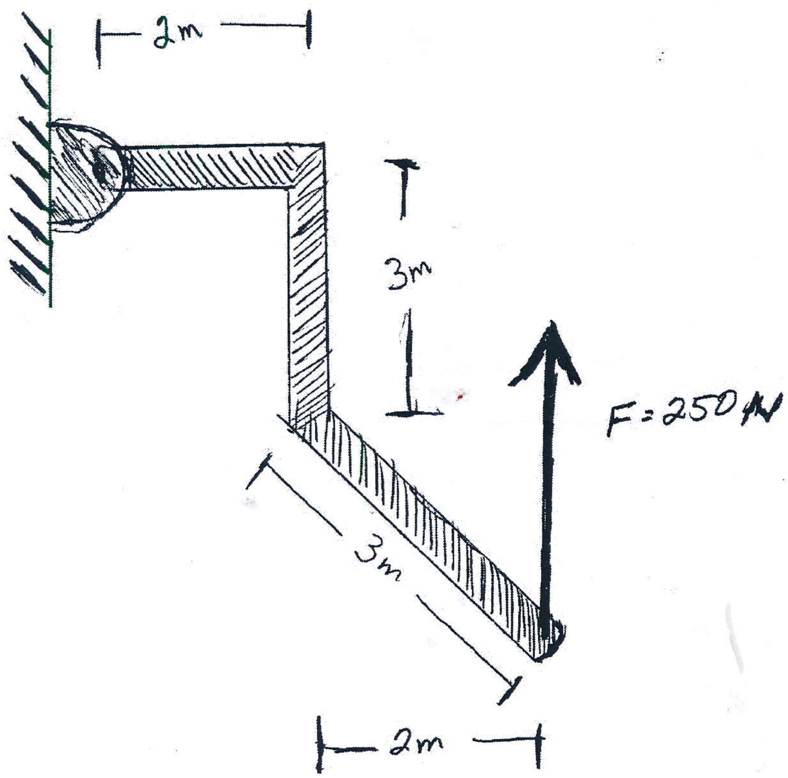
key Level I Physics Pd 3

ROTATIONAL DYNAMICS

AT ROTATIONAL DYNAMICS (14)

Directions: Solve the following problems. Write all work. Be sure to include units with all values (even within the problem!!!). Circle your answer. Each problem is worth 10 points.

1) Determine the torque applied to the rigid object drawn below. The object will rotate around the pin attached to the wall.



(250N)(4m) = 1,000 Nm

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$t = 10s$

2) An electric motor is used to spin a wheel from rest to 10,000 RPM. The solid wheel has a radius of 4.2 cm and a mass of 0.5 kg. Determine the torque that is applied to the wheel.

$$10{,}000 \frac{rev}{min}\left(\frac{1 min}{60 s}\right) = 167 Hz$$

$$\tau = I\alpha$$

$$\alpha = \frac{\Delta\omega}{t}$$

$$\tau = \left(\frac{1}{2}mr^2\right)\left(\frac{\omega}{t}\right)$$

$$\alpha = \frac{\omega}{t}$$

$$\tau = \frac{1}{2}mr^2 \frac{2\pi f}{t}$$

$$\tau = \frac{mr^2\pi f}{t}$$

$$\tau = \frac{(.5 kg)(.042 m)^2 \pi (167 Hz)}{10 s}$$

$$\tau = .046 Nm$$

3) An electric motor is used to spin a wheel from rest to 10,000 RPM. The solid wheel has a radius of 4.2 cm and a mass of 0.5 kg. Determine the work that is done to the wheel to get it up to speed.

$W = KE = \frac{1}{2} I \omega^2$

$\left(10{,}000 \frac{Rev}{min}\right)\left(\frac{1 min}{60 s}\right) = 166.7 \frac{Rev}{s}$

$= \left(\frac{1}{2}\right)\frac{1}{2} m r^2 (2\pi f)^2$

$\frac{1}{4}(.5 kg)(.042 m)^2(4\pi^2)\left(166.7 \frac{Rev}{s}\right)^2 =$

$W = 242 J$

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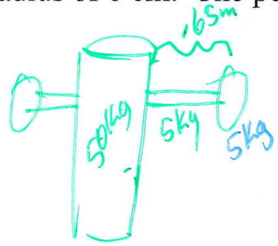
Find Frequency

4) A person on a rotating platform holds a dumbbell in each arm and rotates at 0.3 rev/s. Determine their frequency of rotation when they pull their arms in. Consider the torso of the person to be a cylinder of radius 0.3m and a mass of 50 kg, each arm to be a length of 0.65m and a mass of 5 kg (I'm guessing on this, but the math works to be a "standard" total of 60 kg for the mass of the person). Each dumbbell has a mass of 5kg, and each dumbbell is 12 cm long with a radius of 6 cm. The person pulls their arms in even with their "outer" torso.



$$I_0 \omega_0 = I\omega$$

$$\left(I_{Torso} + I_{Arms} + I_{Dumb}\right) 2\pi f_0 = \left(I_{Torso} + I_{Arms} + I_{Dumbbell}\right) 2\pi f$$

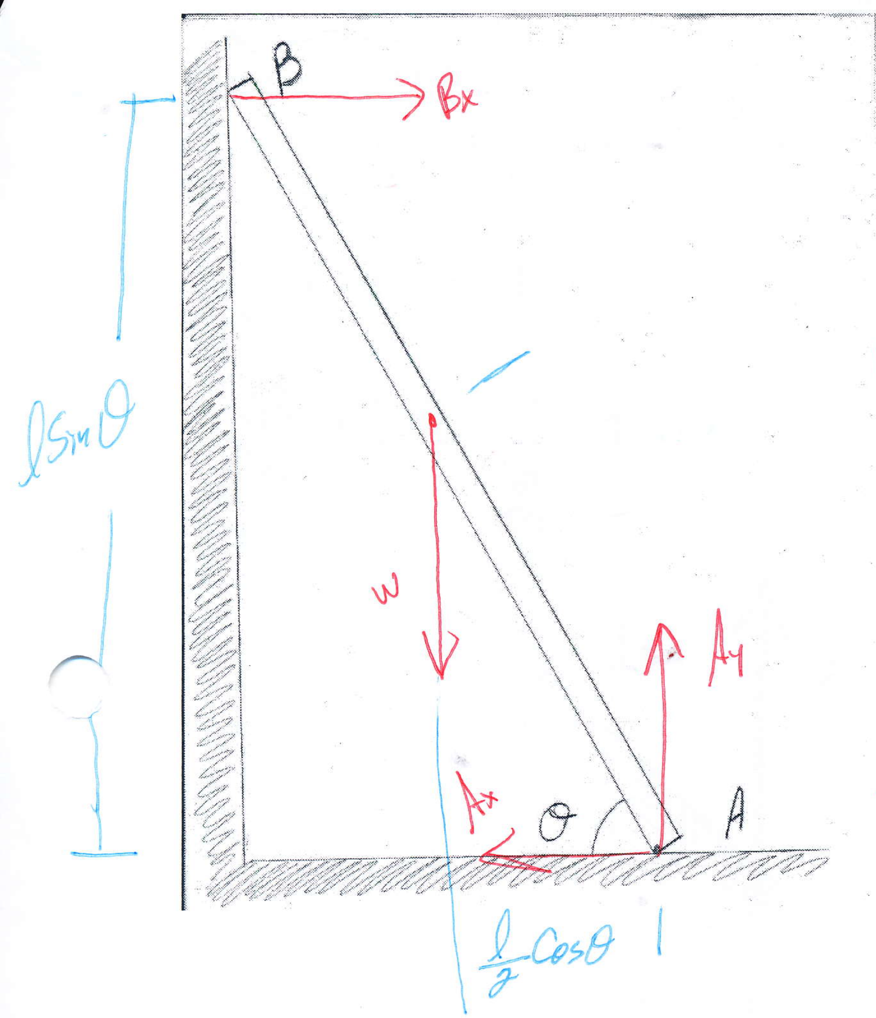
$f_0 = .3$ Rev/s

$$\left(\frac{1}{2} m r_T^2 + \frac{2}{3} m L^2 + (2) m r^2\right) f_0 = \left(\frac{1}{2} m_T r_T^2 + (2) m r^2_{Folded} + (2) m r^2\right) f_f$$

$$\frac{\left[\left(\frac{1}{2}\right)(50kg)(.3m)^2 + \frac{2}{3}(5kg)(.95m)^2 + (2)(5kg)(.95m)^2\right] .3\,\frac{Rev}{s}}{\left[\frac{1}{2}(50kg)(.3m)^2 + \left(\frac{2}{3}\right)(5kg)(.3m)^2 + (2)(5kg)(.3m)^2\right]} = f$$

$$\frac{(14.28\,kg\,m/s^2)(.3\,Rev/s)}{4.05\,kg\,m/s^2} = 1.06\ Rev/s$$

5) Determine the smallest angle where the stick will remain leaning against the wall without sliding. The coefficient of friction between the stick and the floor at point A is 0.23. Point B will be considered frictionless. The stick is 2 m long and is uniformly constructed.



$$\Sigma \tau_A = B_x l \sin\theta - w\frac{l\cos\theta}{2} = 0$$

$$B_x l \sin\theta = w\frac{l\cos\theta}{2}$$

$$B_x \sin\theta = \frac{w\cos\theta}{2}$$

$$\Sigma F_x = B_x - A_x = 0$$

$$B_x = A_x \rightarrow B_x = \mu N$$

$$B_x = \mu A_y$$

$$\Sigma F_y = A_y - W = 0$$

$$A_y = W$$

$$B_x = \mu W$$

$$B_x \sin\theta = \frac{W\cos\theta}{2}$$

$$\mu W \sin\theta = \frac{W\cos\theta}{2}$$

$$\mu \sin\theta = \frac{\cos\theta}{2}$$

$$2\mu \sin\theta = \cos\theta$$

$$\frac{2\mu\sin\theta}{\cos\theta} = 1$$

$$2\mu \tan\theta = 1$$

$$\tan\theta = \frac{1}{2\mu}$$

$$\theta = \tan^{-1}\left(\frac{1}{2\mu}\right) = \tan^{-1}\left(\frac{1}{2(.23)}\right)$$

$$\theta = 65^\circ$$