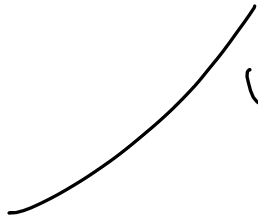
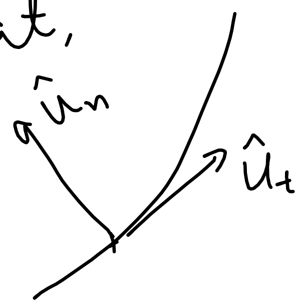


$$y = Kx^2$$

$$V = 180 \; m/h$$

find K so that,

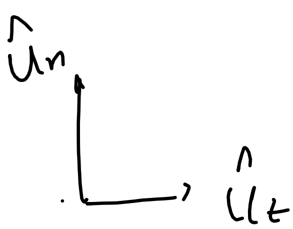
$$\underline{\vec{a}(x=0) = 1.5g}$$



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

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

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



$$y = Kx^2$$

$$y = Kx^2$$

$$\frac{dy}{dx} = 2Kx, \quad \frac{d^2y}{dx^2} = 2K$$

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

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

$$\vec{a} = \dot{\vec{V}} = \cancel{\dot{V}}^{0} \hat{U}_t + \frac{V^2}{\rho} \hat{u}_n$$

$$\vec{a} = \dot{\vec{V}} = 2KV_0^2 \quad \hat{u}_n = 1.5g\,\hat{u}_n$$

$$2K V_0^2 = 1.5g$$

$$\Rightarrow \quad K = \cancel{\frac{4V_0^2}{3g}} \; \frac{3g}{4V_0^2}$$

$$V_0 = 180 \text{ mph}, \quad g = 32.2 \text{ ft/s}^2$$

$$V_0 = 180 \; \frac{m}{h} = \frac{\cancel{180} \times 528\cancel{0}}{\cancel{3600}\; 2\cancel{0}} \; \frac{ft}{s}$$

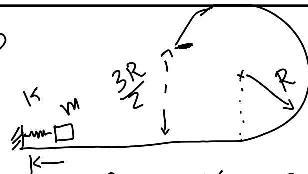
$$= 264 \text{ ft/s}$$

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

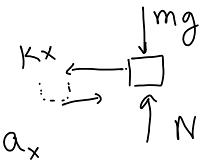
$$K = \frac{3 \times 32.2}{4 \times (264)^2}$$

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

3.84)



find x_0 so that 'm' does not lose contact.



Spring

$$\sum F_x = m a_x$$

$$\Rightarrow -kx = m a_x \quad a_x: \ \frac{v\,dv}{dx} \checkmark,\ \frac{dv}{dt},\ \frac{d^2v}{dt^2}$$

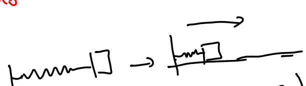
$$\Rightarrow m v \frac{dv}{dx} = -kx$$

$$\Rightarrow v\,dv = -\frac{k}{m} x\,dx$$

$$\Rightarrow \frac{v^2}{2}\Big|_0^{v_0} = -\frac{k}{m}\frac{x^2}{2}\Big|_{-x_0}^{0} \rightarrow -\frac{k}{m}\left(0^2 - (-x_0)^2\right)$$

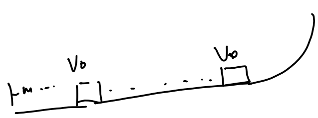
$\vec{v} = \cancel{\dot r}^{\,0}\hat{u}_r + r\omega\hat{u}_\theta$

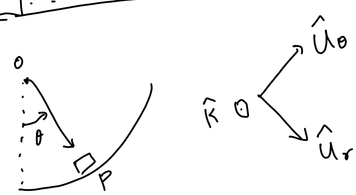
$r\omega\hat{u}_\theta = v_0\hat{u}_\theta$

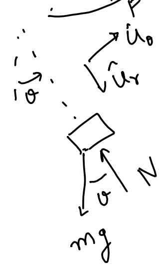


$$\Rightarrow v_0^2 = -\frac{k}{m}\left(-x_0^2\right)$$

$$\Rightarrow v_0 = \sqrt{\frac{k}{m}}\, x_0, \quad \omega_0 = \omega_b = \frac{1}{r}\sqrt{\frac{k}{m}}\, x_0$$







$$\sum F_r = m a_r = m(\cancel{\ddot r}^{\,0} - r\omega^2)$$

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

$$\sum F_\theta = m a_\theta = m(r\alpha + 2\cancel{\dot r}^{\,0}\omega)$$

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

$N = 0$ at top, π

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

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

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

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

$$\omega_b = \frac{1}{r}\sqrt{\frac{k}{m}}\, x_0 \,, \quad \omega_b^2 = \frac{x_0^2}{r^2}\frac{k}{m}$$

Tangential eqn: $\cancel{m} r\alpha = -\cancel{m} g \sin\theta$

$$\frac{\omega\, d\omega}{d\theta} = -\frac{g}{r}\sin\theta$$

$$\int_{\omega_b}^{\omega_t} \omega\, d\omega = \int_0^{\pi} -\frac{g}{r}\sin\theta\, d\theta$$

$$\left.\frac{\omega^2}{2}\right|_{\omega_b}^{\omega_t} = -\frac{g}{r}\Big[-\cos\theta\Big]_0^{\pi}$$

$$LHS = \left(\frac{\omega_t^2 - \omega_b^2}{2}\right) = \frac{1}{2}\left(\frac{g}{r} - \frac{x_0^2}{r^2}\frac{k}{m}\right)$$

$$RHS = -\frac{g}{r}\left.(-\cos\theta)\right|_0^{\pi} = +\frac{g}{r}\Big(+\cos\pi + (-\cos 0)\Big]$$

$$= -\frac{2g}{r}$$

equating LHS & RHS

$$\frac{1}{2}\left(\frac{g}{r} - \frac{x_0^2}{r^2}\frac{k}{m}\right) = -\frac{2g}{r}$$

$$\frac{1}{2}\left(\frac{g}{r} - \frac{x_0^2}{r^2}\frac{k}{m}\right) = -\frac{2g}{r}$$

$$\frac{g}{r} - \frac{x_0^2}{r^2}\frac{k}{m} = -\frac{4g}{r}$$

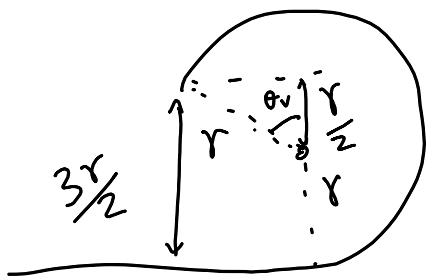
$$\frac{x_0^2}{r^2}\frac{k}{m} = \frac{5g}{r}$$

$$x_0^2 = \frac{5mgr}{k}$$

$$\Rightarrow x_0 = \sqrt{\frac{5mgr}{k}}$$

//

March 2, 2017

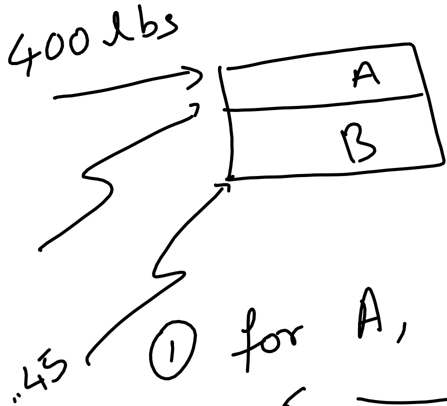


$$\cos\theta = \frac{r/2}{r} = 1/2$$

$$\theta_v = \frac{\pi}{3}$$

$$\theta = \theta_v + \pi \Rightarrow \frac{4\pi}{3}$$

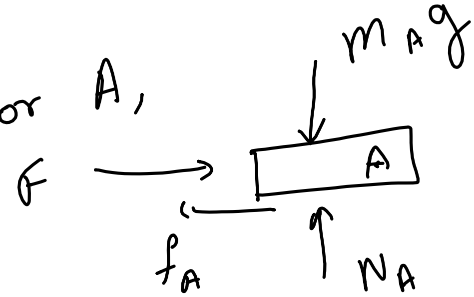
3.114



$W_A = 55$ lbs

$W_B = 73$ lb

① for A,



$\cdots\cdots$ (i)

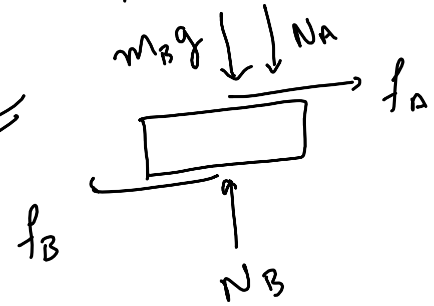
$$\sum F_x = m a_x$$

$$\Rightarrow \quad F - f_A = m_A a_{Ax}$$

$$\sum F_y = m_A a_y = m_A(0) = 0$$

$$N_A - m_A g = 0$$

for B

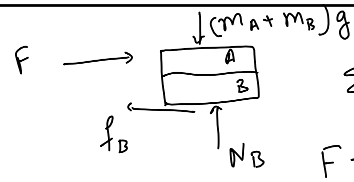


$$\sum F_x = m_B a_{Bx}$$

$$\Rightarrow \quad f_A - f_B = m_B a_{Bx}$$

$$\sum F_y = m_B a_y = m_B(0) = 0$$

$$\Rightarrow \quad N_B - N_A - m_B g = 0$$



$$\sum F_x = m_{AB}\, a_{AB\,x}$$

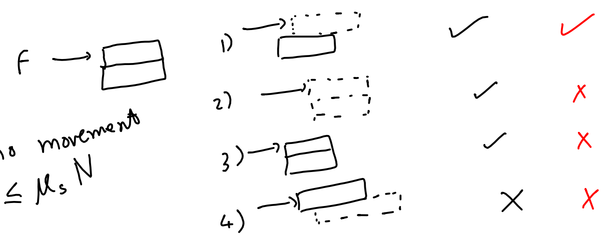
$$F - f_B = m_{AB}\, a_{AB_x}$$
$$= (m_A + m_B)\, a_{AB_x}$$

$$F - f_B = \cancel{(m_A + m_B)} \left(\frac{m_A a_{A_x} + m_B a_{B_x}}{\cancel{m_A + m_B}} \right)$$

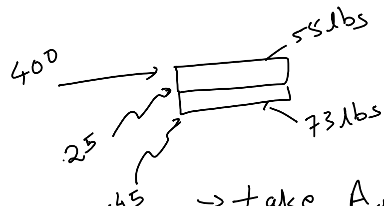
$$F - f_B = m_A a_{A_x} + m_B a_{B_x}$$

$$\sum F_y = m\, a_y = 0$$

$$\Rightarrow \quad N_B - (m_A + m_B) g = 0$$



if no movement
$f \le \mu_s N$



→ take A,

$F = 400$, max f_A can be

$$\mu N = .25 \times 55$$
$$= 13.725 \text{ lb}$$

As $400 > 13.725$ definite movement between A & B.

take B, movement of B is due to f_A. As max f_A is 13.725, max pushing force on B is 13.75 lb

→ sliding will not occur if

$$f_A \le \mu_B N_B = .45 \times 128$$

$$\underbrace{13.725 = f_A \le \mu_B N_B}_{} = 57.6 \text{ lb}$$

B does not move.

B does not move & A moves

$a_{Bx} = 0,$

$f_A = \mu m_A g$

$F - f_A = m_A a_{Ax}$

$\Rightarrow 400 - 13.725 = \frac{55}{32.2} a_{Ax}$

$\Rightarrow \boxed{a_{Ax} = 226.132 \, ft/s^2}$