Midterm 1

Thursday, 16 April 2020 08:03

To go over a loop:

a) At top $F = mv^2/r = mg$, $\frac{v^2}{r} = g$

$v_{top} = \sqrt{rg}$ $r = 9 \times 0.05$, $g = 9.81$

hence $v \approx 2.101$ m/s

b)

let: $v_1 = v_{top}$

$\frac{1}{2}mv^2 + \frac{1}{2}I\omega^2 = mgh + \frac{1}{2}I\omega_1^2 + \frac{1}{2}mv_1^2$

where $v^2 = rg$, $\omega^2 = \frac{v^2}{r^2}$ $\omega_1^2 = \frac{v_1^2}{r^2}$

$h = 2 \times 9r = 18r$

$\frac{1}{2}mv^2 + \frac{1}{2}I\frac{v^2}{r} = mg18r + \frac{1}{2}I\frac{v_1^2}{r} + \frac{1}{2}mv_1^2$

moment of Inertia of solid sphere $= \frac{2}{5}mr^2$

$\frac{1}{2}mv^2 + \frac{1}{5}mr^2 \times \frac{v^2}{r} = mg18r + \frac{1}{5}mr^2\frac{v_1^2}{r} + \frac{1}{2}mv_1^2$

$r = 0.05$, $v_1 = v_{top} = 2.101$ hence: $v \approx 4.661$

c)

at x, $h = \frac{1}{2}r = 9r$

$\frac{1}{2}mv^2 + \frac{1}{5}mr^2\frac{v^2}{r} = mg9r + \frac{1}{5}mr^2\frac{v_1^2}{r} + \frac{1}{2}mv_1^2$

$v \approx 3.615$

$F = \frac{mv^2}{r} = \frac{0.1 \times 3.615^2}{9 \times 0.05} = 2.904$ N

d) Energy conservation: $v_1 = 4.661$

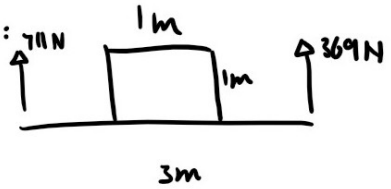
$\frac{1}{2}mv_1^2 + \frac{1}{5}mrv_1^2 = mgh$

$\frac{1}{2} \times 4.661^2 + \frac{1}{5} \times 0.05 \times 4.661^2 = 9.81 \times h$

$h = \frac{11.0797}{9.81}$

$= 1.129$ m

Transporting a Fridge:



a) $711 \times (1.5 + x) = 369 \times (1.5 - x)$

$1080x = -513$

$x = -\frac{19}{40} \approx 0.475$ m $\quad 0.475 + 1.5 = 1.975$

1.975 m from the person with 369N

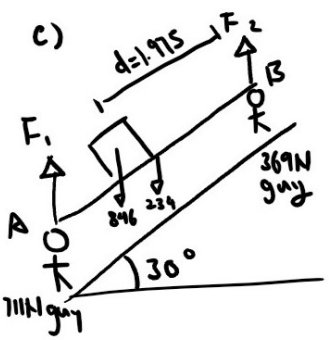
Assuming light board (No mass)

Fridge mg: $711 + 369 = mg = 1080$ N

b) $1080 - 234 = 846$ N

Combined center of gravity should still be at the same point as each still excerts the same force

c)



Assuming center of mass along board: ratio unchanged

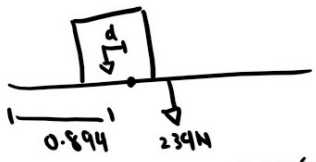
Force still the same

711N & 369 N

$846d = 234 \times 0.475$

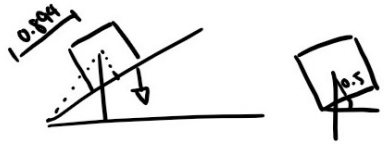
$d = 0.1314$

0.606 from centre



$0.5 \times \tan 30 = 0.289$ m

$0.894 - 0.289 = 0.605$ m



$0.605 \cos(30)846 + 1.5 \cos(30)234 = 3F_2 \cos 30$ $F_2 = 287.61$ N

$(3 - 0.605)\cos(30)846 + 1.5\cos(30)234 = 3F_1 \cos 30$ $F_1 = 792.39$ N