Lecture 27

Wednesday, November 1, 2017 12:34

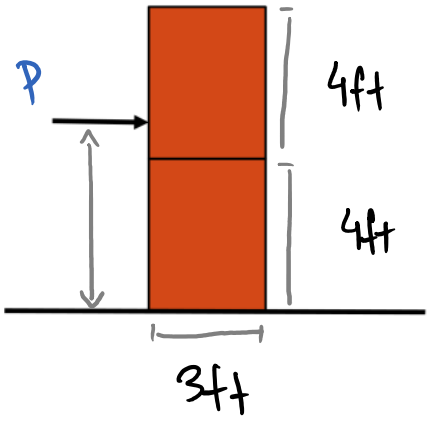
To do ...

- **CBTF Quiz 5** – this week!
- Matlab session – Thurs Nov 2, 5-6 pm, MEB 210
- Homework grade distribution
  - Online + written assignment = 18%
- 211 students **DO NOT TAKE** 210 final, or you will get a zero on 211 final
- HW 18 due **Wed – today!**
- HW 19 due **Thurs**
- WA 3 due **Fri – read submission instructions**

iQ>clicker

A

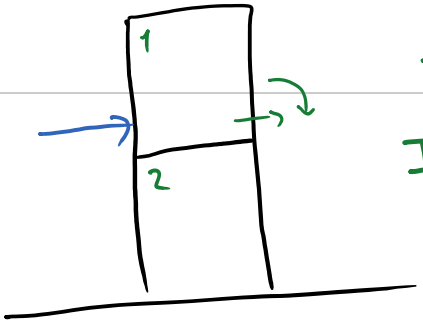
B



Two uniform boxes, each with weight 200 lb, are simply stacked as shown. If the coefficient of static friction between the boxes is $\mu_s = 0.8$ and between the box and the floor is $\mu_s = 0.5$, determine the minimum force P to cause motion.

Q: How many possible motions?

A) 1
B) 2
C) 3
D) 4
E) 5

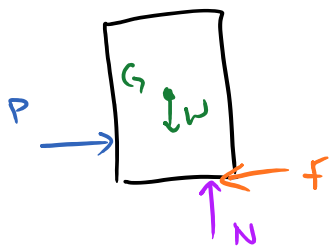


I - 1 slide
II - 1 tip
III - 1&2 slide
IV - 1&2 tip

Q: is the P same for All?

if I: DRAW FBD

Sum forces in x & y

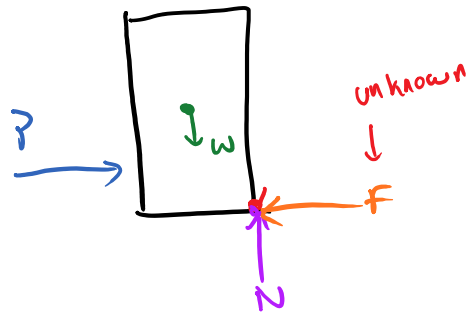


Σf_x: $P - F = 0$ $\quad P = F_s = \mu_s N = \mu_s W$

Σf_y: $N - W = 0$ $\quad N = W$

$P = (0.8)(200) = 160$ lb

if II:

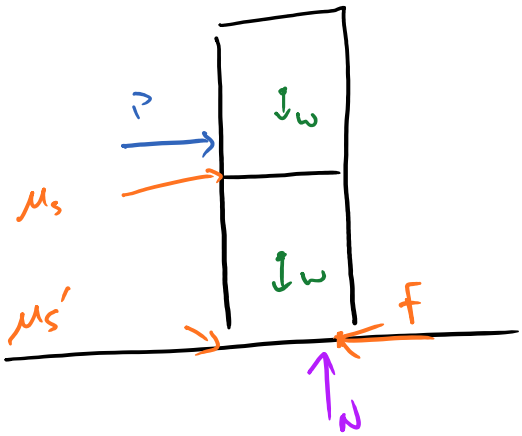


sum moments about O

ΣM_o: $W\left(\frac{3}{2}\right) - P(1) = 0$

$P = \left(\frac{3}{2}\right)(200) = \underline{300\ lb}$

if III:



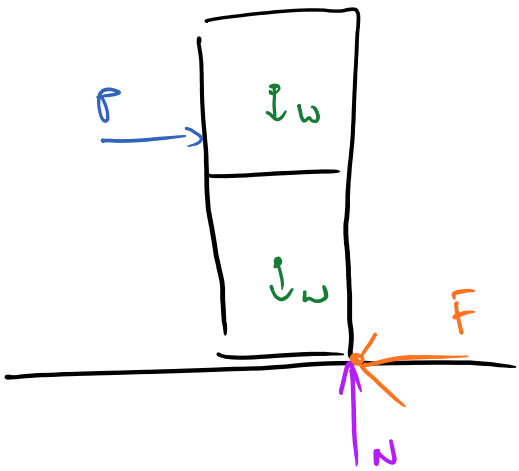
Sum forces in x & y

ΣF_x: $P - F_s = 0$ $\quad P = \mu_s F_s = \mu_s N$

ΣF_y: $N - 2W = 0$ $\quad N = 2W$

$P = \mu_s 2W = \left(\frac{1}{2}\right)(2)(W) = \underline{200\ lb}$

if IV:



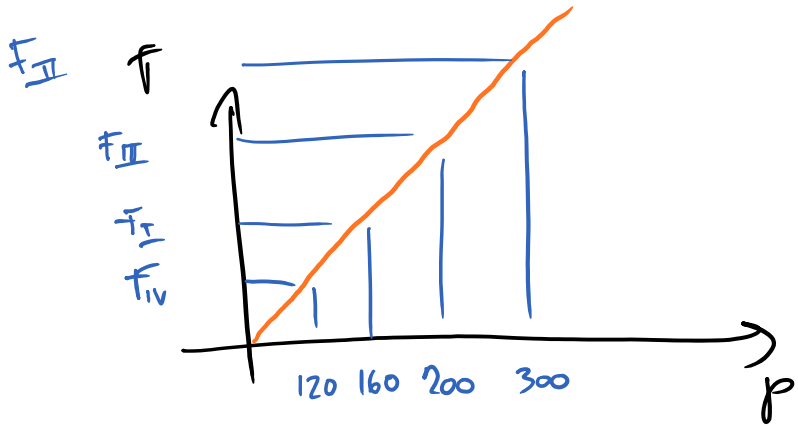
Sum the moments.

ΣM_A: $\left(\frac{3}{2}\right)(2W) - 5P = 0$

$P = \frac{3W}{5} = \frac{3(200)}{5}$

$\underline{P = 120\ lb}$

$P = 120$ lb



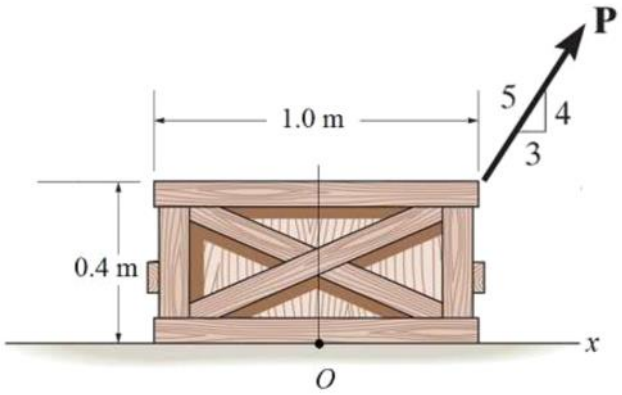
$F_{IV} < F_I < F_{III} < F_{II}$

1 tip

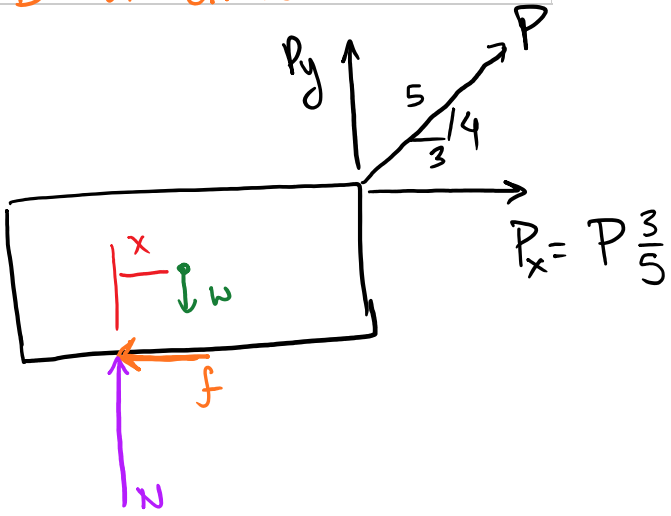
↓ 1 slide 1+2 slide

1+2 tip

The uniform crate has a weight of 80 N. If a force $P = 50$ N is applied to the crate, determine the location of the resultant normal force in terms of x with the origin at O?



DRAW THE FBD of CRATE:



$\Sigma F_x = 0$

$P_x - f = 0 \quad \therefore \quad f = P_x = \frac{3}{5}P$

$\Sigma F_y = 0$ $\quad \therefore \quad N = W - P_y = W - \frac{4}{5}P$

$J \quad N + P_y$

$$\Sigma M_0 = 0$$

$$(x + 0.5)P_y - xW - (0.4)P_x = 0$$

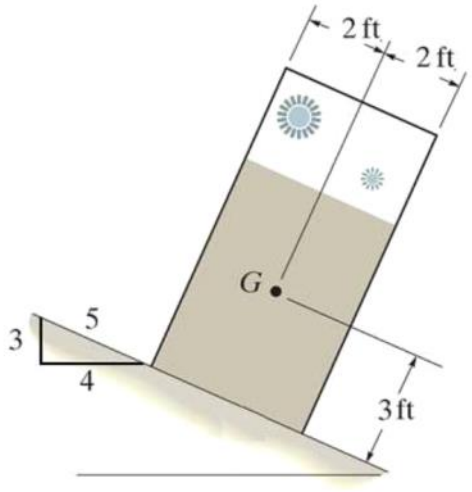
$$x(P_y - W) = (0.4)(P_x) - (0.5)(P_y)$$

$$x = \frac{(0.4)(\frac{3}{5}P) - (0.5)(\frac{4}{5}P)}{\frac{4}{5}P - W}$$

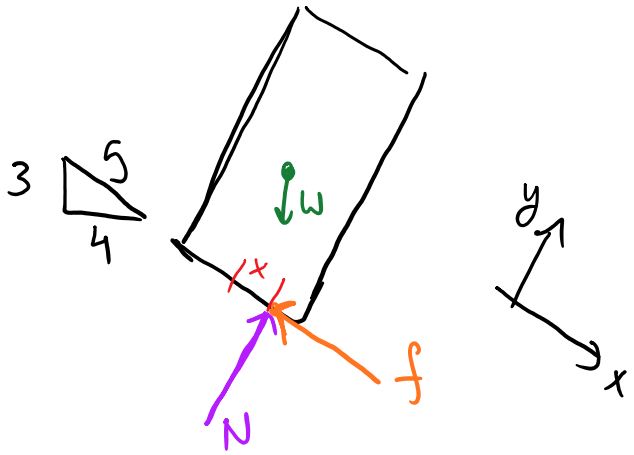
$$x = \frac{0.4(30) - (0.5)(40)}{40 - 80} = \frac{-8 \text{ N·m}}{-40 \text{ N}}$$

$$\boxed{x = 0.2 \text{ m}}$$ to the left of O

The crate is placed on an inclined surface and the coefficient of static friction between the surfaces is 0.8. Which is the correct statement regarding the potential motion of the crate at the instant of release from rest?



DRAW the FBD of the CRATE:



$\Sigma f_x = 0$

$W\sin\theta - f = 0 \quad \therefore \quad f = W\sin\theta$

$$\Sigma F_y = 0$$

$$N - W\cos\theta = 0 \quad \therefore \quad N = W\cos\theta$$

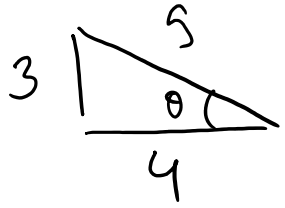
Assume Sliding: $f_s = \mu_s N$

we get

$$\frac{\mu_s N}{N} = \frac{W\sin\theta}{W\cos\theta} \Rightarrow \quad \mu_s = \tan\theta_s$$

the critical angle for sliding is:

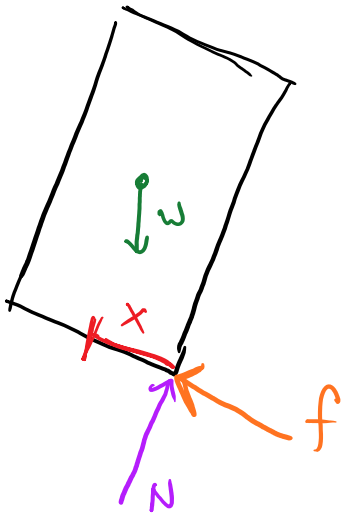
$$\theta_s = \tan^{-1}(\mu_s) = \tan^{-1}(.8) = 38.6^\circ$$



$$\theta = \tan^{-1}\left(\frac{3}{4}\right) = 36.8^\circ$$

SINCE $\theta < \theta_s$ therefore no sliding.

Check for tipping:



$\Sigma M_o = 0$

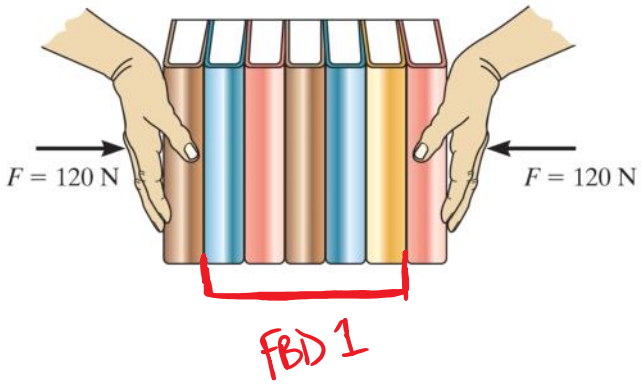
(3) $W\sin\theta - 2W\cos\theta = 0$

$3W\left(\frac{3}{5}\right) - 2W\left(\frac{4}{5}\right) = 0$

$9 - 8 \neq 0$

not in Rotational Equilibrium!

therefore CRATE will tip when Released!



Determine the greatest number of books that can be supported in the stack.

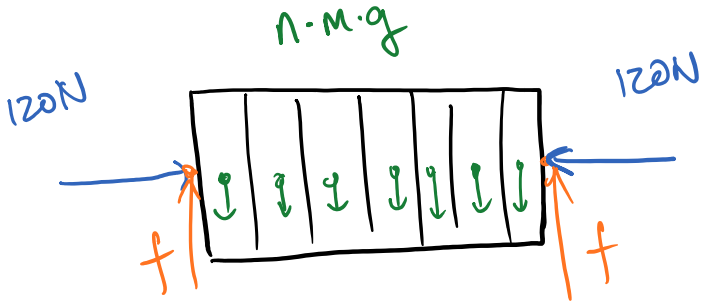
given:

mass of book = 0.95 kg

static friction hand/book = 0.6

static friction book/book = 0.4

DRAW FBD 1 of books



$\Sigma F_x = 0$

$120 - 120 = 0$

$\Sigma F_y = 0$

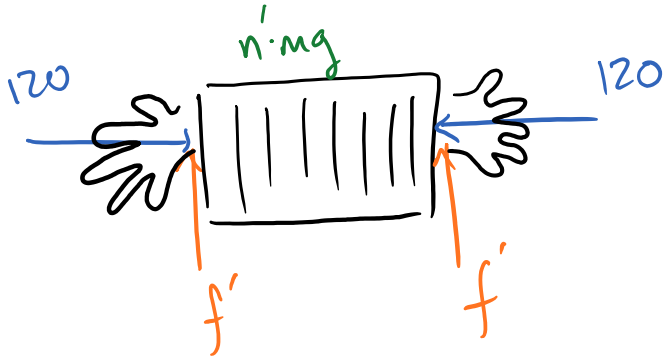
$2f - nMg = 0$

$2\mu(120) - nMg = 0$

$n = \frac{2(0.4)(120)}{(.95)g} = 10.3$

number of books held by outer books before slipping!

Now check hands/book contact.



$\Sigma F_y = 0$

$$2 \cdot f' - n' mg = 0$$

$$2\mu'(120) = n' mg$$

$$n' = \frac{2(0.6)(120)}{9.95\ g} = \underline{15.45}$$

Since $n < n'$, the MAXIMUM number of books before sliding is

$$N = n + 1 = 12 \text{ books}$$

$$N_{max} = n + 2 = 12 \text{ books}$$

(include 2 outer books)

TAM 210/211

The scientist does not study nature because it is useful;

He studies it because he delights in it, and he delights in it because it is beautiful.

If nature were not beautiful, it would not be worth knowing, and if nature were not worth knowing, life would not be worth living.

- J.H. Poincare

Wednesday, November 1, 2017 12:34

TAM 210

Thank you and best wishes!!

- Professor Juarez