Errata Sheet

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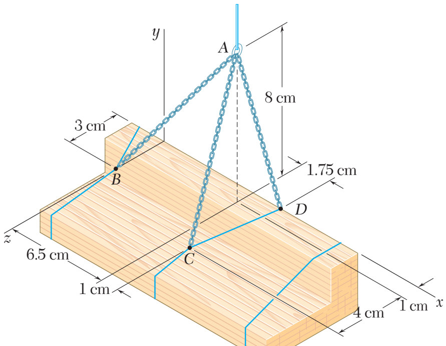

Fig. P2.109 and *P2.110*
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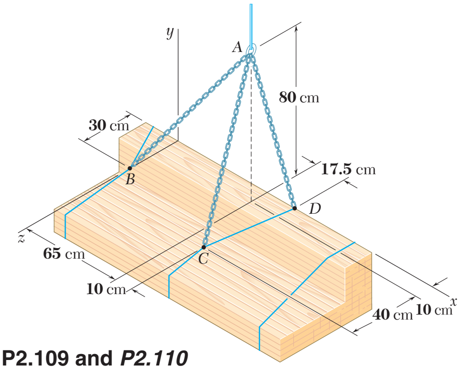

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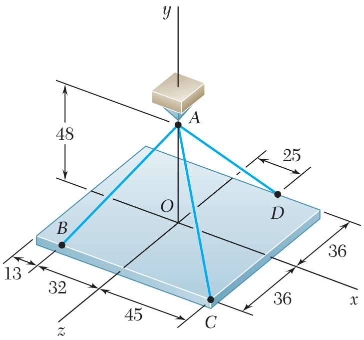

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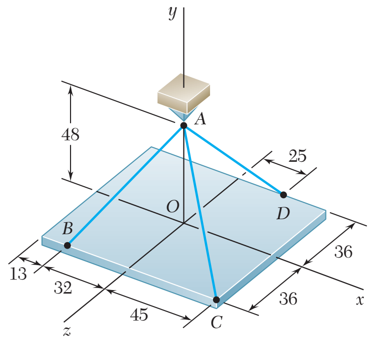

Fig. P2.139
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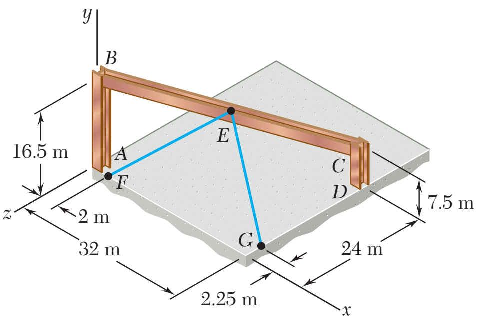

Fig. P3.39 and P3.40
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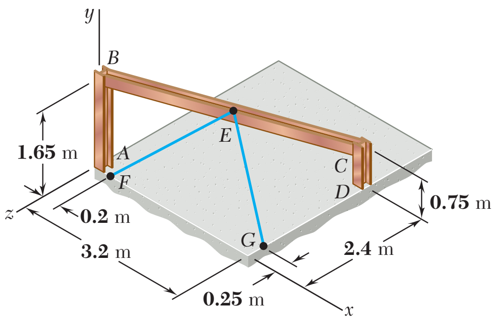

Fig. P3.39 and P3.40
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179	**4.39** Rod *ABCD* is bent in the shape of a circular arc of radius 4 in. and rests against frictionless surfaces at *A* and *D*. Knowing that the collar at *B* can move freely on the rod and that $\theta = 45°$, determine (*a*) the tension in cord *OB*, (*b*) the reactions at *A* and *D*.	**4.39** Rod *ABCD* is bent in the shape of a circular arc of radius 4 **cm** and rests against frictionless surfaces at *A* and *D*. Knowing that the collar at *B* can move freely on the rod and that $\theta = 45°$, determine (*a*) the tension in cord *OB*, (*b*) the reactions at *A* and *D*.
179	**4.40** Rod *ABCD* is bent in the shape of a circular arc of radius 4 in. and rests against frictionless surfaces at *A* and *D*. Knowing that the collar at *B* can move freely on the rod, determine (*a*) the value of θ for which the tension in cord *OB* is as small as possible, (*b*) the corresponding value of the tension, (*c*) the reactions at *A* and *D*.	**4.40** Rod *ABCD* is bent in the shape of a circular arc of radius 4 **cm** and rests against frictionless surfaces at *A* and *D*. Knowing that the collar at *B* can move freely on the rod, determine (*a*) the value of θ for which the tension in cord *OB* is as small as possible, (*b*) the corresponding value of the tension, (*c*) the reactions at *A* and *D*.
188	**4.73** To remove the lid from a 20×10^{-3} m^3 pail, the tool shown is used to apply an upward and radially outward force to the bottom inside rim of the lid. Assuming that the rim rests against the tool at *A* and that a 40-N force is applied as indicated to the handle, determine the force acting on the rim.	**4.73** To remove the lid from a 20×10^{-3} m^3 **can**, the tool shown is used to apply an upward and radially outward force to the bottom inside rim of the lid. Assuming that the rim rests against the tool at *A* and that a 40-N force is applied as indicated to the handle, determine the force acting on the rim.
326	**6.92** Two .25-m-diameter pipes (pipe *1* and pipe *2*) are supported every 3.05 m by a small frame like the one shown. Knowing that the combined weight per unit length of each pipe and its contents is 35 kg/m and assuming frictionless surfaces, determine the components of the reactions at *A* and *E* when $a = 0$.	**6.92** Two .25-m-diameter pipes (pipe *1* and pipe *2*) are supported every **3** m by a small frame like the one shown. Knowing that the combined weight per unit length of each pipe and its contents is 35 kg/m and assuming frictionless surfaces, determine the components of the reactions at *A* and *E* when $a = 0$.

Errata — Answers to Problems

The following are the corrected answers to the problems.

CHAPTER 3

3.70 (*a*) 4.26 N · m. ↻.
3.71 (*a*) 0.862 N · m. ↺.
3.76 M = 35 N · m
3.83 (*a*) $\mathbf{F}_C$ = 54.0 N ⦪ 30.0°; $\mathbf{M}_C$ = 53.2 N · m. ↺.
3.86 $\mathbf{R} = -(60.8\text{ N})\mathbf{i} - (89.7\text{ N})\mathbf{k}$; 3.59 m to the right of A.
3.87 (*a*) $\mathbf{F}_A$ = 22.0 N ⦣ 20.0°; $\mathbf{M}_A$ = 0.65 N · m. ↺.
(*b*) $\mathbf{F}_E$ = 22.0 N ⦣ 20.0°; 0.031 m. below A.
3.94 $\mathbf{R} = -(190.5\text{ N})\mathbf{j} - (110.0\text{ N})\mathbf{k}$;
$\mathbf{M} = (75.7\text{ N}\cdot\text{m})\mathbf{i} + (22.0\text{ N}\cdot\text{m})\mathbf{j} - (38.1\text{ N}\cdot\text{m})\mathbf{k}$.
3.111 350 N ⦬ 21.4°; 92.6 mm from B or 27.4 mm from F.
3.114 (*b*) 0.354 cm.
3.129 (*a*) $2P$; $\theta_x = 0°$, $\theta_y = -90.0°$, $\theta_z = 90.0°$.

CHAPTER 4

4.26 (*a*) $\mathbf{A}$ = 54.29 N ⦣ 58.5°; $\mathbf{E}$ = 7.266 N ⦬ 60.0°.
4.39 (*a*) 4.24 N.
(*b*) $\mathbf{N}_A$ = 5.80 N ⦪ 45.0°; $\mathbf{N}_D$ = 5.80 N ⦣ 45.0°.
4.40 (*a*) 0°. (*b*) 3.00 N.
4.78 (*b*) 4634.7 N ⦬ 73.4°.
4.97 $\mathbf{C} = (370.5\text{ N})\mathbf{j} - (342.5\text{ N})\mathbf{k}$; $\mathbf{D} = -(1170.5\text{ N})\mathbf{j} + (212.5\text{ N})\mathbf{k}$.
4.98 $\mathbf{C} = (55.2\text{ N})\mathbf{j} - (200\text{ N})\mathbf{k}$; $\mathbf{D} = -(1585.2\text{ N})\mathbf{j} + (400\text{ N})\mathbf{k}$.
4.106 (*a*) $\mathbf{A}_y$ = 1.3 N ↑; $\mathbf{B}_y$ = 1.3 N ↑; $\mathbf{C}_y$ = 0.25 N ↑.
4.107 $T_A = W/3$; $T_B = 2W(1 - 1/\sqrt{3})/3$; $T_C = 2W/3\sqrt{3}$.
4.118 T_{EG} = 961.6 N; $T_{CI} = T_{FH}$ = 1166.7 N;
$\mathbf{D} = (2573\text{ N})\mathbf{i} - (280\text{ N})\mathbf{j} - (30.8\text{ N})\mathbf{k}$.
4.162 T_{BG} = 796 N; T_{DH} = 600 N; T_{FJ} = 0;
$\mathbf{A} = (996.8\text{ N})\mathbf{i} + (120\text{ N})\mathbf{j} - (477.6\text{ N})\mathbf{k}$.

CHAPTER 5

5.17 Q_I = 174.125 cm^3; Q_{II} = −174.125 cm^3.
5.18 $Q_I = 42.3 \times 10^3$ mm^3; $Q_{II} = -42.3 \times 10^3$ mm^3.
5.25 (*a*) 1.57 N. (*b*) 0.58 N ⦪ 83.1°.
5.32 $\bar{x} = 2a/5$, $\bar{y} = 3b/7$.
5.47 (*a*) V = 3367.8 cm^3; A = 1520.53 cm^2. (*b*) V = 9072.9 cm^3; A = 3619.1 cm^2.
5.51 V = 2.10 cm^3; A = 16.83 cm^2.
5.58 647 liters
5.76 (*b*) 5.13 m to the right of A.
5.87 $\mathbf{A}$ = 3930 N ⦪ 45.4°; $\mathbf{D}$ = 124.1 N →.
5.101 $\overline{X}$ = 0.06 m, $\overline{Y}$ = 0.09 m, $\overline{Z}$ = 0.06 m.
5.103 $\overline{X}$ = 136.2 mm, $\overline{Y}$ = 197.8 mm.
5.119 $\bar{x} = 5a/128$, $\bar{y} = \bar{z} = 0$.

CHAPTER 6

6.12 $F_{AD} = F_{EG}$ = 17.50 kN C; $F_{AC} = F_{FG}$ = 15.08 kN T;
$F_{BC} = F_{EF}$ = 2.26 kN C; $F_{BD} = F_{DE}$ = 15.50 kN C;
$F_{CD} = F_{DF}$ = 9.00 kN T; F_{CF} = 7.00 kN T.
6.26 $F_{AB} = F_{BD}$ = 8.20 kN T; F_{AC} = 8.00 kN C;
F_{BC} = 0.600 kN C; F_{CD} = 1.342 kN T; F_{CE} = 9.20 kN C;
F_{DE} = 0.330 kN C; F_{DG} = 9.43 kN T; F_{EF} = 9.99 kN C;
F_{EG} = 0.858 kN T; $F_{FG} = F_{FH}$ = 7.99 kN C.
6.39 $F_{AB} = F_{AD} = F_{BC} = 0$; F_{AC} = 1.700 kN C;
F_{AE} = 2.13 kN T; F_{BD} = 1.275 kN T;
$F_{BE} = F_{CD}$ = 1.125 kN C; F_{DE} = 600 N C.
6.71 (*c*) Improperly constrained, statically indeterminate.
6.78 $\mathbf{C}$ = 1824 N ↓; $\mathbf{D}_x$ = 1824 N ←, $\mathbf{D}_y$ = 480 N ↓;
$\mathbf{E}_x$ = 1824 N →, $\mathbf{E}_y$ = 1824 N ↑.
6.79 $\mathbf{C}$ = 1600 N ↑; $\mathbf{D}_x$ = 1600 N →, $\mathbf{D}_y$ = 0;
$\mathbf{E}_x$ = 1600 N ←, $\mathbf{E}_y$ = 1600 N ↓.
6.82 $\mathbf{A}_x$ = 356 N →; $\mathbf{B}_x$ = 229 N ←, $\mathbf{B}_y$ = 127.3 N ↑;
$\mathbf{C}_x$ = 127.3 N ←, $\mathbf{C}_y$ = 178.2 N ↑; $\mathbf{D}$ = 305 N ↓.
6.86 (*b*) $\mathbf{A}_x$ = 51.2 N →, $\mathbf{A}_y$ = 12.80 N ↓;
$\mathbf{E}_x$ = 51.2 N →, $\mathbf{E}_y$ = 12.80 N ↑.
6.88 (*a*) $\mathbf{F}_{AB}$ = 260 N ⦥ 22.6°; $\mathbf{F}_{BC}$ = 480 N →;
$\mathbf{F}_{GH}$ = 240 N ←; $\mathbf{I}_y$ = 100 N ↑. (*b*) $\mathbf{F}_{AB}$ = 260 N ⦥ 22.6°; $\mathbf{F}_{BC}$ = 240 N →; $\mathbf{F}_{FG}$ = 0; $\mathbf{I}_y$ = 100 N ↑.
6.96 (*b*) $\mathbf{C}_x$ = 34.6 kN ←; $\mathbf{D}$ = 34.7 kN ⦬ 4.10°.
6.97 (*b*) $\mathbf{C}_x$ = 4.93 kN ←; $\mathbf{D}_x$ = 4.93 kN →, $\mathbf{D}_y$ = 12.97 kN ↓.
6.103 (*b*) 215 N T.
6.124 101.8 N ⦬ 18.89°.
6.127 (*a*) 3.87 N · m ↻. (*b*) 5.12 N · m ↻.
6.136 $\mathbf{CD}$ = 30.0 kN ←; $\mathbf{F}$ = 37.5 kN ⦬ 36.9°.
6.152 (*b*) $\mathbf{M}_G$ = (14.4 N · m.)$\mathbf{i}$;
$\mathbf{M}_H$ = −(10.3 N · m.)$\mathbf{i}$.
6.162 $\mathbf{A}_x$ = 4.50 kN ←, $\mathbf{A}_y$ = 5.00 kN ↓; $\mathbf{F}_{BE}$ = 2.25 kN →;
$\mathbf{C}_x$ = 2.25 kN →, $\mathbf{C}_y$ = 5.00 kN ↑.

CHAPTER 7

7.6 (On CK) $\mathbf{F}$ = 123.3 N ⦥ 22.9°; $\mathbf{V}$ = 24.1 ⦪ 67.1°;
$\mathbf{M}$ = 7.6 N · m. ↻.
7.11 (On CJ) $\mathbf{F}$ = 1.482 N ⦣ 60°; $\mathbf{V}$ = 103.1 N ⦬ 30°;
$\mathbf{M}$ = 10.3 N · m. ↻.
7.15 (On BJ) $\mathbf{F}$ = 250 N ⦬ 36.9°; $\mathbf{V}$ = 120.0 N ⦣ 53.1°;
$\mathbf{M}$ = 120.0 N · m ↺.
7.16 (On AK) $\mathbf{F}$ = 560 N ←; $\mathbf{V}$ = 90.0 N ↓; $\mathbf{M}$ = 72.0 N · m ↻.
7.18 (On AK) $\mathbf{F}$ = 463 N ⦣ 53.1°; $\mathbf{V}$ = 41.1 N ⦪ 36.9°;
$\mathbf{M}$ = 61.7 N · m ↺.
7.19 (On CJ) $\mathbf{F}$ = 733 N ⦬ 46.4°; $\mathbf{V}$ = 87 N ⦥ 44.6;
$\mathbf{M}$ = 19 N · m. ↺.
7.47 495 N; 194.4 N · m.
7.48 (*b*) 585 N; 290 N · m.
7.74 (*a*) 23.8 kN · m. (*b*) 41.64 kN · m.
7.76 (*b*) 52.0 kN · m.
7.78 (*b*) 6.84 kN · m at E.
7.79 (*b*) 2.77 kN · m at C.
7.87 (*a*) $\mathbf{P}$ = 1.113 N ↓; $\mathbf{Q}$ = 277 N ↓.
7.102 (*a*) 177.5 kN.
7.103 (*b*) T_1 = 410 N; T_2 = 400 N.
7.120 $y = (w_0L^2/T_0\pi^2)\,[1 - (\cos \pi x)/L]$; $T_{\min} = w_0L^2/h\pi^2$;
$T_B = (w_0L/\pi)\sqrt{(L^2/h^2\pi^2) + 1}$.

7.143 (*a*) $1.325T_{max}/w$.

7.154 (*a*) $V = w_0L\left[\frac{1}{3} - \frac{x}{L} + \frac{1}{2}\left(\frac{x}{L}\right)^2\right]$

$$M = w_0L^2\left[\frac{1}{3}\left(\frac{x}{L}\right) - \frac{1}{2}\left(\frac{x}{L}\right)^2 + \frac{1}{6}\left(\frac{x}{L}\right)^3\right]$$

(*c*) $0.0642\ w_0L^2$, at $x = 0.423L$.

7.157 (*a*) 7.2 m to the left of *B*. (*b*) 669 N.

CHAPTER 8

8.3 Equilibrium; $\mathbf{F} = 4.04$ N $\measuredangle$ 20°.
8.4 Block moves; $\mathbf{F} = 19.00$ N $\measuredangle$ 20°.
8.27 0.1900.
8.34 Equilibrium if $17.82 \text{ N} \le w \le 98.2$ N.
8.58 (*b*) Wedge binds in the slot.
8.63 (*a*) 61.3 N →.
8.69 224 N · m.
8.74 33.1 N · m.
8.111 (*b*) 10.95 N · m.

CHAPTER 9

9.41 $\bar{I}_x = 26.76 \times 10^6$ mm^4; $\bar{I}_y = 2650 \times 10^3$ mm^4.
9.48 (*a*) 511.8×10^6 mm^4. (*b*) 33.4×10^6 mm^4.
9.49 $\bar{I}_x = 18.2 \times 10^6$ mm^4, $\bar{I}_y = 11.2 \times 10^6$ mm^4; $\bar{k}_x = 54.5$ mm, $\bar{k}_y = 42.7$ mm.
9.55 $b = 91.2$ mm; $\bar{I}_x = 11.33 \times 10^6$ mm^4.
9.56 (*a*) 363 mm. (*b*) $\bar{I}_x = 46 \times 10^6$ mm^4, $\bar{I}_y = 105.8 \times 10^6$ mm^4.
9.62 2.55 m.
9.72 192.2×10^6 mm^4.
9.74 -0.1596×10^6 mm^4.
9.78 1.17×10^6 mm^4.
9.80 $\bar{I}_{x'} = 1236.7 \times 10^6$ mm^4; $\bar{I}_{y'} = 852.3 \times 10^6$ mm^4; $\bar{I}_{x'y'} = 729.5 \times 10^6$ mm^4.
9.84 $\bar{I}_{x'} = 2.2 \times 10^6$ mm^4; $\bar{I}_{y'} = 2.8 \times 10^6$ mm^4; $\bar{I}_{x'y'} = 1.83 \times 10^6$ mm^4.
9.86 $\theta_m = 7.4°$ and 97.4°; $\bar{I}_{max} = 1795 \times 10^6$ mm^4, $\bar{I}_{min} = 315 \times 10^6$ mm^4.
9.89 $-24.0°$ and 66°, 0.524×10^6 mm^4, 0.0949×10^6 mm^4.
9.90 $\theta_m = -19.6°$ and 70.4°; $\bar{I}_{max} = 4.35 \times 10^6$ mm^4, $\bar{I}_{min} = 0.64 \times 10^6$ mm^4.
9.92 $\bar{I}_{x'} = 1236.7 \times 10^6$ mm^4; $\bar{I}_{y'} = 852.3 \times 10^6$ mm^4; $\bar{I}_{x'y'} = 729.5 \times 10^6$ mm^4.
9.96 $\bar{I}_{x'} = 22 \times 10^6$ mm^4; $\bar{I}_{y'} = 2.8 \times 10^6$ mm^4; $\bar{I}_{x'y'} = 1.83 \times 10^6$ mm^4.
9.98 $\theta_m = 7.4°$ counterclockwise; $\bar{I}_{max} = 1798.9 \times 10^6$ mm^4, $\bar{I}_{min} = 290.1 \times 10^6$ mm^4.
9.104 $\theta_m = -31.3°$; $\bar{I}_{max} = 2221.3 \times 10^6$ mm^4, $\bar{I}_{min} = 702.5 \times 10^6$ mm^4.
9.106 $\theta_m = 19.6°$ counterclockwise; $\bar{I}_{max} = 4.84 \times 10^6$ mm^4, $\bar{I}_{min} = 0.152 \times 10^6$ mm^4.
9.108 $\theta_m = 7.5°$ clockwise; $\bar{I}_{max} = 269 \times 10^6$ mm^4, $\bar{I}_{min} = 113.9 \times 10^6$ mm^4.
9.129 2.74×10^{-3} kg · m^2; 0.044 m.
9.134 (*a*) 0.0309 m. (*b*) 0.117 m.
9.137 $I_x = 4.95 \times 10^{-5}$ kg · m^2; $I_y = 3.34 \times 10^{-4}$ kg · m^2; $I_z = 3.17 \times 10^{-4}$ kg · m^2;
9.141 $I_x = 0.1325$ kg · m^2; $I_y = 0.3186$ kg · m^2; $I_z = 0.2706$ kg · m^2
9.143 $I_x = 0.0436$ kg · m^2; $I_y = 0.064$ kg · m^2; $I_z = 0.0446$ kg · m^2
9.146 4.807×10^{-3} kg · m^2.
9.151 $I_{xy} = 7.52 \times 10^{-4}$ kg · m^2; $I_{yz} = 1.786 \times 10^{-3}$ kg · m^2; $I_{zx} = 4.047 \times 10^{-3}$ kg · m^2.
9.152 $I_{xy} = 1.06 \times 10^{-3}$ kg · m^2; $I_{yz} = 1.19 \times 10^{-3}$ kg · m^2; $I_{zx} = 1.75 \times 10^{-3}$ kg · m^2.
9.161 $I_{xy} = 0.168 \times 10^{-3}$ kg · m^2; $I_{yz} = 0.36 \times 10^{-3}$ kg · m^2; $I_{zx} = 0.225 \times 10^{-3}$ kg · m^2.
9.167 54.7×10^{-3} kg · m^2
9.182 (*b*) $(\theta_x)_1 = (\theta_y)_1 = 90.0°$, $(\theta_z)_1 = 0°$;
9.183 (*a*) $K_1 = 3.42 \times 10^{-3}$ kg · m^2; $K_2 = 31 \times 10^{-3}$ kg · m^2; $K_3 = 33.9 \times 10^{-3}$ kg · m^2.
9.186 (*a*) $K_1 = 29 \times 10^{-3}$ kg · m^2; $K_2 = 53.9 \times 10^{-3}$ kg · m^2; $K_3 = 66.36 \times 10^{-3}$ kg · m^2.
9.192 $\bar{I}_x = 218.2 \times 10^6$ mm^4, $\bar{I}_y = 0.79 \times 10^{-4}$ m^4; $\bar{k}_x = 133.7$ mm, $\bar{k}_y = 0.08$ m.
9.193 $\bar{I}_x = 35.315 \times 10^6$ mm^4; $\bar{I}_y = 23.0 \times 10^3$ mm^4.
9.195 -4.57×10^6 mm^4.
9.196 $\theta_m = -20.1°$; $\bar{I}_{max} = 16.4 \times 10^6$ mm^4, $\bar{I}_{min} = 2.2 \times 10^6$ mm^4.

CHAPTER 10

10.5 132.6 N →.
10.19 (*a*) 38.8 N · m ↺. (*b*) 24.7 N · m ↺.
10.20 (*a*) 1206.7 N →. (*b*) 1568 N →.
10.25 40.6°.
10.41 99.1 N $\measuredangle$ 44.4°.
10.55 0.0363 m (shorter).
10.56 0.0127 m (longer).
10.75 $W = 10.53$ N, stable.
10.76 $\theta = 31.6°$, stable.
10.77 0.21 m.
10.79 (*b*) 6.3°, stable; 90.0°, unstable; 173.8°, stable.
10.86 0.165 m.
10.89 $k > 282.2$ N/m.
10.90 0.15 m.
10.91 $O \le P < ka$.
10.92 $O \le P < 2kL/9$.
10.97 $O \le P < 0.382kl$.
10.99 $O \le P < 0.219ka$.
10.105 $Pl/2 \tan\theta$.
10.107 25.9 N · m ↻.

2.109 A 320 N load of lumber is lifted using a triple leg sling. Knowing that at the instant shown the lumber is at rest, determine the tension in each leg of the sling.

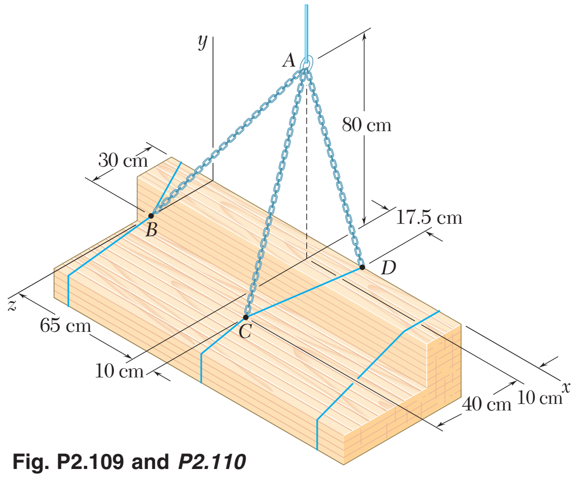


Fig. P2.109 and *P2.110*

2.110 A load of lumber is lifted using a triple leg sling. Knowing that at the instant shown the lumber is at rest and that the tension in leg AD is 220 N, determine the weight of the lumber.

2.111 A force **P** is applied as shown to a uniform cone which is supported by three cords, where the lines of action of the cords pass through the vertex A of the cone. Knowing that $P = 0$ and that the tension in cord BE is 0.2 N, determine the weight W of the cone.

2.112 A force **P** is applied as shown to a uniform cone which is supported by three cords, where the lines of action of the cords pass through the vertex A of the cone. Knowing that the cone weighs 1.6 N, determine the range of values of P for which cord CF is taut.

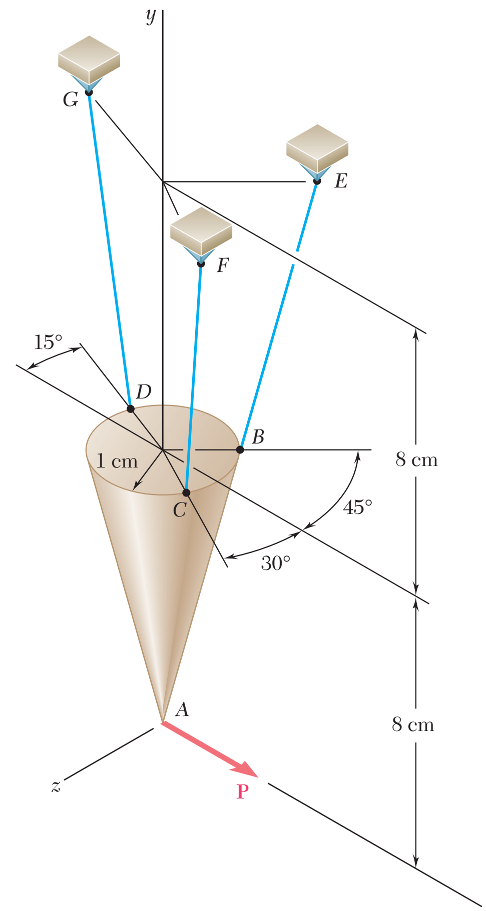


Fig. *P2.111* and P2.112

2.113 A 16-kg triangular plate is supported by three wires as shown. Knowing that $a = 150$ mm, determine the tension in each wire.

2.114 A 16-kg triangular plate is supported by three wires as shown. Knowing that $a = 200$ mm, determine the tension in each wire.

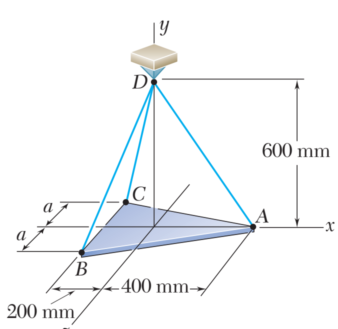


Fig. P2.113 and P2.114

2.115 A transmission tower is held by three guy wires attached to a pin at A and anchored by bolts at B, C, and D. Knowing that the tower exerts on the pin at A an upward vertical force of 8 kN, determine the tension in each wire.

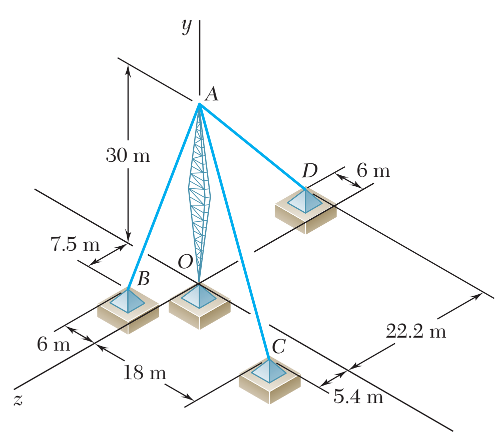


Fig. P2.115

2.135 A horizontal circular plate is suspended as shown from three wires that are attached to a support at D and that form 30° angles with the vertical. Knowing that the x component of the force exerted by wire AD on the plate is 220.6 N, determine (*a*) the tension in wire AD, (*b*) the angles θ_x, θ_y, and θ_z that the force exerted at A forms with the coordinate axes.

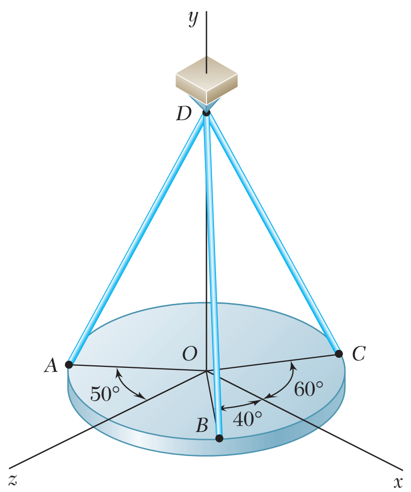


Fig. P2.135

2.136 A force **F** of magnitude 600 N acts at the origin of a coordinate system. Knowing that $F_x = 200$ N, $\theta_z = 136.8°$, and $F_y < 0$, determine (*a*) the components F_y and F_z, (*b*) the angles θ_x and θ_y.

2.137 Find the magnitude and direction of the resultant of the two forces shown knowing that $P = 500$ N and $Q = 600$ N.

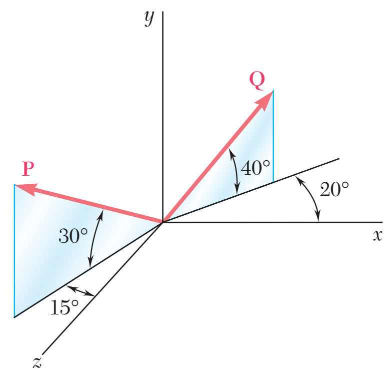


Fig. P2.137

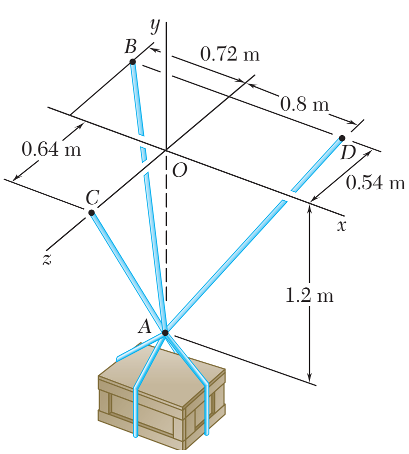
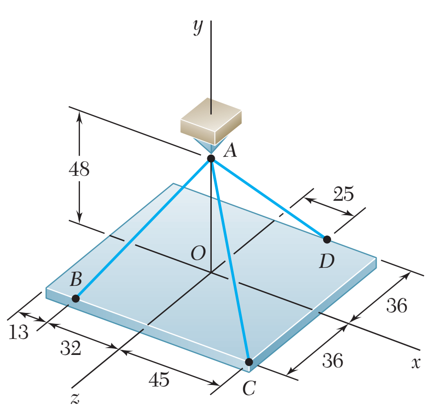


Fig. *P2.138*

2.138 The crate shown is supported by three cables. Determine the weight of the crate knowing that the tension in cable AB is 3 kN.

2.139 A rectangular plate is supported by three cables as shown. Knowing that the tension in cable AD is 120 N, determine the weight of the plate.



Dimensions in cm

Fig. P2.139

2.140 A container of weight W is suspended from ring A. Cable BAC passes through the ring and is attached to fixed supports at B and C. Two forces $\mathbf{P} = P\mathbf{i}$ and $\mathbf{Q} = Q\mathbf{k}$ are applied to the ring to maintain the container in the position shown. Knowing that $W = 1200$ N, determine P and Q. (*Hint:* The tension is the same in both portions of cable BAC.)

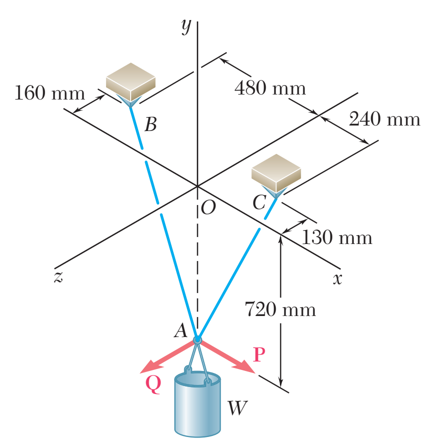


Fig. *P2.140*

Problems

3.35 Given the vectors $\mathbf{P} = -4\mathbf{i} + 8\mathbf{j} - 3\mathbf{k}$, $\mathbf{Q} = 9\mathbf{i} - \mathbf{j} - 7\mathbf{k}$, and $\mathbf{S} = 5\mathbf{i} - 6\mathbf{j} + 2\mathbf{k}$, compute the scalar products $\mathbf{P} \cdot \mathbf{Q}$, $\mathbf{P} \cdot \mathbf{S}$, and $\mathbf{Q} \cdot \mathbf{S}$.

3.36 Form the scalar products $\mathbf{B} \cdot \mathbf{C}$ and $\mathbf{B}' \cdot \mathbf{C}$, where $B = B'$, and use the results obtained to prove the identity

$$\cos\alpha \cos\beta = \tfrac{1}{2}\cos(\alpha + \beta) + \tfrac{1}{2}\cos(\alpha - \beta).$$

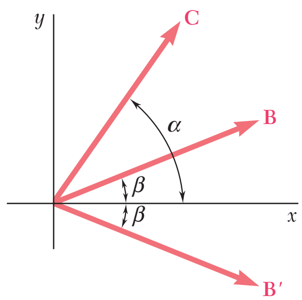


Fig. P3.36

3.37 Three cables are used to support a container as shown. Determine the angle formed by cables *AB* and *AD*.

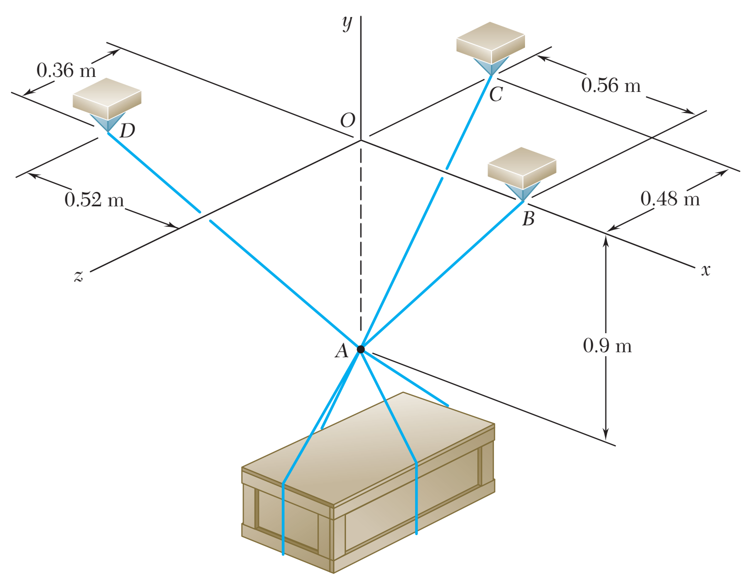


Fig. P3.37 and *P3.38*

3.38 Three cables are used to support a container as shown. Determine the angle formed by cables *AC* and *AD*.

3.39 Steel framing members *AB*, *BC*, and *CD* are joined at *B* and *C* and are braced using cables *EF* and *EG*. Knowing that *E* is at the midpoint of *BC* and that the tension in cable *EF* is 110 N, determine (*a*) the angle between *EF* and member *BC*, (*b*) the projection on *BC* of the force exerted by cable *EF* at point *E*.

3.40 Steel framing members *AB*, *BC*, and *CD* are joined at *B* and *C* and are braced using cables *EF* and *EG*. Knowing that *E* is at the midpoint of *BC* and that the tension in cable *EG* is 178 N, determine (*a*) the angle between *EG* and member *BC*, (*b*) the projection on *BC* of the force exerted by cable *EG* at point *E*.

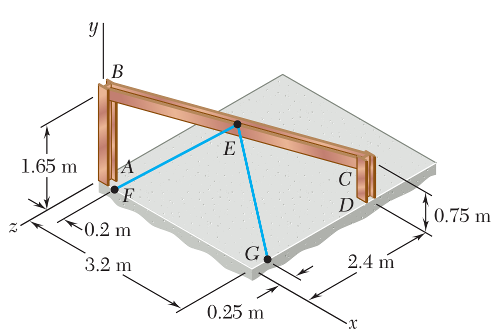


Fig. P3.39 and P3.40

4.39 Rod *ABCD* is bent in the shape of a circular arc of radius 4 cm and rests against frictionless surfaces at *A* and *D*. Knowing that the collar at *B* can move freely on the rod and that $\theta = 45°$, determine (*a*) the tension in cord *OB*, (*b*) the reactions at *A* and *D*.

4.40 Rod *ABCD* is bent in the shape of a circular arc of radius 4 cm and rests against frictionless surfaces at *A* and *D*. Knowing that the collar at *B* can move freely on the rod, determine (*a*) the value of θ for which the tension in cord *OB* is as small as possible, (*b*) the corresponding value of the tension, (*c*) the reactions at *A* and *D*.

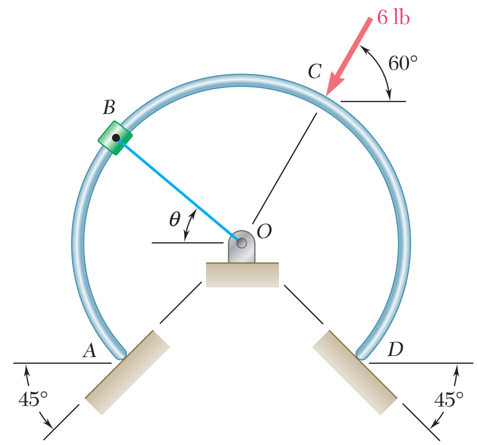


Fig. P4.39 and P4.40

4.41 A movable bracket is held at rest by a cable attached at *E* and by frictionless rollers. Knowing that the width of post *FG* is slightly less than the distance between the rollers, determine the force exerted on the post by each roller when $\alpha = 20°$.

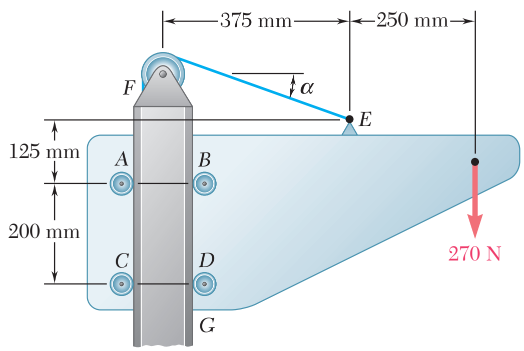


Fig. P4.41

4.42 Solve Prob. 4.41 when $\alpha = 30°$.

4.43 A parabolic slot has been cut in plate *AD*, and the plate has been placed so that the slot fits two fixed, frictionless pins *B* and *C*. The equation of the slot is $y = x^2/4$, where x and y are expressed in cm. Knowing that the input force $P = 2$ N, determine (*a*) the force each pin exerts on the plate, (*b*) the output force **Q**.

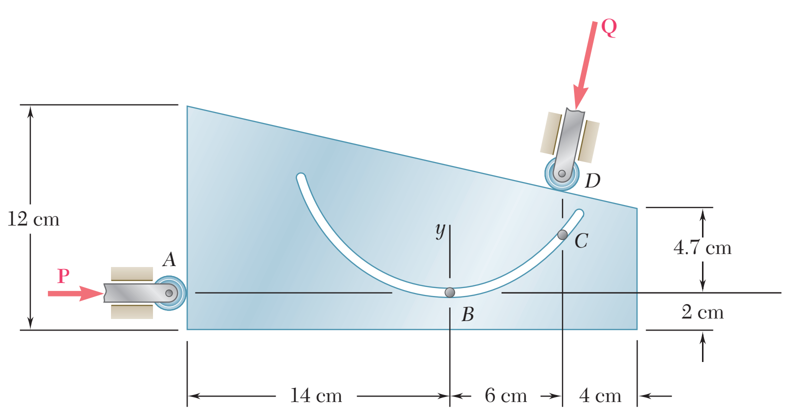


Fig. *P4.43* and *P4.44*

4.44 A parabolic slot has been cut in plate *AD*, and the plate has been placed so that the slot fits two fixed, frictionless pins *B* and *C*. The equation of the slot is $y = x^2/4$, where x and y are expressed in inches. Knowing that the maximum allowable force exerted on the roller at *D* is 4 N, determine (*a*) the corresponding magnitude of the input force **P**, (*b*) the force each pin exerts on the plate.

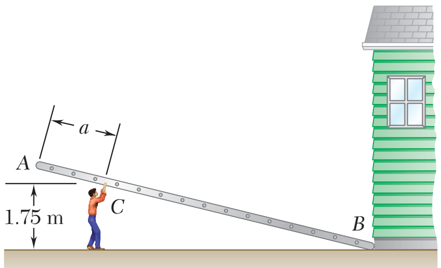


Fig. P4.71 and *4.72*

4.71 A worker is raising a 9.2-m-long ladder of mass 53 kg as shown. Knowing that $a = 1.8$ m and that the force exerted by the worker is perpendicular to the ladder, determine (*a*) the force exerted by the worker, (*b*) the reaction at *B*.

4.72 A worker is raising a 9.2-m-long ladder of mass 53 kg as shown. Knowing that the force exerted by the worker is perpendicular to the ladder, determine (*a*) the smallest value of *a* for which the vertical component of the reaction at *B* is zero, (*b*) the corresponding force exerted by the worker.

4.73 To remove the lid from a 20×10^{-3} m^3 can, the tool shown is used to apply an upward and radially outward force to the bottom inside rim of the lid. Assuming that the rim rests against the tool at *A* and that a 40-N force is applied as indicated to the handle, determine the force acting on the rim.

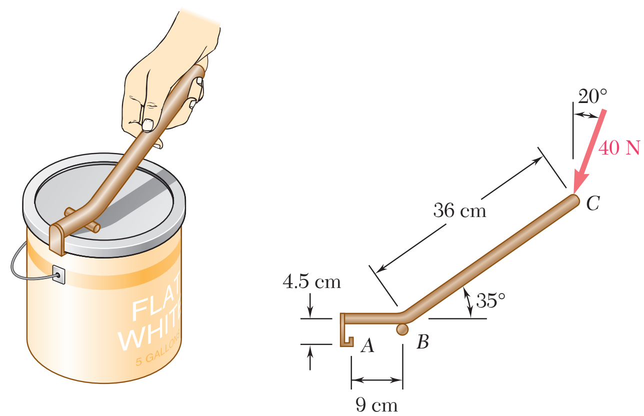


Fig. P4.73

4.74 To remove the lid from a 20×10^{-3} m^3 pail, the tool shown is used to apply an upward and radially outward force to the bottom inside rim of the lid. Assuming that the top and the rim of the lid rest against the tool at *A* and *B*, respectively, and that a 28-N force is applied as indicated to the handle, determine the force acting on the rim.

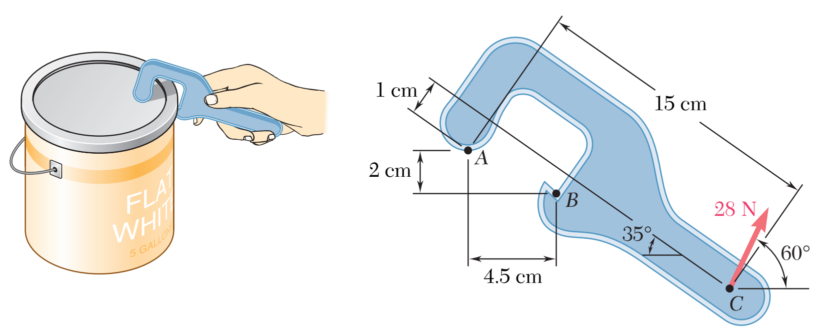


Fig. P4.74

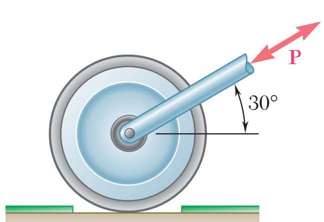


Fig. *P4.75* and P4.76

4.75 A 20-kg roller of diameter 200 mm, which is to be used on a tile floor, is resting directly on the subflooring as shown. Knowing that the thickness of each tile is 8 mm, determine the force **P** required to move the roller onto the tiles if the roller is pushed to the left.

4.76 A 20-kg roller of diameter 200 mm, which is to be used on a tile floor, is resting directly on the subflooring as shown. Knowing that the thickness of each tile is 8 mm, determine the force **P** required to move the roller onto the tiles if the roller is pulled to the right.

4.129 The lever AB is welded to the bent rod BCD which is supported by bearing E and by cable DG. Assuming that the bearing can exert an axial thrust and couples about axes parallel to the x and z axes, determine (*a*) the tension in cable DG, (*b*) the reaction at E.

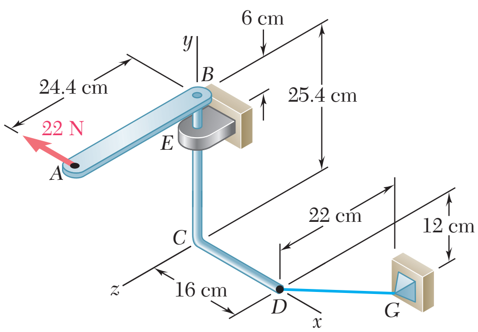


Fig. *P4.129*

4.130 The bearing of lever ABD is free to slide along and to rotate about the horizontal pin at B. Knowing that the 24-N force lies in a plane parallel to the xy plane and that the bearing can exert couples about the y and z axes, determine (*a*) the forces in the stretched springs CF and DE, (*b*) the reaction at B.

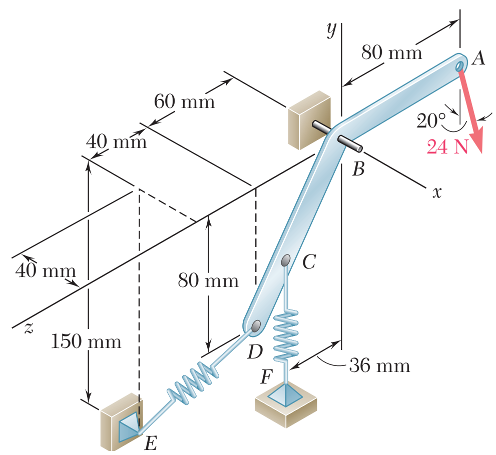


Fig. P4.130

4.131 Solve Prob. 4.124 assuming that the hinge at A is removed and that the hinge at B can exert couples about the y and z axes.

4.132 The rigid L-shaped member ABC is supported by a ball-and-socket joint at A and by three cables. Determine the tension in each cable and the reaction at A caused by the 1-kN load applied at G.

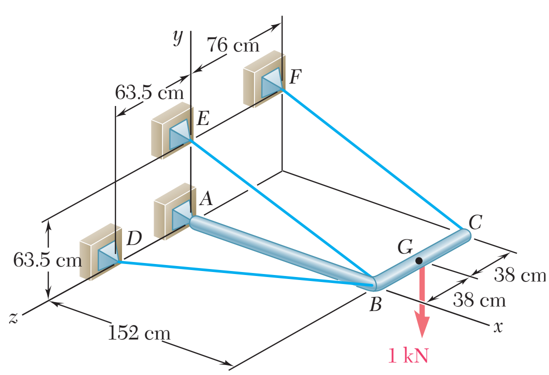


Fig. P4.132

4.133 Solve Prob. 4.132 assuming that an additional downward load of 1600 N is applied at C.

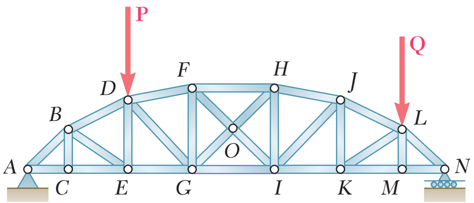


Fig. P6.33

6.33 and *6.34* For the given loading, determine the zero-force members in the truss shown.

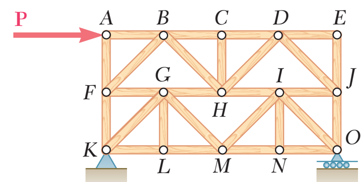


Fig. *P6.34*

6.35 Determine the zero-force members in the truss of (*a*) Prob. 6.9, (*b*) Prob. 6.29.

***6.36** The truss shown consists of six members and is supported by two short links at each of the joints *A*, *B*, and *C*. Determine the force in each of the members for $\mathbf{P} = -(940\text{ N})\mathbf{j}$ and $\mathbf{Q} = 0$.

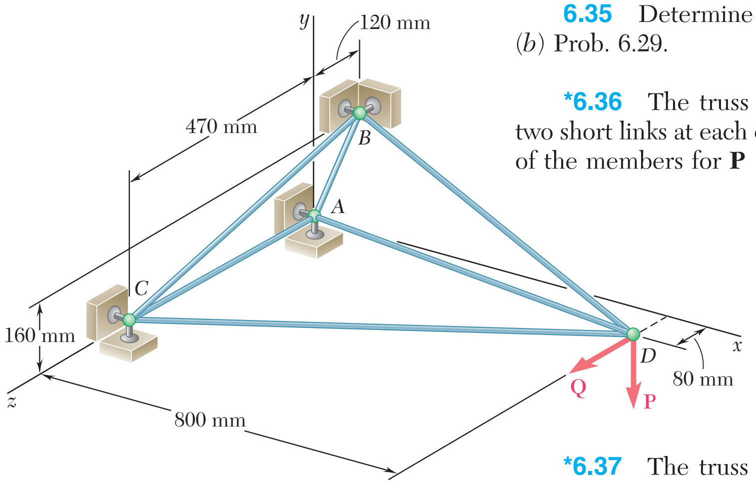


Fig. P6.36 and P6.37

***6.37** The truss shown consists of six members and is supported by two short links at each of the joints *A*, *B*, and *C*. Determine the force in each of the members for $\mathbf{P} = -(940\text{ N})\mathbf{j}$ and $\mathbf{Q} = (987\text{ N})\mathbf{k}$.

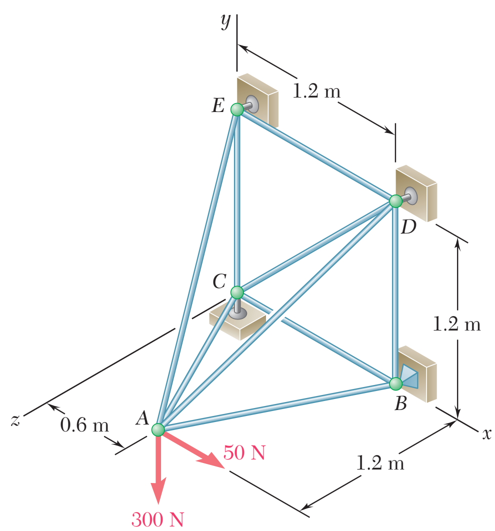


Fig. P6.38

***6.38** The portion of a power transmission line tower shown consists of nine members and is supported by a ball-and-socket joint at *B* and short links at *C*, *D*, and *E*. Determine the force in each of the members for the given loading.

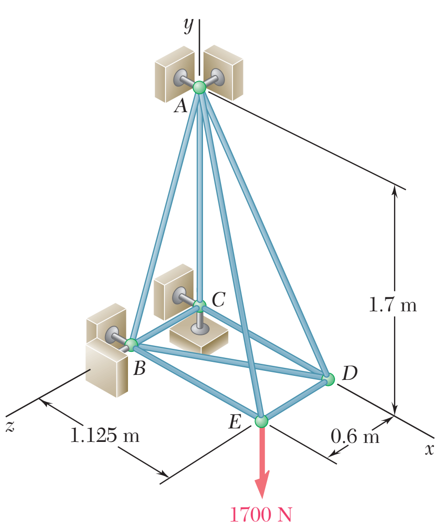


Fig. P6.39

***6.39** The truss shown consists of nine members and is supported by two short links at each of the joints *A*, *B*, and *C*. Determine the force in each of the members for the given loading.

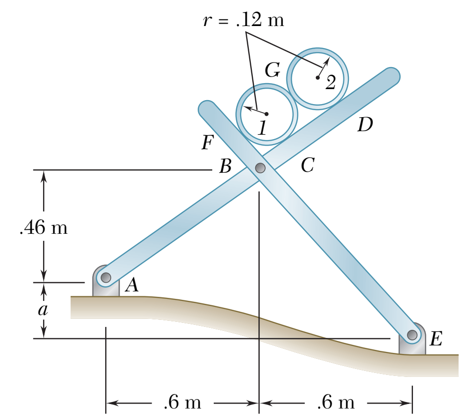


Fig. P6.92

6.92 Two .25-m-diameter pipes (pipe *1* and pipe *2*) are supported every 3 m by a small frame like the one shown. Knowing that the combined weight per unit length of each pipe and its contents is 35 kg/m and assuming frictionless surfaces, determine the components of the reactions at *A* and *E* when $a = 0$.

6.93 Solve Prob. 6.92 when $a = 0.36$ m

6.94 Knowing that the pulley has a radius of 60 mm, determine the components of the reactions at *A* and *E*.

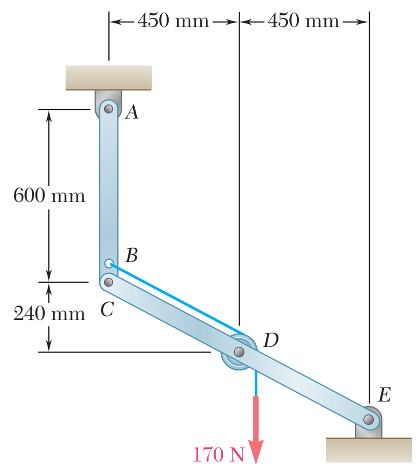


Fig. P6.94

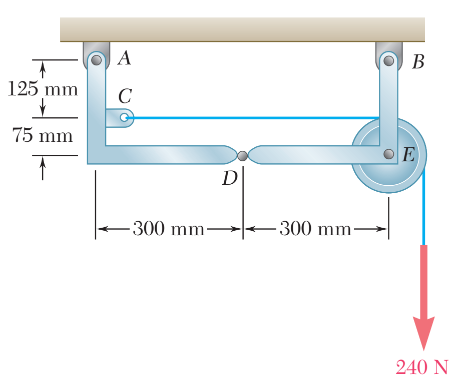


Fig. P6.95

6.95 Knowing that the pulley has a radius of 75 mm, determine the components of the reactions at *A* and *B*.

6.96 The cab and motor units of the front-end loader shown are connected by a vertical pin located 1.5 m behind the cab wheels. The distance from *C* to *D* is .75 m. The center of gravity of the 50-kN motor unit is located at G_m, while the centers of gravity of the 18-kN cab and 16-kN load are located, respectively, at G_c and G_l. Knowing that the machine is at rest with its brakes released, determine (*a*) the reactions at each of the four wheels, (*b*) the forces exerted on the motor unit at *C* and *D*.

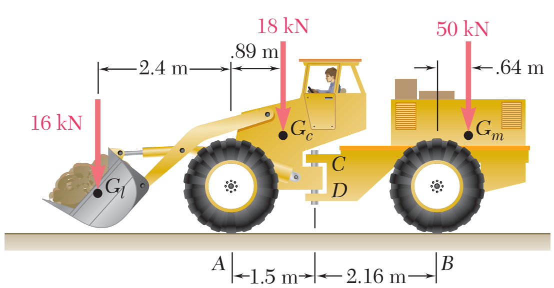


Fig. P6.96

6.97 Solve Prob. 6.96 assuming that the 16-kN load has been removed.

6.108 Two parallel members *ABC* and *DEF* are placed between two walls and are connected by link *BE*. Neglecting friction between the members and the walls, determine the range of values of the distance *a* for which the load **P** can be supported.

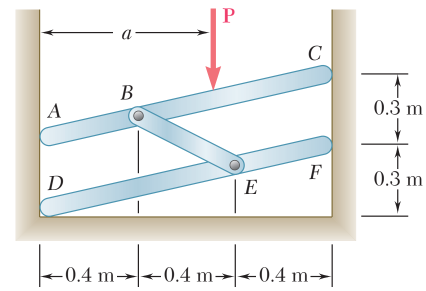


Fig. P6.108

6.109 through 6.111 The frame shown consists of members *ABCD* and *EFGH* and two links that connect the two members. Determine the force in each link for the given loading.

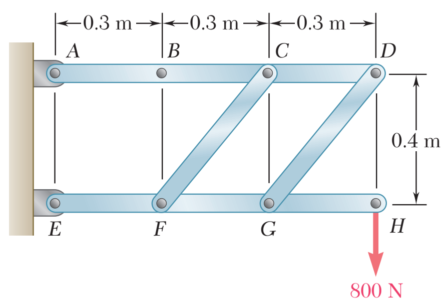


Fig. P6.109

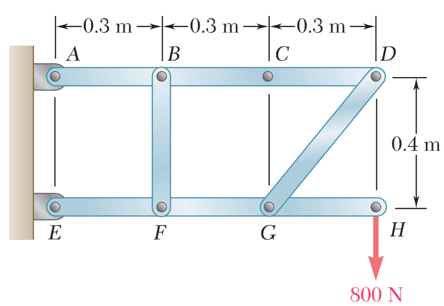


Fig. P6.110

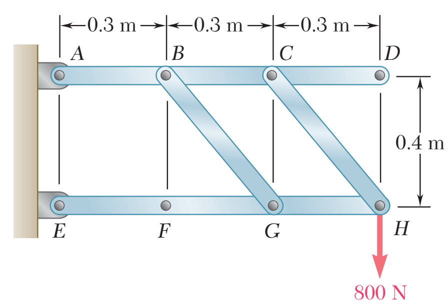


Fig. P6.111

6.112 Members *ABC* and *CDE* are pin-connected at *C* and are supported by the four links *AF*, *BG*, *GD*, and *EH*. For the loading shown, determine the force in each link.

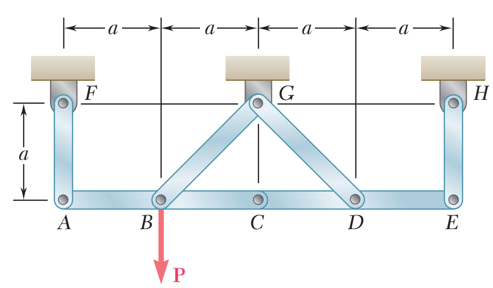


Fig. *P6.112*

6.113 Three wooden beams, each of length 3*a*, are nailed together to form the support system shown. Assuming that only vertical forces are exerted at the connections, determine the vertical reactions at *A*, *D*, and *F*.

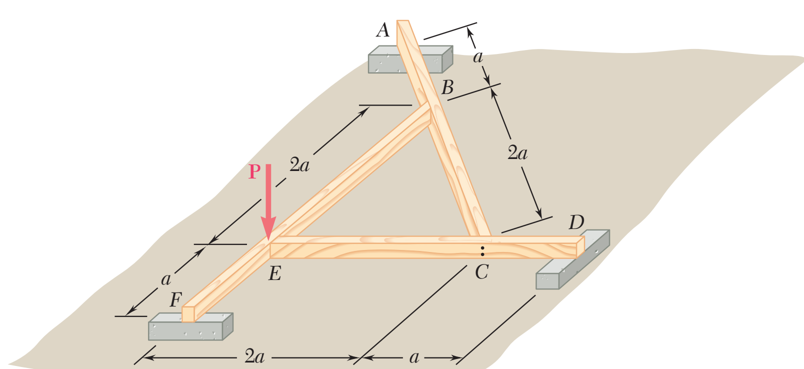


Fig. P6.113

9.161 The figure shown is formed from .0019-m-diameter aluminum wire. Knowing that the specific weight of aluminum is 3000 kg/m^3, determine the mass products of inertia I_{xy}, I_{yz}, and I_{zx} of the wire figure.

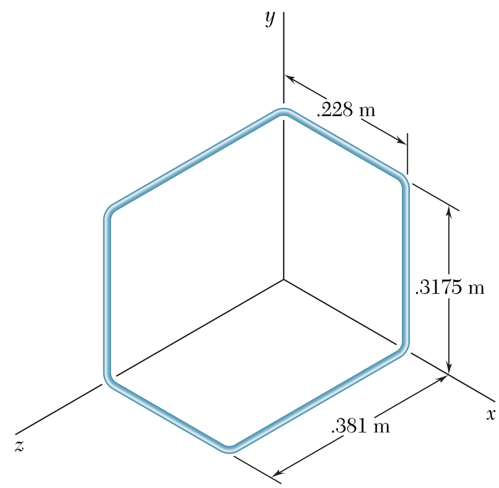


Fig. P9.161

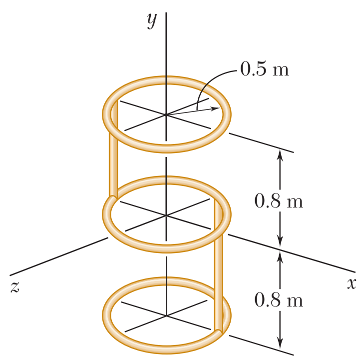


Fig. P9.162

9.162 A homogeneous wire with a mass per unit length of 1.8 kg/m is used to form the figure shown. Determine the mass products of inertia I_{xy}, I_{yz}, and I_{zx} of the wire figure.

9.163 Complete the derivation of Eq. (9.47), which expresses the parallel-axis theorem for mass products of inertia.

9.164 For the homogeneous tetrahedron of mass m shown, (*a*) determine by direct integration the mass product of inertia I_{zx}, (*b*) deduce I_{yz} and I_{xy} from the results obtained in part *a*.

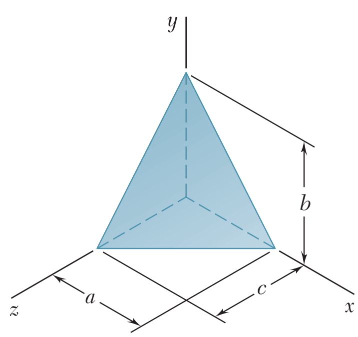


Fig. P9.164

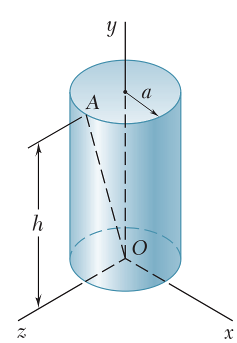


Fig. P9.165

9.165 The homogeneous circular cylinder shown has a mass m. Determine the mass moment of inertia of the cylinder with respect to the line joining the origin O and point A which is located on the perimeter of the top surface of the cylinder.

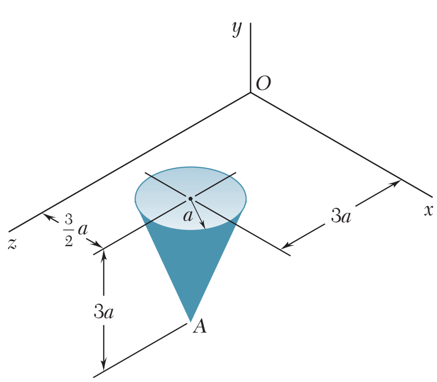


Fig. P9.166

9.166 The homogeneous circular cone shown has a mass m. Determine the mass moment of inertia of the cone with respect to the line joining the origin O and point A.

Answers to Problems

Answers to problems with a number set in straight type are given on this and the following pages. Answers to problems set in italic are not listed. Answers to computer problems are given at www.mhhe.com/beerjohnston8.

CHAPTER 2

2.1 37 N ◹ 76.0°.
2.2 57 N ◸ 86.0°.
2.4 5.4 kN ⦣ 12.0°.
2.5 (*a*) 103.0°. (*b*) 276 N.
2.6 (*a*) 25.1°. (*b*) 266 N.
2.7 (*a*) 72.2°. (*b*) 1.391 kN.
2.8 (*a*) 26.9 N. (*b*) 18.75 N.
2.10 (*a*) 7.48°. (*b*) 138.4 N.
2.11 (*a*) 108.6 N. (*b*) 163.9 N.
2.13 (*a*) 45.9 N →. (*b*) 65.5 N.
2.14 (*a*) 4.88 N ◺ 6.00°. (*b*) 69.8 N.
2.15 37.2 N ◹ 76.6°.
2.16 56.6 N ◸ 85.8°.
2.18 1.302 kN ⦣ 75.8°.
2.19 41.4 kN ◹ 72.0°.
2.21 (2.4 kN) 1.543 kN, 1.839 kN; (1.85 kN) 1.738 kN, 0.633 kN; (1.40 kN) 1.147 kN, −0.803 kN.
2.22 (5 kN) 3.83 kN, 3.21 kN; (7 kN) −2.39 kN, 6.58 kN; (9 kN) −8.46 kN, 3.08 kN.
2.24 (204 N) −96.0 N, 180.0 N; (212 N) 112.0 N, 180.0 N; (400 N) −320 N, −240 N.
2.25 (*a*) 1674 N. (*b*) 1371 N.
2.26 (*a*) 39.2 N. (*b*) 25.2 N.
2.28 (*a*) 339 N. (*b*) 218 N ↓.
2.29 (*a*) 47.9 N. (*b*) 16.38 N.
2.31 4.73 kN ⦣ 20.6°.
2.32 14.66 kN ◺ 61.4°.
2.34 905 N ⦣ 45.0°.
2.35 45.2 N ◸ 62.3°.
2.37 1019 N ⦣ 26.1°.
2.38 1.295 kN ◺ 88.3°.
2.39 (*a*) 116.0 N. (*b*) 60.0 N.
2.40 (*a*) 40.3°. (*b*) 1.130 kN.
2.41 (*a*) 56.3°. (*b*) 1021 N.
2.43 (*a*) 169.7 N. (*b*) 348 N.
2.44 (*a*) 2.20 kN. (*b*) 2.43 kN.
2.46 (*a*) 38.6 N. (*b*) 44.3 N.
2.47 (*a*) 405 N. (*b*) 830 N.
2.49 $T_C = 5.87$ kN; $T_D = 9.14$ kN.
2.51 $F_C = 1.433$ kN; $F_D = 1.678$ kN.
2.52 $F_B = 2.99$ kN; $F_D = 1.060$ kN.
2.53 (*a*) 786 N. (*b*) 3.26 kN.
2.54 (*a*) 3.12 kN. (*b*) 20.3 N.
2.55 (*a*) 169.6 N. (*b*) 265 N.
2.57 (*a*) 62.8 N. (*b*) 758 mm.
2.58 (*a*) 19.85 N. (*b*) 62.3 N.
2.59 (*a*) 50.0°. (*b*) 35.0 N.
2.60 (*a*) 1216 N. (*b*) 77.5°.
2.61 (*a*) 1510 N. (*b*) 57.5°.
2.62 4.97 m.
2.65 16.81 cm.
2.66 (*a*) 90.0°. (*b*) 305 N.
2.67 170.5 N ◸ 7.50°.
2.69 (*b*) 916 N. (*d*) 687 N.
2.70 (*a*) 2.30 kN. (*b*) 3.53 kN.
2.72 $27.4° < \alpha < 223°$.
2.73 (*a*) +557 N, −611 N, +468 N. (*b*) 54.1°, 130.0°, 60.5°.
2.75 (*a*) +706 N, +450 N, −329 N. (*b*) 38.3°, 60.0°, 111.5°.
2.76 (*a*) −611 N, +1785 N, +222 N. (*b*) 108.7°, 20.0°, 83.3°.
2.78 (*a*) +141.3 N, −90.0 N, +65.9 N. (*b*) 38.3°, 120.0°, 68.5°.
2.79 (*a*) −90.1 N, +190.5 N, −63.1 N. (*b*) 114.2°, 30.0°, 106.7°.
2.80 (*a*) 439 N. (*b*) 65.8°, 30.0°, 106.7°.
2.81 $F = 225$ N; $\theta_x = 73.2°$, $\theta_y = 110.8°$, $\theta_z = 152.7°$.
2.83 (*a*) 132.5°. (*b*) $F_x = 53.9$ N, $F_z = 7.99$ N; $F = 74.0$ N.
2.84 (*a*) 153.7°. (*b*) $F_x = -15.37$ N, $F_y = 7.85$ N; $F = 39.0$ N.
2.85 (*a*) $F_y = 75.6$ N, $F_z = 224$ N. (*b*) $\theta_x = 71.3°$, $\theta_z = 26.1°$.
2.87 +30.0 N, −35.0 N, −30.0 N.
2.88 +28.8 N, −36.0 N, +38.4 N.
2.90 +200 N, +1000 N, +740 N.
2.91 −200 N, +370 N, −160.0 N.
2.93 4.28 kN; $\theta_x = 93.7°$, $\theta_y = 31.3°$, $\theta_z = 121.1°$.
2.95 1122 N; $\theta_x = 147.7°$, $\theta_y = 61.6°$, $\theta_z = 104.2°$.
2.96 1122 N; $\theta_x = 150.1°$, $\theta_y = 60.1°$, $\theta_z = 91.6°$.
2.97 (*a*) 1492 N. (*b*) 2040 N; $\theta_x = 90.0°$, $\theta_y = 139.2°$, $\theta_z = 49.2°$.
2.99 (*a*) 360 N. (*b*) 424 N.
2.100 $T_{AB} = 3.25$ kN; $T_{AD} = 1.775$ kN.
2.102 9.71 kN.
2.103 1031 N ↑.
2.105 55.9 N.
2.106 $F_{BA} = 23.5$ N; $F_{CA} = 14.77$ N; $F_{DA} = 26.6$ N.
2.107 6.66 kN ↑.
2.108 8.81 kN ↑.
2.109 $T_{AB} = 86.2$ N; $T_{AC} = 27.7$ N; $T_{AD} = 237$ N.
2.112 $0 \le P \le 0.386$ N.
2.113 $T_{DA} = 62.9$ N; $T_{DB} = T_{DC} = 56.7$ N.
2.114 $T_{DA} = 62.9$ N; $T_{DB} = T_{DC} = 57.8$ N.
2.115 $T_{AB} = 4.33$ kN; $T_{AC} = 2.36$ kN; $T_{AD} = 2.37$ kN.
2.116 $F_{AB} = 1742$ N; $T_{AC} = 1517$ N; $T_{AD} = 403$ N.
2.118 $0 \le P \le 0.1600$ N.
2.120 $T_{AB} = 81.3$ N; $T_{AC} = 22.2$ N.
2.121 $T_{BE} = 1.310$ N; $T_{CF} = 4.38$ N; $T_{DG} = 4.89$ N.
2.122 $T_{BE} = 4.84$ N; $T_{CF} = 1.157$ N; $T_{DG} = 4.58$ N.
2.123 $T_{ADB} = 81.9$ N; $W = 143.4$ N.
2.124 $T_{ADB} = 68.6$ N; $T_{DC} = 14.23$ N.
2.126 (*a*) 221 N. (*b*) 715 N. (*c*) 2060 N.

2.127 (*a*) 2.27 kN. (*b*) 1.963 kN.
2.129 (*a*) 45.6°. (*b*) 27.1 N.
2.131 (*a*) 549 N. (*b*) 315 N.
2.132 (*a*) 5.23 kN. (*b*) 0.503 kN.
2.134 149.1 N ⦥ 32.3° or 274 N ⦤ 32.3°.
2.135 (*a*) 576 N. (*b*) 67.5°, 30.0°, 108.7°.
2.136 (*a*) $F_y = -359$ N, $F_z = -437$ N. (*b*) $\theta_x = 70.5°$, $\theta_y = 126.7°$.
2.137 758 N; $\theta_x = 65.0°$, $\theta_y = 33.0°$, $\theta_z = 69.9°$.
2.139 177.2 N.

CHAPTER 3

3.1 13.02 N · m ↻.
3.2 13.02 N · m ↻.
3.3 16.03 N · m. ↺.
3.5 49.9° or 59.4°.
3.6 (*a*) 386 N · m ↺. (*b*) 160.1 N ∠ 56.0°.
3.7 (*a*) 386 N · m ↺. (*b*) 193.2 N ↑. (*c*) 189.5 N ∠ 78.7°.
3.9 (*a*) 7600 N · cm. ↺. (*b*) 7600 N · cm. ↺.
3.10 250 N.
3.12 140.0 N · m ↺.
3.14 12.54 N · m ↻.
3.16 126.0 mm.
3.17 (*a*) $(-4\mathbf{i} + 7\mathbf{j} + 10\mathbf{k})/\sqrt{165}$.
(*b*) $(-2\mathbf{i} + 2\mathbf{j} - 3\mathbf{k})/\sqrt{17}$.
3.19 (*a*) $-(18.00 \text{ N}\cdot\text{m})\mathbf{i} - (15.75 \text{ N}\cdot\text{m})\mathbf{j} - (40.5 \text{ N}\cdot\text{m})\mathbf{k}$.
(*b*) $(6.38 \text{ N}\cdot\text{m})\mathbf{i} + (1.500 \text{ N}\cdot\text{m})\mathbf{j} + (11.63 \text{ N}\cdot\text{m})\mathbf{k}$.
(*c*) 0.
3.21 $(886 \text{ N}\cdot\text{m})\mathbf{i} + (259 \text{ N}\cdot\text{m})\mathbf{j} - (670 \text{ N}\cdot\text{m})\mathbf{k}$.
3.23 $(236.1 \text{ N}\cdot\text{m})\mathbf{i} - (46.24 \text{ N}\cdot\text{m})\mathbf{j} + (462.4 \text{ N}\cdot\text{m})\mathbf{k}$.
3.24 (*a*) $(1200 \text{ N}\cdot\text{m})\mathbf{i} - (1500 \text{ N}\cdot\text{m})\mathbf{j} - (900 \text{ N}\cdot\text{m})\mathbf{k}$.
(*b*) $-(1200 \text{ N}\cdot\text{m})\mathbf{i} + (1500 \text{ N}\cdot\text{m})\mathbf{j} - (600 \text{ N}\cdot\text{m})\mathbf{k}$.
3.25 $(233.91 \text{ N}\cdot\text{cm})\mathbf{i} - (1187.48 \text{ N}\cdot\text{cm})\mathbf{j} - (25.422 \text{ N}\cdot\text{cm})\mathbf{k}$.
3.27 1.946 m.
3.28 8.9 m.
3.30 1.491 m.
3.31 8.07 cm.
3.32 0.645 m.
3.33 1.141 m.
3.35 $\mathbf{P}\cdot\mathbf{Q} = -23$; $\mathbf{P}\cdot\mathbf{S} = -74$; $\mathbf{Q}\cdot\mathbf{S} = 37$.
3.37 63.6°.
3.39 (*a*) 134.1°. (*b*) −76.6 N.
3.40 (*a*) 65.0°. (*b*) 75.3 N.
3.42 (*a*) 84.0°. (*b*) 26.2 N.
3.43 (*a*) 230 m^3. (*b*) 32.0 m^3.
3.44 13.00.
3.45 $M_x = -1598$ N · m; $M_y = 959$ N · m; $M_z = 0$.
3.46 $M_x = -1283$ N · m; $M_y = 770$ N · m; $M_z = 1824$ N · m.
3.47 15.00 N.
3.49 $P = 186.8$ N; $\phi = 9.87°$; $\theta = 48.1°$.
3.50 28.0 N · m.
3.52 14.75 m.
3.53 −180.0 N · m.
3.54 −222 N · m.
3.55 −24.9 kN · m.
3.56 −35.9 kN · m.
3.57 $aP/\sqrt{2}$.
3.58 (*b*) $a/\sqrt{2}$.
3.60 −225 N · m.
3.62 215 mm.
3.64 8.26 m.
3.65 9.26 m.
3.67 1.741 m.
3.68 (*a*) 24.0 N · m ↺. (*b*) 35.6°. (*c*) 1.000 m.
3.69 (*a*) 26.7 N. (*b*) 50.0 N. (*c*) 23.5 N.
3.70 (*a*) 4.26 N · m. ↻. (*b*) 9.72 cm.
3.71 (*a*) 0.862 N · m. ↺. (*b*) ∠ 53.1°. (*c*) 4.03 N.
3.72 $M = 19.50$ N · m; $\theta_x = 67.4°$, $\theta_y = 90.0°$, $\theta_z = 22.6°$.
3.74 $M = 76.6$ N · m; $\theta_x = 12.20°$, $\theta_y = 90.0°$, $\theta_z = 77.8°$.
3.75 $M = 103.1$ N · m; $\theta_x = 43.4°$, $\theta_y = 52.3°$, $\theta_z = 108.3°$.
3.76 $M = 35$ N · m.; $\theta_x = 33.1°$, $\theta_y = 64.8°$, $\theta_z = 69.9°$.
3.79 (*a*) $\mathbf{F}_B = 135.0$ N ↓; $\mathbf{M}_B = 16.88$ N · m ↺.
(*b*) $\mathbf{F}_B = 225$ N ←; $\mathbf{F}_C = 225$ N →.
3.81 $\mathbf{F}_A = 1.750$ kN ∠ 65.0°; $\mathbf{F}_C = 1.050$ kN ∠ 65.0°.
3.82 $\mathbf{F}_B = 22.5$ N ⦥ 30.0°; $\mathbf{F}_C = 31.5$ N ⦥ 30.0°.
3.83 (*a*) $\mathbf{F}_C = 54.0$ N ⦥ 30.0°; $\mathbf{M}_C = 53.2$ N · m. ↺.
(*b*) $\mathbf{F}_B = 30.3$ N ⦥ 63.0°; $\mathbf{F}_C = 33.0$ N ←.
3.84 (*a*) $\mathbf{F} = 200$ N ↓; $d = 9.00$ m.
(*b*) $\mathbf{F} = 200$ N ↓; $d = 0$.
3.86 $\mathbf{R} = -(60.8 \text{ N})\mathbf{i} - (89.7 \text{ N})\mathbf{k}$; 3.59 m to the right of *A*.
3.87 (*a*) $\mathbf{F}_A = 22.0$ N ∠ 20.0°; $\mathbf{M}_A = 0.65$ N · cm. ↺.
(*b*) $\mathbf{F}_E = 22.0$ N ∠ 20.0°; 0.031 m. below *A*.
3.88 (*a*) 120.0 N; $y = 19.98$ mm. (*b*) −16.26° or −85.0°.
3.90 $\mathbf{F} = -(250 \text{ kN})\mathbf{j}$; $\mathbf{M} = (15.00 \text{ kN}\cdot\text{m})\mathbf{i} + (7.50 \text{ kN}\cdot\text{m})\mathbf{k}$.
3.91 $\mathbf{F} = (6.00 \text{ N})\mathbf{i} - (48.0 \text{ N})\mathbf{j} + (24.0 \text{ N})\mathbf{k}$;
$\mathbf{M} = (540 \text{ N}\cdot\text{m})\mathbf{i} - (135.0 \text{ N}\cdot\text{m})\mathbf{k}$.
3.93 $\mathbf{F} = -(2.00 \text{ kN})\mathbf{i} - (9.50 \text{ kN})\mathbf{j} + (4.00 \text{ kN})\mathbf{k}$;
$\mathbf{M} = (19.00 \text{ kN}\cdot\text{m})\mathbf{i} - (12.00 \text{ kN}\cdot\text{m})\mathbf{j} - (19.00 \text{ kN}\cdot\text{m})\mathbf{k}$.
3.94 $\mathbf{R} = -(190.5 \text{ N})\mathbf{j} - (110.0 \text{ N})\mathbf{k}$;
$\mathbf{M} = (75.7 \text{ N}\cdot\text{m})\mathbf{i} + (22.0 \text{ N}\cdot\text{m})\mathbf{j} - (38.1 \text{ N}\cdot\text{m})\mathbf{k}$.
3.95 $\mathbf{F} = (54.0 \text{ N})\mathbf{i} - (18.00 \text{ N})\mathbf{j} + (27.0 \text{ N})\mathbf{k}$;
$\mathbf{M} = (707 \text{ N}\cdot\text{cm})\mathbf{i} + (778 \text{ N}\cdot\text{cm})\mathbf{j} - (336 \text{ N}\cdot\text{cm})\mathbf{k}$.
3.96 (*a*) $-(2.40 \text{ N})\mathbf{j}$. (*b*) $x = -16.89$ mm, $z = -24.5$ mm.
3.98 (*a*) *Loading a*: $\mathbf{R} = 1000$ N ↓; $\mathbf{M} = 6.00$ kN · m ↺.
Loading b: $\mathbf{R} = 1000$ N ↓; $\mathbf{M} = 6.60$ kN · m ↺.
Loading c: $\mathbf{R} = 1000$ N ↓; $\mathbf{M} = 6.60$ kN · m ↻.
Loading d: $\mathbf{R} = 1000$ N ↓; $\mathbf{M} = 6.60$ kN · m ↺.
Loading e: $\mathbf{R} = 900$ N ↓; $\mathbf{M} = 6.60$ kN · m ↺.
Loading f: $\mathbf{R} = 1000$ N ↓; $\mathbf{M} = 5.80$ kN · m ↺.
Loading g: $\mathbf{R} = 900$ N ↓; $\mathbf{M} = 6.60$ kN · m ↺.
Loading h: $\mathbf{R} = 1000$ N ↓; $\mathbf{M} = 6.60$ kN · m ↺.
(*b*) Loadings *b*, *d*, and *h*.
3.99 Loading *f*.
3.100 (*a*) $\mathbf{R} = 600$ N ↓; 1.500 m. (*b*) $\mathbf{R} = 300$ N ↓; 1.333 m.
(*c*) $\mathbf{R} = 500$ N ↓; 1.600 m.
3.101 Force-couple system at *E*.
3.103 (*a*) 7.82 m. (*b*) 4.48 m.
3.105 (*a*) 158.2 N ⦦ 86.0°. (*b*) 302 mm to the right of *F*.
3.106 (*a*) 72.2°. (*b*) 127.6 N ⦤ 87.4°.
3.107 (*a*) $\mathbf{M} = 115.2$ N · cm. ↺; $\alpha = 39.3°$. (*b*) 56.1 N ⦤ 45.0°.
3.109 (*a*) $\mathbf{R} = 3.72$ kN ⦤ 55.2°; 0.0406 cm. to the left of *EF*.
(*b*) 55.9°.
3.111 350 N ⦦ 21.4°; 92.6 mm from *B* or 27.4 mm from *F*.
3.112 (*a*) 7.35 N ∠ 55.6°. (*b*) 478 mm to the left of *B*.
(*c*) 34.7 mm above and to the left of *A*.
3.113 (*a*) 211 mm. (*b*) 211 mm.
3.114 (*a*) $\mathbf{R} = F$ ⦦ $\tan^{-1}(b^2/2hx)$;
$\mathbf{M} = \dfrac{(2h^2 - b^2)x - 2(h/b)^2 x^3}{\sqrt{b^4 + 4h^2x^2}} F$ ↺. (*b*) 0.354 cm.
3.115 $\mathbf{R} = -(300 \text{ N})\mathbf{i} - (240 \text{ N})\mathbf{j} + (25.0 \text{ N})\mathbf{k}$;
$\mathbf{M} = -(3.00 \text{ N}\cdot\text{m})\mathbf{i} + (13.50 \text{ N}\cdot\text{m})\mathbf{j} + (9.00 \text{ N}\cdot\text{m})\mathbf{k}$.

3.117 **A** = (2.00 N)**i** − (169.1 N)**j** + (12.00 N)**k**; **B** = −(12.00 N)**i** + (169.1 N)**j** − (6.00 N)**k**.
3.118 (*a*) **B** = (2.32 N)**i**; **C** = (1.580 N)**i** − (3.30 N)**j** − (1.110 N)**k**. (*b*) R_y = −3.30 N; M_x = 2.55 N · cm.
3.119 (*a*) 53.1°. (*b*) **R** = (40.0 N)**j** + (5.00 N)**k**; **M** = −(24.0 N · m)**i** + (45.0 N · m)**k**.
3.120 (*a*) **R** = (43.3 N)**j**; **M** = (6.88 N · m)**i** + (5.63 N · m)**j** + (9.74 N · m)**k**. (*b*) Counterclockwise.
3.122 **R** = −(8.00 N)**i** + (56.0 N)**j** − (20.0 N)**k**; **M** = −(81.0 N · m)**i** + (123.0 N · m)**j** + (444 N · m)**k**.
3.123 280 kN; *x* = 0.750 m, *z* = −0.1856 m.
3.124 F_B = 80.0 kN; F_F = 60.0 kN.
3.125 680 kN; *x* = 91.1 m, *z* = 43.2 m.
3.126 *a* = 58.4 m; *b* = 52.4 m.
3.129 (*a*) 2*P*; θ_x = 0°, θ_y = −90.0°, θ_z = 90.0°. (*b*) −0.750*a*. (*c*) *y* = 3.00*a*, *z* = 2.50*a*.
3.131 (*a*) −(21.0 N)**j**. (*b*) 0.571 m. (*c*) Axis of wrench is parallel to the *y* axis at *x* = 0, *z* = 41.7 mm.
3.133 (*a*) **R** = −(35.0 N)**i** − (12.00 N)**k**. (*b*) 5.11 cm. (*c*) *y* = 5.75 cm., *z* = 4.57 cm.
3.135 (*a*) 3*P*(2**i** − 20**j** − **k**)/25. (*b*) −0.0988*a*. (*c*) *x* = 2.00*a*, *z* = −1.990*a*.
3.137 **R** = (4.00 N)**i** + (6.00 N)**j** − (2.00 N)**k**; *p* = 14.7 cm; *y* = −44.21 cm, *z* = −12.375 cm.
3.138 $\mathbf{F}_A$ = −(*M*/*b*)**i** + *R*[1 + (*a*/*b*)]**j**; $\mathbf{F}_B$ = (*M*/*b*)**i** − (*a*/*b*)*R***j**.
3.142 (*a*) 80.0 N · m ↻. (*b*) 205 N. (*c*) 177.8 N ∠ 20.0°.
3.144 (*a*) −(22080 N · cm)**i** − (4416 N · cm)**k**. (*b*) −(22080 N · cm)**i** + (25920 N · cm)**j** + (32928 N · cm)**k**.
3.145 38.9°.
3.146 4.00 m.
3.148 (*a*) **F** = 1000 N ∠ 20.0°; **M** = 1724 N · m ↻. (*b*) **F** = 1000 N ∠ 20.0°; **M** = 958 N · m ↻.
3.150 **F** = (2.00 N)**i** + (38.0 N)**j** − (24.0 N)**k**; **M** = (792 N · cm)**i** + (708 N · cm)**j** + (1187 N · cm)**k**.
3.151 **R** = 362 N ∠ 81.9°; *M* = 327 N · m.
3.152 **R** = −(7.00 N)**i** − (8.00 N)**j** − (4.00 N)**k**; **M** = −(12.00 N · cm)**i** + (10.50 N · cm)**j** + (7.50 N · cm)**k**.

CHAPTER 4

4.1 (*a*) 552 N ↓. (*b*) 1152 N ↑.
4.2 (*a*) 5.75 kN ↑. (*b*) 7.25 kN ↑.
4.3 (*a*) 34.0 kN ↑. (*b*) 4.96 kN ↑.
4.4 (*a*) 81.1 kN. (*b*) 134.1 kN ↑.
4.7 (*a*) **A** = 10.05 kN ↑; **B** = 15.35 kN ↑. (*b*) **A** = 8.92 kN ↑; **B** = 16.48 kN ↑.
4.8 (*a*) 0. (*b*) **A** = 10.68 kN ↑; **B** = 14.72 kN ↑.
4.9 56.7 N ≤ T_C ≤ 70 N.
4.10 1.250 kN ≤ *Q* ≤ 27.5 kN.
4.12 4.64 N ≤ W_A ≤ 531 N.
4.13 25.0 mm ≤ *a* ≤ 125.0 mm.
4.15 (*a*) 150.0 N. (*b*) 292 N ∠ 77.5°.
4.16 (*a*) 16 N ∠ 60.0°. (*b*) 16.1 N ∠ 6.62°.
4.18 (*a*) **A** = 165.0 N ↓; **B** = 165.0 N ↑. (*b*) **A** = 275 N →; **B** = 275 N ←. (*c*) **A** = 141.5 N ∠ 60.0°; **B** = 141.5 N ∠ 60.0°.
4.19 (*a*) 300 N. (*b*) 449 N ∠ 32.3°.
4.21 (*a*) 6.158 N/cm. (*b*) 22.09 N ∠ 13.60°.
4.23 (*a*) **A** = 258 N ∠ 22.8°; **B** = 187.5 N ←. (*b*) **A** = 253 N ∠ 20.2°; **B** = 265 N ∠ 45.0°.
4.24 (*a*) **A** = 238 N →; **B** = 213 N ∠ 28.1°. (*b*) **A** = 336 N ∠ 45.0°; **B** = 233 N ∠ 36.3°.
4.26 (*a*) **A** = 54.29 N ∠ 58.5°; **E** = 7.266 N ∠ 60.0°. (*b*) **A** = 53.4 N ∠ 3.30°; **E** = 42.6 N ∠ 60.0°.
4.27 (*a*) 594 N. (*b*) 646 N ∠ 24.6°.
4.28 (*a*) 384 N. (*b*) 409 N ∠ 22.4°.
4.29 *T* = 195.0 N; **C** = 216 N ∠ 33.7°.
4.30 *T* = 65.7 N; **A** = 75 N ∠ 81.0°.
4.31 *T* = 216.7 N; **A** = 156.1 N ∠ 87.2°.
4.33 (*a*) 26.6°. (*b*) **B** = $P\sqrt{5}/2$ ∠ 26.6°; **C** = $P\sqrt{5}/2$ ∠ 26.6°.
4.34 (*a*) 45.0°. (*b*) **B** = $P\sqrt{2}$ ∠ 45.0°; **C** = *P* ←.
4.35 *T* = 0.566*P*; **C** = 0.364*P* →.
4.37 (*a*) 600 N. (*b*) **A** = 4.00 kN ←; **B** = 4.00 kN →.
4.38 (*a*) **A** = 953 N ∠ 80.0°; **B** = 435 N ∠ 55.0°. (*b*) 415 N →.
4.39 (*a*) 4.24 N. (*b*) $\mathbf{N}_A$ = 5.80 N ∠ 45.0°; $\mathbf{N}_D$ = 5.80 N ∠ 45.0°.
4.40 (*a*) 0°. (*b*) 3.00 N. (*c*) $\mathbf{N}_A$ = 3.67 N ∠ 45.0°; $\mathbf{N}_D$ = 3.67 N ∠ 45.0°.
4.41 **A** = **D** = 0; **B** = 868 N →; **C** = 126.1 N ←.
4.42 **A** = **C** = 0; **B** = 422 N ←; **D** = 45.2 N ←.
4.45 (*a*) **A** = 98.1 N ↑; $\mathbf{M}_A$ = 44.1 N · m ↺. (*b*) **A** = 138.7 N ∠ 45.0°; $\mathbf{M}_A$ = 44.1 N · m ↺. (*c*) **A** = 196.2 N ↑; $\mathbf{M}_A$ = 88.3 N · m ↺.
4.46 **C** = 33.9 N ∠ 45.0°; $\mathbf{M}_C$ = 14.4 N · cm. ↺.
4.48 (*a*) **A** = 6 N ↑; $\mathbf{M}_A$ = 140 N · cm. ↺. (*b*) **A** = 3.6 N ↑; $\mathbf{M}_A$ = 44 N · cm. ↺.
4.50 (*a*) **E** = 39.6 kN ↑; $\mathbf{M}_E$ = 64.8 kN · m ↻. (*b*) **E** = 21.6 kN ↑; $\mathbf{M}_E$ = 91.8 kN · m ↻.
4.51 (*a*) 50.4 kN. (*b*) M_E = 51.8 kN · m.
4.52 T_{max} = 1.999 kN; T_{min} = 1.560 kN.
4.53 (*a*) $\sin^{-1}(2M/mgl)$. (*b*) 20.1°.
4.54 (*a*) 30.0°. (*b*) −15.00°.
4.56 32.0°.
4.57 (*a*) $2\sin^{-1}[kl/\sqrt{2}(kl - P)]$. (*b*) 141.1°.
4.59 (*a*) $\tan^{-1}(P/kl)$. (*b*) 63.4°.
4.60 (*a*) $\tan\theta - \sin\theta = W/2kl$. (*b*) 52.94°.
4.61 (1) Completely constrained; determinate; equilibrium; **A** = 116.6 N ∠ 59.0°, **B** = 60.0 N ←. (2) Improperly constrained; indeterminate; no equilibrium. (3) Partially constrained; determinate; equilibrium; **A** = **C** = 50 N ↑. (4) Completely constrained; determinate; equilibrium; **A** = 50 N ↑, **B** = 78.1 N ∠ 39.8°, **C** = 60 N →. (5) Completely constrained; indeterminate; equilibrium; $\mathbf{A}_y$ = 50 N ↑. (6) Completely constrained; indeterminate; equilibrium; $\mathbf{A}_x$ = 60 N →, $\mathbf{B}_x$ = 60 N ←. (7) Completely constrained; determinate; equilibrium; **A** = **C** = 50 N ↑. (8) Improperly constrained; indeterminate; no equilibrium.
4.63 *P* = 120.0 N; **A** = 150.0 N ∠ 36.9°.
4.64 *a* ≥ 57.7 mm.
4.65 (*a*) 6.298 N/cm. (*b*) 22.5 N ∠ 13.35°.
4.67 (*a*) **A** = 150.0 N ↓; **C** = 167.7 N ∠ 63.4°. (*b*) **A** = 194.5 N ↓; **C** = 253 N ∠ 77.9°.
4.69 $\mathbf{F}_{nail}$ = 1.018 kN ↑; **B** = 1.027 kN ∠ 82.7°.
4.70 76.9 mm.

4.71 $\mathbf{F}_{\text{worker}} = 314$ N $\angle$ 76.3°; $\mathbf{B} = 227$ N $\angle$ 70.9°.
4.73 86 N $\angle$ 80.8°.
4.74 80.8 N $\angle$ 80.9°.
4.76 77.5 N $\angle$ 30.0°.
4.77 (*a*) 88.6 N $\angle$ 64.6°. (*b*) 98.75 N ↑. (*c*) 182.7 N.
4.78 (*a*) 5115.9 N $\angle$ 75.0°. (*b*) 4634.7 N $\angle$ 73.4°.
4.79 (*a*) 440 N. (*b*) 550 N $\angle$ 36.9°.
4.80 $T = 177.28$ N; $\mathbf{C} = 273.4$ N $\angle$ 35°.
4.81 (*a*) 20.3 N $\angle$ 45.0°. (*b*) 174.9 N $\angle$ 85.2°.
4.82 (*a*) 29.8 N $\angle$ 30.0°. (*b*) 176.8 N $\angle$ 81.6°.
4.84 (*a*) 229 N. (*b*) 172.6 N $\angle$ 11.5°.
4.86 (*a*) $2.77R$.
(*b*) $\mathbf{A} = 1.303mg$ $\angle$ 60.7°; $\mathbf{B} = 0.652mg$ $\angle$ 12.15°.
4.87 (*a*) 39.8 N $\angle$ 39.4°. (*b*) 199.2 N $\angle$ 72.0°.
4.89 34.5°.
4.90 $\tan\theta = 2\tan\beta$.
4.91 (*a*) 43.0°. (*b*) $\mathbf{A} = 45.7$ N ←; $\mathbf{B} = 108.2$ N $\angle$ 65.0°.
9.92 $\sin^{-1}(a/L)^{1/3}$.
4.93 15.04°.
4.95 (*a*) 18.43°. (*b*) $mg/5$.
4.96 $\mathbf{A} = (120.0\text{ N})\mathbf{j} + (133.3\text{ N})\mathbf{k}$; $\mathbf{D} = (60.0\text{ N})\mathbf{j} + (166.7\text{ N})\mathbf{k}$.
4.97 $\mathbf{C} = (370.5\text{ N})\mathbf{j} - (342.5\text{ N})\mathbf{k}$; $\mathbf{D} = -(1170.5\text{ N})\mathbf{j} + (212.5\text{ N})\mathbf{k}$.
4.98 $\mathbf{C} = (55.2\text{ N})\mathbf{j} - (200\text{ N})\mathbf{k}$; $\mathbf{D} = -(1585.2\text{ N})\mathbf{j} + (400\text{ N})\mathbf{k}$.
4.100 (*a*) 150.0 N. (*b*) $\mathbf{C} = -(12.08\text{ N})\mathbf{j} - (120.0\text{ N})\mathbf{k}$;
$\mathbf{D} = (52.3\text{ N})\mathbf{j} - (180.0\text{ N})\mathbf{k}$.
4.102 $\mathbf{N}_A = 371$ N ↓; $\mathbf{N}_B = 618$ N ↓; $\mathbf{N}_C = 679$ N ↓.
4.103 34.0 kg; $x = 0.600$ m, $z = 1.200$ m.
4.104 $T_A = 9$ N; $T_C = 4.5$ N; $T_D = 40.5$ N.
4.106 (*a*) $\mathbf{A}_y = 1.3$ N ↑; $\mathbf{B}_y = 1.3$ N ↑; $\mathbf{C}_y = 0.25$ N ↑. (*b*) 50.35°.
4.107 $T_A = W/3$; $T_B = 2W(1 - 1/\sqrt{3})/3$; $T_C = 2W/3\sqrt{3}$.
4.108 (*a*) $T_A = T_B = W/3$; $T_C = 4W/3$.
(*b*) $x = L(2 - \sqrt{3})/3$, $z = L[1 - (1/2\sqrt{3})]$.
4.109 (*a*) 450 mm. (*b*) $R_A = 48.2$ N; $R_B = R_C = 43.4$ N.
4.111 (*a*) 27 N ↑. (*b*) 58.9 N. (*c*) 27 N ↑.
4.112 $T_{BD} = T_{BE} = 353$ N; $\mathbf{C} = -(100\text{ N})\mathbf{j} + (433.5\text{ N})\mathbf{k}$.
4.114 (*a*) $T_{BE} = 857$ N; $T_{BF} = 455$ N.
(*b*) $\mathbf{A} = (73.9\text{ N})\mathbf{i} + (878\text{ N})\mathbf{j} - (127.9\text{ N})\mathbf{k}$.
4.115 (*a*) 29.7°. (*b*) 586 N.
(*c*) $\mathbf{A} = (72.0\text{ N})\mathbf{i} + (842\text{ N})\mathbf{j} - (126.0\text{ N})\mathbf{k}$.
4.116 $T_{AD} = 2160$ N; $T_{BE} = 2990$ N;
$\mathbf{C} = (4480\text{ N})\mathbf{i} - (213\text{ N})\mathbf{j} + (320\text{ N})\mathbf{k}$.
4.117 $T_{AD} = 1890$ N; $T_{BE} = 2610$ N;
$\mathbf{C} = (3920\text{ N})\mathbf{i} - (76.7\text{ N})\mathbf{j} + (280\text{ N})\mathbf{k}$.
4.118 $T_{EG} = 961.6$ N; $T_{CI} = T_{FH} = 1166.7$ N;
$\mathbf{D} = (2573\text{ N})\mathbf{i} - (280\text{ N})\mathbf{j} - (30.8\text{ N})\mathbf{k}$.
4.120 (*a*) 232 N.
(*b*) $\mathbf{A} = -(144.4\text{ N})\mathbf{j} - (75.5\text{ N})\mathbf{k}$; $\mathbf{B} = (75\text{ N})\mathbf{j}$.
4.121 (*a*) 171 N. (*b*) $\mathbf{E} = -(4.37\text{ N})\mathbf{i} - (68\text{ N})\mathbf{k}$;
$\mathbf{F} = (104.37\text{ N})\mathbf{i} + (78\text{ N})\mathbf{j} + (220\text{ N})\mathbf{k}$.
4.122 (*a*) 97.1 N. (*b*) $\mathbf{A} = -(23.5\text{ N})\mathbf{i} + (63.8\text{ N})\mathbf{j} - (7.85\text{ N})\mathbf{k}$;
$\mathbf{B} = (9.81\text{ N})\mathbf{j} + (66.7\text{ N})\mathbf{k}$.
4.123 (*a*) 233 N. (*b*) $\mathbf{A} = (183.9\text{ N})\mathbf{i} + (63.8\text{ N})\mathbf{j} + (139.0\text{ N})\mathbf{k}$;
$\mathbf{B} = (9.81\text{ N})\mathbf{j} - (16.35\text{ N})\mathbf{k}$.
4.125 (*a*) 97.9 N. (*b*) $\mathbf{A} = (50.4\text{ N})\mathbf{j} - (4.75\text{ N})\mathbf{k}$;
$\mathbf{B} = -(5.34\text{ N})\mathbf{i} - (77.8\text{ N})\mathbf{j} + (22.6\text{ N})\mathbf{k}$.
4.126 $F_{CE} = 404$ N; $\mathbf{A} = -(112.5\text{ N})\mathbf{i}$;
$\mathbf{B} = -(112.5\text{ N})\mathbf{i} + (300\text{ N})\mathbf{j} - (150\text{ N})\mathbf{k}$.
4.128 (*a*) 11.2 N. (*b*) $\mathbf{D} = (3\text{ N})\mathbf{k}$;
$\mathbf{M}_D = (6.6\text{ N}\cdot\text{cm.})\mathbf{i} + (51.4\text{ N}\cdot\text{cm.})\mathbf{j} + (4.44\text{ N}\cdot\text{cm.})\mathbf{k}$.
4.130 (*a*) $F_{CF} = 44.4$ N; $F_{DE} = 18.47$ N.
(*b*) $\mathbf{B} = (81.3\text{ N})\mathbf{j} - (8.21\text{ N})\mathbf{k}$;
$\mathbf{M}_B = (1.149\text{ N}\cdot\text{m})\mathbf{j} + (0.657\text{ N}\cdot\text{m})\mathbf{k}$.
4.131 (*a*) 39.4 N. (*b*) $\mathbf{B} = -(7.63\text{ N})\mathbf{i} + (34.3\text{ N})\mathbf{j} + (17.80\text{ N})\mathbf{k}$;
$\mathbf{M}_B = -(3.56\text{ N}\cdot\text{m})\mathbf{j} - (22.3\text{ N}\cdot\text{m})\mathbf{k}$.
4.132 $T_{BD} = 1.4$ kN; $T_{BE} = T_{CF} = 1.25$ kN;
$\mathbf{A} = (3.51\text{ kN})\mathbf{i} - (0.56\text{ kN})\mathbf{k}$.
4.134 $T_{DI} = 164.8$ N; $T_{EH} = 933$ N; $T_{FG} = 187.8$ N;
$\mathbf{A} = (1094\text{ N})\mathbf{i} + (98.7\text{ N})\mathbf{j} - (21.3\text{ N})\mathbf{k}$.
4.135 $T_{DI} = 180.6$ N; $T_{EH} = 960$ N; $T_{FG} = 100.9$ N;
$\mathbf{A} = (1067\text{ N})\mathbf{i} + (110.4\text{ N})\mathbf{j} - (11.45\text{ N})\mathbf{k}$.
4.136 $\mathbf{A} = -(39\text{ N})\mathbf{j} + (80\text{ N})\mathbf{k}$; $\mathbf{B} = -(60\text{ N})\mathbf{i} - (61\text{ N})\mathbf{j}$;
$\mathbf{C} = (60\text{ N})\mathbf{i} + (100\text{ N})\mathbf{j}$.
4.138 $\mathbf{B} = (104.0\text{ N})\mathbf{k}$; $\mathbf{C} = (36.0\text{ N})\mathbf{j} - (36.0\text{ N})\mathbf{k}$;
$\mathbf{D} = -(36.0\text{ N})\mathbf{j} + (12.00\text{ N})\mathbf{k}$.
4.140 (*a*) 7.24 N. (*b*) $\mathbf{A} = -(4.48\text{ N})\mathbf{i} + (20.2\text{ N})\mathbf{j} - (1.379\text{ N})\mathbf{k}$;
$\mathbf{N}_B = (3.68\text{ N})\mathbf{j} + (2.76\text{ N})\mathbf{k}$.
4.141 (*a*) $(6.4\text{ N})\mathbf{i} + (8.6\text{ N})\mathbf{j}$.
(*b*) $\mathbf{A} = -(6.4\text{ N})\mathbf{i} + (11.4\text{ N})\mathbf{j} - (6\text{ N})\mathbf{k}$; $\mathbf{B} = (6\text{ N})\mathbf{k}$.
4.142 127.6 N.
4.143 125.8 N.
4.144 200 N.
4.145 375 N.
4.146 (*a*) $x = 1.8$ m, $y = 4.05$ m. (*b*) 55 N.
4.147 (*a*) $x = 0$, $y = 8.1$ m. (*b*) 57 N.
4.148 37.8 N.
4.150 65.2 N.
4.152 300 mm $\leq d \leq$ 800 mm.
4.153 932 N.
4.155 $\mathbf{C} = 915$ N $\angle$ 88.1°; $\mathbf{M}_C = 3823.6$ N · cm. ↻.
4.157 (*a*) 348.7 N. (*b*) 348.7 N $\angle$ 35°.
4.158 75.0 mm.
4.159 $\mathbf{A} = (112.3\text{ N})\mathbf{i} + (41.7\text{ N})\mathbf{j}$; $\mathbf{B} = (112.3\text{ N})\mathbf{i} + (125.1\text{ N})\mathbf{j}$;
$\mathbf{C} = -(225\text{ N})\mathbf{i}$.
4.161 (*a*) 200.7 N. (*b*) $\mathbf{A} = (66.2\text{ N})\mathbf{i} + (227.5\text{ N})\mathbf{j} + (48.8\text{ N})\mathbf{k}$;
$\mathbf{B} = (57.6\text{ N})\mathbf{j} + (27.5\text{ N})\mathbf{k}$.
4.162 $T_{BG} = 796$ N; $T_{DH} = 600$ N; $T_{FJ} = 0$;
$\mathbf{A} = (996.8\text{ N})\mathbf{i} + (120\text{ N})\mathbf{j} - (477.6\text{ N})\mathbf{k}$.

CHAPTER 5

5.1 $\overline{X} = 140.0$ mm, $\overline{Y} = 165.0$ mm.
5.2 $\overline{X} = 8.22$ cm, $\overline{Y} = 4.00$ cm.
5.3 $\overline{X} = 105.0$ mm, $\overline{Y} = 90.0$ mm.
5.5 $\overline{X} = 18.02$ mm, $\overline{Y} = 84.9$ mm.
5.6 $\overline{X} = 8.32$ cm, $\overline{Y} = 3.61$ cm.
5.8 $\overline{X} = 68.2$ mm, $\overline{Y} = 4.55$ mm.
5.9 3.02.
5.10 $\dfrac{r_1 + r_2}{\pi - 2\alpha}\cos\alpha$.
5.11 $\overline{X} = 8.56$ cm, $\overline{Y} = 0$.
5.13 $\overline{X} = -3.17$ cm, $\overline{Y} = 0.668$ cm.
5.14 $\overline{X} = 90.0$ mm, $\overline{Y} = 26.8$ mm.
5.16 $\overline{X} = 80.4$ mm, $\overline{Y} = 82.9$ mm.
5.17 $Q_I = 174.125\text{ cm}^3$; $Q_{II} = -174.125\text{ cm}^3$.
5.18 $Q_I = 42.3 \times 10^3\text{ mm}^3$; $Q_{II} = -42.3 \times 10^3\text{ mm}^3$.
5.21 $\overline{X} = 116.7$ mm, $\overline{Y} = 166.7$ mm.
5.22 $\overline{X} = 8.71$ cm, $\overline{Y} = 4.32$ cm.
5.23 $\overline{X} = 54.9$ mm, $\overline{Y} = 71.8$ mm.
5.24 $\overline{X} = 60.1$ mm, $\overline{Y} = -3.16$ mm.
5.25 (*a*) 1.57 N. (*b*) 0.58 N $\angle$ 83.1°.
5.26 63.6°.
5.27 319 mm.
5.28 (*a*) $1.427r$. (*b*) $2.11r$.

5.31 $\bar{x} = 2a/3, \bar{y} = 2h/3$.

5.32 $\bar{x} = 2a/5, \bar{y} = 3b/7$.

5.35 $\bar{x} = 2a/3(\pi - 2), \bar{y} = 2b/3(\pi - 2)$.

5.36 $\bar{x} = 0, \bar{y} = \frac{2}{3}R\frac{3 - \sin^2 \alpha}{2\alpha + \sin 2\alpha} \sin \alpha$.

5.37 $\bar{x} = a/4, \bar{y} = 3b/10$.

5.38 $\bar{x} = 39a/50, \bar{y} = -39b/175$.

5.39 $\bar{x} = 2L/5, \bar{y} = 12h/25$.

5.40 $\bar{x} = 18a/19, \bar{y} = 148b/95$.

5.42 $-2r\sqrt{2}/3\pi$.

5.43 $2a/5$.

5.45 $\bar{x} = 0.363L, \bar{y} = 0.1653L$.

5.46 $\bar{x} = 0.549R, \bar{y} = 0$.

5.47 (*a*) $V = 3367.8 \text{ cm}^3$; $A = 1520.53 \text{ cm}^2$. (*b*) $V = 9072.9 \text{ cm}^3$; $A = 3619.1 \text{ cm}^2$.

5.49 (*a*) $V = 155.5 \times 10^6 \text{ mm}^3$; $A = 1.885 \times 10^6 \text{ mm}^2$. (*b*) $V = 2.10 \times 10^6 \text{ mm}^3$; $A = 3.20 \times 10^6 \text{ mm}^2$.

5.50 (*a*) $\pi^2 a^2 b$. (*b*) $2\pi^2 a^2 b$. (*c*) $2\pi a^2 b/3$.

5.51 $V = 2.10 \text{ cm}^3$; $A = 16.83 \text{ cm}^2$.

5.53 720 mm^3.

5.55 $V = 255 \times 10^3 \text{ mm}^3$; $A = 37.5 \times 10^3 \text{ mm}^2$.

5.57 229 kN.

5.58 647 liters

5.59 30.5 g.

5.61 (*a*) $R = 1764$ N; 3.80 m to the right of A. (*b*) $\mathbf{A} = 1764 \text{ N} \uparrow$; $\mathbf{M}_A = 6.70 \text{ kN} \cdot \text{m} \circlearrowleft$.

5.62 (*a*) $R = 720$ N; 11.25 m to the right of A. (*b*) $\mathbf{A} = 270 \text{ N} \uparrow$; $\mathbf{B} = 450 \text{ N} \uparrow$.

5.63 $\mathbf{A} = 1.280 \text{ kN} \uparrow$; $\mathbf{B} = 4.48 \text{ kN} \uparrow$.

5.64 $\mathbf{A} = 6.00 \text{ kN} \uparrow$; $\mathbf{B} = 4.80 \text{ kN} \uparrow$.

5.66 $\mathbf{A} = 90.0 \text{ N} \uparrow$; $\mathbf{M}_A = 675 \text{ N} \cdot \text{m} \circlearrowleft$.

5.67 $\mathbf{A} = 7.20 \text{ kN} \uparrow$; $\mathbf{B} = 3.60 \text{ kN} \uparrow$.

5.69 $\mathbf{B} = 7.04 \text{ kN} \uparrow$; $\mathbf{C} = 15.46 \text{ kN} \uparrow$.

5.71 (*a*) 1.172 m. (*b*) $\mathbf{A} = 3.53 \text{ kN} \uparrow$; $\mathbf{B} = 7.06 \text{ kN} \uparrow$.

5.73 $w_A = 556$ N/m; $R_R = 7.25$ kN.

5.74 (*a*) $1.527 \text{ kN} \downarrow$. (*b*) 1.630 kN/m.

5.75 (*a*) $\mathbf{H} = 76.28 \text{ kN} \rightarrow$; $\mathbf{V} = 511.7 \text{ kN} \uparrow$. (*b*) 4.7 m to the right of A. (*c*) $\mathbf{R} = 76.7 \text{ kN} \angle 5.71°$.

5.76 (*a*) $\mathbf{H} = 176.6 \text{ kN} \rightarrow$; $\mathbf{V} = 1350 \text{ kN} \uparrow$. (*b*) 5.13 m to the right of A. (*c*) $\mathbf{R} = 236 \text{ kN} \angle 41.6°$.

5.78 100.0 mm.

5.79 $\mathbf{B} = 103776 \text{ N} \rightarrow$; $\mathbf{A} = 117920 \text{ N} \rightarrow$.

5.80 4.75%.

5.82 (*a*) $2.35 \text{ kN} \leftarrow$. (*b*) $1.782 \text{ kN} \downarrow$. (*c*) $5.31 \text{ kN} \uparrow$.

5.83 $1.337 \text{ kN} \leftarrow$.

5.84 $\mathbf{A} = 512 \text{ kN} \angle 65.2°$; $\mathbf{B} = 480 \text{ kN} \uparrow$.

5.85 17.9 m.

5.87 $\mathbf{A} = 3930 \text{ N} \angle 45.4°$; $\mathbf{D} = 124.1 \text{ N} \rightarrow$.

5.88 0.782 m.

5.90 (*a*) $-1.118R$. (*b*) 0.884.

5.91 $7h/16$.

5.92 $-3a/4\pi$.

5.93 (*a*) $0.548L$. (*b*) $2\sqrt{3}$.

5.94 -1.312 mm.

5.95 51.4 mm.

5.98 0.075 m.

5.99 0.026 m.

5.100 $\bar{X} = 360$ mm, $\bar{Y} = 266$ mm, $\bar{Z} = -60.7$ mm.

5.101 $\bar{X} = 0.06$ m, $\bar{Y} = 0.09$ m, $\bar{Z} = 0.06$ m.

5.102 $\bar{X} = 150.0$ mm, $\bar{Y} = 200$ mm, $\bar{Z} = 40.2$ mm.

5.103 $\bar{X} = 136.2$ mm, $\bar{Y} = 197.8$ mm.

5.104 $\bar{X} = 9.00$ m, $\bar{Y} = -20.4$ m, $\bar{Z} = 12.81$ m.

5.106 $\bar{X} = 340$ mm, $\bar{Y} = 314$ mm, $\bar{Z} = 283$ mm.

5.108 $\bar{X} = 205$ mm, $\bar{Y} = 255$ mm, $\bar{Z} = 75.0$ mm.

5.109 $\bar{X} = 116.7$ mm, $\bar{Y} = 103.0$ mm, $\bar{Z} = 78.7$ mm.

5.111 $\bar{X} = 0.96$ m, $\bar{Y} = 0.87$ m, $\bar{Z} = 0.9$ m.

5.113 5.35 mm.

5.114 50 mm.

5.115 0.086 m. above the bottom of the base.

5.116 $\bar{x}_1 = 21a/88$; $\bar{x}_2 = 27a/40$.

5.117 $\bar{x}_1 = 21h/88$; $\bar{x}_2 = 27h/40$.

5.119 $\bar{x} = 5a/128, \bar{y} = \bar{z} = 0$.

5.121 $\bar{x} = a, \bar{y} = 77b/100, \bar{z} = 0$.

5.122 $\bar{x} = a[1 - (4/\pi^2)]/2, \bar{y} = \bar{z} = 0$.

5.123 $\bar{x} = \bar{z} = 0, \bar{y} = h(2 + \pi)/16$.

5.128 $b(\frac{1}{2}y_0 - \frac{1}{4}y_1 - \frac{1}{3}y_2)/(y_0 - \frac{1}{2}y_1 - \frac{1}{2}y_2)$.

5.129 $\bar{x} = 0, \bar{y} = 5h/16, \bar{z} = -a/4$.

5.130 $\bar{X} = 1.421$ mm, $\bar{Y} = 12.42$ mm.

5.131 $\bar{X} = 0.14$ m, $\bar{Y} = 0.35$ m.

5.133 0.3 m.

5.134 $\bar{X} = 2a/5, \bar{y} = 4h/7$.

5.136 57781.2 cm^3

5.138 $\mathbf{A} = 3.33 \text{ kN} \uparrow$; $\mathbf{M}_A = 6.33 \text{ kN} \cdot \text{m} \circlearrowleft$.

5.139 1.54 m.

5.141 $\bar{X} = 20.4$ mm, $\bar{Y} = -4.55$ mm, $\bar{Z} = 29.0$ mm.

CHAPTER 6

6.1 $F_{AB} = 1500 \text{ N } T$; $F_{AC} = 800 \text{ N } T$; $F_{BC} = 1700 \text{ N } C$.

6.2 $F_{AB} = 3.39 \text{ kN } C$; $F_{AC} = 2.60 \text{ kN } T$; $F_{BC} = 3.00 \text{ kN } C$.

6.3 $F_{AB} = 1080 \text{ N } T$; $F_{AC} = 1800 \text{ N } C$; $F_{BC} = 1170 \text{ N } C$.

6.5 $F_{AB} = F_{AE} = 6.71 \text{ kN } T$; $F_{AC} = F_{AD} = 10.00 \text{ kN } C$; $F_{BC} = F_{DE} = 6.00 \text{ kN } C$; $F_{CD} = 2.00 \text{ kN } T$.

6.6 $F_{AB} = 21.9 \text{ kN } C$; $F_{AD} = 40.6 \text{ kN } T$; $F_{BC} = 18.50 \text{ kN } C$; $F_{BD} = 30.4 \text{ kN } C$; $F_{CD} = 18.50 \text{ kN } T$.

6.7 $F_{AB} = 4.00 \text{ kN } T$; $F_{AD} = 15.00 \text{ kN } T$; $F_{BD} = 9.00 \text{ kN } C$; $F_{BE} = 5.00 \text{ kN } T$; $F_{CD} = 16.00 \text{ kN } C$; $F_{DE} = 4.00 \text{ kN } C$.

6.9 $F_{AB} = F_{BC} = F_{CD} = 24.0 \text{ kN } T$; $F_{AE} = 38.4 \text{ kN } T$; $F_{AF} = 30.0 \text{ kN } C$; $F_{BF} = F_{BG} = F_{CG} = F_{CH} = 0$; $F_{DH} = F_{FG} = F_{GH} = 26.0 \text{ kN } C$; $F_{EF} = 24.0 \text{ kN } C$.

6.10 $F_{AB} = F_{FH} = 5.00 \text{ kN } C$; $F_{AC} = F_{CE} = F_{EG} = F_{GH} = 4.00 \text{ kN } T$; $F_{BC} = F_{FG} = 0$; $F_{BD} = F_{DF} = 3.98 \text{ kN } C$; $F_{BE} = F_{EF} = 0.238 \text{ kN } C$; $F_{DE} = 0.286 \text{ kN } T$.

6.12 $F_{AD} = F_{EG} = 17.50 \text{ kN } C$; $F_{AC} = F_{FG} = 15.08 \text{ kN } T$; $F_{BC} = F_{EF} = 2.26 \text{ kN } C$; $F_{BD} = F_{DE} = 15.50 \text{ kN } C$; $F_{CD} = F_{DF} = 9.00 \text{ kN } T$; $F_{CF} = 7.00 \text{ kN } T$.

6.13 $F_{AB} = 15.00 \text{ kN } C$; $F_{AC} = 12.92 \text{ kN } T$; $F_{BC} = 2.26 \text{ kN } C$; $F_{BD} = 13.00 \text{ kN } C$; $F_{CD} = 8.00 \text{ kN } T$; $F_{CF} = 5.60 \text{ kN } T$; $F_{DE} = 10.00 \text{ kN } C$; $F_{DF} = 4.00 \text{ kN } T$; $F_{EF} = 0$; $F_{EG} = 10.00 \text{ kN } C$; $F_{FG} = 8.62 \text{ kN } T$.

6.15 $F_{AB} = 6.01 \text{ kN } C$; $F_{AC} = 3.33 \text{ kN } T$; $F_{BC} = 0.601 \text{ kN } C$; $F_{BD} = 5.41 \text{ kN } C$; $F_{CD} = 0.850 \text{ kN } T$; $F_{CG} = 0.583 \text{ kN } C$; $F_{CI} = 3.47 \text{ kN } T$; $F_{DE} = 9.28 \text{ kN } C$; $F_{DF} = 6.00 \text{ kN } T$; $F_{EF} = 0$.

6.16 $F_{CG} = 0.583 \text{ kN } C$; $F_{CI} = 3.47 \text{ kN } T$; $F_{EF} = 0$; $F_{EG} = 9.28 \text{ kN } C$; $F_{FG} = 6.00 \text{ kN } T$; $F_{GH} = 6.25 \text{ kN } C$; $F_{GI} = 0.500 \text{ kN } T$; $F_{HI} = 0.601 \text{ kN } C$; $F_{HJ} = 6.85 \text{ kN } C$; $F_{IJ} = 3.80 \text{ kN } T$.

6.17 $F_{AB} = 3.61 \text{ kN } C$; $F_{AC} = 4.11 \text{ kN } T$; $F_{BC} = 0.768 \text{ kN } C$; $F_{BD} = 3.84 \text{ kN } C$; $F_{CD} = 1.371 \text{ kN } T$; $F_{CE} = 2.74 \text{ kN } T$; $F_{DE} = 1.536 \text{ kN } C$.

6.18 $F_{DF} = 4.06$ kN C; $F_{DG} = 1.371$ kN T; $F_{EG} = 2.74$ kN T;
$F_{FG} = 0.768$ kN C; $F_{FH} = 4.29$ kN C; $F_{GH} = 4.11$ kN T.
6.19 $F_{AB} = 10.06$ kN C; $F_{AC} = 9.00$ kN T; $F_{BC} = 2.81$ kN C;
$F_{BD} = 14.64$ kN C; $F_{BE} = 4.16$ kN T; $F_{CE} = 9.43$ kN T;
$F_{DE} = 2.05$ kN C; $F_{DF} = 18.45$ kN C; $F_{DG} = 3.43$ kN T;
$F_{EG} = 13.72$ kN T.
6.23 $F_{AB} = 8.97$ kN C; $F_{AC} = 8.28$ kN T; $F_{BC} = 3.45$ kN C;
$F_{BD} = 14.04$ kN C; $F_{BE} = 4.68$ kN T; $F_{CE} = 8.97$ kN T;
$F_{CF} = F_{EF} = 0$; $F_{DE} = 5.61$ kN T; $F_{DG} = 8.60$ kN C;
$F_{DH} = 7.10$ kN C; $F_{EH} = 13.14$ kN T.
6.25 $F_{AB} = 430$ N C; $F_{AC} = 255$ N T; $F_{BC} = 1319$ N T;
$F_{BD} = 1700$ N C; $F_{CD} = 986$ N T; $F_{CE} = 744$ N T;
$F_{DE} = 1050$ N T; $F_{DF} = 1750$ N C; $F_{EF} = 1565$ N T;
$F_{EG} = 0$; $F_{FG} = 350$ N C.
6.26 $F_{AB} = F_{BD} = 8.20$ kN T; $F_{AC} = 8.00$ kN C;
$F_{BC} = 0.600$ kN C; $F_{CD} = 1.342$ kN T; $F_{CE} = 9.20$ kN C;
$F_{DE} = 0.330$ kN C; $F_{DG} = 9.43$ kN T; $F_{EF} = 9.99$ kN C;
$F_{EG} = 0.858$ kN T; $F_{FG} = F_{FH} = 7.99$ kN C.
6.27 Trusses of Probs. 6.14, 6.15, and 6.23 are simple trusses.
6.28 Trusses of Probs. 6.21, 6.25, and 6.29 are simple trusses.
6.29 *BE, EI, FG, GH, HI, IJ.*
6.30 *AI, DI, EI, FK, GK.*
6.31 *BC, BE, DE, FH, HI, IJ, OQ, QR.*
6.33 *BC, LM.*
6.35 (*a*) *BF, BG, CG, CH.* (*b*) *BE, EI, FG, GH, HI, IJ.*
6.36 $F_{AB} = 975$ N C; $F_{AC} = 5.00$ N T; $F_{AD} = 5.93$ kN C;
$F_{BC} = 611$ N C; $F_{BD} = 4.94$ kN T; $F_{CD} = 1.335$ kN T.
6.37 $F_{AB} = 1.395$ kN C; $F_{AC} = 415$ N C; $F_{AD} = 4.24$ kN C;
$F_{BC} = 672$ N T; $F_{BD} = 4.94$ kN T; $F_{CD} = 534$ N C.
6.38 $F_{AB} = 335$ N C; $F_{AC} = 0$; $F_{AD} = 375$ N T;
$F_{AE} = 75.0$ N T; $F_{BC} = 100.0$ N T; $F_{BD} = 150.0$ N C;
$F_{CD} = 141.4$ N C; $F_{CE} = 50.0$ N C; $F_{DE} = 25.0$ N C.
6.39 $F_{AB} = F_{AD} = F_{BC} = 0$; $F_{AC} = 1.700$ kN C;
$F_{AE} = 2.13$ kN T; $F_{BD} = 1.275$ kN T;
$F_{BE} = F_{CD} = 1.125$ kN C; $F_{DE} = 600$ N C.
6.40 (*b*) $F_{AE} = 252$ N T; $F_{BE} = 373$ N C; $F_{DE} = F_{EF} = 0$;
$F_{EG} = 365$ N T; $F_{EH} = 240$ N C.
6.41 (*b*) $F_{BG} = 348$ N C; $F_{CG} = F_{DG} = F_{FG} = 0$;
$F_{EG} = 365$ N T; $F_{GH} = 275$ N C.
6.42 $F_{CF} = 3.25$ kN T; $F_{EF} = 0.1398$ kN T; $F_{EG} = 3.38$ kN C.
6.43 $F_{FI} = 2.75$ kN T; $F_{HI} = 1.258$ kN C; $F_{HJ} = 1.625$ kN C.
6.44 $F_{BD} = 2.14$ kN C; $F_{BE} = 429$ N C; $F_{CE} = 2.47$ kN T.
6.46 $F_{CE} = 14.35$ kN T; $F_{DE} = 11.41$ kN T; $F_{DF} = 25.6$ kN C.
6.48 $F_{DF} = 13.00$ kN C; $F_{DG} = 4.22$ kN C; $F_{EG} = 16.22$ kN T.
6.49 $F_{GI} = 16.22$ kN T; $F_{HI} = 1.000$ kN T; $F_{HJ} = 17.33$ kN C.
6.50 $F_{BD} = 29.8$ kN C; $F_{CD} = 6.25$ kN T; $F_{CE} = 22.5$ kN T.
6.51 $F_{EG} = 16.88$ kN T; $F_{FG} = 8.01$ kN T; $F_{FH} = 22.3$ kN C.
6.52 $F_{CE} = 10.00$ kN C; $F_{DE} = 4.00$ kN C; $F_{EF} = 3.00$ kN T.
6.53 $F_{GI} = 4.00$ kN C; $F_{HI} = 15.00$ kN T; $F_{IJ} = 3.00$ kN T.
6.55 $F_{IK} = 0.707$ kN C; $F_{JL} = 0$; $F_{JM} = 6.35$ kN T.
6.57 $F_{GI} = 7.18$ kN T; $F_{HJ} = 8.03$ kN C; $F_{IJ} = 4.46$ kN C.
6.58 $F_{CE} = 7.34$ kN C; $F_{CF} = 3.58$ kN T; $F_{DF} = 2.35$ kN T.
6.60 $F_{DG} = 1.800$ kN C; $F_{FH} = 1.800$ kN T.
6.62 $F_{HK} = 53.9$ kN C; $F_{IK} = 57.3$ kN C.
6.63 $F_{EG} = 44.1$ kN T; $F_{FI} = 26.2$ kN C.
6.64 $F_{BD} = 15.31$ kN C; $F_{CD} = 2.42$ kN T;
$F_{CE} = 13.26$ kN T.
6.65 $F_{BD} = 10.51$ kN C; $F_{BE} = 1.211$ kN T;
$F_{CE} = 9.49$ kN T.
6.67 $F_{BE} = 10.00$ kN T; $F_{DE} = 0$; $F_{EF} = 5.00$ kN T.
6.68 $F_{CE} = 15.00$ kN T; $F_{DE} = 25.0$ kN T;
$F_{DF} = 30.0$ kN C.
6.70 (*a*) Partially constrained.
(*b*) Partially constrained.
(*c*) Completely constrained, statically determinate.
6.71 (*a*) Completely constrained, statically determinate.
(*b*) Partially constrained.
(*c*) Improperly constrained, statically indeterminate.
6.73 (*a*) Improperly constrained.
(*b*) Partially constrained.
(*c*) Improperly constrained.
6.74 (*a*) Completely constrained, statically determinate.
(*b*) Partially constrained.
(*c*) Completely constrained, statically indeterminate.
6.76 $\mathbf{A}_x = 120.0$ N $\rightarrow$, $\mathbf{A}_y = 30.0$ N $\uparrow$; $\mathbf{B}_x = 120.0$ N $\leftarrow$,
$\mathbf{B}_y = 80.0$ N $\downarrow$; $\mathbf{C} = 30.0$ N $\downarrow$; $\mathbf{D} = 80.0$ N $\uparrow$.
6.78 $\mathbf{C} = 1824$ N $\downarrow$; $\mathbf{D}_x = 1824$ N $\leftarrow$, $\mathbf{D}_y = 480$ N $\downarrow$;
$\mathbf{E}_x = 1824$ N $\rightarrow$, $\mathbf{E}_y = 1824$ N $\uparrow$.
6.79 $\mathbf{C} = 1600$ N $\uparrow$; $\mathbf{D}_x = 1600$ N $\rightarrow$, $\mathbf{D}_y = 0$;
$\mathbf{E}_x = 1600$ N $\leftarrow$, $\mathbf{E}_y = 1600$ N $\downarrow$.
6.80 (*a*) 7.32 N C. (*b*) $\mathbf{A} = 6.26$ N $\measuredangle$ 16.69°.
6.82 $\mathbf{A}_x = 356$ N $\rightarrow$; $\mathbf{B}_x = 229$ N $\leftarrow$, $\mathbf{B}_y = 127.3$ N $\uparrow$;
$\mathbf{C}_x = 127.3$ N $\leftarrow$, $\mathbf{C}_y = 178.2$ N $\uparrow$; $\mathbf{D} = 305$ N $\downarrow$.
6.83 $\mathbf{A}_x = 300$ N $\rightarrow$; $\mathbf{B}_x = 300$ N $\leftarrow$, $\mathbf{B}_y = 0$;
$\mathbf{C}_x = 0$, $\mathbf{C}_y = 300$ N $\uparrow$; $\mathbf{D}_y = 300$ N $\downarrow$.
6.84 (*a*) $\mathbf{A}_x = 14.40$ N $\leftarrow$, $\mathbf{A}_y = 9.60$ N $\uparrow$; $\mathbf{E}_x = 14.40$ N $\rightarrow$,
$\mathbf{E}_y = 14.40$ N $\uparrow$. (*b*) $\mathbf{A}_x = 6.40$ N $\leftarrow$, $\mathbf{A}_y = 1.600$ N $\uparrow$;
$\mathbf{E}_x = 6.40$ N $\rightarrow$, $\mathbf{E}_y = 22.4$ N $\uparrow$.
6.85 (*a*) $\mathbf{A}_x = 120.0$ N $\leftarrow$, $\mathbf{A}_y = 200$ N $\uparrow$; $\mathbf{E}_x = 120.0$ N $\rightarrow$,
$\mathbf{E}_y = 120.0$ N $\uparrow$. (*b*) $\mathbf{A}_x = 96.0$ N $\leftarrow$, $\mathbf{A}_y = 96.0$ N $\uparrow$;
$\mathbf{E}_x = 96.0$ N $\rightarrow$, $\mathbf{E}_y = 224$ N $\uparrow$.
6.86 (*a*) $\mathbf{A}_x = 19.20$ N $\rightarrow$, $\mathbf{A}_y = 19.20$ N $\uparrow$; $\mathbf{E}_x = 19.20$ N $\leftarrow$,
$\mathbf{E}_y = 19.20$ N $\downarrow$. (*b*) $\mathbf{A}_x = 51.2$ N $\rightarrow$, $\mathbf{A}_y = 12.80$ N $\downarrow$;
$\mathbf{E}_x = 51.2$ N $\rightarrow$, $\mathbf{E}_y = 12.80$ N $\uparrow$.
6.88 (*a*) $\mathbf{F}_{AB} = 260$ N $\measuredangle$ 22.6°; $\mathbf{F}_{BC} = 480$ N $\rightarrow$;
$\mathbf{F}_{GH} = 240$ N $\leftarrow$; $\mathbf{I}_y = 100$ N $\uparrow$. (*b*) $\mathbf{F}_{AB} = 260$ N $\measuredangle$
22.6°; $\mathbf{F}_{BC} = 240$ N $\rightarrow$; $\mathbf{F}_{FG} = 0$; $\mathbf{I}_y = 100$ N $\uparrow$.
6.89 (*a*) $\mathbf{B}_x = 200$ N $\rightarrow$, $\mathbf{B}_y = 40.0$ N $\downarrow$; $\mathbf{F}_x = 200$ N $\leftarrow$,
$\mathbf{F}_y = 160.0$ N $\uparrow$. (*b*) $\mathbf{B}_x = 320$ N $\rightarrow$, $\mathbf{B}_y = 40.0$ N $\downarrow$;
$\mathbf{F}_x = 320$ N $\leftarrow$, $\mathbf{F}_y = 160.0$ N $\uparrow$. (*c*) $\mathbf{B}_x = 320$ N $\rightarrow$,
$\mathbf{B}_y = 40.0$ N $\downarrow$; $\mathbf{F}_x = 320$ N $\leftarrow$, $\mathbf{F}_y = 160.0$ N $\uparrow$.
6.92 $\mathbf{A}_x = 1315.6$ N $\rightarrow$, $\mathbf{A}_y = 858.3$ N $\uparrow$;
$\mathbf{E}_x = 1315.6$ N $\leftarrow$, $\mathbf{E}_y = 1201.7$ N $\uparrow$.
6.93 $\mathbf{A}_x = 1444$ N $\rightarrow$, $\mathbf{A}_y = 1239$ N $\uparrow$;
$\mathbf{E}_x = 1444$ N $\leftarrow$, $\mathbf{E}_y = 821$ N $\uparrow$.
6.94 $\mathbf{A}_x = 17.00$ N $\leftarrow$, $\mathbf{A}_y = 94.1$ N $\uparrow$;
$\mathbf{E}_x = 17.00$ N $\rightarrow$, $\mathbf{E}_y = 75.9$ N $\uparrow$.
6.95 $\mathbf{A}_x = 45.0$ N $\leftarrow$, $\mathbf{A}_y = 30.0$ N $\downarrow$;
$\mathbf{B}_x = 45.0$ N $\rightarrow$, $\mathbf{B}_y = 270$ N $\uparrow$.
6.96 (*a*) $\mathbf{A} = 15.76$ kN $\uparrow$; $\mathbf{B} = 26.2$ kN $\uparrow$.
(*b*) $\mathbf{C}_x = 34.6$ kN $\leftarrow$; $\mathbf{D} = 34.7$ kN $\measuredangle$ 4.10°.
6.97 (*a*) $\mathbf{A} = 2.52$ kN $\uparrow$; $\mathbf{B} = 31.5$ kN $\uparrow$.
(*b*) $\mathbf{C}_x = 4.93$ kN $\leftarrow$; $\mathbf{D}_x = 4.93$ kN $\rightarrow$, $\mathbf{D}_y = 12.97$ kN $\downarrow$.
6.98 $\mathbf{A}_x = 10.80$ kN $\leftarrow$, $\mathbf{A}_y = 7.00$ kN $\uparrow$;
$\mathbf{B}_x = 16.20$ kN $\leftarrow$, $\mathbf{B}_y = 0.500$ kN $\downarrow$;
$\mathbf{D}_x = 27.0$ kN $\rightarrow$, $\mathbf{D}_y = 6.50$ kN $\downarrow$.
6.100 $\mathbf{B}_x = 530$ N $\rightarrow$, $\mathbf{B}_y = 385$ N $\downarrow$;
$\mathbf{C}_x = 299$ N $\leftarrow$, $\mathbf{C}_y = 385$ N $\uparrow$.
6.101 $\mathbf{B}_x = 60.6$ N $\leftarrow$, $\mathbf{B}_y = 41.7$ N $\downarrow$;
$\mathbf{C}_x = 60.6$ N $\rightarrow$, $\mathbf{C}_y = 29.7$ N $\uparrow$.
6.103 (*a*) A' and B'. (*b*) 215 N T.
6.104 (*a*) $\mathbf{A}_x = 27.5$ kN $\rightarrow$, $\mathbf{A}_y = 16.25$ kN $\uparrow$.
(*b*) $\mathbf{B}_x = 27.5$ kN $\leftarrow$, $\mathbf{B}_y = 2.25$ kN $\downarrow$.
6.105 (*a*) $\mathbf{A}_x = 28.8$ kN $\rightarrow$, $\mathbf{A}_y = 19.38$ kN $\uparrow$.

(*b*) $\mathbf{B}_x$ = 28.8 kN ←, $\mathbf{B}_y$ = 1.625 kN ↑.
6.106 (*a*) 1009 N ∠ 18.18°. (*b*) 357 N *T*.
6.108 $a \geq 0.600$ m.
6.109 F_{CF} = 9.00 kN *C*; F_{DG} = 6.00 kN *T*.
6.110 F_{BF} = 7.20 kN *T*; F_{DG} = 3.00 kN *C*.
6.111 F_{BG} = 6.00 kN *T*; F_{CH} = 3.00 kN *C*.
6.113 **A** = 3*P*/13 ↑; **D** = *P*/13 ↑; **F** = 9*P*/13 ↑.
6.114 **A** = *P*/15 ↑; **D** = 2*P*/15 ↑; **E** = 8*P*/15 ↑; **H** = 4*P*/15 ↑.
6.115 (*a*) Frame is not rigid. (*b*) Reactions can be found for an arbitrary value of B_x; frame is rigid. (*c*) **A** = 2.09*P* ∠ 16.70°; **B** = 2.04*P* ∠ 11.31°; frame is rigid.
6.116 (*a*) **A** = 2.06*P* ∠ 14.04°; **B** = 2.06*P* ∠ 14.04°; frame is rigid. (*b*) Frame is not rigid. (*c*) **A** = 1.250*P* ∠ 36.9°; **B** = 1.031*P* ∠ 14.04°; frame is rigid.
6.117 (*a*) **A** = 2.24*P* ∠ 26.6°; **B** = 2*P* →; frame is rigid. (*b*) Frame is not rigid. (*c*) **A** = *P* ↑; **B** = *P* ↓; **C** = *P* ↑; frame is rigid.
6.118 (*a*) 2.86 kN ↓. (*b*) 2.70 kN ∠ 68.5°.
6.119 (*a*) 420 N. (*b*) 2.83 kN ∠ 68.5°.
6.122 (*a*) 456 N ←. (*b*) 505 N *T*.
6.123 113.7 N ∠ 16.17°.
6.124 101.8 N ∠ 18.89°.
6.125 995 N · m. ↻.
6.127 (*a*) 3.87 N · m ↻. (*b*) 5.12 N · m ↻.
6.128 (*a*) 248 N ←. (*b*) 187.9 N ←.
6.129 9.38 N · m ↻.
6.130 46.3 N · m ↻.
6.131 9.13 N · m ↺.
6.132 7.50 N · m ↺.
6.133 2.77 kN · m. ↻.
6.136 **CD** = 30.0 kN ←; **F** = 37.5 kN ∠ 36.9°.
6.137 **G** = 7.42 kN ↓; **H** = 3.12 kN ∠ 70.3°.
6.139 720 N.
6.140 2.22 kN.
6.141 156.6 N.
6.142 783 N.
6.143 11.46 N ∠ 30.0°.
6.144 43.1 N ∠ 60.0°.
6.146 8.82 kN.
6.147 6.48 kN ∠ 62.1°.
6.148 (*a*) 0. (*b*) $\mathbf{C}_x$ = 7.20 kN ←, $\mathbf{C}_y$ = 1.500 kN ↓.
6.150 (*a*) 7.68 kN *C*. (*b*) 21.7 kN *C*.
6.151 (*a*) 36.0 mm. (*b*) 60.0 N · m ↻.
6.152 (*a*) (9 N · m.)**i**. (*b*) $\mathbf{M}_G$ = (14.4 N · m.)**i**; $\mathbf{M}_H$ = −(10.3 N · m.)**i**.
6.154 (*a*) 43.3 N · m. (*b*) **B** = −(50.0 N)**k**; **D** = (83.3 N)**k**; **E** = −(33.3 N)**k**.
6.155 $\mathbf{E}_x$ = 2040 N →, $\mathbf{E}_y$ = 3160 N ↑; $\mathbf{F}_x$ = 540 N →, $\mathbf{F}_y$ = 2410 N ↓; $\mathbf{H}_x$ = 2580 N ←, $\mathbf{H}_y$ = 750 N ↓.
6.156 $F_{AB} = F_{BD} = 0$; F_{AC} = 3.00 kN *T*; F_{AD} = 5.00 kN *C*; F_{CD} = 4.00 kN *T*; F_{CE} = 9.00 kN *T*; F_{CF} = 10.00 kN *T*; F_{DF} = 6.00 kN *T*; F_{EF} = 8.00 kN *T*.
6.157 F_{FG} = 1.750 kN *T*; F_{FH} = 2.52 kN *C*; F_{GH} = 0.838 kN *T*; $F_{GI} = F_{IK} = F_{KL}$ = 1.677 kN *T*; $F_{HI} = F_{IJ} = F_{JK} = 0$; $F_{HJ} = F_{JL}$ = 2.12 kN *C*.
6.158 F_{AB} = 61.9 kN *C*; F_{AC} = 56.5 kN *C*; F_{AD} = 30.2 kN *T*; F_{AE} = 19.01 kN *T*; F_{BD} = 43.0 kN *T*; F_{BF} = 56.0 kN *C*; F_{CE} = 82.0 kN *T*; F_{CG} = 84.0 kN *C*; F_{DE} = 44.0 kN *T*; F_{DF} = 67.1 kN *T*; F_{EG} = 0.
6.160 F_{AB} = 36.4 kN *T*; F_{AG} = 20.0 kN *T*; F_{FG} = 51.6 kN *C*.
6.162 $\mathbf{A}_x$ = 4.50 kN ←, $\mathbf{A}_y$ = 5.00 kN ↓; $\mathbf{F}_{BE}$ = 2.25 kN →; $\mathbf{C}_x$ = 2.25 kN →, $\mathbf{C}_y$ = 5.00 kN ↑.
6.163 $\mathbf{B}_x$ = 175.0 N ←, $\mathbf{B}_y$ = 50.0 N ↓; $\mathbf{E}_x$ = 175.0 N →, $\mathbf{E}_y$ = 125.0 N ↑.
6.165 (*a*) 220 N →. (*b*) 254 N *T*. (*c*) 280 N ∠ 38.3°.
6.166 1680 N.

CHAPTER 7

7.1 (On *EJ*) **F** = 0; **V** = 1200 N ←; **M** = 180.0 N · m ↻.
7.3 (On *CJ*) **F** = 127.3 N ←; **V** = 178.2 N ↑; **M** = 11.46 N · m ↻.
7.5 (On *AJ*) **F** = 124.8 N →; **V** = 52.0 N ↓; **M** = 13 N · m. ↺.
7.6 (On *CK*) **F** = 123.3 N ∠ 22.9°; **V** = 24.1 ∠ 67.1°; **M** = 7.6 N · m. ↻.
7.7 (On *BJ*) **F** = 0; **V** = 0; **M** = 2.41 N · m ↻.
7.8 (On *BJ*) **F** = 0; **V** = 44.1 N ↑; **M** = 4.22 N · m ↺.
7.9 (On *BJ*) **F** = 4.39 N ∠ 60.0°; **V** = 16.39 N ∠ 30.0°; **M** = 0.76 N · m. ↻.
7.11 (On *CJ*) **F** = 1.482 N ∠ 60°; **V** = 103.1 N ∠ 30°; **M** = 10.3 N · m. ↻.
7.13 (On *AJ*) **F** = 6260 N ∠ 19.80°; **V** = 339 N ∠ 70.2°; **M** = 346 N · m ↻.
7.14 $M_{max} = PL/4$; $a = L/2$.
7.15 (On *BJ*) **F** = 250 N ∠ 36.9°; **V** = 120.0 N ∠ 53.1°; **M** = 120.0 N · m ↺.
7.16 (On *AK*) **F** = 560 N ←; **V** = 90.0 N ↓; **M** = 72.0 N · m ↻.
7.17 (On *DJ*) **F** = 1036 N ∠ 67.4°; **V** = 17.31 N ∠ 22.6°; **M** = 22.5 N · m ↻.
7.18 (On *AK*) **F** = 463 N ∠ 53.1°; **V** = 41.1 N ∠ 36.9°; **M** = 61.7 N · m ↺.
7.19 (On *CJ*) **F** = 733 N ∠ 46.4°; **V** = 87 N ∠ 44.6; **M** = 19 N · m. ↺.
7.21 (*a*) (On *AJ*) **F** = *P*/2 ↓; **V** = 0; **M** = 0. (*b*) (On *AJ*) **F** = 11*P*/14 ↓; **V** = 2*P*/7 ←; **M** = 2*Pa*/7 ↻. (*c*) (On *AJ*) **F** = 5*P*/2 ↓; **V** = 2*P* ←; **M** = 2*Pa* ↻.
7.23 (On *AJ*) **M** = 0.0774*Wr* ↻.
7.24 (On *AJ*) **M** = 0.01085*Wr* ↻.
7.25 θ = 27.7°; (On *AJ*) $\mathbf{M}_{max}$ = 0.0777*Wr* ↻.
7.26 θ = 66.6°; (On *AJ*) $\mathbf{M}_{max}$ = 0.0362*Wr* ↺.
7.29 (*b*) M_0/L; $M_0/2$.
7.30 (*b*) *P*; *Pa*.
7.31 (*b*) $w_0L/2$; $w_0L^2/6$.
7.32 (*b*) *P*; 1.5*Pa*.
7.34 (*b*) 12.63 kN; 8.9 kN · m.
7.36 (*b*) 3.50 kN; 4.50 kN · m.
7.37 (*b*) 5.56 kN; 6.59 kN · m.
7.39 (*b*) 175.0 N; 31.25 N · m.
7.40 (*b*) 39 kN; 59.4 kN · m.
7.41 (*b*) 6.00 kN; 6.00 kN · m.
7.43 (*b*) 4.00 kN; 4.00 kN · m.
7.45 7.00 kN; 7.50 kN · m.
7.47 (*b*) 495 N; 194.4 N · m.
7.48 (*b*) 585 N; 290 N · m.
7.49 360 N; 140.0 N · m.
7.51 (*a*) 0.311 m. (*b*) 232 N · m.
7.52 (*a*) 0.43 m. (*b*) 141 N · m.
7.53 (*a*) 411 N. (*b*) 1029 N · m.
7.54 (*a*) 1.063 m. (*b*) 8.50 kN · m.
7.56 (*a*) imaginary.
7.57 (*a*) 0.414 *wL*; 0.858 wL^2. (*b*) *wL*/4; $wL^2/4$.

7.58 (b) M_0/L; $M_0/2$.
7.60 (b) $w_0L/2$; $w_0L^2/6$.
7.61 (b) P; $1.5Pa$.
7.62 (b) 12.63 kN; 8.9 kN · m.
7.64 (b) 780 N; 210 N · m.
7.65 (b) 8.37 kN; 11.02 kN · m.
7.66 (b) 5.56 kN; 6.59 kN · m.
7.68 (b) 175.0 N; 25 N · m.
7.69 (b) 33.0 kN; 9.9 kN · m.
7.70 (b) 124.0 N; 75.4 N · m.
7.72 (b) 1.985 kN · m, 1.260 m from A.
7.74 (a) 23.8 kN · m. (b)
7.75 1011.2 kN · m, 1.59 m from A.
7.76 (b) 52.0 kN · m.
7.78 (b) 684 kN · m at E.
7.79 (b) 2.77 kN · m at C.
7.80 (a) $V = (w_0/L)(-2x^2 + Lx)$;
$M = (w_0/6L)(-4x^3 + 3Lx^2)$. ($c$) $w_0L^2/6$, at $x = L$.
7.81 (a) For $0 \le x \le 2a$: $V = (w_0/2a)(3a^2 - x^2)$,
$M = (w_0/6a)(-9a^3 + 9a^2x - x^3)$. ($c$) $1.5w_0a^2$, at $x = 0$.
7.82 (b) $1.359w_0a^2$, at $x = 2.10a$.
7.85 (a) **P** = 175.0 N ↓; **Q** = 175.0 N ↓.
7.86 (a) **P** = 600 N ↓; **Q** = 400 N ↓.
(b) M_{max} = 3.40 kN · m, 1.875 m from C.
7.87 (a) **P** = 1.113 N ↓; **Q** = 277 N ↓.
7.88 (a) 1.125 m. (b) $\mathbf{A}_x$ = 4.00 kN ←, $\mathbf{A}_y$ = 2.25 kN ↑.
(c) 5.00 kN.
7.89 (a) 2.26 m. (b) 1.508 m.
7.91 5.00 m.
7.92 (a) 4.65 kN ↗ 23.8°. (b) d_B = 1.112 m;
d_D = 1.641 m.
7.93 (a) 1.385 m.
(b) **A** = 8.45 kN ↘ 39.7°; **E** = 6.61 kN ↗ 10.46°.
7.94 (a) 1229 N. (b) 11.00 m.
7.96 (a) 29.0 N. (b) 4.06 m.
7.97 a = 1.3 m; b = 3.2 m.
7.98 (a) **A** = 2.08 kN ↘ 22.6°. (b) 107.0 kg.
(c) T_{AB} = 2.08 kN; T_{BC} = 1.000 kN; T_{CD} = 0.650 kN.
7.101 (a) 33.1 kg. (b) 99.5 N.
7.102 (a) 177.5 kN. (b) 60.1 m.
7.103 (a) 4.50 m. (b) T_1 = 410 N; T_2 = 400 N.
7.104 (a) 16945.17 kN. (b) 1284.8 m.
7.105 (a) 15041.75 kN. (b) 567.2 m.
7.106 (a) 0.08 m. (b) 0.42°.
7.108 1.4 m.
7.110 (a) 58,900 kN. (b) 29.2°.
7.111 (a) 0.36 m from A. (b) 0.04 N.
7.112 (a) 1.713 m. (b) 6.19 m.
7.113 (a) 2.22 m. (b) 5.36 kN.
7.115 2.26 m.
7.116 d_B = 1.112 m; d_D = 1.641 m.
7.120 $y = (w_0L^2/T_0\pi^2)\,[1 - (\cos \pi x)/L]$; $T_{min} = w_0L^2/h\pi^2$;
$T_B = (w_0L/\pi)\sqrt{(L^2/h^2\pi^2) + 1}$.
7.122 (a) 2.92 m. (b) 5.23 N.
7.123 (a) 8.9 m. (b) 61.5 N.
7.124 (a) 123.6 m. (b) 262.5 N.
7.127 (a) 7.94 m. (b) 24.0 m.
7.128 (a) 0.530 m. (b) 114.7 N.
7.129 (a) 30.2 m. (b) 56.6 kg.
7.131 (a) 1.265 m. (b) 80.3°.
7.132 5.23 m.
7.133 2.4 m and 15 m.
7.135 (a) 18.78 m. (b) 3.53 kg/m.
7.136 8.2 N →.
7.137 12.15 N →.
7.138 (a) a = 26.8 m; b = 20.4 m. (b) 35.3 m.
7.139 (a) a = 20.1 m; b = 15.29 m. (b) 26.5 m.
7.140 (a) 3.15 m. (b) 231 N.
7.141 (a) 6.2 m to the left of B. (b) 2.86 N.
7.143 (a) $1.325T_{max}/w$. (b) 12.72 km.
7.146 (a) 0.338. (b) θ_B = 56.5°; $T_{max} = 0.755wL$.
7.147 (On AJ) **F** = 48.7 N ↖ 60.0°; **V** = 64.3 N ↗ 30.0°;
M = 7.732 N · m. ↻.
7.148 (On EJ) **F** = 50.0 N ↖; **V** = 30.0 N ↙;
M = 27 N · m ↻.
7.150 (b) 8.00 kN; 17.73 kN · m.
7.151 (b) 18.00 kN; 48.5 kN · m.
7.153 (a) 22.5 kN · m, 1.500 m from A.
(b) 30.2 kN · m, 1.350 m from A.
7.154 (a) $V = w_0L\left[\frac{1}{3} - \frac{x}{L} + \frac{1}{2}\left(\frac{x}{L}\right)^2\right]$

$$M = w_0L^2\left[\frac{1}{3}\left(\frac{x}{L}\right) - \frac{1}{2}\left(\frac{x}{L}\right)^2 + \frac{1}{6}\left(\frac{x}{L}\right)^3\right]$$

(c) $0.0642\, w_0L^2$, at $x = 0.423L$.
7.156 (a) 3.35 kN ↘ 17.35°. (b) 3.88 kN ↗ 34.5°.
7.157 (a) 7.2 m to the left of B. (b) 669 N.

CHAPTER 8

8.1 (a) 31.1 N. (b) 127.0 N.
8.3 Equilibrium; **F** = 4.04 N ↙ 20°.
8.4 Block moves; **F** = 19.00 N ↙ 20°.
8.5 7.56 N $\le P \le$ 59.2 N.
8.6 28.9°.
8.7 (a) 81.7 N. (b) 19.29°.
8.9 (a) $0 \le \theta \le 55.7°$. (b) $167.9° \le \theta \le 180.0°$.
8.12 (a) 361 N ←. (b) 196.2 N ←.
8.13 49.1°.
8.14 23.4°.
8.15 (a) 58.1°. (b) 166.4 N.
8.17 (a) $0.360Wr$. (b) $0.422Wr$.
8.18 (a) 1300 N. (b) 1700 N.
8.20 (a) 17.53°. (b) $0.252W$.
8.21 0.539.
8.23 (a) 4.62° and 48.2°. (b) $0.526W$ and $0.374W$.
8.24 $3.46 \le L/a \le 13.63$.
8.25 2.62 kN ↓.
8.26 0.1865.
8.27 0.1900.
8.28 0.283.
8.30 (a) 0.526. (b) 0.277.
8.32 $21.8° \le \theta \le 62.9°$.
8.34 Equilibrium if 17.82 N $\le w \le$ 98.2 N.
8.35 66.1 kg $\le m \le$ 364 kg.
8.36 $2Pl/(\tan \theta - \mu_s)$.
8.37 0.1400.
8.40 (a) 0.614 N · m. ↺. (b) 0.486 N · m. ↺.
8.41 7.72 N.
8.42 (a) 0.322 kg. (b) 3.60 kg.
8.43 0.1757.
8.45 236 N $\le P \le$ 289 N.
8.46 441 N.
8.47 480 N.

8.50 (*a*) 72.3 kN →. (*b*) 27.0 kN ←.
8.51 (*a*) 99.3 kN ←. (*b*) 45.3 kN →.
8.52 (*a*) 367 N. (*b*) 367 N.
8.54 8.89 kN.
8.55 38.6°.
8.56 117.5 N.
8.57 6.60 N.
8.58 (*a*) Wedge is forced up and out from between plates. (*b*) Wedge binds in the slot.
8.60 714 N ⦪ 20.0°.
8.61 0.203.
8.62 (*a*) 53.2 N →. (*b*) Motion of the plank at *B* is impending.
8.63 (*a*) 61.3 N →. (*b*) Plank does not move.
8.64 0.385.
8.65 0.332.
8.69 224 N · m.
8.72 (*a*) Screw *A*. (*b*) 1.535 N · m.
8.73 3.07 N · m.
8.74 33.1 N · m.
8.75 15.35 kN.
8.76 126 N.
8.78 81 N.
8.80 (*a*) 0.344. (*b*) 120.2 N.
8.81 $T_{AB} = 290$ N; $T_{CD} = 310$ N; $T_{EF} = 331$ N.
8.82 $T_{AB} = 310$ N; $T_{CD} = 290$ N; $T_{EF} = 272$ N.
8.83 (*a*) 1.177 kN. (*b*) 1.349°.
8.84 253 N.
8.85 250 N.
8.88 (*a*) 5.96 N. (*b*) 3.99 N.
8.89 99.3 mm.
8.90 1.8 N.
8.91 1.596 N · m.
8.95 1.35 N.
8.97 1.200 mm.
8.98 42.7 N.
8.99 (*a*) 56.0 N. (*b*) 54.0 N.
8.100 216 mm.
8.101 (*a*) 0.329. (*b*) 2.67 turns.
8.104 $286 \text{ N} \leq P \leq 4840$ N.
8.105 $24.3 \text{ N} \leq P \leq 411$ N.
8.106 (*a*) 500 N. (*b*) 0.212.
8.107 10.27 N · m.
8.109 (*a*) 47.9 N. (*b*) 1.900.
8.110 (*a*) $T_A = 42.0$ N; $T_B = 98.0$ N. (*b*) 0.270.
8.111 (*a*) $T_A = 55.7$ N; $T_B = 104.3$ N. (*b*) 10.95 N · m.
8.112 101.1 N · m.
8.114 0.361.
8.115 (*a*) 432 N · m. (*b*) 0.219.
8.116 (*a*) 1.940 kg. (*b*) 63.7 kg. (*c*) 20.2 kg.
8.117 203 kg.
8.118 (*a*) $3.69 \text{ N} \leq W_A \leq 69.3$ N. (*b*) $5.61 \text{ N} \leq W_A \leq 45.6$ N.
8.120 (*a*) $4.55 \text{ N} \leq W_A \leq 56.2$ N. (*b*) $6.92 \text{ N} \leq W_A \leq 37.0$ N.
8.122 5.97 N.
8.123 9.56 N.
8.124 (*a*) 538 N · m ↺. (*b*) 1.142 kN ↓.
8.126 0.350.
8.130 21.76 N · m.
8.131 107 N.
8.132 Block moves; **F** = 193.2 N ↗.
8.133 (*a*) 50.5°. (*b*) 66.5°.
8.135 0.1835.
8.136 0.750.
8.137 (*a*) $W \leq 4.07$ N and $W \geq 86.4$ N. (*b*) $W \geq 246$ N.
8.139 2.46 kN ←.
8.141 0.0787.
8.142 10.08 N · m.

CHAPTER 9

9.1 $a^3(b_1 + 3b_2)/12$.
9.2 $5a^3b/33$.
9.3 $a^3b/21$.
9.5 $a(b_1 + b_2)(b_1^2 + b_2^2)/12$.
9.6 $5ab^3/17$.
9.7 $31ab^3/30$.
9.9 $\pi ab^3/8$.
9.11 $0.1107ab^3$.
9.12 $\pi a^3b/8$.
9.14 $0.273a^3b$.
9.16 $59ab^3/30$; $1.086b$.
9.18 $9a^3b/14$; $0.621a$.
9.19 $0.217ab^3$; $0.642b$.
9.20 $1.482a^3b$; $1.676a$.
9.21 (*a*) $4a^4/3$; $a\sqrt{2/3}$. (*b*) $17a^4/6$; $a\sqrt{17/12}$.
9.22 $11ab(a^2 + 3b^2)/6$; $\sqrt{11(a^2 + 3b^2)/30}$.
9.24 $0.415r^4$; $0.822r$.
9.25 (*a*) $3\pi(R_2^4 - R_1^4)/8$. (*b*) $I_x = I_y = 3\pi(R_2^4 - R_1^4)/16$.
9.26 (*b*) −10.56%; −0.772%; −0.0488%.
9.27 $3\pi a^4/64$; $a\sqrt{6}/4$.
9.31 614×10^3 mm^4; 19.01 mm.
9.32 1.869×10^{-4} m^4; 0.067 m.
9.33 1.894×10^6 mm^4; 33.4 mm.
9.34 3.78×10^{-4} m^4; 0.099 m.
9.37 3000 mm^2; 325×10^3 mm^4.
9.38 24.6×10^6 mm^4.
9.39 0.2 m.; 0.7055×10^{-4} m^4
9.41 $\bar{I}_x = 26.76 \times 10^6$ mm^4; $\bar{I}_y = 2650 \times 10^3$ mm^4.
9.42 $\bar{I}_x = 6.51 \times 10^6$ mm^4; $\bar{I}_y = 5.12 \times 10^6$ mm^4.
9.44 $\bar{I}_x = 2.52 \times 10^6$ mm^4; $\bar{I}_y = 1.056 \times 10^6$ mm^4.
9.45 (*a*) 11.57×10^6 mm^4. (*b*) 7.81×10^6 mm^4.
9.46 (*a*) 60.2×10^6 mm^4. (*b*) 60.1×10^6 mm^4.
9.48 (*a*) 511.8×10^6 mm^4. (*b*) 33.4×10^6 mm^4.
9.49 $\bar{I}_x = 18.2 \times 10^6$ mm^4, $\bar{I}_y = 11.2 \times 10^6$ mm^4; $\bar{k}_x = 54.5$ mm, $\bar{k}_y = 42.7$ mm.
9.50 $\bar{I}_x = 195.9 \times 10^6$ mm^4, $\bar{I}_y = 190.7 \times 10^6$ mm^4; $\bar{k}_x = 114.0$ mm, $\bar{k}_y = 112.5$ mm.
9.52 12.29 mm.
9.53 $\bar{I}_x = 37.7 \times 10^6$ mm^4; $\bar{I}_y = 3.86 \times 10^6$ mm^4.
9.55 $b = 91.2$ mm; $\bar{I}_x = 11.33 \times 10^6$ mm^4.
9.56 (*a*) 363 mm. (*b*) $\bar{I}_x = 46 \times 10^6$ mm^4, $\bar{I}_y = 105.8 \times 10^6$ mm^4.
9.57 $h/2$.
9.59 $h(a + 3b)/(2a + 4b)$.
9.61 $F_A = F_B = 918$ N; $F_C = F_D = 944$ N.
9.62 2.55 m.
9.63 225 mm.
9.64 $5a/4$.
9.68 $3a^2b^2/16$.
9.69 $b^2h^2/8$.
9.70 $0.1419a^2b^2$.
9.71 300×10^3 mm^4.
9.72 192.2×10^6 mm^4.
9.73 138.2×10^6 mm^4.
9.74 -0.1596×10^6 mm^4.
9.75 1.573×10^6 mm^4.
9.78 1.17×10^6 mm^4.

9.80 $\bar{I}_{x'} = 1236.7 \times 10^6\ \text{mm}^4$; $\bar{I}_{y'} = 852.3 \times 10^6\ \text{mm}^4$; $\bar{I}_{x'y'} = 729.5 \times 10^6\ \text{mm}^4$.
9.82 $\bar{I}_{x'} = 4.61 \times 10^6\ \text{mm}^4$; $\bar{I}_{y'} = 3.82 \times 10^6\ \text{mm}^4$; $\bar{I}_{x'y'} = -3.83 \times 10^6\ \text{mm}^4$.
9.83 $\bar{I}_{x'} = 149.9 \times 10^3\ \text{mm}^4$; $\bar{I}_{y'} = 469 \times 10^3\ \text{mm}^4$; $\bar{I}_{x'y'} = 143.5 \times 10^3\ \text{mm}^4$.
9.84 $\bar{I}_{x'} = 2.2 \times 10^6\ \text{mm}^4$; $\bar{I}_{y'} = 2.8 \times 10^6\ \text{mm}^4$; $\bar{I}_{x'y'} = 1.83 \times 10^6\ \text{mm}^4$.
9.86 $\theta_m = 7.4°$ and $97.4°$; $\bar{I}_{\max} = 1795 \times 10^6\ \text{mm}^4$, $\bar{I}_{\min} = 315 \times 10^6\ \text{mm}^4$.
9.88 $12.06°$; $8.06 \times 10^6\ \text{mm}^4$, $0.365 \times 10^6\ \text{mm}^4$.
9.89 $-24.0°$ and $66°$, $0.524 \times 10^6\ \text{mm}^4$, $0.0949 \times 10^6\ \text{mm}^4$.
9.90 $\theta_m = -19.6°$ and $70.4°$; $\bar{I}_{\max} = 4.35 \times 10^6\ \text{mm}^4$, $\bar{I}_{\min} = 0.64 \times 10^6\ \text{mm}^4$.
9.92 $\bar{I}_{x'} = 1236.7 \times 10^6\ \text{mm}^4$; $\bar{I}_{y'} = 852.3 \times 10^6\ \text{mm}^4$; $\bar{I}_{x'y'} = 729.5 \times 10^6\ \text{mm}^4$.
9.94 $\bar{I}_{x'} = 4.61 \times 10^6\ \text{mm}^4$; $\bar{I}_{y'} = 3.82 \times 10^6\ \text{mm}^4$; $\bar{I}_{x'y'} = -3.83 \times 10^6\ \text{mm}^4$.
9.95 $\bar{I}_{x'} = 149.9 \times 10^3\ \text{mm}^4$; $\bar{I}_{y'} = 469 \times 10^3\ \text{mm}^4$; $\bar{I}_{x'y'} = 143.5 \times 10^3\ \text{mm}^4$.
9.96 $\bar{I}_{x'} = 22 \times 10^6\ \text{mm}^4$; $\bar{I}_{y'} = 2.8 \times 10^6\ \text{mm}^4$; $\bar{I}_{x'y'} = 1.83 \times 10^6\ \text{mm}^4$.
9.97 $20.2°$; $1.754a^4$, $0.209a^4$.
9.98 $\theta_m = 7.4°$ counterclockwise; $\bar{I}_{\max} = 1798.9 \times 10^6\ \text{mm}^4$, $\bar{I}_{\min} = 290.1 \times 10^6\ \text{mm}^4$.
9.100 $29.7°$; $405 \times 10^6\ \text{mm}^4$, $83.9 \times 10^6\ \text{mm}^4$.
9.101 $-24.0°$; $524 \times 10^3\ \text{mm}^4$, $94.9 \times 10^3\ \text{mm}^4$.
9.103 $2.95°$; $10.67 \times 10^6\ \text{mm}^4$, $4.84 \times 10^6\ \text{mm}^4$.
9.104 $\theta_m = -31.3°$; $\bar{I}_{\max} = 2221.3 \times 10^6\ \text{mm}^4$, $\bar{I}_{\min} = 702.5 \times 10^6\ \text{mm}^4$.
9.105 (*a*) $-215 \times 10^3\ \text{mm}^4$. (*b*) $-28.1°$. (*c*) $568 \times 10^3\ \text{mm}^4$.
9.106 $\theta_m = 19.6°$ counterclockwise; $\bar{I}_{\max} = 4.84 \times 10^6\ \text{mm}^4$, $\bar{I}_{\min} = 0.152 \times 10^6\ \text{mm}^4$.
9.107 $-24.0°$; $8.33 \times 10^6\ \text{mm}^4$, $1.509 \times 10^6\ \text{mm}^4$.
9.108 $\theta_m = 7.5°$ clockwise; $\bar{I}_{\max} = 269 \times 10^6\ \text{mm}^4$, $\bar{I}_{\min} = 113.9 \times 10^6\ \text{mm}^4$.
9.112 $\pm 159.4 \times 10^3\ \text{mm}^4$.
9.113 (*a*) $0.0699ma^2$. (*b*) $0.320ma^2$.
9.114 (*a*) $m(r_1^2 + r_2^2)/4$. (*b*) $m(r_1^2 + r_2^2)/2$.
9.116 (*a*) $5mb^2/6$. (*b*) $m(28a^2 + 13b^2)/48$.
9.117 (*a*) $I_{AA'} = mb^2/24$; $I_{BB'} = mh^2/18$. (*b*) $m(3b^2 + 4h^2)/72$.
9.118 $I_{DD'} = m(b^2 + 24d^2)/24$; $I_{EE'} = m(h^2 + 18d^2)/18$.
9.119 (*a*) $5ma^2/18$. (*b*) $3.61ma^2$.
9.121 $5mb^2/18$.
9.122 $m(93r_2^2 + 32L^2)/140$.
9.124 $m(b^2 + 3h^2)/5$.
9.125 $m(a^2 + b^2)/5$.
9.126 $m(a^2 + 3h^2)/6$; $\sqrt{(a^2 + 3h^2)/6}$.
9.127 $I_x = I_y = ma^2/4$; $I_z = ma^2/2$.
9.129 $2.74 \times 10^{-3}\ \text{kg} \cdot \text{m}^2$; 0.044 m.
9.131 $2mr^2/3$; $0.816r$.
9.132 (*a*) $\rho\pi h(a_2^4 + 2a_2^2 a_1^2 - 3a_1^4)/2$. (*b*) $a_2/\sqrt{3}$. (*c*) $2\rho\pi h a_2^4/3$.
9.133 $281 \times 10^{-3}\ \text{kg} \cdot \text{m}^2$.
9.134 (*a*) 0.0309 m. (*b*) 0.117 m.
9.136 (*a*) 46.0 mm. (*b*) $8.54 \times 10^{-3}\ \text{kg} \cdot \text{m}^2$; 45.4 mm.
9.137 $I_x = 4.95 \times 10^{-5}\ \text{kg} \cdot \text{m}^2$; $I_y = 3.34 \times 10^{-4}\ \text{kg} \cdot \text{m}^2$; $I_z = 3.17 \times 10^{-4}\ \text{kg} \cdot \text{m}^2$;
9.139 $I_x = 5.14 \times 10^{-3}\ \text{kg} \cdot \text{m}^2$; $I_y = 7.54 \times 10^{-3}\ \text{kg} \cdot \text{m}^2$; $I_z = 3.47 \times 10^{-3}\ \text{kg} \cdot \text{m}^2$.
9.141 $I_x = 0.1325\ \text{kg} \cdot \text{m}^2$; $I_y = 0.3186\ \text{kg} \cdot \text{m}^2$; $I_z = 0.2706\ \text{kg} \cdot \text{m}^2$
9.142 $I_x = 19.31 \times 10^{-3}\ \text{kg} \cdot \text{m}^2$; $I_y = 1.253\ \text{kg} \cdot \text{m}^2$; $I_z = 1.238\ \text{kg} \cdot \text{m}^2$.
9.143 $I_x = 0.0436\ \text{kg} \cdot \text{m}^2$; $I_y = 0.064\ \text{kg} \cdot \text{m}^2$; $I_z = 0.0446\ \text{kg} \cdot \text{m}^2$
9.144 $21.2\ \text{kg} \cdot \text{m}^2$.
9.145 $3.98\ \text{kg} \cdot \text{m}^2$.
9.146 $4.807 \times 10^{-3}\ \text{kg} \cdot \text{m}^2$.
9.148 $I_x = I_z = 6.85 \times 10^{-3}\ \text{kg} \cdot \text{m}^2$; $I_y = 12.63 \times 10^{-3}\ \text{kg} \cdot \text{m}^2$.
9.149 $I_x = 23.2 \times 10^{-3}\ \text{kg} \cdot \text{m}^2$; $I_y = 21.4 \times 10^{-3}\ \text{kg} \cdot \text{m}^2$; $I_z = 17.99 \times 10^{-3}\ \text{kg} \cdot \text{m}^2$.
9.151 $I_{xy} = 7.52 \times 10^{-4}\ \text{kg} \cdot \text{m}^2$; $I_{yz} = 1.786 \times 10^{-3}\ \text{kg} \cdot \text{m}^2$; $I_{zx} = 4.047 \times 10^{-3}\ \text{kg} \cdot \text{m}^2$.
9.152 $I_{xy} = 1.06 \times 10^{-3}\ \text{kg} \cdot \text{m}^2$; $I_{yz} = 1.19 \times 10^{-3}\ \text{kg} \cdot \text{m}^2$; $I_{zx} = 1.75 \times 10^{-3}\ \text{kg} \cdot \text{m}^2$.
9.154 $I_{xy} = -691 \times 10^{-6}\ \text{kg} \cdot \text{m}^2$; $I_{yz} = 203 \times 10^{-6}\ \text{kg} \cdot \text{m}^2$; $I_{zx} = -848 \times 10^{-6}\ \text{kg} \cdot \text{m}^2$.
9.155 $I_{xy} = 786 \times 10^{-6}\ \text{kg} \cdot \text{m}^2$; $I_{yz} = 64.5 \times 10^{-6}\ \text{kg} \cdot \text{m}^2$; $I_{zx} = -71.6 \times 10^{-6}\ \text{kg} \cdot \text{m}^2$.
9.157 $I_{xy} = -0.1931\ \text{kg} \cdot \text{m}^2$; $I_{yz} = 0.310\ \text{kg} \cdot \text{m}^2$; $I_{zx} = 2.26\ \text{kg} \cdot \text{m}^2$.
9.159 $I_{xy} = 12.75wa^3/g$; $I_{yz} = 7wa^3/g$; $I_{zx} = 1.5wa^3(\pi + 4)/g$.
9.161 $I_{xy} = 0.168 \times 10^{-3}\ \text{kg} \cdot \text{m}^2$; $I_{yz} = 0.36 \times 10^{-3}\ \text{kg} \cdot \text{m}^2$; $I_{zx} = 0.225 \times 10^{-3}\ \text{kg} \cdot \text{m}^2$.
9.162 $I_{xy} = -0.576\ \text{kg} \cdot \text{m}^2$; $I_{yz} = I_{zx} = 0$.
9.164 (*a*) $mac/20$. (*b*) $I_{xy} = mab/20$; $I_{yz} = mbc/20$.
9.165 $ma^2(10h^2 + 3a^2)/12(h^2 + a^2)$.
9.166 $3.22ma^2$.
9.167 $54.7 \times 10^{-3}\ \text{kg} \cdot \text{m}^2$
9.169 $5Wa^2/18g$.
9.170 $5\rho t a^4/12$.
9.171 $6.74\ \text{kg} \cdot \text{m}^2$.
9.173 $25.3 \times 10^{-3}\ \text{kg} \cdot \text{m}^2$.
9.174 $10.97 \times 10^{-3}\ \text{kg} \cdot \text{m}^2$.
9.175 (*a*) $b/a = 2.00$; $c/a = 2.00$. (*b*) $b/a = 1.000$; $c/a = 0.500$.
9.176 (*a*) 2.00. (*b*) $\sqrt{2/3}$.
9.177 (*a*) $1/\sqrt{3}$. (*b*) $\sqrt{7/12}$.
9.179 (*a*) $ma^2/6$. (*b*) $I_{x'} = ma^2/6$; $I_{y'} = I_{z'} = 11ma^2/12$.
9.181 (*a*) $K_1 = 0.363ma^2$; $K_2 = 1.583ma^2$; $K_3 = 1.720ma^2$.
(*b*) $(\theta_x)_1 = (\theta_z)_1 = 49.7°$, $(\theta_y)_1 = 113.7°$;
$(\theta_x)_2 = 45.0°$, $(\theta_y)_2 = 90.0°$, $(\theta_z)_2 = 135.0°$;
$(\theta_x)_3 = (\theta_z)_3 = 73.5°$, $(\theta_y)_3 = 23.7°$.
9.182 (*a*) $K_1 = 48 \times 10^{-3}\ \text{kg} \cdot \text{m}^2$; $K_2 = 47 \times 10^{-3}\ \text{kg} \cdot \text{m}^2$; $K_3 = 69 \times 10^{-3}\ \text{kg} \cdot \text{m}^2$
(*b*) $(\theta_x)_1 = (\theta_y)_1 = 90.0°$, $(\theta_z)_1 = 0°$;
$(\theta_x)_2 = 3.43°$, $(\theta_y)_2 = 86.6°$, $(\theta_z)_2 = 90.0°$;
$(\theta_x)_3 = 93.4°$, $(\theta_y)_3 = 3.41°$, $(\theta_z)_3 = 90.0°$.
9.183 (*a*) $K_1 = 3.42 \times 10^{-3}\ \text{kg} \cdot \text{m}^2$;
$K_2 = 31 \times 10^{-3}\ \text{kg} \cdot \text{m}^2$;
$K_3 = 33.9 \times 10^{-3}\ \text{kg} \cdot \text{m}^2$.
(*b*) $(\theta_x)_1 = 72.5°$, $(\theta_y)_1 = 83.0°$, $(\theta_z)_1 = 18.89°$;
$(\theta_x)_2 = 19.38°$, $(\theta_y)_2 = 83.7°$, $(\theta_z)_2 = 108.3°$;
$(\theta_x)_3 = 98.2°$, $(\theta_y)_3 = 9.46°$, $(\theta_z)_3 = 94.7°$.
9.184 (*a*) $K_1 = 0.1639Wa^2/g$; $K_2 = 1.054Wa^2/g$; $K_3 = 1.115Wa^2/g$.
(*b*) $(\theta_x)_1 = 36.7°$, $(\theta_y)_1 = 71.6°$, $(\theta_z)_1 = 59.5°$;
$(\theta_x)_2 = 74.9°$, $(\theta_y)_2 = 54.5°$, $(\theta_z)_2 = 140.5°$;
$(\theta_x)_3 = 57.5°$, $(\theta_y)_3 = 138.8°$, $(\theta_z)_3 = 112.4°$.
9.185 (*a*) $K_1 = 0.203\rho t a^4$; $K_2 = 0.698\rho t a^4$; $K_3 = 0.765\rho t a^4$.
(*b*) $(\theta_x)_1 = 40.2°$, $(\theta_y)_1 = 50.0°$, $(\theta_z)_1 = 86.7°$;
$(\theta_x)_2 = 56.2°$, $(\theta_y)_2 = 134.5°$, $(\theta_z)_2 = 63.4°$;
$(\theta_x)_3 = 70.8°$, $(\theta_y)_3 = 108.0°$, $(\theta_z)_3 = 153.2°$.

9.186 (*a*) $K_1 = 29 \times 10^{-3}$ kg · m^2;
$K_2 = 53.9 \times 10^{-3}$ kg · m^2;
$K_3 = 66.36 \times 10^{-3}$ kg · m^2.
(*b*) $(\theta_x)_1 = 35.2°$, $(\theta_y)_1 = (\theta_z)_1 = 65.9°$;
$(\theta_x)_2 = 90.0°$, $(\theta_y)_2 = 45.0°$, $(\theta_z)_2 = 135.0°$;
$(\theta_x)_3 = 54.7°$, $(\theta_y)_3 = (\theta_z)_3 = 125.3°$.
9.187 $a^3b/30$.
9.189 7.36×10^6 mm^4; 32.0 mm.
9.191 (*a*) 122.4×10^6 mm^4. (*b*) 64.4×10^6 mm^4.
9.192 $\bar{I}_x = 218.2 \times 10^6$ mm^4, $\bar{I}_y = 0.79 \times 10^{-4}$ m^4;
$\bar{k}_x = 133.7$ mm, $\bar{k}_y = 0.08$ m.
9.193 $\bar{I}_x = 35.315 \times 10^6$ mm^4; $\bar{I}_y = 23.0 \times 10^3$ mm^4.
9.195 -4.57×10^6 mm^4.
9.196 $\theta_m = -20.1°$; $\bar{I}_{max} = 16.4 \times 10^6$ mm^4,
$\bar{I}_{min} = 2.2 \times 10^6$ mm^4.
9.197 $m(3a^2 + 4L^2)/12$.

CHAPTER 10

10.1 180.0 N ↓.
10.2 28.0 N ↓.
10.3 18.00 N · m ↻.
10.5 132.6 N →.
10.6 (*a*) 54.0 N; 60.0 mm →. (*b*) 126.0 N; 140.0 mm →.
10.7 (*a*) 36.0 N; 40.0 mm →. (*b*) 54.0 N; 60.0 mm →.
10.9 $2P \sin \theta / \cos (\theta/2)$.
10.10 $(3P/2) \tan \theta$.
10.13 7.96 kN.
10.14 5.47°.
10.15 $3Pa/2$.
10.18 (*a*) $Pl \sin 2\theta$. (*b*) $3Pl \cos \theta$. (*c*) $Pl \sin \theta$.
10.19 (*a*) 38.8 N · m ↺. (*b*) 24.7 N · m ↺.
10.20 (*a*) 1206.7 N →. (*b*) 1568 N →.
10.21 34.6 N ⦣ 30.0°.
10.22 96.5 N · m ↺.
10.23 36.4°.
10.24 57.5°.
10.25 40.6°.
10.28 39.1°.
10.29 90.9 N.
10.31 330 mm.
10.33 26°.
10.34 133.17 N.
10.35 25°.
10.37 10.77°.
10.38 16.41°.
10.39 61.2°.
10.40 78.7°; 324°; 379°.
10.41 99.1 N ⦟ 44.4°.
10.43 15.27°.
10.45 3.21 kN ↗.
10.47 $\eta = 1/(1 + \mu \cot \alpha)$.
10.48 $Pl/[2(\tan \theta - \mu_s)]$.
10.49 $M_{max} = 250$ N · m; $M_{min} = 100.0$ N · m.
10.50 $Q_{max} = P(3 \tan \theta + \mu_s)/2$; $Q_{min} = P(3 \tan \theta - \mu_s)/2$.
10.51 37.6 N; 31.6 N.
10.52 $\eta = \tan \theta / \tan (\theta + \phi_s)$.
10.55 0.0363 m (shorter).
10.56 0.0127 m (longer).
10.57 12.50 mm ↓.
10.58 9.38 mm →.
10.60 330 mm.
10.61 15.03° and 36.9°.
10.62 26°.
10.65 10.77°.
10.69 $\theta = 45.0°$, stable; $\theta = -135.0°$, unstable.
10.70 $\theta = 31.0°$, stable; $\theta = -149.0°$, unstable.
10.73 $\theta = 61.2°$, stable.
10.74 $\theta = 78.7°$, stable; $\theta = 324°$, unstable; $\theta = 379°$, stable.
10.75 $W = 10.53$ N, stable.
10.76 $\theta = 31.6°$, stable.
10.77 0.21 m.
10.79 (*a*) $\cos (\theta/2) - \sin (\theta/2) = [1 - (Wl/ka^2)] \cos \theta$.
(*b*) 6.3°, stable; 90.0°, unstable; 173.8°, stable.
10.81 $\theta = 12.92°$, stable; $\theta = 77.1°$, unstable.
10.82 (*a*) $(1 - \cos \theta) \tan \theta = 2mg/kl$. (*b*) 52.0°, stable.
10.83 49.1°.
10.85 62.2°.
10.86 0.165 m.
10.88 46.6°.
10.89 $k > 282.2$ N/m.
10.90 0.15 m.
10.91 $0 \leq P < ka$.
10.92 $0 \leq P < 2kL/9$.
10.95 m_2c^2/ab.
10.96 $Q > 432$ N.
10.97 $0 \leq P < 0.382kl$.
10.99 $0 \leq P < 0.219ka$.
10.101 (*a*) 75.0 N ↑. (*b*) 225 N ↓.
10.102 17.90 kN ↗.
10.104 18.65 N · m ↻.
10.105 $Pl/2 \tan \theta$.
10.107 25.9 N · m ↻.
10.108 60.0 N ↓.
10.110 31.3 mm →.
10.112 $\theta = 9.69°$, stable; $\theta = 33.8°$, unstable; $\theta = 90.0°$, stable.