Practice Test II

Problems from College Physics Giambattista

Chapter 6

15. $W=\frac{1}{2}kx^2=\frac{1}{2}\left(20.0\ \frac{\text{N}}{\text{m}}\right)(0.40\ \text{m})^2=\boxed{1.6\ \text{J}}$

16. $W=F_x\Delta x$ and the work is represented by the area under the curve, $A=\frac{1}{2}bh.$

(a) $W=\frac{1}{2}(0.20\ \text{m})(15\ \text{N})=\boxed{1.5\ \text{J}}$

(b) $W=\frac{1}{2}(0.20\ \text{m})(15\ \text{N})-\frac{1}{2}(0.10\ \text{m})(7.5\ \text{N})=\boxed{1.1\ \text{J}}$

17. Since the displacement of the model airplane is zero, $\boxed{\text{zero}}$ work has been done on it by the string.

18. $W=\frac{1}{2}(2.0\ \text{N})(1.0\ \text{m})+\frac{1}{2}(1.0\ \text{N})(1.0\ \text{m})+(-1.0\ \text{N})(1.0\ \text{m})=\boxed{0.5\ \text{J}}$

19. $W=(5.0\times10^1\ \text{N})(0.012\ \text{m})+(120\ \text{N})(0.050\ \text{m}-0.012\ \text{m})=\boxed{5.2\ \text{J}}$

20. (a)

$$\begin{aligned}
W_{\text{spring}}&=-W_{\text{g}}\\
-\frac{1}{2}kx^2&=-(-mg\Delta y)\\
\frac{1}{2}kx^2&=-mg\Delta y\\
k&=-\frac{2mg\Delta y}{x^2}\\
&=-\frac{2(780\ \text{N})(68\ \text{m}-182\ \text{m})}{(182\ \text{m}-68\ \text{m}-30.0\ \text{m})^2}\\
&=\boxed{25\ \text{N/m}}
\end{aligned}$$

(b) The kinetic energy gained is the sum of the positive work done by gravity (which increases the kinetic energy during the fall) and the negative work done by the cord (which decreases the kinetic energy).

$$\begin{aligned}
\frac{1}{2}mv^2&=-mg\Delta y-\frac{1}{2}kx^2\\
v&=\sqrt{-2g\Delta y-\frac{k}{m}x^2}\\
&=\sqrt{-2\left(9.8\ \frac{\text{m}}{\text{s}^2}\right)(92\ \text{m}-182\ \text{m})-\frac{25.2\ \frac{\text{N}}{\text{m}}}{\frac{780\ \text{N}}{9.8\ \frac{\text{m}}{\text{s}^2}}}(182\ \text{m}-92\ \text{m}-30.0\ \text{m})^2}\\
&=\boxed{25\ \text{m/s}}
\end{aligned}$$

31. (a) $\Delta U=mg\Delta y=(72\ \text{kg})\left(9.8\ \frac{\text{N}}{\text{kg}}\right)(-2.5\ \text{m})=\boxed{-1.8\ \text{kJ}}$

(b)

$$\Delta K = -\Delta U$$

$$\frac{1}{2}mv^2 = -mg\Delta y$$

$$v = \sqrt{-2g\Delta y}$$

$$= \sqrt{-2\left(9.8\ \frac{\text{m}}{\text{s}^2}\right)(-2.5\ \text{m})}$$

$$= \boxed{7.0\ \text{m/s}}$$

44. v_y can be found from the kinetic energy gained due to gravity.

$$\frac{1}{2}mv_y^2 = mgh$$

$$v_y^2 = 2gh$$

v_x can be found from the kinetic energy gained from the spring.

$$\frac{1}{2}mv_x^2 = \frac{1}{2}k(x_\text{i}^2 - x_\text{f}^2)$$

$$v_x^2 = \frac{k(x_\text{i}^2 - x_\text{f}^2)}{m}$$

$$v = \sqrt{v_x^2 + v_y^2}$$

$$= \sqrt{\frac{k(x_\text{i}^2 - x_\text{f}^2)}{m} + 2gh}$$

$$= \sqrt{\frac{\left(28\ \frac{\text{N}}{\text{m}}\right)[(0.18\ \text{m})^2 - (0.12\ \text{m})^2]}{0.056\ \text{kg}} + 2\left(9.8\ \frac{\text{m}}{\text{s}^2}\right)(1.4\ \text{m})}$$

$$= \boxed{6.0\ \text{m/s}}$$

Chapter 7

4. Use the impulse-momentum theorem.

$$\Delta p = F_\text{av}\Delta t$$

$$p_\text{f} - p_\text{i} =$$

$$mv_\text{f} - m(0) =$$

$$v_\text{f} = \frac{F_\text{av}\Delta t}{m}$$

$$= \frac{(24\ \text{N})(0.028\ \text{s})}{0.16\ \text{kg}}$$

$$= \boxed{4.2\ \text{m/s}}$$

6. (a) $\frac{p_\text{f}}{p_\text{i}} = \frac{mv_\text{f}}{mv_\text{i}} = \frac{v_\text{f}}{v_\text{i}} = \frac{60.0\ \frac{\text{mi}}{\text{h}}}{20.0\ \frac{\text{mi}}{\text{h}}} = \boxed{3.00}$

(b) $\frac{K_\text{f}}{K_\text{i}} = \frac{\frac{1}{2}mv_\text{f}^2}{\frac{1}{2}mv_\text{i}^2} = \left(\frac{v_\text{f}}{v_\text{i}}\right)^2 = 3.00^2 = \boxed{9.00}$

15. Find the initial speed, which is the final speed after the fall.

$$v_y^2 - v_{0y}^2 = -2g\Delta y$$

$$v_y^2 - 0 = 2gh$$

$$v_y = \sqrt{2gh}$$

If up is positive, $\vec{\mathbf{v}}_y = -\sqrt{2gh}$ down $= \vec{\mathbf{v}}_\text{i}$.

(a) $\Delta p = m(v_f - v_i) = m\left[0 - \left(-\sqrt{2gh}\right)\right] = m\sqrt{2gh} = (60.0\text{ kg})\sqrt{2\left(9.8\ \frac{\text{m}}{\text{s}^2}\right)(8.0\text{ m})} = 750\text{ kg}\cdot\text{m/s}$

So, $\Delta\vec{\mathbf{p}} = \boxed{750\text{ kg}\cdot\text{m/s upward}}$.

(b) The impulse on the net is equal to the average force of the boy's weight times Δt plus the final change in momentum of the boy due to the net, $-\Delta\vec{\mathbf{p}}$.

$$mg\Delta t\text{ downward} - \Delta\vec{\mathbf{p}} = (60.0\text{ kg})\left(9.8\ \frac{\text{N}}{\text{kg}}\right)(0.40\text{ s})\text{ downward} + 750\text{ kg}\cdot\text{m/s downward}$$
$$= \boxed{990\text{ N}\cdot\text{s downward}}$$

(c) $\vec{\mathbf{F}}_{\text{av}} = \frac{\Delta\vec{\mathbf{p}}}{\Delta t} = \frac{990\text{ kg}\cdot\text{m/s downward}}{0.40\text{ s}} = \boxed{2500\text{ N downward}}$

31. Let east be in the $+x$-direction. Use momentum conservation. The block is initially at rest, so $v_{2i} = 0$.

$$m_1v_{1f} + m_2v_{2f} = m_1v_{1i} + m_2v_{2i}$$
$$m_2v_{2f} = m_1v_{1i} + m_2(0) - m_1v_{1f}$$
$$v_{2f} = \frac{m_1(v_{1i} - v_{1f})}{m_2}$$
$$= \frac{0.020\text{ kg}}{2.0\text{ kg}}\left[200.0\ \frac{\text{m}}{\text{s}} - \left(-100.0\ \frac{\text{m}}{\text{s}}\right)\right]$$
$$= 3.0\text{ m/s}$$

So, $\vec{\mathbf{v}}_{\text{block}} = \boxed{3.0\text{ m/s east}}$.

Chapter 8

23.(a) The rotational inertia of a hoop is MR^2.

$$W = \Delta K = \frac{1}{2}I(w_f^2 - w_i^2) = \frac{1}{2}(MR^2)(w_f^2 - 0) = \frac{1}{2}(1.90\times10^6\text{ kg})(67.5\text{ m})^2\left(3.50\times10^{-3}\ \frac{\text{rad}}{\text{s}}\right)^2 = \boxed{53.0\text{ kJ}}$$

(b) Constant torque implies constant angular acceleration, so $q = w_{av}\Delta t$.

$$W = tq = tw_{av}\Delta t = t\left(\frac{w_f + w_i}{2}\right)\Delta t = t\left(\frac{w_f + 0}{2}\right)\Delta t,\text{ so}$$

25.(a) Choose the axis of rotation at the point at which the right -hand cable connects to the platform. Let $m_1 = 75$ kg and $m_2 = 20.0$ kg. Let $l = 5.0$ m.

The system is in equilibrium.

$$t_{\text{net}} = 0 = -Fl + m_1g(l - d) + m_2g\left(\frac{l}{2}\right),\text{ so}$$
$$Fl = g\left[m_1(l - d) + m_2\frac{l}{2}\right]$$
$$F = g\left[m_1\left(1 - \frac{d}{l}\right) + \frac{m_2}{2}\right]$$
$$= \left(9.8\ \frac{\text{N}}{\text{kg}}\right)\left[(75\text{ kg})\left(1 - \frac{2.0\text{ m}}{5.0\text{ m}}\right) + \frac{20.0\text{ kg}}{2}\right]$$
$$= \boxed{540\text{ N}}.$$

(b) $F_{\text{net}} = 0 = -m_1 g - m_2 g + F_\text{L} + F_\text{R}$, so

$$F_\text{R} = (m_1 + m_2)g - F_\text{L} = (75\text{ kg} + 20.0\text{ kg})\left(9.8\ \frac{\text{N}}{\text{kg}}\right) - 539\text{ N} = \boxed{390\text{ N}}.$$

26. Choose the axis of rotation at the fulcrum.

$$\tau_{\text{net}} = 0 = F_\text{A}\cos\theta(2.4\text{ m}) - F_\text{L}\cos\theta(1.2\text{ m})$$

$$F_\text{A}\cos\theta(2.4\text{ m}) = F_\text{L}\cos\theta(1.2\text{ m})$$

$$\begin{aligned} F_\text{A} &= \frac{1.2\text{ m}}{2.4\text{ m}}F_\text{L} \\ &= 0.50mg \\ &= 0.50(20.0\text{ kg})\left(9.8\ \frac{\text{N}}{\text{kg}}\right) \\ &= \boxed{98\text{ N}} \end{aligned}$$

27. Choose the axis of rotation at the fulcrum.

$\tau_{\text{net}} = 0 = F(3.0\text{ m}) - (1200\text{ N})(0.50\text{ m})$, so

$$F = \frac{(1200\text{ N})(0.50\text{ m})}{3.0\text{ m}} = \boxed{200\text{ N}}.$$

41. Use the rotational form of Newton's second law.

$I = \frac{1}{2}mr^2$ for a uniform disk.

$$\tau = I\alpha = \frac{1}{2}mr^2\left(\frac{\omega_\text{f}^2 - \omega_\text{i}^2}{2\Delta\theta}\right) = \frac{mr^2\omega_\text{f}^2}{4\Delta\theta} = \frac{(0.22\text{ kg})\left(\frac{0.305\text{ m}}{2}\right)^2\left(3.49\ \frac{\text{rad}}{\text{s}}\right)^2}{4(2.0\text{ rev})\left(\frac{2\pi\text{ rad}}{\text{rev}}\right)} = \boxed{0.0012\text{ N}\cdot\text{m}}$$

42.(a) This is just the relation between tangential acceleration and angular acceleration, $\boxed{a = R\alpha}$.

(b) $\Sigma\tau = T_1R - T_2R = (T_1 - T_2)R$

The motion is CCW, so $\tau = \boxed{(T_1 - T_2)R\text{ CCW}}$.

(c) If $m_1 = m_2$, $T_1 = T_2$, so $\tau_{\text{net}} = 0$. If $m_1 \neq m_2$, the blocks accelerate, so the pulley has an angular acceleration. Since a nonzero net torque is required for the pulley to accelerate, $T_1 - T_2 \neq 0$, thus $T_1 \neq T_2$.

(d) From Newton's second law:

$m_1(-a) = T_1 - m_1g \Rightarrow \boxed{T_1 = m_1(g - a)}$

$m_2a = T_2 - m_2g \Rightarrow \boxed{T_2 = m_2(g + a)}$

Now,

$$\begin{aligned} \tau &= I\alpha \\ (T_1 - T_2)R &= \frac{1}{2}MR^2\frac{a}{R} \\ m_1g - m_1a - m_2g - m_2a &= \frac{1}{2}Ma \\ a\left(m_2 + m_1 + \frac{1}{2}M\right) &= (m_1 - m_2)g \end{aligned}$$

$$\boxed{a = \frac{(m_1 - m_2)g}{\frac{M}{2} + m_1 + m_2}}$$

(e) From Example 8.2: $v=\sqrt{\dfrac{2(m_1-m_2)gh}{m_1+m_2+\frac{I}{R^2}}}$

$$2a_y\Delta y=v_y{}^2-v_{0y}{}^2$$
$$2ah=v^2$$
$$=\frac{2(m_1-m_2)gh}{m_1+m_2+\frac{I}{R^2}}$$
$$a=\frac{(m_1-m_2)g}{m_1+m_2+\frac{I}{R^2}}$$

Now, $I=\dfrac{1}{2}MR^2$, so

$$a=\frac{(m_1-m_2)g}{m_1+m_2+\frac{\frac{1}{2}MR^2}{R^2}}=\frac{(m_1-m_2)g}{m_1+m_2+\frac{M}{2}}.$$

The expression for a is the same as that found in part (d).

Chapter 9

30. Let the +*y*-direction be upward. Use Newton's second law.

(a) $\Sigma F_y=F_\text{B}-mg=ma$

$$a=\frac{F_\text{B}}{m}-g=\frac{r_\text{w}gV}{m}-g=g\left(\frac{r_\text{w}V}{rV}-1\right)=\left(9.8\ \frac{\text{m}}{\text{s}^2}\right)\left(\frac{1.00\ \frac{\text{g}}{\text{cm}^3}}{0.50\ \frac{\text{g}}{\text{cm}^3}}-1\right)=9.8\ \text{m/s}^2$$

So, $\vec{\mathbf{a}}=\boxed{9.8\ \text{m/s}^2\ \text{upward}}$.

(b) $a=\left(9.8\ \dfrac{\text{m}}{\text{s}^2}\right)\left(\dfrac{1.00\ \frac{\text{g}}{\text{cm}^3}}{0.750\ \frac{\text{g}}{\text{cm}^3}}-1\right)=3.3\ \text{m/s}^2$

So, $\vec{\mathbf{a}}=\boxed{3.3\ \text{m/s}^2\ \text{upward}}$.

(c) $a=\left(9.8\ \dfrac{\text{m}}{\text{s}^2}\right)\left(\dfrac{1.00\ \frac{\text{g}}{\text{cm}^3}}{0.125\ \frac{\text{g}}{\text{cm}^3}}-1\right)=69\ \text{m/s}^2$

So, $\vec{\mathbf{a}}=\boxed{69\ \text{m/s}^2\ \text{upward}}$.

32. The weight of the alcohol displaced is equal to the buoyant force.

$W_\text{alcohol}=mg=1.03\ \text{N}-0.730\ \text{N}=0.30\ \text{N}$

$$\text{S.G.}=\frac{r_\text{alcohol}}{r_\text{w}}=\frac{m_\text{alcohol}}{r_\text{w}V_\text{alcohol}}=\frac{W_\text{alcohol}}{r_\text{w}V_\text{alcohol}g}=\frac{0.30\ \text{N}}{\left(1.00\times10^3\ \frac{\text{kg}}{\text{m}^3}\right)(3.90\times10^{-5}\ \text{m}^3)\left(9.8\ \frac{\text{m}}{\text{s}^2}\right)}=\boxed{0.78}$$

33. The new density of the fish is $r = \dfrac{m_\mathrm{f} + m_\mathrm{a}}{V_\mathrm{f} + V_\mathrm{a}} = \dfrac{m_\mathrm{f} + r_\mathrm{a} V_\mathrm{a}}{\frac{m_\mathrm{f}}{r_\mathrm{f}} + V_\mathrm{a}} = r_\mathrm{w}.$

Solve for V_a.

$$m_\mathrm{f} + r_\mathrm{a} V_\mathrm{a} = \frac{r_\mathrm{w}}{r_\mathrm{f}} m_\mathrm{f} + r_\mathrm{w} V_\mathrm{a}$$

$$V_\mathrm{a}(r_\mathrm{a} - r_\mathrm{w}) = m_\mathrm{f}\left(\frac{r_\mathrm{w}}{r_\mathrm{f}} - 1\right)$$

$$V_\mathrm{a} = m_\mathrm{f} \frac{1 - \frac{r_\mathrm{w}}{r_\mathrm{f}}}{r_\mathrm{w} - r_\mathrm{a}}$$

$$= (0.0100\ \text{kg}) \frac{1 - \frac{1060\ \frac{\text{kg}}{\text{m}^3}}{1080\ \frac{\text{kg}}{\text{m}^3}}}{1060\ \frac{\text{kg}}{\text{m}^3} - 1.20\ \frac{\text{kg}}{\text{m}^3}}$$

$$= \boxed{0.17\ \text{cm}^3}$$

34. The weight of the water displaced by the fish is $W_\mathrm{w} = 200.0\ \text{N} - 15.0\ \text{N} = 185.0\ \text{N}.$

The volume of the fish is equal to the volume of the displaced water.

$$V_\mathrm{f} = V_\mathrm{w} = \frac{W_\mathrm{w}}{r_\mathrm{w} g}$$

Find the average density of the fish.

$$r_\mathrm{f} = \frac{m_\mathrm{f}}{V_\mathrm{f}} = \frac{\frac{W_\mathrm{f}}{g}}{\frac{W_\mathrm{w}}{r_\mathrm{w} g}} = \frac{W_\mathrm{f}}{W_\mathrm{w}} r_\mathrm{w} = \frac{200.0\ \text{N}}{185.0\ \text{N}}\left(1.00\times 10^3\ \frac{\text{kg}}{\text{m}^3}\right) = \boxed{1080\ \text{kg/m}^3}$$

Chapter 10

38.(a) The speed is maximum when the spring and mass system is at its equilibrium point. Use Newton's second law.

$$\Sigma F_y = kx - mg = 0$$

$$kx = mg$$

$$x = \frac{mg}{k}$$

$$= \frac{(0.60\ \text{kg})\left(9.8\ \frac{\text{N}}{\text{kg}}\right)}{15\ \frac{\text{N}}{\text{m}}}$$

$$= \boxed{0.39\ \text{m}}$$

(b) $v_\mathrm{m} = wA = \sqrt{\dfrac{k}{m}}\,x = \sqrt{\dfrac{15\ \frac{\text{N}}{\text{m}}}{0.60\ \text{kg}}}(0.39\ \text{m}) = \boxed{2.0\ \text{m/s}}$

40.(a) Use Newton's second law to determine the spring constant of the cord. At equilibrium, $\Sigma F_y = 0 = kd - mg$.

So, $k = \dfrac{mg}{d}$, where $d = 0.20$ m.

Calculate the period.

$$T = \frac{2p}{w} = \frac{2p}{\sqrt{\frac{k}{m}}} = 2p\sqrt{\frac{m}{k}} = 2p\sqrt{\frac{m}{\frac{mg}{d}}} = 2p\sqrt{\frac{d}{g}} = 2p\sqrt{\frac{0.20\ \text{m}}{9.8\ \frac{\text{m}}{\text{s}^2}}} = \boxed{0.90\ \text{s}}$$

(b) $v_\mathrm{m} = wA = A\sqrt{\dfrac{k}{m}} = A\sqrt{\dfrac{mg}{dm}} = A\sqrt{\dfrac{g}{d}} = (0.080\ \text{m})\sqrt{\dfrac{9.8\ \frac{\text{m}}{\text{s}^2}}{0.20\ \text{m}}} = \boxed{0.56\ \text{m/s}}$