Reminders 04-06-10:

-POW 9 Due Tuesday
-Exam 3 Average 68%

Objectives:

-Rotational Kinematics
-Rotational Energy
-Moment of Inertia
-Torque

Example:

The angular position of a rotating object is given by $\theta = 2t - 5t^2 + 2t^4$ rad. Find:

a) the angular acceleration at t = 1 s;
b) the average angular acceleration between 1 and 2 s;
c) the average angular speed between 1 and 2 s.

a) $\frac{d^2\theta}{dt^2} = ?$

$\frac{d\theta}{dt} = \omega = 2 - 10t + 8t^3$

$\frac{d^2\theta}{dt^2} = -10 + 24t^2$

sub. t = 1

$\alpha = -10 + 24(1s) = +14/s^2$

b) $\alpha_{avg} = \frac{\Delta\omega}{\Delta t}$

$\omega(t=2) = 2 - 10(2) + 8(2)^3 = 2 - 20 + 64$
$= 46/s$

$\omega(t=1) = 2 - 10(1) + 8(1) = 2 - 10 + 8$
$= 0$

$\alpha_{avg} = \frac{46/s - 0}{1s} = 46/s^2$

$\omega_{Avg} = \frac{\Delta\theta}{\Delta t}$

$\theta(t=2) = 2(2) - 5(2)^2 + 2(2)^4 = 4 - 20 + 32$
$= 16$

$\theta(t=1) = 2(1) - 5(1)^2 + 2(1)^4 = 2 - 5 + 2$
$= -1$

$\omega_{avg} = \frac{16 - -1}{1s} = 17/s$

Title: Apr 6-11:21 AM (2 of 5)

A car with tires of radius of 25 cm comes to a stop from a 100 km/h (27.8 m/s) in 50 m without any slipping of the tires. Find:

a) the angular acceleration of the wheels;

b) the number of revolutions made in stopping.

Since object is rolling we Know $a_T = a_{cm} = R\alpha$

$V_i = 27.8\ m/s$ $V_f = 0$ $\Delta x = 50m$

use $V_f^2 = V_i^2 + 2a\Delta x$

$0 = V_i^2 + 2a\Delta x$

$a_{cm} = \frac{-V_i^2}{2\Delta x} = \frac{-(27.8\frac{m}{s})^2}{2(50m)} = -7.73\frac{m}{s^2}$

$\alpha = \frac{-7.73\,m/s^2}{.25m} = -30.9/s^2$

b) Need $\Delta\theta$

$\Delta x = 50m$ $\Delta S = \Delta X = R\Delta\theta$

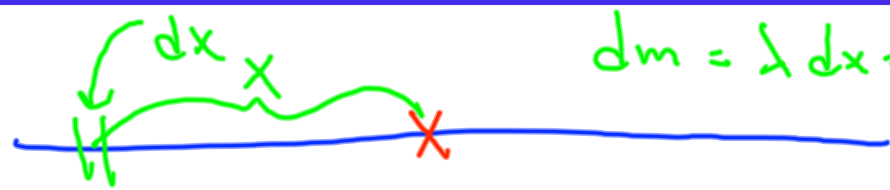
$\Delta\theta = \frac{\Delta X}{R}$

$\#\ rev = \frac{\Delta\theta}{2\pi} = \frac{\Delta X}{2\pi R} = \frac{50m}{2\pi(.25)}$

$= 31.8\ rev.$

Example:

What is the moment of inertia for a thin rod of length L and mass M, rotating on an axis through the center of mass of the rod and perpendicular to the rod.



$$dm = \lambda\, dx = \frac{m}{L}\, dx$$

$$\frac{m}{L} = \text{constant} = \lambda$$

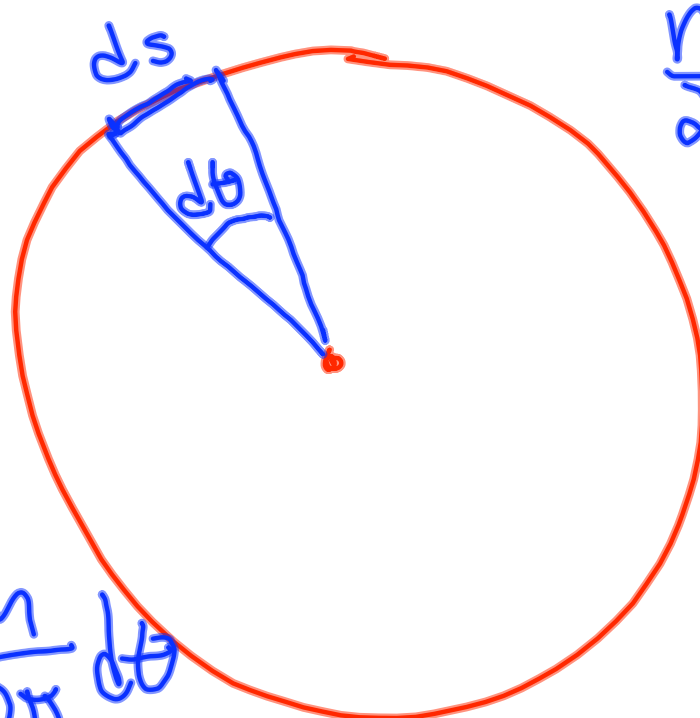
$$I = \int r^2\, dm = \int_{-L/2}^{L/2} x^2 \frac{m}{L}\, dx$$

$$I = \frac{m}{L} \frac{x^3}{3} \Big|_{-L/2}^{L/2} = 2 \frac{m}{L} \frac{(L/2)^3}{3}$$

$$I = 2 \frac{m}{L} \left(\frac{L^3}{8}\right) \frac{1}{3} = \frac{1}{12} m L^2$$

Examples: What is the moment of inertia for a ring of mass M and radius R rotating about an axis through its center?

$dm = \lambda\, ds$



$\frac{m}{2\pi R} = \lambda$

$ds = R\, d\theta$

$dm = \lambda R\, d\theta$

$dm = \frac{m}{2\pi \cancel{R}} \cancel{R}\, d\theta$

$= \frac{m}{2\pi} d\theta$

$I = \int_0^{2\pi} R^2 \frac{m}{2\pi} d\theta$

$= mR^2$