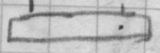
$m = 0.144\,kg$

25cm 75cm

1. $T_L = ?$ $\quad \Sigma F = T_L + T_R - mg = 0$ $\quad \Sigma\tau = T_L(0.25) - T_R(0.25) = 0$

$2T_L = mg$ $\quad T_L = T_R$

$T_L = \frac{(0.144)(9.8)}{2} = 0.7056\,N$

2. 

$\alpha_0 = ?$ $\quad \Sigma\tau = I\alpha = -0.125\left(\frac{0.144}{4}\right)(9.8) + \left(\frac{3}{4}\right)(0.144)(0.375)(9.8)$ $\quad I = \frac{1}{3}MR^2 + MD^2$

$I\alpha = 0.3528 = \left(\frac{1}{3}MR^2 + MD^2\right)\alpha$ $\quad 0.3528 = \left(\frac{1}{3}(0.144)(0.5)^2 + (0.144)(0.25)^2\right)\alpha$

$0.3528 = 0.021\alpha$ $\quad \alpha = 16.8\ rad/s^2$

3. $T_L = ?$ after cut

$\Sigma F = ma = T_1 - mg$ $\quad a = \alpha R$

$1.24m = T_1 - (0.144)(9.8)$ $\quad a = (16.8)(0.25) = 4.2$

$T_1 = 0.8064\,N$

4. ω when it is vertical? $\quad \omega_f^2 = \omega_0^2 + 2\alpha(\theta - \theta_0)$

$\alpha_{avg} = \frac{1}{\pi/2}\int_0^{\pi/2} 16.8\sin\theta\, d\theta = 16.8 \cdot \frac{2}{\pi} \approx 10.69$

$\omega_f^2 = 0 + 2(10.69)(\pi/2 - 0) = 33.6$ $\quad \sqrt{33.6} \approx 5.79655\ \frac{rad}{s}$

5 a_{cm} when vertical?

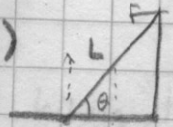
$a_c = v^2/r \rightarrow v = \omega R$

$a_{ccm} = \frac{\omega^2 R^2}{R} = \omega^2 R = 33.6 \cdot 0.25 = 8.4\ m/s^2$

6. T when vertical?

$\Sigma F = ma = T - mg$ $\quad T - (0.144)(9.8) = (0.144)(8.4)$

$T = 0.2016$

3) 

$L = 2.6\,m$ $\quad m = 15\,kg$ $\quad \mu_s = 0.48$ $\quad$ No friction w/ wall

1. $\vec{N}_{floor} = ?$ $\quad \Sigma F_y = \vec{N}_{floor} - mg = 0$ $\quad \vec{N}_{floor} = mg = 15(9.8) = 147\,N$

2. $\theta_{min} = ?$ to not slip $\quad f_s \le \mu_s \vec{N}_{floor}$

$\Sigma\tau = \frac{L}{2}mg\sin(90-\theta) - \vec{N}_{wall}L\sin\theta = 0$ $\quad \frac{L}{2}mg\cos(90-\theta) = \vec{N}_{wall}L\sin\theta$

↳ or using dist ↳ $\frac{L}{2}mg\cos\theta$

$\Sigma F_x = f_s - N_{wall} = 0$ $\quad N_{wall} = f_s$

$\frac{L}{2}mg = \vec{N}_{wall}L\tan\theta$ $\quad \tan\theta = \frac{mg}{2\mu_s N_{floor}} = 1.0416 \rightarrow \theta \approx 46.17°$

3. 

$M = 65\,kg$ $\quad \vec{N}_{floor} = ?$ $\quad d = \frac{L}{2}\cos\theta$

$\Sigma F_y = -Mg - mg + N_{floor} = 0$ $\quad N_{floor} = 784\,N$

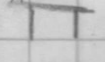
4) $\theta_{min} = ?$

$\Sigma\tau = \frac{L}{2}\cos\theta \cdot mg + L\cos\theta \cdot Mg - N_{wall} \cdot L\sin\theta = 0$ $\quad \Sigma F_x = f_s - N_{wall} = 0$ $\quad f_s = N_{wall} = \mu N_{floor}$

$\Rightarrow mg\cos\theta + 2Mg\cos\theta = 2\mu_s N_{floor}\sin\theta$ $\quad \frac{mg + 2Mg}{2\mu_s N_{floor}} = \tan\theta \approx 1.188$

$\theta \approx 62.09°$

3. How much mass can the gymnast hold before it begins to tip: $F_R = 0$



$\Sigma F = F_L + F_R - m_1 g - m_2 g \rightarrow F_L - m_1 g - m_2 g = 0 \quad F_L = m_1 g + (108)(9.8)$

$\Sigma \tau = \frac{5}{6} F_L - \frac{5}{6} F_R - \frac{5}{2} m_1 g \rightarrow \frac{5}{6} F_L - \frac{5}{2} m_1 g = 0 \quad \frac{5}{6} F_L = \frac{5}{2} m_1 g \quad 2F_L = 6 m_1 g$

$2(m_1' g + 1058.4) = 6 m_1 g \qquad 2116.8 = 4 m_1' g - m_1 g = 529.2 \quad m_1' = 54$

$m_1' - m_1 = 54 - 41 = \boxed{13 \text{ kg}}$

4.

Directly over R, what is F_L?

$\Sigma F = F_L + F_R - m_1 g - m_2 g = 0 \quad F_R = m_1 g + m_2 g - F_L$

$\Sigma \tau = \frac{5}{6} F_L - \frac{5}{6} F_R + \frac{5}{6} F_1 = 0 \quad F_R = F_L + m_1 g$

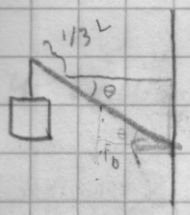
$m_1 g + m_2 g - F_L = F_L + m_1 g \quad m_2 g = 2F_L$

$F_L = \frac{m_2 g}{2} = \frac{(108)(9.8)}{2} = 529.2 \text{ N}$

5. $F_R = ?$

$F_R = m_1 g + m_2 g - F_L = 401.8 + 1058.4 - 529.2 = \boxed{931 \text{ N}}$

5)



$m_b = 6.1 \text{ kg} \quad \theta = 32.6°$

$m_s = 16.8 \text{ kg} \quad \Sigma F_y = m_b g - m_s g + F_{hy} = 0$

$L = 2.43 \text{ m} \quad \Sigma F_x = -F_w + T_x = 0$

$\Sigma \tau = -(2.43)(16.8)(9.8)\sin(57.4) - 1.215(6.1)(9.8)\sin(57.4) + (1.62) T \sin(32.6) = 0$

1. $(-400.0752 - 72.6327)\sin(57.4) + 1.62 T \sin(32.6) = 0$

$T = 456.267 \text{ N} \qquad T \sin(32.6) = 245.8233872$

2. If of hinge on beam?

$\Sigma F_x = T_x - F_{hx} = 0 \quad T_x = F_{hx} = T = 456.267 \text{ N}$

$\Sigma F_y = F_{hy} - m_b g - m_s g = 0 \quad F_{hy} = 224.42 \text{ N}$

$\Sigma F_h \rightarrow F_h = \sqrt{F_{hy}^2 + F_{hx}^2} = \boxed{508.472 \text{ N}}$

3. $T_{max} = 977 \text{ N}$

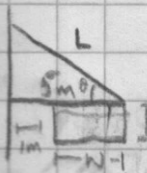
Max $m_s = ? = m'$

$\Sigma \tau = (1.62)(977)\sin(32.6) - (2.43) m' (9.8)\sin(57.4) - 1.215(6.1)(9.8)\sin(57.4) = 0$

$791.5444801 = (2.43) m' (9.8)\sin(57.4) \quad m' = 39.454596 \text{ kg}$

Homework 20

1)



$m = 1050 \text{ kg} \quad h = 1 \text{ m} \quad w = 4 \text{ m} \quad \theta = 23°$

μ to keep the sign up?

$\Sigma \tau = -T(w-1)\sin\theta + (1 + \frac{w}{2}) mg = 0 \quad -5T\sin(23) + 3(1050)(9.8) = 0 \quad T = 15801.$

$\Sigma F_x = F_N - T_x = 0 \quad F_N = T_x = T\cos\theta = 14545.03 \text{ N}$

$\Sigma F_y = \mu F_N + T_y - mg = 0 \quad \mu F_N = mg - T_y$

$\mu 14545 = (1050)(9.8) - 15801\sin 23$

$\mu = 0.2829832108$