Ang. Disp.: $\theta = \frac{s}{r}$

Ang. Speed: $\omega = 2\pi f = \frac{\theta}{t} = \frac{s}{rt} = \frac{2\pi}{T}$

Ang. Acc.: $\alpha = \omega^2 r = \frac{v^2}{r} = \omega v$

linear speed: $v = \omega r$

linear acc.: $a = \alpha r$

Ang. Kinematics

$$\omega_f^2 = \omega_i^2 + 2\alpha\theta$$

$$\omega_f = \omega_i + \alpha t$$

$$\theta = \omega_i t + \frac{1}{2}\alpha t^2$$

$$\theta = \frac{(\omega_f + \omega_i)\, t}{2}$$

Torque

$$\tau = F r \sin\theta$$

$$\tau = I \alpha$$

Moment of Inertia

Hoop $I = mr^2$

Thin rod $I = \frac{1}{12}mr^2$

Sphere $I = \frac{2}{5}mr^2$

Board $I = m\left(\frac{l^2+h^2}{12}\right)$

Disk $I = \frac{1}{2}mr^2$

Donut $I = \frac{1}{2}m(a^2+b^2)$

1. a. $\tau = ?$ $I = 0.85\,kg\,m^2$ $\omega_i = 0\frac{rad}{s}$ $\omega_f = 9.4\frac{rad}{s}$
$t = 6.0s$

$\tau = I\alpha$

$\omega_f = \omega_i + \alpha t$

$\frac{\omega_f - \omega_i}{t} = \alpha$

$\alpha = \frac{9.4 - 0}{6}$

$\alpha = 1.56\frac{rad}{s^2}$

$\tau = (0.85\,kg\,m^2)(1.56\frac{rad}{s^2})$

$\boxed{\tau = 1.3\,Nm}$

1.b. $r = .25m$ $\omega_i = 9.4 \frac{rad}{s}$ $\omega_f = 0 \frac{rad}{s}$ $\theta = 4 rev \Rightarrow 8\pi$

$F = ma$ $\quad I = \frac{1}{2} m r^2$

$$m = \frac{2I}{r^2} = \frac{2(.85)}{(.25)^2} = 27.2\ kg$$

$F = (27.2kg)(0.44 m/s^2)$

$\omega_f^2 = \omega_i^2 + 2\alpha\theta$

$F = 11.95N \Rightarrow$ **10N**

$$\frac{\omega_f^2 - \omega_i^2}{2\theta} = \alpha = \frac{9.4^2 - 0^2}{2(8\pi)} = 1.76 \frac{rad}{s^2}$$

$a = \alpha r = 1.76(.25) = 0.44 \frac{m}{s^2}$

2. $f_1 = \frac{100\,rev}{3\,min} \cdot \frac{1\,min}{60s} = \frac{5}{9}\frac{rev}{s}$ $\quad \omega_1 = \frac{10\pi}{9}\frac{rad}{s}$

$f_2 = 45\frac{rev}{min} \cdot \frac{1\,min}{60s} = \frac{3}{4}\frac{rev}{s}$ $\quad \omega_2 = \frac{3\pi}{2}\frac{rad}{s}$

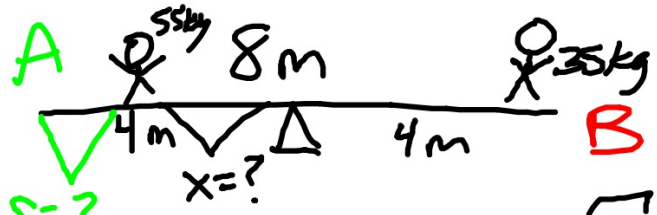
$t = 2.5s$ $\omega = 2\pi f$

$$\theta = \frac{(\omega_1 + \omega_2)\,t}{2}$$

$$\theta = \frac{\left(\frac{10\pi}{9} + \frac{3\pi}{2}\right) 2.5s}{2} = 10.25\,rad$$

$\approx 10\,rad.$

3.



$S = 4 - x$

$\Gamma_A = \Gamma_B$

$\Gamma_A = (55kg)(g)(x\,m)$

$\Gamma_B = (35kg)(g)(4m)$

$55gx = 35g(4)$

$55x = 35(4)$

$x = 2.54\,m$

$4\,m - 2.54\,m = 1.45\,m \Rightarrow \boxed{1m}$

4. a. $m = 5.0\,kg$ $\Gamma = 18\,Nm$ $r = .15\,m$

$\Gamma = I\alpha$ $I = \frac{2}{5}mr^2$

$\alpha = ?$ $\frac{\Gamma}{\frac{2}{5}Mr^2} = \alpha$

$\frac{18}{\frac{2}{5}(5)(.15)^2} = \alpha = 4.0(10^2)\,\frac{rad}{s^2}$

4b.

$\alpha_{.15} = 400$

$a = \alpha r$

$a_{.15} = (400)(.15)$

$a_{.15} = 60\ m/s^2$

$-36\ m/s^2$

$\boxed{24\ m/s^2}$

$\frac{\Gamma}{\frac{2}{5} m r^2} = \alpha$

$\frac{18}{\frac{2}{5}(5.0)(.25)^2} = 144$

$a_{.15} = \alpha r$

$a = (144)(.25)$

$a_{.25} = 36\ m/s^2$

5a. $s = 25m$ $\alpha = .75 \frac{rad}{s^2}$ $\omega_0 = 0 \frac{rad}{s}$

$r = .80m$ $v = \omega r = 0 \frac{m}{s}$

$m = 50kg$ $a = \alpha r = (.75)(.8) = .6 \frac{m}{s^2}$

$$v^2 = v_0^2 + 2as$$

$$v = \sqrt{v_0^2 + 2as}$$

$$v = \sqrt{0^2 + 2(.6)(25)}$$

$$v = 5.477 \Rightarrow 5 \, m/s$$

5b. $\tau = ?$ $\quad r = .80\,m$ $\quad m = 50\,kg$ $\quad \alpha = .75\,\frac{rad}{s^2}$

$$I = \frac{1}{2}mr^2$$

$$\tau = I\alpha$$

$$\tau = \frac{1}{2}mr^2\alpha$$

$$\tau = \frac{1}{2}(50)(.8)^2(.75)$$

$$\tau = 12\,Nm \Rightarrow \boxed{10\,Nm}$$

6.

FBD

$F_H = W_a + \frac{1}{2}W_b$

$= 65(9.8) + \frac{1}{2}(15)(9.8)$

$F_H = 46915.09875$

$\boxed{F_H = 47000\ N}$

$\sum_{bH} = \sum_{bB}$

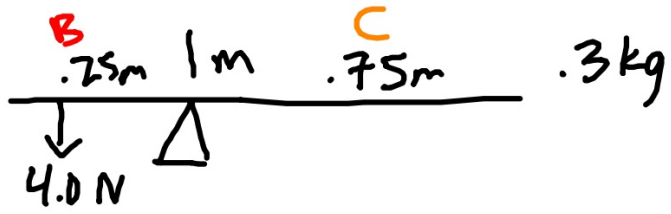
$F_{bH}\, r_{bH} = F_{bB}\, r_{bB}$

$F_{bH} = F_{bB}$

$F_{bH} = \frac{1}{2}W_b$

$\frac{11m}{2} = r_{bH} = r_{bB}$

7.



$$\Gamma_A + \Gamma_B = \Gamma_C$$

$$(4.0\,N)(x\,m) + (.3kg)\left(\frac{25}{100}\right)\left(\frac{.25\,m}{2}\right)\left(9.81\,m/s^2\right) = \left(.3\right)\left(\frac{75}{100}\right)\left(\frac{.75\,m}{2}\right)\left(9.81\,m/s^2\right)$$

$$4x + .09197 = .8277$$

$$4x = .73575$$

$$x = .184 \Rightarrow \boxed{18\,cm}$$

8. 

$\Gamma = \Gamma_{mass} + \Gamma_{pole}$

$\Gamma = (25kg)(9.81 m/s^2)(5m)(\sin 45) +$

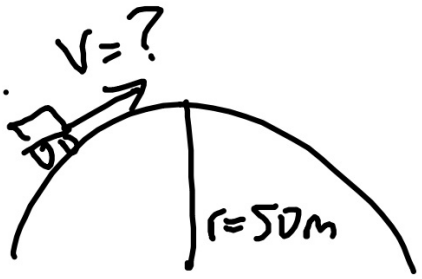
$(15kg)(9.81 m/s^2)(\frac{5}{2} m)(\sin 45)$

$\Gamma = F r \sin\theta$

$= ma r \sin\theta$

$\Gamma = 1127 \ Nm$

$\boxed{\Gamma = 1100 \ Nm}$

9. 

FBD 

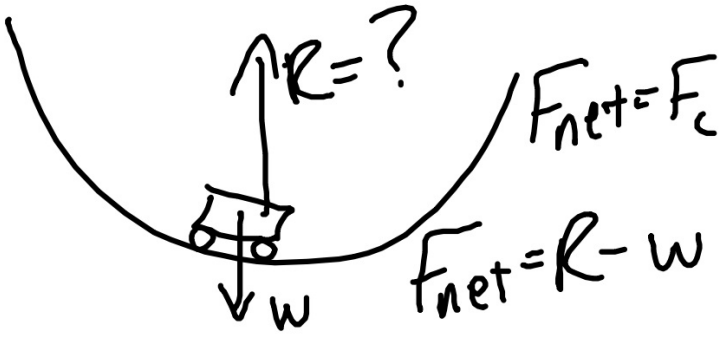
$$mg = \frac{mv^2}{r}$$

$$v = \sqrt{rg}$$

$$v = 22.147$$

$$\boxed{v = 22\ m/s}$$

10. $v = 22.147\ m/s$



$F_{net} = F_c$

$F_{net} = R - w$

$\frac{mv^2}{r} + mg = R$

$R = \frac{350(22)^2}{50} + 350(9.81)$

$R = 68670$

$\boxed{R = 69000\ N}$