Lecture 25 - 4.6

Thursday, April 6, 2023 9:37 AM

Equillibrium

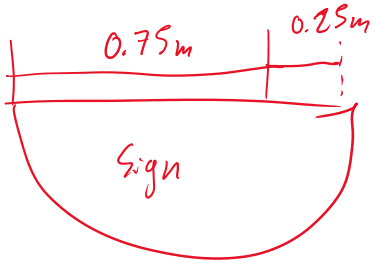
Inertial Frames of Reference:

- constant velocity
- laws of physics do not change
- can quickly jump betweeen frames of reference
  - we can do coordinate transformations

we can choose where our frame of reference is
Choose the origins, or points of reference, wisely to do less work!

Experiment
Try to balance a solid box on one corner. Why is it so hard?
What is the margin of equillibrium?
When the center of mass is outside of that margin, it will come out of equillibrium

It is easier to move something out of equllibrium when it is unstable



A. 0-15 N
B. 15-30 N
C. 30-45 N
D. 45-66 N

Sign weighs 66 N.
What is the tension in the left wire?

if they were equidistant from the center of mass, they would hold the same, but since the right wire is closer to the center of mass, it holds slightly more.

since the right wire holds more, the less is going to hold less.
how much less is a bit harder to calculate, but we can tell 15 is probably too small, and 45 is too big. So its probably between 15-30.

$\sum F = 0 \Rightarrow T_L + T_R = W$

$\sum \tau = 0 \quad T_L \cdot 0.75 = W \cdot 0.25m$

$T_L = \frac{0.25}{0.75} \cdot W$

$T_L = \frac{1}{3} \cdot W = 22\,N$

$T_R = \text{Total} - T_L$

$= 66 - 22 = 44\,N$

$\sum \tau = 0 \Rightarrow 0.5\,W = 0.75 \cdot T_R$

$T_R = \frac{0.5\,m}{0.75\,m} \cdot W$

$T_R = \frac{2}{3} \cdot W = 44\,N$

Use right wire as frame of reference.

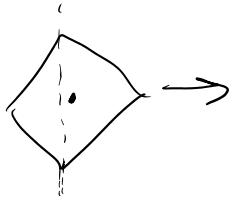
From T_R we are 0.25m from the center of mass.

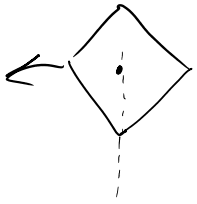
Analyze Tipping

Semi truck example

what is the position of the center of mass?

the object(truck) will fall on whatever side of the area of support the center of mass finds itself.

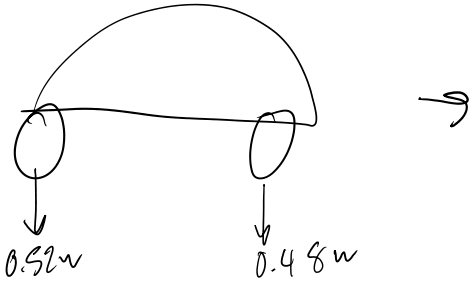


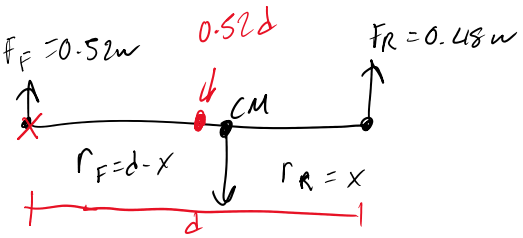


since a box has such a small area of support, it is extremely difficult to balance it on its corner

0.52d

$T_R = 0.48\,W$





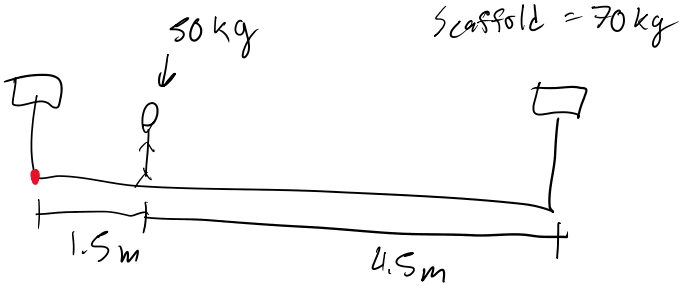
$\Sigma F = 0 \Rightarrow F_F + F_R = w$

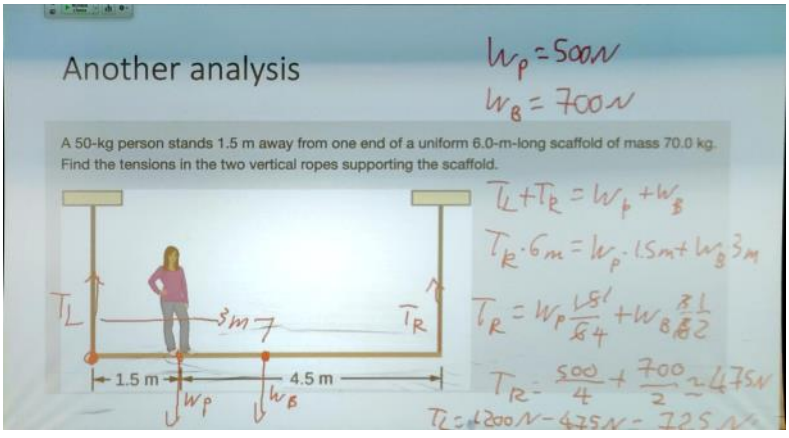
$\Sigma \tau = 0$

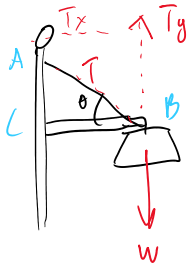
$F_R \cdot d = w(d - x)$

$0.48w \cdot d = wd - wx$

$x = (1 - 0.48) \cdot d = \boxed{0.52d}$







to find the tension in the cable, which point would you use as the rotation axis? C

knowing that the mass of the floodlight is 19kg, and the angle is 30 degrees, what is the tension in the cable?

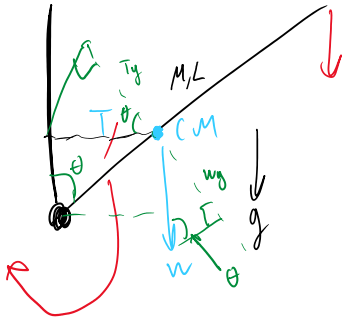
$T_y = T \cdot \sin\theta$

$\Sigma F = 0$

$$m \cdot g = \sin\theta \, T$$

$$T = \frac{19\,kg \cdot 10\,m/s^2}{\sin 30} = \frac{190}{1/2} = \boxed{380\ N}$$

Homework hint



Balance w & T

$$T_y = \cos\theta \cdot T$$

$$w_y = T_y$$

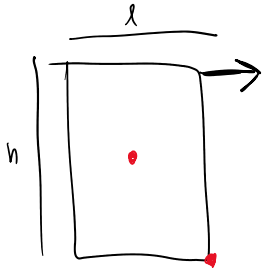
$$\sin\theta \, w = \cos\theta \, T$$

$$T = \tan\theta \cdot w$$

Leaning Tower of Lire

Place N identical rigid rectangular blocks in a stable stack on a table edge in such a way as to maximize the overhang

infinite number



$m = 5kg \quad l = 0.10m \quad h = 0.15m$

$$T_F = h \cdot F$$

$$T_{cm} = w \cdot \frac{l}{2}$$

$$h \cdot F = w\frac{l}{2}$$

$$F = \frac{wl}{h \cdot 2} = \frac{m \cdot g \cdot l}{h \cdot 2} = \boxed{16.667\ N}$$