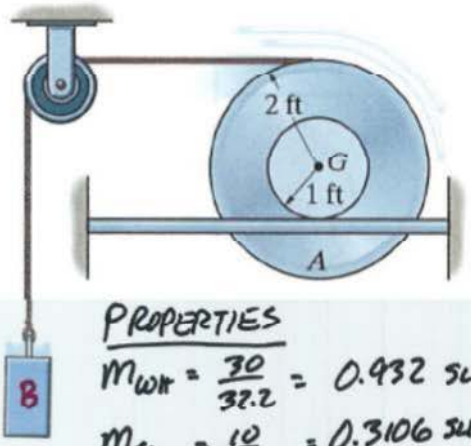
**Problem 11.** The inner hub of the wheel rests on the horizontal track. Determine the speed of the 10-lb block 2 seconds after it is released from rest. The wheel has a weight of 30 lb and a radius of gyration of 1.30 ft. $\mu_s = 0.2$ and $\mu_k = 0.1$. If you assume a No-slip wheel, you must verify your assumption.




CLASSIFY MOTION
WHEEL - GPM
BLOCK - TRANS

TIME
∴ IMPULSE MOMENTUM

PROPERTIES
$m_{WH} = \frac{30}{32.2} = 0.932$ SLUG
$m_{BL} = \frac{10}{32.2} = 0.3106$ SLUG
$I_{G\,WH} = mK^2 = 0.932(1.3)^2 = 1.57$ SLUG-FT$^2$

$mom_1 + imp_{1-2} = mom_2$

$\int_0^2 (T - 10)\,dt = mv_B = 0.3106 v_B$

ASSUME NO SLIP
∴ $V_C = 3\omega_{WH} = V_B$
$V_G = (1)\omega_{WH} = \omega_{WH}$

$\uparrow \Sigma F_y$ $\int_0^2 (T - 10)\,dt = -0.3106 V_B \Rightarrow \int T\,dt - 20 = -0.3106(3\omega_{WH})$

$\int T\,dt + 0.932\omega_{WH} = 20$ (1)

$I_G\omega$

$\int_0^2 (T - 30 - F)\,dt = mv_G$

$\circlearrowleft \Sigma M_A$ $3\int T\,dt = I_G\omega_{WH} + (1)mv_G = 1.57\omega_{WH} + 0.932(\omega_{WH})$

$3\int T\,dt - 2.5\omega_{WH} = 0$ (2)

SOLVE (1) & (2)

$\begin{bmatrix} 1 & 0.932 \\ 3 & -2.5 \end{bmatrix} \begin{Bmatrix} \int T\,dt \\ \omega_{WH} \end{Bmatrix} = \begin{Bmatrix} 20 \\ 0 \end{Bmatrix}$

$\int T\,dt = 9.44$ $\omega_{WH} = 11.32$ rad/s ↺

$V_G = (1)\omega_{WH} = 11.32$ Ft/s ←

$V_B = 3\omega_{WH} = 34.0$ Ft/s ↓

CHECK ASSUMPTION

$\rightarrow \Sigma F_x$ $-\int T\,dt + \int_0^2 F\,dt = -mv_G = -0.932(11.32)$

$F_{MAX} = \mu_s N = 0.2(30) = 6$

$-9.44 + 2F = -10.55$

$2F = -1.1 \Rightarrow F = -0.55$ lb $< F_{MAX} = 6$ lb ∴ NO SLIP

Answer: $V_B = 34.0$ ft/s ↓