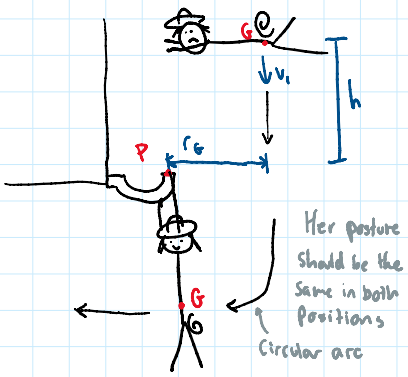
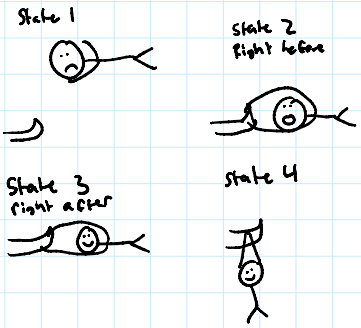
20-R-IM-DK-14

July 9, 2020 1:29 PM

Intermediate 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Montana James is now too old for the movie industry and has instead been replaced by his daughter, Mississippi Jane.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 degrees. 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. Assume that her arms stay in the same position as she swings, such that her center of gravity and radius of gyration do not change.

$T_1 + V_1 = T_2 + V_2$ 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

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

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

$\omega_3 = 6.39456$ rad/s

$T_3 + V_3 = T_4 + V_4$

$\frac{1}{2}(60(0.25)^2 + 60(0.9)^2)(6.39456)^2 + 0 = \frac{1}{2}(60(0.25)^2 + 60(0.9)^2)\omega_4^2 + (60)(9.81)(0.9)$

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

$\omega_4 = 7.9185$ rad/s