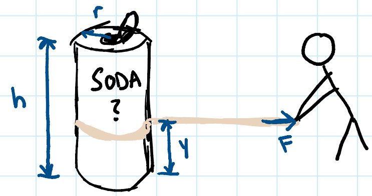
20-R-KIN-DK-27

July 22, 2020 9:38 AM

20-R-KIN-DK-27 Beginner General Plane Motion

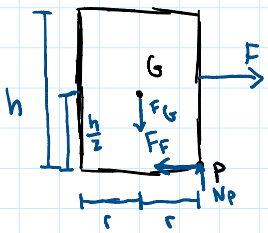
Inspiration: Hibbeler pg. 485



Movers are trying to set up an art gallery. They attempt to drag a human-size statue of a soda can with mass ***m = 120 kg*** by tying a rope around it. Determine the force required for the statue to tip and the force for the statue to slip if the coefficient of static friction and kinetic friction is found to be ***mu_s = 0.4*** and mu_k = 0.3, respectively. The can has a height of ***h = 1.8 m*** and the rope is tied ***1 m*** off the ground. Assume the statue to be a solid cylinder with radius ***r = 0.3 m*** and constant density.
If the movers can apply the force required for the statue to slip, where is the minimum height they should tie the rope to safely drag the statue?

P is the point of tipping when it does tip

No tip $\Rightarrow \vec{\alpha} = \vec{0}$



a)

$$\Sigma F_x = F - F_F = F - \mu_s N_P = m a_{Gx}$$

$$\Sigma F_y = N_P - mg = m a_{Gy} = 0$$

$$\Sigma M_P = mgr - Fy = 120(9.81)(0.3) - F(1) = I_P \alpha$$

Tipping:

ΣF_y: $N_P = mg = (120)(9.81) = 1177.2$

ΣM_P: $mgr - Fy = 0 \Rightarrow 120(9.81)(0.3) = F(1)$

$\boxed{F = 353.16\ N}$ The maximum force for $\vec{\alpha} = 0$ (Right before it tips)

Slipping:

ΣF_x: $F - \mu_s N_P = 0$ $F = 0.4 N_P = 0.4(1177.2) = \boxed{470.88\ N}$

The maximum force for $a_{Gx} = 0$ (Right before it slips)

b)

$$\Sigma F_x = F - F_F = F - \mu_s N_P = m a_{Gx}$$

$$\Sigma F_y = N_P - mg = m a_{Gy} = 0$$

$$\Sigma M_P = mgr - Fy = I_P \alpha$$

$N_P = mg = 120(9.81) = 1177.2$

ΣM_P: $120(9.81)(0.3) - (470.88)y = 0$

$\boxed{y = 0.75\ m}$