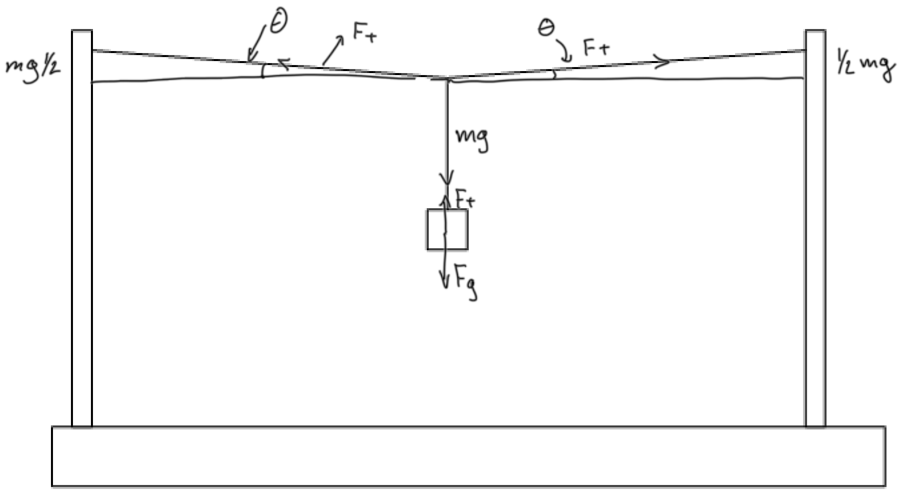
CTST-4

A mass m is hung from a clothesline stretched between two poles as shown. As a result, the clothesline sags slightly as shown.



Note: the tension force of a string is parallel to the string itself, and is a "restoring force" like normal forces or spring-like forces

$$F_T \leq \infty$$

The tension T in the clothesline has magnitude..

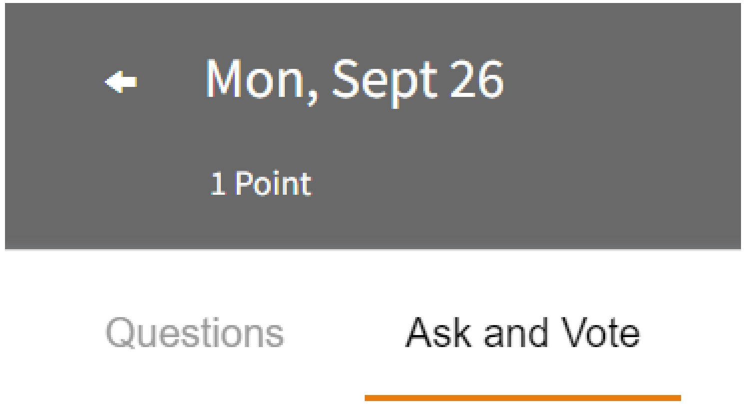
A: mg B: mg/2

C: slightly greater than mg

D: considerably greater than mg.

E: considerably less than mg.

Note: Ask and Vote

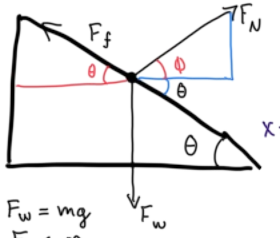


Midterm I: Wed, Sept 25

Monday will be a Review: Come with questions!

Recap Example: Climbing Up an Incline

The coefficient of static friction for a tennis shoe on pavement is about 0.8. What's the steepest angle of incline a person could stand up on without slipping and falling down?



$F_w = mg$

$F_N \leq \infty$

$F_f = \mu F_N$

$\Phi + \theta = 90$

$x = F_N \sin\theta + (-F_f \cos\theta) = 0$

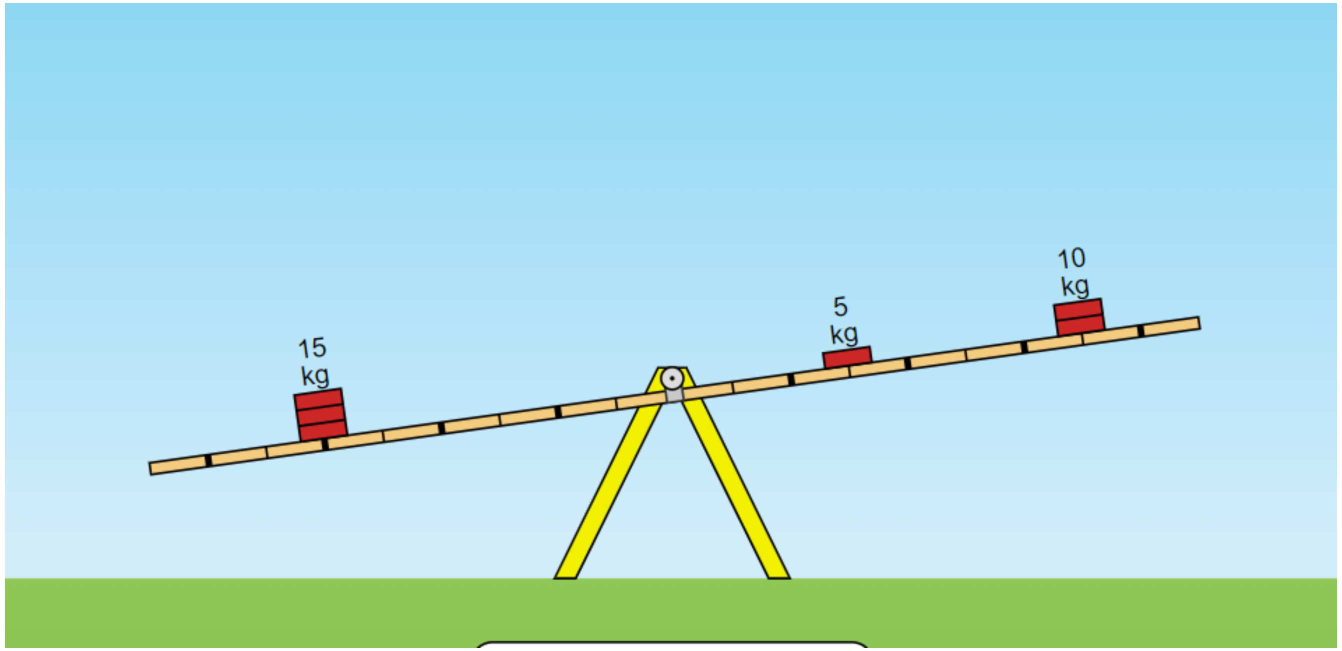
$\frac{F_N \sin\theta}{F_N} = \frac{\mu F_N \cos\theta}{F_N}$

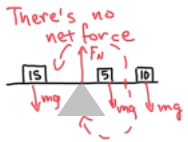
$\frac{\sin\theta}{\cos\theta} = \frac{\mu \cos\theta}{\cos\theta}$

$\frac{\sin\theta}{\cos\theta} = \mu = \tan\theta$

$\theta = \tan^{-1}(\mu) \approx 39°$

Prelecture Review: Rotational Equilibrium





Rotational Static Equilibrium

If the sum of the forces on an object are zero, it will not undergo translational motion. However it could still *rotate*! Let's try to understand the conditions for rotational static equilibrium. Open up [this simulation](), and go to "balance lab".

Remove the pillars supporting the balance beam, and try adding weights to different locations on the beam. Can you get it to balance? What patterns do you notice about when it does/doesn't? Are the net forces on the beam equal to zero?

What are our questions and/or comments?

Comments and Questions

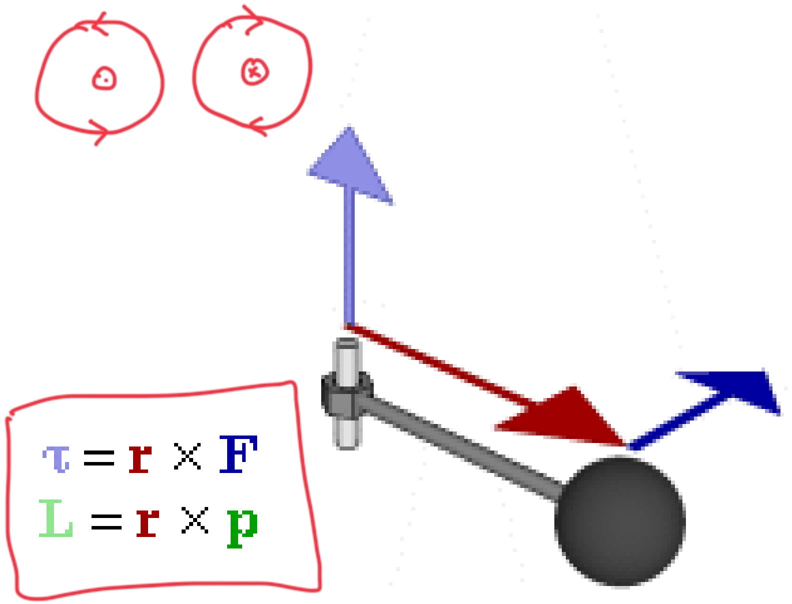
- For the seesaw to be level, it heavily depends on if the weights add up to be the same on either side, as well as the placements of the weight. 20 pounds could be placed on both sides but if distributed differently it will fall to one side.
- I am more curious on the effects of putting a larger weight closer to the fulcrum and balancing it out by putting 2 or more weights further away from the fulcrum. Why is it that certain positions can reach an equilibrium depending on mass?
- The center of mass changes based on the location of the weights
- I managed to get the beam to balance. It seems that when multiplying the length by the center of the beam and the mass of the object are the same on both sides of the beam, the beam balances. When the beam balances, the net forces on the beam should be zero.

New Idea: Torque

In physics and mechanics, **torque** is the rotational analogue of linear force.[1] It is also referred to as the **moment of force** (also abbreviated to **moment**). The symbol for torque is typically $\boldsymbol{\tau}$, the lowercase Greek letter *tau*. When being referred to as moment of force, it is commonly denoted by M. Just as a linear force is a push or a pull applied to a body, a torque can be thought of as a twist applied to an object with respect to a chosen point; for example, driving a screw uses torque, which is applied by the screwdriver rotating around its axis. A force of three newtons applied two metres from the fulcrum, for example, exerts the same torque as a force of one newton applied six metres from the fulcrum.

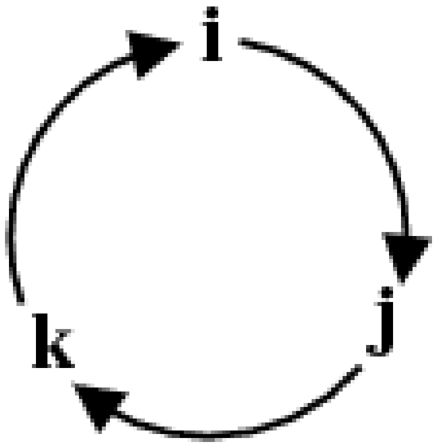
- This quantity is a vector, it has derived units (nameless), =Newton-Meter
- The magnitude is $|\tau|$=r $F_{\perp}$
- The direction is “out” for counterclockwise and “in” for clockwise

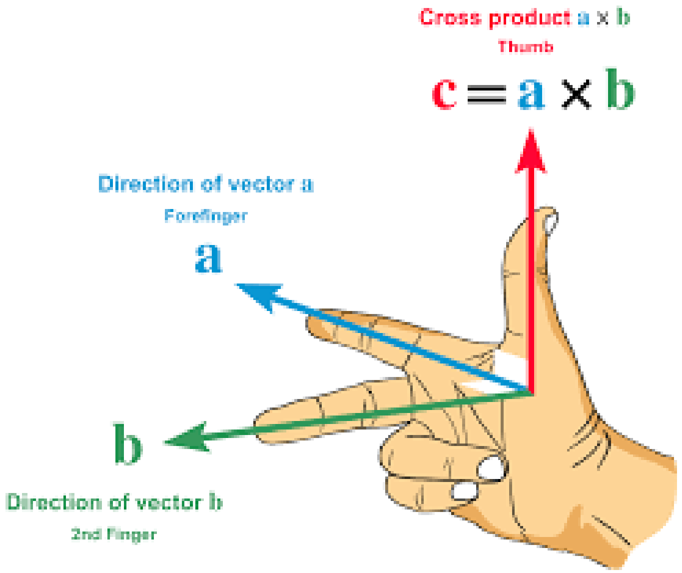
Key Point: <u>Rotational Static Condition</u>
If the (vector!) sum of all the torques acting on a stationary object are 0, it will not rotate, and if they are not, it will.

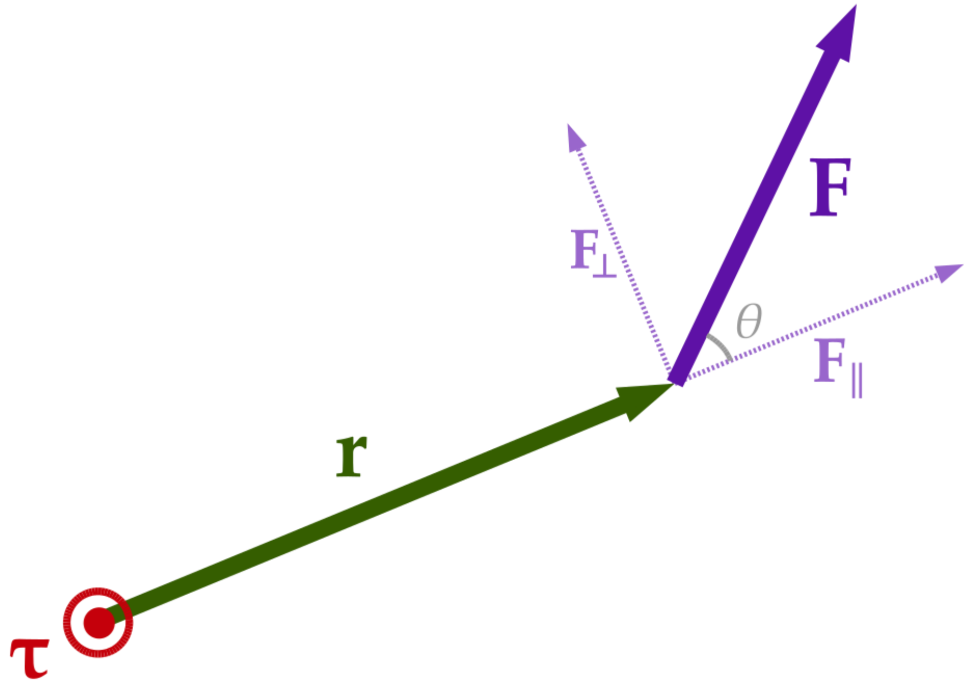


Tool: Cross Product

- We can define the “cross product” of two vectors geometrically as the product of the perpendicular components, in a direction orthogonal to both in a “right-handed” way.
- Then we can write a vector equation: $\vec{\tau} = \vec{r} \times \vec{F}$

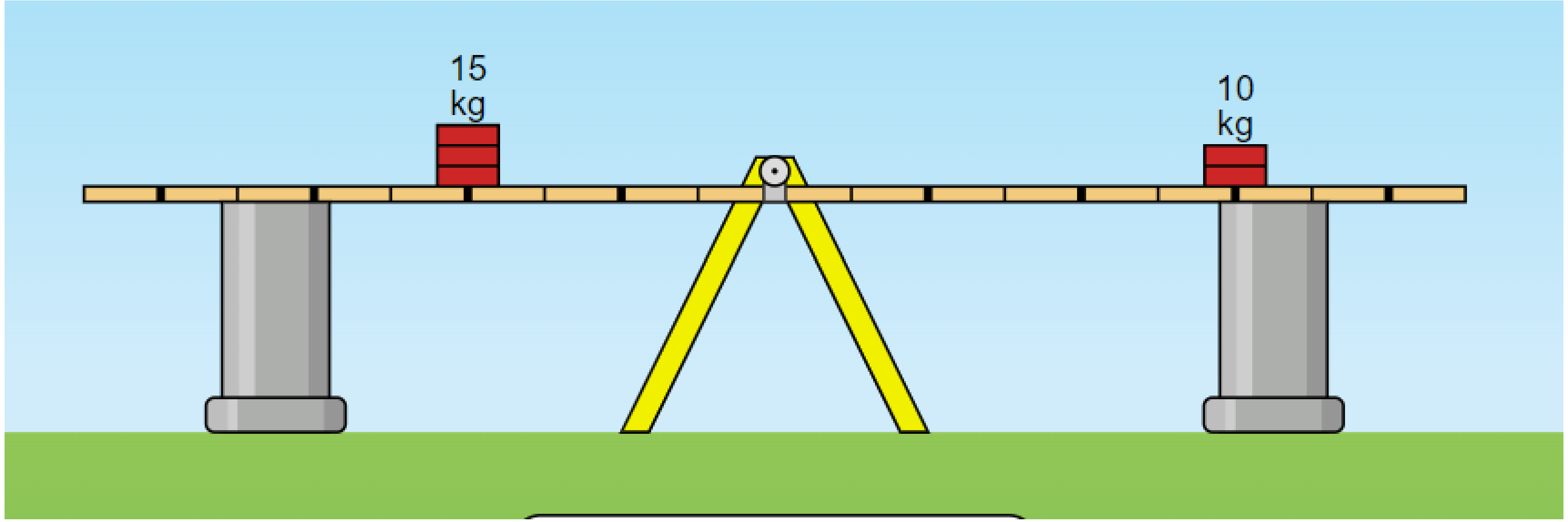






$$|\vec{c}| = |\vec{a}||\vec{b}| \sin\theta$$

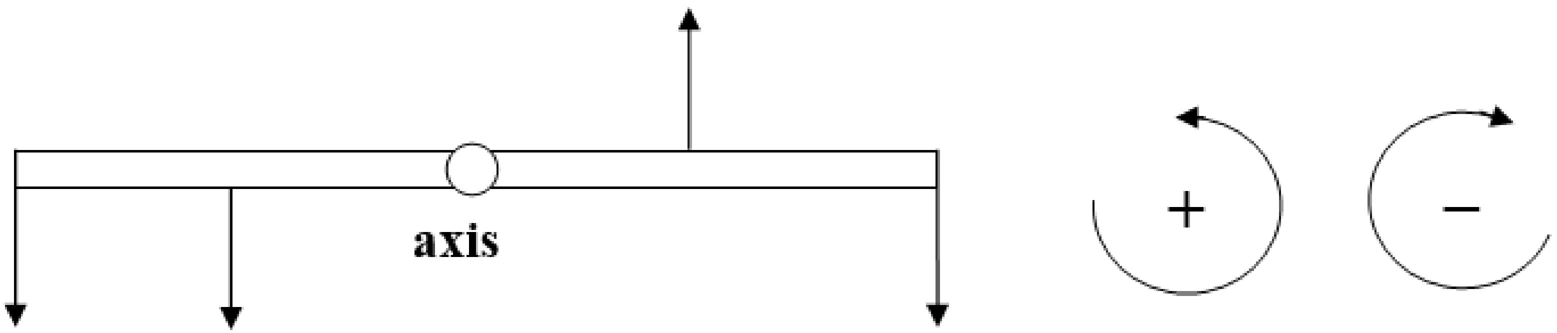
Example: If the columns are removed will the object move at all?



Need to check linear *and* rotational equilibrium

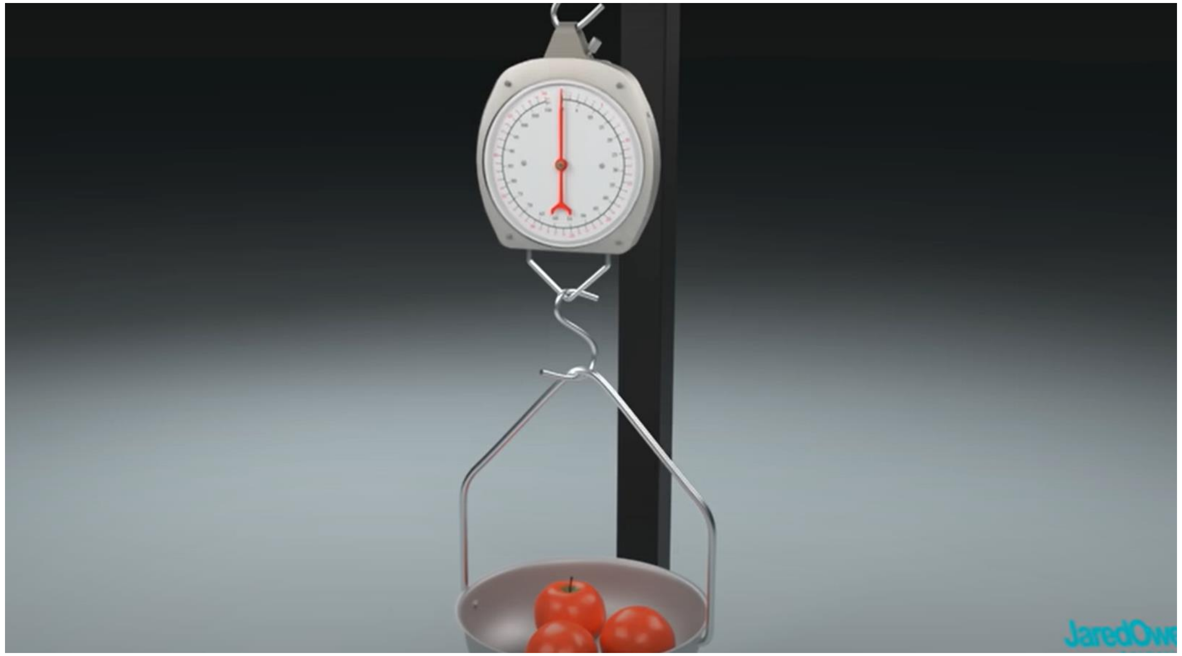
Concept Check:

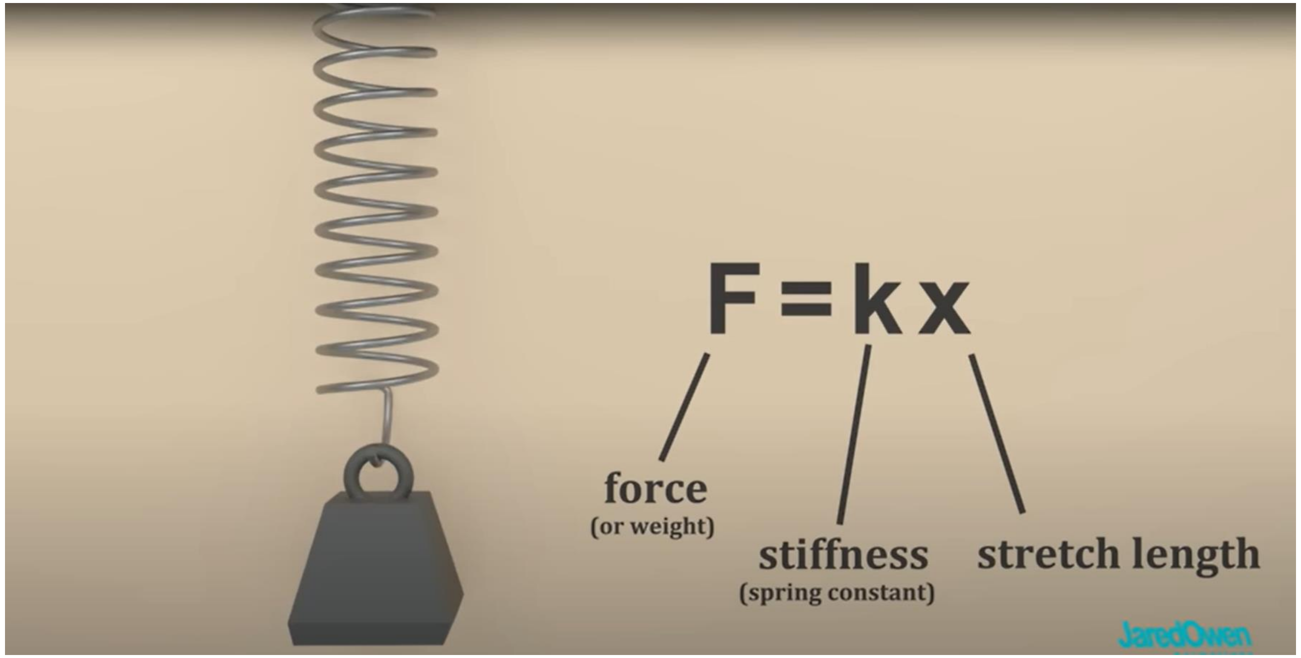
A bar has four forces, all of the same magnitude, exerted on it, as shown. What is the sign of the torque about the axis of rotation? Use the sign convention shown.



A) torque is zero B) positive (+) C) negative (–)

Prelecture Review: Linear Elasticity





$$F_E = -k\Delta x$$

Direction: Restoring Force

What are our questions and/or comments?

Comments and Questions

- Hooke's Law describes a linear relationship between force and deformation for small stretches, but what happens when materials are stretched beyond their elastic limit? Do the atomic bonds stretch and rearrange, or do they break? Can advancements in materials science lead to new materials with more flexible elastic limits, creating stronger, more resilient structures.
- How is it that we can determine mathematically the elastic limit of an object or material?
- I find it interesting that the spring constant can change. I wonder what factors would affect a springs specific spring constant. Would the diameter of the spring or the material make more of a difference?

My Comments and Questions

- Comment: There is an approximate sense in which spacetime itself has an elasticity, causing it to expand. This can be made precise in the "Newton-Hooke" approximation of general relativity (I'll try to bring this up later on).