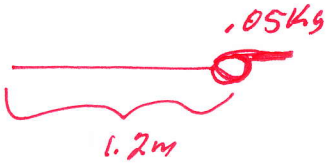
ROTATIONAL DYNAMICS; DAY 2

AT Rotational dynamics (17)

5) A 0.05kg whistle is swung at the end of a 1.2 m long lanyard at a rate of 1.7 revs/sec. Determine the frequency of the whistle when the lanyard is shortened (because it wraps around a finger) to 0.2 m.



$L_0 = L$

$I_0\omega_0 = I\omega$

$mr_0^2 2\pi f_0 = mr^2 2\pi f$

$r_0^2 f_0 = r^2 f$

$\frac{r_0^2 f_0}{r^2} = f$

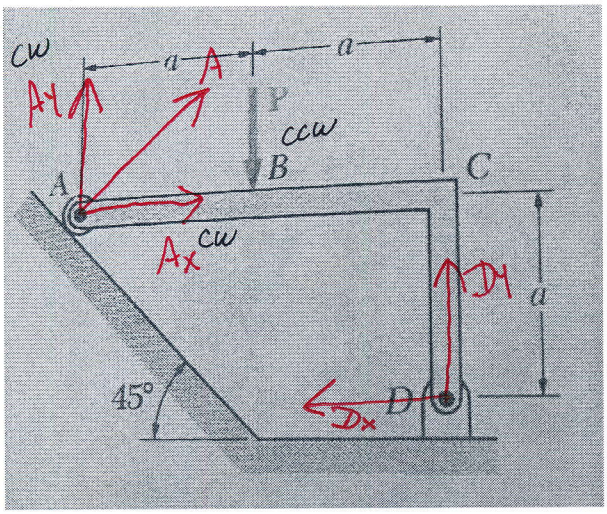
$\frac{(1.2m)^2(1.7 rev/s)}{(.2m)^2} = 61.2 rev/s$

Answer Key Pd 1

Rotational Inertia

Particle $I=mr^2$
Solid cylinder $I=(1/2)mr^2$
Stick about end $I=(1/3)mL^2$
Solid Sphere $I=(2/5)mr^2$
Stick about middle $I=(1/12)mL^2$

6) Determine the reaction at "A" and "D" knowing the distance "a" is 4 inches and the force "B" is 26 pounds. Assume the weight of the structure is negligible.



A Is A Normal

$\Sigma T_D = T_{Ay} + T_{Ax} - T_B = 0$

$A_y(8in) + A_x(4in) - B(4in) = 0$

$A_y = A\sin\theta = A\cos\theta = A(.707)$

$\theta = 45°$

$A(.707)(8in) + A(.707)(4in) = B(4in)$

$A(.707)(12in) = B(4in)$

$A = \frac{(26\,lb)(4in)}{(.707)(12in)}$

$A = 12.31\,lb$ $\quad A_x = 8.67\,lb$ $\quad A_y = 8.67\,lb$

$\Sigma F_x = A_x - D_x = 0$

$D_x = 8.67\,lb$

$\Sigma F_y = D_y + A_y - B = 0$

$D_y = B - A_y$

$D_y = (26\,lb) - (8.67\,lb)$

$D_y = 17.33\,lb$

Answer Key Pd 1

Rotational Inertia

Particle $I=mr^2$
Solid cylinder $I=(1/2)mr^2$
Stick about end $I=(1/3)mL^2$
Solid Sphere $I=(2/5)mr^2$
Stick about middle $I=(1/12)mL^2$

7) A 32cm sphere of mass 4 kg is attached to a 2 kg, 1.4 m long rod. Determine the rotational inertia of the combination if it is spun around the end opposite of the sphere.

$I = I_{\text{stick end}} + I_{\text{particle}}$

$I = \frac{1}{3}mL^2 + mr^2$

$I = \frac{1}{3}(2\text{kg})(1.4\text{m})^2 + (4\text{kg})(1.4\text{m})^2$

$I = 9.15\ \text{kg m}^2$

$1.3\ \text{kg m}^2 + 7.84\ \text{kg m}^2$

Answer Key Pd 1

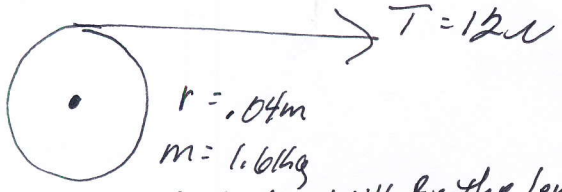
Rotational Inertia

Particle $I=mr^2$
Solid cylinder $I=(1/2)mr^2$
Stick about end $I=(1/3)mL^2$

Solid Sphere $I=(2/5)mr^2$
Stick about middle $I=(1/12)mL^2$

12N Force In String

8) A solid cylinder of radius 4 cm and mass 1.6 kg has a string wrapped around the outer edge. The cylinder is able to rotate through its center like a wheel. Determine the length of string that would need to be pulled off the wheel for the wheel to be spun at 5 rev/s. Assume the string is massless.



$r = .04m$

$m = 1.6kg$

$S = ?$ This will Be the length of String

$\omega =$

$f = 5\ Rev/s$

$v^2 = v_0^2 + 2ax$

$\omega^2 = \omega_0^2 + 2\alpha\theta$

$\omega_0 = 2\pi$

$S = \theta r$

$\frac{S}{r} = \theta$

$\omega^2 = \frac{2\alpha S}{r}$

$\omega = 2\pi f$

$(2\pi f)^2 = \frac{2\alpha S}{r}$

$4\pi^2 f^2 = \frac{2\alpha S}{r}$

$2\pi^2 f^2 = \frac{\alpha S}{r}$

$\tau = I\alpha$

$\frac{\tau}{I} = \alpha$

$\frac{\tau}{\frac{1}{2}mr^2} = \alpha$

$\frac{2\tau}{mr^2} = \alpha$

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

$2\pi^2 f^2 = \frac{2\tau S}{mr^3}$

$\pi^2 f^2 = \frac{\tau S}{mr^3}$

$\tau = Fr$

$\pi^2 f^2 = \frac{FrS}{mr^3}$

$\pi^2 f^2 = \frac{FS}{mr^2}$

$\frac{\pi^2 f^2 m r^2}{F} = S$

$\frac{(\pi^2)(5\frac{Rev}{s})^2(1.6kg)(.04m)^2}{(12N)} = 5.3cm$

$\frac{Rev^2\ kg\ m^2}{s^2\ kg\ m/s^2} \Rightarrow m$ Unit Check

Particle $I = mr^2$

Solid cylinder $I = (1/2)mr^2$

Stick about end $I = (1/3)mL^2$

Answer Key Pd 1

Rotational Inertia

Solid Sphere $I = (2/5)mr^2$

Stick about middle $I = (1/12)mL^2$