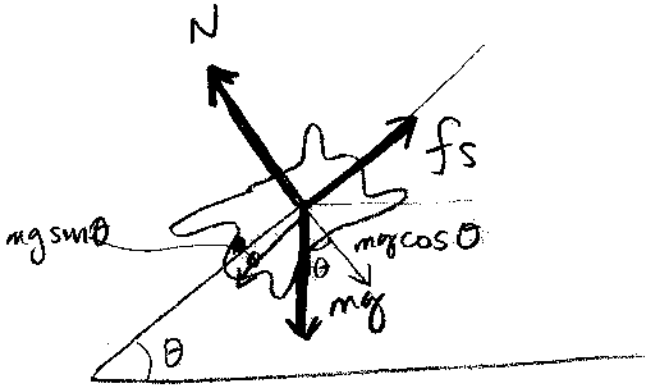
Quiz 2 Solutions



$$\sum \vec{F} = 0$$

$$\sum F_x = 0 \qquad \sum F_y = 0$$

$$mg\sin\theta - f_s = 0 \qquad N - mg\cos\theta = 0$$

At slipping $f_s = \mu_s N$ $\qquad N = mg\cos\theta$

$$mg\sin\theta - \mu_s N = 0$$

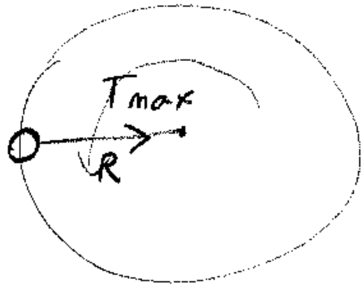
$$mg\sin\theta - \mu_s mg\cos\theta = 0$$

$$\tan\theta = \mu_s$$

$$\boxed{\theta = \tan^{-1}\mu_s}$$

Problem 2

a)



$R = 0.5\ M$

$m = 0.5\ kg$

$T_{max} = 20\ N$

$\hat{r}$ dir

$$T_{max} = m\,a_{max} = \frac{m V_{max}^2}{R}$$

$$V_{max} = \sqrt{\frac{R\,T_{max}}{m}} = \underline{\underline{4.4\ m/s}}$$

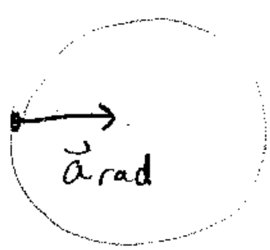
b) $U = R\omega \Rightarrow \omega_{max} = \frac{4.4}{0.5} = \underline{\underline{8.9\ rad/s}}$

$dir(\omega)$ = out of paper ⊙

This direction does not change after the monkey starts slowing down (still CCW)

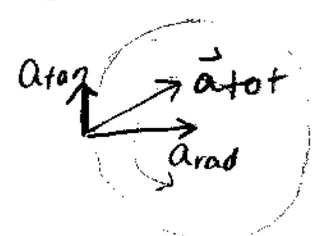
c)

Before



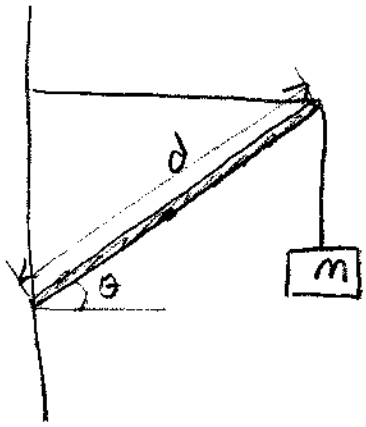
Radial acceleration

After starts slowing

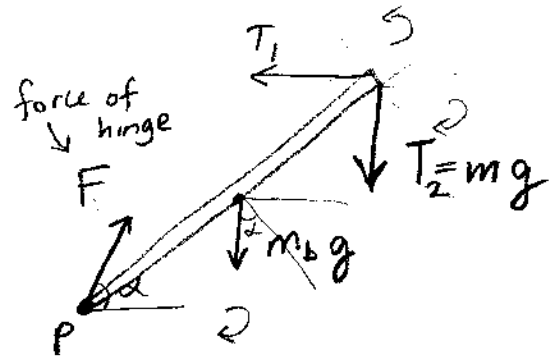


Has radial and tangential components

Problem 3



FBD for boom



a) Apply conditions for static equilibrium

$$\sum \vec{F} = 0$$

$\sum F_x = 0$

$F\cos\alpha - T_1 = 0$ ①

$\sum F_y = 0$

$F\sin\alpha - T_2 - m_b g = 0$ ②

$$\sum \vec{\tau} = 0$$

Choose pivot at hinge

$$-\frac{\ell}{2} m_b g \cos\theta - T_2 \cos\theta\, \ell + T_1 \sin\theta\, \ell = 0 \quad (3)$$

($T_2 = mg$)

$$\boxed{T_1 = g\left(\frac{m_b}{2} + m\right)\cot\theta}$$

① → $F\cos\alpha = T_1 = g\left(\frac{m_b}{2} + m\right)\cot\theta$

② → $F\sin\alpha = mg + m_b g$

Dividir $\frac{②}{①}$ ⇒ $\boxed{\tan\alpha = \dfrac{(m_b + m)}{\left(\frac{m_b}{2} + m\right)\cot\theta}}$

c) $|\vec{F}| = \sqrt{F_x^2 + F_y^2}$

$F_x = F\cos\alpha = T = g\left(\frac{m_b}{2} + m\right)\cot\theta$

$F_y = F\sin\alpha = mg + m_b g$

$$\boxed{|\vec{F}| = g\left(\left(\frac{m_b}{2} + m\right)^2 \cot^2\theta + (m_b + m)^2\right)^{1/2}}$$

Problem 4

a) $b = \text{slope of } \log F_m \text{ vs } \log S_c = \dfrac{\log(0.34) - \log(0.055)}{\log(10) - \log(25)}$

$$\boxed{b = -2.0}$$

b) $F \propto N$

$$\frac{N_1}{N_2} = \frac{S_{c_1}{}^{b}}{S_{c_2}{}^{b}} = \left(\frac{S_{c1}}{S_{c2}}\right)^{-2} \qquad \text{for } b = -2$$

$$\frac{S_{c_2}}{S_{c_1}} = \frac{10}{20} \Rightarrow N_2 = \left(\frac{S_{c_2}}{S_{c_1}}\right)^{-2} N_1 = \left(\frac{1}{2}\right)^{-2} N_1$$

$$\boxed{N_2 = 4N_1}$$