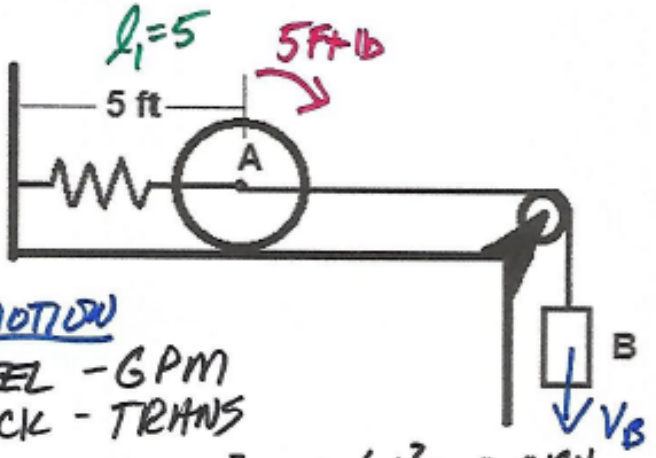
Work Energy III - Problem 3

The no-slip wheel A, weighs 10 lbs, a radius of 6 inches and a radius of gyration of 0.25 ft. The block B weighs 5 lbs. If a 5 ft-lb CW couple-moment is applied to the at-rest wheel, what is the velocity of the block when the wheel rotates 2π radians? The spring constant is 3 lbs/ft and the unstretched length is 4 ft.



MOTION
WHEEL - GPM
BLOCK - TRANS

PROPERTIES

$W_W = 10\text{lbs}$, $m_W = \frac{10}{32.2} = 0.31\text{SLUG}$, $I_G = mk^2 = 0.31(.25)^2 = 0.0194\ \text{SLUG-FT}^2$

$W_B = 5\text{ lbs}$, $m_B = \frac{5}{32.2} = 0.155\ \text{SLUG}$

WORK

SPRING, M, WEIGHT

HOW FAR DOES WHEEL + BLOCK TRAVEL WHEN WHEEL ROTATES 2π rad?

$S_o = \theta r_w$ $\quad S = 2\pi(\frac{1}{2}) = \pi\ \text{FT}$

$U_m = 5(2\pi) = 31.4\ \text{FT-lb}$

$U_B = 5(\pi) = 15.7\ \text{FT-lb}$

$l_o = 4'$ $l_1 = 5'$ $l_2 = l_1 + \pi\text{FT} = 8.14'$

$S_1 = (5-4) = 1$

$S_2 = 8.14 - 4 = 4.14$

$U_{sp} = -\frac{1}{2}k(S_2^2 - S_1^2)$

$= -\frac{1}{2}(3(4.14^2 - 1^2) = -24.2\ \text{FT-lb}$

$U_{1-2} = 22.9\ \text{FT-lb}$

ENERGY

$T_1 = 0$ $\quad T_2 = \frac{1}{2}I_G\omega_2^2 + \frac{1}{2}m_W V_2^2 + \frac{1}{2}m_B V_2^2$ $\quad V = \omega r$, $\omega = V/r_2$

$= \frac{1}{2}(0.0194)\left(\frac{V_2}{r_2}\right)^2 + \frac{1}{2}(.31)V_2^2 + \frac{1}{2}(.155)V_2^2$

$= 0.27125\,V^2$

W-E $\quad T_1 + U_{1-2} = T_2$ $\quad 0 + 22.9 = 0.27125\,V^2$

$V_B = V_2 = 9.19\ \text{FPS}\downarrow$