Physics 8 — Wednesday, August 28, 2019

Welcome!

- Web page: `http://positron.hep.upenn.edu/physics8`
- Note that this course is offered every **other** year! So Phys 008 will next be offered in fall 2021. (Remind your friends.)
- Physics 8 covers a pretty similar set of topics to other introductory college physics courses, such as Phys 101 (for premeds), Phys 150 (for engineers), Phys 170 (for physics majors). What makes it **Physics for Architects?**
  - About half of you are ARCH students. Having your own course lets us tailor it to your interests and your backgrounds.
  - Once we've covered the basics, we'll spend several weeks applying what we've learned to study topics related to architectural structures: trusses, cables, beams, etc. Fun!
  - Most of you are "visual learners." Lots of in-class demonstrations make the physics concepts memorable.
  - You're used to working together. So we encourage a lot of cooperation and discussion in this course.
  - We know how much time you spend on your studio projects. So we do our best to keep this course low-stress for you.

Physics can give us new insights into the everyday world. We should go through this video a second time at end of semester.

https://www.youtube.com/watch?v=XfZFuw7a13E https://www.youtube.com/watch?v=XfZFuw7a13E&t=35

- 0:35 — impulse
- 0:43 — rotational inertia, torque
- 0:51 — torque, periodic motion, velocity, projectile motion
- 2:53 — friction, circular motion, projectile motion (173 s)
- 3:30 — center of mass (210 s)
- 6:18 — friction, “normal force” (378 s)

https://www.youtube.com/watch?v=XfZFuw7a13E&t=378

- For a long time, architects have been designing structures to span spaces. Is physics relevant to this pursuit?
- Let's make a **model** of a bridge. (Physics often uses models to simplify problems into a form you can analyze more easily.)

- The two supports are spring scales that read kilograms. The "bridge deck" is an 8 kg wooden plank.

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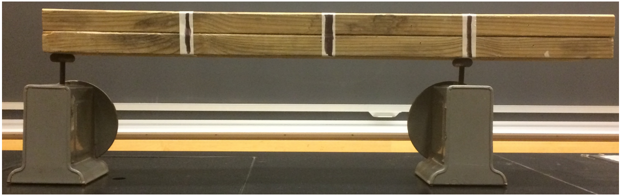
- If I use the two scales to support the plank symmetrically, as shown, from its very ends, what will each scale read?
- (For now, you and your neighbor should discuss, and use your intuition to "guess." As we study forces and torques in Sep/Oct, we'll draw diagrams to analyze more formally.)

(A) Both scales will read 8 kg

(B) Both scales will read 4 kg

(C) The left scale will read more than the right scale

(D) The left scale will read less than the right scale



- The "bridge deck" is an 8 kg wooden plank.
- Now one support stays at the far left, but the right support moves left, so that 1/4 of the plank hangs over the R end.
- What will the left and right scales read now?

(A) 4 kg (L) and 4 kg (R)

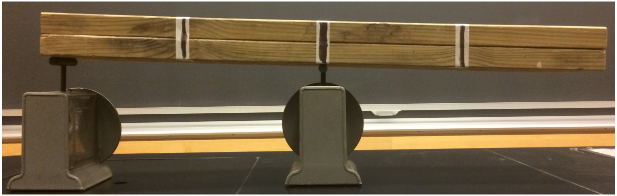
(B) (2/3)(8 kg)=5.33 kg (L) and (1/3)(8 kg)=2.67 kg (R)

(C) (1/3)(8 kg)=2.67 kg (L) and (2/3)(8 kg)=5.33 kg (R)

(D) (3/4)(8 kg)=6 kg (L) and (1/4)(8 kg)=2 kg (R)

(E) (1/4)(8 kg)=2 kg (L) and (3/4)(8 kg)=6 kg (R)

(F) 3 kg (L) and 6 kg (R)



- The "bridge deck" is an 8 kg wooden plank.
- Now one support stays at the far left, but the right support moves left, so that 1/2 of the plank hangs over the R end.
- What will the left and right scales read now?

By the way, these two scales report values in kilograms. What does a spring-based scale (like this one) really measure, anyway?

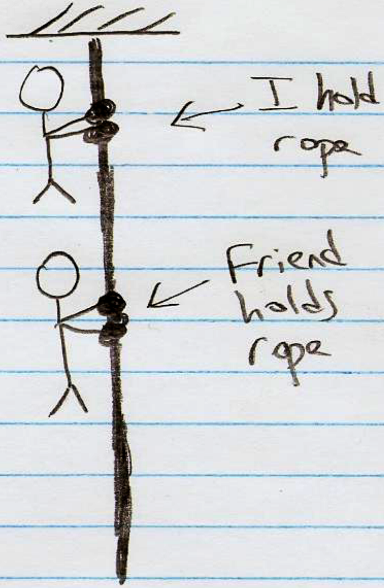
(A) mass

(B) weight

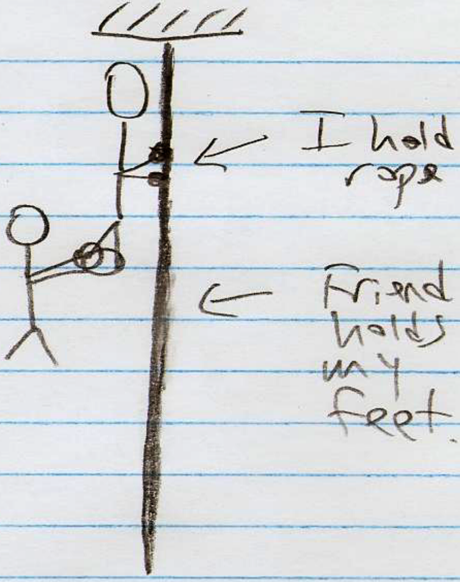
(C) inertia

(D) What's the difference?

- All materials deform (change shape) when you push or pull on them. In November, we'll study how the beams (or joists) beneath a floor bend in response to the "load" (the downward push) imposed by e.g. heavy furniture in the middle of the floor. (Illustrate with ruler.)
- The scale measures how far an internal metal spring bends in response to an object's pushing down on the scale's platform.
- Usually(*) that downward push exerted by the object on the scale is equal to the downward pull that Earth's gravity exerts on the object. We call that downward pull of gravity the object's **weight**. Weight is usually measured in Newtons (a unit of **force**), while mass is usually measured in kilograms.
- (*) Assuming that the object and scale are not accelerating.
- But weight is proportional to mass. The constant of proportionality is smaller on the Moon than it is on Earth.
- By the way, *inertia* is the same thing as mass. It measures an object's tendency to resist being accelerated.
- After a few weeks, this vocabulary will feel much more familar.

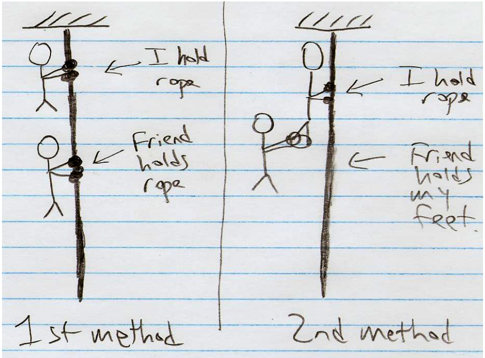


1st method



2nd method

To keep me from falling, the required force between *my* hands and the rope is . . .



(A) The same for both methods: equal to mg ($m =$ my mass)

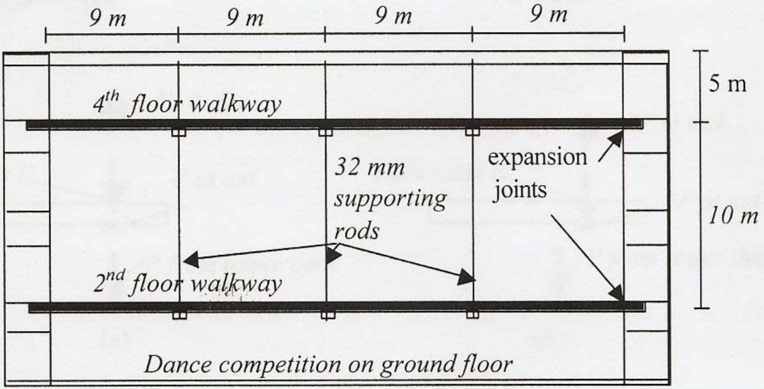
(B) The same for both methods: equal to $2mg$

(C) Twice as much for 1st method ($2mg$ vs. mg)

(D) Twice as much for 2nd method ($2mg$ vs. mg)

Kansas City Hyatt Regency skywalk collapse

On *7^th^* July *1981*, a dance was being held in the lobby of the Hyatt Regency Hotel, Kansas City. As spectators gathered on suspended walkways above the dance floor, the support gave way and the upper walkway fell on the lower walkway, and the two fell onto the crowded dance floor, killing *114* people and injuring over *200*.



For more like this, read *To Engineer is Human* by Henry Petroski.

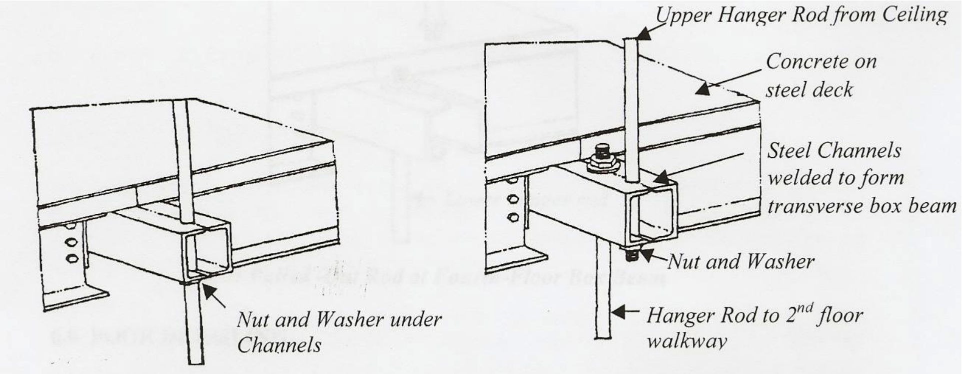


Fig. 5(a): Hyatt Regency Hanger Details As-Designed

Fig. 5(b): Hyatt Regency Hanger Details As-Built

As designed, each of the two skywalks hangs onto the rope with its own hands. As built, the lower skywalk's hands are effectively hanging onto the upper skywalk's feet! So the upper skywalk's grip on the rope feels $2\times$ larger force than in original design. Oops!

Look! A real use for drawing force diagrams!

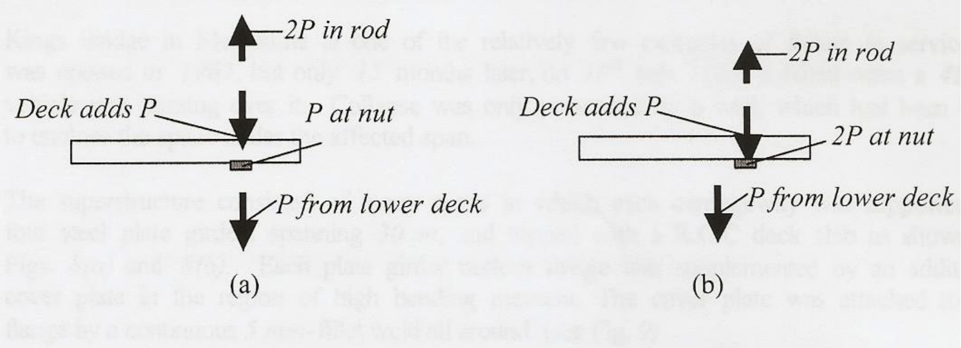


Fig. 6: Free-Body Diagram (a) As Designed (b) As Built

The author uses the symbol P for a "point" force (or point load), as is the custom in engineering. When you see "P" here, pretend it says "F" or "mg" instead.

We'll learn in September how to draw "free-body diagrams" as a graphical method to analyze forces (and then later, torques).

Upper skywalk loses its grip on the "rope"

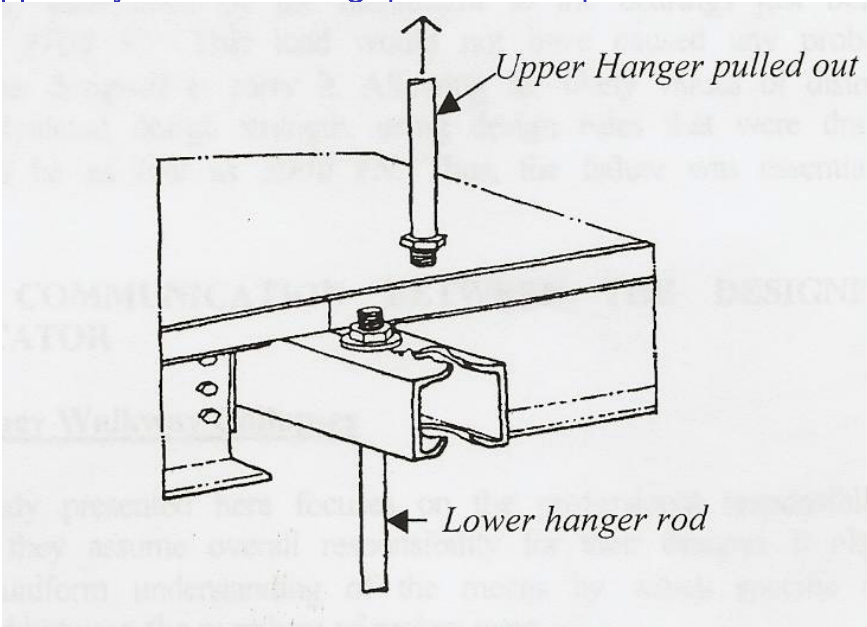
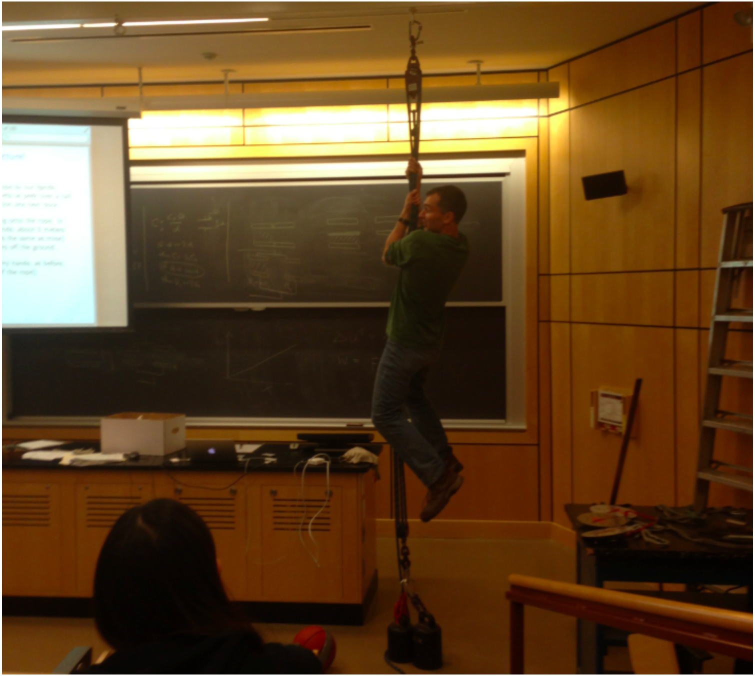
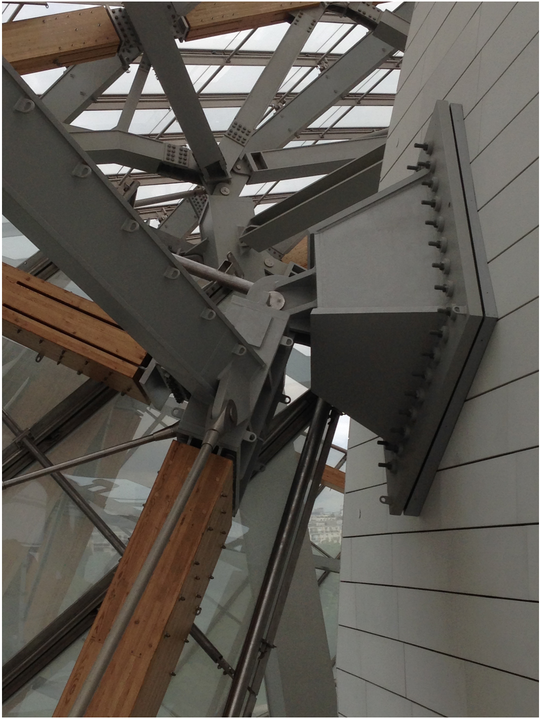
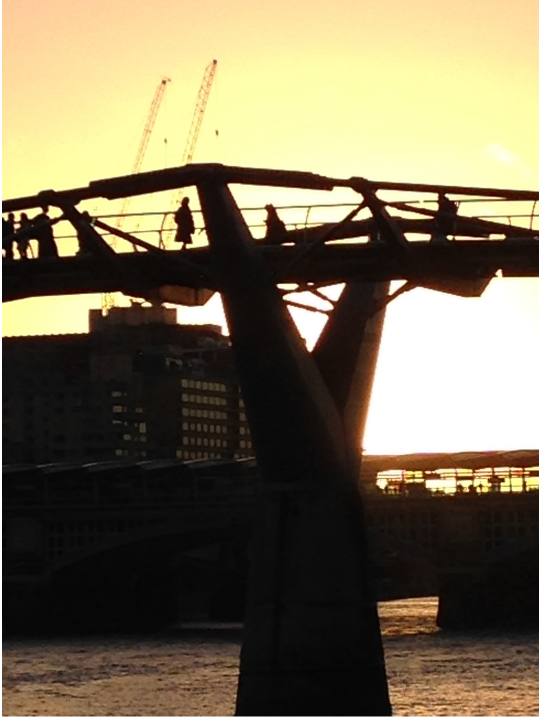
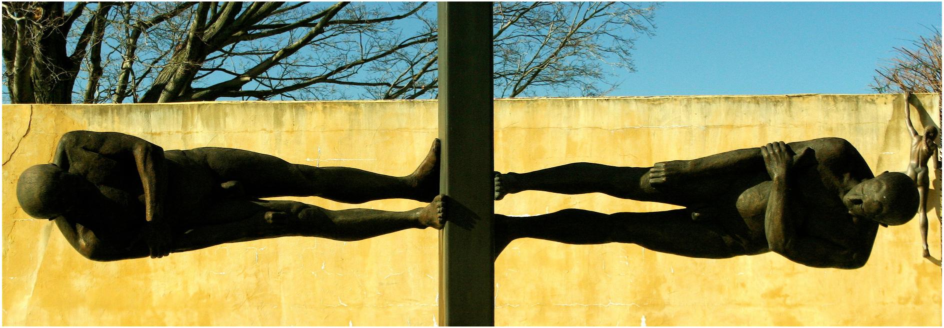


Fig. 7: Pulled -Out Rod at Fourth-Floor Box Beam









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- Course web page is at
  http://positron.hep.upenn.edu/physics8
- The reading for the first segment of the course is on Canvas. I'll explain later how to purchase or borrow a copy of the textbook for the second segment of the course.
- **Read Chapter 2 before Friday's class.**
- Skim Chapter 1 as soon as you can, e.g. by the end of the long weekend. (You'll also read Chapter 3 this weekend, and Chapter 4 early next week. Then we'll settle into a more comfortable pace.)
- Remember to fill out online response forms for both reading assignments at http://positron.hep.upenn.edu/q008 . (This is linked from Canvas and from course web page, so you don't need to write it down.)
- PDFs of these slides and other handouts can be found at
  http://positron.hep.upenn.edu/physics8/files