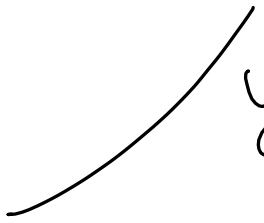


$y = Kx^2$

$V = 180 \text{ m/h}$

find K so that,

$\vec{a}(x=0) = 1.5g$

$$\vec{V} = V \hat{u}_t$$

$$\vec{a} = \dot{V} \hat{u}_t + \frac{V^2}{\rho} \hat{u}_n$$

$$\rho = \frac{\left(1 + \left(\frac{dy}{dx}\right)^2\right)^{3/2}}{\left|\frac{d^2y}{dx^2}\right|}$$

$y = Kx^2$

$$y = kx^2$$

$$\frac{dy}{dx} = 2kx, \quad \frac{d^2y}{dx^2} = 2k$$

$$\rho(x=0) = \frac{\left(1 + 2k(0)\right)^{3/2}}{2k}$$

$$= \frac{1}{2k}$$

$$\vec{v} = \cancel{v}^{0}\hat{u}_t + \frac{v^2}{\rho}\hat{u}_n$$

$$\vec{v} = 2kv_0^2 \quad \hat{u}_n = 1.5g\,\hat{u}_n$$

$$2k V_0^2 = 1.5g$$

$$\Rightarrow k = \frac{4V_0^2}{3g}\,\frac{3g}{4V_0^2}$$

$V_0 = 180$ mph , $g = 32.2\ ft/s^2$

$$V_0 = 180\ \frac{m}{h} = \frac{180 \times 5280}{3600}\ \frac{ft}{s}$$

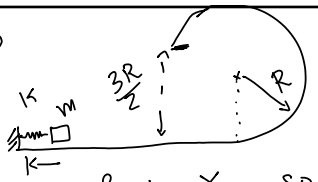
$$= 264\ ft/s$$

$$k = \frac{4 \times 264^2}{3 \times 32.2}$$

$$k = \frac{3 \times 32.2}{4 \times (264)^2}$$

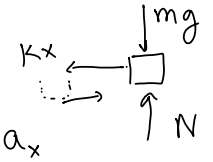
$$k = 3.46 \times 10^{-4}\left[1/ft\right]$$

3.84)



find X_0 so that 'm' does not lose contact.

Spring



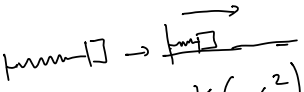
$\Sigma F_x = ma_x$

$\Rightarrow -Kx = m\,a_x$ ($a_x \to \frac{d^2V}{dt^2}$, $\frac{dV}{dt}$, $\frac{V\,dV}{dx}$)

$\Rightarrow mV\frac{dV}{dx} = -Kx$

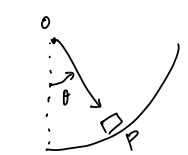
$\Rightarrow V\,dV = -\frac{K}{m}x\,dx$

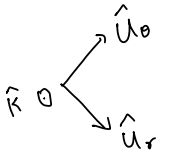
$\Rightarrow \frac{V^2}{2}\Big|_0^{V_0} = -\frac{K}{m}\frac{x^2}{2}\Big|_{-X_0}^{0}$

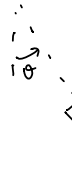


$\Rightarrow V_0^2 = -\frac{K}{m}(-X_0^2)$

$\Rightarrow V_0 = \sqrt{\frac{K}{m}}\,X_0$, $\omega_0 = \omega_b = \frac{1}{r}\sqrt{\frac{K}{m}}\,X_0$







$\Sigma F_r = ma_r = m(\ddot{r} - r\omega^2)$

$-N + mg\cos\theta = -mr\omega^2$

$\Sigma F_\theta = m\,a_\theta = m(r\alpha + 2\dot{r}\omega)$

$-mg\sin\theta = mr\alpha$

$N = 0$ at top, π

$$-N + mg\cos\theta = -mr\omega^2$$

$$-0 + mg\cos\pi = -mr\omega_t^2$$

$$-mg = -mr\omega_t^2$$

$$\omega_t^2 = g/r$$