10-5. a) $2\pi/\text{min} = \frac{2\pi}{\text{min}}\frac{\text{min}}{60s} = .105\ \text{rad}$

b) $2\pi/1\,\text{hour} = 2\pi/3600s = 1.74\times10^{-3}\ \text{rad}$

c) $2\pi/12\,\text{hr} = 1.45\times10^{-4}\ \text{rad}$

d) $\alpha = 0$

11) $3.5m = s = r\theta$

$3.5m = r\,(15\,\text{rev})\left(2\pi/\text{rev}\right)$

$r = .037m$ so $d = .074m$

17) $\alpha = 5t^2 - 3.5t$

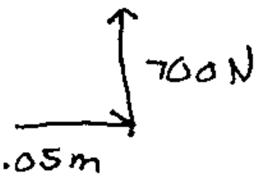
$\omega = \int \alpha\, dt = 5/3\,t^3 - \frac{3.5}{2}t^2$

$\theta = \int \omega\, dt = 5/12\,t^4 - \frac{3.5}{6}t^3$

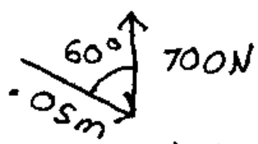
for $t = 2s$: $\omega = 40/3 - 7 = 19/3$ rad/s

$\theta = 20/3 - 14/3 = 2$

21)



$\tau = 35Nm$



$\tau = (.05m)(700N)\sin 60^0 = 30.3Nm$

10-27 $\omega = \alpha t \qquad \tau = I\alpha = \left(\frac{1}{2}mr^2\right)\alpha$

$$\frac{(1800)2\pi}{s} = \alpha(6s) \quad \text{so } \alpha = 47.7 \text{ rad}/s^2$$

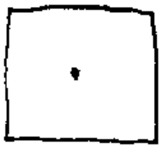
$$\tau = \tfrac{1}{2}(1.4\,\text{Kg})(.20\,\text{m})^2(47.7\,\text{rad}/s^2) = 1.34\,\text{Nm}$$

10-33. $\tau = \left(\frac{1}{2}mr^2\right)\alpha \qquad \omega = \alpha t$

$$3\,\text{rad}/s = \alpha(24s)$$

$$\tau = \tfrac{1}{2}(31000)(7m)^2(.125\,\text{rad}/s^2) \qquad \alpha = .125\,\text{rad}/s^2$$

$$\tau = 9500\,\text{Nm}$$

10-43)  $I_{zz} = I_{xx} + I_{yy} = \frac{1}{6}Ms^2$ (from chart)

For both a) and b) $I_{xx} = I_{yy}$ (symmetry)

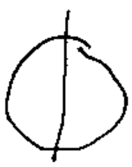
so $\frac{1}{6}Ms^2 = 2I_{xx}$ so $I_{xx} = \frac{1}{12}Ms^2$

10-47)  Parallel

$$I_{New} = I_{old} + M(.25R_0)^2$$

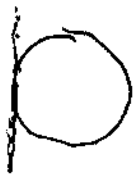
$$I_{New} = \tfrac{1}{2}MR_0^2 + M(.25R_0)^2$$

$$= .5625\,MR_0^2$$

b)  $\perp$ axis theorum

$$I_{zz} = \frac{MR_0^2}{2} = 2I_{xx}$$

so $I_{xx} = \dfrac{MR_0^2}{4}$

c)  Now parallel to B)

$$I_{New} = MR_0^2/4 + MR_0^2 = 5/4\,MR_0^2$$

10.55) L = conserved

$I_i(1.30\,\text{rev/s}) = I_f(.80\,\text{rev/s})$

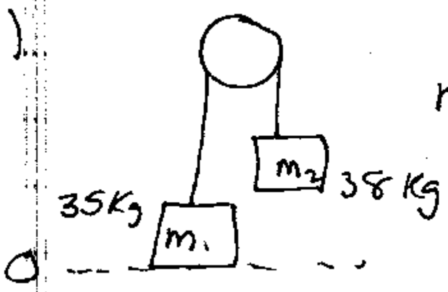
$\frac{I_f}{I_i} = \frac{1.30\,\text{rev/s}}{.80\,\text{rev/s}} = 1.625$

59) $(1950\,\text{Kg m}^2)(.80\,\text{rad/s}) = L \Rightarrow$ conserved

$\cancel{1950}\quad 1560\,\text{Kg m}^2/\text{s} = \left[(1950\,\text{Kg})\text{m}^2 + 4(65\,\text{kg})(2.4\,\text{m})^2\right]\omega_f$

$\omega_f = .45/\text{s}$; If they jump off, it goes back to .80 rad/s

65)



$m_2 g(2.5\text{m}) = m_1 g(25\text{m}) + \frac{1}{2}m_1 v^2 + \frac{1}{2}m_2 v^2 + \frac{1}{2}\left(\frac{1}{2}m_p r_p^2\right)\omega^2$

$\omega = v/r$

$932\,\text{J} = 858\,\text{J} + 17.5v^2 + 19v^2 + 1.2v^2$

$v = 1.4\,\text{m/s}$

75) Energy again

$mg(R_0 - r_0) = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$

$mg(R_0 - r_0) = \frac{1}{2}mv^2 + \frac{1}{2}\left(\frac{2}{5}mr^2\right)\frac{v^2}{r^2}$

$g(R - r_0) = \frac{7}{10}v^2$ so

$v = \sqrt{\frac{10}{7}g(R_0 - r_0)}$

Ch 11)

3. $a_{tan} = \alpha \times r$

(a)

Assume α out of paper

ω out of paper

$\vec{r}$ and $\vec{\alpha}$ are $\perp$ so

$|\alpha \times r| = \alpha r = \left(\frac{a}{r}\right) r = a$ ✓

direction by r.h.r.:

α out of paper, r to left so

a_{tan} is down.

(b) $\vec{\omega} \times \vec{v}$ produces

a_R toward center of circle ✓

$\omega \times v$ are $\perp$ so $|\omega \times v| = \frac{v}{r} v = v^2/r$

13) $\tau = \vec{r} \cdot \vec{F}$

Not zero

$(\cancel{r_y F_z} - F_y r_z)\hat{i} + (r_z F_x - \cancel{r_x F_z})\hat{j} + (\cancel{r_x F_y} - F_x r_y)\hat{k}$

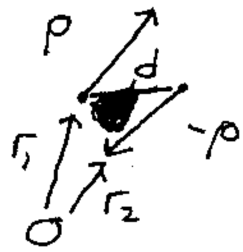
$r_z = 6\,m \quad r_y = 8\,m \quad r_x = 0$

$F_x = \pm 2.4\,KN \quad F_y = -3\,KN \quad F_z = 0$

$\tau = (-r_z F_y)\hat{i} - (F_x r_y)\hat{k} = 18\,KNm\,\hat{i} \mp 19\,KNm\,\hat{k}$

$\pm (r_z F_x)\hat{j} \quad \pm(14.4\,KNm)\hat{j}$ ✓

17)



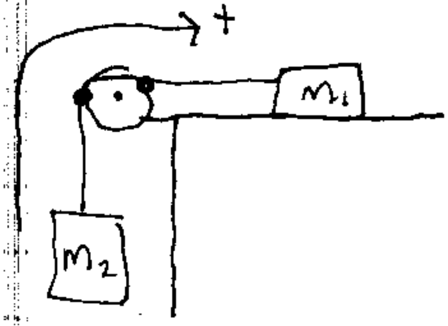
$r_2 - r_1 = d$ (displacement between)

$L = r_1 \times p + r_2 \times (-p)$

$= (r_1 - r_2) \times p$

$= -d \times p$ (ind. of origin)

11) 25



$$L = I\omega + R_0 m_1 V + R_0 m_2 V$$

Pulley   Masses   Masses

$$= I\frac{V}{R_0} + R_0 m_1 V + R_0 m_2 V$$

① $m_2 a = F_{T_2} - m_2 g$

② $m_1 a = -F_{T_1}$ ③ $I\alpha = R_0 F_1 - R_0 F_2$

$$\frac{Ia}{R_0^2} = F_1 - F_2$$

$$(m_1 + m_2)a = -\frac{Ia}{R_0^2} - m_2 g$$

$$a = \frac{-m_2 g}{(m_1 + m_2 + I/R_0^2)}$$

36) $L = I\omega + rp$ => conserved

initial $\omega = 0$ $r = .25m$!

$$L = rp = \left(\frac{.5m}{2}\right)(.003kg)(250m/s) = \frac{.375}{2} kgm^2/s$$

$$L_f = \left(\frac{.375}{2} kgm^2/s\right) = I\omega + \left(\frac{.5m}{2}\right)(.003kg)(160m/s)$$

$$I\omega = \frac{.135}{2} kgm^2/s = (1/12)M(1m)^2\omega$$

$$\omega = 2.7\ rad/s$$

11)38 L is conserved

$$L_i = (670\,kg\,m^2)(2\,rad/s)$$

$$L_f = \left((670\,kg\,m^2) + (55\,kg)(2.5\,m)^2\right)\omega_f$$

$$\omega_f = 1.32\,rad/s$$

$$E_B = \tfrac{1}{2} I \omega^2 = 1340\,J$$

$$E_A = \tfrac{1}{2}(I + I_p)\omega^2 = 880\,J$$

j 10.7 the turntable stoped in about 2.1 Rev and 2.5s

so $\omega_f^2 = \omega_0^2 + 2\alpha\Delta\theta$

$$0 = \omega_0^2 + 2\alpha(2.1)(2\pi)$$

$\omega_0 = \alpha t$ so $\alpha^2 t^2 + 2\alpha(2.1)(2\pi) = 0$

$$\alpha(2.5s)^2 = -2(2.1)(2\pi)$$

$\alpha = -4.22\,rad/s^2$ so $\tau = I\alpha = \tfrac{1}{2} m r^2 (\alpha)$

$$= \tfrac{1}{2}(5\,kg)(.3\,m)^2(4.22\,rad/s^2)$$

$$= .95\,N\,m$$

Energy) 10.12 java

$E_i = 0 \quad E_f = \frac{1}{2}m_1 V^2 + \frac{1}{2}m_2 V^2 + m_2 g(-8.6m)$
$+ \frac{1}{2}I\omega^2$

$\omega^2 = \frac{V^2}{R^2} \quad V_f = 5.125 m/s$

solve for I $\quad I = \frac{g(8.6m) - m_1 V^2 - m_2 V^2}{V^2/R^2}$

11-4) Slides $V_f = \sqrt{2gh}$

$V_{Ave} = \frac{\Delta r}{\Delta t} \qquad V_f = (V_{Ave}) * 2$

$\Delta r = \sqrt{\Delta x^2 + \Delta y^2} = \sqrt{(1.33m)^2 + (.665m)^2} = 1.5m$

$\Delta t = 1s \qquad$ so $V_{AVE} = 1.5 m/s \quad V_f = 3 m/s$

Slides $V_f = \sqrt{2g(.665m)} = 3.6 m/s$

so probably Rolling

$(1kg)(9.81 m/s^2)(.665m) = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$

$I = CmR^2$

$6.52J = 4.5J + \frac{C}{2}(1kg)(3m/s)^2$

$C \simeq .45$ (prob a cylinder)