ROTATIONAL DYNAMICS

DAY 1

ROTATIONAL DYNAMICS (12)

Directions: Solve the following problems. Each is worth 5 point. Show all work and circle your answer. All diagrams were taken from Vector Mechanics for Engineers by Ferdinand Beer and Russell Johnson. McGraw Hill, 1988.

4.48 One end of rod AB rests in the corner A and the other is attached to cord BD. If the rod supports at 200-N load at its midpoint C, find the reaction at A and the tension in the cord.

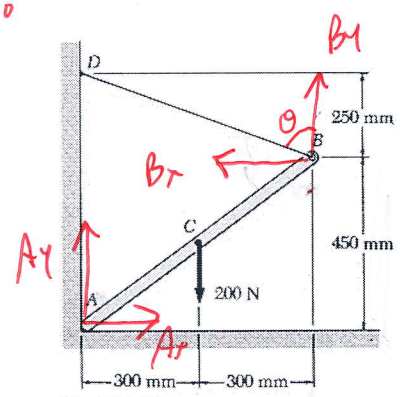
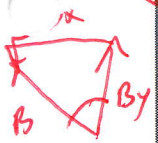


Fig. P4.48



$\Sigma J_A = (B_y)600mm + B_x 450mm - (200N)300mm = 0$

$(B\cos 67)600mm + (B\sin 67)450 = (200N)(300mm)$

$B = \dfrac{(200N)(300mm)}{(\cos 67)(600mm) + (\sin 67)(450mm)}$

$B = 92.5N$

$\Sigma F_x = A_x - B_x = 0$

$A_x = B\sin\theta$

$A_x = (92.5N)\sin(67.4°)$

$A_x = 85.4N$

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

$A_y = W - B_y$

$A_y = 200N - B\cos 67.4$

$A_y = 164N$

A person with a rotational inertia of 120 kgm^2 is rotating at 1 rev/s. Determine their frequency of rotation if their rotational inertia is reduced by half.

$I_0 \omega_0 = I \omega$

2 Rev/s

key Level I Physics Pd 3

A solid wooden cylinder of radius 20 cm has a mass of 8 kg. This wheel has a 2mm thick steel 4 kg covering on the outer most edge (Think like a tire on a rim) to protect the wood as it would roll along. Determine the rotational inertia of the wheel.

$I_{Total} = I_{wood} + I_{steel}$

$\frac{1}{2}mr^2 + mr^2$

$I_{Total} = \left(\frac{1}{2}\right)(8kg)(.2m)^2 + (4kg)(.2m)^2$

$I_{Total} = .32 kgm^2$

Determine the torque produced when a 165 pound person stands on the end of an 8 foot long diving board. Work in English units.

(165 pound)(8 ft) 1320 ~~1650~~ ft-lb

A hoop is rolled down a track on hill of height "h," then rolls up a second hill of height 2m. The second hill curves downward with a radius of 15 cm. Determine the greatest height of "h" such that the hoop will not leave the surface of the track at the highest point of the second hill.

$a_c = g = \frac{v^2}{r}$

$gr_c = v^2$

r_c Radius of Curve

$h = h_o + 2m$

$PE = KE + RKE$

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

$mgh_o = \frac{1}{2}mv^2 + \frac{1}{2}mr^2\frac{v^2}{r^2}$

$gh_o = \frac{1}{2}v^2 + \frac{1}{2}v^2$

$gh_o = v^2$

$gh_o = gr_c$

$h_o = r_c$

$h = 2.15\,m$

A solid wheel of mass 0.75 kg and radius 25 cm starts at rest. Determine the linear speed of the outer edge of the wheel after 15 seconds of an applied 9Nm of torque.

$\omega = \omega_0 + \alpha t$

$\omega = \alpha t$ $\qquad$ $\tau = I\alpha$

$\frac{v}{r} = \frac{\tau}{I} t$

$v = \frac{\tau t r}{I} = \frac{\tau t r}{\frac{1}{2} m r^2} = \frac{2\tau t}{mr} = \frac{(2)(9\ Nm)(15\ s)}{(.75 kg)(.25 m)} = 1440\ m/s$

$\frac{kg\ m\ m\ s}{s^2\ kg\ m}$