Announcements 1 Apr 09

- **Thursday office hours from now on**
  - **Earlier than usual: 2:00 to 3:30 pm**
- **Homework #8**
  - **Written + online homework #8 due on Friday**
- **Exam 2**
  - **Tuesday April 7 from 7 to 9 pm**
  - **Includes material from homeworks #4, #5, #6, #7, #8**
  - **See full info on course blog (next slides)**
  - ***Arrange makeup exams this week!***

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Solving Static Equilibrium Problems

PROBLEM-SOLVING STRATEGY 8.1 **Static equilibrium problems**

PREPARE Model the object as a simple shape. Draw a visual overview that shows all forces and distances. List known information.

- Pick an axis or pivot about which the torques will be calculated.
- Determine the torque about this pivot point due to each force acting on the object.
- Determine the sign of each torque about this pivot point.

SOLVE The mathematical steps are based on the fact that an object in static equilibrium has no net force and no net torque.

$$\vec{F}_{\text{net}} = \vec{0} \quad \text{and} \quad \tau_{\text{net}} = 0$$

- Write equations for $\sum F_x = 0$, $\sum F_y = 0$, $\sum \tau = 0$.
- Solve the resulting equations.

Counter clockwise rotation: torque > 0
Clockwise rotation: torque < 0

ASSESS Check that your result is reasonable and answers the question.

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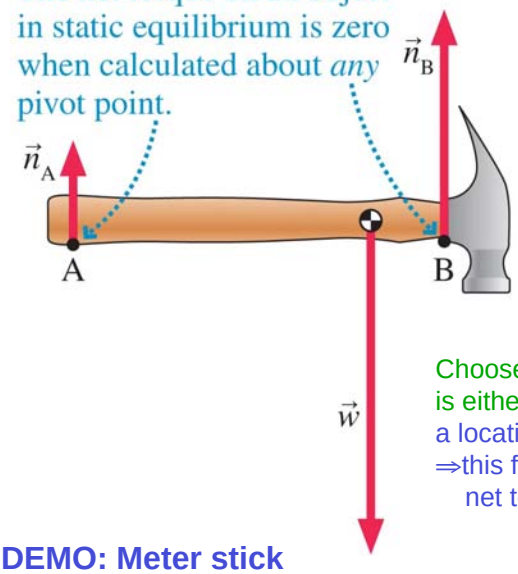
Choosing the Pivot Point

The net torque on an object in static equilibrium is zero when calculated about *any* pivot point.



Hammer resting on pegs A and B

Choose pivot point at a location which is either a natural axis of rotation or a location where the force is unknown
⇒this force will not contribute to the net torque at that point

DEMO: Meter stick

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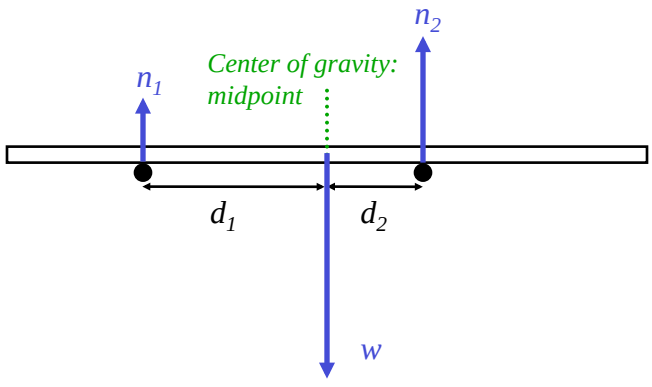
Meter Stick Demo



$$\text{If } d_2 > d_1 \Rightarrow n_2 > n_1 \Rightarrow f_{s2} > f_{s1}$$

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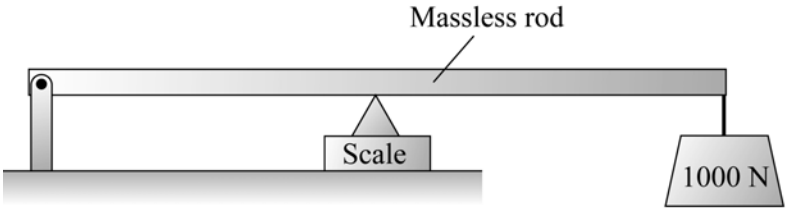
Static Equilibrium Question

PRS

What does the scale read?

A. 500 N
B. 1000 N
C. 2000 N
D. 4000 N



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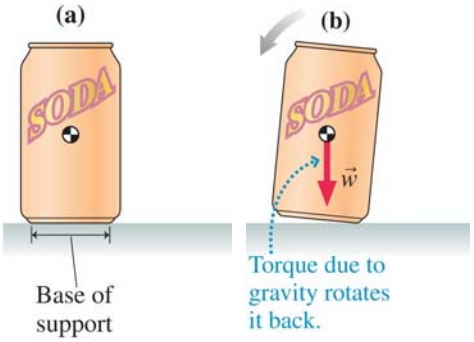
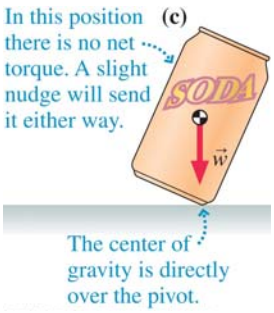
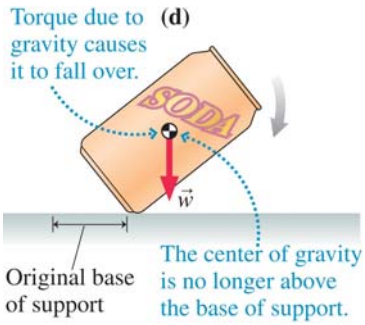
What makes an object stable?





For an object to be stable, the center of gravity of the object must lie over its base of support

DEMO: soda can lean against wall



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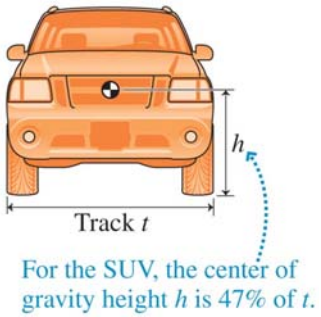
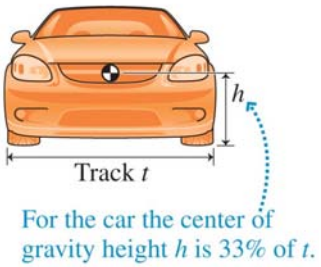
Which is more stable?

The ratio of the height of the center of gravity to the base of support is relevant to the overall stability of an object

The smaller the ratio, the greater the stability of the object





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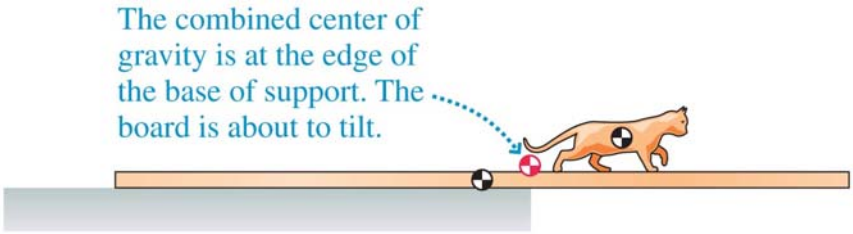
Static Equilibrium Sample Problem

A 2-m-long board weighing 50 N extends out over the edge of a table, with 40% of the board's length off the table. How far beyond the table edge can a 25 N cat walk before the board begins to tilt?



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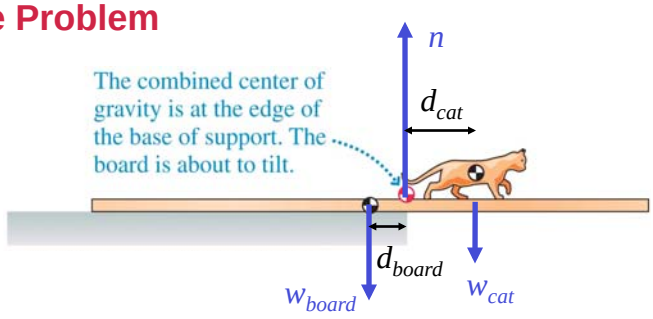
Sample Problem



Draw a picture showing all forces acting on the board

Choose point on the board in contact with the edge of the table as the pivot point

Require that the net torque about that point be zero:

$$\tau_{net} = d_{board} w_{board} - d_{cat} w_{cat} = 0$$

$$\tau_{net} = 0.2m(50N) - d_{cat}(25N) = 0$$

$$\Rightarrow 10Nm - d_{cat}(25N) = 0$$

$$\Rightarrow d_{cat} = \frac{10Nm}{25N} = 0.40m$$

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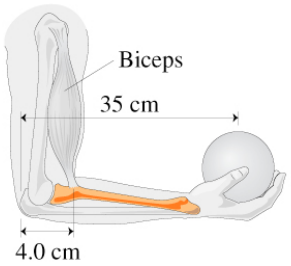
Problem 8.38 (homework #8)

If the person in the figure lowers his forearm with mass 1.2 kg to be 15° below horizontal, how much force must the biceps exert to hold the 500 g ball? Note that the "insertion point" where the biceps attaches to the forearm is always 4.0 cm from the elbow joint, and assume that the person's wrist remains unbent as they lower their forearm.



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Problem 8.39 (homework #8)

A man is attempting to raise a 7.5 m-long, 25 kg flagpole that has a hinge at the base by pulling on a rope attached to the top of the pole, as shown in the figure below. With what force does the man have to pull on the rope to hold the pole motionless in this position?

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