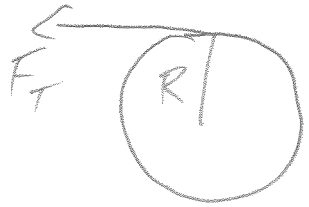
Physics 10154 - Summer 2013 - Exam #4B

Instructions: Be sure to SHOW ALL WORK and clearly indicate your answers. I will not give full credit if I cannot logically follow how you got your answer, even if the answer is correct. Partial credit will be given provided you are solving parts of the problem correctly. Clearly indicate your final answer, including correct units and significant figures.

1. (30 pts) A large uniform cylinder in a factory has a mass of 2500 kg and a radius 52 cm. The cylinder is initially at rest. A thin, massless rope is wrapped around the cylinder, and a machine pulls the rope tangentially to make the cylinder rotate. There is a 45 N-m frictional torque opposing the rotation. If the cylinder reaches a rotation speed of 33 revolutions per minute in 25 seconds, what is the tension in the rope?

$I = \frac{1}{2}MR^2 = 338\ kg \cdot m^2$



$\Sigma\tau = \tau_T - \tau_{Fric} = I\alpha$

$= +RF_T \sin 90 - 45 = I\alpha$

$\Delta\theta = ?$

$\omega_0 = 0$

$\omega = 33\frac{rev}{min} = 3.456\ rad/s$

$\alpha = ?$

$t = 25\ s$

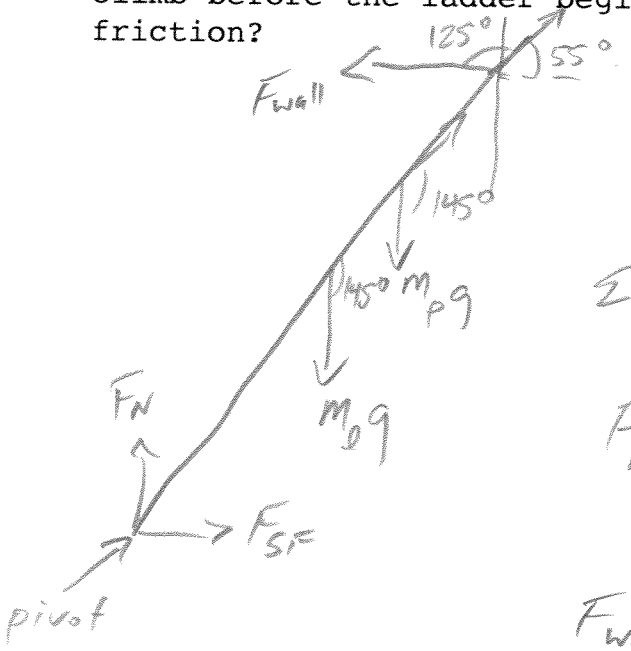
$\omega = \omega_0 - \alpha t$

$\alpha = \frac{3.456 - 0}{25} = 0.138\ rad/s^2$

$0.52F_T - 45 = (338)(0.138)$

$F_T = 180\ N$

2. (30 pts) A uniform 15-kg, 8.0-meter long ladder rests against a smooth wall. Because the wall is smooth, the only force the wall exerts on the ladder is perpendicular to the wall. The ladder makes an angle of 55° above the horizontal. The coefficient of static friction between the ladder and the ground is 0.64. How far up the ladder can a 65-kg person climb before the ladder begins to slip, overcoming static friction?



about to slip

$$\Sigma F_x = -F_{wall} + \mu_s F_N = 0$$

$$\Sigma F_y = F_N - m_l g - m_p g = 0$$

$$F_N = (15)(9.8) + (65)(9.8)$$

$$= 784$$

$$F_{wall} = (.64)(784) = 502\ N$$

$$\Sigma \tau = \tau_l + \tau_p + \tau_{wall} = 0$$

$$= -(4.0)(15)(9.8)\sin 145 - x(65)(9.8)\sin 145 + (8.0)(502)\sin 125° = 0$$

$$= -337.3 - 365.4x + 3289.7 = 0$$

$$-365.4x = 2952.4$$

$x = 8.1\ m$, so top of ladder

3. (40 pts) An object weighs 550 Newtons in air and 380 Newtons when immersed in water. What is (a) the volume of the object and (b) the density of the object?

$$\rho_o V_o g = 550$$

$$\underbrace{\rho_o V_o g}_{\uparrow} - \rho_f \underbrace{V_f}_{\uparrow} g = 380$$

$\uparrow$ 550 $\qquad$ $\uparrow$ V_o since it is immersed

$$550 - \rho_f V_o g = 380$$

$$170 = (1000) V_o (9.8)$$

$$V_o = .017\ m^3$$

$$\rho_o = \frac{550}{(.017)(9.8)} = 3200\ kg/m^3$$