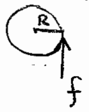
Serway + Vuille 8th Edition

Chapter 8 Homework

1. $R = 0.350\,m$

$f = ?$

$\tau = 76.0\,N \cdot m$



$\tau = Rf \therefore f = \tau / R = \frac{76.0\,N \cdot m}{0.350\,m}$

$f = 217\,N$

13. $m_1 = 5.0\,kg$ at $(0.0, 0.0)\,m$

$m_2 = 3.0\,kg$ at $(0.0, 4.0)\,m$

$m_3 = 4.0\,kg$ at $(3.0, 0.0)\,m$

$m_4 = 8.0\,kg$ at $(x_4, y_4)\,m$

C.G. located at $(0.0, 0.0)\,m$

$$x_{c.g.} = 0 = \frac{m_1 x_1 + m_2 x_2 + m_3 x_3 + m_4 x_4}{m_1 + m_2 + m_3 + m_4}$$

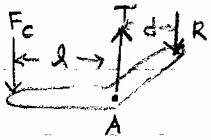
$$0 = \frac{0 + 0 + (4.0\,kg)(3.0\,m) + (8.0\,kg)\,x_4}{(20.0\,kg)}$$

$$\therefore x_4 = 12\,kg \cdot m / 8.0\,kg = -1.5\,m$$

$$y_{c.g} = 0 = \frac{0 + (3.0\,kg)(4.0\,m) + 0 + (8.0\,kg)\,y_4}{(20.0\,kg)}$$

$\therefore y_4 = -1.5\,m$ $\quad$ m_4 is located at $(-1.5, -1.5)\,m$

27.



$l = 7.50\,cm$

$d = 3.50\,cm$

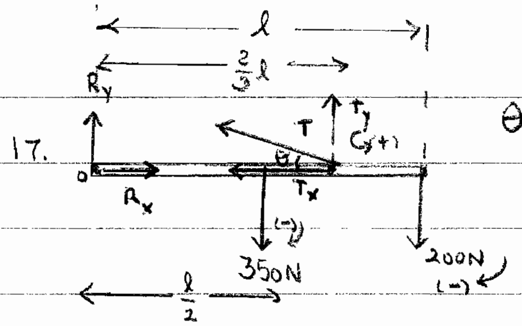
$F_c = 50.0\,N$

$\Sigma \tau_A = 0 = -Rd + F_c l$

$\therefore R = \frac{F_c l}{d}$

$$R = \frac{(50.0\,N)(7.50\,cm)}{(3.50\,cm)} = 107\,N$$

$\Sigma F_y = 0 = T - R - F_c \quad \therefore T = R + F_c = 107\,N + 50.0\,N = 157\,N$

17. 

$\theta = 12.0°$

Find T and R_x (compression force)

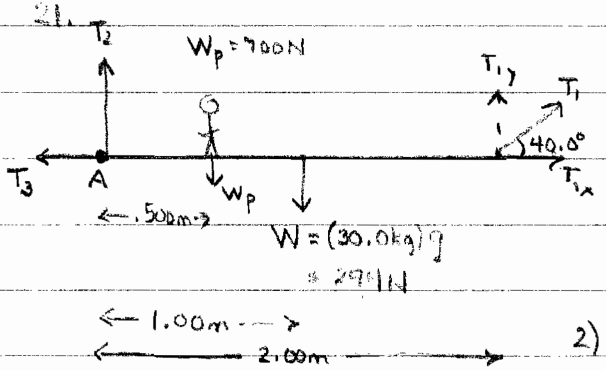
① $\Sigma F_x = R_x - T_x = 0 \quad \therefore R_x = T_x$

$R_x = T\cos 12.0° = .978\,T$

② $\Sigma \tau_0 = 0 = -200N(l) - (350N)\left(\frac{l}{2}\right) + (T\sin 12.0°)\left(\frac{2}{3}l\right)$

$375N = T(.139) \quad \therefore \quad T = 2.70 \times 10^3 N$ (sub. into ①)

$\therefore \quad R_x = (2.70\times 10^3 N)(.978) = 2.64 \times 10^3 N$

21. 

1) $\Sigma \tau_A = 0$

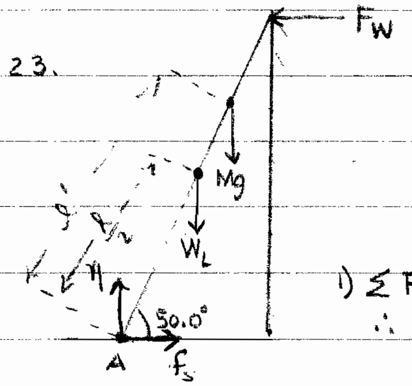
$0 = -(700N)(.500m) - (294N)(1.00m) + T_1\sin(40.0°)(2.00m)$

$\therefore T_1 = 501N$

2) $\Sigma F_x = 0 = T_{1x} - T_3 \quad \therefore T_3 = T_1\cos 40.0°$

$T_3 = (501N)(.766) = 384N$

3) $\Sigma F_y = 0 = T_{1y} + T_2 - 700N - 294N \quad \therefore \quad T_2 = 672N$

23. 

$l = 8.00m$

$\mu_s = 0.600$

$W_L = 200N$

$mg = 800N$

$\theta = 50.0°$

1) $\Sigma F_y = 0$

$\therefore n = W_L + M_g = 1000N$

2) $\Sigma F_x = 0 = f_s - F_W \quad \therefore f_s = F_W = \mu_s n$

$f_s = F_W = (.600)(1000N) = 600N$

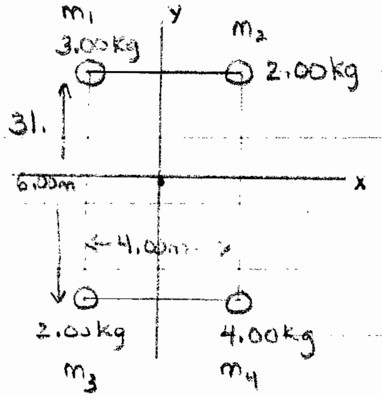
3) $\Sigma \tau_A = 0$

$0 = -W_L\left(\frac{l}{2}\cos 50.0°\right) - M_g(l'\cos 50.0°) + F_W(l\sin(50.0°))$

$0 = -200N(4.00m)(.643) - 800N(l')(.643) + (600N)(8.00m)(.766)$

$l' = 6.15m$ = distance person can climb ladder without the ladder slipping

31.



a) I about x axis:

$$I = m_1 r_1^2 + m_2 r_2^2 + m_3 r_3^2 + m_4 r_4^2$$

but $r_1 = r_2 = r_3 = r_4$

$$\therefore \quad I = (m_1 + m_2 + m_3 + m_4) r^2$$

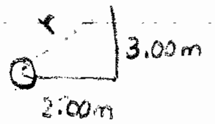
$$= (3.00 + 2.00 + 2.00 + 4.00)\,kg\,(3.00 m)^2$$

$$= 99.0\ kg \cdot m^2$$

b) I about y axis $\quad I = (\Sigma m) r^2 = (11.00 kg)(2.00 m)^2$

r = 2.00 m for all m's $\quad = 44.0\ kg \cdot m^2$

c)

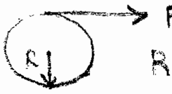


$$r^2 = (2.00 m)^2 + (3.00 m)^2 = 13.0 m^2$$

$$I = (\Sigma m)(r^2)$$

$$I = (11.00 kg)(13.0 m^2) = 143\ kg \cdot m^2$$

39.



R = 1.50 m $\quad \Delta T = 2.00 s$

M = 150 kg $\quad f_f = 0.500$ rev/s

$\omega_o = 0 \quad \omega_f = .500 \frac{rev}{s}\left(\frac{2\pi\, rad}{rev}\right) = \pi\ rad/s = 3.14\ rad/s$

$$I_{disk} = \frac{1}{2} M R^2 = \frac{1}{2}(150 kg)(1.50 m)^2 = 169\ kg \cdot m^2$$

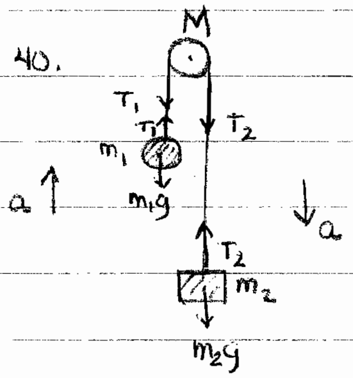
$$\alpha = \frac{\omega_f - \omega_o}{\Delta t} = \frac{3.14\ rad/s - 0}{2.00 s} = 1.57\ rad/s^2$$

$$\therefore \quad \tau = I\alpha = FR$$

$$F = \frac{I\alpha}{R}$$

$$F = \frac{(169\ kg \cdot m^2)(1.57\ rad/s^2)}{(1.50\ m)} = 177 N$$

40.



$m_1 = 10.0\ \text{kg}$

$m_2 = 20.0\ \text{kg}$

pulley (cylinder) $M = 8.00\ \text{kg}$

$r = 0.200\ \text{m}$

a) $m_2 > m_1$

T_2 must be greater than T_1 to provide a net torque on the pulley and produce the α of the pulley.

b) $a = ?$

For m_1: $\Sigma F = m_1 a \quad \therefore \quad T_1 - m_1 g = m_1 a$ ①

For m_2: $\Sigma F = m_2 a \quad \therefore \quad m_2 g - T_2 = m_2 a$ ②

For M: $\Sigma \tau = I\alpha$

$$r T_2 - r T_1 = \left(\tfrac{1}{2} M r^2\right)\left(\frac{a}{r}\right) \quad \therefore \quad \cancel{r}\left[T_2 - T_1\right] = \tfrac{1}{2} M \cancel{r} a \quad ③$$

Substitute ① + ② for T's into ③ ⇒

$$m_2(g-a) - m_1(g+a) = \tfrac{1}{2} M a$$

$$m_2 g - m_2 a - m_1 g - m_1 a = \tfrac{1}{2} M a$$

$$(m_2 - m_1) g = \left[\tfrac{1}{2} M + m_1 + m_2\right] a$$

$$(20.0\ \text{kg} - 10.0\ \text{kg})(9.80\ \text{m/s}^2) = \left[4.00\ \text{kg} + 10.0\ \text{kg} + 20.0\ \text{kg}\right] a$$

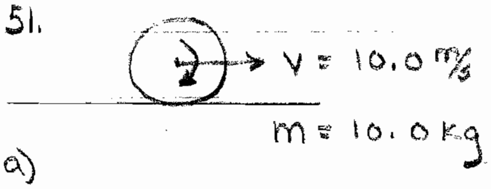
$$\therefore \quad a = 2.88\ \text{m/s}^2$$

c) Substitute value of "a" into ① + ② to find T's:

$$T_1 = m_1 [a + g] = 10.0\ \text{kg}\,[2.88 + 9.80]\ \text{m/s}^2 = 127\ \text{N}$$

$$T_2 = m_2 [g - a] = (20.0\ \text{kg})\,[9.80 - 2.88]\ \text{m/s}^2 = 138\ \text{N}$$

51.



cylinder $\therefore I_c = \frac{1}{2} m R^2$

a)

$$KE_{translational} = \frac{1}{2} m v^2$$

$$= \frac{1}{2}(10.0\,\text{kg})(10.0\,\text{m/s})^2$$

$$= 500\,\text{J}$$

b)

$$KE_{rotational} = \frac{1}{2} I \omega^2$$

$$= \frac{1}{2}\left[\frac{1}{2} m R^2\right]\left[\frac{v}{R}\right]^2$$

$$= \frac{1}{4} m v^2$$

$$= \frac{1}{4}(10.0\,\text{kg})(10.0\,\text{m/s})^2$$

$$= 250\,\text{J}$$

c)

$$KE_{total} = KE_{translational} + KE_{rotational}$$

$$= 500\,\text{J} + 250\,\text{J}$$

$$= 750\,\text{J}$$

62.

$m_1 = m_2 = 3.0\,kg = m$

$r_1 = r_2 = 1.0\,m = r$

$\omega_{1_0} = \omega_{2_0} = .75\,rad/s$

$I_{student\ \&\ stool} = 3.0\,kg \cdot m^2 = constant$

$r_{1_f} = r_{2_f} = 0.30\,m$

a) Conservation of $\vec{L}$:

$L_0 = L_f$

$I_0 \omega_0 = I_f \omega_f$

$(2mr^2 + 3.0\,kg \cdot m^2)(.75\,rad/s) =$

$(2mr_f^2 + 3.0\,kg \cdot m^2)\,\omega_f$

$[2(3.0\,kg)(1.0\,m)^2 + 3\,kg\,m^2](.75\,rad/s)$

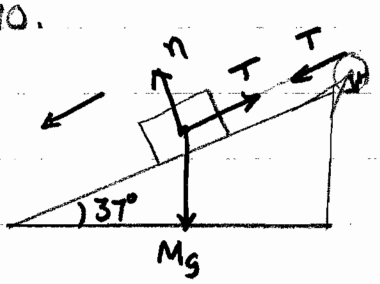
$= (2(3.0\,kg)(.30\,m)^2 + 3)\,\omega_f$

$\omega_f = 1.9\,rad/s$

b) $KE_0 = \frac{1}{2} I_0 \omega_0^2 = \frac{1}{2}(9.0\,kg \cdot m^2)(.75\,rad/s)^2 = 2.5\,J$

$KE_f = \frac{1}{2} I_f \omega_f^2 = \frac{1}{2}(3.5\,kg \cdot m^2)(1.9\,rad/s)^2 = 6.3\,J$

70.



$M = 12.0\,kg$

$r = 10.0\,cm = .100\,m$

$a = 2.00\,m/s^2$

frictionless incline

$\omega_0 = 0$

$\omega_f = ?$

$\Delta t = 2.00\,s$

a) $\Sigma F = ma$

① $Mg\sin 37° - T = Ma$

$(12.0\,kg)(9.8\,m/s^2)(.6) - T = (12.0\,kg)(2\,m/s^2)$

$70.77 - T = 24$

$T = 46.8\,N$

b) For wheel:

$\tau = I\alpha = Tr$

$I\left(\frac{a}{r}\right) = Tr$

$I = \frac{Tr^2}{a} = \frac{(46.8\,N)(.100\,m)^2}{(2.00\,m/s^2)} = .234\,kg \cdot m^2$

c) $\alpha = \frac{a}{r} = \frac{2.00\,m/s^2}{.100\,m} = 20\,rad/s^2 \therefore \omega_f = \alpha t = (20\,rad/s^2)(2s)$

$= 40\,rad/s$