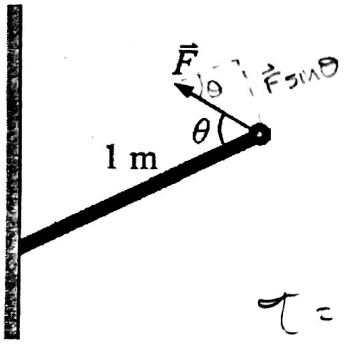
PRACTICE QUESTIONS—EQUILIBRIUM

Use the following information to answer the next question.

Four different forces are applied at different angles to the end of a 1 m long wooden beam, as shown in the given table.

Force (N)	Angle
10	60°
15	45°
20	90°
30	30°

The other end of the beam is attached to a wall by a hinge, as shown in the figure.



$\tau = F_\perp d$

$= F\sin\theta\, d$

1. Which of the forces will produce the greatest torque about the hinge?

A. 10 N $10\sin 60 \times 1m =$

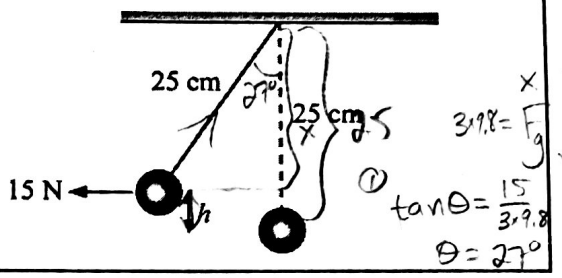
B. 15 N $15\sin 45 \times 1m =$

C. 20 N $20\sin 90 \times 1m = 20$

D. 30 N $30\sin 30 \times 1m = 15$

Use the following information to answer the next question.

A horizontal force of 15 N is applied to the bob of a 25 cm long pendulum. The mass of the bob is 3.0 kg.



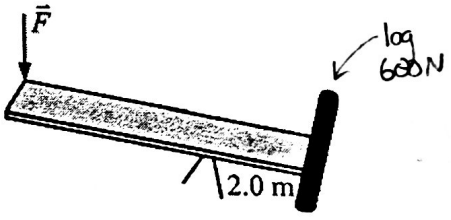
2. The height that the bob will reach above its equilibrium position will be

A. 2.7 cm ✓ **B.** 4.1 cm

C. 11 cm **D.** 22 cm

Use the following information to answer the next question.

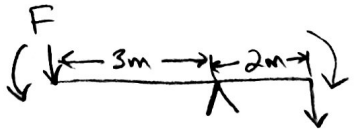
A woodcutter wants to lift a wooden log that weighs 600 N with the help of a 5.0 m long board. The board is pivoted at a distance of 2.0 m from the log as shown in the given figure. Assume that the forces are vertical with respect to the board.



3. The magnitude of the minimum force (F) necessary to lift the log is

A. 1.0×10^2 N **B.** 4.0×10^2 N ✓

C. 6.0×10^2 N **D.** 9.0×10^2 N



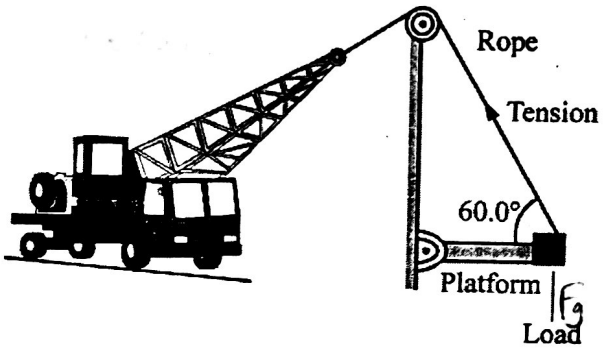
$\tau_{ccw} = \tau_{cw}$

$F \times 3m = 600N \times 2m$

$F = 400N$

Use the following information to answer the next question.

A platform is suspended by a supporting rope, as shown in the given figure.
The tension in the rope must not exceed 7.00×10^3 N or it will snap. The mass and length of the platform are 100 kg and 10.0 m, respectively. The support rope makes an angle of 60.0° with the platform. Assume that the load's centre of mass resides on the very tip of the platform.



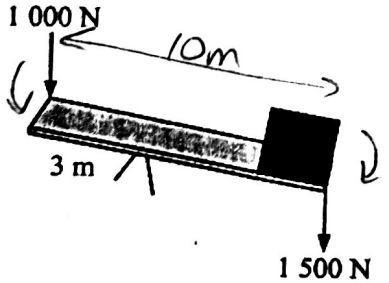
4. The maximum load on the platform that the rope can withstand is

A. 3.12×10^3 N **B.** 4.26×10^3 N

C. 5.57×10^3 N **D.** 6.90×10^3 N

Use the following information to answer the next question.

A worker can exert a maximum force of 1 000 N. He has to lift a load with a weight of 1 500 N with the help of a 10 m long lever arm. This support is initially placed 3 m away from the application point of the force, as shown in the figure. Assume the lever arm is horizontal, the forces are vertical, and that the load is a point mass at the very end of the beam.



5. In order to lift the load, the minimum distance the worker would have to move the support is

A. 1 m away from the load

B. 2 m away from the load

C. 3 m toward the load ✓

D. 4 m toward the load

6. A body is in rotational equilibrium if the

A. net force acting on the body is zero

B. net torque acting on the body is zero ✓

C. sum of all the forces acting on the body is positive

D. sum of all the torque acting on the body is positive

7. A car moving with uniform velocity on a horizontal road is in translational equilibrium because

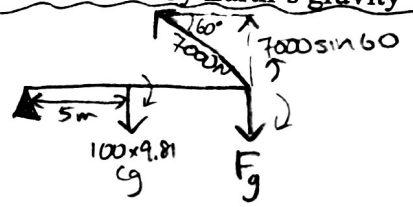
A. no forces are acting on it

B. no air pressure is acting on it

C. the sum of all external forces acting on it is zero ✓

D. the friction between the tires and the road is balanced by Earth's gravity

(4)



$\Sigma \tau_{cw} = \Sigma \tau_{ccw}$

$981N(5m) + F_g(10m) = (7000\sin 60)(10m)$

$F_g = 5572N \rightarrow$ (C)

(5)

$\Sigma \tau_{ccw} = \Sigma \tau_{cw}$

$1000N(d) = 1500N(10-d)$

$1000d = 15000 - 1500d$

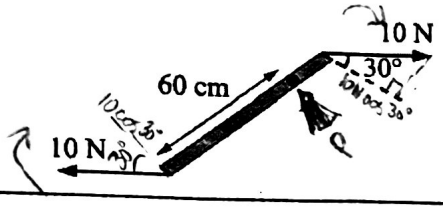
$2500d = 15000$

$d = 6m$

∴ 1000N must be applied 6 m from fulcrum. So fulcrum must be moved 3m closer to the load.

Use the following information to answer the next question.

Two 10 N forces act on an 80 cm long massless beam, as shown in the given figure. The beam can rotate freely about point P.



8. What will be the magnitude of the net torque about point P?

A. $2\sqrt{3}$ N·m in the counterclockwise direction

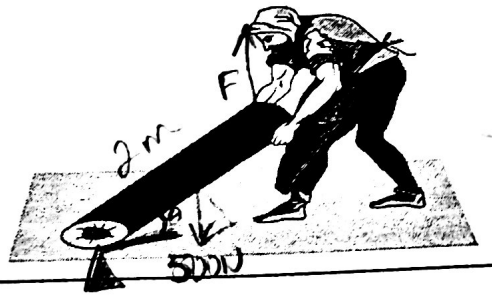
B. $3\sqrt{3}$ N·m in the clockwise direction

C. $3\sqrt{3}$ N·m in the counterclockwise direction

D. $4\sqrt{3}$ N·m in the clockwise direction

Use the following information to answer the next question.

A worker lifts one end of a heavy, uniform wooden beam while the other end remains on the floor. The beam is 2.0 m long and has a weight of 500 N. The force of static friction between the beam and floor is 31 N (when the beam is about to slide away from the worker). Assume that the force applied by the worker is perpendicular to the length of the wooden beam.



9. What is the maximum angle (measured with respect to the ground) through which the beam can rise without slipping?

A. 3.6°

B. 7.2°

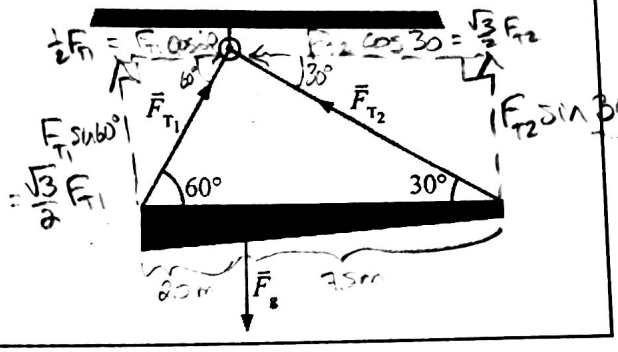
C. 14°

D. 29°

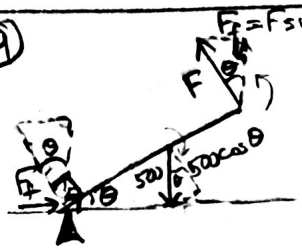
Written Response

Use the following information to answer the next question.

A thin, non-uniform beam is supported by two ropes attached to a rigid concrete ceiling, as shown in the given figure. The beam is 10.0 m long and the centre of gravity of the beam is located 2.5 m from its left end. Assume the ropes have negligible mass and that the beam is supported horizontally.

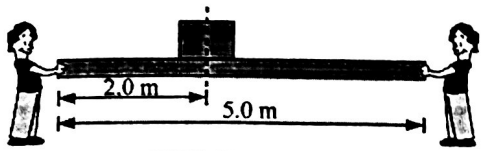


1. What are the values of F_{T_1} and F_{T_2} expressed in terms of the magnitude of the weight of the beam (F_g)?



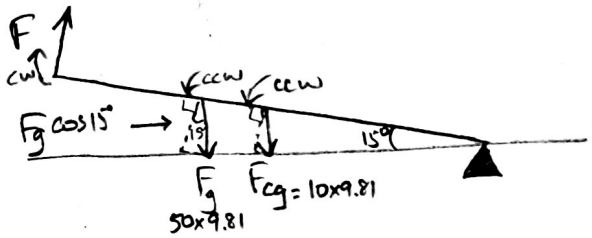
Use the following information to answer the next question.

Two people were holding a uniform beam that was 5.0 m long and had a mass of 10.0 kg. A 50.0 kg load was placed on the beam 2.0 m from its left end, as shown. The person at the right end of the beam then put the beam down on the ground, making an angle of 15° with the ground.



2. Assuming the load did not slide on the beam when the right end was put down on the ground, what was the magnitude of the force exerted on the hands of the person still holding the beam?

Assume person left holding the beam exerts a F at right angles to beam.



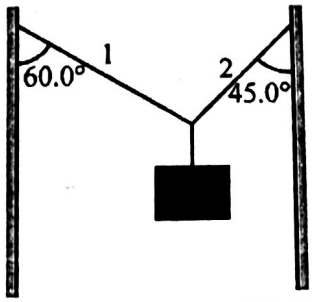
$\Sigma \tau_{cw} = \Sigma \tau_{ccw}$

$F(5m) = (50 \times 9.81)\cos 15 (3m) + 10 \times 9.81 \times \cos 15 \times 2.5m$

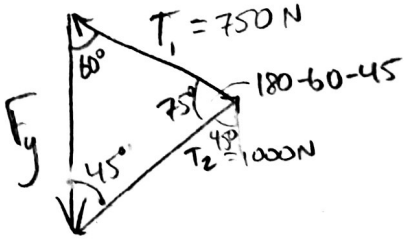
$F = 3.3 \times 10^2 N$ ✓

Use the following information to answer the next question.

The given figure shows a wooden block suspended between two vertical walls by ropes 1 and 2. Ropes 1 and 2 are not flexible and have failing tensions of 750 N and 1.00×10^3 N, respectively.



3. What is the greatest mass that this system can support without failing?



$\frac{F_g}{\sin 75°} = \frac{750}{\sin 45}$

$F_g = 1024.5$ N

$m = \frac{1024.5}{9.81} = 104$ kg ✓