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A bowling ball is traveling at 2.85 m/s (linear speed) in a lower return rail. If the rail rises 0.53 m (vertical distance) answer the following questions.

1) What is the linear speed at the top of the rail?

2) How would an increased radius change your answer?

$\Delta E = 0$

$0 = E_f - E_i$

$E_f = E_g + E_{k_T} + E_{k_R}$

$E_i = E_{k_R} + E_{k_T}$

$E_f = E_i$

$mgh + \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2 = \frac{1}{2}mv_i^2 + \frac{1}{2}I\omega_i^2$

$V = r\omega$ $\qquad I = \frac{2}{5} m r^2$ solid sphere

$\omega = \frac{V}{r}$

$$\frac{1}{2} I \omega^2 = \frac{1}{2}\left(\frac{2}{5} m r^2\right)\left(\frac{v^2}{r^2}\right) = \frac{1}{5} m v^2$$

$$mgh + \frac{1}{2} m v^2 + \frac{1}{5} m v^2 = \frac{1}{2} m v_i^2 + \frac{1}{5} m v_i^2$$

$$mgh + .7 m v^2 = .7 m v_i^2$$

$$v = \sqrt{\frac{.7 m v_i^2 - mgh}{.7m}} = \sqrt{\frac{.7 v_i^2 - gh}{.7}}$$

$$= \sqrt{\frac{.7\left(2.85 \frac{m}{s}\right)^2 - \left(9.81 \frac{m}{s^2}\right)(0.53 m)}{.7}}$$

$$\boxed{= 0.834 \frac{m}{s}}$$