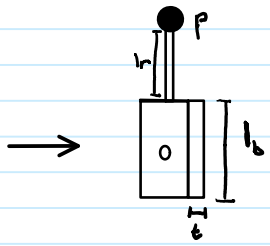
20-R-CM-PT-5

July 3, 2020 7:55 PM

A 35 g dart is thrown at a swinging rectangular dart board with a painted bullseye. The dart hits the bullseye at a speed of 18 m/s. Find the angular velocity of the board around point p.
Assume the mass of the board is 0.35 kg, the mass of the connecting rod is $m_r = 0.15$ kg the length of the rod is $l_r = 0.5m$, the length of the board is $l_b = 0.25m$, and the thickness of the board is $t = 0.1m$.



$m_B = 0.35$ kg
$m_r = 0.15$ kg
$l_r = 0.5m$
$l_b = 0.25m$
$t = 0.1m$

- $(H_{sys})_1 = (H_{sys_2})$

$$(m_1 \cdot v_1) \cdot r_{p1} = (I_p)_2 \omega_2$$

$I_{p_2} = I_{board} + I_{rod} + I_{dart}$ $\quad I_{rod} = \frac{1}{3} m_r l_r^2 = \frac{1}{3}(0.15)(0.5^2) = 0.0125$ kg·m²

$I_{board} = \frac{1}{12} m_b (l_b^2 + t^2) + m d_{b\to p}^2 = \frac{1}{12}(0.35)(0.25^2 + 0.1^2) + (0.35)(0.625) = 0.221$ kg·m²

$I_{dart} = m d_{b\to p}^2 = (0.035)(0.625)^2 = 0.0137$ kg·m² $\quad I_{p_2} = 0.2472$ kg·m²

$$\omega_2 = \frac{m_1 \cdot v_1 \cdot r_{p1}}{(I_p)_2}$$

$$\omega_2 = \frac{0.035 \cdot 18 \cdot 0.625}{0.2472} = 1.5928 \text{ rad/s}$$

$\omega_2 = 1.59$ rad/s