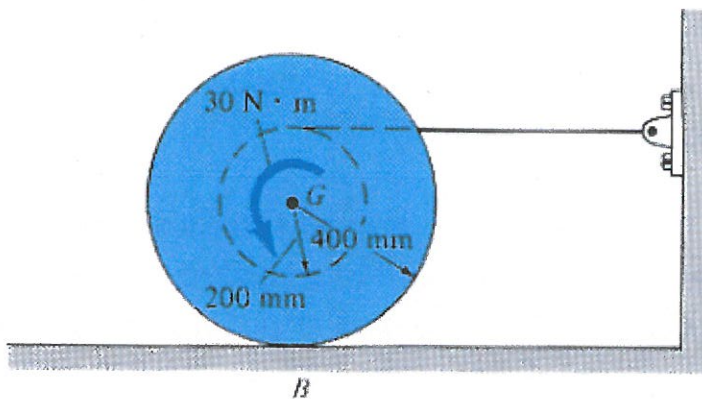## Force Acceleration II – Problem 2

The spool and wire wrapped around its core have a mass of 20 kg and a centroidal radius of gyration $k_G = 250$ mm. If the coefficient of kinetic friction at the ground is $\mu_B = 0.1$, determine the angular acceleration of the spool when the 30 Nm couple is applied.
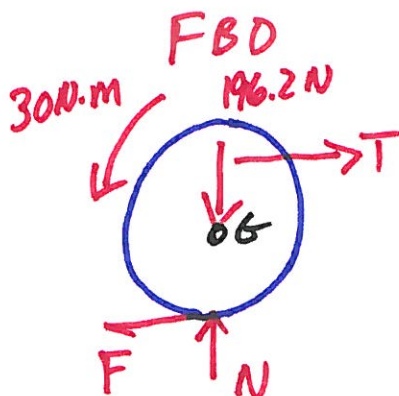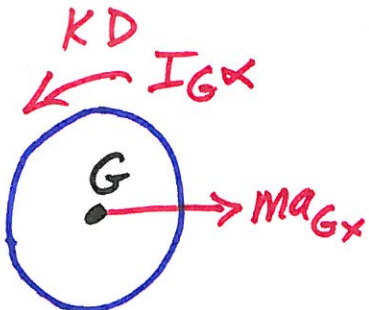

CLASSIFY MOTION

GPM

PROPERTIES

$M = 20\,kg \qquad W = 20(9.81) = 196.2\,N$

$I_G = MK^2 = 20(.25)^2 = 1.25\,kg\cdot m^2$

FBD $\qquad = \qquad$ KD

30N·m 196.2 N $\qquad\qquad$ $I_G\alpha$

$\rightarrow T$

$\oint G$ $\qquad\qquad$ G $\rightarrow ma_{Gx}$

F N

$\rightarrow \Sigma F_x \qquad -F + T \qquad = \quad ma_{Gx} = 20\,a_{Gx}$

MUST BE SLIPPING $\therefore F = \mu_k N = 0.1(196.2) = 19.62\,N$
AT GROUND

NO SLIP ON CORD $\therefore a_0 = \alpha r \Rightarrow 0.2\alpha$

SO $\quad T - 20(.2\alpha) = 19.62$ ①

$\circlearrowright \Sigma M_G \qquad 30 - 19.62(.4) - 0.2T = 1.25\,\alpha$

SO $\quad 0.2T + 1.25\alpha = 22.15$ ②

SOLVE ①+②

$\begin{bmatrix} 1 & -4 \\ 0.2 & 1.25 \end{bmatrix} \begin{Bmatrix} T \\ \alpha \end{Bmatrix} = \begin{Bmatrix} 19.62 \\ 22.15 \end{Bmatrix}$

$T = 55.2\,N$

$\alpha = 8.89\,rad/s^2 \,\circlearrowright$