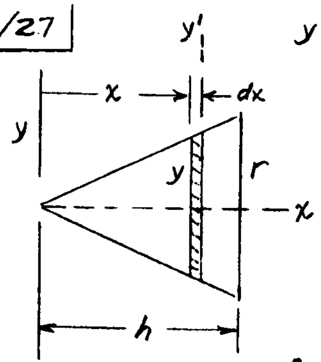
B/27



$$y = \frac{r}{h}x\,;$$

$$dI_{xx} = \frac{1}{2}dm\,(y^2) = \frac{1}{2}(\pi y^2 \rho\, dx)\,y^2$$

$$= \frac{\pi}{2}\rho\frac{r^4}{h^4}x^4 dx$$

$$I_{xx} = \frac{\pi}{2}\rho\frac{r^4}{h^4}\int_0^h x^4 dx$$

$$= \frac{\pi}{10}\rho\frac{r^4}{h^4}h^5 = \frac{\pi}{10}\rho h r^4$$

But $m = \frac{1}{3}\pi\rho r^2 h$ so $\underline{I_{xx} = \frac{3}{10}mr^2}$

$$dI_{yy} = dI_{y'y'} + x^2 dm = \frac{1}{4}dm\,y^2 + x^2 dm = \left(\frac{y^2}{4} + x^2\right)dm$$

$$= \left(\frac{1}{4}\frac{r^2}{h^2} + 1\right)x^2\rho\pi y^2 dx = \left(\frac{r^2}{4h^2} + 1\right)\rho\pi\frac{r^2}{h^2}x^4 dx$$

$$I_{yy} = \frac{\rho\pi r^2}{h^2}\left(\frac{r^2}{4h^2} + 1\right)\int_0^h x^4 dx = \frac{\rho\pi r^2 h^3}{5}\left(\frac{r^2}{4h^2} + 1\right)$$

$$\underline{I_{yy} = \frac{3}{5}m\left(\frac{r^2}{4} + h^2\right)}$$

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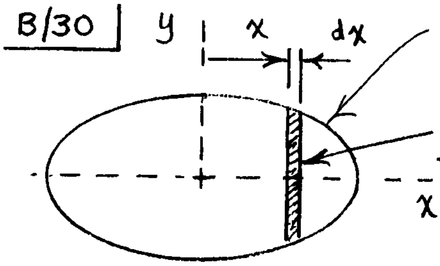

$$\frac{x^2}{a^2}+\frac{y^2}{b^2}=1,\quad y^2=b^2\left(1-\frac{x^2}{a^2}\right)$$

$$\begin{cases} dm = \rho\, dA = \rho\, 2y\, dx \\ I_{xx} = \frac{1}{12}\, dm\, (2y)^2 \end{cases}$$

$$= \frac{1}{12}(\rho\, 2y\, dx)(2y)^2$$

$$= \frac{2}{3}\rho y^3 dx$$

$$= \frac{2}{3}\rho b^3\left(1-\frac{x^2}{a^2}\right)^{3/2} dx$$

$$I_{xx} = \int dI_{xx} = \frac{2}{3}\rho b^3 \int_{-a}^{a}\left(1-\frac{x^2}{a^2}\right)^{3/2} dx$$

$$= \frac{2}{3}\rho\frac{b^3}{a^3}\int_{-a}^{a}(a^2-x^2)^{3/2} dx$$

$$= \frac{2}{3}\rho\frac{b^3}{a^3}\left[\frac{x}{8}(-2x^2+5a^2)\sqrt{a^2-x^2}+\frac{3a^4}{8}\sin^{-1} x\sqrt{\frac{1}{a^2}}\right]_{-a}^{a}$$

$$= \frac{1}{4}\rho b^3 a\left[\frac{\pi}{2}-\left(-\frac{\pi}{2}\right)\right]\left[\frac{m}{\rho\pi ab}\right]$$

$$= \underline{\frac{1}{4}mb^2}$$

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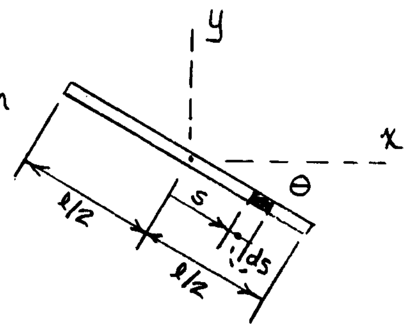

Let ρ = mass/unit length

$dm = \rho\, ds$, $m = \rho l$

$dI_{xy} = xy\, dm$

$= (s\cos\theta)(-s\sin\theta)\rho\, ds$

$= -\frac{1}{2}\rho \sin 2\theta\, s^2 ds$

$$I_{xy} = -\frac{1}{2}\rho \sin 2\theta \int_{-l/2}^{l/2} s^2 ds = \underline{-\frac{1}{24} m l^2 \sin 2\theta}$$

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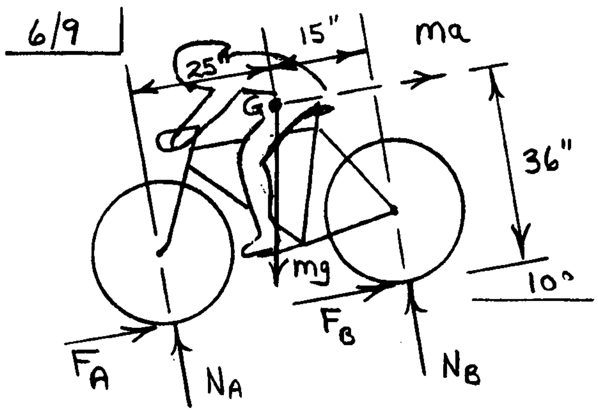
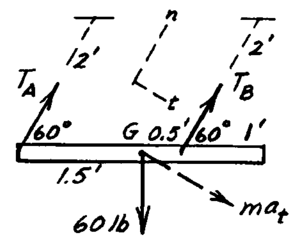


Tipping at front wheel : $N_B, F_B \rightarrow 0$

$$+\circlearrowleft \Sigma M_A = ma d : mg\,(25 \cos 10° - 36 \sin 10°)$$
$$= ma\,(36)$$

Solve to obtain $a = \underline{0.510 g}$ ($\underline{16.43 \text{ ft/sec}^2}$)

6/15 | Curvilinear translation



$\Sigma F_t = ma_t$: $60 \cos 60° = \frac{60}{32.2} a_t$,

$a_t = 16.1$ ft/sec^2

$\alpha = a_t / r = 16.1/2 = \underline{8.05 \text{ rad/sec}^2}$

$+\Sigma M_G = 0$: $T_B \sin 60° \times 0.5 - T_A \sin 60° \times 1.5 = 0$, $T_A = \frac{1}{3} T_B$

$\Sigma F_n = ma_n = 0$: $T_A + T_B - 60 \sin 60° = 0$, $T_A + T_B = 52.0$ lb

Combine & get $\underline{T_A = 12.99 \text{ lb}}$, $\underline{T_B = 39.0 \text{ lb}}$

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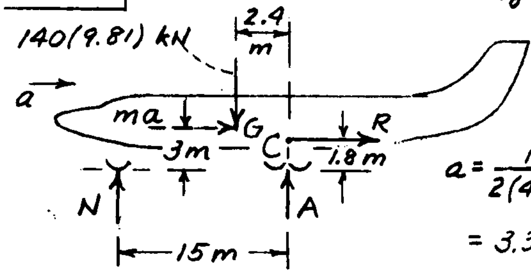
$$v^2 = v_0^2 + 2as$$



$$a = \frac{1}{2(425)}\left[(200)^2 - (60)^2\right]\frac{1}{(3.6)^2}$$

$$= 3.30 \text{ m/s}^2$$

$\Sigma M_C = m\bar{a}d$; $15N - 140(9.81)(2.4) = 140(3.30)(3-1.8)$

$\underline{N = 257 \text{ kN}}$

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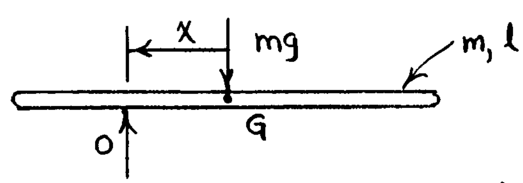

$$I_O = I_G + mx^2 = \frac{1}{12}ml^2 + mx^2 = m\left(\frac{l^2}{12} + x^2\right)$$

$$\circlearrowleft \Sigma M_O = I_O\alpha : \quad mgx = m\left(\frac{l^2}{12} + x^2\right)\alpha$$

$$\alpha = \frac{gx}{\frac{1}{12}l^2 + x^2}$$

$$\frac{d\alpha}{dx} = \frac{\left(\frac{1}{12}l^2 + x^2\right)g - gx(2x)}{\left(\frac{1}{12}l^2 + x^2\right)^2} = 0 \Rightarrow \underline{x = \frac{l}{2\sqrt{3}}}$$

$$\alpha = \frac{g\frac{l}{\sqrt{12}}}{\frac{1}{12}l^2 + \frac{1}{12}l^2} = \underline{\sqrt{3}\,\frac{g}{l}}$$

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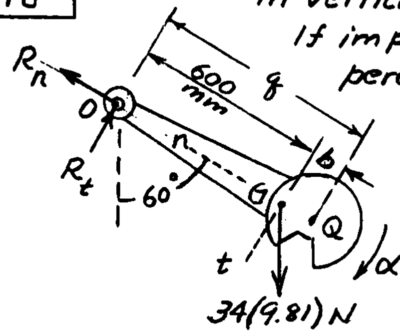

In vertical position $R_t = 0$

If impact occurs at center of percussion so

$q = k_o^2/\bar{r}$,

$0.600 + b = \dfrac{(0.620)^2}{0.600}$

$b = 0.0407$ m

or $\underline{b = 40.7\text{ mm}}$

$\Sigma M_Q = 0;\ 34(9.81)(0.0407 \sin 60°) - (0.6407)R_t = 0$

$R_t = 18.35$ N

$\Sigma F_n = m\bar{r}\omega^2 = 0;\ R_n - 34(9.81)\cos 60° = 0$

$R_n = 166.8$ N

$R = \sqrt{(166.8)^2 + (18.35)^2} = \underline{167.8\text{ N}}$

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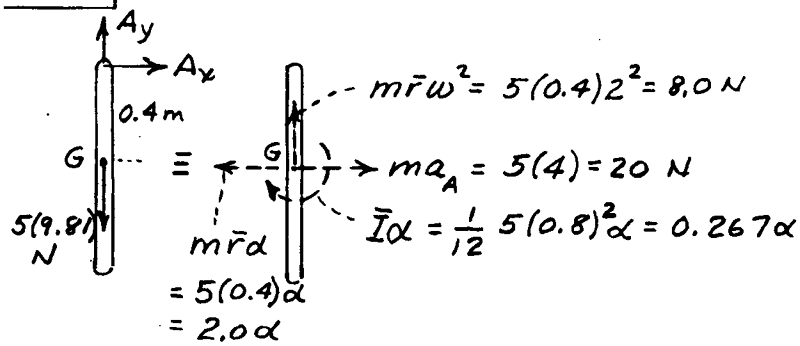

$\Sigma M_A = \bar{I}\alpha + \Sigma m\bar{a}d;\quad 0 = 0.267\alpha + 2.0\alpha(0.4) - 20(0.4)$

$\alpha = 7.50 \text{ rad/s}^2$

$\Sigma F_x = m\bar{a}_x;\quad A_x = 20 - 2.0(7.50) = \underline{5 \text{ N}}$

$\Sigma F_y = m\bar{a}_y;\quad A_y - 5(9.81) = 8,\quad A_y = \underline{57.1 \text{ N}}$