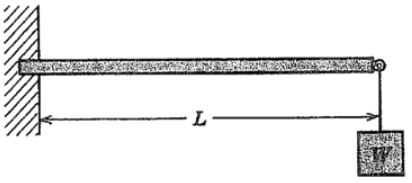
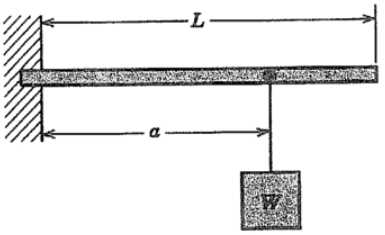
PROBLEMS

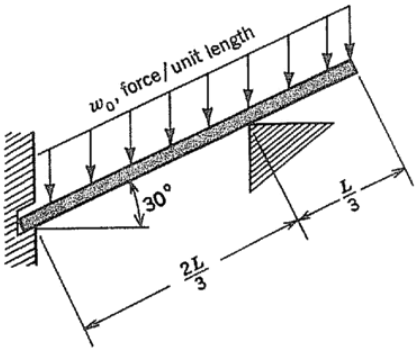
3.1–3.8. In each case, sketch shear-force and bending-moment diagrams. Indicate sign convention employed and label important values.



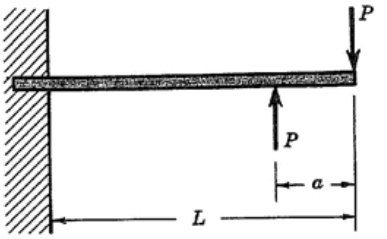
Prob. 3.1



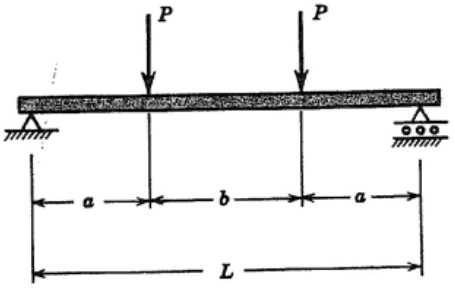
Prob. 3.2



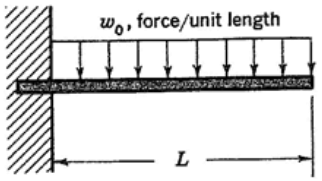
Prob. 3.3



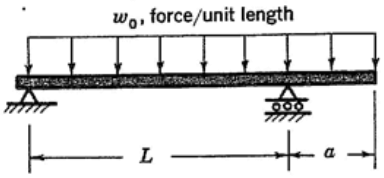
Prob. 3.4



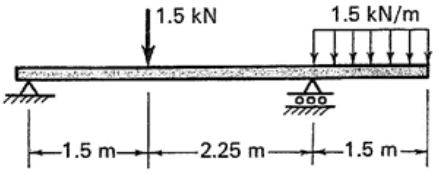
Prob. 3.5



Prob. 3.6

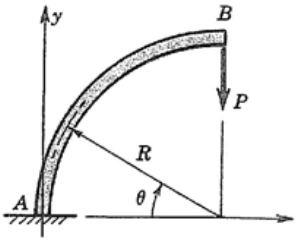


Prob. 3.7



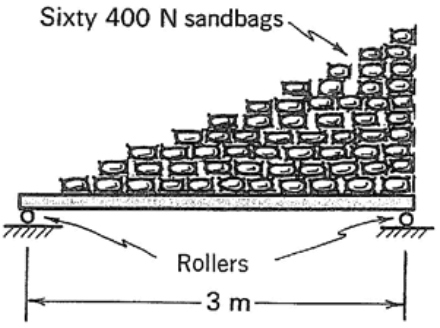
Prob. 3.8

3.9. Determine the axial force, the shear force, and the bending moment acting at any section θ in the circular arc AB.



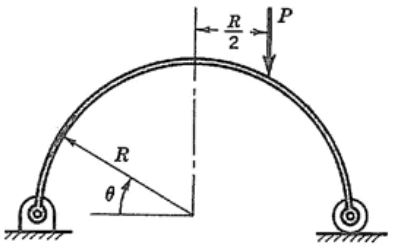
Prob. 3.9

3.10. Find the reactions and expressions for the shear force and bending moment as functions of distance along the beam.



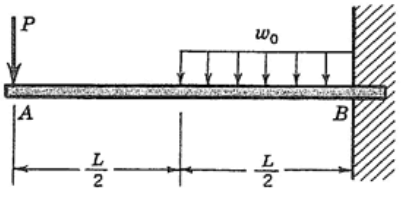
Prob. 3.10

3.11. Sketch the diagram of bending moment as a function of θ for the semicircular member.



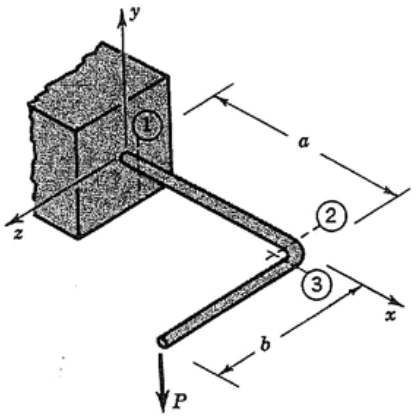
Prob. 3.11

3.12. Sketch shear-force and bending-moment diagrams for the cantilever beam which carries a concentrated force P and a distributed load of intensity w_o force per unit length.



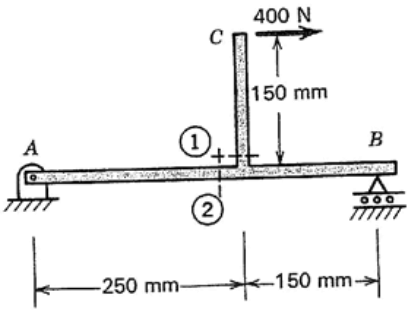
Prob. 3.12

3.13. Draw sketches showing the internal forces and moments acting at sections 1, 2, and 3 in the member shown.



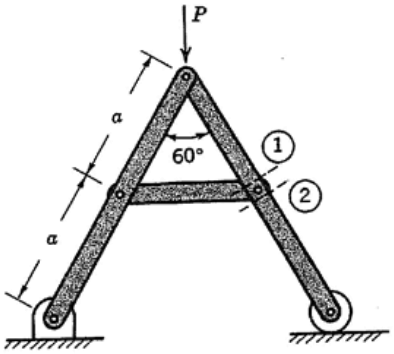
Prob. 3.13

3.14. Calculate the internal forces and moments acting at sections 1 and 2 in the structure shown.



Prob. 3.14

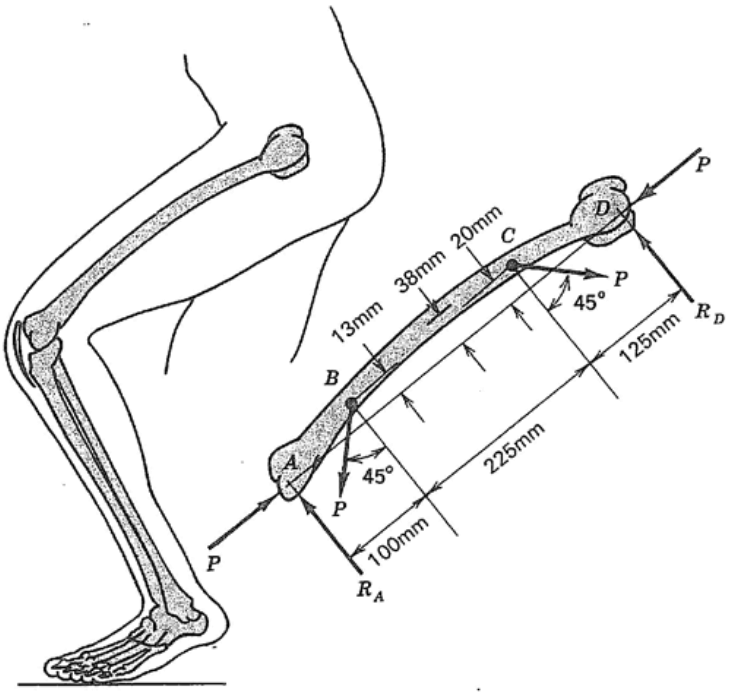
3.15. Calculate the internal forces and moments acting at sections 1 and 2 in the pinned framework shown.



Prob. 3.15

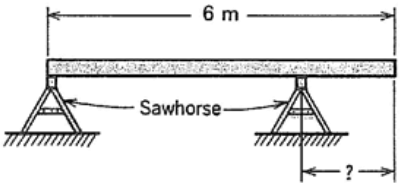
3.16. The sketch shows a possible set of muscle forces acting on the femur of a man who is running upstairs. Find the unknown reactions R_A and R_D in terms of P and show how the transverse force varies along the femoral shaft. Show how the bending moment varies along the

shaft, and comment on the compensating effect of the muscles attached at B and C in terms of reducing the bending moments in the shaft.



Prob. 3.16

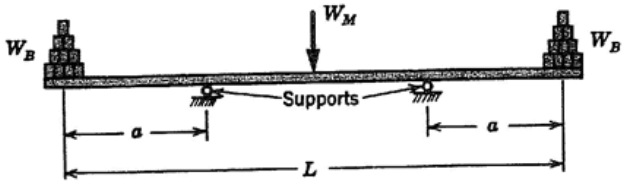
3.17. A carpenter with a power saw has a 6-m plank of uniform weight per unit length w_o and two sawhorses. He wishes to cut a 1.8-m length from the plank, but in order to minimize splitting of the ends he wants to cut it at a point where the bending moment in the plank is zero. If he places one sawhorse at one end of the plank, where should he put the other so that the bending moment will be zero 1.8 m from the other end of the plank?



Prob. 3.17

3.18. A section of a scaffold consists of a plank laid across two supports and extending a distance a on either side of the supports. A mason working at the center of the plank thinks that he should stack his supply of bricks on the ends of the plank in order to minimize the bending moment in the plank. Is he correct? If equal numbers of bricks are stacked at each end of the plank, for

what weight of bricks, W_B, is the maximum bending moment in the plank a minimum? The man weighs W_M.

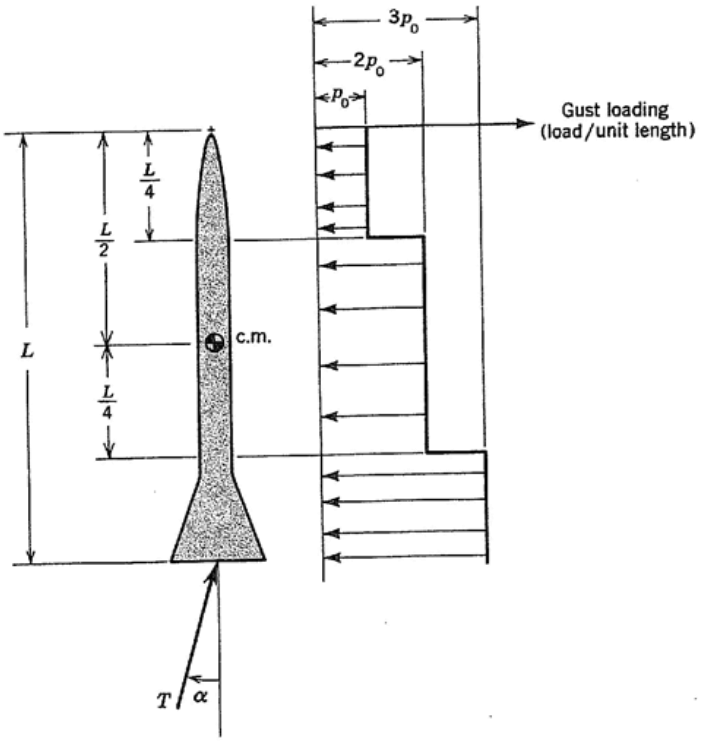


Prob. 3.18

3.19. The rocket shown experiences a wind gust during its vertical ascent which results in the loading shown. Rotation of the system may be prevented if the resultant moment about the center of mass of the system vanishes. This is to be achieved by varying the orientation of the thrust vector T with respect to the vertical axis.

(*a*) What relationship must exist among T, α, p_o, and L in order that this requirement be satisfied?

(*b*) Determine the internal shear force and bending moment at $L/4$ and $3L/4$ in terms of p_o.

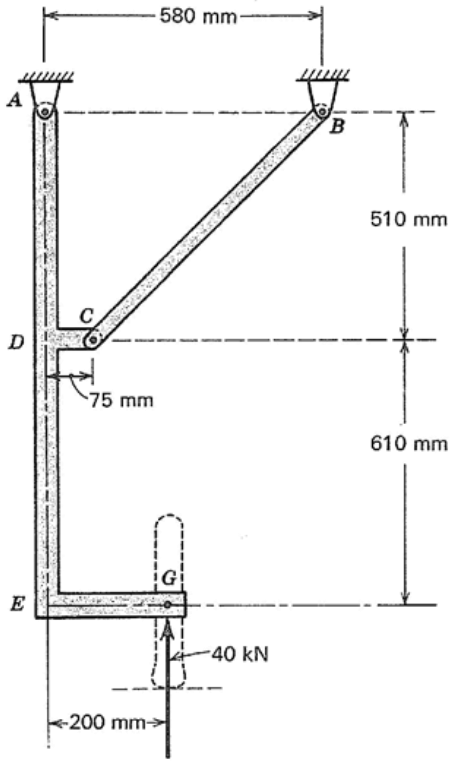


Prob. 3.19

3.20. A portion of an airplane landing gear is shown, with a coplanar force system present. Frictionless pin joints with their axes perpendicular to the plane of the paper are located at A, B, and C.

(a) Find reaction forces at A, B, and C.

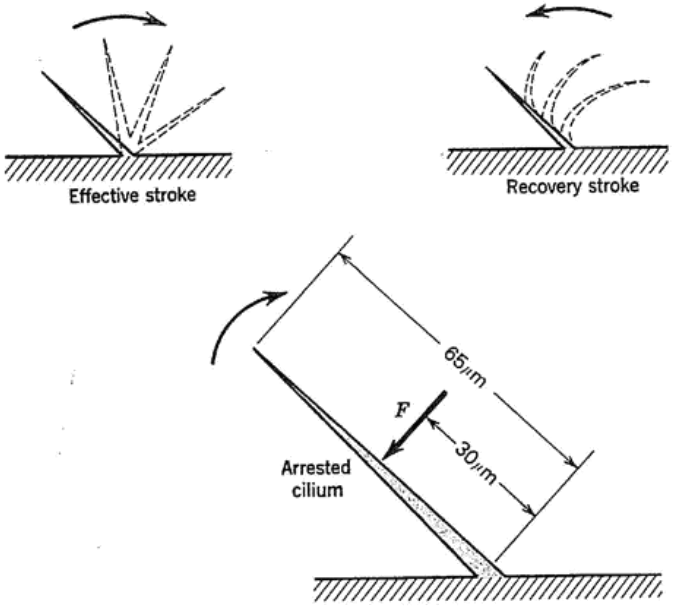
(b) Find all forces (i.e., all axial loads, shears, and moments) along each member AD, DE, EG, DC, and CB; show in the sketch for each member the positive sense of each force and moment.



Prob. 3.20

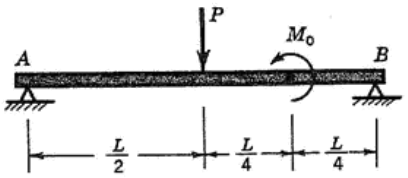
3.21. (a) Cilia are motile hairlike appendages on the free surfaces of certain cells. They are present in the trachea and in the reproductive tracts of humans as well as in lower animals. Their motion can be considered as made up of an effective stroke which can be thought of as a pendular motion with constant angular velocity through an angle of approximately 140° and a return or recovery stroke as shown in the figure. For the configuration shown in the figure in which the cilium is *arrested* by a force $F = 2.2$ nN, calculate the moment at the cell boundary.

(b) If a cilium moving in a viscous fluid rotates through its effective stroke, estimate the driving moment at the cell boundary. The viscous force on an *element of length* of the cilium may be taken to be proportional to the length of the element, the angular velocity, the viscosity, and to a function which depends upon the position along the cilium.



Prob. 3.21

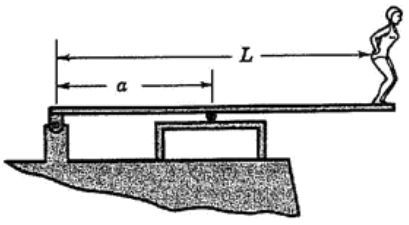
3.22. Construct shear-force and bending-moment diagrams for the case where the concentrated moment is $M_o = PL/4$.



Prob. 3.22

3.23. (*a*)–(*h*). Solve Probs. 3.1–3.8 again, but this time obtain the shear-force and bending-moment diagrams by using the singularity-function notation.

3.24. A diving board is supported by a hinged joint at the left end and a simple support near the center. How should the distance a be varied in order that the maximum bending moment should be the same for divers of all weights?



Prob. 3.24