PHYS 201 Help Session on Equilibrium and Statics 11/14/19, 11-12, Sims 209.

1. Before coming, please watch the attached video and be ready to talk about what you learned from the video. https://www.youtube.com/watch?v=0BIgFKVnlBU

2. A gymnast with mass 46.0 kg stands on the end of a uniform balance beam as shown below. The beam is 4.60 m long and has a mass of 260 kg (excluding the mass of the two supports). Each support is 0.500 m from its end of the beam. Assume that the forces on the beam due to support 1 and support 2 are vertical.

a. Draw a free-body diagram for the beam.
b. Write down a force equation by balancing the forces vertically.
c. Write down a torque equation by balancing the torques.
d. Calculate the forces on the beam due to (a) support 1 and (b) support 2?

$X_1 = 1211\ N$
$X_2 = 1788\ N$

$X_1 + X_2 = 255 + 451 = 3000\ N$

$\Sigma\tau = 0$ about 1

$X_2 \times 3.6 = 255 \times 1.8 + 451 \times 4.1$

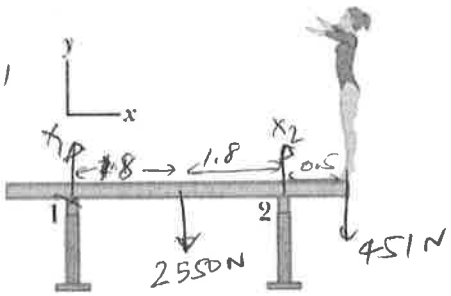
$3.6 X_2 = 6439.1$

$X_2 = 1788\ N$

$X_1 = 3000 - 1788$

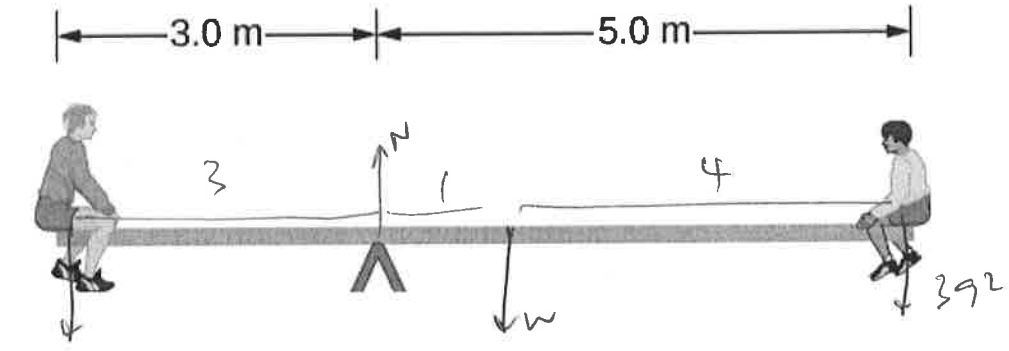
$X_1 = 1211\ N$

$X_1 = 1211\ N,\ X_2 = 1788\ N$



3. The uniform seesaw shown below is balanced on a fulcrum located 3.0 m from the left end. The smaller boy on the right has a mass of 40 kg and the bigger boy on the left has a mass 80 kg.

a. What is the mass of the board? b. What is the normal force by the fulcrum?



$W \times 1 + 392 \times 5 = 784 \times 3$

$W = 392\ N \rightarrow M = 40\ kg$

$N = 784 + W + 392 = 1568\ N$

PHYS 201 Help Session on Rotational Dynamics 11/18/19, 2-3 pm, Sims 207.

1. Before coming, please watch the attached video and be ready to talk about what you learned from the video. https://www.youtube.com/watch?v=jb93dUFCUBE

$\downarrow \Sigma F = ma$, m, $mg - T = ma$ — (1)

$\curvearrowleft \tau = I\alpha$, M, $T \times R = I\alpha$, $a = R\alpha$

$T \times R = \frac{1}{2} MR^2 \times \frac{a}{R}$

$T \times R = \frac{MRa}{2}$ — (2)

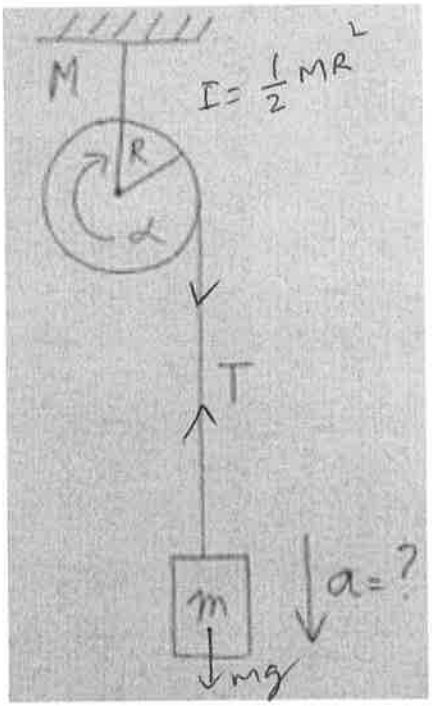
$T = \frac{Ma}{2}$ — (2)

$mg - T = ma$

$mg - \frac{Ma}{2} = ma$

$mg = a\left(m + \frac{M}{2}\right)$

$a = \frac{mg}{m + (M/2)}$



3. Three forces are applied to a solid cylinder of mass 15 kg (see the drawing). The magnitudes of the forces are $F_1 = 16$ N, $F_2 = 25$ N, and $F_3 = 17$ N. The radial distances are $R_2 = 0.25$ m and $R_3 = 0.12$ m. The forces $\mathbf{F}_2$ and $\mathbf{F}_3$ are perpendicular to the radial lines labeled R_2 and R_3.
a. Find the magnitude of the angular acceleration of the cylinder about the axis of rotation.
b. If the cylinder is at rest initially, how long will it take the cylinder to rotate 3 revolutions?

(a) $\Sigma \tau = I\alpha$, $I = \frac{1}{2} MR^2 =$

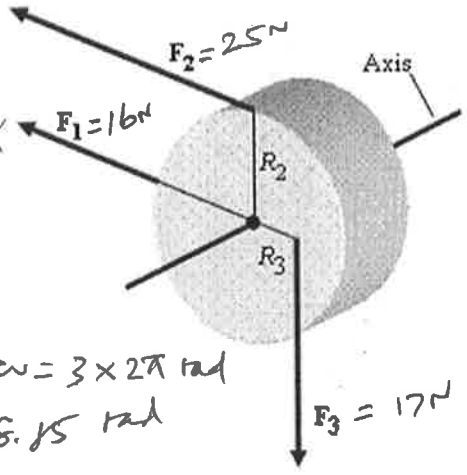
$F_1 \times 0 + F_2 \times 0.25 + F_3 \times 0.12 = \frac{1}{2} \times 15 \times 0.25^2$

(ccw) (cw)

$0 + 25 \times 0.25 - 17 \times 0.12 = (0.47 \text{ kg.m})\alpha$

$6.25 - 2.04 = 0.47\alpha$

$8.96 \text{ rad/s}^2 = \alpha$



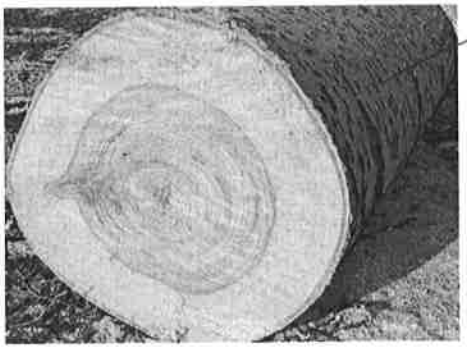
(b) $\omega_0 = 0$, $\alpha = 8.96 \text{ rad/s}^2$, $\theta = 3 \text{ rev} = 3 \times 2\pi \text{ rad}$

$= 18.85 \text{ rad}$

$t = ?$

$\theta = \omega_0 t + \frac{1}{2}\alpha t^2$

$18.85 = 0 + \frac{1}{2} \times 8.96 \times t^2 \rightarrow$ **$t = 2.05$ sec**



Cylinder ≈ Disk

$I = \frac{1}{2}mr^2 = \frac{1}{2} \times 170 \times 0.25^2 = 5.31\ kg.m^2$

$\tau = I\alpha = 5.31 \times 15 = F \times LA$

$= F \times 0.25$

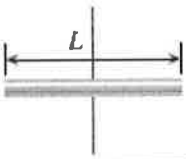
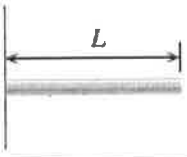
$318.75\ N = F$

4. A tree stump (cylindrical in shape, mass of 170 kg and diameter of 50 cm) needs to be moved by rotating it. Assume that the force is exerted parallel to the cylindrical surface.

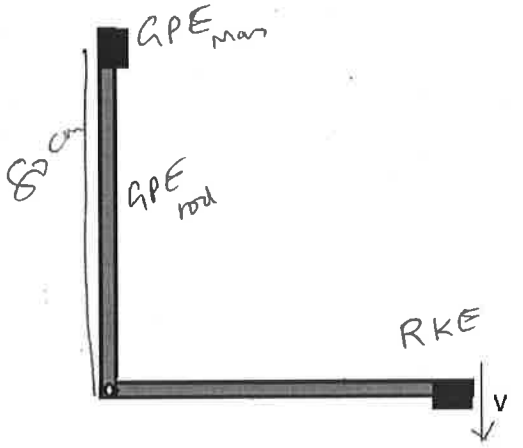
a. What force is needed to give an initial angular acceleration of 15 rad/s²? 319 N

b. If a human can exert a maximum force of 80 N, how many people are necessary to give the above initial angular acceleration?

$\frac{319}{80} = 4$

$I = \frac{1}{12}ML^2$	$I = \frac{1}{3}ML^2$
Thin rod, axis perpendicular to rod and passing through center	Thin rod, axis perpendicular to rod and passing through one end
	

5. A rod of mass 65 g and length 80 cm with a mass of 25 g attached at one end and hinged at the other end is shown below. It is held at rest vertically and released and falls as shown.



$= 0.025 \times 0.8^2 = 0.016$

$mr^2 = 0.046 = 0.03$ kg.m²

$+$

$\frac{1}{3}ML^2 = 0.0139$

a. Determine the moment of inertia of the mass and rod about the hinge as the axis. 0.03 kg.m²

b. Using conservation of energy, find the velocity of the mass when the rod is horizontal and falling? 4.4 m/s

$GPE_{mass} + GPE_{rod} = RKE$

$0.025 \times 9.8 \times 0.8 + 0.065 \times 9.8 \times 0.4 = \frac{1}{2} I\omega^2 \longrightarrow \omega = 5.48\ rad/s$

$V = r\omega = 4.4\ m/s$