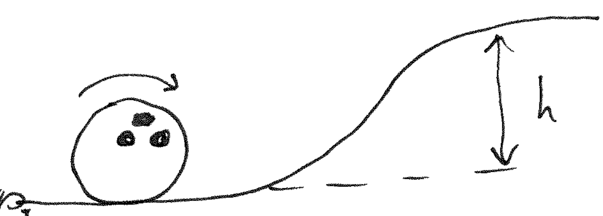
Chapter 11 Problem 28

$h = 0.5\,m$

$v_0 = 3.0\,m/s$



As the ball rolls up the ramp, it gains potential energy and loses kinetic energy. The kinetic energy of the ball is both translational and rotational.

$$K = K_{cm} + K_{Rot} = \frac{1}{2} M v_{cm}^2 + \frac{1}{2} I \omega^2$$

for a solid ball $I = 2/5\, MR^2$

also $v_{cm} = R \cdot \omega$ (no slipping) $\rightarrow \omega = \frac{v_{cm}}{R}$

Then the kinetic energy for the rolling ball is

$$K = \frac{1}{2} M v_{cm}^2 + \frac{1}{2}\left[\frac{2}{5} MR^2\right]\left(\frac{v_{cm}}{R}\right)^2$$

$$= \frac{1}{2} M v_{cm}^2 + \frac{1}{5} M v_{cm}^2 = \frac{7}{10} M v_{cm}^2$$

a) Now by conservation of energy

$$U_0 + K_0 = U_f + K_f$$

$$0 + \frac{7}{10} M v_0^2 = mgh + \frac{7}{10} M v_f^2$$

$$\frac{7}{10} M v_0^2 - mgh = \frac{7}{10} M v_f^2$$

$$v_0^2 - \frac{10}{7} gh = v_f^2$$

$$v_f = \sqrt{v_0^2 - \frac{10gh}{7}} = \sqrt{(3.0\,m/s)^2 - \frac{10}{7}(9.8\,m/s^2)(0.5\,m)}$$

$$v_f = \sqrt{9 - 7} = \boxed{1.41\,m/s}$$

b) Does it make it to the top if $h = 1.0\,m$

$$v_f = \sqrt{(3.0\,m/s) - \frac{10}{7}(9.8\,\tfrac{m}{s^2})(1.0\,m)} = \sqrt{9 - 14} = \sqrt{-5}$$

No Real answer - Doesn't make it.