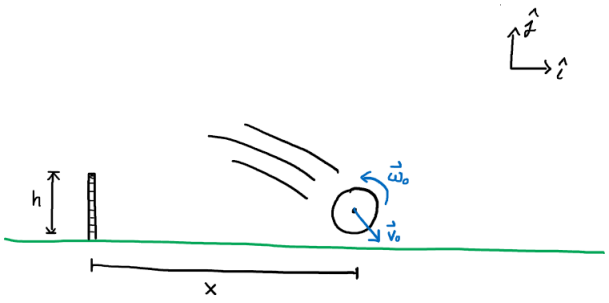
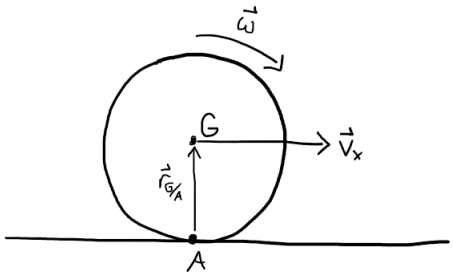
22-R-IM-TW-39



A ping pong ball (radius 2 cm and mass 2.7 g) hits the table with a horizontal velocity of $\vec{v}_x = 1\hat{i}$ m/s and a vertical velocity of $\vec{v}_y = -0.5\hat{j}$ m/s. If the coefficient of restitution between the ball and the table is $e = 0.8$, what spin, $\vec{\omega}$, must the ball have before impact in order for it to bounce straight up? (Assume that no slipping occurs and use $g = 9.81$ m/s^2)

Solution:



$$I_G = mk^2 = (0.0027)(0.01625)^2 = 7.13 \times 10^{-7}[\text{kg} \cdot \text{m}^2]$$
$$(H_A)_0 = (H_A)_f$$
$$I_G\vec{\omega}_0 + m\vec{r}_{G/A} \times \vec{v}_{x,0} = I_G\vec{\omega}_f + m\vec{r}_{G/A} \times \vec{v}_{x,f}$$

Because the ball bounces straight up, $\vec{v}_{x,f} = \vec{0}$
And since there is no slipping, $v_{x,f} = \omega_f r \Rightarrow \omega_f = 0$

$$(I_G\omega_0 - mv_{x,0}r)\hat{k} = \vec{0}$$
$$I_G\omega = mv_{x,0}r$$
$$\omega = \frac{mv_{x,0}r}{I_G}$$
$$\vec{\omega} = \frac{mv_{x,0}r}{I_G}\hat{k} = \frac{(0.0027)(1)(0.02)}{7.13 \times 10^{-7}}\hat{k} = 72.7\hat{k} \text{ [rad/s]}$$