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Ch 11 Supplemental

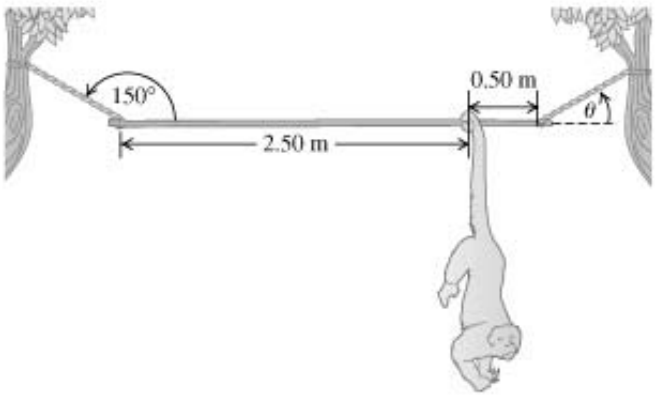
Due: 10:24am on Sunday, December 11, 2011

Note: To understand how points are awarded, read your instructor's Grading Policy.

Exercise 11.19

Description: A 3.00-m-long, w-N, uniform rod at the zoo is held in a horizontal position by two ropes at its ends (the figure). The left rope makes an angle of 150 degree(s) with the rod and the right rope makes an angle theta with the horizontal. A w2-N howler...

A 3.00-m-long, 260-N, uniform rod at the zoo is held in a horizontal position by two ropes at its ends (the figure). The left rope makes an angle of 150 $^\circ$ with the rod and the right rope makes an angle θ with the horizontal. A 86-N howler monkey (*Alouatta seniculus*) hangs motionless 0.50 m from the right end of the rod as he carefully studies you.



Part A

Calculate the tension in the left rope.

Express your answer using two significant figures.

ANSWER:

$$T_L = \frac{1.5w + w2 \cdot 0.5}{3\sin\left(\frac{150\pi}{180}\right)} \quad \mathrm{N}$$

Part B

Calculate the tension in the right rope.

Express your answer using two significant figures.

ANSWER:

$$T_R = \sqrt{\left((w + w2) - \frac{\frac{1.5w + w2 \cdot 0.5}{3\sin\left(\frac{150\pi}{180}\right)}}{2}\right)^2 + \left(\frac{1.5w + w2 \cdot 0.5}{3\sin\left(\frac{150\pi}{180}\right)}\cos\left(\frac{150\pi}{180}\right)\right)^2} \quad \mathrm{N}$$

Part C

Calculate the angle θ.

Express your answer using two significant figures.

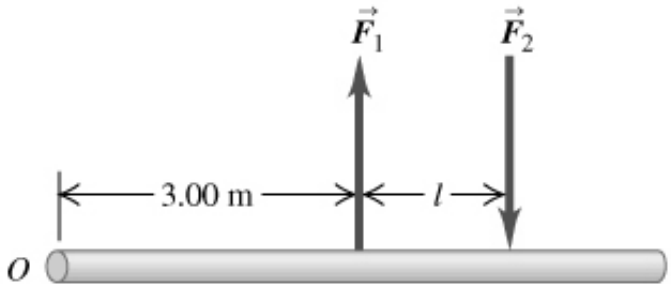
ANSWER:

$$\theta = \frac{-\text{atan}\left(\frac{(w+w2)-\frac{1.5w+w2\cdot 0.5}{3\sin\left(\frac{150\pi}{180}\right)}}{\frac{1.5w+w2\cdot 0.5}{3\sin\left(\frac{150\pi}{180}\right)}\cos\left(\frac{150\pi}{180}\right)}\right)}{\pi}\cdot 180 \quad ^\circ$$

Exercise 11.21

Description: Two forces equal in magnitude and opposite in direction, acting on an object at two different points, form what is called a couple. Two antiparallel forces with equal magnitudes F_1 = F_2 =F are applied to a rod as shown in the figure . (a) What...

Two forces equal in magnitude and opposite in direction, acting on an object at two different points, form what is called a *couple*. Two antiparallel forces with equal magnitudes $F_1 = F_2 =$8.40 N are applied to a rod as shown in the figure .



Part A

What should the distance l between the forces be if they are to provide a net torque of 6.90 $\text{N}\cdot\text{m}$ about the left end of the rod?

ANSWER:

$$l = \frac{\tau}{F} \quad \text{m}$$

Part B

Is the sense of this torque clockwise or counterclockwise?

ANSWER:

- (●) **clockwise**
- ( ) **counterclockwise**

Part C

Repeat part A for a pivot at the point on the rod where $\vec{F}_2$ is applied.

ANSWER:

$$l = \frac{\tau}{F} \quad \text{m}$$

Part D

Repeat part B for a pivot at the point on the rod where $\vec{F}_2$ is applied.

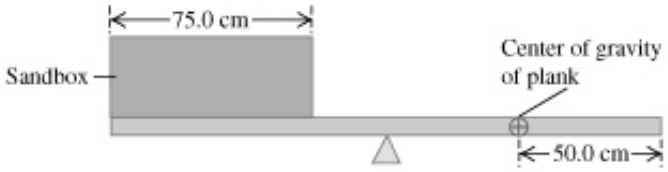
ANSWER:

- (●) **clockwise**
- ( ) **counterclockwise**

Problem 11.43

Description: A box of negligible mass rests at the left end of a l-m, m-kg plank (the figure). The width of the box is w, and sand is to be distributed uniformly throughout it. The center of gravity of the nonuniform plank is d from the right end. (a) What mass...

A box of negligible mass rests at the left end of a 2.20-m, 27.5-kg plank (the figure). The width of the box is 75.0 cm, and sand is to be distributed uniformly throughout it. The center of gravity of the nonuniform plank is 50.0 cm from the right end.



Part A

What mass of sand should be put into the box so that the plank balances horizontally on a fulcrum

placed just below its midpoint?

ANSWER:

$$m_{\text{sand}} = \frac{m\left(\frac{l}{2}-d\right)}{\frac{l}{2}-\frac{w}{2}} \quad \text{kg}$$

Problem 11.49

Description: A uniform, w0-N rod that is l long carries a 225-N weight at its right end and an unknown weight W toward the left end (see the figure). When W is placed x from the left end of the rod, the system just balances horizontally when the fulcrum is...

A uniform, 260-N rod that is 1.99 m long carries a 225-N weight at its right end and an unknown weight W toward the left end (see the figure). When W is placed 43.1 cm from the left end of the rod, the system just balances horizontally when the fulcrum is located 80.6 cm from the right end.

Part A

Find W.

ANSWER:

$$W = \frac{\left|\frac{lw0-2dw0-2d\cdot 225}{2}\right|}{x-l+d} \quad \text{N}$$

Part B

If W is now moved 29.5 cm to the right, how far must the fulcrum be moved to restore balance?

ANSWER:

$$\Delta x = d - \frac{\frac{w0l}{2} + \frac{\frac{lw0-2dw0-2d\cdot 225}{2}}{x-l+d}(l-x-x2)}{\frac{\frac{lw0-2dw0-2d\cdot 225}{2}}{x-l+d} + w0 + 225} \quad \text{m}$$

Part C

If W is now moved 29.5 cm to the right, in what direction must the fulcrum be moved to restore balance?

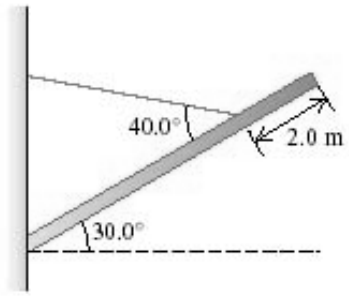
ANSWER:

- ○ **to the left**
- ◉ **to the right**

Problem 11.50

Description: A uniform ## m, ## kg beam is hinged to a wall and supported by a thin cable attached ## m from the free end of the beam, as shown in the figure below . The beam is supported at an angle of ## degree(s) above the horizontal. (a) Find the tension in...

A uniform 8.00 m, 1500 kg beam is hinged to a wall and supported by a thin cable attached 2.00 m from the free end of the beam, as shown in the figure below . The beam is supported at an angle of 30.0° above the horizontal.



Part A

Find the tension in the cable.

ANSWER: $T = 1.32 \cdot 10^4$ N

Part B

How hard does the beam push inward on the wall?

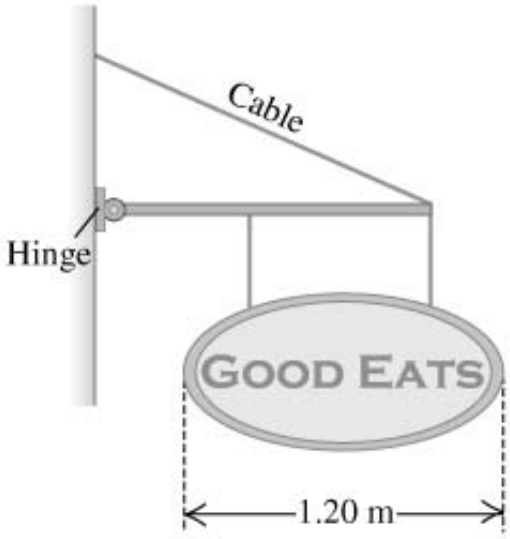
ANSWER: $F = 1.80 \cdot 10^4$ N

Problem 11.51

Description: You open a restaurant and hope to entice customers by hanging out a sign (see the figure). The uniform horizontal beam supporting the sign is l long, has a mass of m_1, and is hinged to the wall. The sign itself is uniform with a mass of m_2 and...

You open a restaurant and hope to entice customers by hanging out a sign (see the figure). The uniform horizontal beam supporting the sign is 1.70 m long, has a mass of 17.0 kg, and is hinged to the wall. The

sign itself is uniform with a mass of 33.0 kg and over-all length of 1.20 m. The two wires supporting the sign are each 38.0 cm long, are 95.0 cm apart, and are equally spaced from the middle of the sign. The cable supporting the beam is 2.20 m long.



Part A

What minimum tension must your cable be able to support without having your sign come crashing down?

ANSWER:

$$T_{\min} = \frac{m_1 \cdot 9.8l + m_2 \cdot 9.8\,(2l - d)}{2l\sqrt{1 - \left(\frac{l}{l_4}\right)^2}} \quad \text{N}$$

Part B

What minimum vertical force must the hinge be able to support without pulling out of the wall?

ANSWER:

$$F_{\min} = m_2 \cdot 9.8 + m_1 \cdot 9.8 - \frac{m_1 \cdot 9.8l + m_2 \cdot 9.8\,(2l - d)}{2l} \quad \text{N}$$

Problem 11.62

Description: A uniform drawbridge must be held at a 37 degree(s) angle above the horizontal to allow ships to pass underneath. The drawbridge weighs 45,000 N and is 14.0 m long. A cable is connected 3.5 m from the hinge where the bridge pivots (measured along the …

A uniform drawbridge must be held at a 37 ° angle above the horizontal to allow ships to pass underneath. The drawbridge weighs 45,000 N and is 14.0 m long. A cable is connected 3.5 m from the hinge where the bridge pivots (measured along the bridge) and pulls horizontally on the bridge to hold it in place.

Part A

What is the tension in the cable?

ANSWER:

T = $1.19 \cdot 10^5$ N

Part B

Find the magnitude of the force the hinge exerts on the bridge.

ANSWER:

N = $1.27 \cdot 10^5$ / $1.28 \cdot 10^5$ N

Part C

Find the direction of the force the hinge exerts on the bridge.

ANSWER:

ϕ = 20.7 ° above the horizontal

Part D

If the cable suddenly breaks, what is the magnitude of the angular acceleration of the drawbridge just after the cable breaks?

ANSWER:

α = 0.839 rad/s^2

Part E

What is the angular speed of the drawbridge as it becomes horizontal?

ANSWER:

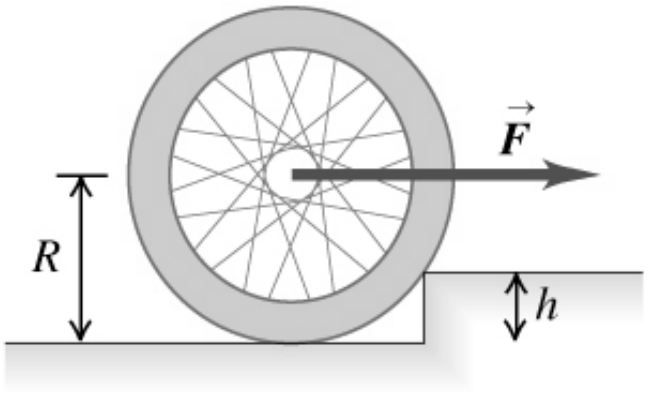
ω = 1.12 rad/s

Problem 11.76

Description: You are trying to raise a bicycle wheel of mass m and radius R up over a curb of height h. To do this, you apply a horizontal force F_vec. (a) What is the least magnitude of the force F_vec that will succeed in raising the wheel onto the curb when...

You are trying to raise a bicycle wheel of mass m and radius R up over a curb of height h. To do this,

you apply a horizontal force $\vec{F}$.



Part A

What is the least magnitude of the force $\vec{F}$ that will succeed in raising the wheel onto the curb when the force is applied at the center of the wheel?

ANSWER:

$$F = \frac{mg\sqrt{2Rh - h^2}}{R - h}$$

Part B

What is the least magnitude of the force $\vec{F}$ that will succeed in raising the wheel onto the curb when the force is applied at the top of the wheel?

ANSWER:

$$\frac{mg\sqrt{2Rh - h^2}}{2R - h}$$

$$F = mg\sqrt{\frac{h}{2R - h}}$$

Part C

In which case is less force required?

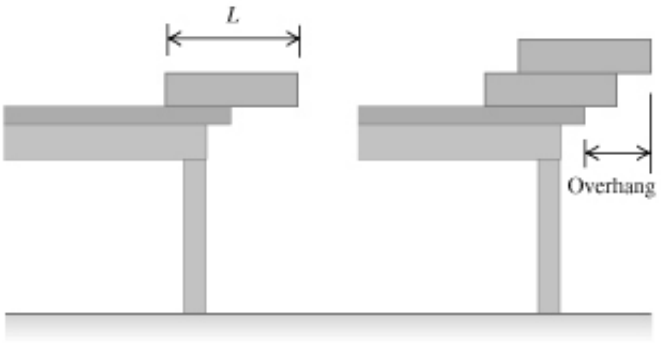
ANSWER:

- case A
- case B

Problem 11.78

Description: If you put a uniform block at the edge of a table, the center of the block must be over the table for the block not to fall off. (a) If you stack two identical blocks at the table edge, the center of the top block must be over the bottom block, and...

If you put a uniform block at the edge of a table, the center of the block must be over the table for the block not to fall off.



Part A

If you stack two identical blocks at the table edge, the center of the top block must be over the bottom block, and the center of gravity of the two blocks together must be over the table. In terms of the length L of each block, what is the maximum overhang possible?

ANSWER: $\frac{3}{4}L$

Part B

Repeat part (A) for three identical blocks.

ANSWER: $\frac{11}{12}L$

Part C

Repeat part (A) for four identical blocks.

ANSWER: $\frac{25}{24}L$

Part D

Is it possible to make a stack of blocks such that the uppermost block is not directly over the table at all?

ANSWER:

- (●) yes
- ( ) no

Part E

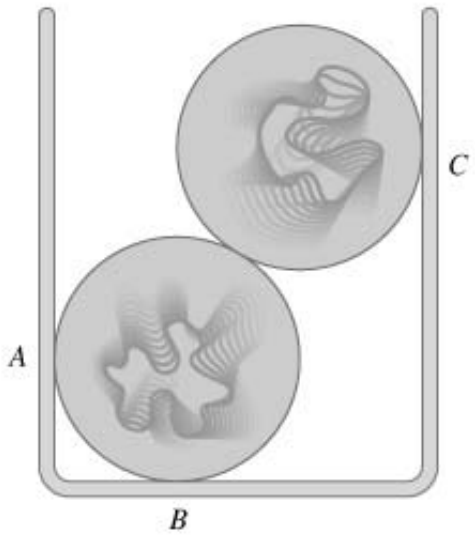
How many blocks would it take to do this? (Try this with your friends using copies of this book.)

ANSWER: 4

Problem 11.79

Description: Two uniform m-g marbles d in diameter are stacked as shown in the figure in a container that is l wide. (a) Find the force that the container exerts on the marble at the point of contact A. (b) Find the force that the container exerts on the marble ...

Two uniform 68.1-g marbles 2.10 cm in diameter are stacked as shown in the figure in a container that is 2.98 cm wide.



Part A

Find the force that the container exerts on the marble at the point of contact *A*.

ANSWER: $N_A = m \cdot 9.8 \tan\left(\text{asin}\left(\frac{l}{d} - 1\right)\right)$ N

Part B

Find the force that the container exerts on the marble at the point of contact *B*.

ANSWER: $N_B = 2 \cdot 9.8m$ N

Part C

Find the force that the container exerts on the marble at the point of contact *C*.

ANSWER: $N_C = m \cdot 9.8 \tan\left(\text{asin}\left(\frac{l}{d} - 1\right)\right)$ N

Part D

What force does each marble exert on the other?

ANSWER: $N = \frac{m \cdot 9.8}{\cos\left(\text{asin}\left(\frac{l}{d} - 1\right)\right)}$ N