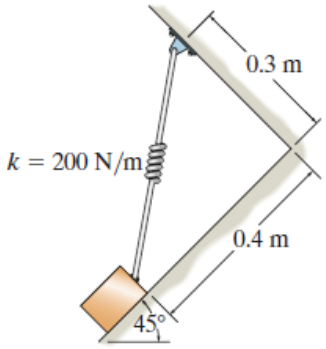
PS 2-3

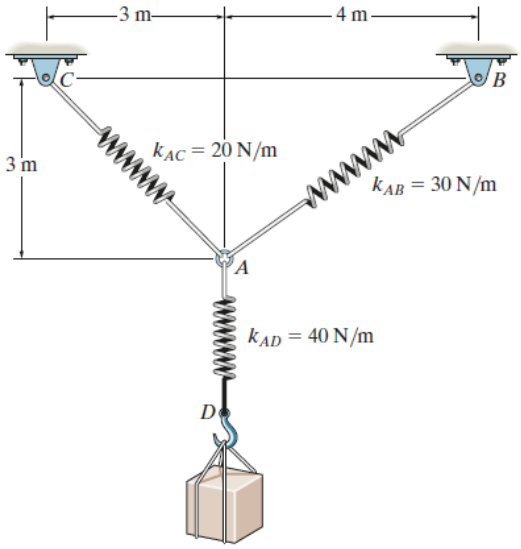
K.T.U.
DEPARTMENT of CIVIL ENGINEERING
STATICS PROBLEM SET 2-3

1



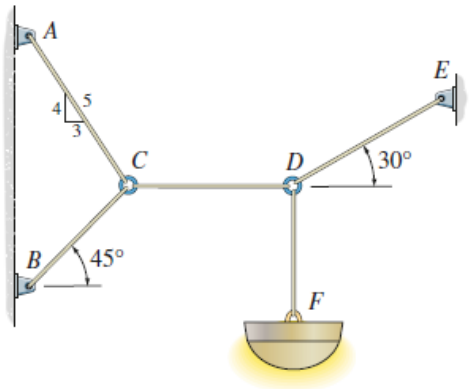
The block has a mass of 5 kg and rests on the smooth plane. Determine the unstretched length of the spring.

2



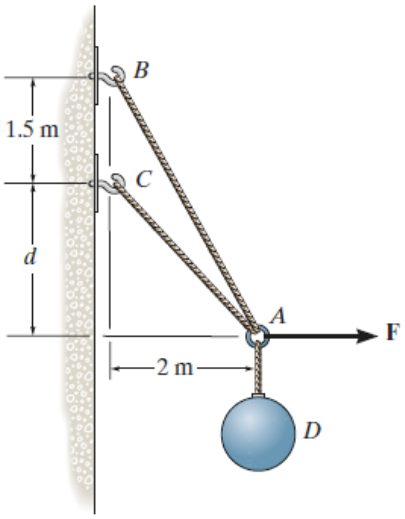
The unstretched length of spring AB is 3 m. If the block is held in the equilibrium position shown, determine the mass of the block at D.

3



Determine the maximum mass of the lamp that the cord system can support so that no single cord develops a tension exceeding 400 N.

4



The ball D has a mass of 20 kg. If a force of $F = 100$ N is applied horizontally to the ring at A, determine the dimension d so that the force in cable AC is zero.

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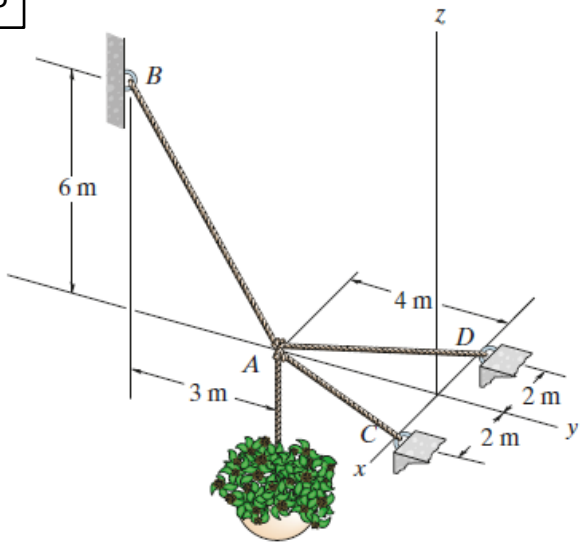
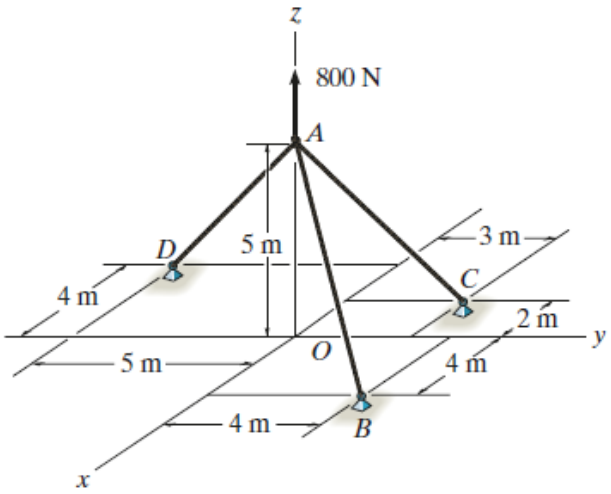


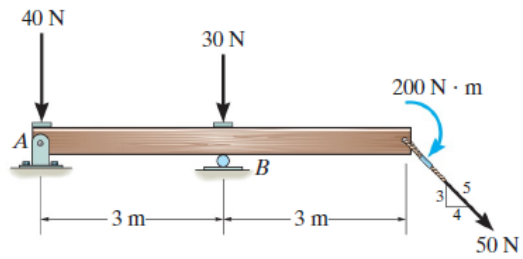
Determine the force in each cable needed to suppor the 20-kg flowerpot.

6



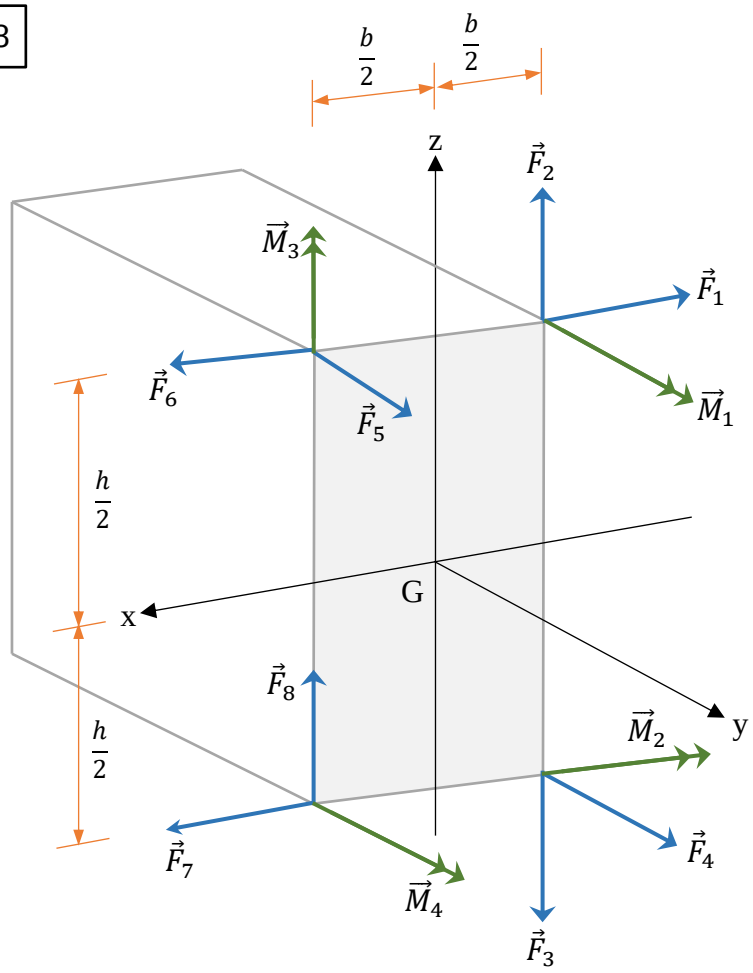
Determine the tension in each cable for equilibrium.

7



Replace the loading system by an equivalent resultant force and couple moment acting at point *A*.

8



$\vec{F}_1$,..., $\vec{F}_8$ and $\vec{M}_1$,..., $\vec{M}_4$ are applied to the end of a cantilever beam as shown in the figure. (All forces and couple moments are parallel to one of the *x*, *y* or *z* axis.)

a) Replace $\vec{F}_1$,..., $\vec{F}_8$ and $\vec{M}_1$,..., $\vec{M}_4$ with an an equivalent resultant force and resultant couple moment at the center of the cross-section (G).

b) What are the coordinate direction angles (α, β *and* θ) of the resultant force.

F_1	F_2	F_3	F_4	F_5
150 N	*0*	*0*	*0*	*200 N*

F_6	F_7	F_8	M_1	M_2
0	*0*	*200 N*	*100 Nm*	*200 Nm*

M_3	M_4	b (m)	h (m)
180 Nm	*0*	*0.4 m*	*0.6 m*

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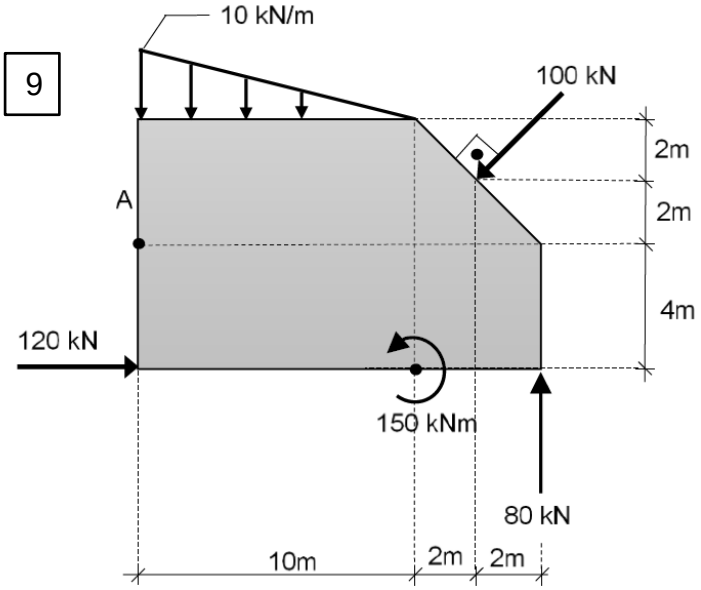

Replace system of forces and couple moment system by

a) a resultant force and a resultant couple moment at A.

b) a equivalent resultant force and specify where the resultant's line of action intersects the body measured from A horizontally and vertically. (Assume A is the origin of the coordinate system)

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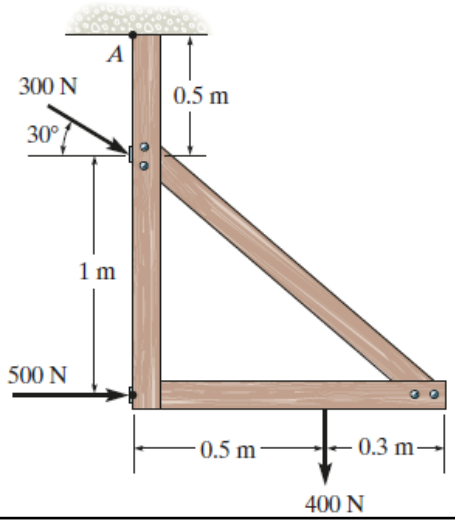
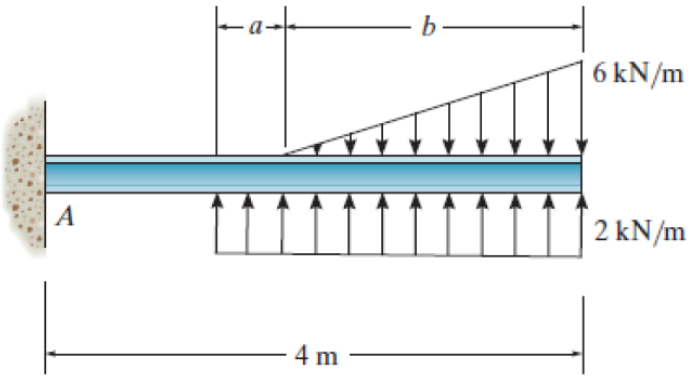


Replace the loading system by an equivalent resultant force and specify where the resultant's line of action intersects the member AB measured from A.

11



Determine the length *b* of the triangular load and its position *a* on the beam such that the equivalent resultant force is zero and the resultant couple moment is 8 kNm clockwise.

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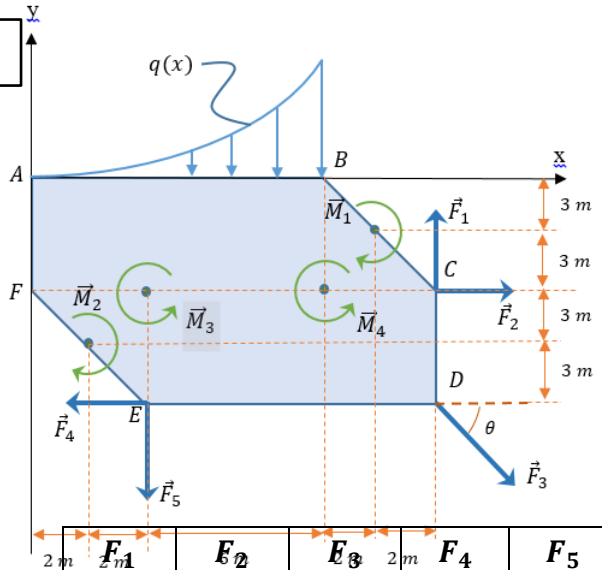

A distributed force $\boldsymbol{q(x)}$, concentrated forces $\vec{\boldsymbol{F}}_{\boldsymbol{1}}$, ..., $\vec{\boldsymbol{F}}_{\boldsymbol{5}}$ and couple moments $\vec{\boldsymbol{M}}_{\boldsymbol{1}}$, ..., $\vec{\boldsymbol{M}}_{\boldsymbol{4}}$ are applied to a plate (ABCDEF) as in the figure.

a) Determine the magnitude and location of the equivalent resultant force of the distributed load from *A*.

b) Replace the force and couple system shown in the figure equivalent resultant force and couple moment acting at point *A*.

c) Further replace the force and couple moment system acting on the plate by only an equivalent resultant force, and find where its line of action intersects the *x* and *y* axis.

F_1	F_2	F_3	F_4	F_5	M_1	M_2	M_3	M_4	q(x)
100N	150N	100N	0	0	100Nm	0	150Nm	0	x^2

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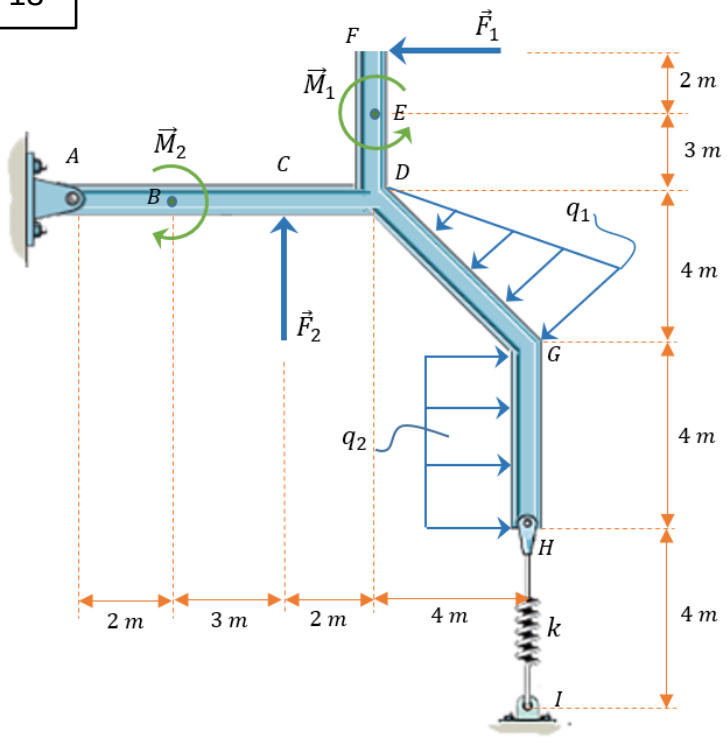

Concentrated forces $\vec{F}_1$ and $\vec{F}_2$, couple moments $\vec{M}_1$ and $\vec{M}_2$, a triangular and a rectangular distributed loads perpendicular to the member are applied to the system as in the given figure. The stiffness of spring at H is $\boldsymbol{k}$.

a) Find the support reactions at *A* and the force in the spring at *H*.

b) If the stiffness of the spring is $\boldsymbol{k}$, find the upstretched length of the spring $\boldsymbol{l_0}$.

F_1	F_2	M_1	M_2	q_1	q_2	k
200 N	*300 N*	*700 Nm*	*800 Nm*	*100 N/m*	*80 N/m*	*1.8 kN/m*

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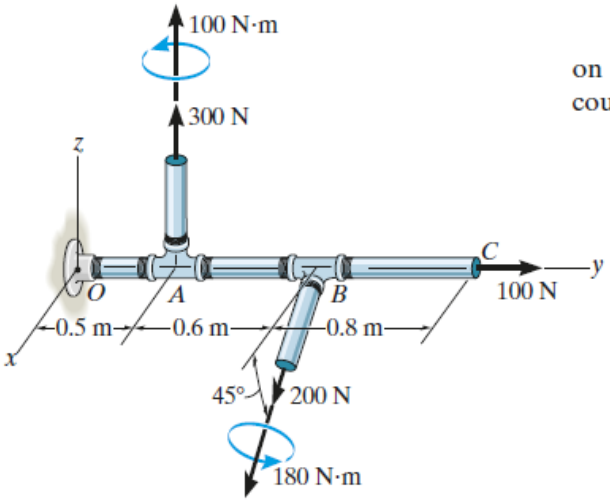
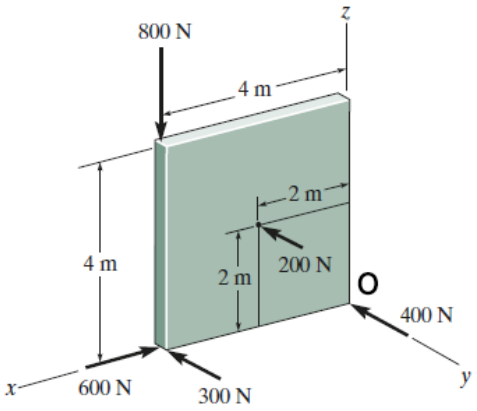


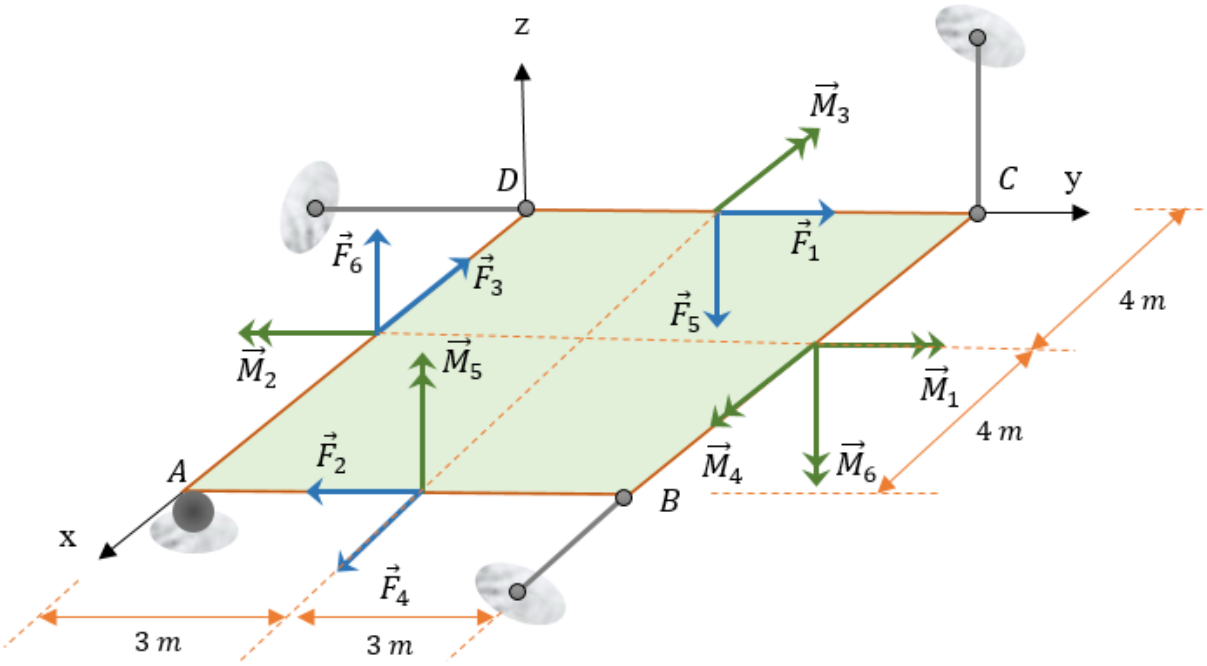
Replace the two wrenches and the force, actin on the pipe assembly, by an equivalent resultant force an couple moment at point *O*.

15



Replace the two wrenches and the force, actin on the pipe assembly, by an equivalent resultant force an couple moment at point *O*.

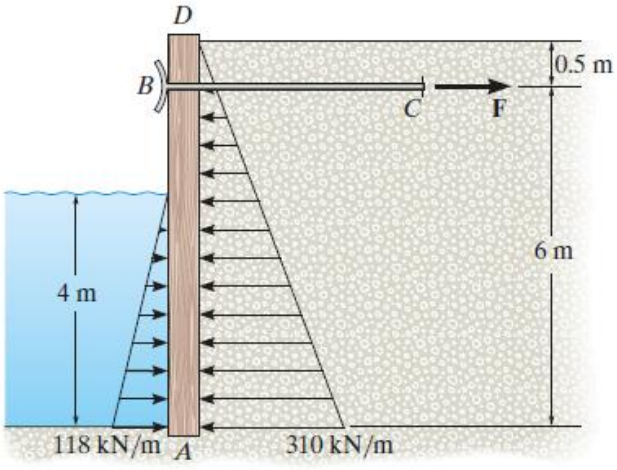
16



Concentrated forces $\vec{F}_1$,..., $\vec{F}_6$ and couple moments $\vec{M}_1$,..., $\vec{M}_6$ are applied to a rigid plate (ABCD). The plate supported by a ball and socket at A and three rigid weightless link at B, C and D which are parallel to x, z and y axis, respectively. All the forces and couple moments are parallel to one of the x, y or z axis. Find all the support reactions and forces in the weightless links.

F_1 (N)	F_2 (N)	F_3 (N)	F_4 (N)	F_5 (N)	F_6 (N)	M_1 (N.m)	M_2 (N.m)	M_3 (N.m)	M_4 (N.m)	M_5 (N.m)	M_6 (N.m)
100	0	250	0	0	200	100	0	0	100	300	0

17



The bulk head AD is subjected to both water and soil-backfill pressures. Assuming AD is "pinned" to the ground at A, determine the horizontal and vertical reactions there and also the required tension in the ground anchor BC necessary for equilibrium. The bulk head has a mass of 800 kg.

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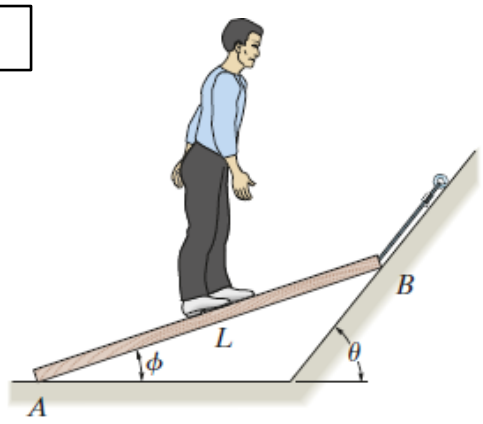

The man has a weight W and stands at the center of the plank. If the planes at A and B are smooth, determine the tension in the cord in terms of W and θ.

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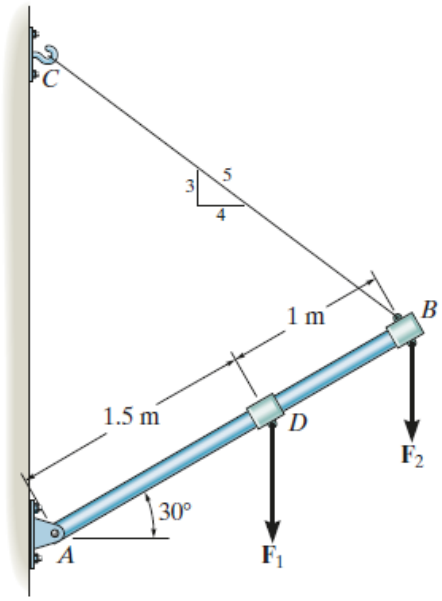
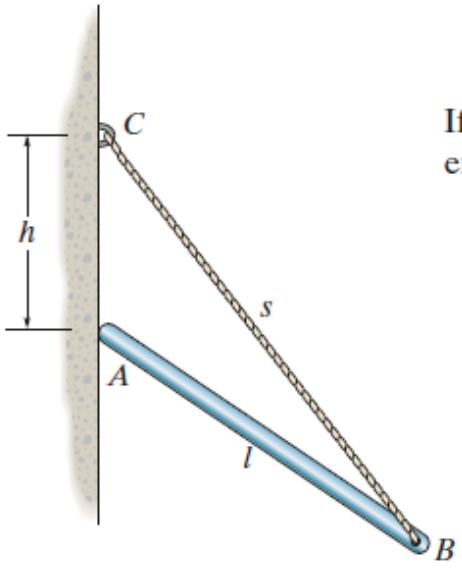


The boom is intended to support two vertical loads, $\mathbf{F}_1$ and $\mathbf{F}_2$. If the cable CB can sustain a maximum load of 1500 N before it fails, determine the critical loads if $F_1 = 2F_2$. Also, what is the magnitude of the maximum reaction at pin A?

20



The 30-N uniform rod has a length of $l = 1$ m. If $s = 1.5$ m, determine the distance h of placement at the end A along the smooth wall for equilibrium.

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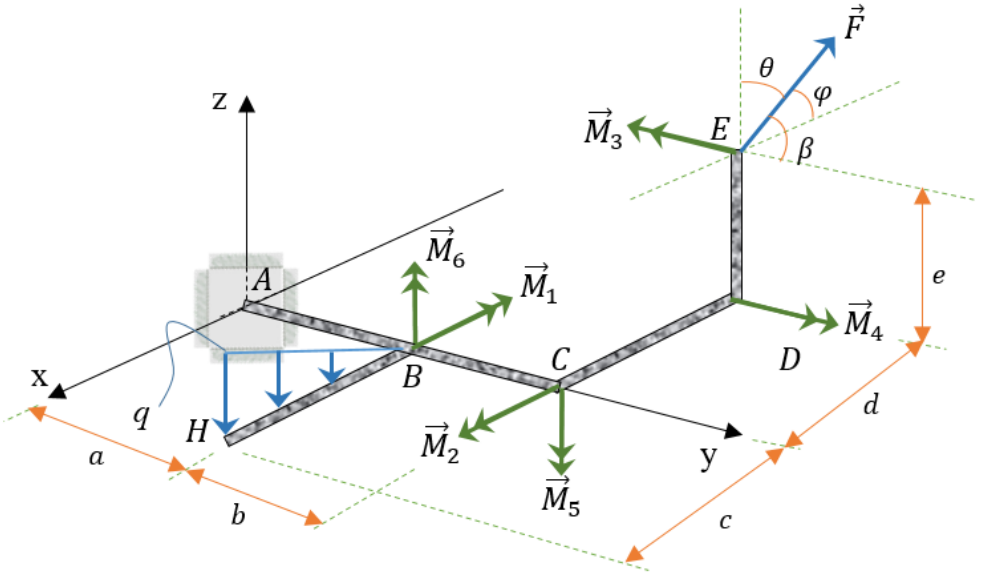

$\vec{F}$, a triangular distributed load and couple moments M_1,..., M_6 are applied a rigid frame structure which has a fixed support at *A*. Distributed load is in the negative z direction and couple moments are parallel to one of the *x*, *y* or *z* axis. All members of the frame structure are rigidly connected and parallel to one of the *x*, *y* or *z* axis. Find the support reactions. (Neglect the dimensions of the frame members)

F (N)	M_1 (Nm)	M_2 (Nm)	M_3 (Nm)	M_4 (Nm)	M_5 (Nm)	M_6 (Nm)	q (N/m)	β (deg)
100	100	0	150	0	200	0	50	50
θ (deg)	φ (deg)	a (m)	b (m)	c (m)	d (m)	e (m)		
60	70	2	2	3	2	3		

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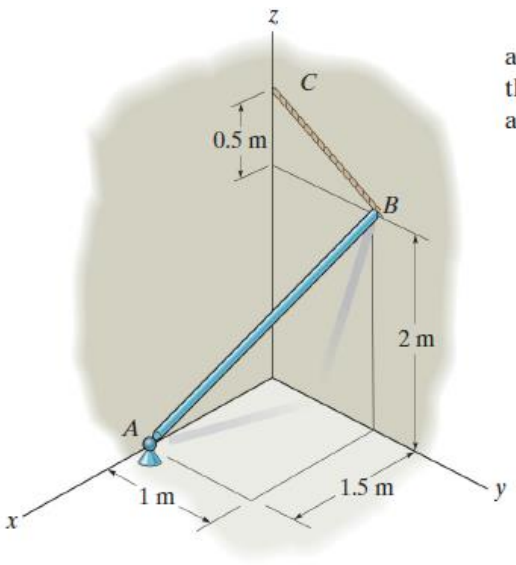

The smooth uniform rod *AB* is supported by a ball-and-socket joint at *A*, the wall at *B*, and cable *BC*. Determine the components of reaction at *A*, the tension in the cable, and the normal reaction at *B* if the rod has a mass of 20 kg.

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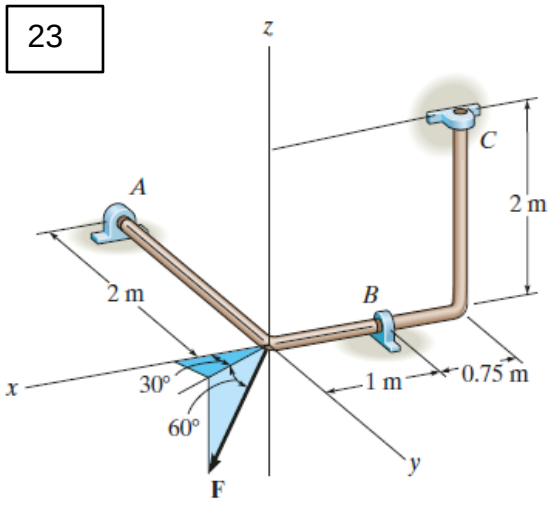

The bent rod is supported at A, B, and C by smooth journal bearings. Determine the components of reaction at the bearings if the rod is subjected to the force $F = 800$ N. The bearings are in proper alignment and exert only force reactions on the rod.

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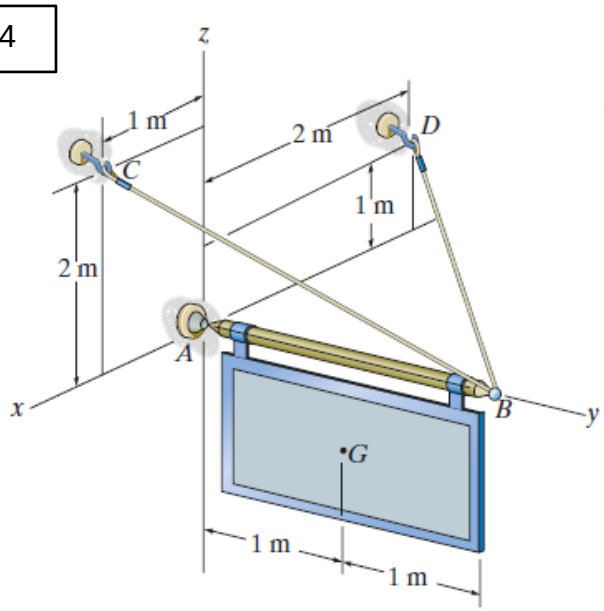
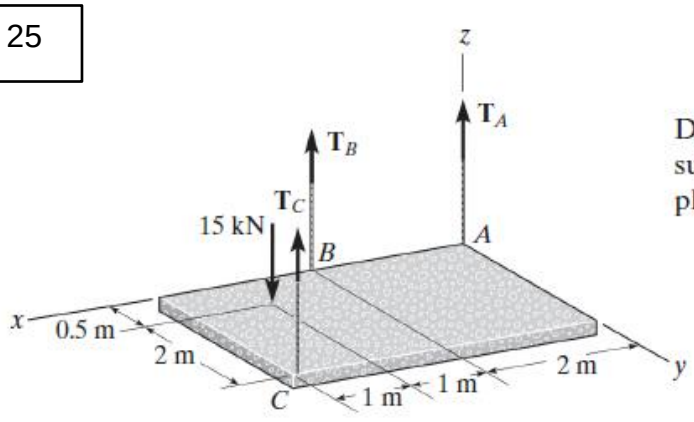


The sign has a mass of 100 kg with center of mass at G. Determine the x, y, z components of reaction at the ball-and-socket joint A and the tension in wires BC and BD.

25



The uniform concrete slab has a mass of 2400 kg. Determine the tension in each of the three parallel supporting cables when the slab is held in the horizontal plane as shown.

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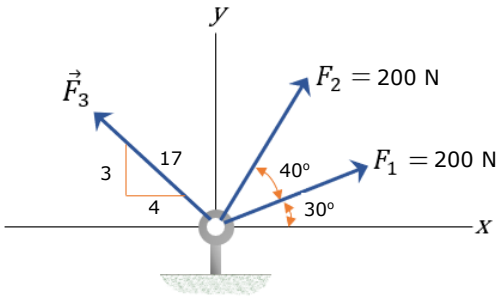
Determine the magnitude of $\vec{F}_3$ so that the resultant force $\vec{R}$ is directed upwards vertically.



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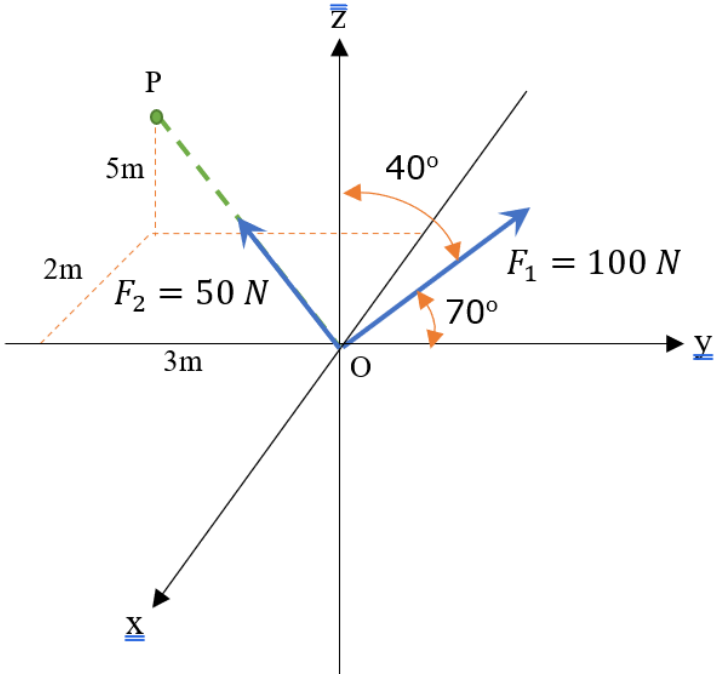
Find the angle in degrees between $\vec{F}_1$ and $\vec{F}_2$.



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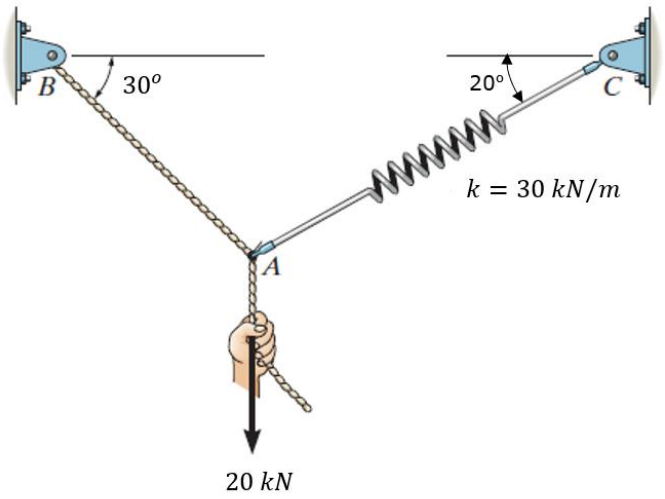
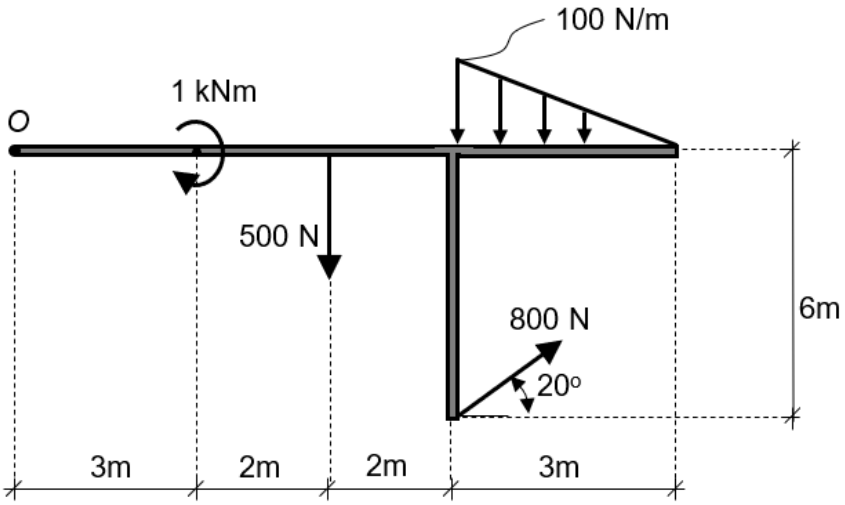
If the spring has an unstretched length of 1 m, determine the final length of the spring in meter after loading.



29

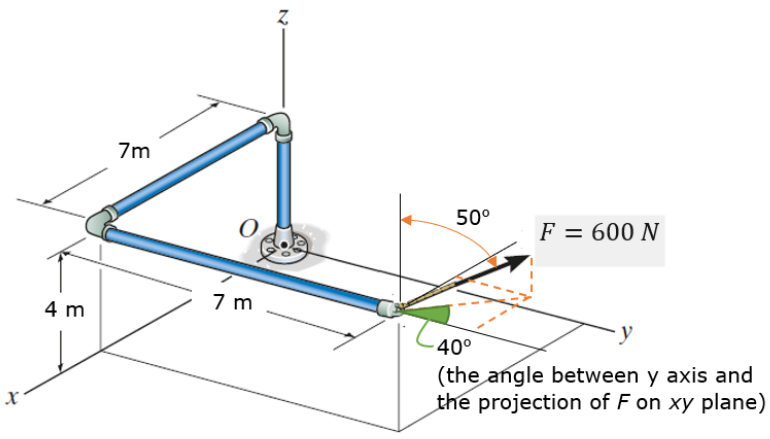
Find the resultant moment of the force system and the concentrated moment about O.

NOTE: *consider counterclockwise (CCW) moments are positive (+) and write your answer according to this sign vonvention.*



30

Find the magnitude of moment of $\vec{F}$ about point O.



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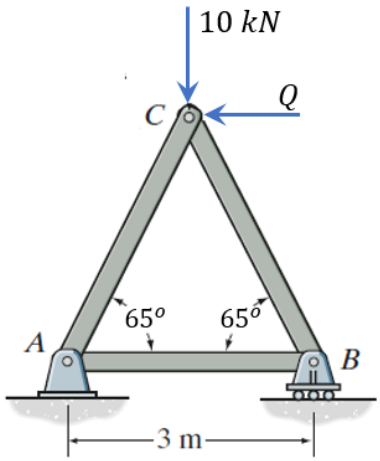
Determine the maximum load $\boldsymbol{Q}$ in kN that can be applied to the truss structure so that the member force of AB remains tension.



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Determine the support reactions at the smooth journal bearings A, B, and C of the pipe assembly.

Note: *Only consider forces at the bearings*

(do not consider moments at bearings)

Sign Convention: *If a support reaction is in the direction of axis, its sign is positive (+), otherwise negative (-)*