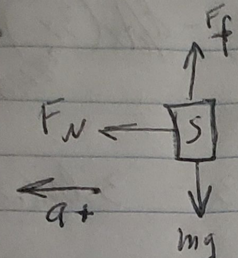
HW#8

1.




$\mu = 0.7 \quad r = 2.5\,m$

$\Sigma F_y = \mu F_N - mg = 0$

$\Sigma F_x = F_N = ma \Rightarrow a = \frac{v^2}{r}$

$\mu m \frac{v^2}{r} - mg = 0 \qquad \mu \frac{v^2}{r} - g = 0$

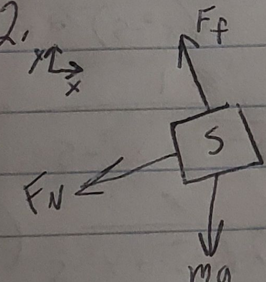
$\frac{\mu v^2}{r} = g \qquad \mu v^2 = rg \qquad v^2 = \frac{rg}{\mu}$

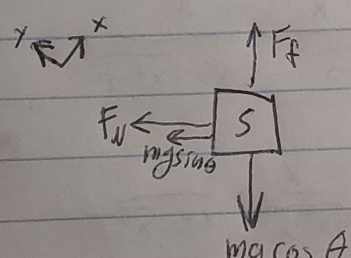
$v = \sqrt{\frac{rg}{\mu}}$ plug in $\sqrt{\frac{(2.5)(9.8)}{0.7}} = 5.92\,m/s$

$C = 2\pi r = 15.71\,m \qquad v = \frac{d}{t} \qquad t = \frac{d}{v}$

$t = \frac{15.71}{5.92} = 2.65\,rps = \boxed{159\,rpm}$

2.




$\theta = 20°$

$\Sigma F_y = \mu F_N - mg\cos\theta = 0$

$\Sigma F_x = F_N + mg\sin\theta = ma$

$F_N = \frac{mg\cos\theta}{\mu} \qquad \mu F_N = mg\cos\theta$

$\frac{mg\cos\theta}{\mu} + mg\sin\theta = m\frac{v^2}{r}$

$\frac{mg\cos\theta}{\mu} + \frac{\mu mg\sin\theta}{\mu}$

$\frac{mg\cos\theta + \mu mg\sin\theta}{\mu} = m\frac{v^2}{r}$

$\cancel{m}(g\cos\theta + \mu g\sin\theta) = \cancel{m}\left(\mu\frac{v^2}{r}\right) \qquad mg\cos\theta + \mu mg\sin\theta = \mu m\frac{v^2}{r}$

$\sqrt{\frac{r\,g\cos\theta + \mu g\sin\theta}{\mu}} = v$ plug in $\sqrt{\frac{(2.5)(9.8)(\cos 20) + (0.7)(9.8)(\sin 20)}{(0.7)}}$

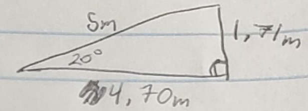
$\frac{15.71}{5.94} = \boxed{158.69\,rpm} \qquad \sqrt{\frac{22.32 + 2.35}{0.7}} \approx 5.94\,m/s$

HW#8

3. $t = \frac{d}{v}$ $4.49 = \frac{7.86}{1.75}$

$\omega = 40 rpm = 1.75 m/s = 0.67 rps$

$d = vt$

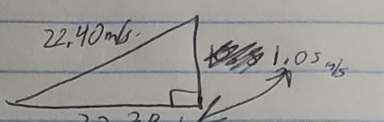



$x_f = v_i t + x_i$ $0 = v_i(4.49) - 4.70$

$\frac{4.70}{4.49} = 1.05 m/s = V_{ix}$

$y_f = \frac{1}{2}at^2 + V_{iy}t + y_i$ $0 = \frac{1}{2}(9.8)(4.49^2) + V_{iy}(4.49) + 1.71$

$\frac{-4.9(4.49)^2 - 1.71}{4.49} = V_{iy} = 22.38 m/s$

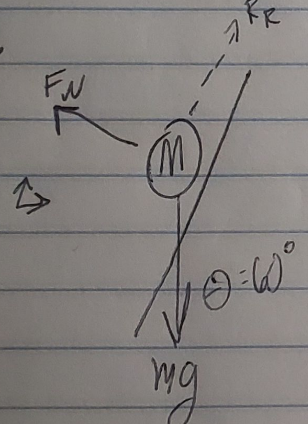



$\sqrt{501.97} = 22.40 m/s$

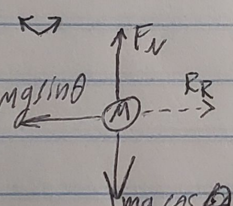
$\tan^{-1}\left(\frac{1.05}{22.38}\right) = \cancel{2.69°} \rightarrow 87.31°$

Stan's vomit was launched at 22.40m/s at 87.31° above horizontal

4.




$m = 0.05 kg$




$\Sigma F_y = F_N - mg\cos\theta = 0$

$\Sigma F_x = mg\sin\theta = ma \rightarrow \frac{v^2}{r}$

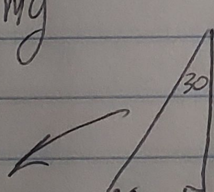
$g\sin\theta = \frac{v^2}{r}$

$\cancel{(0.05)}(9.8)(0.87)$ $rg\sin\theta = v^2$

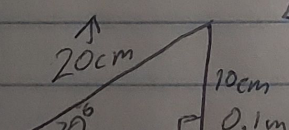
$v = \sqrt{rg\sin\theta}$

$0.92 \, m/s = v = \sqrt{(0.1)(9.8)(0.87)}$

a. $\boxed{0.92 m/s}$




0.2m




$r = 0.1$

$\sqrt{\frac{r(mg\sin\theta - R_R)}{m}} = v$

b. Rolling resistance would act in the opposite direction as $mg\sin\theta$ and would change $\Sigma F_x = mg\sin\theta = m\frac{v^2}{r}$ to $\Sigma F_x = mg\sin\theta - R_R = m\frac{v^2}{r}$. It would need a force higher than what $mg\sin\theta$ can be so y won't change.

1. $F(x) = \ln\left(\frac{2x^{3/2}}{\sin x}\right) \rightarrow \frac{\sin x}{2x^{3/2}} \cdot \frac{d}{dx}\left[\frac{2x^{3/2}}{\sin x}\right]$

$$\frac{(\sin x)(3x^{1/2}) - (2x^{3/2})(\cos x)}{\sin^2 x} \cdot \frac{\cancel{\sin x}}{2x^{3/2}}$$

$$\boxed{\frac{3\sqrt{x}\,\sin x - 2x^{3/2}\cos x}{2x^{3/2}\sin x}}$$

2.

$G(x) = \frac{x\sqrt{x^2+1}}{(x+1)^{2/3}} \rightarrow \ln G(x) = \ln\left(\frac{x\sqrt{x^2+1}}{(x+1)^{2/3}}\right)$

$$\ln G(x) = \underbrace{\ln\left(x\sqrt{x^2+1}\right)}_{\text{product}} - \ln\left((x+1)^{2/3}\right)$$

$$(x) \cdot \frac{d}{dx}\left((x^2+1)^{1/2}\right) + (1) \cdot \left(\sqrt{x^2+1}\right)$$

$\frac{1}{2}(x^2+1)^{-1/2}$

$1/2\sqrt{x^2+1}$

3. $p(t) = 5500e^{0.0375t}$ $\qquad \frac{11000}{5500} = \frac{5500e^{0.0375t}}{5500}$ $\qquad 2 = e^{0.0375t}$

$\boxed{a.\ t = 18.48 \text{ years}}$

$\boxed{b.\ p'(t) = 0.0375\, p(t)}$

$\boxed{c.\ 300.1}$