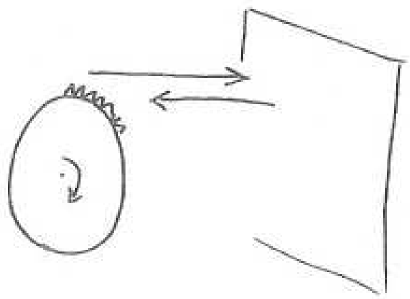
Ch. 10 29, 41, 55, 67, 78, 85

#29



The total distance light travels = 2x 500m = 1000m

the time for .. $= \frac{d}{V} = \frac{1000\,m}{3\times10^8\,m/sec} = 3.\dot{3}\times10^{-6}$ sec

within this time, the wheel must rotate 1 slot out of 500 slots/wheel → How many radian is this?

500 slots = 2π rad

1 slot = ?

1 slot = $\frac{2\pi\,rad}{500} = \underline{1.256637061\times10^{-2}\,rad}$

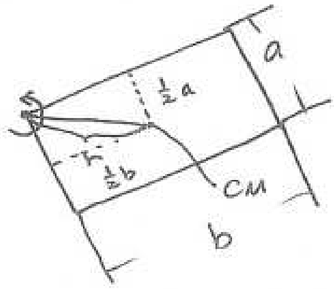
the wheel rotates 1.257×10^{-2} rad in $3.\dot{3}\times10^{-6}$ sec.

(a) $\omega = \frac{\theta}{t} = \frac{1.257\times10^{-2}\,rad}{3.\dot{3}\times10^{-6}\,sec} = \underline{\underline{3.769911184\times10^{3}\,rad/sec}}$

(b) $V = r\omega$

$= 0.05\times3.77\times10^{3} = \underline{\underline{188.4955592\,m/sec}}$

#41



$I = I_{CM} + I_{\text{Rectangle about its center}}$

$r = ((\frac{1}{2}a)^2 + (\frac{1}{2}b)^2)^{1/2}$

$= \frac{1}{2}(a^2+b^2)^{1/2}$

$I_{CM} = Mr^2 = M(\frac{1}{2}(a^2+b^2)^{1/2})^2$

$= \underline{\underline{\frac{1}{4}M(a^2+b^2)}}$

$I = \frac{1}{4}M(a^2+b^2) + \underbrace{\frac{1}{12}M(a^2+b^2)}$

$= \underline{\underline{\frac{1}{3}M(a^2+b^2)}}$

This has been proven elsewhere, and you should be able to prove w/o any difficulty.

\# 55

$M = 500\,g = 0.5\,kg$

$m = 460\,g = 0.46\,kg$

$R = 5\,cm = 0.05\,m$

$d = 75\,cm, \quad t = 5.00\,sec$

(a) $a = -\text{const.}$ ———— ①

$V = \int a \cdot dt = -at + \cancel{V_0}^{0}$ ———— ②

$y = \int v \cdot dt = -\frac{1}{2}at^2 + \cancel{y_0}^{0.75}$ ———— ③

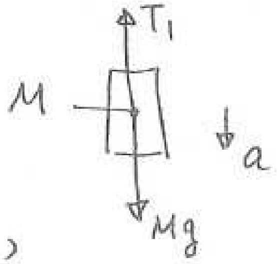
Eqn. ③ $t = 5$, $y = 0$, solve for a.

$0 = -\frac{1}{2}at^2 + 0.75$

$\frac{1}{2}at^2 = 0.75$

$a = \frac{0.75 \cdot 2}{5^2} = \underline{\underline{0.06\ m/sec^2}}$ (downward for M)

(b)

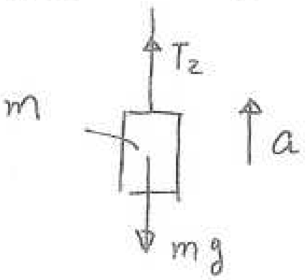


$-Mg + T_1 = -Ma$

$T_1 = Mg - Ma$

$= M(9.81 - 0.06) = \underline{\underline{4.875N}}$

(c)



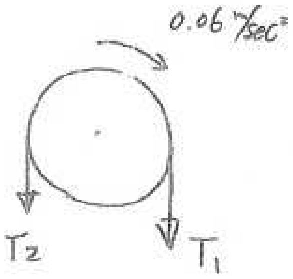
$T_2 - mg = ma$

$T_2 = mg + ma$

$= m(g + a) = 0.46\,(9.81 + 0.06) = \underline{\underline{4.5402N}}$

(d) $a = r\alpha \Rightarrow \alpha = \frac{a}{r} = \frac{0.06\ m/sec^2}{0.05} = \underline{\underline{1.2\ rad/sec^2 \text{ clockwise}}}$

(e)



$T_1 \rightarrow$ clockwise
$T_2 \rightarrow$ Counterclockwise

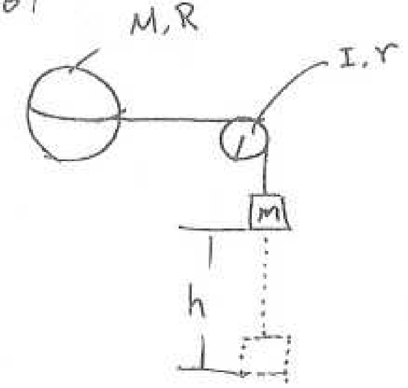
} they oppose each other

$$\tau = r \times F_{net} = I\alpha$$

$$I = \frac{r \times F_{net}}{\alpha} = \frac{0.05(T_1 - T_2)}{\alpha}$$

$$= \underline{\underline{0.01395\ kg\,m^2}}$$

#67



lost of PE of m is transfered to KE of m, RE of pulley & RE of the shell.

$$I_{shell} = \frac{2}{3} MR^2$$

$$V = r\omega \Rightarrow \omega = \frac{V}{r}$$

$$\Delta PE = KE + RE_{pully} + RE_{shell}$$

$$mgh = \frac{1}{2}mv^2 + \frac{1}{2} I_p \omega_p^2 + \frac{1}{2} I_{shell} \omega_{shell}^2$$

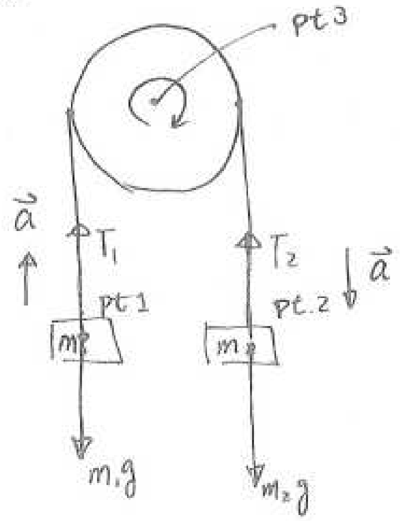
$$= \frac{1}{2}mV^2 + \frac{1}{2} I_p \frac{V^2}{r^2} + \frac{1}{2}\left(\frac{2}{3}MR^2\right)\cdot\left(\frac{V^2}{R^2}\right)$$

$$= \left(\frac{1}{2}m + \frac{1}{2}\frac{I_p}{r^2} + \frac{1}{3}M\right)V^2$$

$$V = \sqrt{\frac{mgh}{\frac{1}{2}m + \frac{1}{2}\frac{I_p}{r^2} + \frac{1}{3}M}} = \sqrt{\frac{mgh}{\frac{1}{6r^2}(3mr^2 + 3I_p + 12Mr^2)}}$$

$$= \sqrt{\frac{6r^2mgh}{3mr^2 + 3I_p + 12Mr^2}}$$

#78



Since $m_1 < m_2$, the pulley will rotate clockwise.

pt 1

$$T_1 - m_1 g = m_1 a \rightarrow T_1 = m_1 a + m_1 g \quad \text{——} \quad (1)$$

pt 2

$$T_2 - m_2 g = -m_2 a \rightarrow T_2 = m_2 g - m_2 a \quad \text{——} \quad (2)$$

pt 3

$$\tau = \vec{r} \times \vec{F} = I \cdot \alpha \quad \text{——} \quad (3)$$

$$\underset{\text{(clockwise)}}{RT_2} - \underset{\text{(counter clockwise)}}{RT_1} = I\alpha$$

$$R(m_2 g - m_2 a) - R(m_1 a + m_1 g) = I_{Disk}\alpha \quad \left(\begin{array}{l} I_{Disk} = \frac{1}{2} m_{Disk} R^2 \\ \alpha = \frac{a}{R} \end{array} \right)$$

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

$$m_2 g - m_2 a - m_1 a - m_1 g = \frac{1}{2} m_D a$$

$$m_2 g - m_1 g = m_2 a + m_1 a + \frac{1}{2} m_D a$$

(a) $$a = \frac{(m_2 - m_1) g}{(m_2 + m_1 + \frac{1}{2} m_D)} = \underline{\underline{1.5696 \text{ m/sec}^2}} \text{ ——— } ③'$$

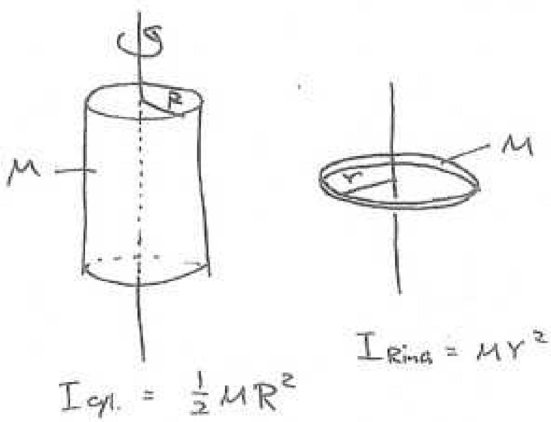
(b) ① ⟵ ③'

$$T_1 = m_1 a + m_1 g = \underline{\underline{4.55184 N}}$$

(C) ② ⟵ ③'

$$T_2 = m_2 g - m_2 a = \underline{\underline{4.94424 N}}$$

#85



(a) If

$$I_{cyl.} = I_{Ring}$$

$$\frac{1}{2} MR^2 = Mr^2$$

$$r^2 = \frac{1}{2} R^2$$

$$\underline{\underline{r = \frac{R}{\sqrt{2}}}}$$

(b) $$K = \sqrt{\frac{I}{M}}$$

$$(K)^2 = \left(\sqrt{\frac{I}{M}}\right)^2$$

$$K^2 = \frac{I}{M}$$

$$\underline{\underline{\therefore I = MK^2}}$$