NATIONAL UNIVERSITY OF SCIENES & TECHNOLOGY

Applied Physics (PHY-102)

Assignment # 2

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Class: BEE-12-C

Semester: 1st

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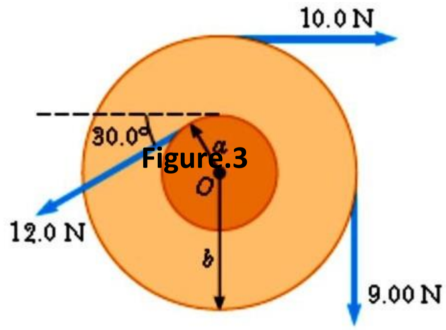
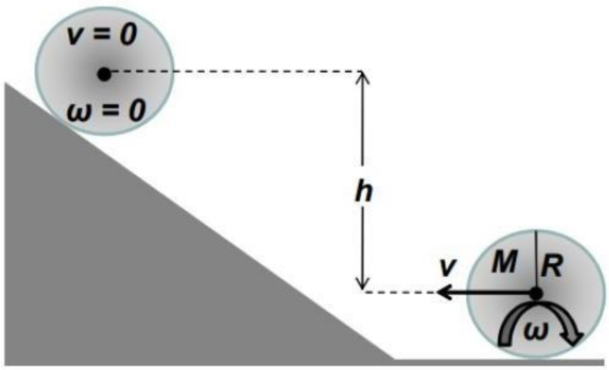
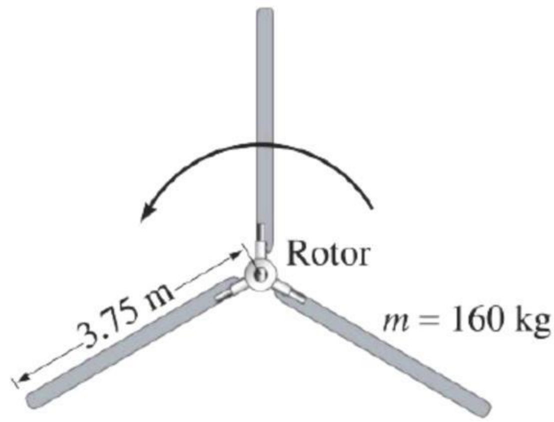
1) Find the net torque on the wheel in figure about the axle through O if a = 10.0 cm and b = 25.0 cm.



2) A bowling ball that has an 11-cm radius and a 7.2-kg mass is rolling without slipping at 2.0 m/s on a horizontal ball return. It continues to roll without slipping up a hill to a height h before momentarily coming to rest and then rolling back down the hill. Model the bowling ball as a uniform sphere and find h.

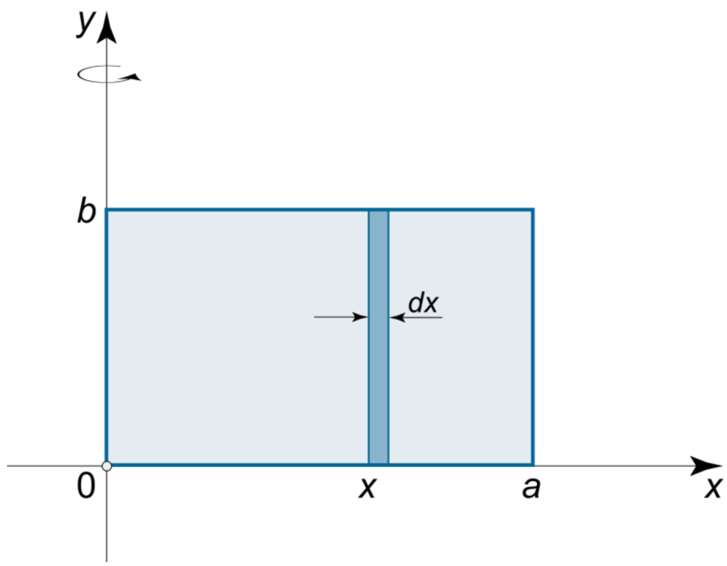


3) A helicopter rotor blade can be considered a long thin rod, as shown in figue, (a) If each of the three rotor helicopter blades is 3.75 m long and has a mass of 160 kg, calculate the moment of inertia of the three rotor blades about the axis of rotation. (b) How much torque must the motor apply to bring the blades up to a speed of 5.0 rev/s in 8.0 s?

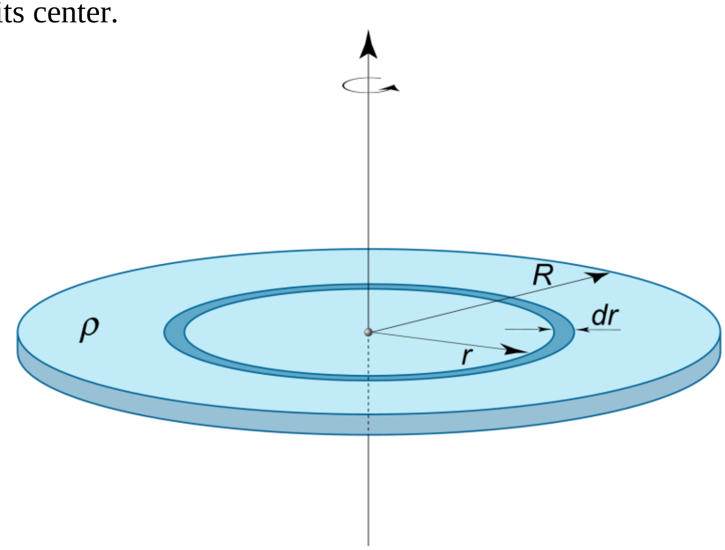


4) A centrifuge rotor rotating at 10,300 rpm is shut off and is eventually brought uniformly to rest by a frictional torque of 1.20 m.N. If the mass of the rotor is 4.80 kg and it can be approximated as a solid cylinder of radius 0.0710 m, through how many revolutions will the rotor turn before coming to rest, and how long will it take?

5) Find the moment of inertia of a rectangle with sides a and b with respect to an axis passing through the side b.

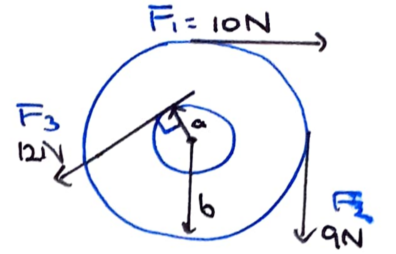


6) Find the moment of inertia of a uniform thin disk of radius R and mass m rotating about an axis passing through its center.



1)

Net torque $\tau = \Sigma\tau_{cw} + \Sigma\tau_{ccw}$



$= rF_1 + rF_2 + (-(rF_3))$

Since all the forces are acting perpendicular,
$\sin\theta = 1$

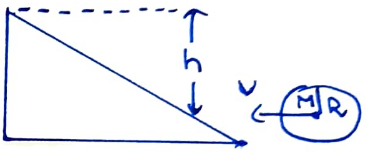
$= bF_1 + bF_2 - aF_3$

Given that $b = 25cm$ or $0.25m$ and $a = 10cm$ or $0.1m$

$= (0.25)(10) + (0.25)(9) - (0.1)(12)$
$= \underline{3.55 Nm}$ (in clockwise)

2)

Since Solid Sphere has moment of inertia $I = mR^2\left(\frac{2}{5}\right)$



The P.E gained will be equal to K.E lost.

$$mgh = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$$

$$mgh = \frac{1}{2}mv^2 + \frac{1}{2}\left(\frac{2}{5}mR^2\right)\omega^2$$

$$\cancel{m}gh = \frac{1}{2}\cancel{m}v^2 + \frac{2}{10}\cancel{m}R^2\omega^2$$

$$gh = \frac{1}{2}v^2 + \frac{2}{10}v^2$$

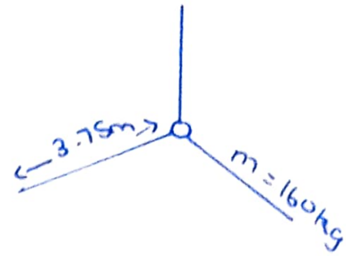
$$gh = \frac{7}{10}v^2$$

$$h = \frac{7}{10}\frac{v^2}{g}$$

$$h = \frac{7}{10}\frac{(2)^2}{9.8}$$

$$\underline{h = 0.29m}$$

3) a)



Moment of inertia of uniform thin rod $= \frac{1}{3}MR^2$

Total moment $\Sigma I_T = I_1 + I_2 + I_3$

Since they're identical, $I_1 = I_2 = I_3 = I$

$$\Sigma I_T = 3I$$
$$= \cancel{3}\left(\frac{1}{\cancel{3}}MR^2\right)$$
$$= MR^2$$
$$= (160)(3.75)^2$$
$$= \underline{2250 \text{ kgm}^2}$$

b)

As $\tau = I\alpha$
$$= (2250)\left(\frac{\Delta\omega}{\Delta t}\right)$$
$$= (2250)\left(\frac{5}{8}\right)(2\pi)$$
$$= 8835 \text{ Nm}$$

4)

$\omega = 10300 \text{ rpm} = 1078 \text{ rad/s}$

$\tau = -1.2 \text{ Nm}$

$m = 4.8 \text{ kg}$

$r = 0.071 \text{m}$

$\Big\} \; I_{cyl} = \frac{1}{2}mr^2 = 0.01209 \text{ kgm}^2$

As $\tau = I\alpha$
$$\alpha = I/\tau$$
$$= 0.01209/-1.2 = -99.9 \text{ rad/s}^2 = -15.9 \text{ rev/s}^2$$

$$\underline{\theta} = \frac{0 + (-\omega_i^2)}{2\alpha} = \frac{-\omega_i^2}{2\alpha} = \frac{-(1078)^2}{2(-99.9)} = \underline{5816 \text{ rad}} = \underline{925.6 \text{ rev}}$$

$$\underline{t} = \frac{2\theta}{\omega_i} = \frac{2(5816)}{1078} = \underline{10.79 \text{ s}}$$

5)

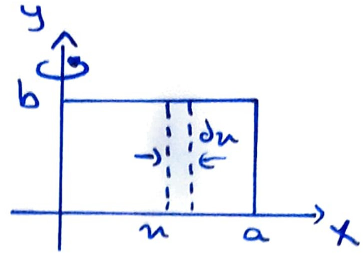
In two dimensions, hence;

$$\sigma = \frac{m}{A}$$

$$dm = dA(\sigma)$$

$$dI = r^2 dm$$

Taking integral



$$I = \int_0^a x^2 \, dA \, \sigma$$

$$= \int_0^a x^2 \, d(xb) \, \frac{m}{A}$$

$$= \int_0^a x^2 \, b \, dx \, \frac{m}{A}$$

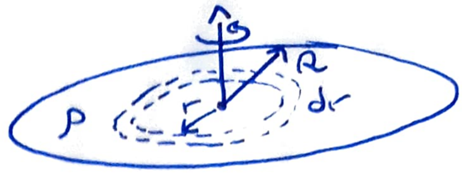
$$= \frac{m}{A}(b) \int_0^a x^2 \, dx$$

$$= \frac{m}{A}(b) \left. \frac{x^3}{3} \right|_0^a$$

$$= \frac{m}{\cancel{a}\cancel{b}} (\cancel{b}) \left(\frac{a^{\cancel{3}\,2}}{3} \right)$$

$$= \frac{1}{3} m a^2$$

6)



Since disk is thin, we can distribute its mass completely on xy-plane.

$$\rho = \frac{m}{A} = \frac{m}{\pi r^2} = \frac{m}{2\pi r\, dr}$$

$$dm = 2\pi r (dr) \rho$$

$$dI = r^2 dm$$

$$I = \int_0^R r^2 dm$$

$$= \int_0^R r^2 \, 2\pi r \, dr \, \frac{m}{A}$$

$$= \frac{m}{A} \int_0^R r^3 \, dr \, 2\pi$$

$$= \frac{2\pi (m)}{A} \int_0^R r^3 \, dr$$

$$= \frac{2\pi (m)}{A} \left. \frac{r^4}{4} \right|_0^R$$

$$= \frac{\cancel{2}\pi (m)}{A} \frac{R^4}{\cancel{4}2}$$

$$= \frac{\cancel{\pi}}{\cancel{\pi} \cancel{R^2}} m \frac{R^{\cancel{4}2}}{2}$$

$$= \underbrace{\frac{1}{2} m R^2}$$