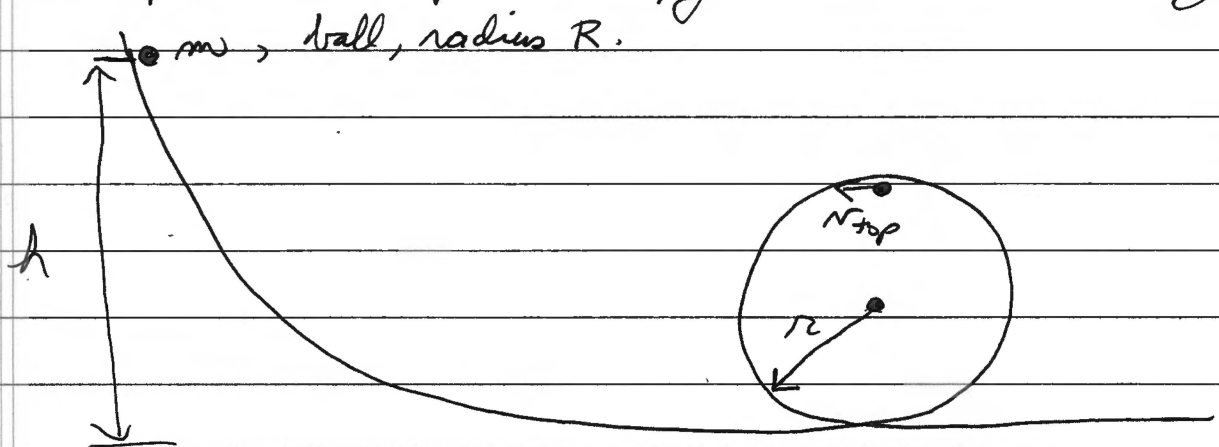


Loop - the Loop: Energy Conservation / Rolling



Release ball from rest. What is the initial minimum height h such that the rolling ball just barely stays on track at the top?

1st: Newton's 2nd Law



yields $N_{top} = \sqrt{gr}$

2nd Apply energy conservation for a rolling ball

$$E_i = E_f$$

$$U_i + K_i = U_f + K_f$$

$$mgh + 0 = mg(2r) + \frac{1}{2}mN_{top}^2 + \frac{1}{2}I\omega^2$$

rolling $\Rightarrow \omega = N_{top}/R$

ball $\Rightarrow I = \frac{2}{5}mR^2$

just stays on $\Rightarrow N_{top} = \sqrt{gr}$

$$\therefore mgh + 0 = mg(2r) + \frac{1}{2}m(gr) + \frac{1}{2}\left(\frac{2}{5}mR^2\right)\left(\frac{gr}{R^2}\right)$$

$$mgh = mg(2r) + \frac{1}{2}m(gr) + \frac{1}{5}m(gr)$$

$$h = \left(2 + \frac{1}{2} + \frac{1}{5}\right)r = \boxed{2.7r}$$

If $r = 0.215\text{m}$, $h \approx \boxed{0.581\text{m}}$