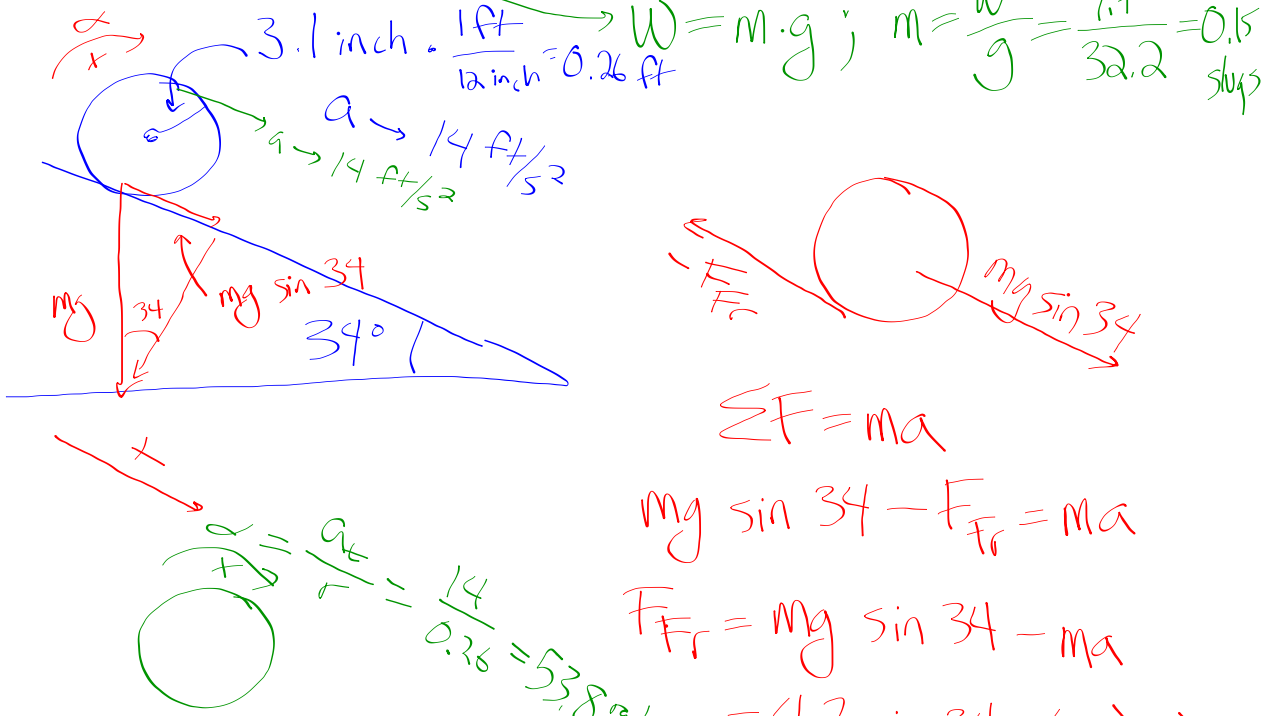
27. A 4.7-lb object with a 3.1-inch radius rolls down a 34° slope at 14 ft/sec^2. What is its moment of inertia? [.0028 slug·ft^2]



$W = m \cdot g$; $m = \frac{W}{g} = \frac{4.7}{32.2} = 0.15$ slugs

$\Sigma F = ma$

$mg \sin 34 - F_{Fr} = ma$

$F_{Fr} = mg \sin 34 - ma$

$= 4.7 \sin 34 - (0.15)(14)$

$= 0.53$ lbs

$\Sigma \tau = I\alpha$

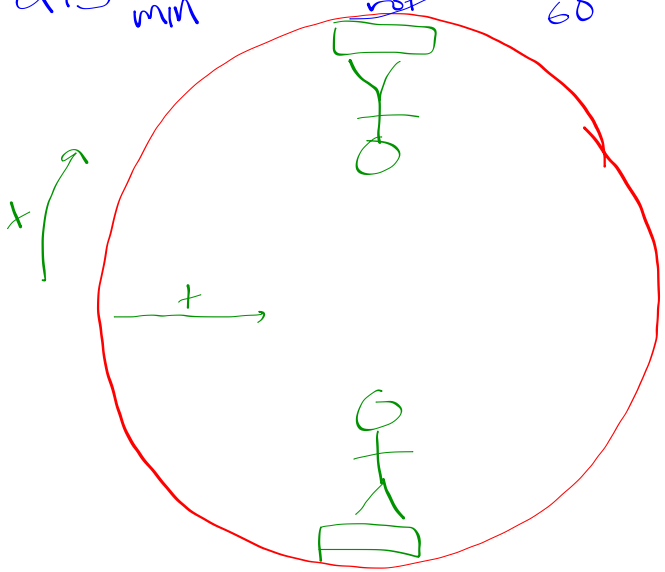
$F_{Fr} \cdot r = I\,(53.8)$

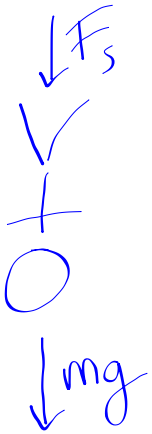
$(0.53)(0.26) = I\,(53.8)$

$I = 2.58 \times 10^{-3}$ slug·ft^2

22. What are the apparent weights of a 85-kg passenger at the top and the bottom of a 5-meter radius Ferris Wheel turning at 2.3 RPM? [Top: 808.4 N; bottom: 857.6 N]

$2.3\frac{\text{rot}}{\text{min}} \cdot \frac{(2)\pi(5)\text{m}}{\text{rot}} \cdot \frac{1\text{ min}}{60} = 1.2\text{ m/s}$





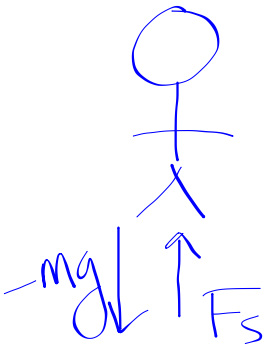
$\Sigma F = ma = F_c$

$F_s + mg = \frac{mv^2}{r}$

$F_s = \frac{mv^2}{r} - mg$

$= \frac{(85)1.2^2}{5} - (85)(9.8)$

$= \boxed{808.52\text{ N}}$

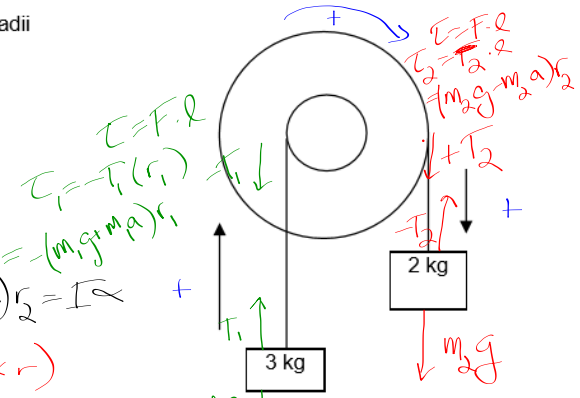


$\Sigma F = F_c$

$F_s - mg = \frac{mv^2}{r}$

$F_s = \frac{mv^2}{r} + mg = \boxed{857.5\text{N}}$

26. A two-disk Atwood machine with radii of 15-cm and 38-cm, has a moment of inertia of 4 kg·m^2. What is the acceleration of the mass on the right? [.265 m/sec^2]



$\tau = F \cdot R$

$\tau_1 = -T_1(r_1)$

$= -(m_1g + m_1a)r_1$

$\tau_2 = T_2 \cdot R$

$= (m_2g - m_2a)r_2$

$\Sigma\tau = I\alpha$

$-(m_1g + m_1a)r_1 + (m_2g - m_2a)r_2 = I\alpha$

$\left(\alpha = \frac{a_t}{r};\ a_t = \alpha r\right)$

$-(m_1g + m_1\alpha r_1)r_1 + (m_2g - m_2\alpha r_2)r_2 = I\alpha$

$-m_1gr_1 - m_1\alpha r_1^2 + m_2gr_2 - m_2\alpha r_2^2 = I\alpha$

$I\alpha + m_1\alpha r_1^2 + m_2\alpha r_2^2 = m_2gr_2 - m_1gr_1$

$\alpha = \frac{m_2gr_2 - m_1gr_1}{I + m_1r_1^2 + m_2r_2^2} = \frac{2(9.8)(.38) - 3(9.8)(.15)}{4 + 3(.15)^2 + 2(.38)^2}$

$\Sigma F = ma$

$T_1 - mg = m_1a$

$T_1 = m_1g + m_1a$

$-T_2 + m_2g = m_2a$

$T_2 = m_2g - m_2a$

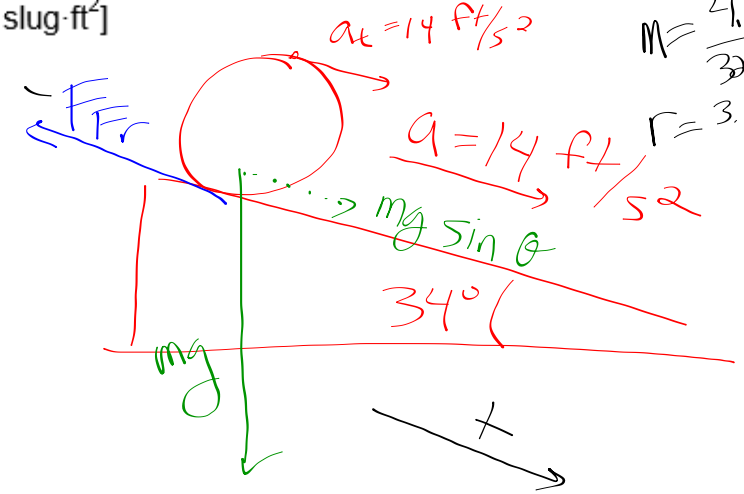
$0.71 = \alpha = \frac{7.5 - 4.41}{4 + 0.068 + 0.29}$

$\alpha = \frac{a_t}{r}$

$a_t = \alpha r = 0.71 \cdot 0.38$

$= 0.269\ m/s^2$

27. A 4.7-lb object with a 3.1-inch radius rolls down a 34° slope at 14 ft/sec^2. What is its moment of inertia? [.0028 slug·ft^2]



$m = \frac{4.7}{32.2} = 0.15$ slugs

$r = \frac{3.1" \cdot 1\text{ft}}{12"} = 0.26$ ft

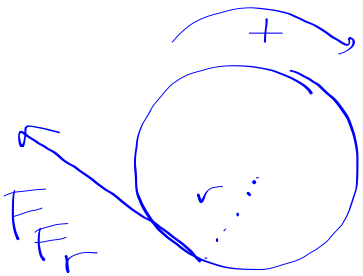
$\sum F = ma$

$-F_{Fr} + mg\sin\theta = ma$

$F_{Fr} = mg\sin\theta - ma$

$= 4.7\sin 34 - (0.15)(14)$

$F_{Fr} = 0.53$ lbs



$\alpha = \frac{a_t}{r}$

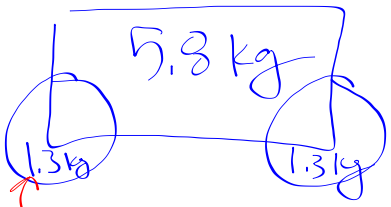
$\alpha = \frac{14}{0.26} = 53.8$ rad/s^2

$\sum t = I\alpha$

$F_{Fr} \cdot r = I\alpha$

$I = \frac{F_{Fr} \cdot r}{\alpha} = \frac{(0.53)(0.26)}{53.8} = 2.6 \times 10^{-3}$

29. A bicycle has a 5.8 kg frame and two wheels, each at 1.3 kg. What is its total kinetic energy when it's rolling at 6 m/sec? [198 J]



$KE_{tot} = KE_{lin} + KE_{rot}$

$\frac{1}{2}Iw^2 = \frac{1}{2}(mr^2)\left(\frac{v}{r}\right)^2 = \frac{1}{2}mv^2$

$\underbrace{\frac{1}{2}mv^2}_{wheel_1} + \underbrace{\frac{1}{2}mv^2}_{wheel_2} + \underbrace{\frac{1}{2}mv^2}_{bike} = KE_{lin}$

$I = mr^2$

$v = 6\ m/s = w \cdot r$

$w = \frac{6}{r}$

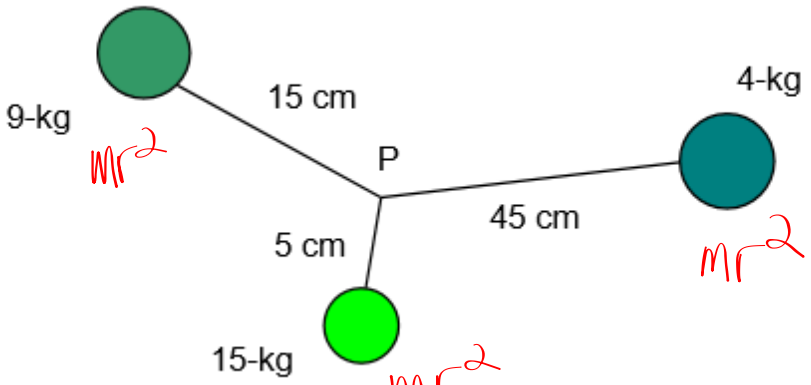
$\underbrace{\frac{1}{2}mv^2}_{wheel_1} + \underbrace{\frac{1}{2}mv^2}_{wheel_2} = KE_{rot}$

$\frac{1}{2}(1.3)(6)^2 + \frac{1}{2}(1.3)(6)^2 + \frac{1}{2}(5.8)(6^2) = 151.2\ J$

$\frac{1}{2}(1.3)(6^2) + \frac{1}{2}(1.3)6^2 = 46.8\ J$

$KE_{tot} = 198\ J$

24. Calculate the moment of inertia of the system shown at right. Assume the system rotates about point P. [1.05 kg·m^2]



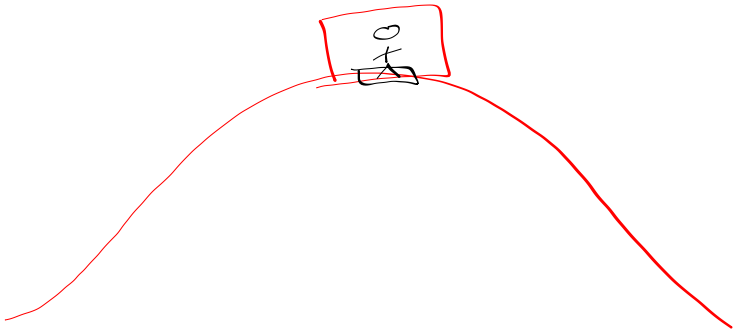
$I_{tot} = \Sigma I_{parts}$

mr^2 mr^2 mr^2

$= (9)(0.15)^2 + 15(0.05)^2 + 4(0.45)^2$

$= 1.05 \text{ kg} \cdot \text{m}^2$

19. A car speeds over a hill at 18 m/sec. If the hill has a radius of 130 meters, what is the apparent weight of a 70-kg passenger at the top of the hill? [511.5 N]



$F_g = F_c$

$\Sigma F = ma$

$mg - F_s = ma = \frac{mv^2}{r}$

$F_s = mg - \frac{mv^2}{r} = (70)(9.8) - \frac{(70)18^2}{130}$

$= 511.5N$

$W = m \cdot g = 5 \cdot 9.8$

$\simeq 50\ N$

85 N (apparent weight)