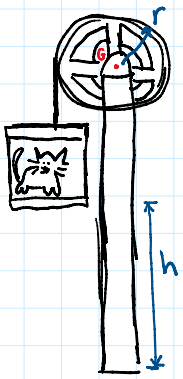
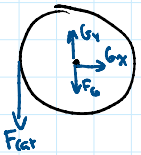
20-R-WE-DK-10 Beginner Principle of Work and Energy

Inspiration: 18-12 Hibbeler





Recently your cat has become too fat and senile to descend from his cat tower so you have made him a little cat "elevator". There is no brake - the maximum speed of descent is controlled by the moment of inertia of the reel. If the safest maximum velocity for the platform is considered to be ***v = 1 m/s***, what should be the mass of the reel if the platform descends from a height ***h = 1.8 m***. The reel has a radius of gyration about its center of mass ***k_G = 1.1 m***. Assume the total mass of your cat and the platform is ***m = 10 kg***, and the reel has a radius ***r = 0.25 m***.

$T_1 = 0 \quad V_1 = mgh = (10)(9.81)(1.8) = 176.58 \quad I_G = mk_G^2 \quad \omega = \frac{v}{r} = \frac{1}{0.25} = 4$

$T_2 = \frac{1}{2}m_{cat}v^2 + \frac{1}{2}I_G\omega^2 = \frac{1}{2}(10)(1^2) + \frac{1}{2}m(1.1)^2(4^2)$

$= 5 + 9.68\,m$

$V_2 = 0 \Rightarrow$ Reel has not moved and platform has reached datum

$T_1 + V_1 + \sum_{\text{non-cons}} U_{1\to2} = T_2 + V_2$ No external work has been done on the system

$176.58 = 5 + 9.68\,m$ $\quad m = 17.72520661\ kg$