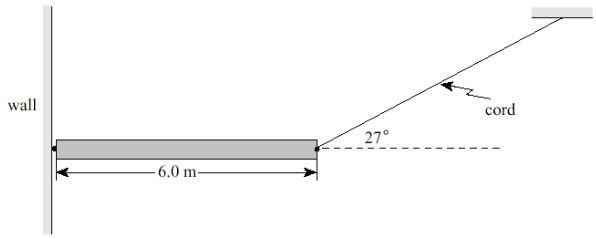
Unit 3: Equilibrium

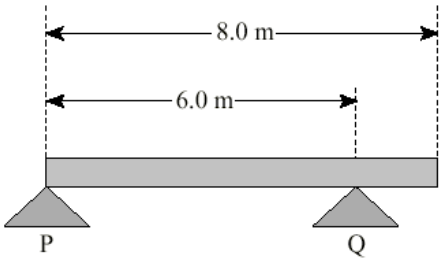
Multiple Choice Portion

1. A uniform 25 kg bar, 6.0 m long, is suspended by a cord as shown.



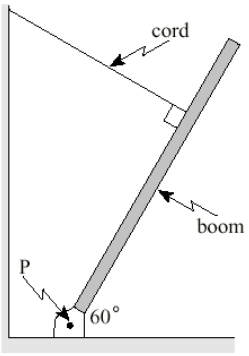
What is the tension in the cord?
a. 1.2×10^2 N
b. 2.7×10^2 N
c. 3.7×10^2 N
d. 5.4×10^2 N

2. A uniform beam of mass 25 kg rests on supports P and Q, as shown in the diagram below.



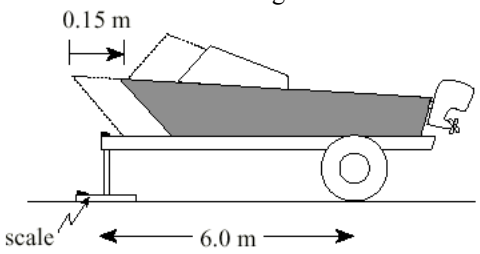
What force is exerted by support Q on the beam?
a. 1.2×10^2 N
b. 1.6×10^2 N
c. 3.3×10^2 N
d. 4.9×10^2 N

3. A boom hinged at P is held stationary, as shown in the diagram below.



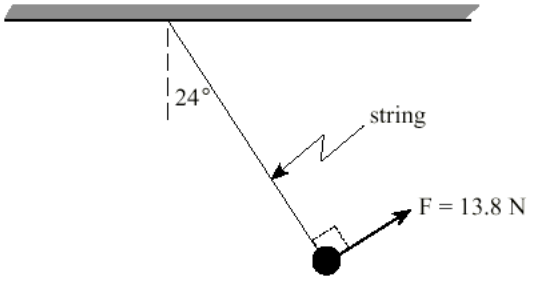
If the tension in the supporting cord, attached three-quarters of the way along the boom from P, is 720 N, what is the weight of the boom?
a. 720 N
b. 1 080 N
c. 1 440 N
d. 2 160 N

4. A trailer carrying a boat is supported by a scale which initially reads 48 kg. The boat (and therefore its centre of gravity) is moved 0.15 m further back on the trailer. The scale now reads 37 kg. Find the mass of the boat.



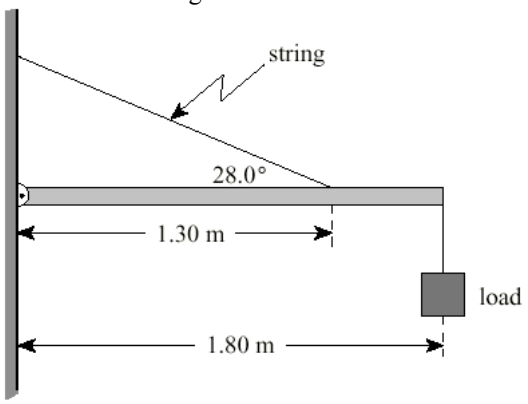
a. 440 kg
b. 1 600 kg
c. 1 700 kg
d. 3 400 kg

5. A mass suspended by a string is held 24° from vertical by a force of 13.8 N as shown. Find the mass.



a. 0.57 kg
b. 1.5 kg
c. 3.2 kg
d. 3.5 kg

6. The diagram shows a horizontal beam of negligible mass. The wall exerts a 42.0 N horizontal force on the lever. Find the weight of the load.



a. 16.1 N
b. 22.3 N
c. 34.4 N
d. 47.6 N

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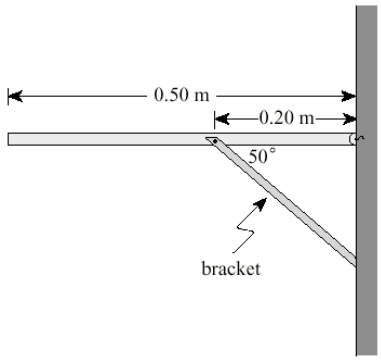
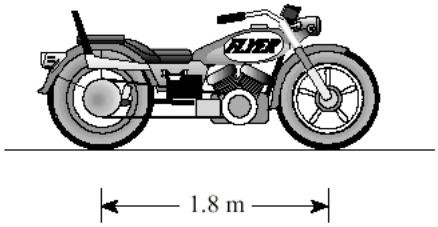
7. A uniform 3.0 kg shelf of width 0.50 m is supported by a bracket, as shown in the diagram below.



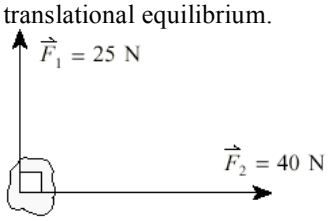
What force does the bracket exert on the shelf?
a. 7.4 N
b. 38 N
c. 48 N
d. 57 N

8. The motorcycle shown has a mass of 200 kg and a wheel base of 1.8 m.



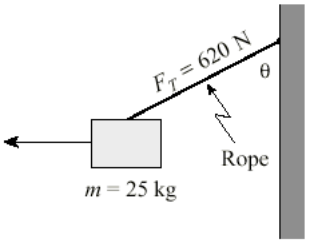
If the rear wheel exerts a 1 200 N force on the ground, find how far the motorcycle's centre of gravity is located from the front wheel.
a. 0.70 m
b. 0.90 m
c. 1.1 m
d. 1.2 m

9. Two forces act on an object as shown. Find the magnitude of the third force required to achieve translational equilibrium.



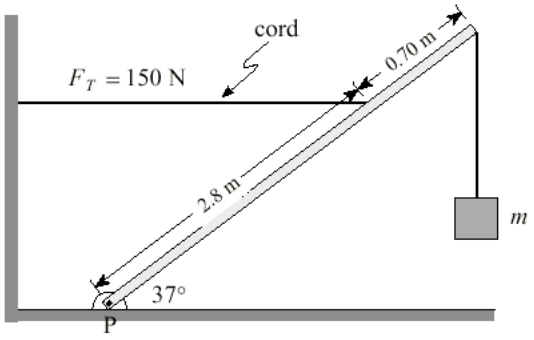
a. 15 N
b. 33 N
c. 47 N
d. 65 N

10. A 25 kg block is pulled by a horizontal force. The supporting rope can withstand a maximum tension force of 620 N.



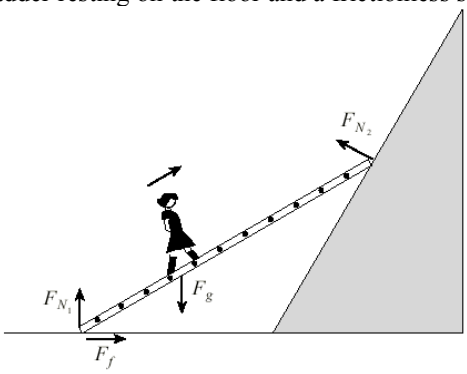
To what maximum angle, θ, can the block be pulled without the rope breaking?
a. 22°
b. 23°
c. 67°
d. 88°

11. A uniform 3.5 m beam of negligible mass, hinged at P, supports a hanging block as shown.



If the tension F T in the horizontal cord is 150 N, what is the mass of the hanging block?
a. 9.2 kg
b. 12 kg
c. 16 kg
d. 46 kg

12. The diagram shows the forces acting on a massless ladder resting on the floor and a frictionless slope.



As a person walks up the stationary ladder, what happens to the magnitude of the forces F_{N1} and F_{N2}?

	MAGNITUDE OF F_{N1}	MAGNITUDE OF F_{N2}
a.	Decreases	Decreases
b.	Decreases	Increases
c.	Increases	Decreases
d.	Increases	Increases

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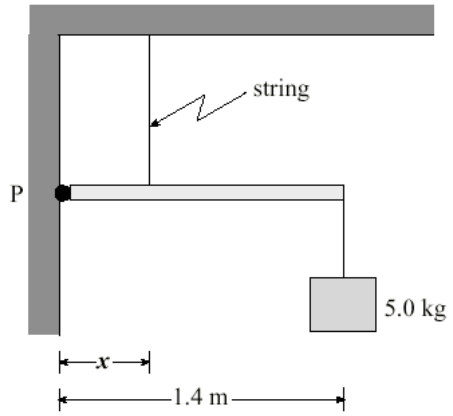
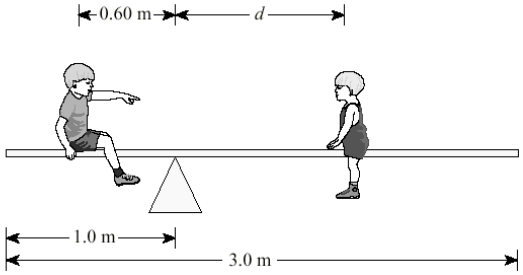
13. A uniform 18 kg beam hinged at P is held horizontal by a vertical string that can withstand a maximum tension of 350 N. A 5.0 kg mass is suspended from the end of the beam as shown.



At what minimum distance, x, can the string be attached without breaking?

a. 0.16 m
b. 0.20 m
c. 0.55 m
d. 0.70 m

14. A 3.0 m uniform beam of mass 15 kg is pivoted 1.0 m from the end as shown below.

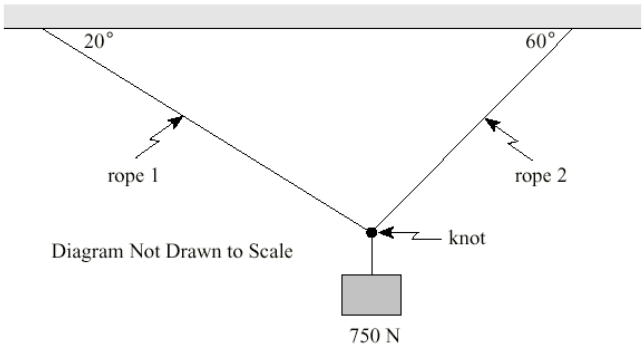


A 35 kg child sits 0.60 m from the pivot. How far, d, from the pivot, must a 20 kg child sit in order for the beam to be in equilibrium?

a. 0.68 m
b. 1.0 m
c. 1.1 m
d. 1.4 m

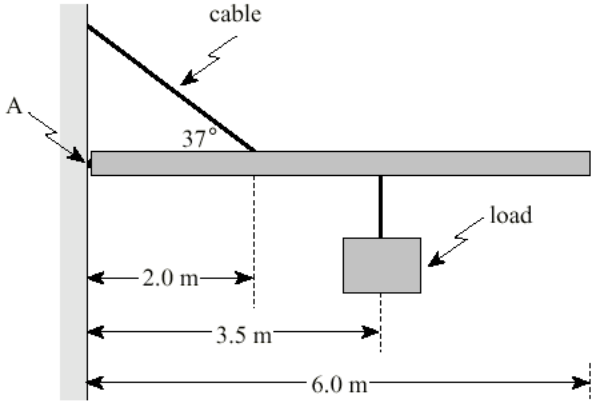
Written Portion

1. A 750 N weight is supported by two ropes fastened together by a knot, as shown in the diagram below.



a. Draw a free-body diagram showing the forces acting on the knot.
b. What is the tension in rope 1?

2. A uniform beam 6.0 m long, and with a mass of 75 kg, is hinged at A. The supporting cable keeps the beam horizontal.



If the maximum tension the cable can withstand is 2. 4 x10^3 N, what is the maximum mass of the load?

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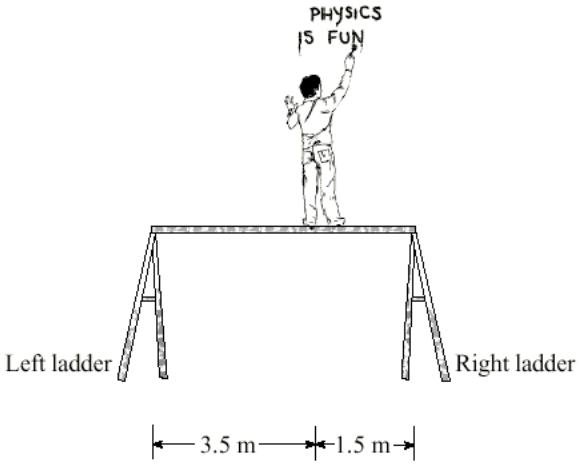
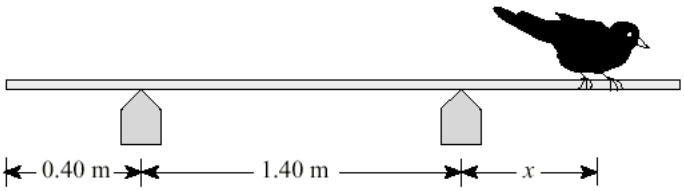
3. A 75 kg painter stands on a uniform 5.0 m board of mass 16 kg supported horizontally by two ladders. Find the forces exerted by each ladder on the board.

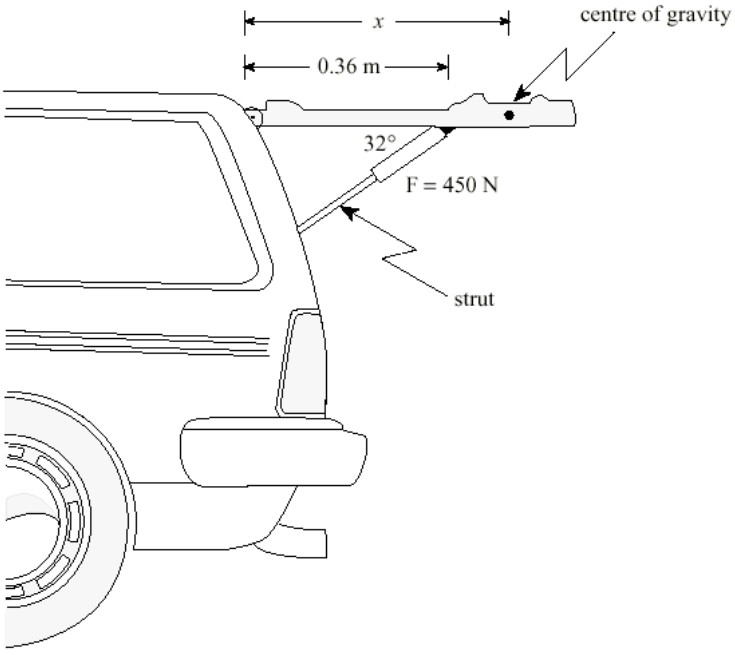


4. A 0.75 kg board of length 2.60 m initially rests on two supports as shown.



   a. What maximum distance, x, from the right-hand support can a 1.20 kg bird walk before the board begins to leave the left-hand support?
   b. What force does the right-hand support exert on the board at that instant?

5. The diagram shows the rear door of a station wagon supported horizontally by a strut. The mass of the door is 18 kg and the compression force in the strut is 450 N.



   a. Draw and label a free body diagram showing the forces acting on the door.
   b. At what distance, x, from the hinge is the centre of gravity of the door located?

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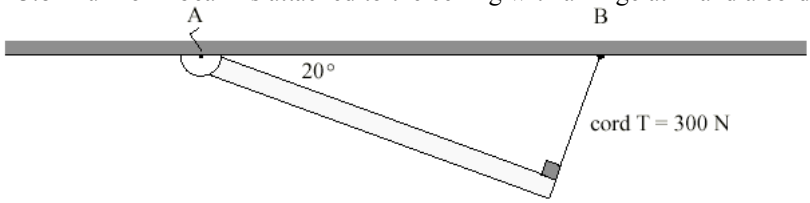
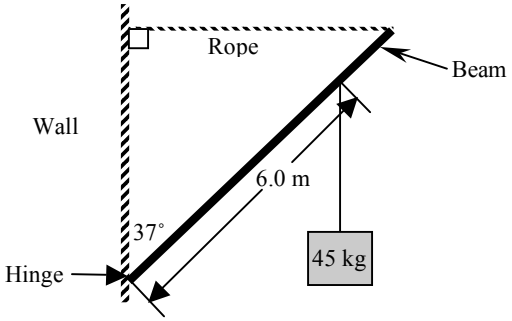
6. A 3.8 m uniform beam is attached to the ceiling with a hinge at A and a cord with a tension of 300 N at B.

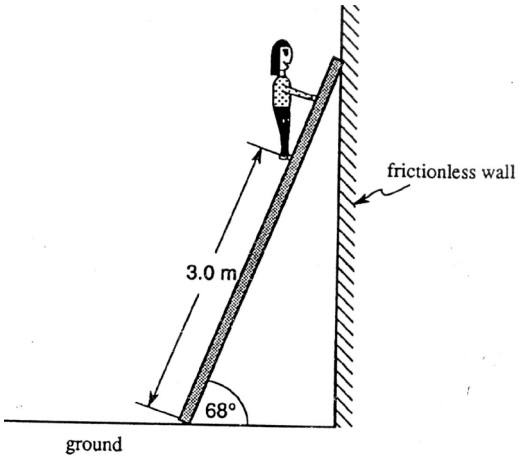


Determine the mass of the beam.

7. A uniform beam of length 8.0 m and mass 25 kg is connected to a wall by a hinge as shown below. A 45 kg mass is suspended from the beam. What is the tension in the rope?

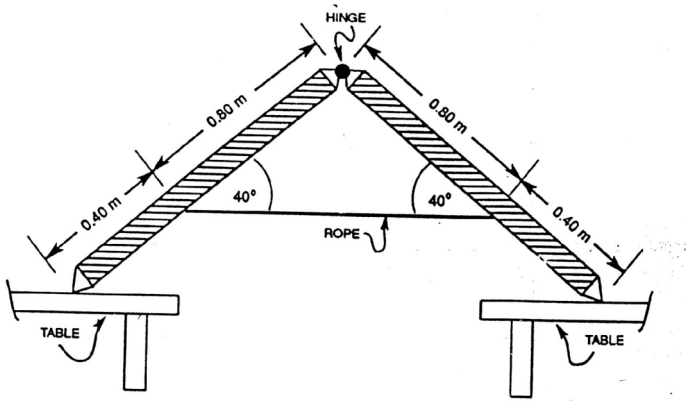


8. A uniform 42 kg ladder leans against a frictionless wall as shown. The ladder is 3.8 m long. A 52 kg girl stands 3.0 m up the ladder



a. Draw a free body diagram for the ladder and label the forces.
b. What minimum coefficient of friction will prevent the ladder from slipping

9. Two uniform beams, each of mass 42 kg, are hinged and roped together on a frictionless tables as shown in the diagram below.



What is the tension in the rope?

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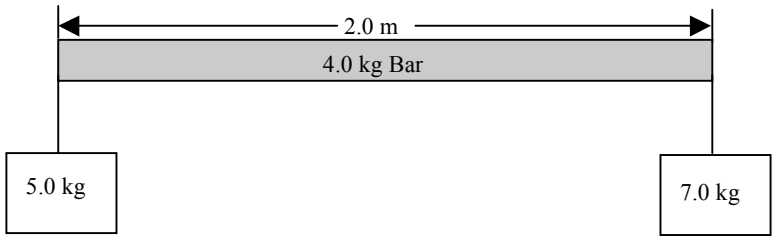
10. A uniform 2.0 m long bar has a mass of 4.0 kg. A 5.0 kg mass is attached at one end and a 7.0 kg mass is attached at the opposite end. Calculate the magnitude and location of a single force required to produce static equilibrium

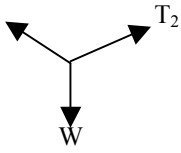


Answers:

Multiple Choice

1.	b	6.	a	11.	a
2.	b	7.	c	12.	b
3.	d	8.	c	13.	c
4.	a	9.	c	14.	a
5.	d	10.	c		

Written Portion

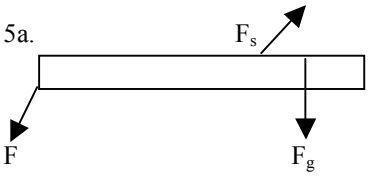
1a. 

b. 381 N

2. 20 kg

3. $F_{right} = 593$ N $F_{left} = 299$ N

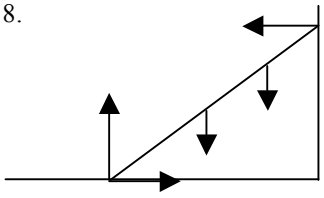
4a. 0.31 m b. 19 N

5a. 

b. 0.49 m

6. 65 kg

7. 3.4×10^2 N

8. 

b. 0.27

9. 3.7×10^2 N

10. 157 N and 0.8750 m from the right

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