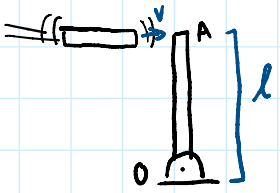
20-R-IM-DK-17

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 and the stick can be modelled as a rod connected to a pin joint which is held stationary until impact. If the frisbee with mass $m = 0.2$ 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 $m = 0.5$ kg and the coefficient of restitution is $e = 0.8$.

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

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

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

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

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

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

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

$$v_{A_2} = 5.890\,90 \text{ m/s} \qquad \boxed{v_{d_2} = \frac{12}{11} \text{ m/s}}$$