We are told that \( I = \beta MR^2 \), hence rotational kinetic energy while rolling as
\[
K_r = \frac{1}{2} \beta MR^2 \omega^2 - \frac{1}{2} \beta \text{MV}^2
\]
Therefore, the total kinetic energy while rolling is
\[
K = \frac{1}{2} \text{MV}^2 + \frac{1}{2} \beta \text{MV}^2 = \frac{1}{2} \text{MV}^2 (1+\beta)
\]

Hence, the speed of the cylinder at launch point is may be determined from Energy conservation

\[
MgH = mgh + \frac{1}{2} \text{MV}^2 (1+\beta) \quad \Rightarrow \beta = \frac{2Mg(H-h)}{M\text{V}^2} - 1
\]

We can determine \( V \) from the information provided by the problem on the trajectory

\[
d = Vt \quad \text{where} \quad \frac{1}{2} gt^2 = h \quad \Rightarrow t^2 = \frac{2 \cdot 0.1m}{9.80 \text{m/s}^2} \quad t = 0.1429 \text{sec}
\]

\[
\Rightarrow v = \frac{0.506m}{0.1429s} = 3.542 \text{ m/s}
\]

\[
\beta = \frac{2 \cdot 9.6 \text{m/s}^2 (0.8m)}{(3.54 \text{m/s})^2} - 1 = 0.251
\]

\[
\beta = 0.25
\]
There are 2 different moment of inertia to consider.

\[ I_0 = 2M \cdot (2R)^2 + M(0) \]
\[ = 8MR^2 \]

(2 balls at a distance 2R from the axis, one on the axis)

(3 balls at a distance R from the axis, one on the axis)

Angular momentum must be conserved.

\[ I_0 \omega_0 = I_1 \omega_1 \]
\[ \Rightarrow \omega_1 = \omega_0 \frac{I_0}{I_1} \]

\[ \Rightarrow \frac{\omega_1}{\frac{8}{3} \omega_0} \]

\[ K_0 = \frac{1}{2} I_0 \omega_0^2 \]
\[ K_1 = \frac{1}{2} I_1 \omega_1^2 \]
\[ = \frac{1}{3} \left( \frac{8}{3} I_0 \right) \left( \frac{8}{3} \omega_0 \right)^2 \]

\[ K_1 = \frac{8}{3} K_0 \]
\[ I_{rod} = \frac{1}{12} M L^2 \quad \text{(table 10.2e)} \]
\[ I_{bullet} = m \left( \frac{L}{2} \right)^2 \]

\[
L_0 = R \times R
\]
\[
L_{01} = m \left( \frac{L}{2} \right)^\perp \cdot \sin 60^\circ
\]

\[ L_f = (I_{track} + I_{whi.}) \omega = \left[ 4.00 \text{kg} \cdot \left( \frac{0.5 \text{m}}{12} \right)^3 + 0.003 \text{kg} \cdot \left( \frac{0.5 \text{m}}{2} \right)^2 \right] \cdot 10 \text{rad/s} \]

\[ = 0.0352 \text{ kg m}^2/\text{s} \]

\[ 0.003 \text{kg} \cdot \left( \frac{0.5 \text{m}}{2} \right) \cdot v \cdot \sin(60^\circ) = 0.0352 \text{ kg m}^2/\text{s} \]

\[ v = 1.29 \times 10^3 \text{ m/s} \]

\[ v = 1.3 \times 10^3 \text{ m/s} \]
\[ I = I_{\text{rod}} + I_{\text{puck}} + I_{\text{whl}} \]

**Note:** The block is a point mass

a) \[ I = 0.060 \text{ kg m}^2 + 0.050 \text{ kg} \text{ (0.60 m)}^2 + 0.001 \text{ kg} \text{ (0.60 m)}^2 \]

\[ I = 0.240 \text{ kg m}^2 \]

b) \[ L_f = L_0 \]

\[ 0.240 \text{ kg m}^2 \times 4.5 \text{ rad/s} = 0.001 \text{ kg} \text{ m}^2 \text{ s}^2 \]

\[ \Rightarrow u = 1800 \text{ m/s} \]
The point P is in static equilibrium so both x + y components of the forces acting on it must balance.

\[ F = 550 \text{ N} \]
\[ \tan \theta = \frac{0.30 \text{ m}}{9.0 \text{ m}} \]
\[ \Rightarrow \theta = 1.91^\circ \]

\[ F - 2T \tan \theta = ma_y = 0 \]
\[ T = \frac{550 \text{ N}}{2 \tan (1.91^\circ)} = 8250 \text{ N} \]

This is the magnitude of the force acting on the car.

\[ T = 8200 \text{ N} \]
The statement of the problem

\[ F_y = \mu_s F_x \]

(since her feet are on the verge of slipping)

Take point \( a \) as the pivot point for the torque equation.

1. \[ F_y + T \cos \theta - mg = m \dot{y} = 0 \]
2. \[ F_x - T \sin \theta = m \ddot{x} = 0 \]
3. \[ mg \sin \theta \cdot l - T \sin \alpha = I \ddot{x} = 0 \]

\[ \alpha = 180^\circ - 40^\circ - 30^\circ = 110^\circ \]

\[ T = \frac{533.8 \text{ N} \cdot \sin(40^\circ)}{\sin(110^\circ)} = 365.1 \text{ N} \]

\[ F_y = 533.8 \text{ N} - 365.1 \text{ N} \cdot \cos(30^\circ) = 217.6 \text{ N} \]

\[ F_x = 365.1 \text{ N} \cdot \sin(30^\circ) = 182.6 \text{ N} \]

\[ \mu_s = \frac{F_y}{F_x} = 1.19 \]

Yes, it is possible to have \( \mu_s \) greater than 1, although this is not uncommon achieving \( \mu_s < 1 \).