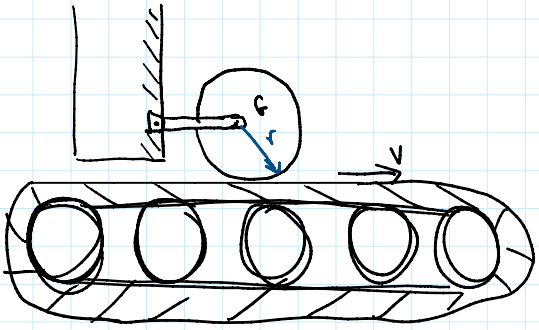
20-R-WE-DK-12 Intermediate Principle of Work and Energy

Inspiration: 18-23 Hibbeler

You are prototyping a new type of garbage disposal, in which a conveyor belt transports waste to be flattened by a roller. In your test run, you want to study how the machine will work without any garbage. The roller is adjusted so it is in contact with the conveyor belt. If the roller can be treated as a cylinder with mass ***m = 300 kg*** and the coefficient of kinetic friction between the roller and the conveyor belt is ***mu_k = 0.25***, determine the distance the roller must travel in order to reach the same speed ***v = 8 m/s*** as the conveyor belt. The roller has a radius ***r = 0.6 m***.



$\sum F_y = N - (300)(9.81) = 0 \qquad N = 2943\ N$

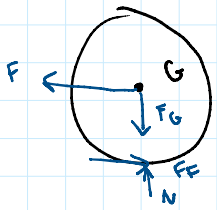
$f_F = \mu_k N = 0.25(2943) = 735.75\ N$

$M_{FF} = F_F r = (735.7)(0.6) = 441.45\ Nm$

$U_{FF} = M_{FF}\theta = 441.45\theta$

$V = \omega r \qquad \omega = \frac{v}{r} = \frac{8}{0.6} = \frac{40}{3}$

$I_G = \frac{1}{2}mr^2 = \frac{1}{2}(300)(0.6)^2 = 54$



$T_1 = 0 \quad V_1 = 0 \qquad T_2 = \frac{1}{2}I_G\omega^2 \quad V_2 = 0$

$T_1 + V_1 + \sum_{\text{non-cons}} U_{1\to 2} = T_2 + V_2 \qquad U_{FF} = T_2 \qquad 441.45\theta = \frac{1}{2}(54)\left(\frac{40}{3}\right)^2$

$\theta = 10.67325858$

$\theta = 10.67325 \times \frac{1\ rev}{2\pi} = 1.730532465\ rev$

For 1 rev, the roller travels a distance equal to its circumference $1\ rev = 2\pi r = 2\pi(0.6)$

$d = 1.73053 \times 2\pi(0.6) = \boxed{6.523955\ m}$