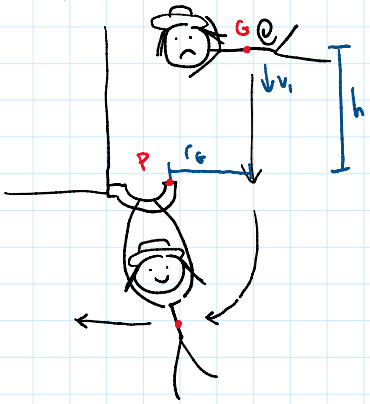
20-R-IM-DK-14

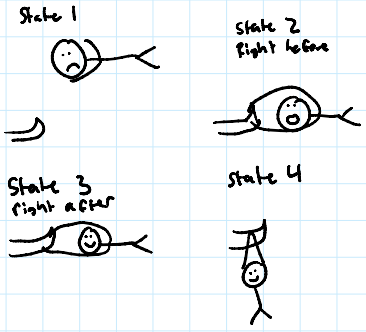
July 9, 2020 1:29 PM

Intermediate Conservation of Momentum ← might be moved as it deals with impact

Inspiration: 19-44 Hibbeler



Montana James is now too old for the movie industry and has instead been replaced by his daughter, Mississippi Jane. In her new movie, Mississippi Jane makes a daring escape by jumping off a ledge. In an incredible feat of athletics, she grabs a hook and swings in a perfect circular arc to safety. If Jane has a mass $m = 60$ kg and a radius of gyration $k_G = 0.25$ m, determine her angular velocity after she has swung 90°. Jane had an original velocity of $v_1 = 3$ m/s at a vertical height $h = 1.5$ m away from the hook, and her center of gravity was a horizontal distance $r_G = 0.9$ m. Assume her weight during impact does not act as an impulsive force.



$T_1 + V_1 = T_2 + V_2$ Take datum as the location of the hook

$\frac{1}{2}mv_1^2 + mgh = \frac{1}{2}mv_2^2$

$\frac{1}{2}(60)(3)^2 + (60)(9.81)(1.5) = \frac{1}{2}(60)v_2^2$

$v_2 = 6.19919$ m/s

$\Sigma(H_P)_2 = \Sigma(H_P)_3$ $H_{P_2} = I_G\omega_2 + r_{G/P} \times mv_2$ $H_{P_3} = (mk_G^2 + mr_G^2)\omega_3$

$0 + (0.9)(60)(6.19919) = (60(0.25)^2 + 60(0.9)^2)\omega_3$

$\omega_3 = 6.39458$ rad/s

$T_3 + V_3 = T_4 + V_4$

$\frac{1}{2}(60(0.25)^2 + 60(0.9)^2)(6.39458)^2 + 0 = \frac{1}{2}(60(0.25)^2 + 60(0.9)^2)\omega_4^2 + (60)(9.81)(0.9)$

$1070.31404 = 0.5(52.35)\omega_4^2 - 529.74$

$\omega_4 = 7.9185$ rad/s