Name_____

Physics 110 Quiz #5, May 23, 2025

Please show all work, thoughts and/or reasoning to receive partial credit. The quiz is worth 10 points total.

I affirm that I have carried out my academic endeavors with full academic honesty.

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1. A cylinder of mass $m = 200g$, radius $r = 5cm$, and moment of inertia $I = \frac{1}{2}mr^2$ is held at rest on the top of an incline by a light string. If the ramp is inclined at $\theta = 25^0$, what is the tension in the string?
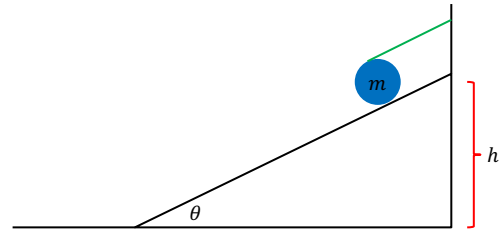
The forces parallel to the ramp:

$$F_T - F_{Wx} = ma_x = 0$$

$$F_T = F_{Wx} = mg \sin\theta = 0.2kg \times 9.8\frac{m}{s^2} \sin 25 = 0.83N$$

2. Suppose that the string is cut, at which point the cylinder begins to roll down the ramp. If the center of the cylinder starts from a height $h = 50cm$ of above the ground, what is the translational speed of the cylinder when it reaches the horizontal surface?

$$\Delta E_{system} = \Delta K_T + \Delta K_R + \Delta U_g + \Delta U_s = \Delta K_T + \Delta K_R + \Delta U_g$$

$$0 = \frac{1}{2}mv_f^2 + \frac{1}{2}I\omega_f^2 + (mgy_f - mgy_i)$$

$$0 = \frac{1}{2}mv_f^2 + \frac{1}{2}\left(\frac{1}{2}mr^2\right)\left(\frac{v_f}{r}\right)^2 + mg(r - h)$$

$$v_f = \sqrt{\frac{4}{3}g(h - r)} = \sqrt{\frac{4}{3} \times 9.8\frac{m}{s^2} \times (0.5m - 0.05m)} = 2.43\frac{m}{s}$$

3. What is the rate at which the cylinder is spinning when it reaches the horizontal surface?

$$v = r\omega \rightarrow \omega = \frac{v}{r} = \frac{2.43\frac{m}{s}}{0.05m} = 48.5\frac{rad}{s}$$

4. A forklift is used to transport freight in a warehouse where the forks can be extended to put, say a load of mass $m = 500kg$ onto a shelf. The load is at a horizontal distance x across the floor measured from the front tires. At this point the forklift (of mass $m_{fl} = 2000kg$ is just about to tip over and pivot about the front tires. What is the normal force on one of the two front tires at this point?
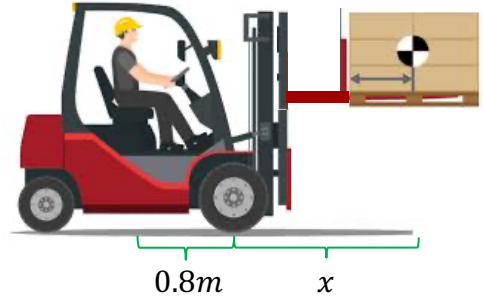
$$2F_N - F_{W,fl} - F_W = m_{total}a_y = 0$$

$$F_N = \frac{F_{W,fl} + F_W}{2} = \frac{(2000kg + 500kg) \times 9.8\frac{m}{s^2}}{2} = 12{,}250N$$

5. What is the distance x at which the forklift just begins to tip over?

$$\tau = 0 = -mgx + m_{fl}gy$$

$$x = \frac{m_{fl}}{m}y = \frac{2000kg}{500kg} \times 0.8m = 3.2m$$