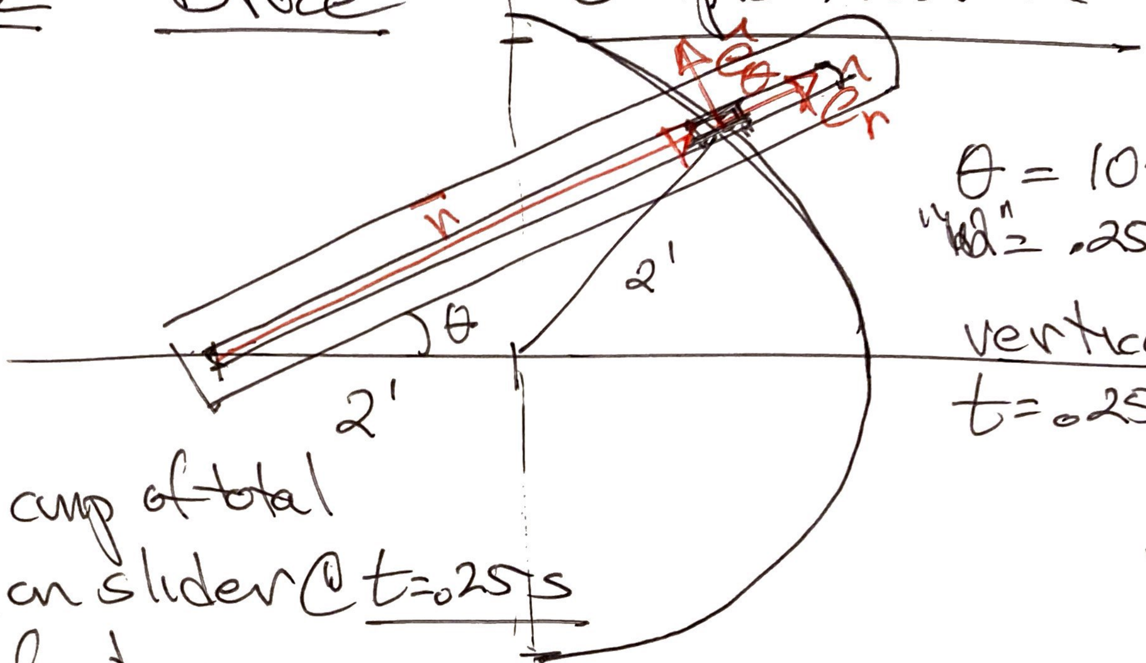
Given



$\theta = 10t^2$

"wt" = .25 lb $m = \dfrac{.25 \text{ lb}}{32.2 \text{ ft/s}^2}$

vertical plane

$t = .25$ s

$m = 7.76 \cdot 10^{-3}$ slug

Req'd Polar comp of total force on slider @ $t = .25$ s

Assump no friction,

Strategy $F_{net} = m\bar{a}_p \Rightarrow$ find a_{polar}, multiply by m and we're there. Freebody diagram to get all force components.

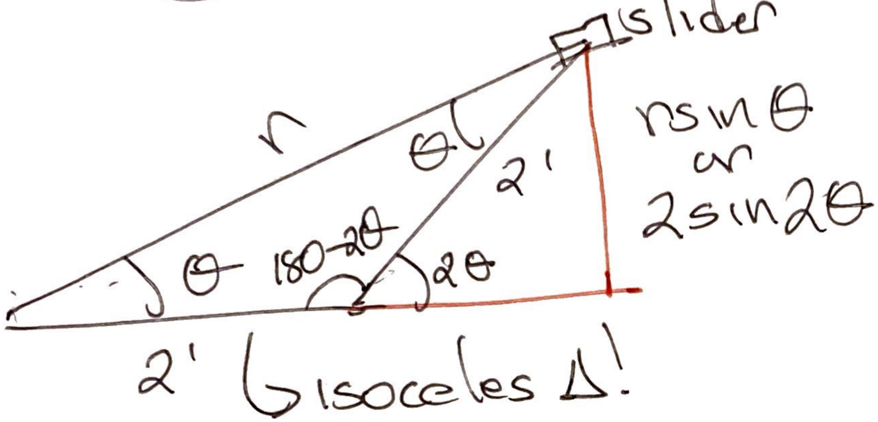
Estimate – tough $\theta = 1$ rad when $t^2 = \frac{1}{10} \Rightarrow .3\text{ s} = t$

circ of circle $= 2\pi r \cong 12' \Rightarrow 1$ rad $= \frac{1}{6}$ of circle

$\Rightarrow s = 2'$ after $.3\text{ s} \cong \omega \cong 3$ rad/s

I expect an inward normal force pushing slider closer to pivot and a upward normal force other than gravity (= .25 lbs)

Geometry before soln

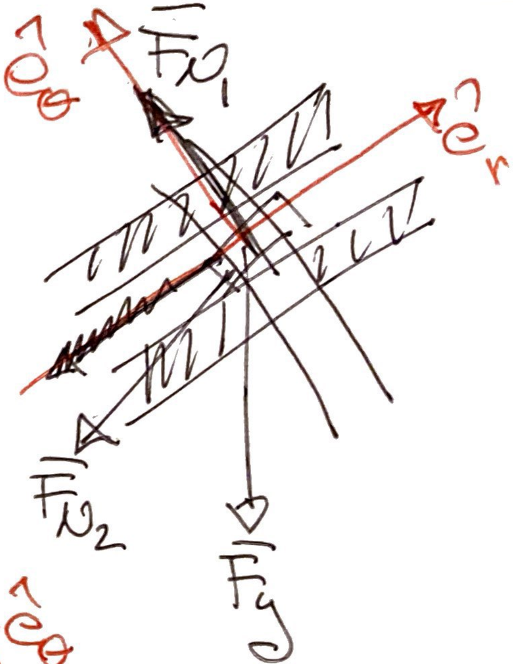


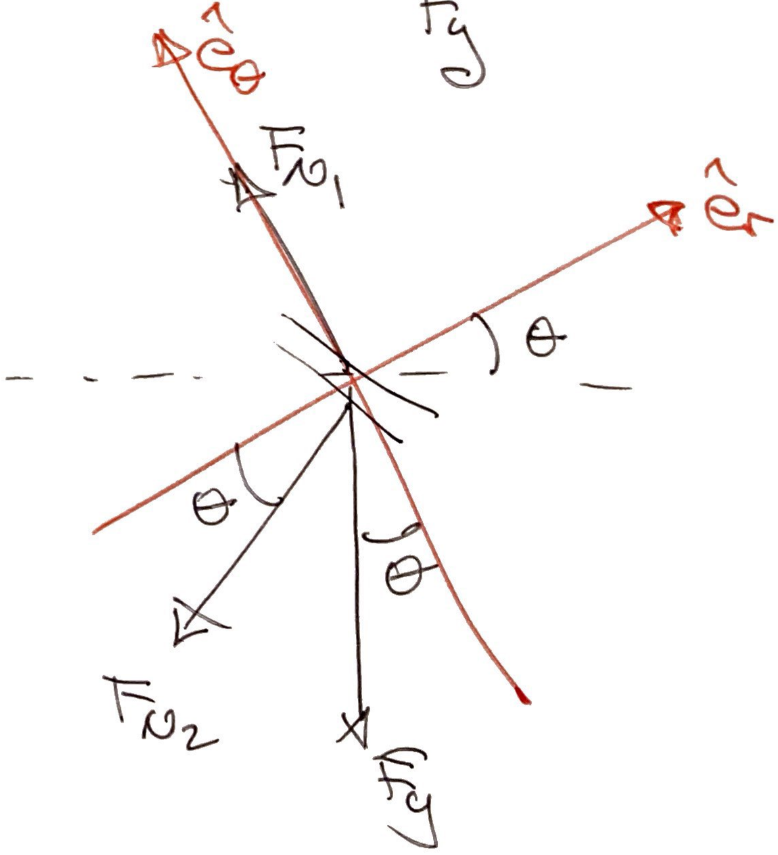
$\Rightarrow r\cancel{\sin\theta} = 2\sin 2\theta$

$= 2(2\cos\theta\cancel{\sin\theta})$

(trig identity)

$\underline{\underline{r = 4\cos\theta}} = 4\cos(10t^2)$





Soln Build Table

	$\hat{e}_\theta$	$\hat{e}_r$
F_g	$-F_g\cos\theta$	$-F_g\sin\theta$
F_{N_1}	F_{N_1}	0
F_{N_2}	$-F_{N_2}\sin\theta$	$-F_{N_2}\cos\theta$
ma	$m\left[r\alpha+2\frac{dr}{dt}\omega\right]$	$m\left[\frac{d^2r}{dt^2}-r\omega^2\right]$

Calculus

$\theta = 10t^2 \quad \theta\big|_{t=1/4} = .625 \text{ rad}$

$\omega = \frac{d\theta}{dt} = 20t \quad \omega\big|_{t=.25} = 5 \text{ rad/s}$

$\alpha = \frac{d\omega}{dt} = 20 \quad \alpha\big|_{t=.25} = 20 \text{ rad/s}^2$

$r = 4\cos\theta = 4\overset{.81}{\cos}(10t^2)$

$r\big|_{t=.25} = 3.24 \text{ ft} < 4$ good!

$\frac{dr}{dt} = -4\sin(10t^2)\cdot 20t$

$= -\underset{20}{80t}\underset{.58}{\sin}(10t^2) = -11.7 \text{ ft/s}$ @ $t=.25s$

$\frac{d^2r}{dt^2} = -80\sin(10t^2)$
$\quad -80t\cos(10t^2)20t$

$= -80\sin(10t^2) - 1600t^2\cos(10t^2)$

@ $t=.25s$

$= -80(.58) - 1600\left(\frac{1}{16}\right).81$

$= -46.4 \text{ ft/s}^2 - 81 \text{ ft/s}^2 = -127.4 \text{ ft/s}^2$

Soln: cont Newton's Laws

$$-F_g\sin\theta - F_{N_2}\cos\theta = m\left[\frac{d^2r}{dt^2} - r\omega^2\right] \quad (\hat{e}_r)$$

$$-F_g\cos\theta + F_{N_1} - F_{N_2}\sin\theta = m\left[r\alpha + 2\frac{dr}{dt}\omega\right] \quad (\hat{e}_\theta)$$

2 unknowns, 2 eqns — sweet!

$$F_{N_2} = \frac{1}{\underset{.81}{\cos\theta}}\left[-\overset{.25\,lb}{F_g}\overset{.58}{\sin\theta} - \underset{7.76\cdot10^{-3}}{m}\left[\overset{-12.7}{\frac{d^2r}{dt^2}} - \overset{3.245^2}{r\omega^2}\right]\right] = 1.23\left[\underset{lbs}{-.145} - \underbrace{7.76\cdot10^{-3}\,[208\ ft/s^2]}_{1.61\ lbs}\right]$$

$$\boxed{F_{N_2} = 1.80\ lbs}$$

$$F_{N_1} = m\left[\overset{3.4\ \ 20}{r\alpha} + 2\overset{-11.7}{\frac{dr}{dt}}\overset{5}{\omega}\right] + \underset{1.8}{F_{N_2}}\overset{.58}{\sin\theta} + \overset{.25}{F_g}\underset{.81}{\cos\theta} = 7.76\cdot10^{-3}\,slg\underset{-.38}{(68-117)} + 1.04\ lb + .203\ lb$$

$$\boxed{F_{N_1} = .863\ lb}$$

Discussion These forces are 3-6 g's which seems plausible. At various check points the values are consistent w/ estimates and F_{N_1} & F_{N_2} are in the directions I expected. whew!