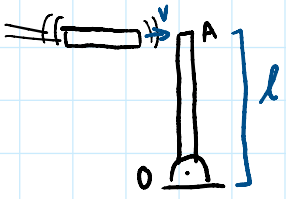
20-R-IM-DK-17

July 9, 2020 4:03 PM

Beginner Eccentric Impact

Inspiration: None



There is a popular party game which involves throwing a frisbee to knock off cups resting on a stick. For simplicity, assume the frisbee can be modelled as a disk, the stick can be modelled as a rod connected to a pin joint which is held stationary until impact, and neglect any frictional effects. If the frisbee, with mass m_frisbee = 0.2 kg and radius r = 0.135 m, strikes the very top of the stick with length ***l = 1.3 m*** at a velocity ***v = 6 m/s***, determine the velocity of the frisbee immediately after collision. The stick has mass ***m_stick = 0.5 kg*** and the coefficient of restitution is ***e = 0.8***.

$I_O = \frac{1}{3} m l^2 = \frac{1}{3}(0.5)(1.3)^2 = \frac{169}{600}$ $\quad \omega = \frac{v_A}{l} = \frac{v_A}{1.3}$

$\sum (H_O)_1 = \sum (H_O)_2$

$m_d v_{d_1} l = I_O \omega_2 + m_d v_{d_2} l$

$(0.2)(6)(1.3) = \frac{169}{600}\omega_2 + (0.2) v_{d_2} (1.3)$

$1.56 = \frac{169}{600}\left(\frac{v_{A_2}}{1.3}\right) + 0.26\, v_{d_2}$

$e = \frac{v_{A_2} - v_{d_2}}{v_{d_1} - v_{A_1}}$ $\quad 0.8 = \frac{v_{A_2} - v_{d_2}}{6 - 0}$ $\quad v_{d_2} = v_{A_2} - 4.8$

$1.56 = \frac{13}{60} v_{A_2} + 0.26 v_{A_2} - 1.248$

$v_{A_2} = 5.490\,09$ m/s $\quad$ $v_{d_2} = \frac{12}{11}$ m/s