p 317 1–5, 7, 8, 20, 25, 27–31, 33

(1) In each quarter period it travels 1 amplitude.
∴ Total distance = $4A = 4(.18) = 0.72$ m

(2) $F = -kx$

$k = \frac{-F}{x}$ so $k = \frac{\Delta F}{\Delta x} = \frac{180 - 75}{.85 - .65} = \underline{525}$ N/m

(3) $T = 2\pi\sqrt{\frac{m}{k}}$

$F = -kx$

$k = \frac{F}{x} = \frac{68(9.8)}{5\times10^{-3}} = 1.3\times10^{5}$

$\frac{1}{f} = 2\pi\sqrt{\frac{1500}{1.3\times10^{5}}} = 0.67$

$\underline{f = 1.5 \text{ Hz}}$

(4) (a) $F = kx$

$k = \frac{F}{x} = \frac{mg}{x} = \frac{2.7(9.8)}{36\times10^{-2}} = \underline{735}$ N/m

(b) $\frac{1}{f} = T = 2\pi\sqrt{\frac{m}{k}} = 2\pi\sqrt{\frac{2.7}{735}} = 0.381$

$f = 2.6$ Hz

(5) $T = 2\pi\sqrt{\frac{m}{k}}$

$f_1 = \frac{1}{2\pi}\sqrt{\frac{k}{m_1}}$ $\qquad$ $f_2 = \frac{1}{2\pi}\sqrt{\frac{k}{m_2}}$

$k = (2\pi f_1)^2 m_1$ $\qquad$ $f_2 = \frac{1}{2\pi}\sqrt{\frac{(2\pi f_1)^2 m_1}{m_2}}$

$= \frac{1}{2\pi} 2\pi f_1 \sqrt{\frac{m_1}{m_2}}$

$f_2 = 3\sqrt{\frac{.6}{.38}} = \underline{3.8\ Hz}$

(7) (a) $T = 2\pi\sqrt{\frac{m}{k}}$

$k = \frac{4\pi^2 m}{T^2} = 4\pi^2 m f^2 = 4\pi^2 (0.25\times10^{-3})(4)^2$

$k = 0.16\ N/m$

(b) $T = 2\pi\sqrt{\frac{m}{k}}$

$f = \frac{1}{2\pi}\sqrt{\frac{k}{m}} = \frac{1}{2\pi}\sqrt{\frac{0.16}{.5\times10^{-3}}} = \underline{2.8\ Hz}$

(8) $T = 2\pi\sqrt{\frac{m}{k}}$

$$f_1 = \frac{1}{2\pi}\sqrt{\frac{k}{m_1}} \qquad f_2 = \frac{1}{2\pi}\sqrt{\frac{k}{m_2}}$$

$$f_1^2 (2\pi)^2 m_1 = k = f_2^2 (2\pi)^2 m_2$$

$$m_2 = m_1 + .68$$

$$f_1^2 m_1 = f_2^2 (m_1 + .68)$$

$$f_1^2 m_1 = f_2^2 (m_1 + .68)$$

$$f_1^2 m_1 = f_2^2 m_1 + .68 f_2^2$$

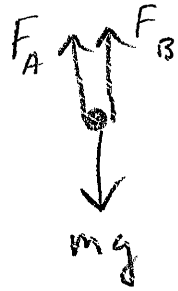
$$f_1^2 m_1 - f_2^2 m_1 = 0.68 f_2^2$$

$$m_1 = \frac{0.68 f_2^2}{f_1^2 - f_2^2}$$

$$= \frac{0.68(.6)^2}{(.88^2 - .6^2)}$$

$$m_1 = 0.59\ \text{kg}$$

(20)



$$F_A + F_B = mg$$

$$kx + kx = mg$$

$$\underline{2k}x = mg$$

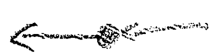
spring equivalent is $2k$

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

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

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

(25)



$$\Sigma F = ma$$

$$-k_1 x - k_2 x = ma$$

$$-(k_1 + k_2)\,x = ma$$

$$k_{eq} = k_1 + k_2$$

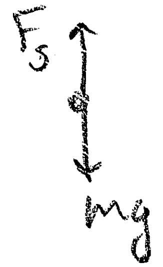
$$T = 2\pi\sqrt{\frac{m}{k_1 + k_2}}$$

(27) $f = \frac{8}{38} = 0.2105$

$T = 4.75\ s$

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

$k = \frac{(2\pi)^2 m}{T^2} = \frac{(2\pi)^2\, 65}{(4.75)^2} = 114\ N/m$



$kx = mg$

$x = \frac{mg}{k} = \frac{65(9.8)}{114} = 5.6\ m$

The bungee cord was stretched 5.6 m.

Unstretched length is $25 - 5.6 = \underline{19.4\ m}$

(28) $f = \frac{36}{60} = \underline{0.6\ Hz}$ $T = \underline{1.7}\ s$

(29) $T_p = 2\pi\sqrt{\frac{l}{g}}$

$l = \frac{T_p^2\, g}{4\pi^2} = \frac{(2)^2(9.8)}{4\pi^2} = \underline{0.99\ m}$

(30) $T_{Earth} = 2\pi\sqrt{\frac{l}{g}}$ $T_{Mars} = 2\pi\sqrt{\frac{l}{.37g}}$

$= \sqrt{\frac{1}{.37}}\, T_{Earth}$

$= \sqrt{\frac{1}{.37}}\, .8 = \underline{1.3\,s}$

(31) (a) $T = 2\pi\sqrt{\frac{l}{g}} = 2\pi\sqrt{\frac{.8}{9.8}} = 1.8\ s.$

(b) In free fall $g \to 0$
therefore, mathematically period is undefined.
As well, a pendulum will not work without
gravitational force.

(33) The number of seconds in a day:

$$24 \times 60 \times 60 = 86\,400\,s$$

The clock is running 30s slow, so it is only counting $86400 - 30 = 86370\,s$.

The period has to be adjusted by $\frac{86370}{86400}$

$$T_{NEW} = \frac{86370}{86400} T_{OLD}$$

$$2\pi\sqrt{\frac{l_2}{g}} = \frac{86370}{86400} 2\pi\sqrt{\frac{l_1}{g}}$$

$$l_2 = \left(\frac{86370}{86400}\right)^2 l_1$$

$$l_2 = \left(\frac{86370}{86400}\right)^2 (0.9930)$$

$$l_2 = 0.9923$$

The pendulum should be shortened by

$.9930 - .9923 = \underline{0.0007\ m}$ or $\underline{.7\ mm}$