Exercise 11.7

Description: Two people carry a heavy electric motor by placing it on a light board 1 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 m long. One person lifts at one end with a force of 440 N, and the other lifts the opposite end with a force of 640 N.

Part A

What is the weight of the motor?

ANSWER:

$$w = F_1 + F_2 = 1080 \text{ N}$$

Part B

Where along the board is its center of gravity located?

ANSWER:

$$x = \frac{IF_2}{F_1 + F_2} = 0.889 \text{ m from the end where the 440-N force is applied}$$

Part C

Suppose the board is not light but weighs 220 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:

$$w = F_1 + F_2 - F_0 = 860 \text{ N}$$

Part D

Where is its center of gravity located?

ANSWER:
Exercise 11.9

Description: A 367-N, uniform, 1.54-m bar is suspended horizontally by two vertical cables at each end. Cable A can support a maximum tension of 497.0 N without breaking, and cable B can support up to 442.0 N. You want to place a small weight on this bar. (a) What is the...

A 367-N, uniform, 1.54-m bar is suspended horizontally by two vertical cables at each end. Cable A can support a maximum tension of 497.0 N without breaking, and cable B can support up to 442.0 N. 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:

\[ w = T_A + T_B - w = 572 \text{ N} \]

Part B

Where should you put this weight?

ANSWER:

\[ d = \frac{T_B l - w l}{T_A + T_B - w} = 0.696 \text{ m from the cable A} \]

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 550 N stands at the free end. The diving board is of uniform cross section and weighs 270 N.
Part A

Find the magnitude of the force at the support point.

ANSWER:

\[ F = \frac{w_2 \cdot 3.00}{2} + w_1 \cdot 3.00 \left( \frac{1.00}{1.00} \right) = 2060 \text{ N} \]

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:

\[ F = \frac{w_2 \cdot 3.00}{2} + w_1 \cdot 3.00 \left( \frac{1.00}{1.00} \right) - w_1 - w_2 = 1240 \text{ N} \]

Part D

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

ANSWER:
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 \( w \).

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**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:

- upward
- downward
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:

$$\phi = 48.8^\circ$$ from the horizontal

Exercise 11.14

Description: The horizontal beam in weighs 190 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 force...

The horizontal beam in weighs 190 N, and its center of gravity is at its center.
Part A

Find the tension in the cable.

Express your answer to three significant figures and include the appropriate units.

ANSWER:

\[ T = 658 \text{ N} \]

Part B

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

Express your answer to three significant figures and include the appropriate units.

ANSWER:

\[ N_H = 527 \text{ N} \]

Part C

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

Express your answer to three significant figures and include the appropriate units.

ANSWER:

\[ N_V = 95.0 \text{ N} \]

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° 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° 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:

\[ T = 2.9 \times 10^4 \text{ N} \]

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

Enter positive value if the force is rightward and negative value if the force is leftward.

ANSWER:

\[ F_H = 2.5 \times 10^4 \text{ N} \]

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

Enter positive value if the force is upward and negative value if the force is downward.

ANSWER:

\[ F_V = 4.1 \times 10^4 \text{ N} \]
**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 $5.80 \times 10^3$ 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 11.50**

**Description:** End A of the bar $AB$ in rests on a frictionless horizontal surface, and end B is hinged. A horizontal force $\vec{F}$ of magnitude 290 N is exerted on end A. Ignore the weight of the bar. (a) What is the horizontal component of the force exerted by the bar...

End A of the bar $AB$ in rests on a frictionless horizontal surface, and end $B$ is hinged. A horizontal force $\vec{F}$ of magnitude 290 N is exerted on end A. Ignore the weight of the bar.
**Part A**

What is the horizontal component of the force exerted by the bar on the hinge at \( B \)?

Express your answer with the appropriate units.

ANSWER:

\[
F_h = F = 290\, \text{N}
\]

**Part B**

What is the vertical component of the force exerted by the bar on the hinge at \( B \)?

Express your answer with the appropriate units.

ANSWER:

\[
F_v = \frac{F \cdot 4.00}{\sqrt{5.00 \cdot 5.00 - 4.00 \cdot 4.00}} = 390\, \text{N}
\]

Also accepted:

\[
\frac{F \cdot 4.00}{\sqrt{5.00 \cdot 5.00 - 4.00 \cdot 4.00}} = 387\, \text{N}, \quad \frac{F \cdot 4.00}{\sqrt{5.00 \cdot 5.00 - 4.00 \cdot 4.00}} = 390\, \text{N}
\]

**Problem 11.52**

**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 ...
Part A

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

ANSWER:

$$T = 2.84 \times 10^5 \text{ N}$$

Part B

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

ANSWER:

$$N_H = 2.18 \times 10^5 \text{ N}$$

Part C

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

ANSWER:

$$N_V = 2.88 \times 10^5 \text{ N}$$

Problem 11.65

**Description:** A worker wants to turn over a uniform 1080-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 1080-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:

\[ P = w \cdot 0.918 = 991 \text{ N} \]

Part B

How hard does the floor push on the crate?

ANSWER:

\[ N = w \cdot 1.552 = 1680 \text{ N} \]

Part C

Find the friction force on the crate.

ANSWER:

\[ f = w \cdot 0.733 = 792 \text{ N} \]

Part D

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

ANSWER:

\[ \mu_s = 0.472 \]
Problem 11.73

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 diagram. The tension in \( CD \) is increased until the horizontal force at hinge \( A \) is zero.

A gate 4.00 m wide and 2.00 m high weighs 700 N. 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 diagram. The tension in \( CD \) is increased until the horizontal force at hinge \( A \) is zero.

### Part A

What is the tension in the wire \( CD \)?

Express your answer with the appropriate units.

ANSWER:

\[
T = \frac{w}{2\sin(30.0) + \cos(30.0)} = 375 \text{ N}
\]

### Part B

What is the magnitude of the horizontal component of the force at hinge \( B \)?

Express your answer with the appropriate units.

ANSWER:

\[
F_h = \frac{w}{1 + 2\tan(30.0)} = 325 \text{ N}
\]

### Part C

What is the magnitude of the combined vertical force exerted by hinges \( A \) and \( B \)?

Express your answer with the appropriate units.

ANSWER:
Part D

What is the direction of this force?

ANSWER:

- upward
- downward