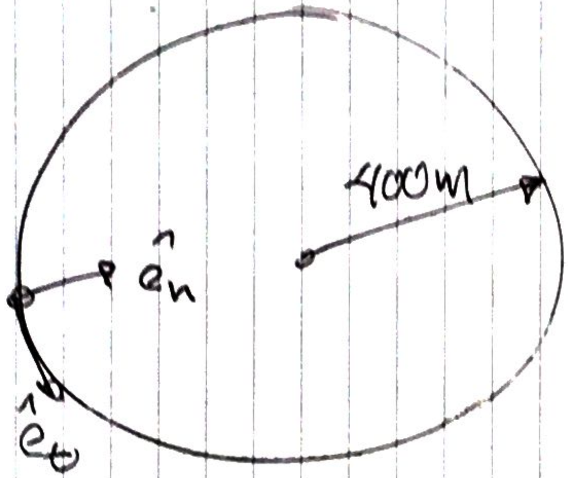
Given:



$a_t = 2 + 0.2t^2 \, m/s$

$\mu_s = .8$

$m = 160 \, kg$

Req'd: t for initial slippage.

Assump: Planar motion, $F_f \leq \mu_s F_N$,

Strategy: determine a(t) for total then $ma = F_f$ = only planar force

Estimate: $a = \frac{v^2}{r}$ is bigger effect

$F_{f_{max}} = .8(160 kg)(10 m/s^2) \cong 1.28 kN \cong m\frac{v^2}{r} \Rightarrow \frac{v^2}{r} \simeq 8 m/s^2$

$v^2 = 8(400) = 3200 \Rightarrow v \cong 55 m/s$

$a_t = 2 m/s$ @ $t=0$, $= 7 m/s$ @ $t=5s$ $= 22 m/s$ @ 10s

looks like t between 5 & 10 s to get to 55 m/s

Soln:

$$a_{n/t} = a_t\hat{e}_t + a_n\hat{e}_n \qquad a_n = r\omega^2 = \frac{v_t^2}{r}$$

$$a_{n/t} = (2+0.2t^2)e_t + [\,?\,]\hat{e}_n \qquad a = \frac{dv}{dt} \Rightarrow \int_0^t a(t)\,dt = \int_0^{v(t)} dv$$

$$\Rightarrow \int_0^t (2+.02t^2)\,dt = v(t) = 2t + \frac{0.2t^3}{3}$$

$$a_{n/t} = (2+0.2t^2)\hat{e}_t + \frac{\left(2t+\frac{0.2t^3}{3}\right)^2}{r}\hat{e}_n$$

$\Rightarrow$ foiling this out to get the magnitude of $|a_{n/t}|$ gives

$$1.9\cdot10^{-5}t^{12} + 2.4\cdot10^{-3}t^{10} + .1t^8 + 2.14t^6 + 16t^4 + 128000t^2 - 6.14\cdot10^6 = 0$$

Wolfram says this ~~has~~ roots @ ± 6.43 s fits.

Looking only @ a_n gives $t = 8.4$ s which is substantially different.

Discussion: Messy problem but it actually works as long as I don't get intimidated by the math.