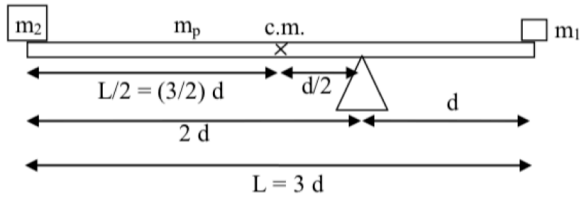
PROBLEMS for STATIC EQULIBRIUM

PROBLEM 1: A uniform plank (beam) of mass $m_p = 10kg$ and length $L = 3m$ is balanced on a pivot as shown below with two masses m_1 is unknown and $m_2 = 6kg$ at the ends. $\{c.m.\ is\ the\ center\ of\ mass\ of\ the\ plank\ (beam)\}$



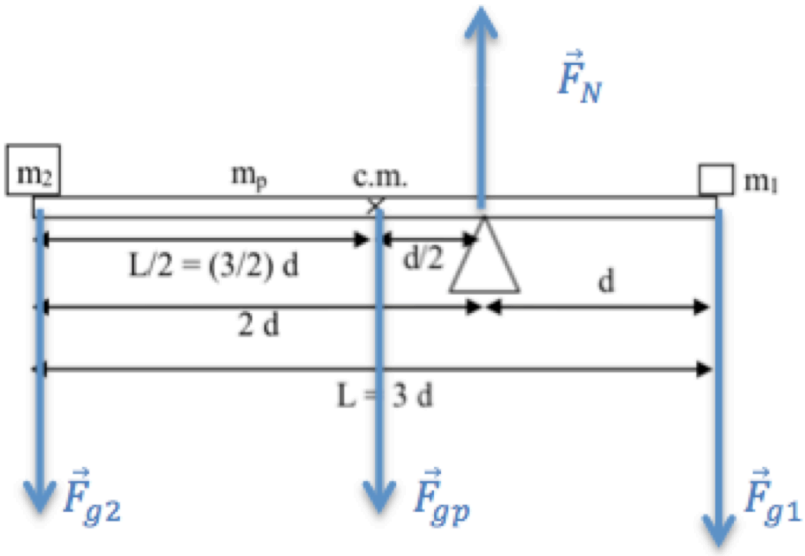
a) Show all the forces acting on the plank.

b) Find the unknown mass m_1.

c) Find the magnitude of the normal force applied by the pivot on the plank (beam).

SLN:

a)



b) $\sum \tau(pivot) = 0$

$(m_2 g)(2d) + (m_p g)(d/2) - (m_1 g)(d) = 0$

$(6)(9.8)(2) + (10)(9.8)(0.5) - (m_1)(9.8)(1) = 0$

$117.6 + 49 - 9.8m_1 = 0$

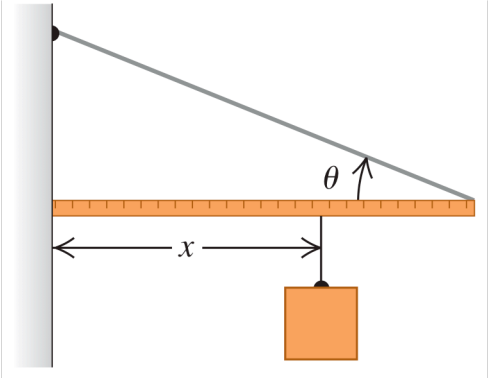
$m_1 = \frac{166.6}{9.8} = 17kg$

c) $\sum F_y = 0$

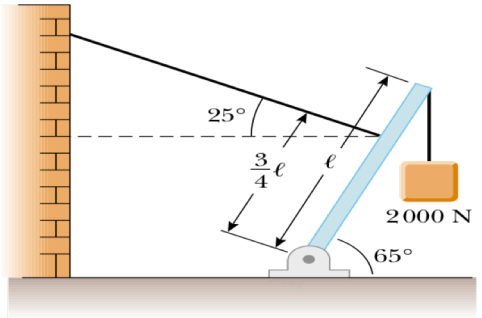
$-(m_2 g) - (m_p g) - (m_1 g) + F_N = 0$

$F_N = (6)(9.8) + (10)(9.8) + (17)(9.8) = 323.4N$

PROBLEM 2: A uniform beam of weight $120N$ and length $2.2m$ is connected by a pin to the wall and is held horizontal by a cable, as shown in the figure. The cable makes an angle of $\theta = 37^{\circ}$ with the beam. A mass of $m = 80kg$ is connected and freely hangs from the beam at a distance of $x = 1.7m$. Determine the magnitude of the tension in the cord and the components of the reaction force applied by the pin on the beam.



PROBLEM 3: A $1200N$ uniform boom is supported by a cable as in Figure. The boom is pivoted at the bottom, and a $2000N$ object hangs from its top. Find the tension in the cable and the components of the reaction force exerted by the floor on the boom.

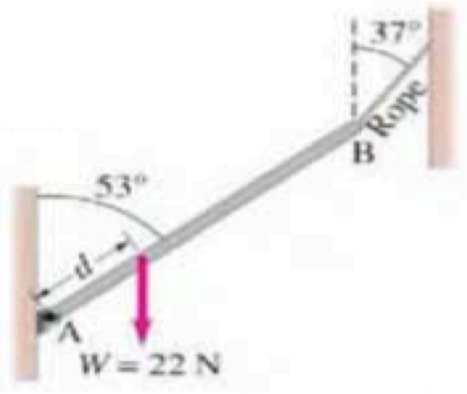


PROBLEM 5: A uniform rod AB of length $5m$ and mass $M = 3.8kg$ is hinged at A and held in static equilibrium by a light cord, as shown in Figure. A load $W = 22N$ hangs from the rod at a distance of d so that the tension in the cord is $85N$.

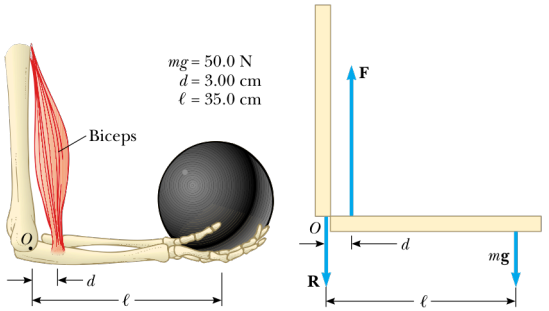
a) Draw a free-body diagram for the rod.

b) Determine the vertical and horizontal forces on the rod exerted by the hinge.

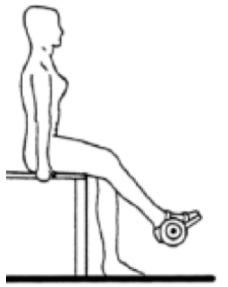
c) Determine d.

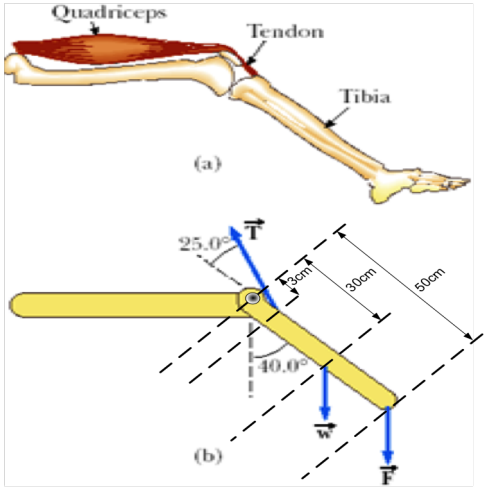


PROBLEM 6: A person holds a $50N$ sphere in his hand. The forearm is horizontal. The biceps muscle is attached $3cm$ from the joint, and the sphere is $35cm$ from the joint. Find the upward force exerted by the biceps on the forearm and downward force exerted by the upper arm on the forearm and acting at the joint. Neglect the weight of the forearm.

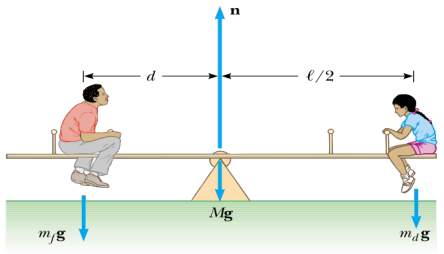


PROBLEM 7: The positions of quadriceps, the tendon connected to it and tibia, during an exercise performed by a student are shown in the figure. The tibia of the student has a weight of $W = 50N$, and a length of $50cm$. The centre of mass of the tibia is $30cm$ from the cartilage, and the tendon connects to the tibia at a point $3cm$ apart from the cartilage. If the magnitude of the force effecting the student's foot wrist is $F = 60N$; calculate the magnitude of the tension, T, on the tendon.





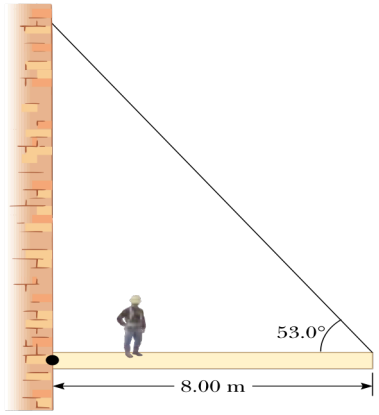
PROBLEM 8: A seesaw consisting of a uniform board of mass M and legth l supports a father and daughter with masses m_f and m_d, respectively, as shown in the Figure. the support is under the center of gravity of the board, the father is a distance d from the center, and the daughter is a distance $l/2$ from the center.



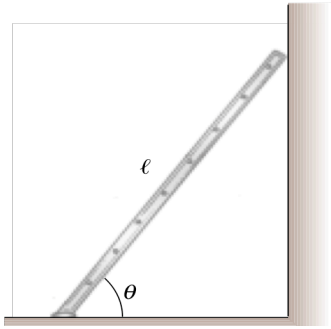
a) Determine the magnitude of the upward force **n** exerted by the support on the board.

b) Determine where the father should sit to balance the system.

PROBLEM 9: A uniform horizontal beam with a length of $8m$ and a weight of $200N$ is attached to a wall by a pin connection. Its far end is supported by a cable that makes an ange of 53° with the beam, as shown in the Figure. If a $600N$ person stands $2m$ from the wall, find the tension in the cable as well as the magnitude and direction of the force exerted by the pin on the beam.



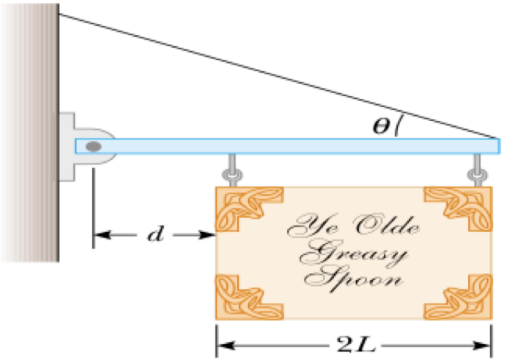
PROBLEM 10: A uniform ladder of length l rests against a smooth, vertical wall, as seen in the Figure. If the mass of the ladder is m and the coefficient of static friction between the ladder and the ground is $\mu_s = 0.4$, find the minimum angle θ_{min} at which the ladder des not slip.



PROBLEM 11: A uniform sign of weight F_g and width $2L$ hangs from a light, horizontal beam, hinged at the wall and supported by a cable as seen in the Figure.

a) Determine the tension in the cable.

b) Determine the components of the reaction forceexerted by the wall on the beam, in terms of F_g, d, L and θ.

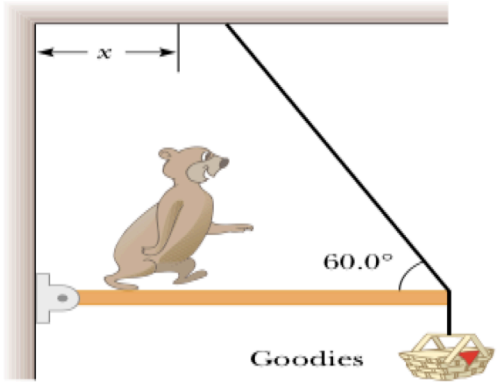


PROBLEM 12: A hungry bear weighting $700N$ walks out on a beam in an attemt to retrive a basket of food hanging at the end of the beem, as seen in the Figure. the beam is uniform, weighs $200N$, and is $6m$ long; the basket weigs $80N$.

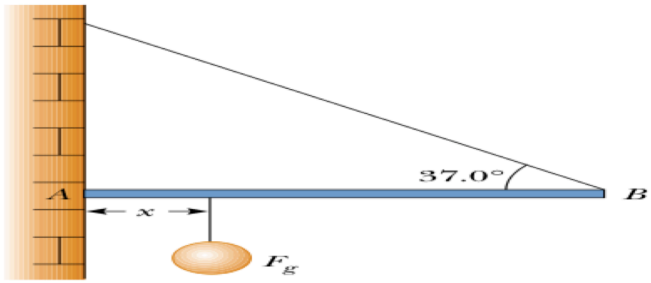
a) Draw a free-body diagram for the beam.

b) When the bear is at $x = 1m$, find the tension in the wire and the components of the force exerted by the pin on the left end of the beam.

c) What if? If the wire can with stand a maximum tension of $900N$, what is the maximum distance the bear can walk before the wire breaks?



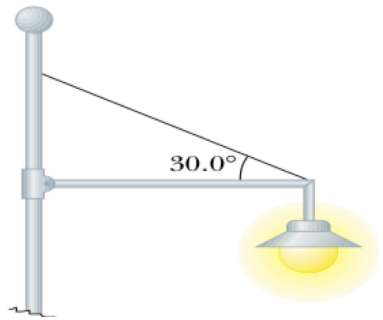
PROBLEM 13: One end of a uniform $4m$ long rod of weight F_g is supported by a cable. The other end rests against the wall, where is held by friction, as shown in the Figure. the coefficient of static friction between the wall and the rod is $\mu_s = 0.5$. Determine the minimum distance x from point A at which an additional weight F_g (the same as the weight of the rod) can be hung without causing the rod to slip at point A.



PROBLEM 14: A $20kg$ floodlight in a park is supported at the end of a horizontal beam of negligible mass that is hinged to a pole, as shown in the Figure. A cable at an angle of 30° with the beam helps to support the light.

a) Find the tension in the cable.

b) Find the horizontal and vertical forces exerted on the beam by the pole.



PROBLEM 15: A $15m$ uniform ladder wighing $500N$ rests against a frictionless wall. The ladder makes a 60° angle with the horizontal.

a) Find the horizontal and vertical forces the ground exerts on the base of the ladder when an $800N$ firefighter is $4m$ from the buttom.

b) If the ladder is just on the verge of slipping when the firefighteris $9m$ up, what is the coefficient of static friction between ladder and ground?

PROBLEM 16: A mobile is constructed of light rods, light strings, and beach souvenirs, as shown in the figure. determine the masses of the objects a) m_1, b) m_2, and c) m_3.