TABLE 5–1 Supports for Rigid Bodies Subjected to Two-Dimensional Force Systems

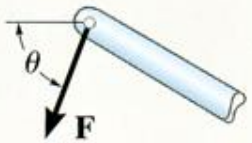
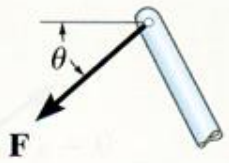
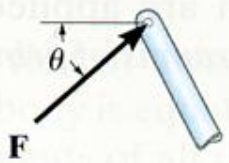
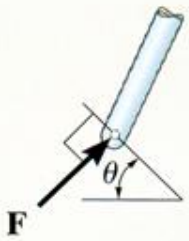
Types of Connection	Reaction	Number of Unknowns
(1)  cable		One unknown. The reaction is a tension force which acts away from the member in the direction of the cable.
(2)  weightless link	 or 	One unknown. The reaction is a force which acts along the axis of the link.
(3)  roller		One unknown. The reaction is a force which acts perpendicular to the surface at the point of contact.

TABLE 5–1 Continued

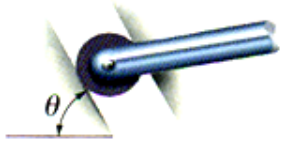
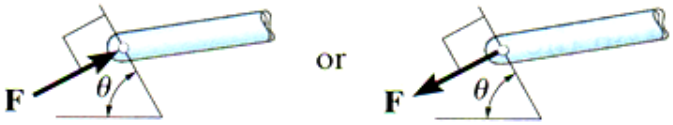
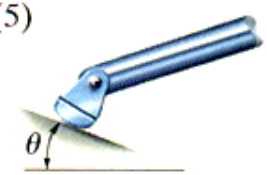
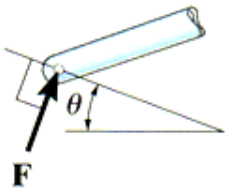
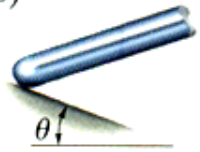
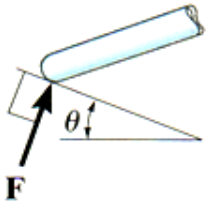
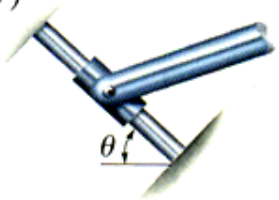
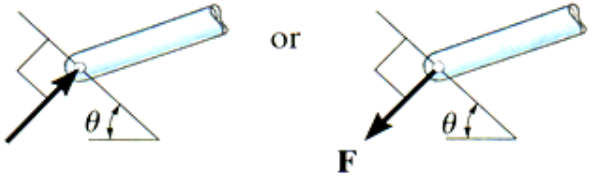
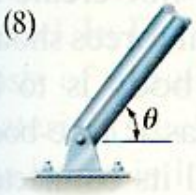
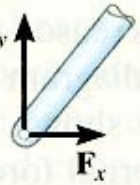
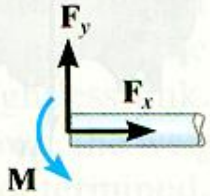
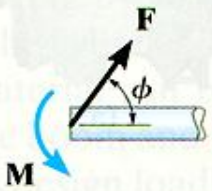
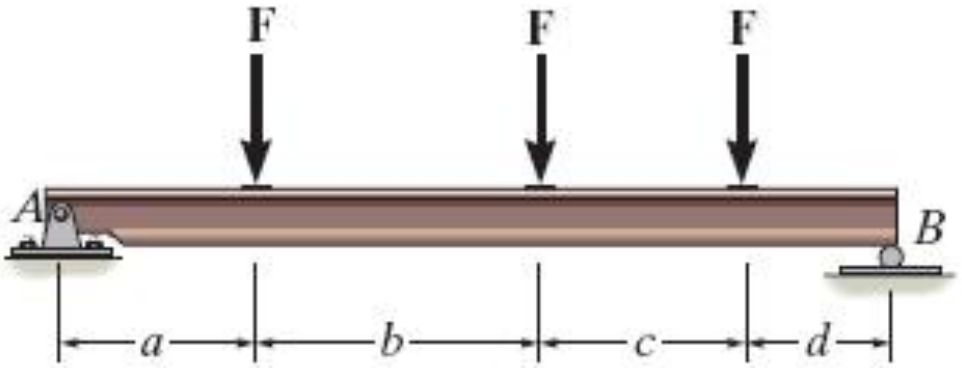
Types of Connection	Reaction	Number of Unknowns
(4)  roller or pin in confined smooth slot		One unknown. The reaction is a force which acts perpendicular to the slot.
(5)  rocker		One unknown. The reaction is a force which acts perpendicular to the surface at the point of contact.
(6)  smooth contacting surface		One unknown. The reaction is a force which acts perpendicular to the surface at the point of contact.
(7)  member pin connected to collar on smooth rod		One unknown. The reaction is a force which acts perpendicular to the rod.

TABLE 5–1 Continued

Types of Connection	Reaction	Number of Unknowns
(8)  smooth pin or hinge	 or 	Two unknowns. The reactions are two components of force, or the magnitude and direction ϕ of the resultant force. Note that ϕ and θ are not necessarily equal [usually not, unless the rod shown is a link as in (2)].
(9)  member fixed connected to collar on smooth rod		Two unknowns. The reactions are the couple moment and the force which acts perpendicular to the rod.
(10)  fixed support	 or 	Three unknowns. The reactions are the couple moment and the two force components, or the couple moment and the magnitude and direction ϕ of the resultant force.

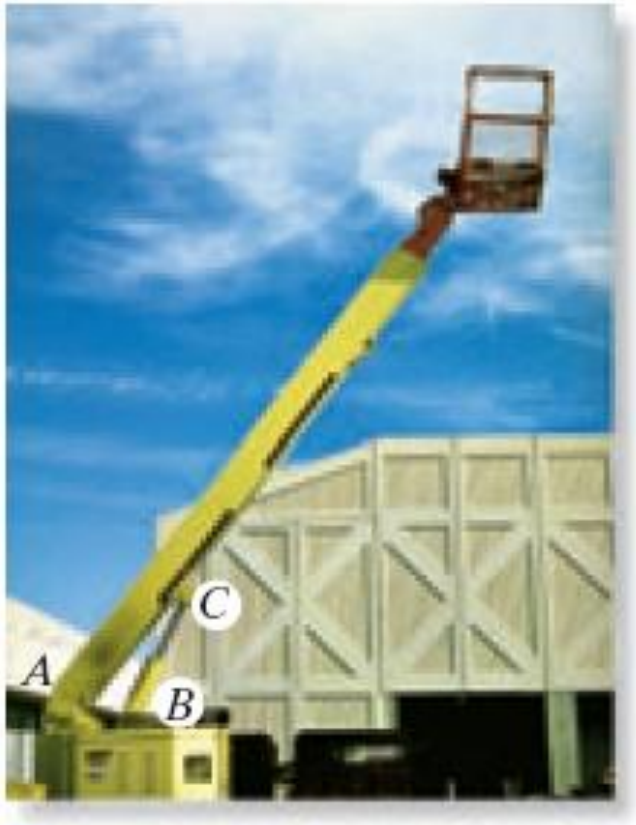
Idealized Models of Real Life.

(a)

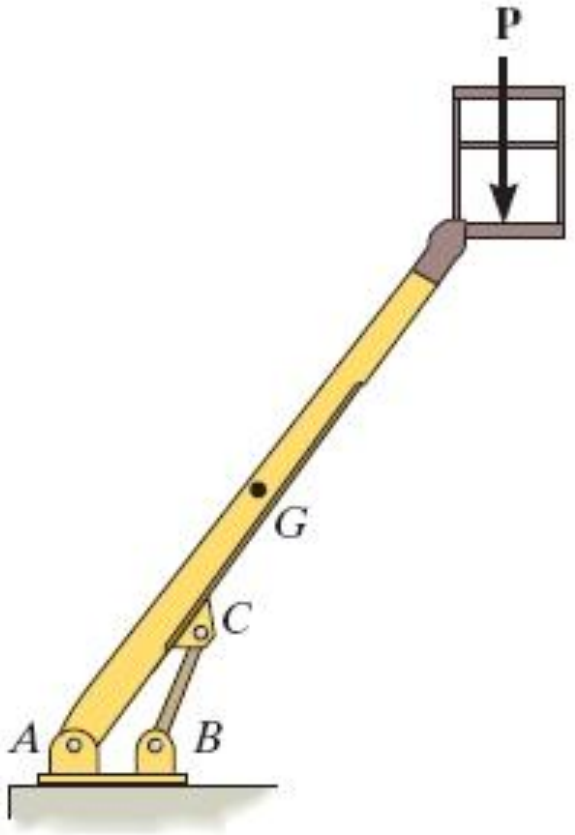


(b)

Idealized Models of Real Life.

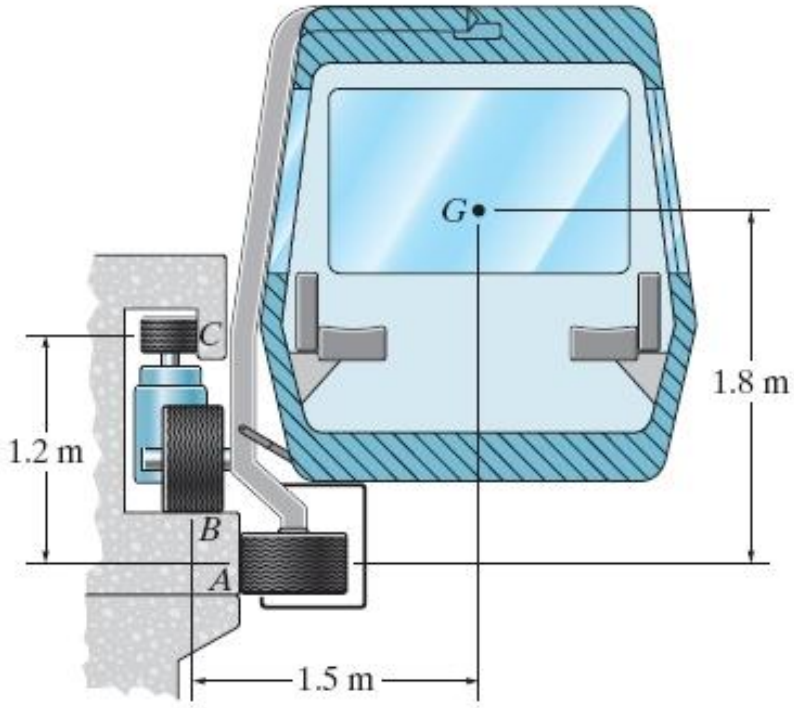


(a)

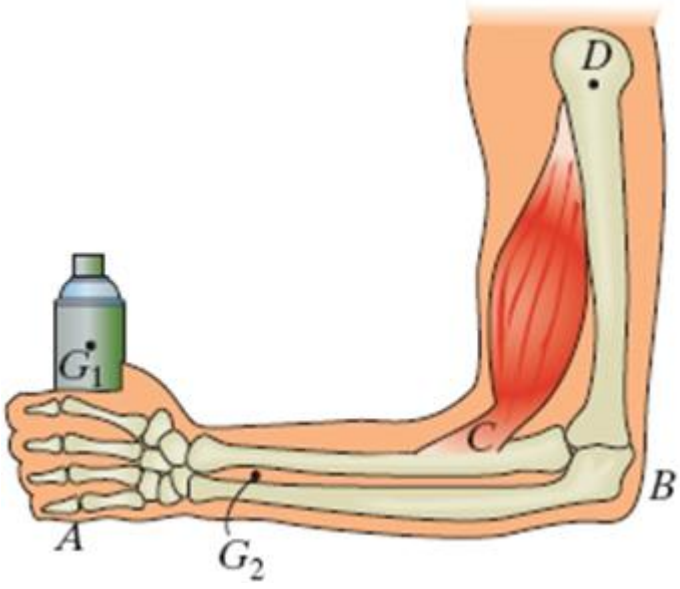


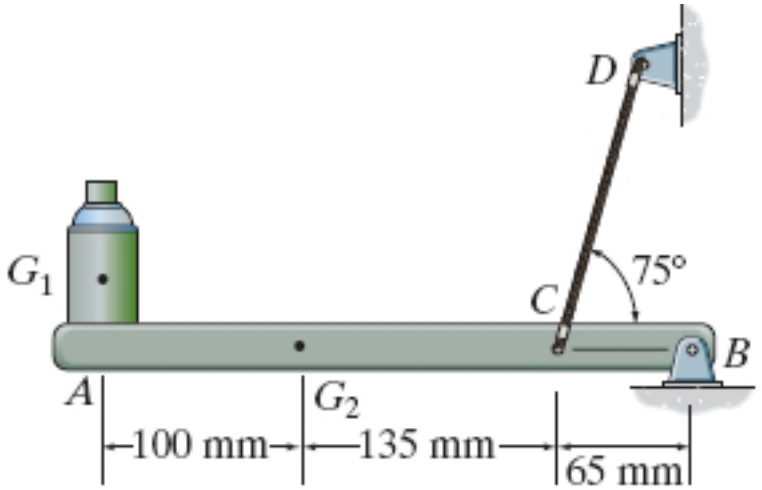
(b)

5-20. The train car has a weight of 120 kN and a center of gravity G. It is suspended from its front and rear on the track by six tires located at A, B, and C. Determine the normal reactions on these tires if the track is assumed to be a smooth surface and an equal portion of the load is supported at both the front and rear tires.

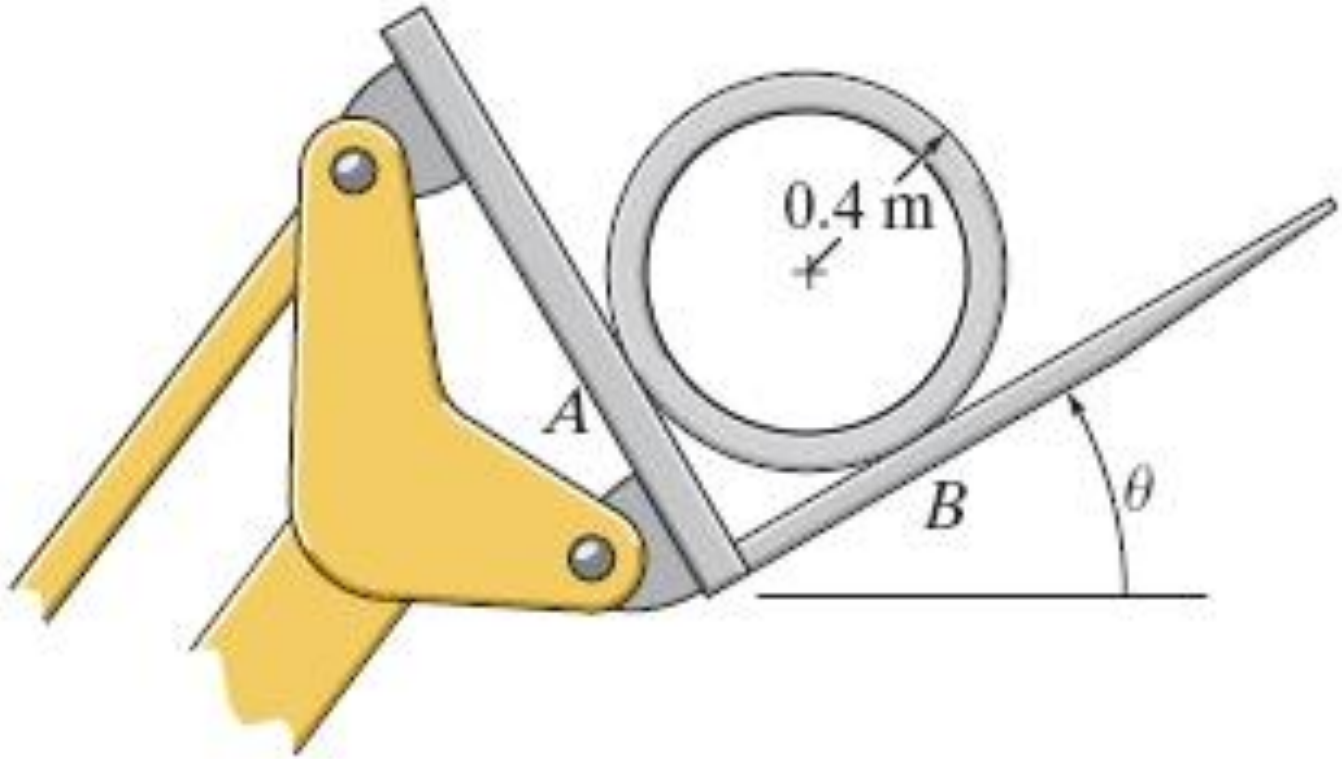


5-26. A musclo-skeletal diagram of a hand holding a load is shown in the figure. If the load and forearm have masses of 2 kg and 1.2 kg respectively, and their centers of mass are located at G_1 and G_2, determine the force developed in the biceps muscle CD and the horizontal and vertical components of reaction at the elbow joint B. The idealized mechanical equivalent is shown on the right.

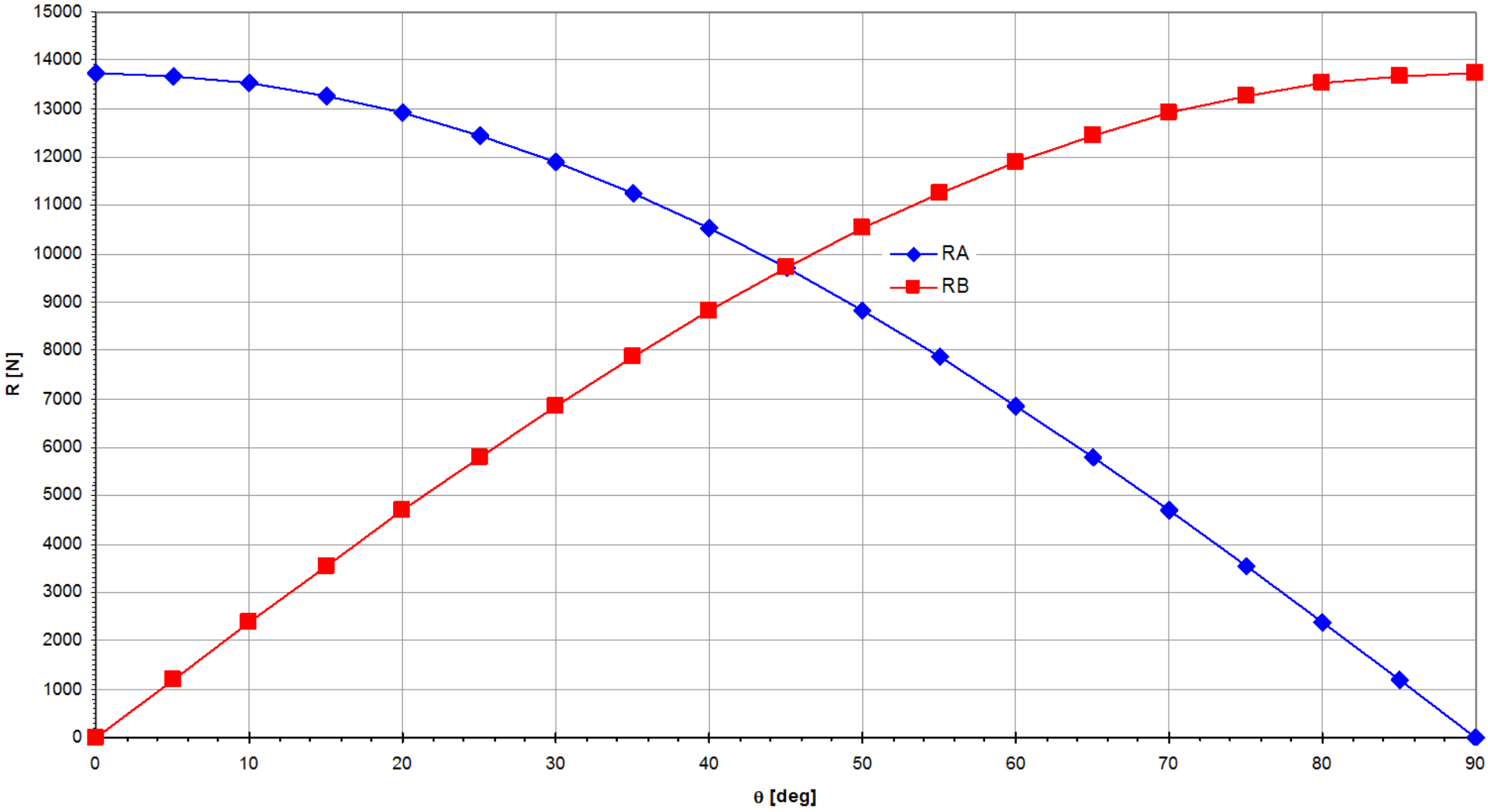




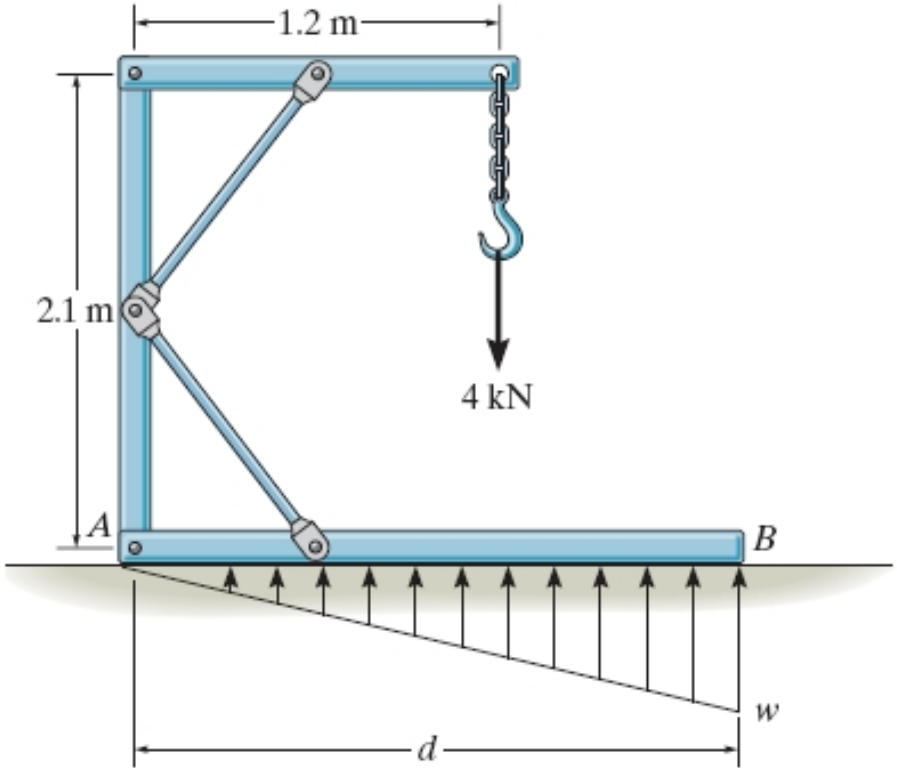
5-28. The 1.4 Mg drainpipe is held in the tines of the fork lift. Determine the normal forces at A and B as functions of the blade angle θ and plot the forces versus θ.



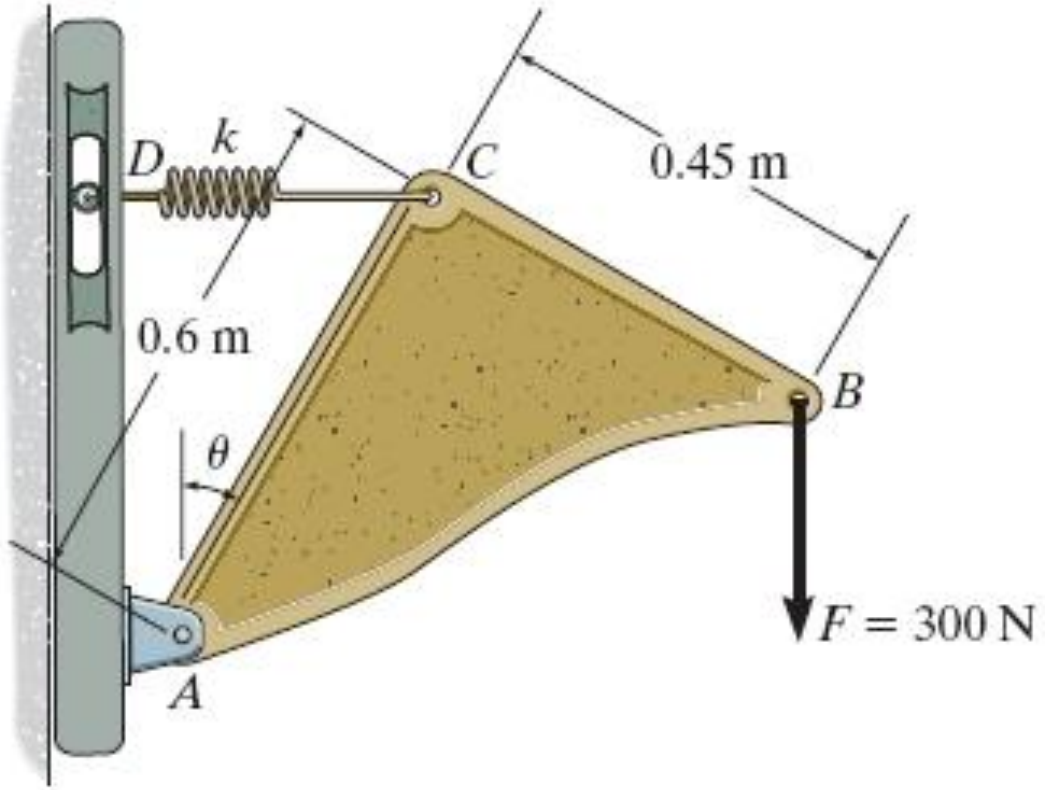
Theta	NA	NB			
0	13734	0			
5	13681.74	1196.997			
10	13525.35	2384.884			
15	13266.03	3554.621			
20	12905.74	4697.305			
25	12447.23	5804.239			
30	11893.99	6867			
35	11250.23	7877.499			
40	10520.85	8828.045			
45	9711.405	9711.405			
50	8828.045	10520.85			
55	7877.499	11250.23			
60	6867	11893.99			
65	5804.239	12447.23			
70	4697.305	12905.74			
75	3554.621	13266.03			
80	2384.884	13525.35			
85	1196.997	13681.74			
90	8.41E-13	13734			
	=1400*9.81*COS(A21*PI()/180)				
		=1400*9.81*SIN(A21*PI()/180)			


15000
14000
13000
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
R [N]
0
10
20
30
40
50
60
70
80
90
θ [deg]
RA
RB

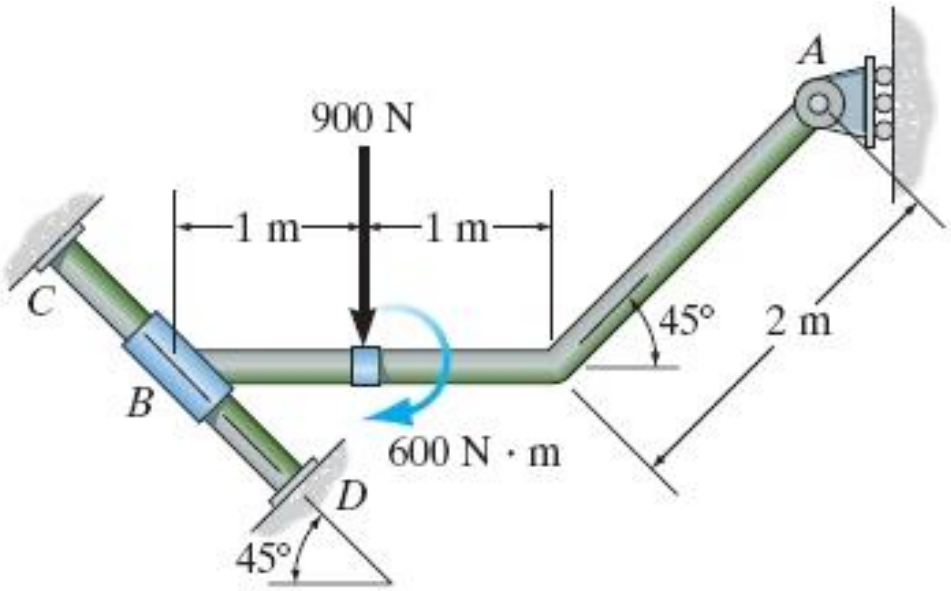
5-35. The framework is supported by the member AB which rests on the smooth floor. When loaded, the pressure distribution on AB is linear as shown. Determine the length, d, of the member AB and the intensity w for this case.



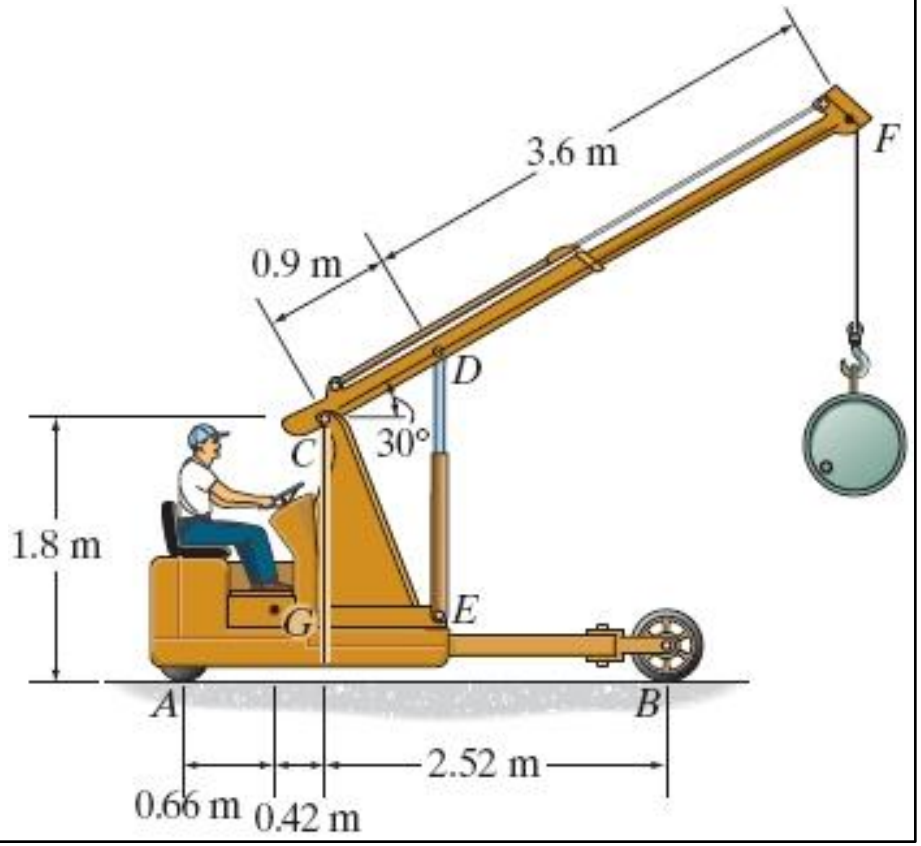
5-39. Spring CD remains in the horizontal position at all times due to roller at D. If the spring is unstretched when $\theta = 0°$ and the stiffness is k = 1.5 kN/m, determine the smallest angle, θ, for equilibrium and the horizontal and vertical components of reaction at pin A.



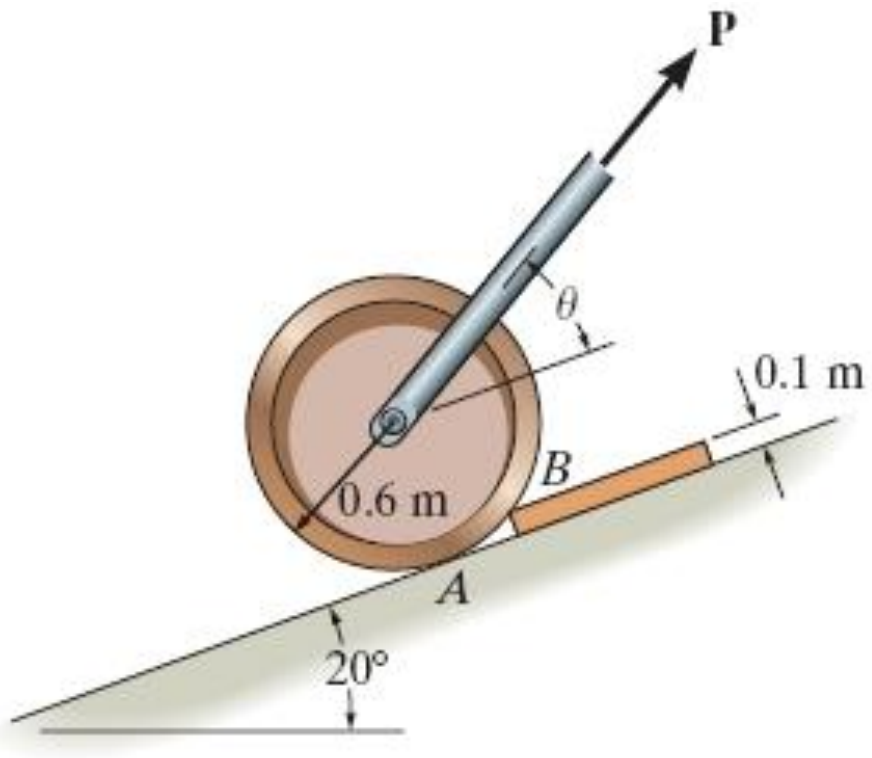
5-42. Determine the support reactions of roller A and the smooth collar B on the rod. The collar is fixed to the rod at AB but allowed to slide along rod CD.



5-46. The floor crane and the driver have a total weight of 12.5 kN with the center of gravity at G. Determine the largest weight of the drum that can be lifted without causing the crane to overturn when the boom is in the position shown.



5-49. Determine the magnitude and direction θ of the minimum force P needed to pull the 50 kg roller over the smooth step.



5-56. The horizontal beam is supported by springs at its ends. If the stiffness of the spring at A is k_A = 5kN/m, determine the required stiffness of the spring at B so that if the beam is loaded with 800 N, it remains in the horizontal position. The springs are originally constructed so that the beam is in horizontal position when it is unloaded.

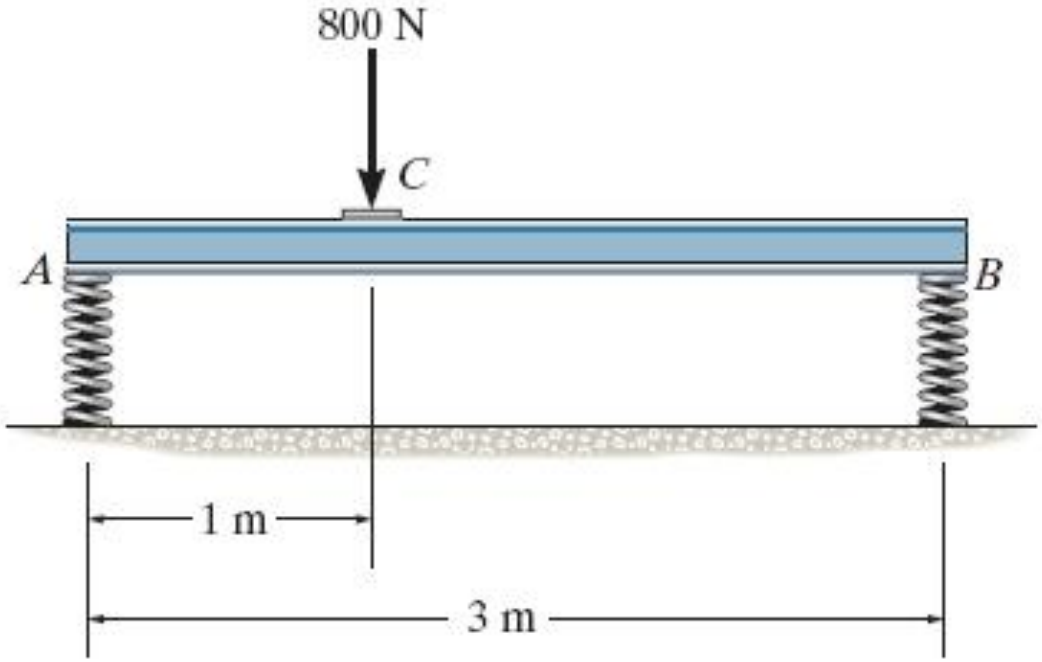


TABLE 5–2 Supports for Rigid Bodies Subjected to Three-Dimensional Force Systems

Types of Connection	Reaction	Number of Unknowns
(1)  cable		One unknown. The reaction is a force which acts away from the member in the known direction of the cable.
(2)  smooth surface support		One unknown. The reaction is a force which acts perpendicular to the surface at the point of contact.
(3)  roller		One unknown. The reaction is a force which acts perpendicular to the surface at the point of contact.

TABLE 5–2 Continued

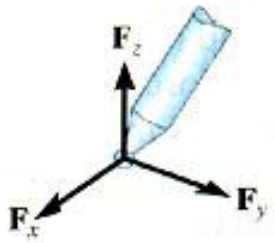
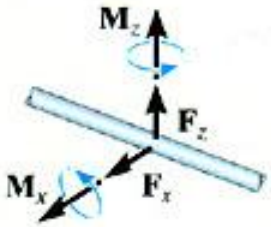
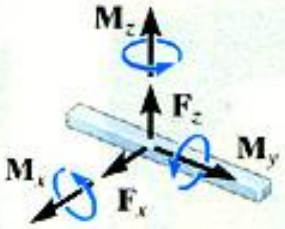
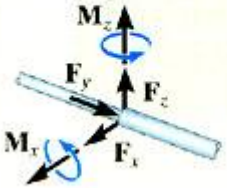
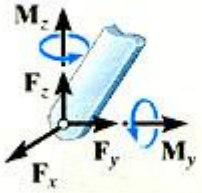
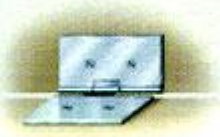
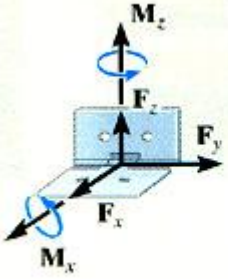
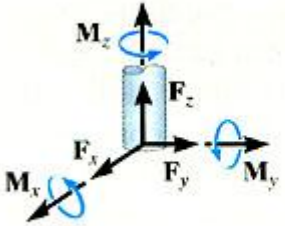
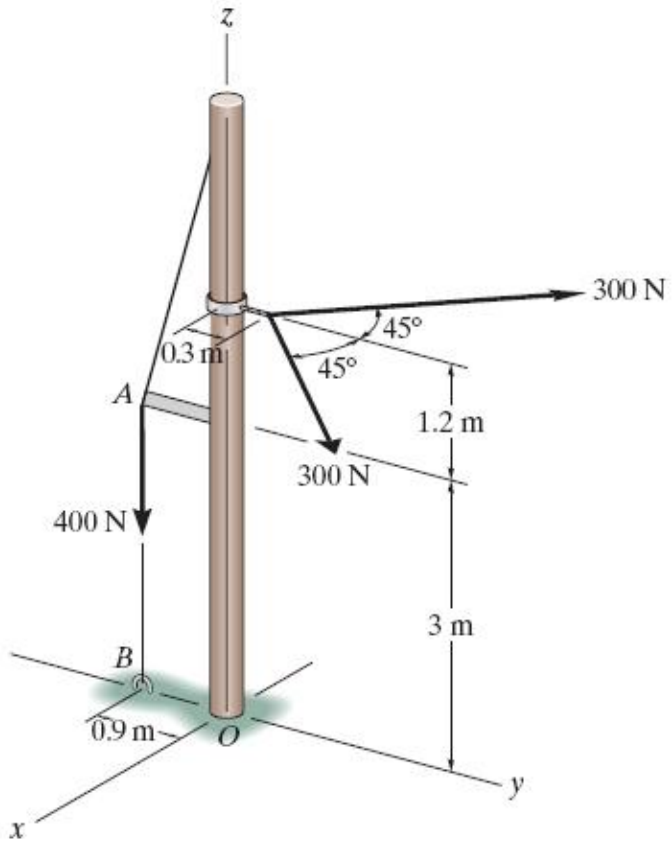
Types of Connection	Reaction	Number of Unknowns
(4)  ball and socket		Three unknowns. The reactions are three rectangular force components.
(5)  single journal bearing		Four unknowns. The reactions are two force and two couple-moment components which act perpendicular to the shaft. Note: The couple moments are generally not applied if the body is supported elsewhere. See the examples.
(6)  single journal bearing with square shaft		Five unknowns. The reactions are two force and three couple-moment components. *Note*: The couple moments are generally not applied if the body is supported elsewhere. See the examples.

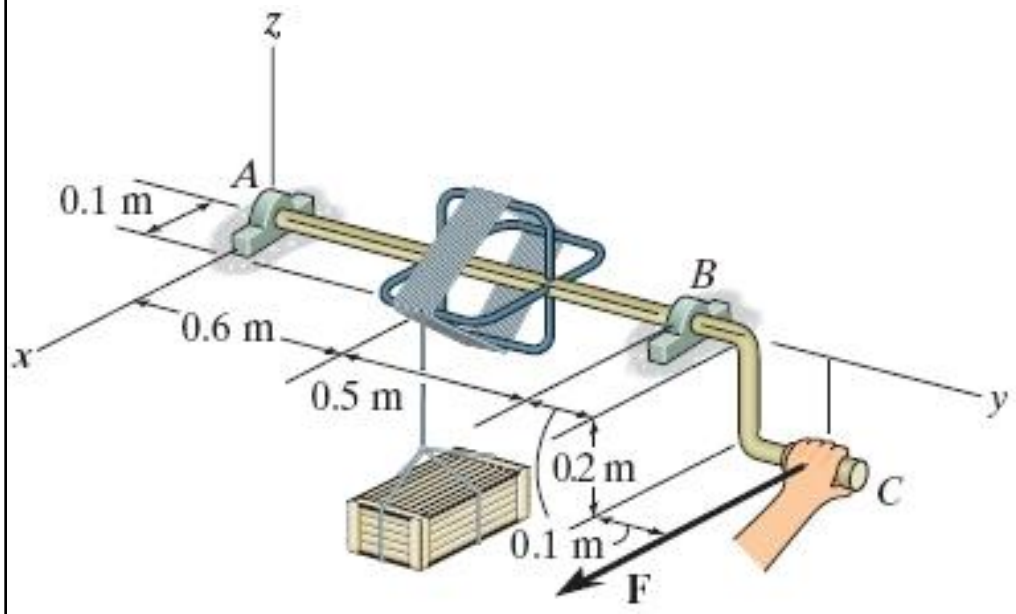
TABLE 5–2 Continued

(7)  single thrust bearing		Five unknowns. The reactions are three force and two couple-moment components. *Note*: The couple moments are generally not applied if the body is supported elsewhere. See the examples.
(8)  single smooth pin		Five unknowns. The reactions are three force and two couple-moment components. *Note*: The couple moments are generally not applied if the body is supported elsewhere. See the examples.
(9)  single hinge		Five unknowns. The reactions are three force and two couple-moment components. *Note*: The couple moments are generally not applied if the body is supported elsewhere. See the examples.
(10)  fixed support		Six unknowns. The reactions are three force and three couple-moment components.

5-64. The pole for a power line is subjected to two cable forces of 300 N, each force lying in a plane parallel to the x-y plane. If the tension in the guy wire AB is 400 N, determine the x, y, z components of reaction at the fixed base of the pole O.



5-68. Determine the magnitude of force F that must be exerted on the handle at C to hold the 75 kg crate in the position shown. Also, determine the components of reaction at the thrust bearing A and smooth journal bearing B.



5-84. Determine the largest weight of the oil drum that the floor crane can support without overturning. Also, what are the vertical reactions at the smooth wheels A, B, and C for this case. The floor crane has a weight of 1.5 kN, with its center of gravity located at G.