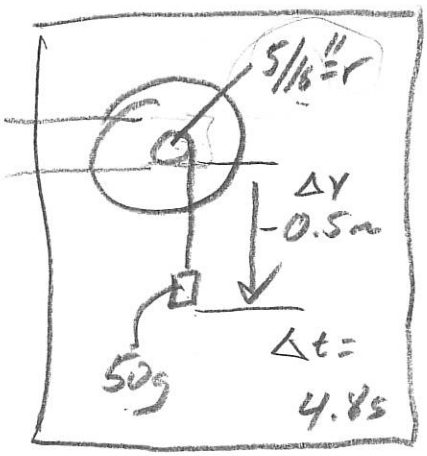
Rubber Band Problems #1



1. a) $\Delta y = V_{oy}t + \frac{1}{2}at^2$

$-0.5m = 0 + \frac{1}{2}a(4.8s)^2$

$a = -0.0434\ m/s^2$ (downward)

b) $r = \frac{5}{16}\text{ inch}\left(\frac{2.54\text{cm}}{\text{inch}}\right)\left(\frac{1\text{m}}{100\text{cm}}\right) = 0.00794\text{m}$

$a = \alpha r \quad \alpha = \frac{a}{r} = \frac{0.0434\ m/s^2}{0.00794m} = 5.47\ rad/s^2$

c)

$\Sigma F = ma = T - mg$

$T = ma + mg = m(a+g)$

$T = 0.05kg(-0.0434\ m/s^2 + 9.8\ m/s^2)$

$T = 0.488N$

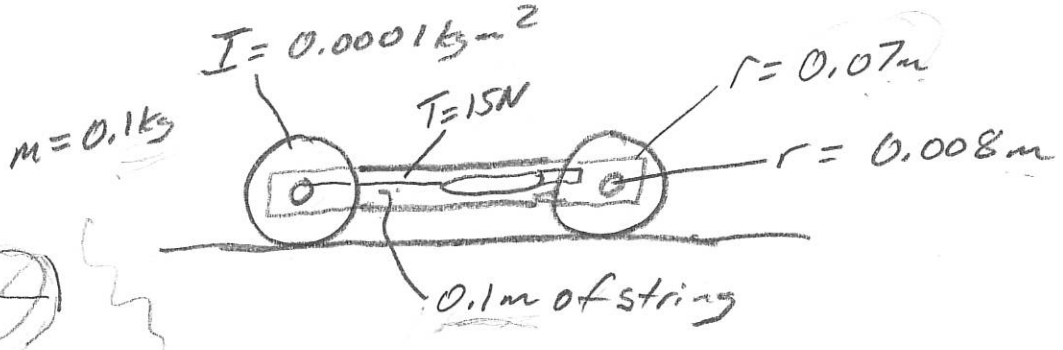
d) $\tau = F_r = 0.488N(0.00794m) = 0.00387\ N\cdot m$

Tension

e) $\tau = I\alpha \Rightarrow I = \frac{\tau}{\alpha} = \frac{0.00387\ N\cdot m}{5.47\ rad/s^2}$

$I = 7.08 \times 10^{-4}\ kgm^2$

2.



a) $0.1\text{ m}\left(\frac{1\text{ rad}}{0.008\text{ m}}\right) = 12.5\text{ rad}$

b) $12.5\text{ rad}\left(\frac{0.07\text{ m}}{1\text{ rad}}\right) = 0.875\text{ m}$

d) $v = \frac{\Delta x}{\Delta t} = \frac{1\text{ foot}\left(\frac{0.305\text{ m}}{1\text{ foot}}\right)}{22\text{ frames}\left(\frac{1\text{ sec}}{240\text{ frames}}\right)} = 3.33\text{ m/s}$

c) $W = Fd = (\text{Ave Tension})(\text{string length})$
$= 15\text{ N}(0.1\text{ m}) = 1.5\text{ J}$

e) $KE_{Trans} = \frac{1}{2}mv^2 = \frac{1}{2}(0.1\text{ kg})(3.33\text{ m/s})^2$
$= 0.554\text{ J}$

f) $KE_{rot} = \sum_{\text{2 axles}}\left(\frac{1}{2}I\omega^2\right) = I\left(\frac{v}{r}\right)^2 = 0.0001\text{ kg·m}^2\left(\frac{3.33\text{ m/s}}{0.07\text{ m}}\right)^2$
$= 0.226\text{ J}$

g) $KE_{Total} = KE_{Trans} + KE_{rot} = 0.554\text{ J} + 0.226\text{ J} = 0.780\text{ J}$

continued

h) $\text{Efficiency} = \frac{E\ \text{Output}}{E\ \text{Input}} = \frac{0.780\text{J}}{1.5\text{J}} = 0.52 = 52\%$

i) $W_{Net} = \Delta KE = KE_F - KE_i = 0.780\text{J} - 0 = 0.780\text{J}$

(KE_F: top; KE_i: start)

j) $P = \frac{W_{net}}{\Delta t} = \frac{0.780\text{J}}{0.5\text{s}} = 1.56\text{W}$

$1.56\text{W}\left(\frac{1\text{hp}}{746\text{W}}\right) = 0.00209\text{hp}$

k) $KE_i + PE_i + W_{NC} = KE_F + PE_F$

$0.780\text{J} + 0 + W_{Fr} = 0 + 0$

$W_{Fr} = -0.780\text{J} = F_{Fr}\,d$

$-0.780\text{J} = F_{Fr}(50\text{m})$

$F_{Fr} = -0.0156\text{N}$