrt{\frac{5.00m}{11.0\frac{m}{s^2}}} = 4.24s$$

54. a. A=0.25 m

b.

$$\omega = 0.4\pi$$

$$f = \frac{\omega}{2\pi} = \frac{0.4\pi}{2\pi} = 0.2Hz$$

$$T = \frac{1}{f} = 2\pi\sqrt{\frac{m}{k}}$$

$$k = 4\pi^2 mf^2 = 0.47\frac{N}{m}$$

c.

$$x = (0.25m)\cos(0.4\pi \bullet 0.30s) = 0.23m$$

d.

$$U_{g,i} + U_{s,i} + KE_i = U_{g,f} + U_{s,f} + KE_f$$

$$U_{s,i} = U_{s,f} + KE_f$$

$$\frac{1}{2}kx_i^2 - \frac{1}{2}kx_f^2 = \frac{1}{2}mv^2$$

$$v = \sqrt{\frac{k\left(x_i^2 - x_f^2\right)}{m}} = \sqrt{\frac{0.47\frac{N}{m}\left((0.25m)^2 - (0.23m)^2\right)}{0.30kg}}$$

$$v = 0.12\frac{m}{s}$$

55.

$$F_s = \mu_s mg$$

$$a_{\max} = \frac{\Sigma F}{m} = \frac{\mu_s mg}{m} = \mu_s g$$

$$a_s = \frac{F_s}{m} = \frac{kx}{m_{total}}$$

$$T = \frac{1}{f} = 2\pi\sqrt{\frac{m_{total}}{k}}$$

$$m_{total} = \frac{k}{4\pi^2 f^2}$$

$$a_s = \frac{kx}{m_{total}} = \frac{kx}{\frac{k}{4\pi^2 f^2}} = 4\pi^2 x f^2$$

$$\mu_s g = 4\pi^2 x f^2$$

$$x = \frac{\mu_s g}{4\pi^2 f^2} = 0.662m = 6.62cm$$