Week 11: Chapter 11 [Edit]

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Week 11: Chapter 11

Due: 11:59pm on Sunday, April 12, 2015

To understand how points are awarded, read the Grading Policy for this assignment.

Exercise 11.7

Description: Two people carry a heavy electric motor by placing it on a light board l long. One person lifts at one end with a force of F_1, and the other lifts the opposite end with a force of F_2. (a) What is the weight of the motor? (b) Where along the board...

Two people carry a heavy electric motor by placing it on a light board $1.50\,\mathrm{m}$ long. One person lifts at one end with a force of $430\,\mathrm{N}$, and the other lifts the opposite end with a force of $590\,\mathrm{N}$.

Part A

What is the weight of the motor?

ANSWER:

$w =$ $F_1 + F_2$ = 1020 N

Part B

Where along the board is its center of gravity located?

ANSWER:

$x =$ $\dfrac{lF_2}{F_1 + F_2}$ = 0.868 m from the end where the 430-N force is applied

Part C

Suppose the board is not light but weighs $210\,\mathrm{N}$, with its center of gravity at its center, and the two people each exert the same forces as before. What is the weight of the motor in this case?

ANSWER:

$w =$ $F_1 + F_2 - F_0$ = 810 N

Part D

Where is its center of gravity located?

ANSWER:

x = $\dfrac{l\left(F_2 - \frac{F_0}{2}\right)}{F_1 + F_2 - F_0}$ = 0.898 m from the end where the 430-N force is applied

Exercise 11.9

Description: A w-N, uniform, l-m bar is suspended horizontally by two vertical cables at each end. Cable A can support a maximum tension of T_A without breaking, and cable B can support up to T_B. You want to place a small weight on this bar. (a) What is the...

A 342-N, uniform, 1.53-m bar is suspended horizontally by two vertical cables at each end. Cable *A* can support a maximum tension of 463.0N without breaking, and cable *B* can support up to 372.0N . You want to place a small weight on this bar.

Part A

What is the heaviest weight you can put on without breaking either cable?

ANSWER:

w = $T_A + T_B - w$ = 493 N

Part B

Where should you put this weight?

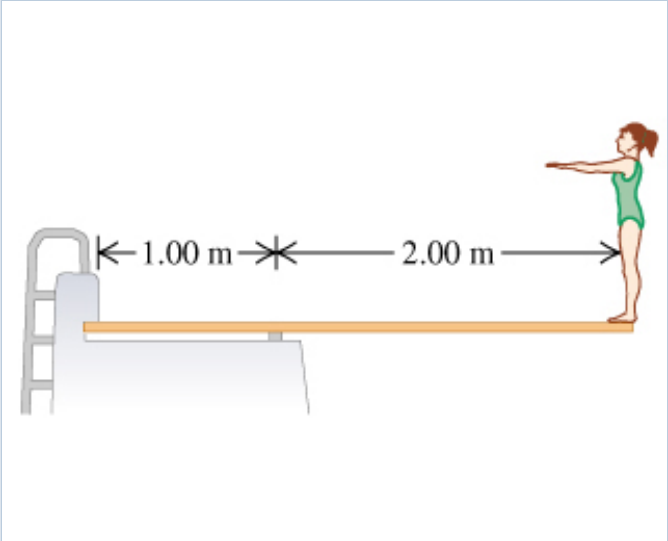
ANSWER:

d = $\dfrac{T_B l - \frac{wl}{2}}{T_A + T_B - w}$ = 0.624 m from the cable *A*

Exercise 11.11

Description: A diving board of length 3.00 m is supported at a point 1.00 m from the end, and a diver weighing w_1 stands at the free end . The diving board is of uniform cross section and weighs w_2. (a) Find the magnitude of the force at the support point. (...

A diving board of length 3.00 m is supported at a point 1.00 m from the end, and a diver weighing 490N stands at the free end . The diving board is of uniform cross section and weighs 275N .



Part A

Find the magnitude of the force at the support point.

ANSWER:

$$F = \frac{\frac{w_2 \cdot 3.00}{2} + w_1 \cdot 3.00}{1.00} = 1880 \text{ N}$$

Part B

Find the direction of the force at the support point.

ANSWER:

- (•) upward
- ( ) downward

Part C

Find the magnitude of the force at the left-hand end.

ANSWER:

$$F = \frac{\frac{w_2 \cdot 3.00}{2} + w_1 \cdot 3.00}{1.00} - w_1 - w_2 = 1120 \text{ N}$$

Part D

Find the direction of the force at the left-hand end.

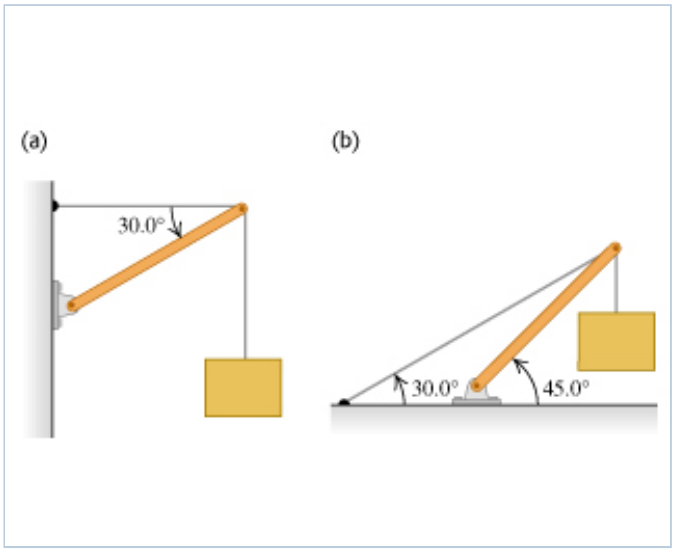
ANSWER:

- upward
- (•) downward

Exercise 11.13

Description: In each case let w be the weight of the suspended crate full of priceless art objects. The strut is uniform and also has weight w. (a) Find the tension T in the cable in the arrangement (a). (b) Find the magnitude of the force exerted on the...

In each case let w be the weight of the suspended crate full of priceless art objects. The strut is uniform and also has weight w.



Part A

Find the tension T in the cable in the arrangement (a).

Express your answer in terms of w.

ANSWER:

T = $2.60w$

Part B

Find the magnitude of the force exerted on the strut by the pivot in the arrangement (a).

Express your answer in terms of w.

ANSWER:

F = $3.28w$

Part C

Find the direction of the force exerted on the strut by the pivot in the arrangement (a).

ANSWER:

ϕ = 37.6 $^\circ$ from the horizontal

Part D

Find the tension T in the cable in the arrangement (b).

Express your answer in terms of w.

ANSWER:

T = $4.10w$

Part E

Find the magnitude of the force exerted on the strut by the pivot in the arrangement (b).

Express your answer in terms of w.

ANSWER:

F = $5.38w$

Part F

Find the direction of the force exerted on the strut by the pivot in the arrangement (b).

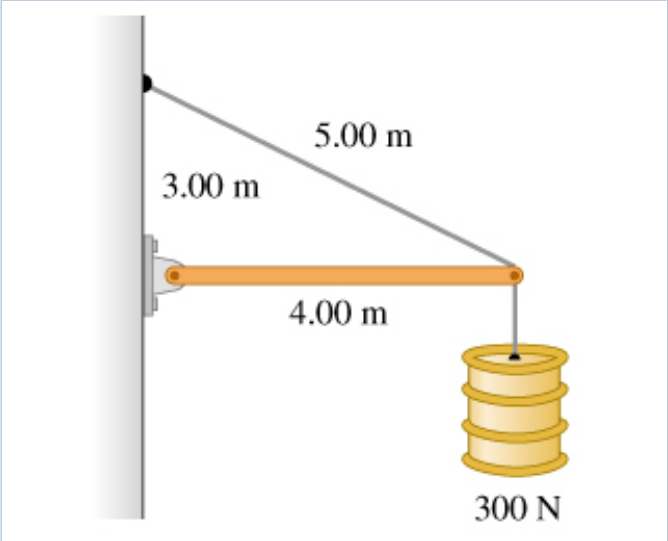
ANSWER:

ϕ = 48.8 $^\circ$ from the horizontal

Exercise 11.14

Description: The horizontal beam in the figure weighs 150 N, and its center of gravity is at its center. (a) Find the tension in the cable. (b) Find the horizontal component of the force exerted on the beam at the wall. (c) Find the vertical component of the...

The horizontal beam in the figure weighs 150 N, and its center of gravity is at its center.



Part A

Find the tension in the cable.

ANSWER:

T = 625 N

Part B

Find the horizontal component of the force exerted on the beam at the wall.

ANSWER:

N_H = 500 N

Part C

Find the vertical component of the force exerted on the beam at the wall.

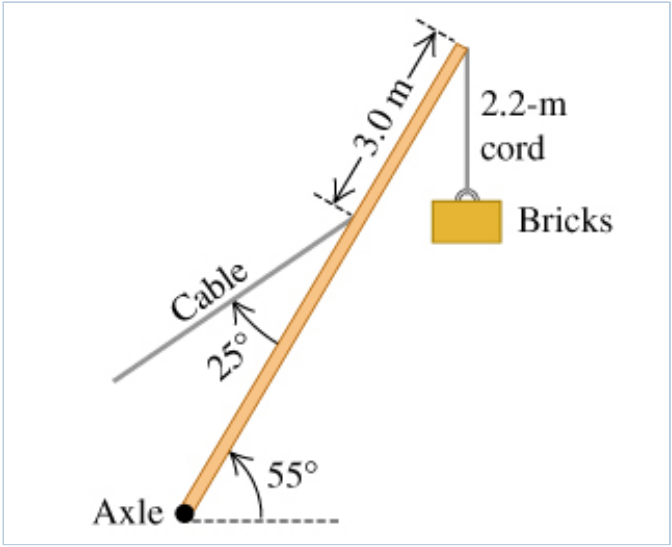
ANSWER:

N_V = 75.0 N

Exercise 11.18

Description: A 15000-N crane pivots around a friction-free axle at its base and is supported by a cable making a 25 degree(s) angle with the crane (the figure). The crane is 16 m long and is not uniform, its center of gravity being 7.0 m from the axle as...

A 15000-N crane pivots around a friction-free axle at its base and is supported by a cable making a 25 $^\circ$ angle with the crane (the figure). The crane is 16 m long and is not uniform, its center of gravity being 7.0 m from the axle as measured along the crane. The cable is attached 3.0 m from the upper end of the crane.



Part A

When the crane is raised to 55 $^\circ$ above the horizontal holding an 11000-N pallet of bricks by a 2.2-m very light cord, find the tension in the cable.

Express your answer using two significant figures.

ANSWER:

T = 2.9×10^4 N

Part B

Find the horizontal component of the force that the axle exerts on the crane.

Express your answer using two significant figures.

ANSWER:

F_H = 2.5×10^4 N

Part C

Find the vertical component of the force that the axle exerts on the crane.

Express your answer using two significant figures.

ANSWER:

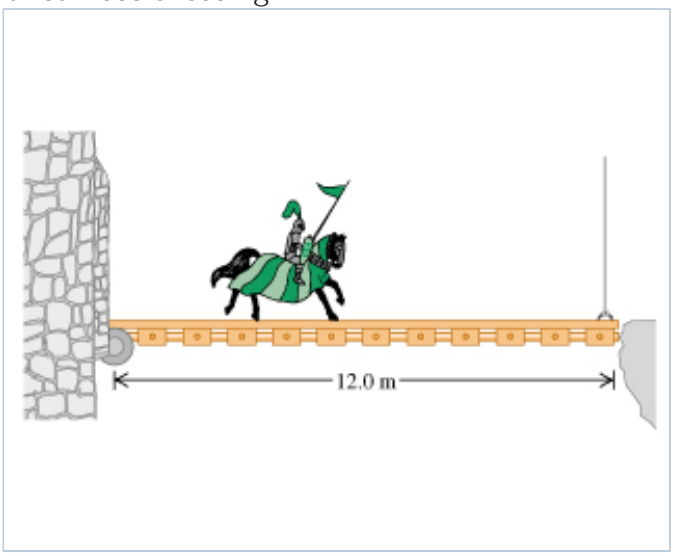
F_V = 4.1×10^4 N

Problem 11.46

Description: Sir Lancelot rides slowly out of the castle at Camelot and onto the 12.0-m-long drawbridge that passes

over the moat. Unbeknownst to him, his enemies have partially severed the vertical cable holding up the front end of the bridge so that it will...

Sir Lancelot rides slowly out of the castle at Camelot and onto the 12.0-m-long drawbridge that passes over the moat. Unbeknownst to him, his enemies have partially severed the vertical cable holding up the front end of the bridge so that it will break under a tension of 5.80×10^3 N. The bridge has mass 200 kg and its center of gravity is at its center. Lancelot, his lance, his armor, and his horse together have a combined mass of 600 kg.



Part A

Will the cable break before Lancelot reaches the end of the drawbridge?

ANSWER:

- (•) yes
- ( ) no

Part B

If so, how far from the castle end of the bridge will the center of gravity of the horse plus rider be when the cable breaks?

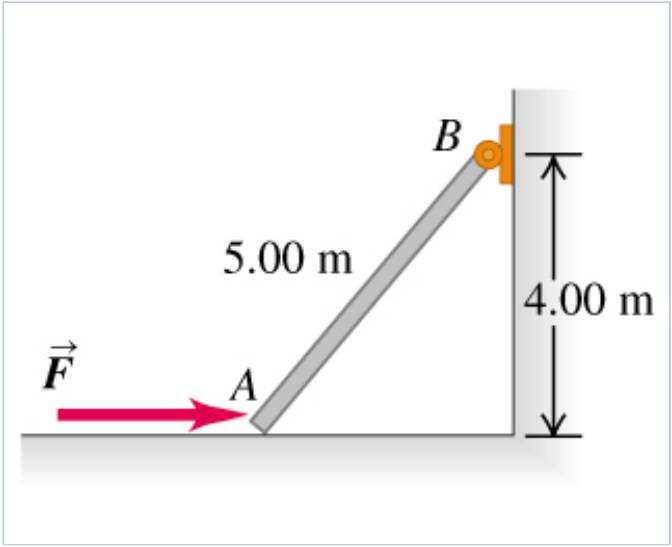
ANSWER:

L = 9.84 m

Problem 11.53

Description: End A of the bar AB in the figure rests on a frictionless horizontal surface, and end B is hinged. A horizontal force F_vec of magnitude F is exerted on end A. You can ignore the weight of the bar. (a) What is the horizontal component of the force...

End *A* of the bar *AB* in the figure rests on a frictionless horizontal surface, and end *B* is hinged. A horizontal force $\vec{F}$ of magnitude 118N is exerted on end *A*. You can ignore the weight of the bar.



Part A

What is the horizontal component of the force exerted by the bar on the hinge at *B*?

ANSWER:

F_h = F = 118 N

Also accepted: $-F$ = -118

Part B

What is the vertical component of the force exerted by the bar on the hinge at *B*?

ANSWER:

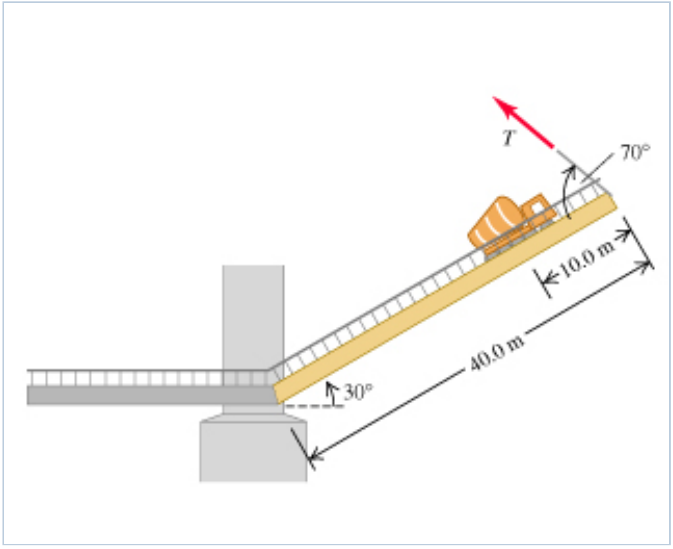
F_v = $\frac{F \cdot 4}{3}$ = 157 N

Also accepted: $\frac{-F \cdot 4}{3}$ = -157

Problem 11.56

Description: A loaded cement mixer drives onto an old drawbridge, where it stalls with its center of gravity three-quarters of the way across the span. The truck driver radios for help, sets the handbrake, and waits. Meanwhile, a boat approaches, so the drawbridge ...

A loaded cement mixer drives onto an old drawbridge, where it stalls with its center of gravity three-quarters of the way across the span. The truck driver radios for help, sets the handbrake, and waits. Meanwhile, a boat approaches, so the drawbridge is raised by means of a cable attached to the end opposite the hinge (the figure). The drawbridge is 40.0 m long and has a mass of 18,000 kg; its center of gravity is at its midpoint. The cement mixer, with driver, has mass 30,000 kg. When the drawbridge has been raised to an angle of 30 $^\circ$ above the horizontal, the cable makes an angle of 70 $^\circ$ with the surface of the bridge.



Part A

What is the tension T in the cable when the drawbridge is held in this position?

ANSWER:

T = 2.84×10^5 N

Part B

What is the horizontal component of the force the hinge exerts on the span?

ANSWER:

N_H = 2.18×10^5 N

Part C

What is the vertical component of the force the hinge exerts on the span?

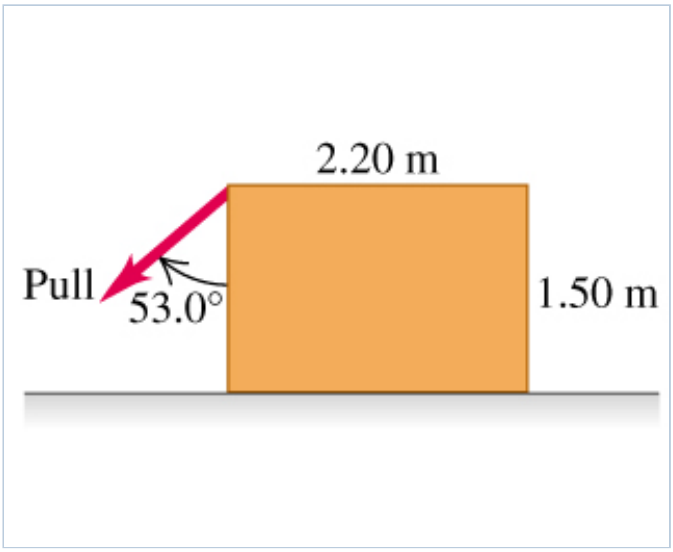
ANSWER:

N_V = 2.88×10^5 N

Problem 11.69

Description: A worker wants to turn over a uniform w-N rectangular crate by pulling at 53.0 degree(s) on one of its vertical sides (the figure). The floor is rough enough to prevent the crate from slipping. (a) What pull is needed to just start the crate to...

A worker wants to turn over a uniform 1220-N rectangular crate by pulling at 53.0 ° on one of its vertical sides (the figure). The floor is rough enough to prevent the crate from slipping.



Part A

What pull is needed to just start the crate to tip?

ANSWER:

P = $w \cdot 0.918$ = 1120 N

Part B

How hard does the floor push on the crate?

ANSWER:

N = $w \cdot 1.552$ = 1890 N

Part C

Find the friction force on the crate.

ANSWER:

f = $w \cdot 0.733$ = 894 N

Part D

What is the minimum coefficient of static friction needed to prevent the crate from slipping on the floor?

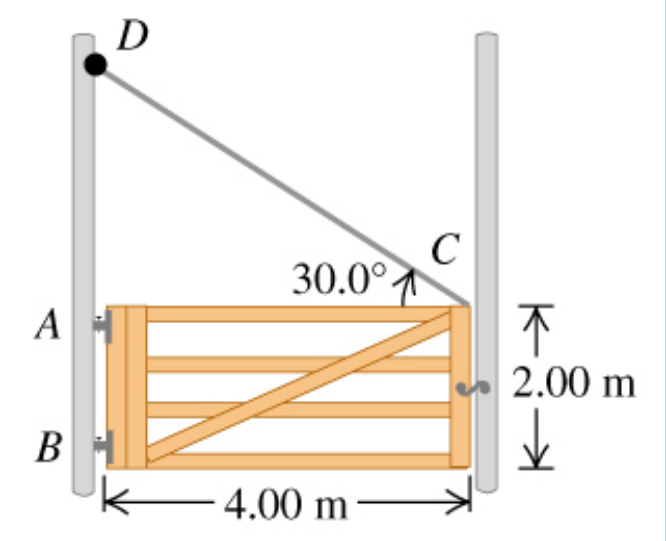
ANSWER:

μ_s = 0.472

Problem 11.77

Description: A gate 4.00 m wide and 2.00 m high weighs w. Its center of gravity is at its center, and it is hinged at A and B. To relieve the strain on the top hinge, a wire CD is connected as shown in the figure . The tension in CD is increased until the...

A gate 4.00 m wide and 2.00 m high weighs 460N . Its center of gravity is at its center, and it is hinged at *A* and *B*. To relieve the strain on the top hinge, a wire *CD* is connected as shown in the figure . The tension in *CD* is increased until the horizontal force at hinge *A* is zero.



Part A

What is the tension in the wire *CD*?

ANSWER:

$$T = \frac{w \cdot 2}{\sqrt{4^2 + 2^2}\sin\left(\frac{\pi}{6} + \operatorname{atan}\left(\frac{2}{4}\right)\right)} = 247 \quad \mathrm{N}$$

Part B

What is the magnitude of the horizontal component of the force at hinge *B*?

ANSWER:

$$F_H = \frac{w \cdot 2}{2 + 4\tan\left(\frac{\pi}{6}\right)} = 213 \quad \mathrm{N}$$

Part C

What is the combined vertical force exerted by hinges *A* and *B*?

ANSWER:

$$F_V = w - \frac{w \cdot 2}{2 + 4\tan\left(\frac{\pi}{6}\right)}\tan\left(\frac{\pi}{6}\right) = 337 \quad \text{N}$$

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