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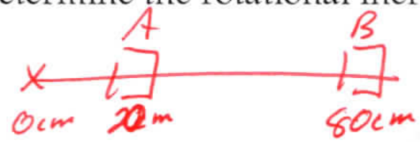
Rotational Dynamics

AT Rotational Dynamics (15).doc

Directions: Solve the following problems. Each is worth 5 points. Show all work

1) A meter stick is hinged at the 0cm mark. A 0.4kg spherical mass with a radius of 2 cm is located at the 20 cm mark, and another 0.06kg spherical mass with a radius of 1.2 cm is located at the 80cm mark. Determine the rotational inertia of the meter stick.



$$I = m_A r_A^2 + m_B r_B^2$$

$$(.4kg)(.2m)^2 + (.06kg)(.8m)^2$$

$$I = .0544\ kgm^2$$

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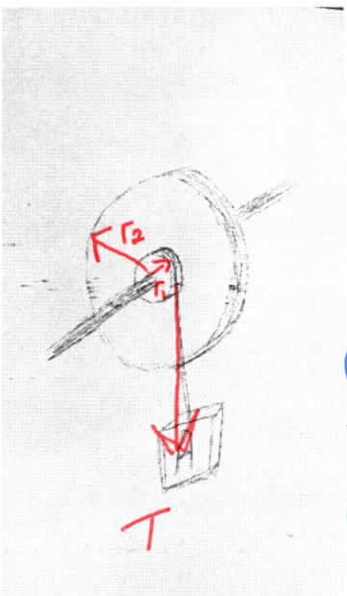
2) The diagram below shows a large wheel and a small wheel. The two wheels are connected, and are able to spin on the frictionless axle as shown. Mass "A" is attached to a string that wraps around the smaller wheel. The wheels are initially at rest when the mass "A" is allowed to fall. Determine the downward acceleration of the mass "A". The small wheel has a diameter of 8 cm and a mass of 150g, and the large wheel has a diameter of 28 cm and a mass of 680g. The mass of "A" is 250g. Both wheels are solid.



$\Sigma F_y = T - w = ma$

on "A" $\quad T = ma + w$

$T = ma + mg$

$\tau = I\alpha$ ⇐ Looking At Linear accel (Change In Linear Velocity) of "A" which Is Attached To r_1

$\tau = \frac{Ia}{r_1}$

$Tr_1 = \frac{Ia}{r_1}$

$Tr_1^2 = Ia$

$(m_A a + m_A g)r_1^2 = Ia$

$-m_A a r_1^2 + m_A g r_1^2 = Ia$

$m_A g r_1^2 = Ia + m_A a r_1^2$

$\frac{m_A g r_1^2}{(I + m_A r_1^2)} = a$

$r_1 = .08m \quad m_1 = .15kg$

$r_2 = .28m \quad m_2 = .68kg$

$A \Rightarrow .25kg$

$$\frac{m_A g r_1^2}{\left[\frac{1}{2}(m_1 r_1^2 + m_2 r_2^2) + m_A r_1^2\right]} = a = \frac{(.25kg)(9.8 m/s^2)(.08m)^2}{\left[\left[\frac{1}{2}\left((.15kg)(.08m^2) + (.68kg)(.28m)^2\right)\right] + (.25kg)(.08m)^2\right]}$$

$a = \cancel{.61 m/s^2}$ $\quad .55 m/s^2$

$$\frac{kg\, m^{\cancel{3}}/s^2}{\cancel{kg}\, \cancel{m^2}}$$

Note I Don't Like this negative... As m_A Gets Real Large the acceleration Downward Should Approach $9.8 m/s^2$... I Found An error... the Correction Is Orange

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3) A lifeguard is spinning their whistle at the end of a meter long lanyard such that the whistle has a linear speed of 4 m/s. If the lanyard is allowed to wrap around the lifeguard's finger such that the radius is 20 cm, determine the linear speed of the whistle.

$$L_0 = L$$

$$I_0 \omega_0 = I\omega$$

$$m r_0^2 \frac{v_0}{r_0} = m r^2 \frac{v}{r}$$

$$r_0 v_0 = r v$$

$$(1\,m)(4\,m/s) = (.2\,m)\,v$$

$$20\,\frac{m}{s} = v$$

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4) A flywheel has a rotational inertia of 12 kgm^2 and is rotating at 12 rev/s. Determine the work needed to stop the flywheel.

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

$$\left(\frac{1}{2}\right)\left(12\,kg\,m^2\right)\left(2\pi\, 12\,\frac{Rev}{s}\right)^2$$

Work = 34075 J

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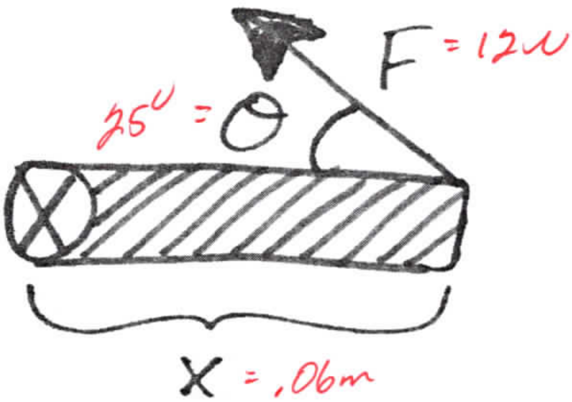
5) Using the diagram below, determine the torque resulting from the 12N force, 6cm lever arm and 25 degree angle.



$\tau = (12N)(06m)(\sin 25°)$

$\tau = .3\ Nm$

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