Ch 12 18, 25, 27, 31, 35, 38

18. $\omega = \alpha t$ $1\,\frac{rev}{sec} = \alpha(20\,s)$ so $\alpha = 1\,rev/20\,s^2$

$= .05\,rev/s^2 = .314\,rad/s^2$

b) $\Delta\theta = \frac{1}{2}\alpha t^2$ $\Delta\theta = \frac{1}{2}\left(\frac{.05\,rev}{s^2}\right)(20\,s)^2 = 10\,rev$

c) $S = R\theta$ so $S = (.60\,m)(10\,rev)\left(\frac{2\pi\,rad}{rev}\right) = 37.7\,m$

25) $\bar{\alpha} = \frac{\Delta\omega}{\Delta t}$ $\omega_0 \sim \frac{365\,rot}{year}$ $\omega_f \sim \frac{365\,rot}{year + 1.1\,s}$

$\Delta t = 77$ years $1\,year = 3.1536 \times 10^7\,s$

$\Delta\omega = (365\,rot)\left(\frac{2\pi}{rot}\right)\left(\frac{1}{31536001.1} - \frac{1}{31536000}\right)$

$= 2.54 \times 10^{-12}\,rad/s$

$\frac{\Delta\omega}{\Delta t} = \alpha = \frac{2.54 \times 10^{-12}\,rad/s}{77(31536000)} \simeq 1.0 \times 10^{-21}\,rad/s^2$

27 $\omega = \int \alpha\,dt = \int ct^2\,dt = \frac{c}{3}t^3 + \omega_0$

so at $t = 3s$ $\omega = \left(\frac{.25\,rad}{\frac{s^4}{3}}\right)(3s)^3 + 8\,\frac{rad}{s} = 10.25\,rad/s$

27 cont $\Delta\phi = \int \omega \, dt = \int \left(\frac{c}{3}t^3 + \omega_0\right) dt =$

$\Delta\phi = \omega_0 t + \frac{c}{12} t^4$ at 1s $\Delta\phi = \omega_0 + \frac{c}{12}$

$= 8\,\text{rad/s} + \frac{.25}{12} = 8.02\,\text{rad}$

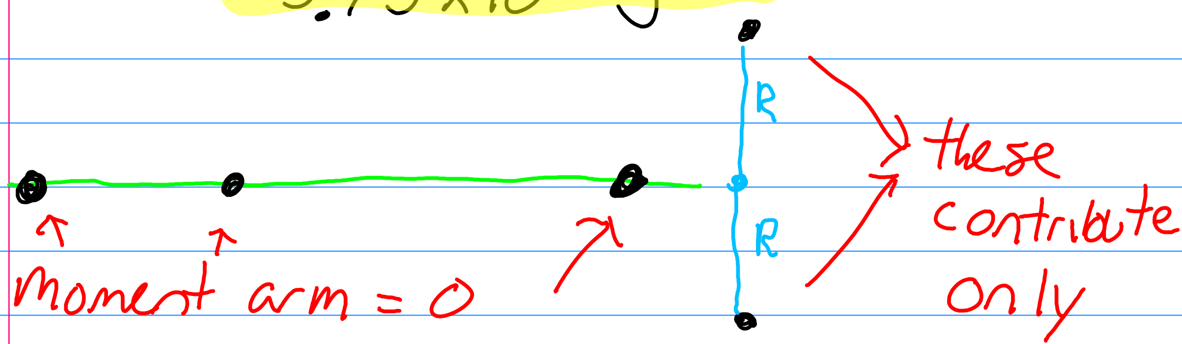
31. $K = \frac{1}{2} I \omega^2 = \frac{1}{2} M R^2 \omega^2$

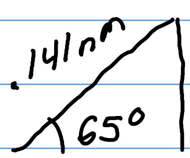
$\omega = .05 \frac{\text{rev}}{\text{min}} \left(\frac{2\pi}{\text{rev}}\right)\left(\frac{1\,\text{min}}{60\,\text{s}}\right) = 5.23 \times 10^{-3}\,\text{rad/s}$

$K = \frac{1}{2}(1.9 \times 10^6\,\text{kg})(38\,\text{m})^2 (5.23 \times 10^{-3}\,\text{rad/s})^2$

$= 3.75 \times 10^4\,\text{J}$

35.





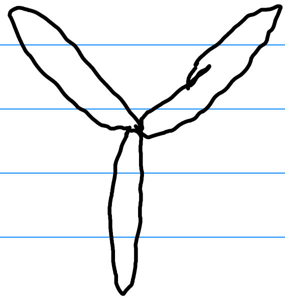
$R = (.141\,\text{nm}) \sin 65^\circ = .128\,\text{nm}$

So $I = 2I_0 = 2\left(M_0 (.128 \times 10^{-9}\,\text{m})^2\right)$

$= 2(16)(1.66 \times 10^{-27}\,\text{kg})(.128 \times 10^{-9}\,\text{m})^2$

$= 8.7 \times 10^{-46}\,\text{kg m}^2$!!

Answer in book is wrong..

38. 

$$I = 3\left(\tfrac{1}{3} M l^2\right)$$

$$K = \tfrac{1}{2} I \omega^2$$

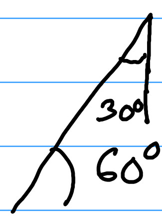
$$\omega = \frac{2500\,\text{rev}}{\text{min}}\left(\frac{2\pi}{\text{rev}}\right)\left(\frac{1\,\text{min}}{60\,\text{s}}\right) = 262\ \text{rad/s}$$

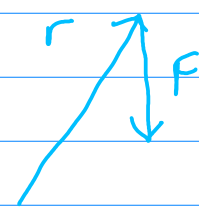
$$K = \tfrac{1}{2}(6\,\text{kg})(1.2\,\text{m})^2(262\ \text{rad/s})^2$$

$$= 3.0 \times 10^5\ \text{J}$$

Ch 13 - 4, 10, 14, 33, 61, 63, 68

4 $\tau = rF\sin\theta$





$$\tau = (2\,\text{m})(2\,\text{kg})(9.8\,\text{m/s}^2)\sin 30^\circ$$

$$= 19.6\ \text{Nm}$$

10. $P = \vec{\tau} \cdot \vec{\omega}$

$$\tau = rF = (.18\,\text{m})(35\,\text{N}) = 6.3\,\text{Nm}$$

$$\omega = 60\ \text{rev/min}\left(\frac{2\pi}{\text{rev}}\right)\left(\frac{1}{60\,\text{s}}\right)$$

$$= 6.28\ \text{rad/s}$$

two feet

so $P = (6.3\,\text{Nm})(6.28\ \text{rad/s}) = 39.6\,\text{W} \times 2$

$$= 39.6\ \text{J/s}\left(\frac{1\,\text{kC}}{4186\,\text{J}}\right)\left(\frac{60\,\text{s}}{\text{min}}\right) = .567\ \text{kC/min} \times 2$$

14

.381 L

$mg = \frac{(.125M)}{2} g$ $\quad \tau = RF$

only 1 arm

$\tau = \left(\frac{.381L}{2}\right)\left(\frac{.125M}{2}\right)(9.8\,m/s^2)$

$\tau = .12ML$

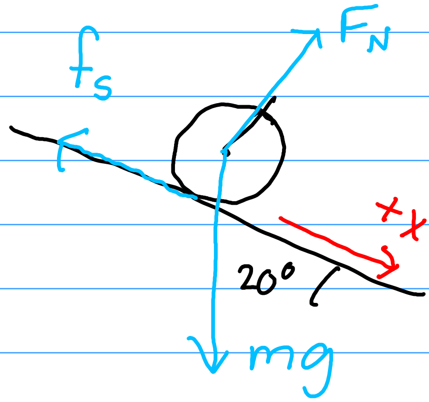
if $M \sim 70\,kg$ $\quad L = 1.8\,m$ then $\tau = 15\,Nm$

Legs .503 ℓ

$mg = \frac{.345Mg}{2}$ $\quad \tau = \left(\frac{.503L}{2}\right)\left(\frac{.345M}{2}\right)(9.8)$

$= .42ML \simeq 53\,Nm$

33



$I = \frac{2}{5}MR^2 \quad a = R\alpha$

x: ① $Ma = mg\sin 20° - \mu_s F_N$

y: ② $0N = F_N - mg\cos 20°$

③ $I\alpha = \mu_s F_N R$

① $ma = mg\sin\theta - \frac{Ia}{R^2}$ so $a = \frac{g\sin\theta}{1 + 2/5}$

$a = (g \sin\theta)\, 5/7$ g is unknown

$\Delta x = \frac{1}{2} a t^2$ so $a = \frac{2\Delta x}{t^2}$

$\frac{2\Delta x}{t^2} = \frac{5}{7} g \sin\theta$ so $g = \frac{14}{5} \frac{\Delta x}{t^2 \sin\theta}$

$\Delta x = 3\,m$ $t = 1.6\,s$ $\theta = 20^\circ$

$g = 9.6\,m/s^2$

61. L is conserved

$I_{MG}\,\omega_0 = I_{MG}\,\omega + I_c\,\omega$

$I_{MG} = \frac{1}{2} M_{MG} R_{MG}^2$

$I_c = M_c R_c^2$

$\frac{1}{2}(20\,kg)(1.5\,m)^2 \left(2\,\frac{rad}{s}\right)$

$= \left(\frac{1}{2}(20\,kg)(1.5\,m)^2 + (25\,kg)(1.5\,m)^2\right)\omega$

$\omega = .57\,rad/s$

b) Child kicks ground so now $\omega = 2\,rad/s$

No contrib. from child

$\left(\frac{1}{2}(20\,kg)(1.5\,m)^2 + (25(1.5\,m)^2\right)(2\,rad/s)$

$= \left(\frac{1}{2}(20\,kg)(1.5\,m)^2\right)\omega'$

$\omega' = 7\,rad/s$

63 L is conserved

$$\left(\left(6\,kg\,m^2\right)+(10\,kg)(2)(1\,m)^2\right)\left(.5\,\frac{rev}{s}\right)$$

I ↗

$$=\left(\left(4\,kg\,m^2\right)+(10\,kg)(2)(.10\,m)^2\right)\omega'$$

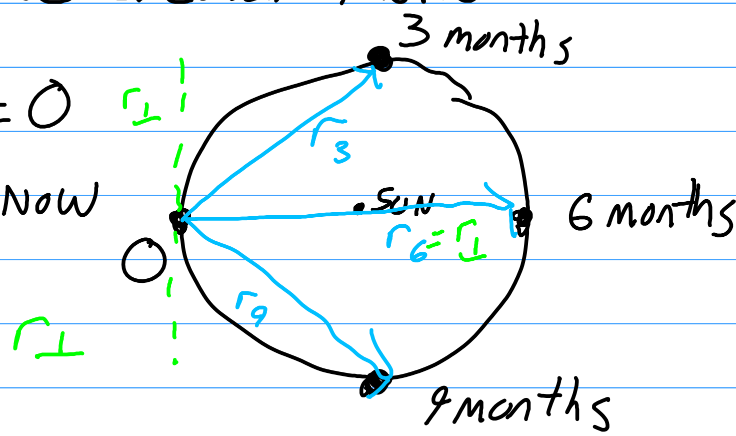
I' ↗

$\omega' = 3.1\ rev/s$

68

Assume circular Motion

Now $L=0$ because Now $r=0$



v is about the same

r is different!

$r_E = 1.5\times10^{11}\,m$

$$L=\vec{r}\times\vec{p} = \vec{r}\times m\vec{v} = r_\perp m v =$$

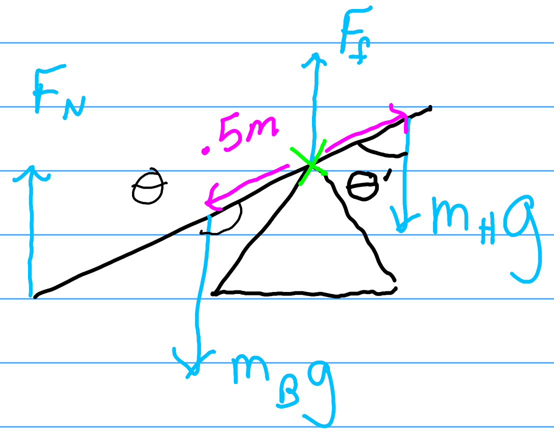
so $v \sim$ const but r is changing $\quad L_6 = 2 * L_3$

$$L = r\left(5.98\times10^{24}\,kg\right)\left(3\times10^4\,m/s\right)$$

$$L_3 = L_9 = \left(1.5\times10^{11}\,m\right)\left(5.98\times10^{24}\,kg\right)\left(3\times10^4\,m/s\right) = 2.7\times10^{40}\,\frac{kg\,m^2}{s}$$

Ch 14 10, 18, 22

10)



When Rotation begins

$F_N = 0$

$\tau = 0$

so $0 = (.5m)(m_B g)\sin\theta - R(m_H g)\sin\theta'$

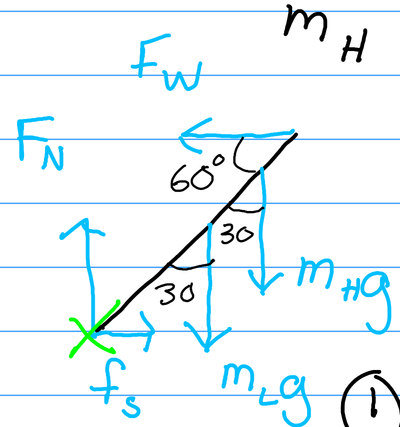
$\sin\theta = \sin\theta'$ because $\theta + \theta' = 180°$

so

$0 = (.5m)m_B - R\,m_H$

$R = (.5m)\dfrac{m_B}{m_H} = .3125\text{ m}$

18)



When static friction hits maximum Ladder Begins to slip

$\Sigma F = 0$

① x: $0 = f_s - F_W = \mu_s F_N - F_W$

② y: $0 = F_N - m_L g - m_H g$

① $F_W = (.35)(m_L g + m_H g) = 240\text{ N}$

② $F_N = (m_L g + m_H g) = 687\text{ N}$

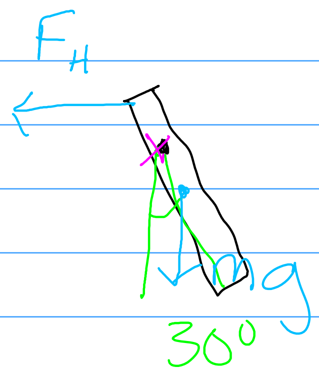
$\Longrightarrow$

$\tau = 0 = (240\,N)(5m)\sin 60^\circ - (98\,N)(2.5m)\sin 30^\circ$

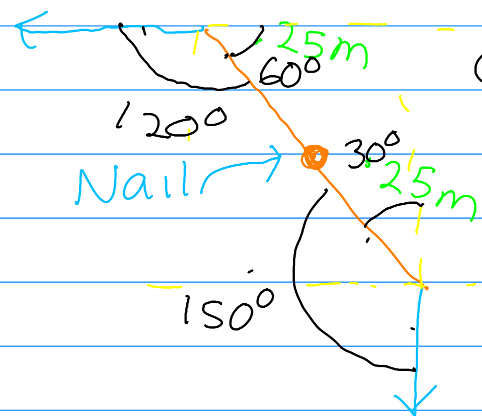
$- (589\,N) R_H \sin 30^\circ$

$R = 3.1\,m$

22)



Torque at fixed axis of Nail is 0



$0 = (.25 F_H)\sin 120^\circ$

$- (.25\,mg)\sin 150^\circ$

$F_H = mg \frac{\sin 150}{\sin 120}$

$F_H = 2.26\,N$