Rotational Momentum, Energy, Rolling Motion

$E_0 = mgh$

$* h_0 = 2.00\text{m} \sin 15^\circ$

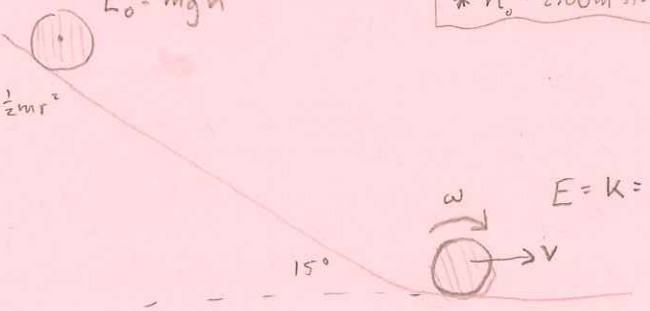
① Solid Cylinder:

$I = \frac{1}{2}mr^2$

$\omega_{nc} = 0$

$E = E_0$

$E = K = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$



$\frac{1}{2}mv^2 + \frac{1}{2}I\omega^2 = mgh_0$

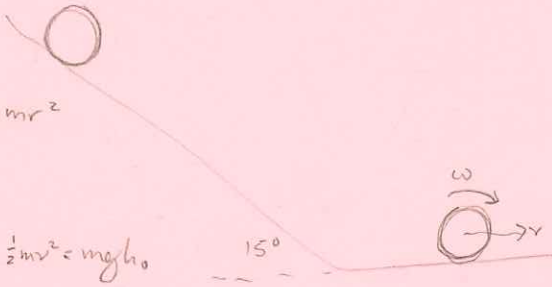
$\frac{1}{2}mv^2 + \frac{1}{2}\left(\frac{1}{2}mr^2\right)\left(\frac{v}{r}\right)^2 = mgh_0$

$\frac{1}{2}mv^2 + \frac{1}{4}mv^2 = mgh_0$

$v = 2.6\ ^m/_s$

Hollow Cylinder:

$I = mr^2$



$\omega_{nc} = 0$

$E = E_0$

$\frac{1}{2}mv^2 + \frac{1}{2}mv^2 = mgh_0$

$\frac{1}{2}mv^2 + \frac{1}{2}I\omega^2 = mgh_0$

$\frac{1}{2}mv^2 + \frac{1}{2}(mr^2)\left(\frac{v}{r}\right)^2 = mgh_0$

$v = 2.3\ ^m/_s$

② $\vec{L} = \vec{L}_0$

$I\omega' = I_0\omega_0$

$mr^2\omega = mr_0^2\omega_0$

$mr^2\left(\frac{v}{r}\right) = mr_0^2\left(\frac{v_0}{r_0}\right)$

$rv = r_0v_0$

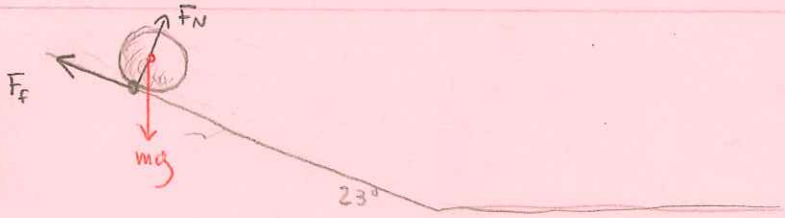
$v = 4.2\ ^m/_s$

③ $\vec{L} = \vec{L}_0$

$r_1v_1 = r_2v_2$ (see above!)

$v_2 = 5260\ ^m/_s$

④ $I = \frac{2}{5}MR^2$



$\sum \vec{F} = m\vec{a}$

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

$mg\sin\theta - \frac{2}{5}Ma = Ma$

$Mg\sin\theta = \frac{7}{5}Ma$

$\sum \vec{\tau} = I\vec{\alpha}$

$F_fR = \frac{2}{5}MR^2\frac{a}{R}$

$F_f = \frac{2}{5}Ma$

$\vec{a} = 2.7\ ^m/_{s^2}$ down the ramp

B. At max θ $\quad F_{fs} = \mu F_N = \mu Mg\cos\theta_{max}$

so... $\quad a = \frac{5}{7} g\sin\theta_{max} \Rightarrow F_f = \frac{2}{5}Ma = \frac{2}{5}M\left(\frac{5}{7} g\sin\theta_{max}\right)$

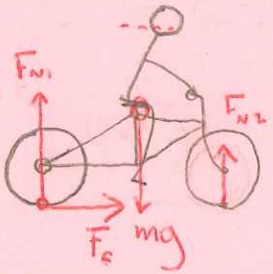
$\Rightarrow \mu Mg\cos\theta_{max} = \frac{2}{7}Mg\sin\theta_{max}$

$\frac{7\mu}{2} = \frac{\sin\theta}{\cos\theta} = \tan\theta_{max}$

$\theta_{max} = \tan^{-1}\left(\frac{7\mu}{2}\right) = 53.06123727^\circ$

$\theta_{max} = 53^\circ$

5. * Look at the whole bicycle



$\Sigma\vec{F} = m\vec{a}$ $\quad F_{N1} = 0.75mg$

$F_f = ma$

$\mu F_{N1} = ma$

$\mu(0.75mg) = ma$

$0.75(0.75g) = a$

$a = 5.5125\ m/s^2$

$\alpha = \frac{a}{r} = \frac{5.5125\ m/s^2}{0.45\ m} = 12.25\ rad/s^2$

A. $\alpha = 12.2\ rad/s^2$

B. $a = r\alpha = 0.080m\left(12.25\ rad/s^2\right) = 0.98\ m/s^2$

C. DONE in A. $\quad 5.5\ m/s^2$

D. Look at Front cog