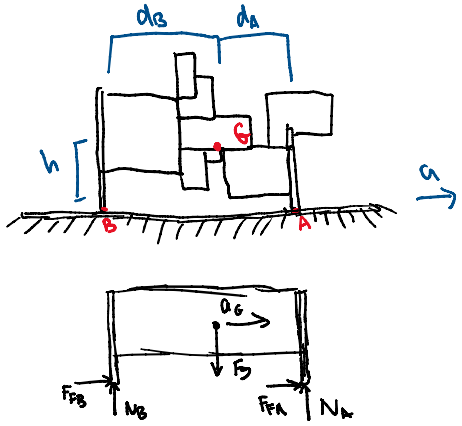
20-R-KIN-DK-19

July 22, 2020 9:47 AM

20-R-KIN-DK-19 Intermediate Translation (RBK)

Inspiration: F17-4 Hibbeler



Your friend is trying to carefully move his mom's modern-art sculpture by dragging a rug underneath it. What is the maximum acceleration of the rug without causing the sculpture to move relative to the rug? Determine the normal reaction on the sculpture's legs if the sculpture has a mass of ***m = 80 kg*** with a centre of gravity at G. Assume the coefficient of static and kinetic friction to be ***mu_s = 0.3*** and mu_k = 0.15 respectively. The center of gravity is located at a height ***h = 0.6 m*** from the ground. G is a horizontal distance ***d_A = 0.4 m*** from A while it is a horizontal distance ***d_B = 0.5 m*** from B.

$\sum F_x = F_{FB} + F_{FA} = ma_{Gx}$ $\quad \sum F_y = N_B + N_A - mg = ma_{Gy} = 0$

$\circlearrowleft \sum M_A = mg(0.4) - N_B(0.9) = -ma_{Gx}(0.6)$

Not slipping $\Rightarrow F_F \leq \mu_s N$

$\sum F_x = 0.3N_B + 0.3N_A = 80a_{Gx}$

$\sum F_y = N_B + N_A - (80)(9.81) = 0 \Rightarrow N_B + N_A = 784.8$

$N_A = 784.8 - N_B$

$0.3N_B + 0.3(784.8) - 0.3N_B = 80a_{Gx}$

$235.44 = 80a_{Gx}$ $\quad a_{Gx} = 2.943$

$80(9.81)(0.4) - 0.4N_B = -80(2.943)(0.6)$

$455.184 = 0.4N_B$ $\quad N_B = 505.76$ N

$N_A = 784.8 - 505.76$ $\quad N_A = 279.04$ N

Alternatively: $\circlearrowleft \sum M_G = F_{FB}(0.6) + F_{FA}(0.6) - N_B(0.5) + N_A(0.4) = 0$

$0.3(0.6)N_B + 0.3(0.6)N_A - 0.5N_B + 0.4N_A = 0$

$0.32N_B = 0.56N_A$

$N_B = 1.8125N_A$

$1.8125N_A + N_A = 80(9.81)$ $\quad N_A = 279.04$ N

$N_B = 1.8125(279.04)$ $\quad N_B = 505.76$ N

$\sum F_x = 0.3(505.76) + 0.3(279.04) = 80a_{Gx}$

$a_{Gx} = 2.943 \text{ m/s}^2$