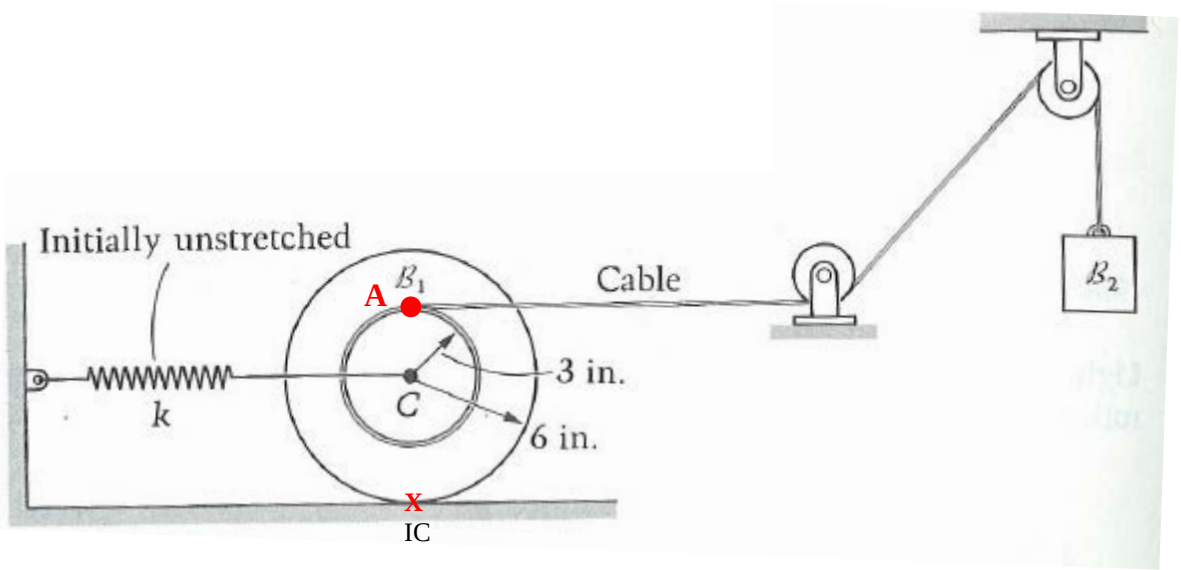
Problem 12. If the system is released from rest in the position shown below, determine the angular velocity of the wheel once the block has fallen 1 foot. The 20-lb no slip wheel, B_1, has a radius of gyration of 4 inches about its center. A cable wrapped around the inner radius passes under and over two small frictionless pulleys and is attached to the 50-lb block B_2. The spring (k = 90 lb/ft) is initially unstretched at a length of 13 in. (from the wall to the contact point on the disk), and there is enough friction to prevent slipping. Note that $I_G = mk^2$.



Energy Eqn

$T_1 + U_{1-2} = T_2$

T_1: 0 (at rest)

U_{1-2}: 30 ft-lbs (next page)

$T_2 = \frac{1}{2}mV_{B_1}^2 + \frac{1}{2}I_G\omega_{B_1}^2 + \frac{1}{2}mV_{B_2}^2$

$= \frac{1}{2}\left(\frac{20}{32.2}\right)\left(\omega^2(.5)^2\right) + \frac{1}{2}\left[\left(\frac{20}{32.2}\right)\left(\frac{4}{12}\right)^2\right]\omega^2$

$+ \frac{1}{2}\left(\frac{50}{32.2}\right)\left[\omega^2\left(\frac{9}{12}\right)^2\right]$

$= 0.5488\,\omega^2$

$30 = 0.5488\,\omega^2$

$\omega = 7.39$ rps

Answer: ω_{B1} = 7.39 rad/s CW

Problem 12 Continued

Work

Spring

$U_{sp} = -\frac{1}{2} k (s_2^2 - s_1^2)$

$k = 90 \text{ lb/ft}$

$s_1 = 0$

$s_2 =$ distance pt C moves

block falls 1 ft = pt A moves 1 ft

$s_A = \theta r_A$

$\theta = 1/(9/12) = 1.33$

$s_C = \theta r_C$

$= (1.33)(6/12) = 0.67$

$U_{sp} = -\frac{1}{2} (90 \frac{\text{lb}}{\text{ft}})(.67^2 - 0^2)$

$= -20 \text{ ft lbs}$

Block

$U_w = -W \Delta y$

$= -(50 \text{ lbs})(-1 \text{ ft})$

$= 50 \text{ ft lbs}$

Total Work

$U = U_{sp} + U_w$

$= -20 + 50$

$= 30 \text{ ft lbs}$