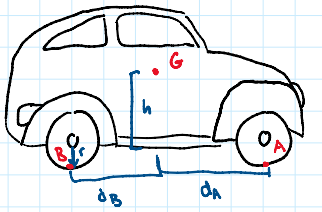
20-R-KIN DK17-19

May 29, 2020 9:19 AM

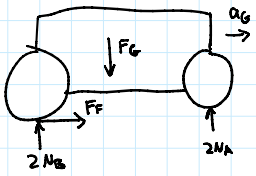
20-R-KINDK-17 Intermediate Translation (RBK) Video

Inspiration: 17-27 Hibbeler



Reworded

A punch buggy is challenged to race. As it starts from rest, slamming on the accelerometer causes the rear wheels to slip. If the punch buggy has a mass of ***m = 1400kg*** with a centre of gravity at G, determine the distance it would travel in ***t = 5 seconds*** and the normal force on each of its four wheels. Assume the mass of the wheels are negligible and the coefficients of static and kinetic friction are mu_s = 0.45 and ***mu_k = 0.3***, respectively.
The radius of both wheels is ***r = 0.25 m***. G is a height of ***h = 0.5 m*** from the bottom of the frame, and ***d_A = 2 m*** and ***d_B = 1.5 m***



$\sum F_x = ma_{Gx} = F_F = \mu_k (2N_B) = 0.3(2N_B)$ ← sliding

$\sum F_y = 2N_B + 2N_A - 1400(9.81) = 0$

$\sum M_A = 1400(9.81)(2) - 2N_B(3.5) = 1400\, a_{Gx}(0.5+0.25)$

$0.6N_B = 1400\, a_{Gx}$

$N_B = \frac{7000}{3} a_{Gx}$

$2N_B + 2N_A = 13734$

$N_A = 3140.020134$

$27468 - 7N_B = 1050\, a_{Gx}$

$27468 - \frac{49000}{3} a_{Gx} = 1050\, a_{Gx}$

$N_B = 3646.479986$

$a_{Gx} = \frac{5986}{3726} = 1.580134$

$d = v_0 t + \frac{1}{2} a t^2 = \frac{1}{2}(1.580134)(5^2) = 19.75167785$ m

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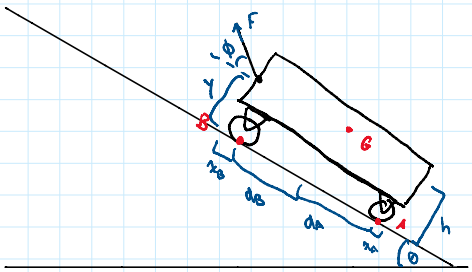
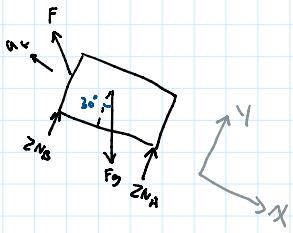
20-R-KIN-DK-18 Intermediate Translation (RBK)

Inspiration: 17-32 Hibbeler

Reworded

You are hauling a heavy cart up a ***theta = 30 degree*** incline. Luckily, you have been working out so you can apply a force of ***F = 250 N*** to the cart. If you apply this force at an angle ***phi = 42 degrees*** and the cart has a mass of ***m = 30 kg***, what is the acceleration of the cart and the normal force on each of the cart's wheels? The cart has a center of gravity at G.
The force is applied at a height ***y = 0.4 m*** from the ground and G is located at a height ***h = 0.5 m***.
Wheel A is located ***x_A = 0.1 m*** from one side of the cart while wheel B is located ***x_B = 0.05 m*** from the other end.
Wheel A is a distance ***d_A = 0.3 m*** from G while wheel B is a distance ***d_b = 0.25 m***.





$\sum F_x = ma_{Gx} = -F\cos 42 + F_g \sin 30$

$\sum F_y = F\sin 42 - F_g \cos 30 + 2N_B + 2N_A = 0$

$\sum M_A = -F_g \sin 30(0.5) + F_g \cos 30(0.3) + 2N_B(0.55) + F\cos 42(0.4) - F\sin 42(0.6) = ma_{Gx}(0.5)$

$30\, a_{Gx} = -250\cos 42 + 30(9.81)\sin 30$

$a_{Gx} = -1.287973546$

$250\sin 42 - 30(9.81)\cos 30 + 2N_B + 2N_A = 0$ $\quad 2N_B + 2N_A = 76.09459104$

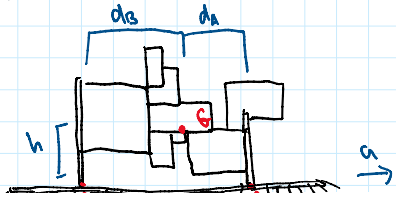
$-30(9.81)\sin 30(0.5) + 30(9.81)\cos 30(0.3) + 1.1N_B + 250\cos 42(0.4) - 250\sin 42(0.6) = 30\, a_{Gx}(0.5)$

$-28.86515172 + 1.1N_B = 30(-1.287973546)(0.5)$

$N_B = 6.679135036$ $\quad N_A = 30.36815548$

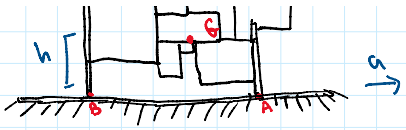
20-R-KIN-DK-19 Intermediate Translation (RBK)

Inspiration: F17-4 Hibbeler

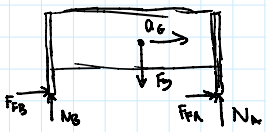


Reworded

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.



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.



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

① $\sum M_A = mg(0.4) - N_B(0.9) = -ma_{Gx}(0.6)$

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

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

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

$N_A = 784.8 - N_B$

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

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

$80(9.81)(0.4) - 0.9N_B = -80(2.943)(0.6)$

$455.184 = 0.9N_B$ $\quad N_B = 505.76$ N

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

Alternatively: ④ $\sum M_B = F_{FB}(0.6) + F_{FA}(0.6) - N_B(0.5) + N_A(0.4) = 0$

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

$0.32N_B = 0.56N_A$

$N_B = 1.8125N_A$

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

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

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

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