Homework Problem Statements
ME 270 – Collection FSp II

Homework H1.B

***Given*:** The speed v of a small propelled vehicle is given in terms of the vehicle's position $x > 0$ by the following equation:

$$v = ax^2 \, ln\left(b\sqrt{x}\right)$$

where x is in feet (ft) and v is in feet/second (ft/s). When the vehicle is at $x = 4$ ft, its speed is 15 miles per hour (mph), and when $x = 16$ ft, its speed is 60 mph.

Find: For this problem:

a) Determine the numerical values for the parameters a and b in terms of British gravitational units.

b) What is the speed of the vehicle when $x = 10$ ft?

Homework H2.B

Given: Pre-tensioned cables AB and AD, having tensions of $2T$ and T, respectively, are attached to end A of the L-shaped bracket and exert forces of $\vec{F}_{AB}$ and $\vec{F}_{AD}$, respectively, on the bracket due to these tensions.

Find:

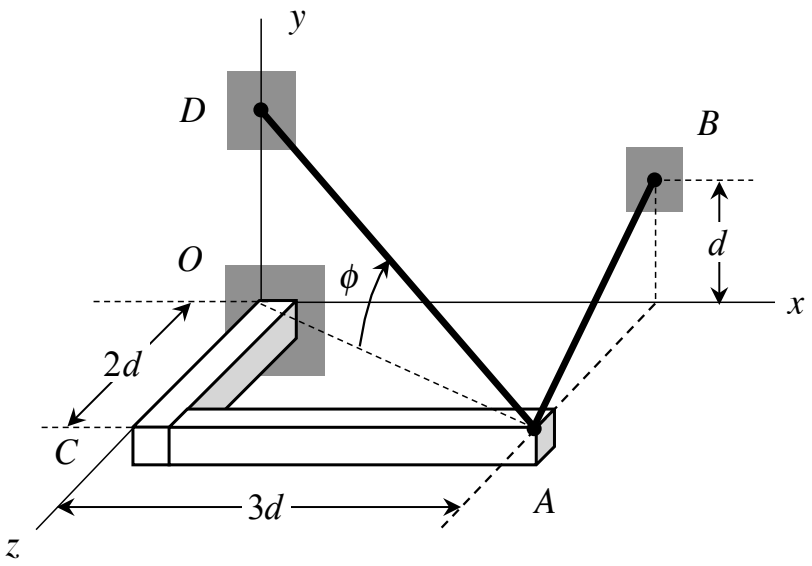
a) Determine the unit vector and force vector for $\vec{F}_{AB}$.

b) Determine the unit vector and force vector for $\vec{F}_{AD}$.

c) Calculate the direction cosines and direction angles for $\vec{F}_{AD}$.

d) Determine the resultant of $\vec{F}_{AB}$ and $\vec{F}_{AD}$.

Use the following parameter value in your analysis: $\phi = 40°$.



Homework H3.B

Given: Cables BD and CD are attached to corners B and C, respectively, of a hinged door and exert forces of $\vec{F}_{BD}$ and $\vec{F}_{CD}$, respectively, on the door due to their tensions. The tensions in cables BD and CD are known to be T and $2T$, respectively. The door hinges are locked so that these cable loads on the door result from pre-tensioning.

Find:

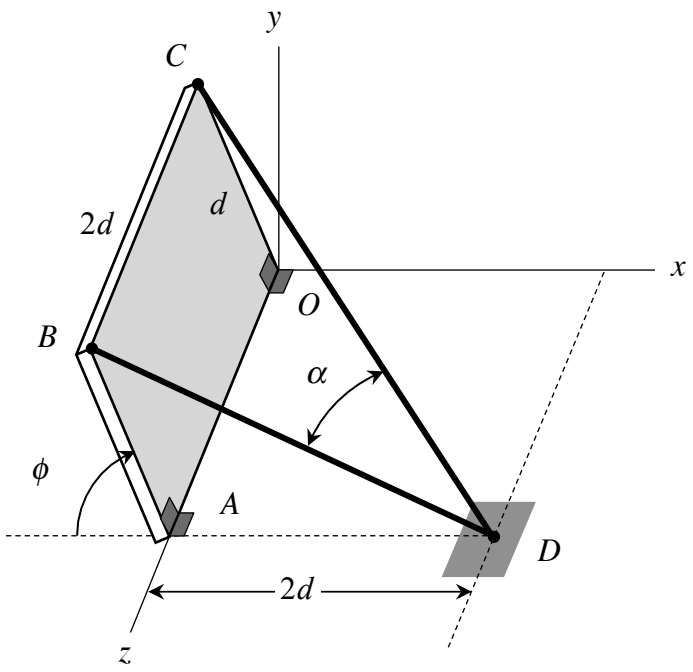
a) Write out the force vectors $\vec{F}_{BD}$ and $\vec{F}_{CD}$ in terms of their Cartesian components.

b) Determine the vector projection of $\vec{F}_{BD}$ onto cable CD.

c) Determine the vector projection of $\vec{F}_{CD}$ onto cable BD.

d) Determine the angle α that exists between cables BD and CD.

Use the following parameter value in your analysis: $\phi = 40°$.

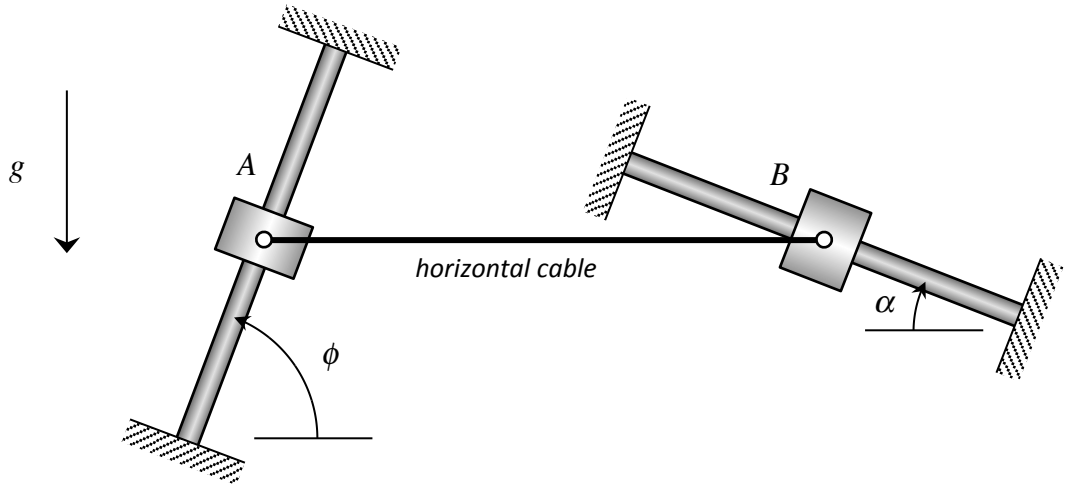


Homework H4.B

Given: Blocks A and B are at rest on a pair of smooth guides, as shown in the figure, where m_A and m_B are the masses for A and B, respectively. A horizontal cable connects the two blocks.

Find: Determine the mass ratio m_A/m_B required for equilibrium.

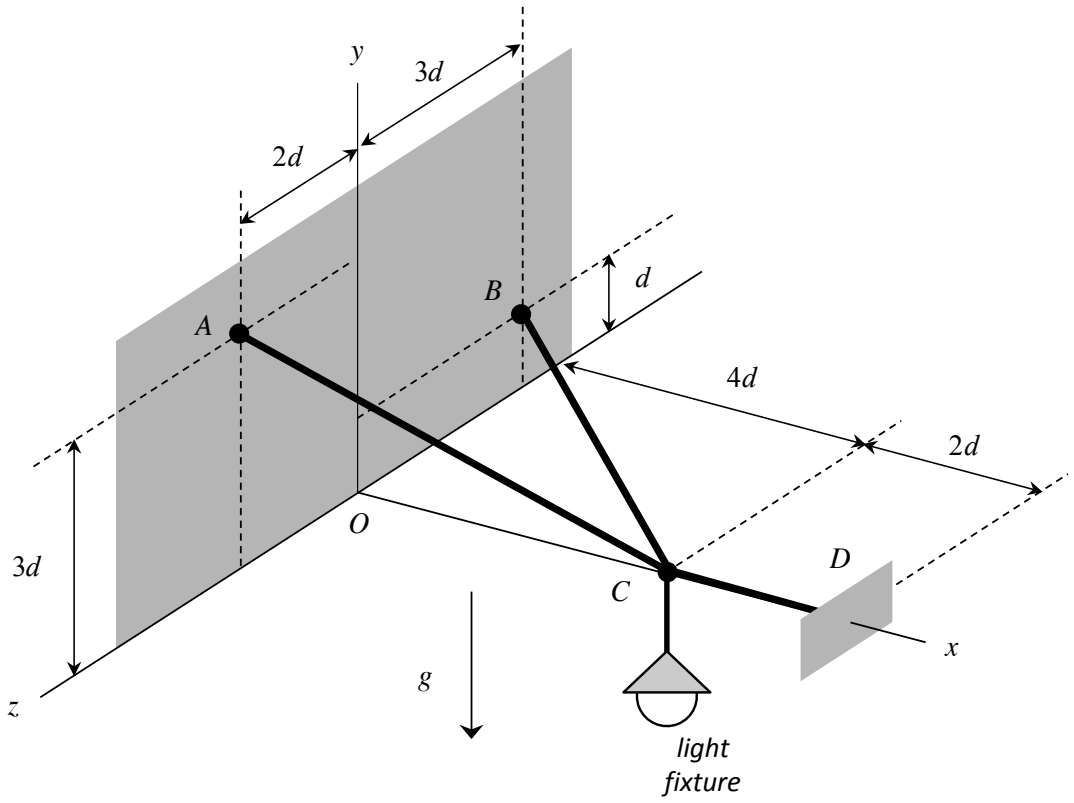
Use the following parameters in your analysis: $\phi = 70°$ and $\alpha = 30°$.



Homework H5.B

Given: A light fixture, having weight of *W*, is supported by three cables: CA, CB and CD.

Find: Determine the tension in each cable. Leave your answers in terms of the light fixture weight *W*.



Homework H6.B

Given: A pre-tensioned cable DE is attached between ground E and end D of the pipe structure shown. The tension in cable DE is T_{DE}. Let $\vec{F}_{DE}$ represent the force vector on the structure at D due to the cable.

Find:

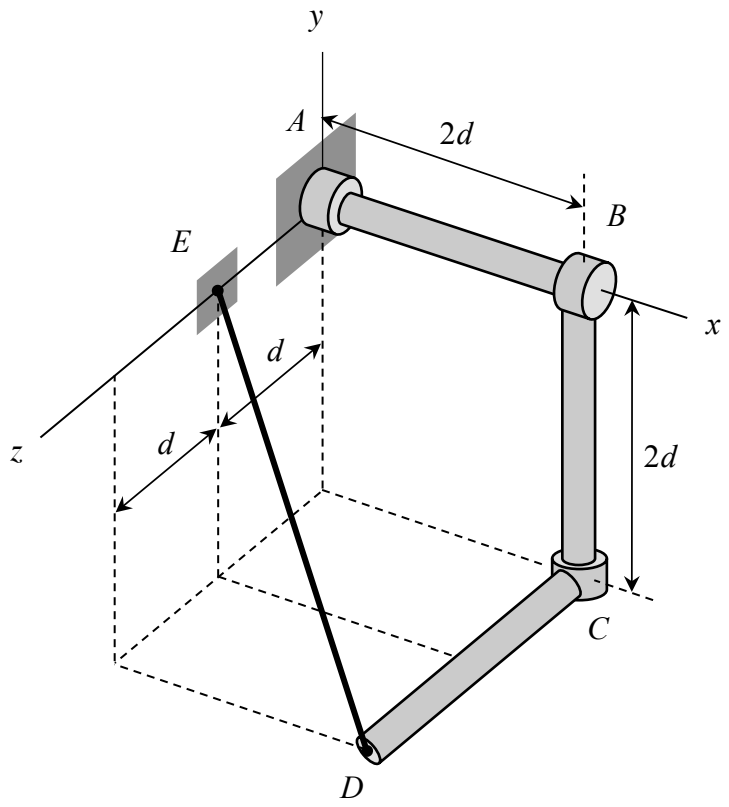
a) Write out $\vec{F}_{DE}$ in terms of its Cartesian components.

b) Determine the moment about point A due to $\vec{F}_{DE}$ using $\vec{r}_{AD} \times \vec{F}_{DE}$.

c) Determine the moment about point A due to $\vec{F}_{DE}$ using $\vec{r}_{AE} \times \vec{F}_{DE}$. Compare your answer with what you found in part b) above.

d) Determine the moment about point C due to $\vec{F}_{DE}$.

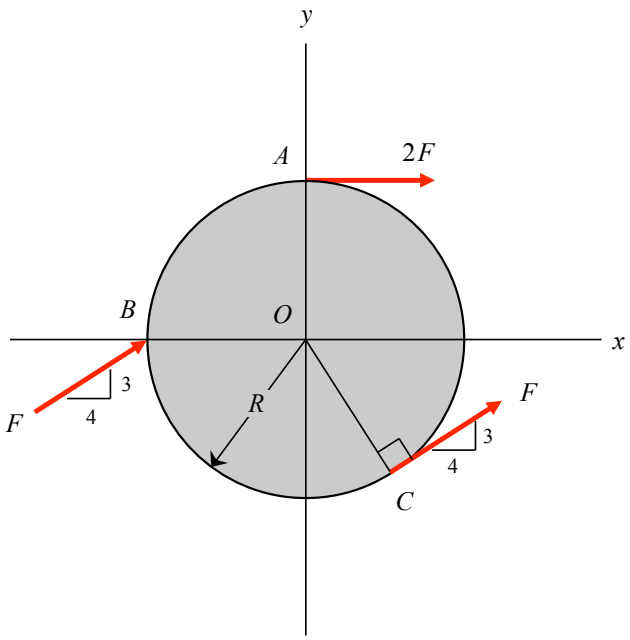
Write your answers as vectors and in terms of, at most: T_{DE} and d.



Homework H7.B

Given: A set of three forces act on the perimeter of a circular disk, as shown.

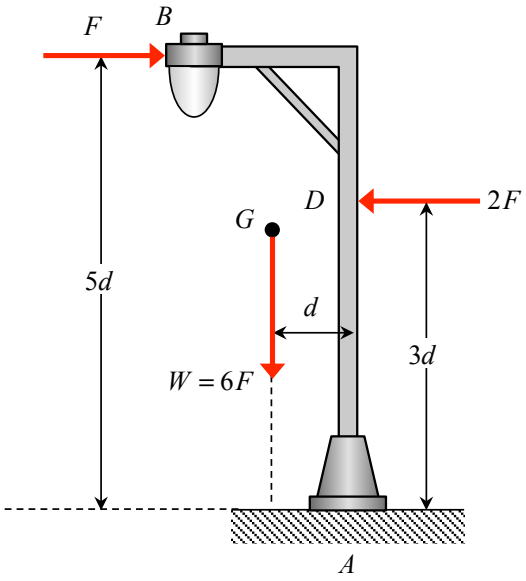
Find: Determine the equivalent force-couple system at the circle's center O. Express your answers in terms of F and R.



Homework H8.B

Given: A street light is acted upon by a pair of horizontal forces at B and D, and by its weight at the center of mass G. Consider the connection of the light at A to be fixed to the ground.

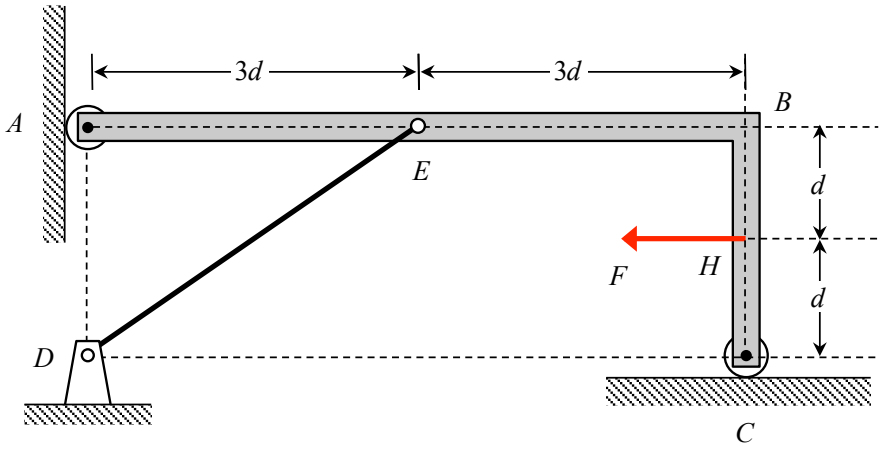
Find: Determine the reactions on the street light at support A. Express your answers as vectors in terms of, at most, *F* and *d*.



Homework H9.B

Given: An L-shaped bent bar is supported by smooth rollers at ends A and C, and by cable DE at E. A horizontal force *F* acts on the bar at location H. The weight of the bar is negligible compared to the load *F*.

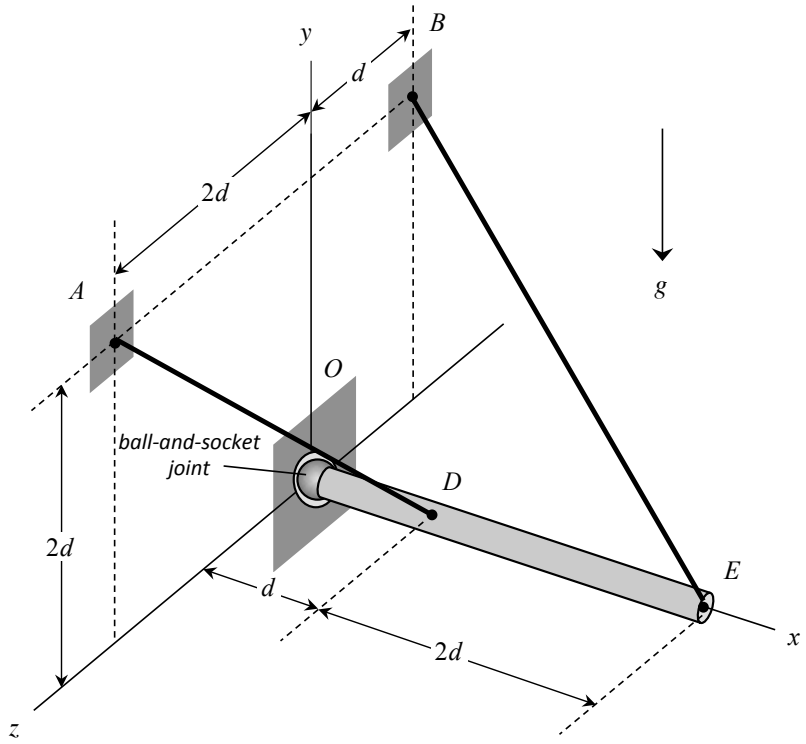
Find: Determine the reactions on the bar at A and C, and the tension in cable DE. Express your answers in terms of *F*.



Homework H10.B

Given: A homogeneous boom pole having a weight of *W* is supported by a ball-and-socket joint at end O, and by two cables, AD and BE.

Find: Determine the reactions on the pole at O and the tension forces acting on the pole by the cables. Write your answers as vectors in terms of *W*.



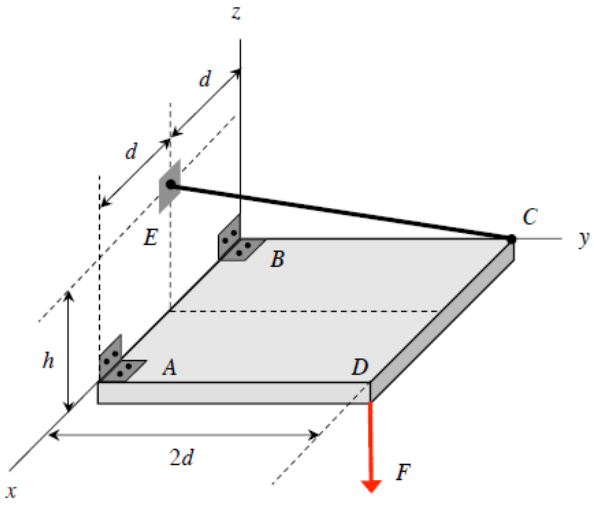
Homework H11.B

Given: The door is loaded at D with a force F and is supported by a cable CE and hinges at A and B. The cable carries a tension of T_{CE}. The hinge at B *carries* a load in the x-direction and the hinge at A *does NOT* carry a load in the x-direction. The weight of the plate is negligible compared to the applied load at D.

Find:

a) Determine the load F.
b) Determine the reactions at hinges A and B.

Use the following parameters in your analysis: $T_{CE} = 300$ N, $h = 0.50$ m and $d = 0.6$ m.

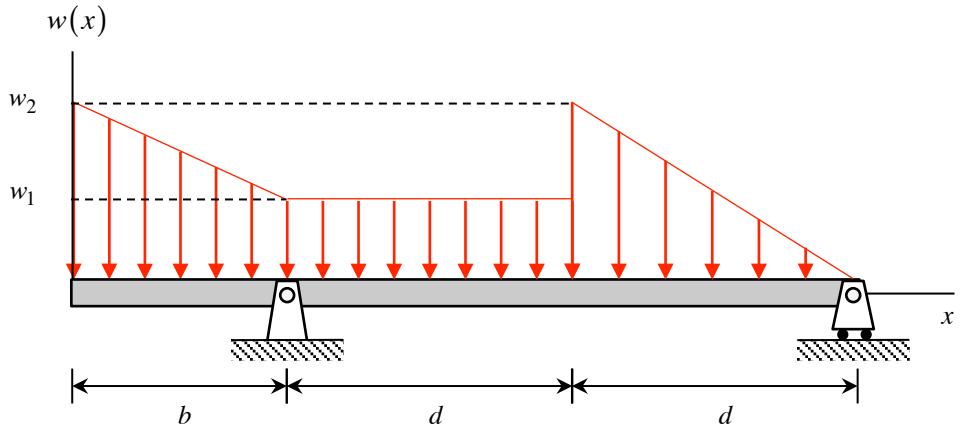


Homework H12.B

Given: The beam is loaded with the distributed load as shown.

Find: Calculate the magnitude and location of the single-force equivalent load.

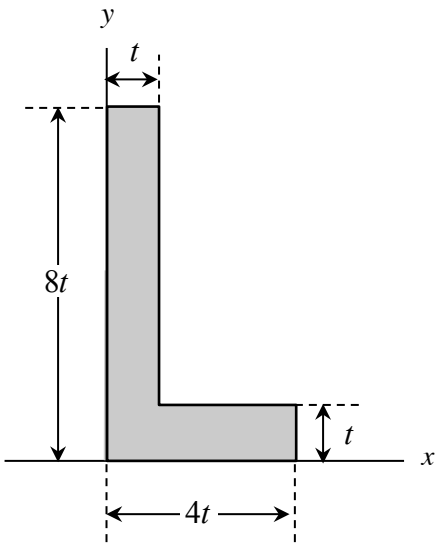
Use the following parameter values for your work: $b = 3$ ft, $d = 4$ ft, $w_1 = 50$ lb/ft and $w_2 = 90$ lb/ft.



Homework H13.B

Given: The shaded area in the figure.

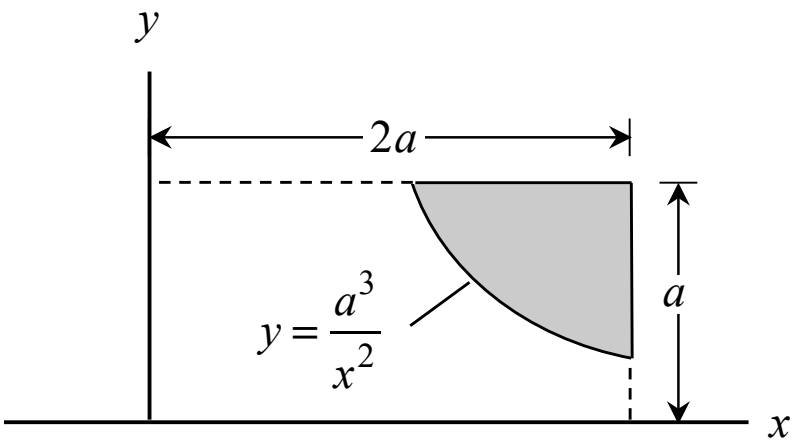
Find: Using the composite section method, determine the area, and the *x*- and *y*-components for the location of the centroid of the area. Leave you answers in terms of *t*.



Homework H14.B

Given: The shaded area in the figure.

Find: Using integration methods, determine the area, and the *x*- and *y*-components for the location of the centroid of the area. Leave you answers in terms of *a*.

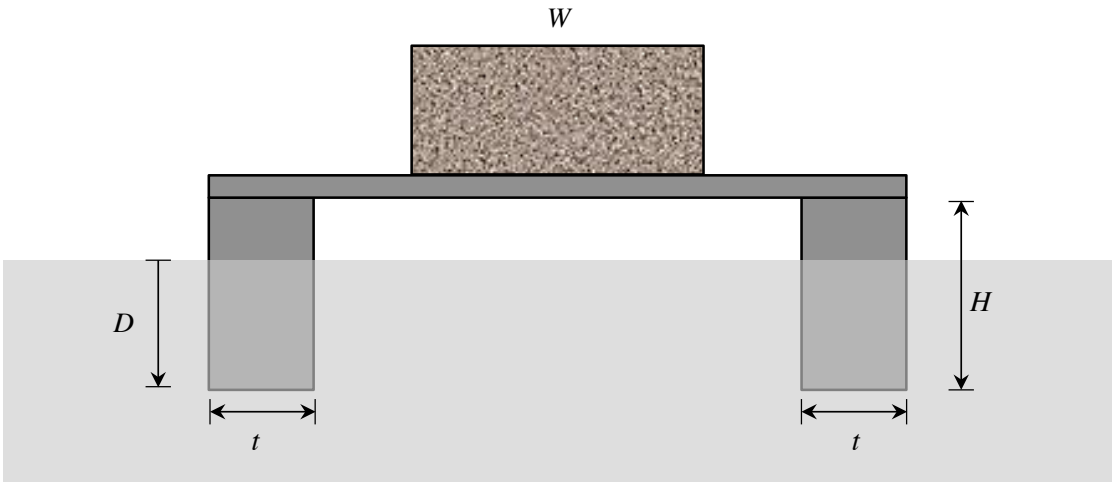


Homework H15.B

Given: A catamaran pontoon boat is made up a pair of hulls that are to be idealized as rectangular parallelpiped bodies with dimensions of ($t \times L \times H$), where L is the length of each hull (the dimension into the page in the figure shown below). The boat is to carry a heavy slab of material with a weight of W. The weight of the boat can be considered to be negligible as compared to the slab.

Find: Determine the minimum hull dimension t such that the draft of the boat, D, does not exceed D_{max}.

Use the following parameter values in your work: L = 14 ft, W = 1800 lb, D_{max} = 16 in and ρg = 62.4 lb/ft^3.

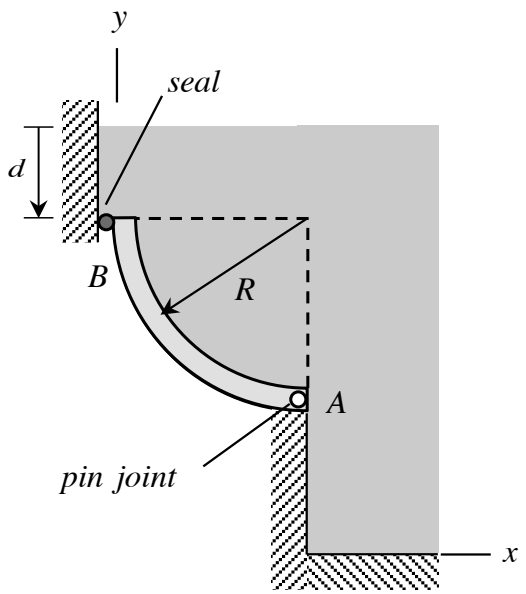


Homework H16.B

Given: A water gate, shaped as a quarter-circle arc, has a width of b (out of the paper). The gate is pinned to a fixed support at A and is supported by a seal at B. The specific weight of the water is ρg.

Find: Determine the reaction on the gate at pin joint A and seal B.

Use the following parameter values in your work: b = 10 ft, d = 8 ft, R = 16 ft and ρg = 62.4 lb/ft^3.

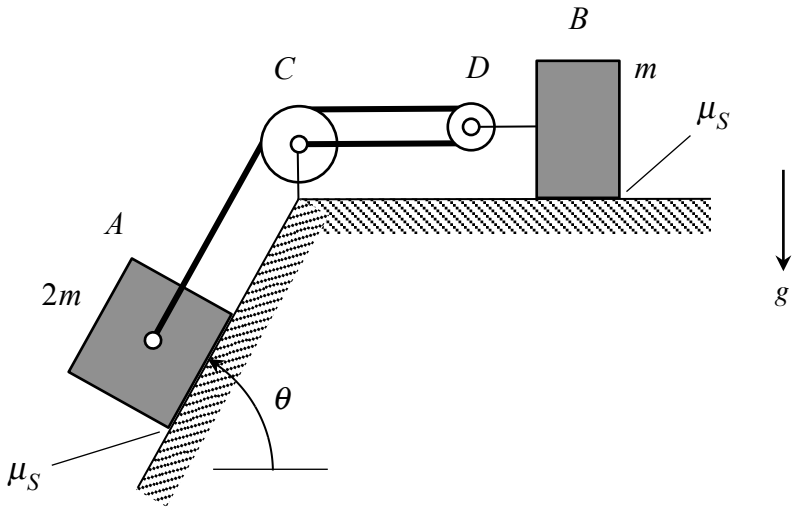


Homework H17.B

Given: Blocks A and B have masses of 2m and m, respectively, and are connected by the cable-pulley system shown. The coefficient of friction between each block and ground is μ_S.

Find: Determine the numerical value for the minimum μ_S required to keep the system in equilibrium.

For this problem, use the following parameter: $\theta = 36.87°$.



Homework H18.B

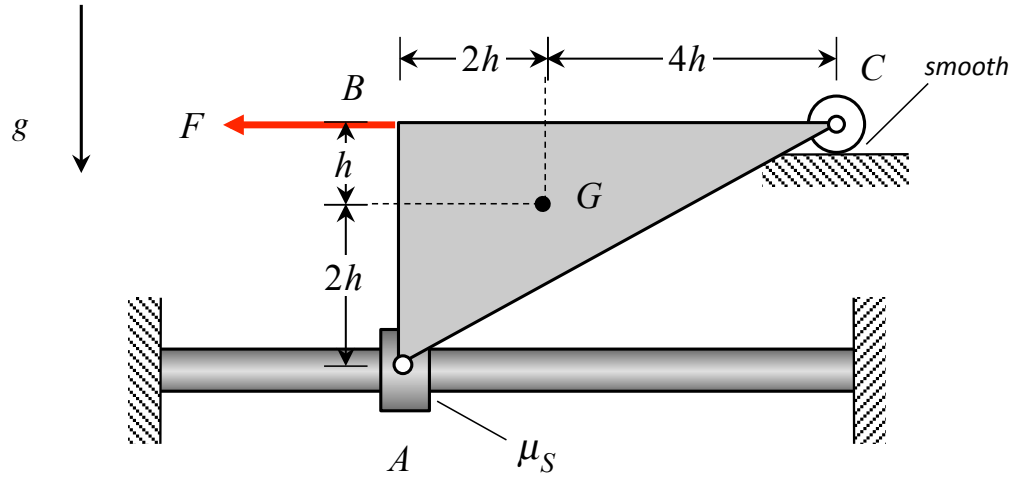
Given: A homogeneous triangular block having a weight of W and its center of mass at G is supported by a slider on a rough horizontal guide at A and by smooth roller on a horizontal surface at C. The coefficient of static friction of μ_S exists between the slider and the guide at A.

Find:

a) Determine the maximum force F that can be applied at B and not have the block move. Express your answer in terms of the weight W.

b) For the force F found above, is the block in a state of impending tipping or impending slipping?

For this problem, use the following parameter value: $\mu_s = 0.50$.

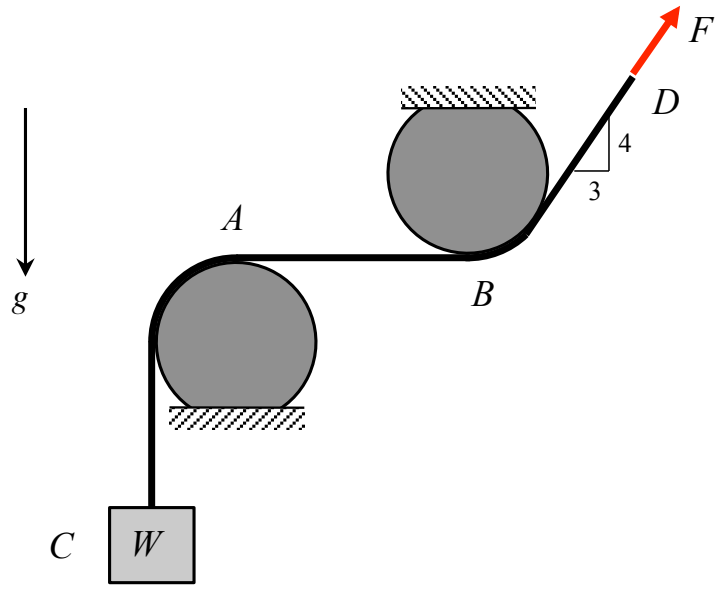


Homework H19.B

Given: Block C, having a weight of W, is supported by cable CD that is pulled over a pair of rough, fixed cylinders, where μ_s is the coefficient of static friction between the cable and cylinders. Note that section AB is horizontal.

Find: Determine the range of values for the force F applied to end D of the cable for which block C remains in static equilibrium. Provide your answer in terms of the block's weight W.

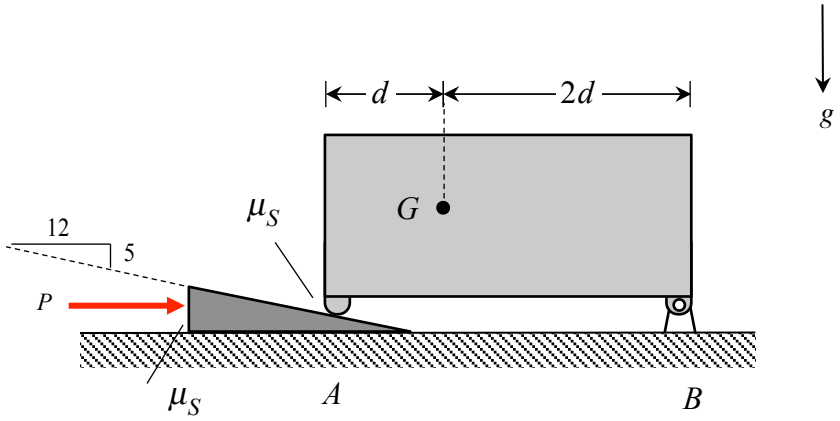
For this problem, use the following parameter: $\mu_s = 0.6$.



Homework H20.B

Given: An inhomogeneous block having a weight of W and its center of mass at G is to be raised with a wedge at support A. The coefficient of static friction between the block and the wedge is μ_S.

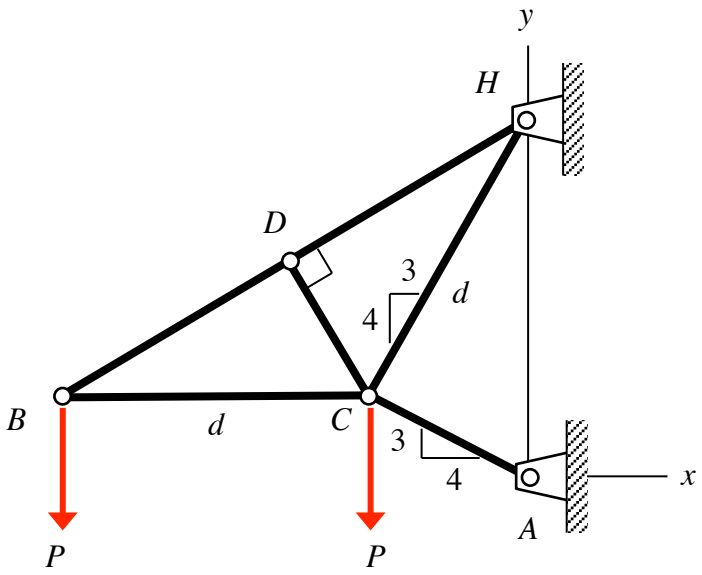
Find: Determine the minimum value of the wedge force P in order to raise the block at A.



Homework H21.B

Given: Consider the truss shown below with the loading on joints B and C.

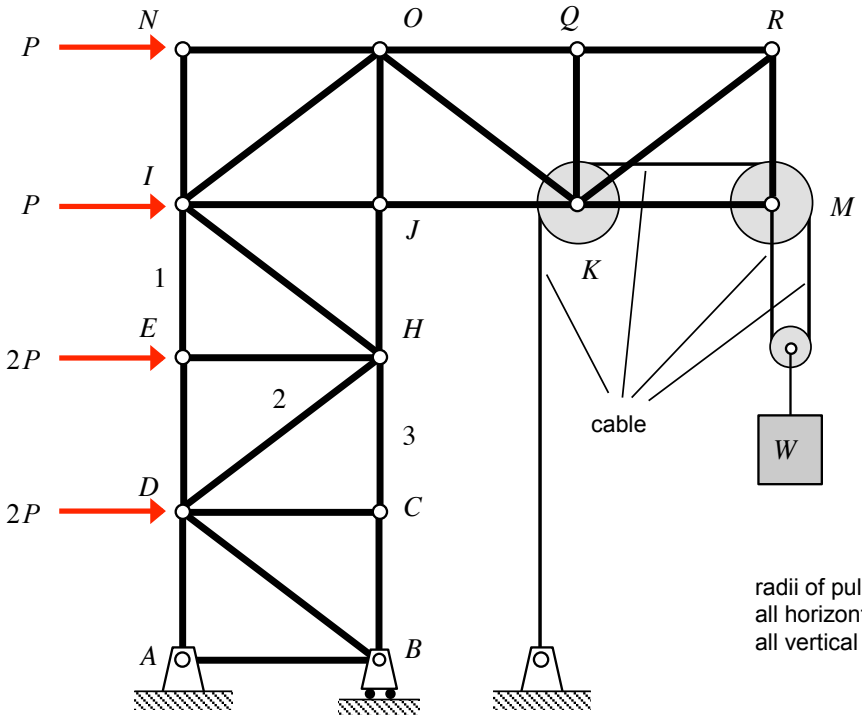
Find: Determine the load carried by all members in the truss. Identify each member as either being in tension, in compression or carrying zero load. Leave your answers in terms of *P*.



Homework H22.B

Given: Consider the truss shown below with the loading on joints D, E, I and N, in addition to the loading due to the weight W of the block that is supported by the cable-pulley system shown, where $W = 2P$.

Find: Determine the load carried by members 1, 2 and 3. Identify each member as either being in tension, in compression or carrying zero load. Leave your answers in terms of P.



radii of pulleys at K and M: r
all horizontal members of length: 4*d*
all vertical members of length: 3*d*

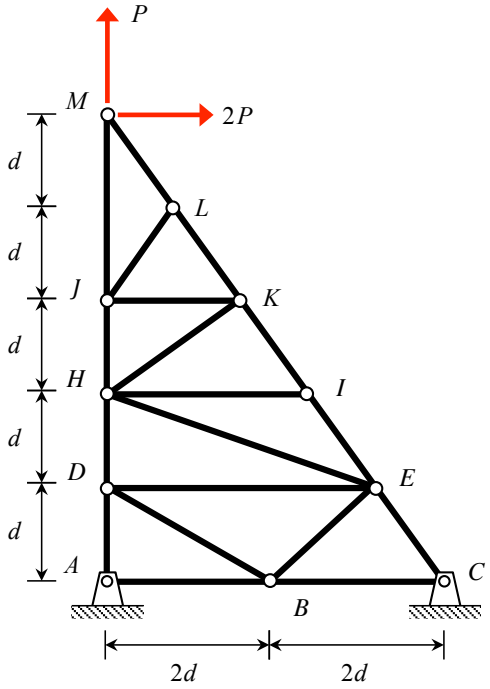
Homework H23.B

Given: Consider the truss shown below with the loading on joint M.

Find: For this problem:

a) Identify all zero-force members in the truss.

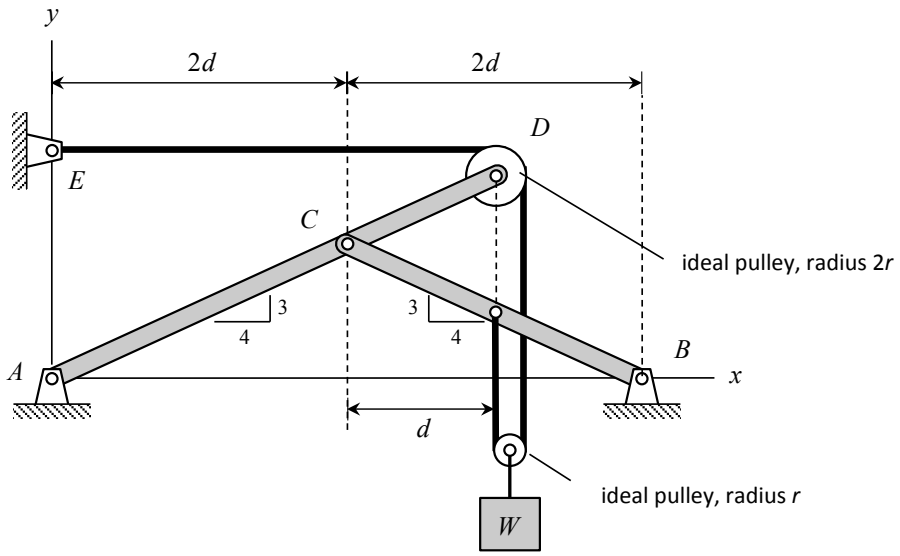
b) Determine the load carried by members HJ, HK, HI and EI of the truss. Identify each member as either being in tension, in compression or carrying zero load. Leave your answers in terms of P.



Homework H24.B

Given: A frame is made up of members AD and BC, with these two member pinned together at C. A pulley system with one pulley pinned to AD at D, one pulley supporting a block having a weight of W and with the cable attached to points E and the midpoint of BC.

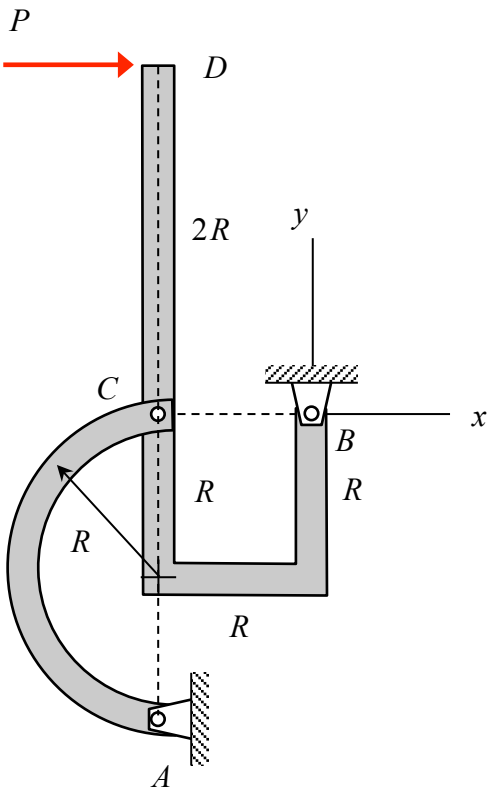
Find: Determine the reactions at A and B on the frame. Express your answer in terms *W*.



Homework H25.B

Given: A structure is made up of members BD and AC, as shown below. A force *P* is applied at end D of member BD.

Find: Determine the reactions acting on the structure at A and B. Write your answers as vectors and in terms of the applied force *P*.

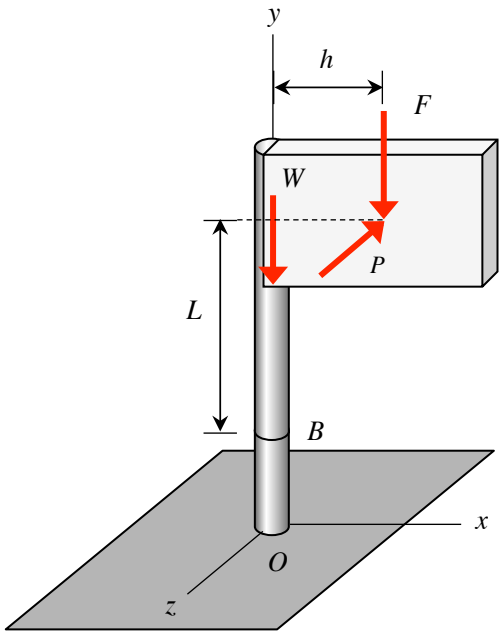


Homework H26.B

Given: A sign/pole structure is acted up by three forces F, P and W, in the $-y$, $-z$ and $-y$ directions, respectively.

Find: Determine internal resultants acting on section OB of the pole at location B. Write your answers as vectors.

For this problem, use the following parameters: L = 12 ft, h = 5 ft, W = 800 lb, F = 1000 lb and P = 1400 lb.

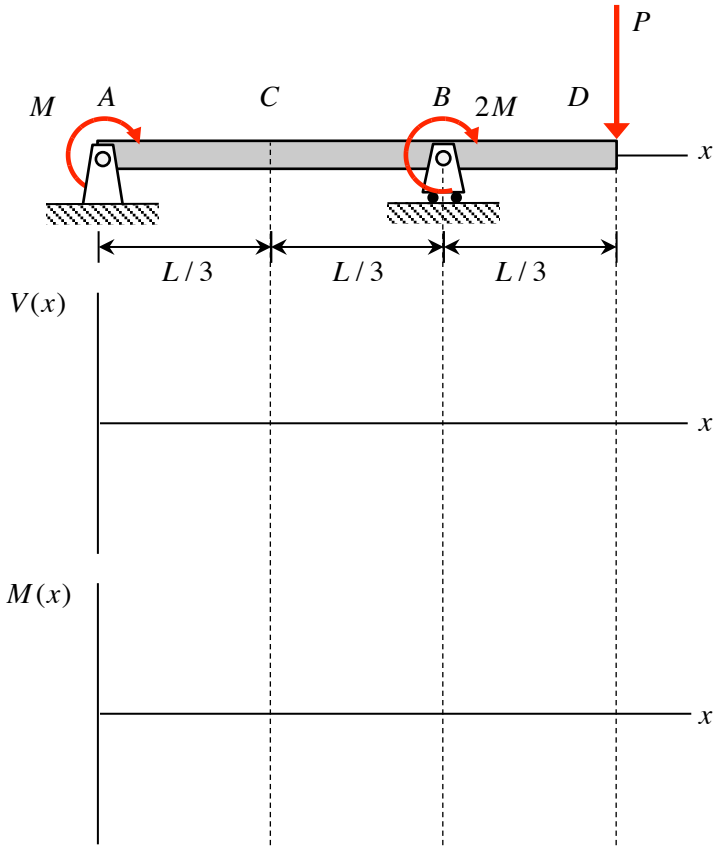


Homework H27.B

Given: Beam loaded with force P at D, along with concentrated couples at A and B.

Find: Construct the shear force and bending moment diagrams for this beam.

For this problem, use the following parameters: $L = 9$ ft, $M = 50$ kip-ft and $P = 50$ kips.

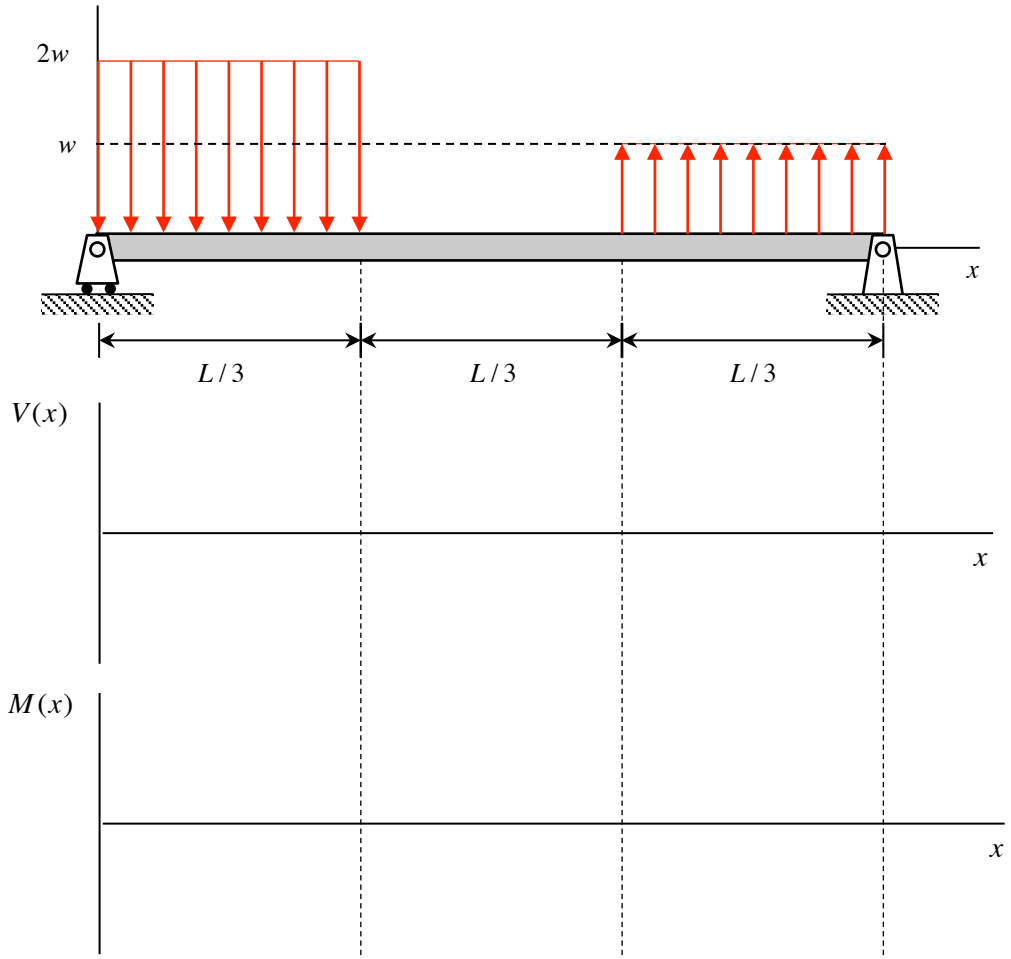


Homework H28.B

Given: Simply-supported beam with the line loading shown.

Find: Construct the shear force and bending moment diagrams for this beam.

For this problem, use the following parameters: $w = 10$ kips/ft and $L = 6$ ft.

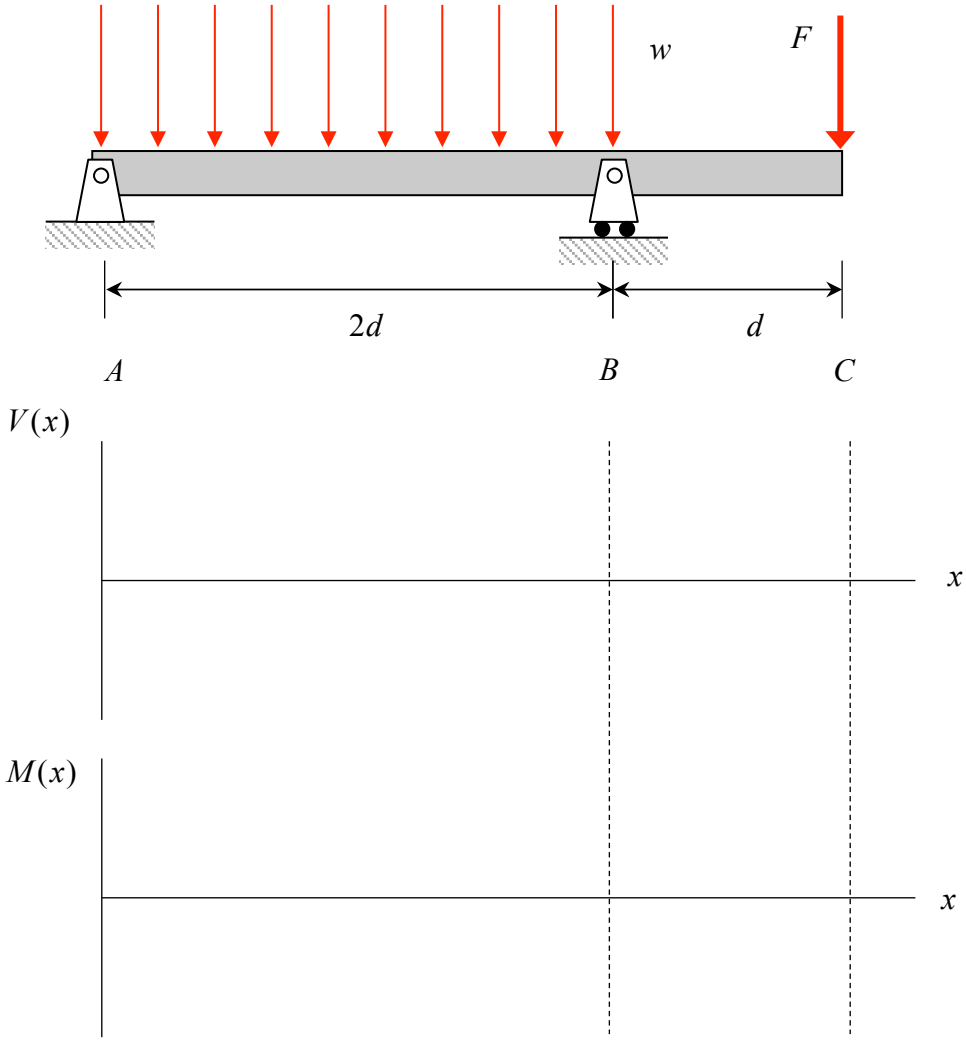


Homework H29.B

Given: Beam with the line loading w acting over section AM and a concentrated force F acting at end C.

Find: Using the graphical technique, construct the shear force and bending moment diagrams for this beam.

For this problem, use the following parameters: $w = 15$ kips/ft, $F = 60$ kips and $d = 3$ ft.

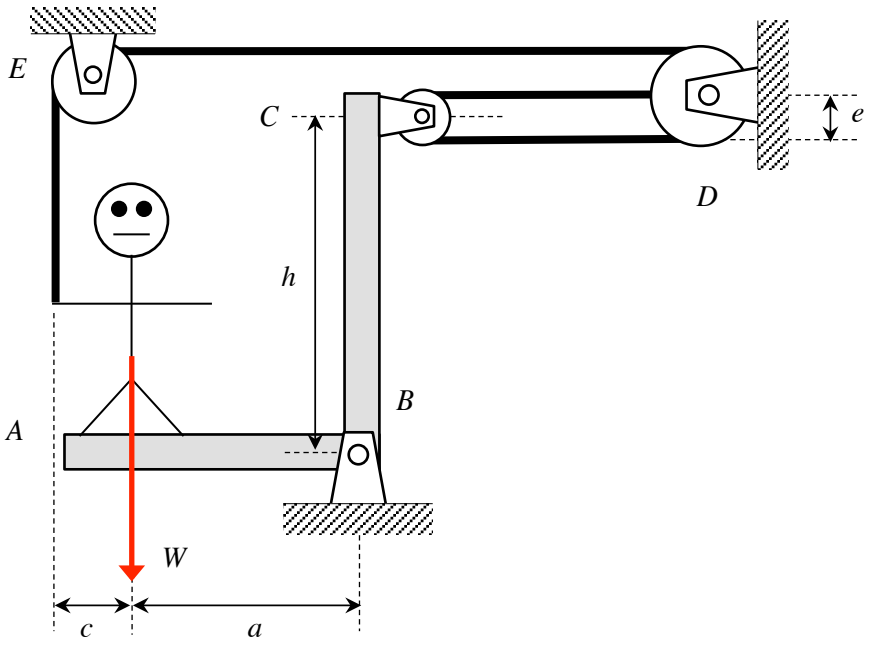


Homework H30.B

Given: The L-shaped stand is pinned to ground at B. A person having a weight of W is positioned near end A of the stand. The person is supporting herself and the stand through a cable-pulley system as shown. Consider the weight of the stand to be negligible compared to the weight of the person, and consider the pulleys to be ideal. The cable has a diameter of d.

Find: Determine the stress in the cable.

For this problem, use the following parameters: $W = 160$ lb, $h = 5$ ft, $a = 3$ ft, $c = 1$ ft, $e = 0.4$ ft and $d = 0.50$ in.



Homework H31.B

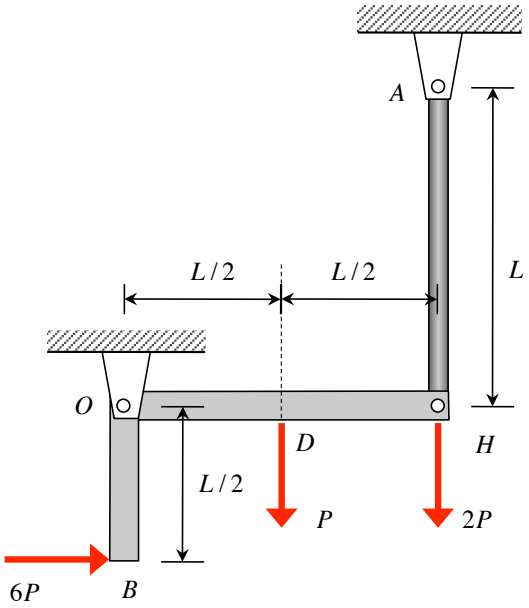
Given: The frame shown below is made up of the L-shaped member BH that is pinned to ground at O. AB is also supported by the rod AH that has a cross-sectional area of A. Member BH carries loads at locations B, D and H, as shown. Rod AH is made up of an aluminum alloy 6061-T6.

Find: For this problem:

a) Determine the stress in rod AH.

b) Has the material in rod AH failed due to yielding? If not, what is the factor of safety for this loading against yielding?

For this problem, use the following parameters: $P = 30$ kN, $L = 1.5$ m and $A = 100$ mm^2.

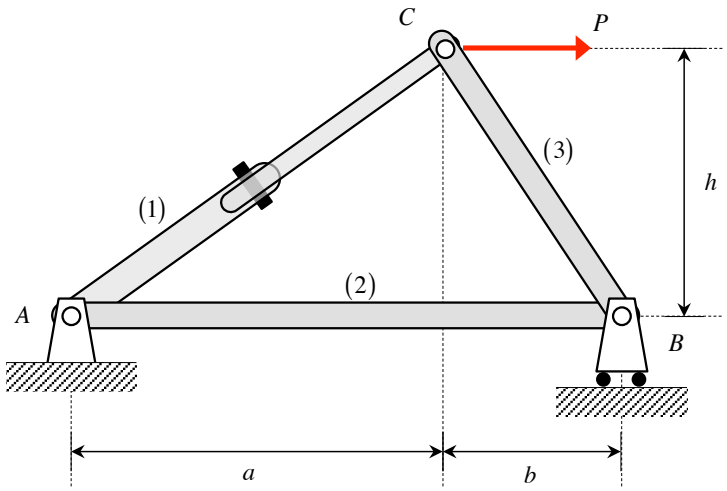


Homework H32.B

Given: The truss shown below is loaded with a force P at joint C. Member (1) of the truss is made up of two components that are joined with a pin having a diameter of d with a yield strength in shear of τ_Y.

Find: For this problem,
a) Determine the loads carried by the three members of the truss.
b) Determine the minimum diameter d of the pin joining the two components of member AC such that the material of the pin does not yield.

For this problem, use the following parameters: a = 16/15 ft, b = 3/5 ft, h =4/5 ft, P = 20 kips and τ_Y = 18 ksi.



Homework H33.B

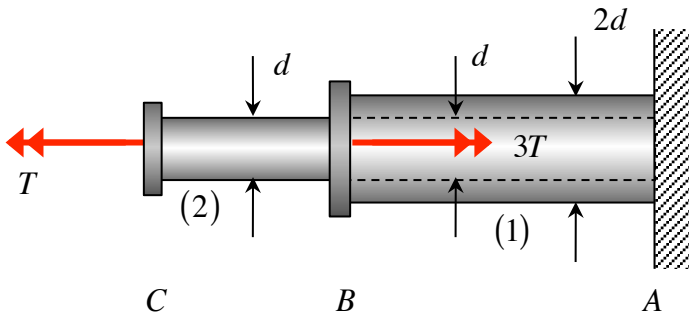
Given: A circular cross-sectioned shaft is made up of components (1) and (2). Component (1) has a tubular cross section, with inner and outer diameters of d and $2d$, respectively. Component (2) has a solid cross section with a diameter of d. Components (1) and (2) are joined by a rigid connector at B with (1) being attached to a fixed wall at end A. Rigid connector C is attached to end C of component (2). Torques $3T$ and T act on connectors B and C, respectively, as shown.

Find: For this problem:

a) Determine the torque load on each of the components as a result of the applied torques.

b) What is the maximum shear stress in the shaft? At what location(s) does this maximum stress exist?

Leave your answers in terms of T and d.

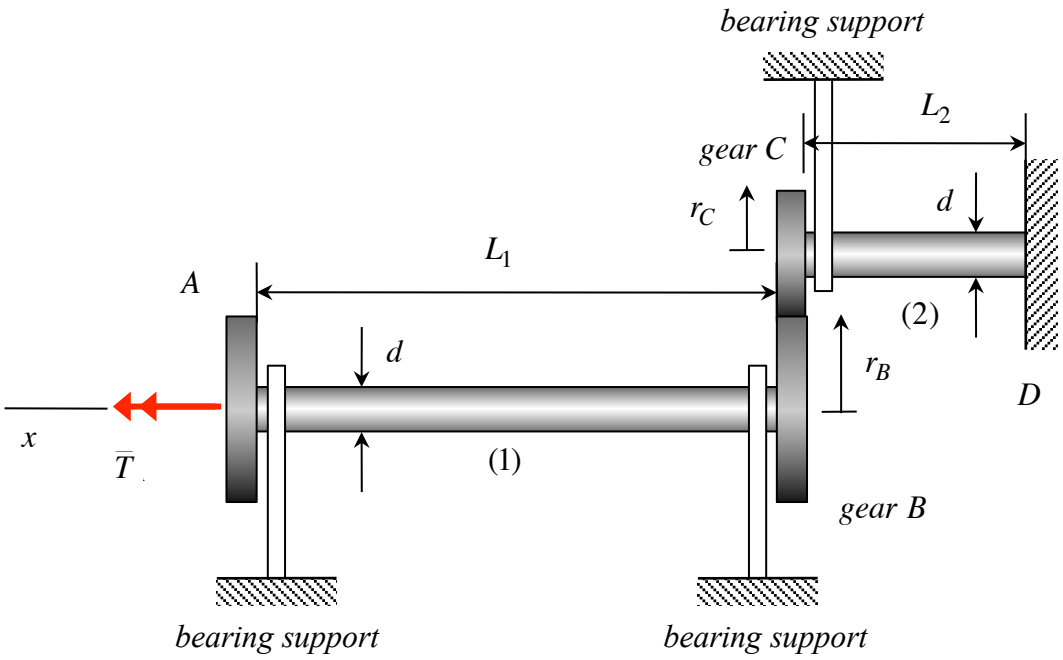


Homework H34.B

Given: Circular cross-sectioned shafts (1) and (2) are coupled through a pair of meshing gears B and C, where $r_B > r_C$. End D of shaft (2) is connected to a fixed wall, whereas a torque of T is applied to end A of shaft (1). Both shafts have solid cross sections with a diameter of d.

Find: For this problem, determine the maximum shear stress in the system. In which shaft does this maximum shear stress occur, and where on the cross section does it occur?

Express your answers in terms of the parameters defined in the figure.



Homework H35.B

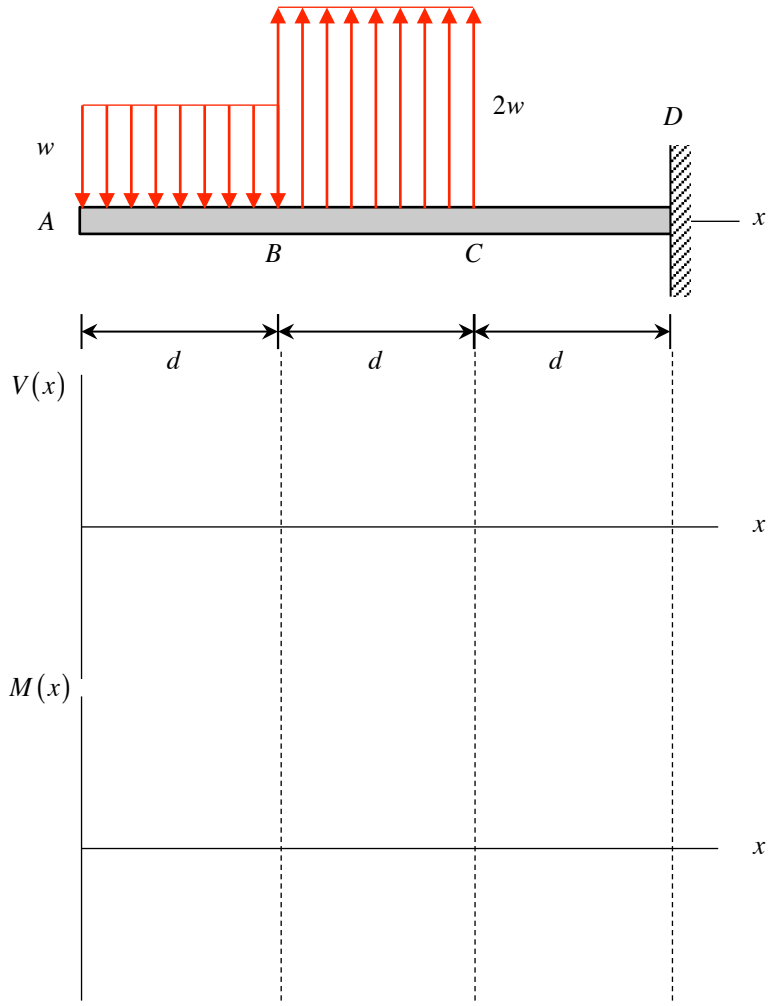
Given: Consider the beam loaded as shown below. The beam has a solid square cross section with cross-section dimensions b x b.

Find: For this problem:

a) Determine the location(s) for which pure bending exists on the cross section of the beam.

b) For the location(s) found in a) above, determine the maximum normal stress.

For this problem, use the following parameters: $d = 2$ m, $w = 10$ kN/m and $b = 100$ mm.



Homework H36.B

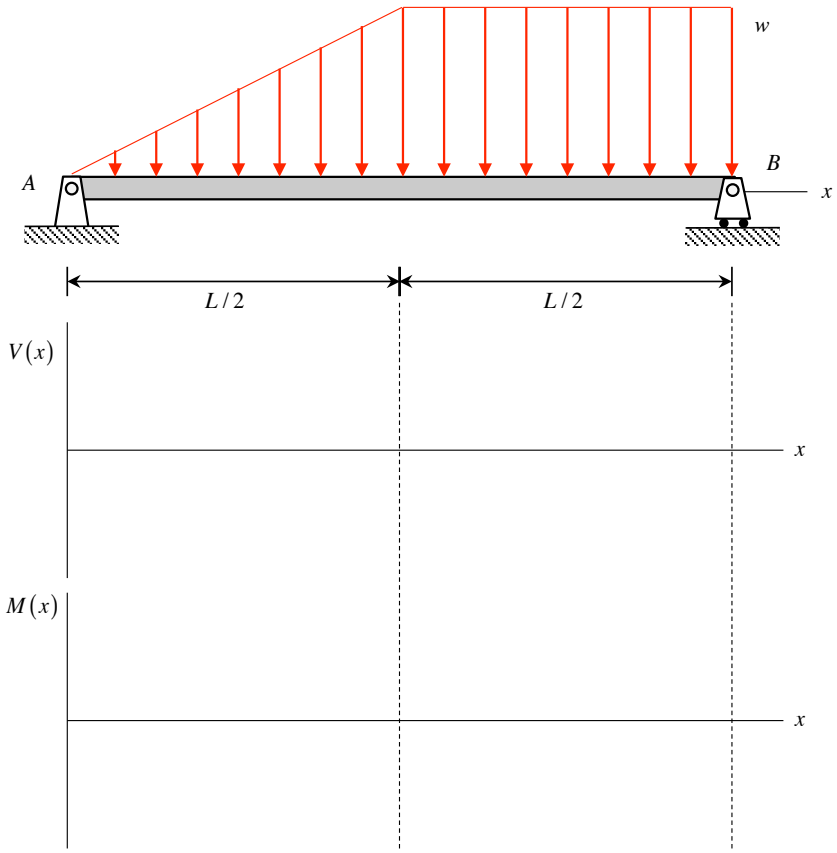
Given: Consider the beam loaded as shown below. The beam has a rectangular cross section with cross-section dimensions of b x h, where b is the dimension into the page.

Find: For this problem:

a) Determine the location(s) for which pure bending exists on the cross section of the beam.

b) For the location(s) found in a) above, determine the maximum normal stress.

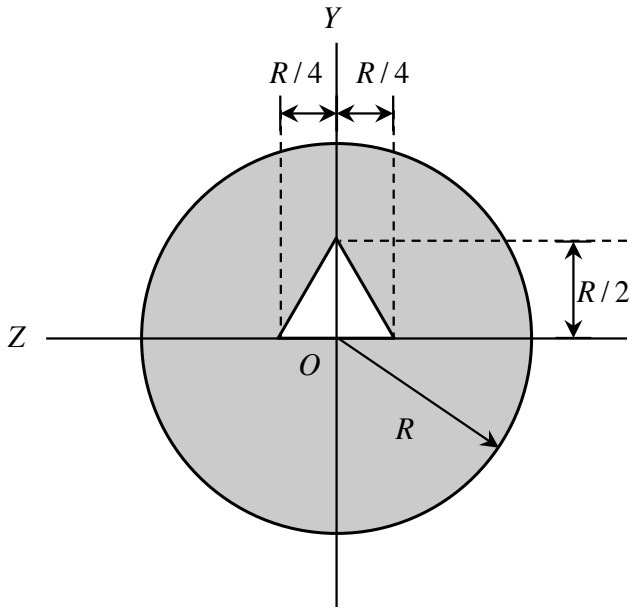
For this problem, use the following parameters: $L = 5$ m, $w = 20$ kN/m, $b = 0.1$ m and $h = 0.3$ m.



Homework H37.B

Given: Consider the greyed area shown below.

Find: Using the method of composite sections, determine the Y-position of the centroid for this area and the second area moment for the section about its centroid for bending about the Z direction.



Homework H38.B

Given: Consider the greyed area shown below.

Find: Using integration, determine the Y-position of the centroid for this area and the second area moment for the section about its centroid for bending about the Z direction.