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Online Instructor's Solutions Manual
to accompany

Applied Mechanics for Engineering Technology

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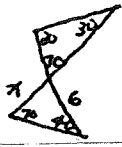
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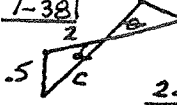
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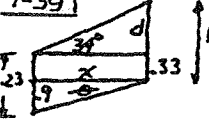
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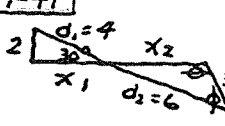
1-1	$24 + 8x - 12x = 8x$ $8x - 12x - 8x = -24$ $x = 2$	1-17	$R = 5m \quad \theta = 36.9^\circ$ $R = 13m \quad \theta = 67.4^\circ$ $R = 17 \quad \theta = 28.1^\circ$
1-2	$12 + 6x + 3 = 27$ $6x = 27 - 12 - 3$ $x = 2$	1-18	$\tan 20 = \frac{A}{6} \quad A = 2.18in$ $\tan 40 = \frac{A}{4} \quad A = 3.36ft$ $\tan 55 = \frac{20}{A} \quad A = 14in.$
1-3	$28 = \frac{3}{4}x + \frac{5}{12}x$ $= \frac{9}{12}x + \frac{5}{12}x$ $= \frac{14}{12}x$ $\frac{28 \times 12}{14} = x$ $x = 24$	1-19	$\sin \theta = \frac{25}{40} \quad \theta = 38.7^\circ$
1-4	$\textcircled{1} \times 5 \quad 10x + 40y = 100$ $\textcircled{2} \times -2 \quad -10x + 6y = -20$ $\hline 46y = 80$ $y = 1.74$	1-20	$\tan 65 = \frac{y}{4} \quad y = 8.58mm$
1-5	$\textcircled{1} \times 8 \quad 176x + 24y = 968$ $\textcircled{2} \times 3 \quad 39x - 24y = 168$ $\hline 215x + 0 = 1136$ $x = 5.28$	1-21	$\sin \theta = \frac{33}{72} \quad \theta = 27.3^\circ$
1-6	$x = \frac{+2 \pm \sqrt{4 - (4)(13)(-8)}}{2(13)}$ $= \frac{+2 \pm 20.5}{26}$ $= 0.865 \text{ or } 0.712$	1-22	$c^2 = 15^2 + 42^2 - 2(15)(42)\cos 120$ $c = 51.2cm$
1-7	$(3x)x + \frac{5}{x}(x) = 8(x)$ $3x^2 - 8x + 5 = 0$ $x = \frac{-(-8) \pm \sqrt{(-8)^2 - (4)(3)(5)}}{2(3)}$ $x = \frac{+8 \pm \sqrt{64 - 60}}{6}$ $x = 1.67 \text{ or } 1$	1-23	$c^2 = 15^2 + 25^2 - 2(15)(25)\cos 65$ $c = 23.1ft$
1-8	$a = 35^\circ$ opposite angle $b = 180 - 35 - 90 = 55^\circ$ $c = 180 - 55 = 125^\circ$	1-24	$(5.5)^2 = 3^2 + 4^2 - 2(3)(4)\cos \theta$ $\theta = 77.36^\circ$ (2 nd quadrant) or $\theta = 102.6^\circ$
1-9	$a = 80^\circ$ opposite angle $b = 180 - 80 = 100^\circ$ $c = 100^\circ$ opposite angle	1-25	$(CB)^2 = 55^2 + 90^2 - 2(55)(90)\cos 25$ $CB = 46.2in.$
1-10	$a = 90 - 40 = 50^\circ$ $b = 15^\circ$ opposite angle $c = 180 - 50 - 15 = 115^\circ$ $d = 180 - 115 = 65^\circ$ $e = 65^\circ$ opposite angle	1-26	$d^2 = 6^2 + 8^2 - 2(6)(8)\cos 130$ $d = 12.7m$
1-11	$\frac{21}{7} = \frac{ED}{5} \quad ED = \frac{21}{7} \times 5 = 15in.$	1-27	$(CD)^2 = (25)^2 + (4)^2 - 2(25)(4)\cos 16^\circ$ $CD = 0.174m$
1-12	$\frac{CE}{8} = \frac{12.5}{5} \quad CE = \frac{12.5}{5} \times 8 = 20m$	1-28	$\frac{A}{\sin 120} = \frac{50}{\sin 20} \quad A = 127m.$
1-13	$A = 20 \sin 38^\circ = 12.3m$	1-29	$\frac{AC}{\sin 73} = \frac{640}{\sin 42} \quad AC = 913ft$ $\frac{AD}{\sin 65} = \frac{640}{\sin 42} \quad AD = 865ft$
1-14	$\cos \theta = \frac{4}{10} \quad \theta = 66.4^\circ$	1-30	$\frac{d}{\sin 40} = \frac{14}{\sin 105} \quad d = 9.32m$
1-15	$\tan \theta = \frac{6}{A} \quad A = 16.5ft$	1-31	$\cos \theta = \frac{14}{48} \quad \theta = 73^\circ$
1-16	$\tan 70^\circ = \frac{y}{4} \quad y = 11m$	1-32	$\frac{6}{\sin 70} = \frac{x}{\sin 40}$ $x = 4.1ft$ 
1-17		1-33	$\tan \theta = \frac{1}{10} \quad \theta = 5.7^\circ$ included angle = 11.4°
1-18		1-34	$\cos 50 = \frac{y}{10} \quad y = 6.43m.$ $h = 10 - 6.43 = 3.57m.$
1-19		1-35	$x = 3.3 \cos 55 = 1.9m.$ $y = 3.3 \sin 55 = 2.7in.$
1-20		1-36	Corner width = $1.875 / \cos 30 = 2.17in.$

1-37 $d^2 = (3.75)^2 + (3.75)^2 - 2(3.75)^2 \cos 120$
 $d = 6.49 \text{ cm}$

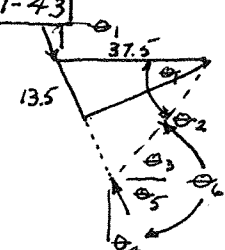
1-38  $c^2 = .5^2 + 2^2 - 2(.5)(2) \cos 105$
 $c = 2.18 \text{ m}$
 $\frac{2.18}{\sin 105} = \frac{.5}{\sin \theta}$ $\therefore \theta = 12.8^\circ$

1-39  $x^2 = 20^2 - .9^2$
 $x = 19.979$
 $\tan 34^\circ = \frac{d}{19.979}$
 $d = 13.476$
 $h = 13.476 + .33 = 13.867 \text{ m}$

1-40 ① $(BD)^2 = 3^2 + 2^2 - 2(3)(2) \cos 120$
 $BD = 4.36 \text{ m}$
 ② $(BD)^2 = 3^2 + 2^2 - 2(3)(2) \cos 50$
 $BD = 2.29$
 $A \text{ drops } 4.36 - 2.29 = 2.07 \text{ m}$

1-41  $x_1 = \frac{2}{\tan 30} = 3.47$
 $d_1 = \frac{2}{\sin 30} = 4$
 $\frac{6}{\sin \theta} = \frac{3.25}{\sin 30}$ $\therefore \theta = 112.7^\circ$
 $\phi = 37.3^\circ$
 $\frac{x_2}{\sin 37.3} = \frac{3.25}{\sin 30}$ $x_2 = 3.94$
 $\text{horiz. dist.} = 3.47 + 3.94 = 7.41 \text{ m.}$

1-42 $\frac{6}{\sin 105} = \frac{2.5}{\sin \theta}$ $\theta = 23.7^\circ$
 $\phi = 180 - 23.7 - 105 = 51.3^\circ$
 $\frac{d}{\sin 51.3} = \frac{6}{\sin 105}$ $d = 4.85 \text{ m}$
 $x = 2.5 \sin 51.3 = 1.95 \text{ m}$

1-43  $\sin \theta = \frac{13.5}{37.5}$
 $\theta_1 = 21.1^\circ$
 $\therefore \theta_2 = 42.2^\circ$
 $\theta_3 = 42.2^\circ$
 $\theta_4 = 21.1^\circ$
 $\theta_5 = 90 - 21.1 = 68.9^\circ$
 $\theta_6 = 68.9 + 42.2 = 111.1^\circ$

R1-1 $x = 15 \cos 25 = 13.6 \text{ m}$
 $y = 15 \sin 25 = 6.34 \text{ m}$

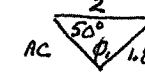
R1-2 $\cos 18 = \frac{4.5}{B}$ $B = 4.73 \text{ m}$
 $\tan 18 = \frac{A}{4.5}$ $A = 1.46 \text{ m}$

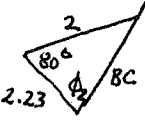
R1-3 $\theta^2 = 6^2 + 5^2 - 2(6)(5) \cos \theta$
 $\theta = 70.5$
 or $\theta = 109.5^\circ$ (2nd quadrant)

R1-4 $\frac{3.5}{\sin \phi} = \frac{2.8}{\sin 40}$ $\phi = 53.5^\circ$
 $\theta = 180 - 40 - 53.5 = 86.5^\circ$

R1-5 $(160)^2 = (120)^2 + (85)^2 - 2(120)(85) \cos \theta$
 $\theta = 101^\circ$

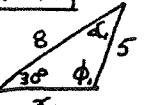
R1-6 $\frac{5}{\sin 40} = \frac{3}{\sin \theta}$ $\theta = 22.69^\circ$
 $\phi = 180 - 22.69 - 40 = 117.3^\circ$
 $\frac{R}{\sin 117.3} = \frac{5}{\sin 40}$ $R = 6.91 \text{ m}$

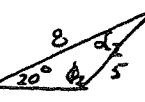
R1-7 original triangle ABC  $\frac{2}{\sin \phi_1} = \frac{1.8}{\sin 50}$ $\phi_1 = 58.3^\circ$
 $180 - 50 - 58.3 = 71.7^\circ$
 $\frac{AC}{\sin 71.7} = \frac{1.8}{\sin 50}$ $AC = 2.23$
 final triangle ABC

 $(BC)^2 = 2^2 + 2.23^2 - 2 \times 2.23 \cos 80^\circ$
 $BC = 2.72$
 $\frac{2}{\sin \phi_2} = \frac{2.72}{\sin 80}$ $\phi_2 = 46.4^\circ$
 $\theta = 71.7 - 46.4 = 25.3^\circ$

R1-8 $(AC)^2 = .5^2 + 2^2 - 2(.5)(2) \cos 6^\circ$
 $AC = 0.302$
 $\frac{.302}{\sin 6^\circ} = \frac{.5}{\sin \theta}$ $\theta = 170^\circ$
 $\phi = 360 - 170 - 80 - 70 = 40^\circ$
 $(CB')^2 = (.2)^2 + (.302)^2 - 2(.2)(.302) \cos 40$
 $CB' = 0.197 \text{ m}$

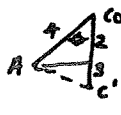
R1-9 $(AB)^2 = (20)^2 + (60)^2 - 2(20)(60) \cos 115$
 $AB = 70.81$
 $\frac{20}{\sin \phi} = \frac{70.81}{\sin 115}$ $\phi = 14.8^\circ$

R1-10  $\frac{8}{\sin \phi_1} = \frac{5}{\sin 30}$ $\phi_1 = 126.87^\circ$
 $\therefore d_1 = 23.13^\circ$
 $\frac{x_1}{\sin 23.13} = \frac{5}{\sin 30}$ $x_1 = 3.928$



 $\frac{8}{\sin \phi_2} = \frac{5}{\sin 20}$ $\phi_2 = 146.82^\circ$
 $\therefore d_2 = 13.18^\circ$




$\frac{x_2}{\sin 13.18} = \frac{5}{\sin 20}$ $x_2 = 3.333$
 $\text{horiz. dist. of C} = 3.928 - 3.333 = 0.595 \text{ m}$



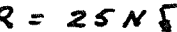
R1-11 $(40)^2 = (35)^2 + (45)^2 - 2(35)(45) \cos \theta$
 $\theta = 58.4^\circ$


R1-12 $AC^2 = 4^2 + 5^2 - 2 \times 4 \times 5 \cos 143.1$
 $AC = 8.54$
 $h = 5 \sin 36.9 = 3$
 $\cos \theta = \frac{3}{4} \Rightarrow \theta = 60^\circ$

 $(AC')^2 = 4^2 + 5^2 - 2 \times 4 \times 5 \cos 60$
 $AC' = 4.58$
 $\Delta AC = 3.96 \text{ m}$


2-1 $R = 42.7 \text{ lb}$ 


2-2 60.2 lb  1060 lb 


2-3 $R = 80.8 \text{ lb}$  $R = 539 \text{ lb}$ 
 $R = 7210 \text{ lb}$ 


2-4 $R = 15.2 \text{ kN}$ 
 $R = 16.2 \text{ MN}$ 
 $R = 25 \text{ N}$ 


2-5 $R = 632 \text{ N}$ 


2-6 $R = 17 \text{ lb}$ 

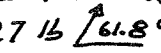
2-7 $\tan \theta = \frac{250}{1500} \Rightarrow \theta = 9.5^\circ$
 $\therefore R = 1.5 \text{ N kN}$ 


2-8 $R = \sqrt{(1.5)^2 + 4^2} = 4.27$
 $\tan \theta = \frac{4}{1.5} \Rightarrow \theta = 69.4^\circ$
 $69.4 + 12 = 81.4^\circ$
 $R = 4.27 \text{ kN}$ 


2-9 $R = \sqrt{30^2 + 20^2} = 36.1 \text{ lb}$ 
 $\tan^{-1} \frac{30}{20} = 56.3^\circ$
 $56.3 + 20 = 76.3^\circ$

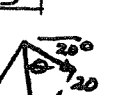
2-10 $R^2 = 120^2 + 250^2 - 2(120)(250) \cos 122$
 $R = 300 \text{ N}$ 
 $\frac{330}{\sin 122} = \frac{250}{\sin \theta} \Rightarrow \theta = 40^\circ$
 $40 + 40 = 80^\circ$

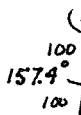
2-11 $R^2 = 30^2 + 40^2 - 2(30)(40) \cos 130$
 $R = 63.6 \text{ kN}$ 
 $\frac{\sin \phi}{40} = \frac{\sin 50}{63.5} \Rightarrow \phi = 28.8^\circ$



2-12 $R^2 = 20^2 + 15^2 - 2(20)(15) \cos 100$
 $R = 27 \text{ lb}$ 
 $\frac{27}{\sin 100} = \frac{20}{\sin \theta} \Rightarrow \theta = 46.8^\circ$
 $46.8 + 15 = 61.8^\circ$

2-13 $R^2 = (6.5)^2 + (8)^2 - 2(6.5)(8) \cos 151.6^\circ$
 $R^2 = 197.7$
 $R = 14.1 \text{ kN}$ 
 $\frac{6.5}{\sin \theta} = \frac{14.1}{\sin 151.6} \Rightarrow \theta = 12.7^\circ$
 $21.8 + 12.7 = 34.5^\circ$

2-14 $R^2 = 400^2 + 150^2 - 2(400)(150) \cos 40$
 $R = 301 \text{ lb}$ 
 $\frac{301}{\sin 40} = \frac{150}{\sin \theta} \Rightarrow \theta = 18.7^\circ$
 $30 + 18.7 = 48.7^\circ$

2-15 $\sin \theta = \frac{2.5}{6.5} \Rightarrow \theta = 22.6^\circ$

 $\frac{R}{\sin 134.8} = \frac{100}{\sin 22.6}$
 $R = 185 \text{ lb}$

$\frac{R}{\sin 157.4} = \frac{100}{\sin 11.3}$
 $R = 196 \text{ lb}$ 

2-16 $\tan \theta = \frac{3}{4} \Rightarrow \theta = 36.9^\circ$

 $180 - 55 - 36.9 = 88.1^\circ$
 $R = 5 \text{ kips}$ 

2-17 $P_x = 25 \sin 20 = 8.55 \text{ lb} \leftarrow$
 $P_y = 25 \cos 20 = 23.5 \text{ lb} \downarrow$
 $P_x = 2 \cos 50 = 1.29 \text{ kips} \rightarrow$
 $P_y = 2 \sin 50 = 1.53 \text{ kips} \uparrow$
 $P_x = 20 \cos 30 = 17.3 \text{ lb} \leftarrow$
 $P_y = 20 \sin 30 = 10 \text{ lb} \uparrow$

2-18 $F_x = \frac{8}{17} \times 85 = 40 \text{ N} \rightarrow$
 $F_y = \frac{15}{17} \times 85 = 75 \text{ N} \uparrow$
 $F_x = .707 \times 40 = 28.3 \text{ kN} \leftarrow$
 $F_y = .707 \times 40 = 28.3 \text{ kN} \downarrow$
 $F_x = \frac{4}{5} \times 120 = 96 \text{ N} \rightarrow$
 $F_y = \frac{3}{5} \times 120 = 72 \text{ N} \uparrow$
 $F_x = \frac{12}{13} \times 52 = 48 \text{ kN} \leftarrow$
 $F_y = \frac{5}{13} \times 52 = 20 \text{ kN} \downarrow$

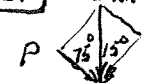
2-19 $F_y = 30 \text{ lb} \uparrow$ $F_x = 52 \text{ lb} \rightarrow$
 $F_y = 75.2 \text{ kips} \downarrow$ $F_x = 27.4 \text{ kips} \leftarrow$
 $v_y = 400 \text{ ft/sec} \uparrow$ $v_x = 300 \text{ ft/sec} \leftarrow$
 $v_y = 16 \text{ mph} \downarrow$ $v_x = 30 \text{ mph} \leftarrow$

2-20 $F_x = 200 \cos 38 = 158 \text{ lb} \leftarrow$
 $F_y = 200 \sin 38 = 123 \text{ lb} \uparrow$
 $F_x = 28 \sin 25 = 11.8 \text{ ft/sec} \leftarrow$
 $F_y = 28 \cos 25 = 25.4 \text{ ft/sec} \downarrow$
 $F_x = 190 \sin 63 = 169 \text{ lb} \rightarrow$
 $F_y = 190 \cos 63 = 86.3 \text{ lb} \uparrow$
 $F_x = 860 \cos 20.5 = 806 \text{ lb} \rightarrow$
 $F_y = 860 \sin 20.5 = 301 \text{ lb} \downarrow$

2-21 $F_x = 1.8 \cos 80 = 0.313 \text{ kN} \rightarrow$
 $F_y = 1.8 \sin 80 = 1.77 \text{ kN} \downarrow$

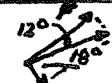
2-22 $A_x = 637.6 \cos 45 = 451 \text{ N} \rightarrow$
 $A_y = 451 \text{ N} \downarrow$

2-23 $P_y = 100 \sin 40 = 64.3 \text{ N} \nearrow 70^\circ$
 $P_x = 100 \cos 40 = 76.6 \text{ N} \nearrow 20^\circ$
 $Q_y = 12 \cos 10 = 11.8 \text{ kN} \nearrow 70^\circ$
 $Q_x = 12 \sin 10 = 2.1 \text{ kN} \nearrow 20^\circ$
 $R_y = 40 \sin 16.8 = 11.6 \text{ N} \nearrow 70^\circ$
 $R_x = 40 \cos 16.8 = 38.3 \text{ N} \nearrow 20^\circ$

2-24 5 kN

 $\cos 75 = \frac{P}{5}$
 $P = 1.29 \text{ kN}$

2-25 $F_x = 20 \sin 30 = 10 \text{ lb} \nearrow 15^\circ$

2-26 $P_y = 80 \sin 32 = 42.4 \text{ N} \searrow 70^\circ$
 $P_x = 80 \cos 32 = 67.8 \text{ N} \nearrow 20^\circ$

2-27 $\cos 12^\circ = \frac{F}{25}$

 $F = 24.5 \text{ lb} \nearrow 80^\circ$

2-28 $P_x = 400 \cos 10^\circ = 394 \text{ N} \nearrow 70^\circ$
 $P_y = 400 \sin 10^\circ = 69.5 \text{ N} \nearrow 10^\circ$

2-29 $R_y = \frac{4}{5} \times 50 + \frac{5}{13} \times 52 = 60 \text{ N} \uparrow$
 $R_x = \frac{12}{13} \times 52 - \frac{3}{5} \times 50 = 19 \text{ N} \rightarrow$
 $R = 62.6 \text{ N} \nearrow 10^\circ$

2-30 $R_y = \frac{3}{5} \times 50 + \frac{1}{4.12} \times 100 = 57.3 \text{ lb} \uparrow$
 $R_x = \frac{4}{5} \times 50 + 65 - 25 - \frac{4}{4.12} \times 100 = 17 \text{ lb} \rightarrow$
 $R = 56.9 \text{ lb} \nearrow 20^\circ$

2-31 $R_x = \frac{15(204)}{17} - 160 \sin 15 + 70 \cos 65 = 168.2$
 $R_y = \frac{8(204)}{17} - 160 \cos 15 - 70 \sin 65 = -73.9$
 $R = 184 \text{ N} \nearrow 23.7^\circ$

2-32 $R_x = 90 \sin 75 - 70 \cos 10 - \frac{5}{13} \times 104 = -22$
 $R_y = +80 + 90 \cos 75 + 70 \sin 10 + \frac{12}{13} \times 104 = +211.5$
 $R = 213 \text{ lb} \nearrow 84.1^\circ$

2-33 $R_x = 4 \sin 20 + 2 - 3 \cos 30 - 5 \sin 15 = -0.524$
 $R_y = 4 \cos 20 - 3 \sin 30 + 5 \cos 15 = +7.09$
 $R = 7.11 \text{ kN} \nearrow 85.8^\circ$

2-34 $R_x = -1200 \cos 20 - 700 \sin 35 = -1530$
 $R_y = 1200 \sin 20 - 700 \cos 35 - 800 = -963.4$
 $R = 1810 \text{ lb} \searrow 57.8^\circ$

2-35 $R_x = \frac{12}{13} \times 52 - 20 - \frac{3}{5} (30) - 40 \cos 80 = +3.054$
 $R_y = \frac{5}{13} (52) + \frac{4}{5} (30) - 40 \sin 80 = 4.608$
 $R = 5.53 \text{ kN} \nearrow 56.5^\circ$

2-36 $R_x = 70 \cos 25 + 150 \sin 30 + 200 \cos 70 = 206.8$
 $R_y = 70 \sin 25 + 150 \cos 30 + 200 \sin 70 = 87.6$
 $R = 225 \text{ lb} \nearrow 23^\circ$

2-37 $R_x = -40 \sin 20 - 20 \cos 40 + \frac{12}{13} (39) = +6.99$
 $R_y = 40 \cos 20 - 20 \sin 40 - \frac{5}{13} \times 39 = 9.73$
 $R = 12 \text{ lb} \nearrow 59.3^\circ$

R2-1 $R = 65 \text{ N} \nearrow 12^\circ$
 $R = 8.54 \text{ kN} \nearrow 8^\circ$ $R = 102 \text{ N} \nearrow 15^\circ$

R2-2 $\tan \theta = \frac{6}{3}$ $\theta = 63.4^\circ$
 $180 - 30 - 63.4 = 86.6^\circ$
 $R = 6.7 \text{ kN} \nearrow 86.6^\circ$

R2-3 $R_x = -180 \cos 45 - 300 \cos 10 = -422.7$
 $R_y = 180 \sin 45 + 300 \sin 10 = +179.4$
 $R = 459 \text{ N} \nearrow 23^\circ$

R2-4 $F_x = 80 \sin 15 = 20.7 \text{ lb} \rightarrow$
 $F_y = 80 \cos 15 = 77.3 \text{ lb} \downarrow$
 $v_x = 19 \cos 37 = 15.2 \text{ ft/sec} \leftarrow$
 $v_y = 19 \sin 37 = 11.4 \text{ ft/sec} \uparrow$
 $F_x = 2 \cos 48 = 1.34 \text{ lb} \rightarrow$
 $F_y = 2 \sin 48 = 1.49 \text{ lb} \downarrow$
 $F_x = 920 \cos 21.8 = 390 \text{ lb} \leftarrow$
 $F_y = 920 \sin 21.8 = 156 \text{ lb} \downarrow$

R2-5 $v_x = 6 \cos 55 = 3.44 \text{ m/s} \leftarrow$
 $v_y = 6 \sin 55 = 4.91 \text{ m/s} \downarrow$
 $s_x = 18 \sin 10 = 3.13 \text{ m} \rightarrow$
 $s_y = 18 \cos 10 = 17.7 \text{ m} \uparrow$
 $a_x = \frac{15}{17} (68) = 60 \text{ m/s}^2 \leftarrow$
 $a_y = \frac{8}{17} (68) = 32 \text{ m/s}^2 \uparrow$
 $P_x = \frac{2}{3.605} (65) = 36.1 \text{ N} \rightarrow$
 $P_y = \frac{3}{3.605} (65) = 54.1 \text{ N} \uparrow$

R2-6 initial $F_x = 3 \cos 6 = 2.98 \text{ kN} \nearrow 40^\circ$
 Final $F_x = 3 \cos 15 = 2.9 \text{ kN} \nearrow 40^\circ$

$$R2-1 \quad F_x = -400 \cos 10 + 150 \cos 50 + 200 \sin 15$$

$$= -245.7$$

$$F_y = +300 + 400 \sin 10 + 150 \sin 50 - 200 \cos 15$$

$$= +291.2$$

$$R = 381 \text{ N } \overset{R}{49.8^\circ}$$

$$R2-8 \quad R_x = 120 - \frac{12}{13}(26) - \frac{8}{17}(170)$$

$$= +16$$

$$R_y = -90 - \frac{5}{13}(26) + \frac{15}{17}(170)$$

$$= +50$$

$$R = 52.5 \text{ N } \overset{R}{72.3^\circ}$$

$$3-1 \quad M_A = -12 \times 2 - 9 \times 1 - 24 \times 2 + 10 \times 4$$

$$+ 30 \times 3 - 16 \times 3$$

$$M_A = 1 \text{ lb-ft}^2$$

$$3-2 \quad M_A = -48 \times 2 + 36 \times 1 - 20 \times 4 + 15 \times 3$$

$$M_A = 95 \text{ N}\cdot\text{m}^2$$

$$3-3 \quad M_A = +(60)(20) + (36)(32)$$

$$M_A = 2350 \text{ lb}\cdot\text{in}^2$$

$$3-4 \quad M_A = -5.66(.5) - 3(.5) - 5.2(.3) - 4(.4)$$

$$M_A = 7.49 \text{ N}\cdot\text{m}^2$$

$$3-5 \quad M_A = -160(7) + 400(10) - 800(2)$$

$$M_A = 1280 \text{ lb}\cdot\text{ft}^2$$

$$3-6 \quad M_A = -800(5 \sin 38)$$

$$= 2460 \text{ N}\cdot\text{m}^2$$

$$3-7 \quad M_A = 850(63 \sin 30) = 26,800 \text{ lb}\cdot\text{in}^2$$

$$3-8 \quad M_C = 1800 \times 2.3 = 4140 \text{ N}\cdot\text{m}^2$$

$$M_B = (1800)(1.7) = 3060 \text{ N}\cdot\text{m}^2$$

$$3-9 \quad M_A = 360(24) - 150(18) = 5940 \text{ lb}\cdot\text{in}^2$$

$$3-10 \quad M_P = -36(15) + 15(8) = 420 \text{ lb}\cdot\text{in}^2$$

$$3-11 \quad M_A = F \times d$$

$$500 = P \cos 28(1.8) \quad P = 315 \text{ N } \overset{P}{75^\circ}$$

$$3-12 \quad M_A = 200(3) + 360(6) - 150(4)$$

$$= 2160 \text{ N}\cdot\text{m}^2$$

$$3-13 \quad M_A = 90(.1) - 120(.24)$$

$$= 19.8 \text{ N}\cdot\text{m}^2$$

$$3-14 \quad M_A = -60(3) + 240(1) + 200(0) + 80(0)$$

$$= 60 \text{ kN}\cdot\text{m}^2$$

$$3-15 \quad M_A = (200 \cos 20)1 - (200 \sin 20)9.5 + (600)4.5$$

$$+ (160)1.5 + (120)6$$

$$= 889 \text{ lb}\cdot\text{ft}^2$$

$$3-16 \quad M_B = (500 \sin 15)(2 \cos 25)$$

$$+ (500 \cos 15)(2 \sin 25)$$

$$= 643 \text{ N}\cdot\text{m}^2$$

$$643 = F \times .8 \cos 25$$

$$F = 887 \text{ N}$$

$$3-17 \quad M_A = -4000(8) - 1500(68)$$

$$= -134,000 \text{ lb}\cdot\text{in}$$

$$= 11.2 \text{ Kip}\cdot\text{ft}^2$$

$$M_B = 4000(38) - 1500(22)$$

$$= 119,000 \text{ lb}\cdot\text{in}$$

$$= 9.92 \text{ Kip}\cdot\text{ft}^2$$

$$3-18 \quad \text{Moment about wheels} = \text{hitch load} \times 2$$

$$= 45 \times 2$$

$$= 90 \text{ N}\cdot\text{m}$$

$$\text{Moment about wheels} = \text{dolly load} \times 1.5$$

$$90 = \text{dolly load} \times 1.5$$

$$\text{dolly load} = 60 \text{ N}$$

$$3-19 \quad \text{Top Arm } M_B = (30 \cos 21.1)(34)$$

$$= 952 \text{ lb}\cdot\text{in}^2$$

$$\text{Bottom Arm } M_C = (30 \cos 21.1)(32.77)$$

$$= 917 \text{ lb}\cdot\text{in}^2$$

$$\therefore \text{greater moment in upper arm}$$

$$3-20 \quad M_A = M_B = 8(2) = 16 \text{ N}\cdot\text{m}^2$$

$$3-21 \quad M_A = 1.294(.3) - 2(.5)$$

$$= 0.612 \text{ kN}\cdot\text{m}^2$$

$$3-22 \quad M_A = -10(4 \cos 10) + 8(6)$$

$$= 8.6 \text{ lb}\cdot\text{ft}^2$$

$$3-23 \quad M_A = -80(2) - 60(4.2) = -412$$

$$= 412 \text{ lb}\cdot\text{ft}^2$$

$$3-24 \quad M_A = 30 \times .376$$

$$= 11.3 \text{ N}\cdot\text{m}^2$$

$$3-25 \quad M_A = 10(8) - 25(15)$$

$$= 280 \text{ lb}\cdot\text{in}^2$$

$$3-26 \quad 500(4) = F \times .15$$

$$F = 13,300$$

$$\therefore A = 13,300 \rightarrow$$

$$B = 13,300 \leftarrow$$

$$3-27 \quad M = 20 \times 8$$

$$= 160$$

$$3-28 \quad 6 \times 3 = F(4)$$

$$F = 4.5 \text{ N}$$

$$3-29 \quad 0.4(8) = F(.25)$$

$$F = 12.8 \text{ kN}$$

$$3-30 \quad 4(2000) = F(300)$$

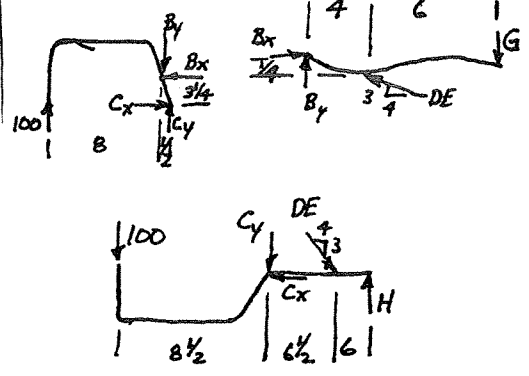
$$F = 26.7 \text{ N}$$

$$3-31 \quad 4(2000) = 50 F$$

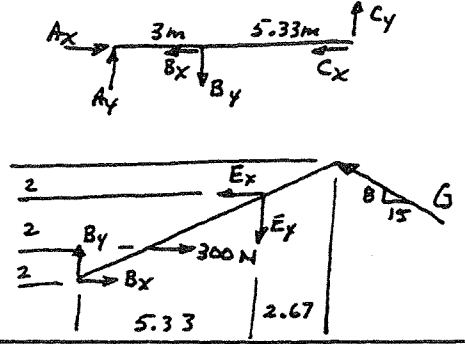
$$F = 160 \text{ N}$$

<p>R3-1 $M_A = -24(4) + 10(0) - 30(1) + 16(3)$ $-6(1) - 8(2) + 8(1)$ $= 92 \text{ N}\cdot\text{m}$</p>	<p>4-8 </p>
<p>R3-2 $M_A = 1200(15 \cos 18) = 17,120 \text{ lb}\cdot\text{ft}$ $17,120 = B(8 \sin 20)$ $B = 6260 \text{ lb}$ $\uparrow 38^\circ$</p>	<p>4-9 </p>
<p>R3-3 </p> <p>$M_A = 140 \times 1.5 = 210 \text{ N}\cdot\text{m}$ $M_A = 140 \times 1.65 = 231 \text{ N}\cdot\text{m}$</p>	<p>4-10 </p>
<p>R3-4 $M_A = -10(1.5) - 30(1) = 45 \text{ N}\cdot\text{m}$ $M_B = -10(1.5) - 30(1) = 45 \text{ N}\cdot\text{m}$</p>	<p>4-11 </p>
<p>R3-5 </p> <p>$15(B) = F(10)$ $F = 12 \text{ lb}$</p>	<p>4-12 </p>
<p>4-1 </p>	<p>4-13 </p>
<p>4-2 </p>	<p>4-14 </p>
<p>4-3 </p>	<p>4-15 </p>
<p>4-4 </p>	<p>4-16 </p>
<p>4-5 </p>	<p>4-17 </p>
<p>4-6 </p>	<p>4-17 </p>

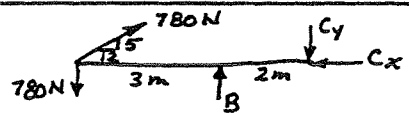
4-18



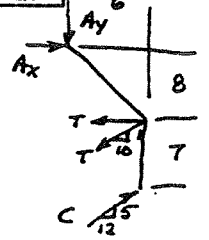
4-24



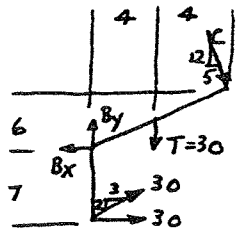
4-19



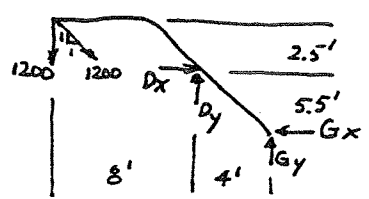
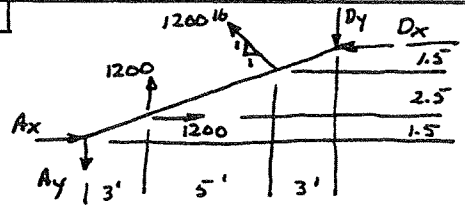
4-20



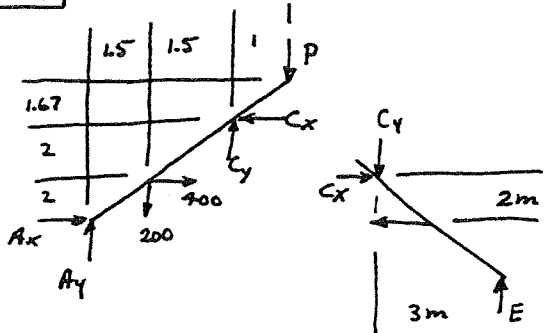
4-21



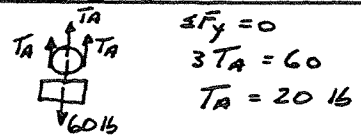
4-22



4-23



4-25

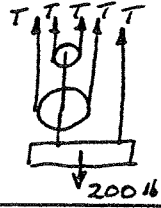


$$\sum F_y = 0$$

$$3T_A = 60$$

$$T_A = 20 \text{ lb}$$

4-26

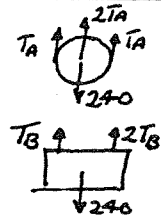


$$\sum F_y = 0$$

$$5T = 200$$

$$T = 40 \text{ lb}$$

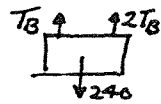
4-27



$$\sum F_y = 0$$

$$4T_A = 240$$

$$T_A = 60 \text{ lb}$$

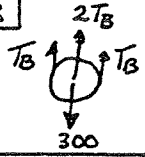


$$\sum F_y = 0$$

$$3T_B = 240$$

$$T_B = 80 \text{ lb}$$

4-28

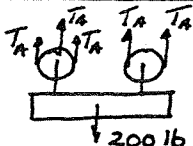


$$\sum F_y = 0$$

$$4T_B = 300$$

$$T_B = 75 \text{ kg}$$

4-29

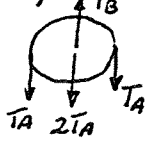


$$\sum F_y = 0$$

$$5T_A = 200$$

$$T_A = 40 \text{ lb}$$

Top Pulley



$$\sum F_y = 0$$

$$T_B = 4T_A = 4 \times 40$$

$$T_B = 160 \text{ lb}$$

4-30

$6T = 60$
 $T = 10 \text{ kN}$

FBD of C

$\sum F_y = 0$
 $\frac{8}{17} CE = \frac{3}{5} \times 125$
 $CE = 160 \text{ lb T}$
 $\sum F_x = 0$
 $CD = \frac{4}{5} (125) + \frac{15}{17} (160)$
 $CD = 241 \text{ lb T}$

4-31

$4T_1 = 60$
 $T_1 = 15 \text{ kg}$
 $T_2 = 45 \text{ kg}$
 $T = 75 \text{ kg}$
 $= 736 \text{ N}$

4-37

FBD of B

$\sum F_y = 0$
 $\frac{4}{5} AB - \frac{15}{17} (680) = 0$
 $AB = 750 \text{ N T}$
 $\sum F_x = 0$
 $BC = \frac{8}{17} (680) + \frac{3}{5} (750)$
 $BC = 770 \text{ N C}$

4-32

$5T_1 = 400$
 $T_1 = 80 \text{ lb}$
 $T_2 = 2 \times 80 = 160 \text{ lb}$
 $T_3 = 4T_1 \text{ or } 2T_2$
 $T_3 = 320 \text{ lb}$

4-38

FBD of B

$\sum F_x = 0$
 $\frac{5}{13} BD = \frac{4}{5} (100)$
 $BD = 208 \text{ lb T}$

FBD of D

$\sum F_x = 0$
 $\frac{15}{17} DE = \frac{5}{13} (208)$
 $DE = 90.7 \text{ lb T}$
 $\sum F_y = 0$
 $DF = \frac{8}{17} (90.7) + \frac{12}{13} (208)$
 $DF = 234 \text{ lb T}$

4-33

$2T_1 = 40$
 $T_1 = 20$
 $T = 3 \times 10$
 $T = 30 \text{ kN}$

FBD of F

$\sum F_y = 0$
 $3T = 234$
 $T = 78.2 \text{ lb}$

FBD of G

$\sum F_y = 0$
 $W = 156 \text{ lb}$

4-34

FBD of C

$\sum F_y = 0$
 $\frac{3}{5} AC = 600$
 $AC = 1000 \text{ N T}$
 $\sum F_x = 0$
 $\frac{4}{5} \times 1000 = BC$
 $BC = 800 \text{ N C}$

4-39

FBD of B

$\sum F_x = 0$
 $\frac{15}{17} BC = 4000$
 $BC = 4530 \text{ lb T}$
 $\sum F_y = 0$
 $BD + 2000 = \frac{8}{17} (4530)$
 $BD = 130 \text{ lb T}$

4-35

FBD of B

$\sum F_y = 0$
 $\frac{8}{17} AB = 160$
 $AB = 340 \text{ lb C}$
 $\sum F_x = 0$
 $\frac{15}{17} \times 340 = BC$
 $BC = 300 \text{ lb C}$

4-40

FBD of A

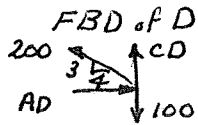
$\sum F_y = 0$
 $AC \sin 50 + AB \sin 20 + 3 \sin 15 = 3$
 $AC = 2.9 - .446 AB \dots \textcircled{1}$
 $\sum F_x = 0$
 $3 \cos 15 = AB \cos 20 - AC \cos 50$
 Subst. $\textcircled{1}$
 $AB = 1.59 \text{ kN C}$
 $\therefore AC = 2.19 \text{ kN C}$

4-36

FBD of B

$\sum F_x = 0$
 $\frac{4}{5} BC = 100$
 $BC = 125 \text{ lb T}$
 $\sum F_y = 0$
 $AB = \frac{3}{5} \times 125$
 $AB = 75 \text{ lb T}$

4-41



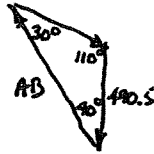
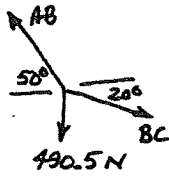
$$\sum F_x = 0$$

$$AD = \frac{4}{5}(200)$$

$$= 160 \text{ lb}$$

4-42

FBD of B



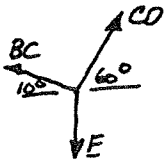
$$\frac{490.5}{\sin 30} = \frac{AB}{\sin 110}$$

$$AB = 922 \text{ N T}$$

$$\frac{490.5}{\sin 30} = \frac{BC}{\sin 40}$$

$$BC = 631 \text{ N T}$$

FBD of C



$$\frac{631}{\sin 30} = \frac{CD}{\sin 70}$$

$$CD = 1190 \text{ N T}$$

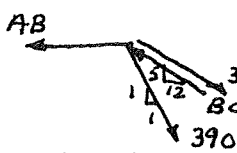
$$\frac{E}{\sin 80} = \frac{631}{\sin 30}$$

$$E = 1242 \text{ N}$$

$$= 126 \text{ kg}$$

4-43

FBD of B

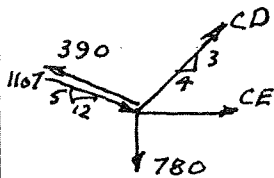


$$\sum F_y = 0$$

$$\frac{5}{13}BC = \frac{5}{13}(390) + .707(390)$$

$$BC = 1107 \text{ N}$$

FBD of C



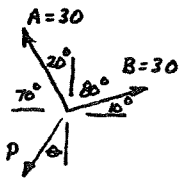
$$\sum F_y = 0$$

$$\frac{5}{13}(390) + \frac{3}{5}CD$$

$$= \frac{5}{13}(1107) + 780$$

$$CD = 1760 \text{ N T}$$

4-44

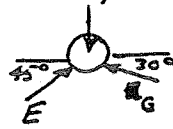


$$\frac{P}{\sin 80} = \frac{30}{\sin 50}$$

$$P = 38.6 \text{ N}$$

4-45

FBD Top roller



$$\sum F_x = 0$$

$$E \cos 45 = G \cos 30$$

$$E = 1.225 G \text{ --- (1)}$$

$$\sum F_y = 0$$

$$E \sin 45 + G \sin 30 = 50$$

Subst. (1)

$$G = 36.6$$

$$E = 44.8$$

FBD middle roller

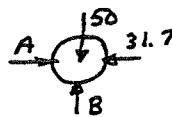


$$\sum F_x = 0$$

$$C = 44.8 \cos 45$$

$$= 31.7 \text{ lb}$$

FBD left roller



$$\sum F_x = 0$$

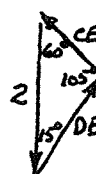
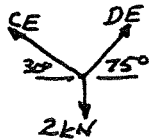
$$A = 31.7 \text{ lb} \rightarrow$$

$$\sum F_y = 0$$

$$B = 50 \text{ lb} \uparrow$$

4-46

FBD of E



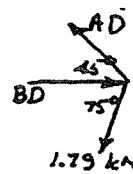
$$\frac{CE}{\sin 15} = \frac{2}{\sin 105}$$

$$CE = 0.536 \text{ kN T}$$

$$\frac{DE}{\sin 60} = \frac{2}{\sin 105}$$

$$DE = 1.79 \text{ kN T}$$

FBD of D



$$\sum F_y = 0$$

$$1.79 \sin 75 = AD \sin 45$$

$$AD = 2.45 \text{ kN T}$$

$$\sum F_x = 0$$

$$BD = 2.45 \cos 45 + 1.79 \cos 75$$

$$BD = 2.2 \text{ kN C}$$

4-47

$$\tan \theta = \frac{.25}{15} \quad \theta = 1^\circ$$

$$\sin \theta \approx \tan \theta$$

FBD of A



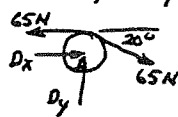
$$\sum F_y = 0$$

$$2(T \sin 1^\circ) = 10$$

$$T = 300 \text{ lb}$$

4-48

FBD of pulley



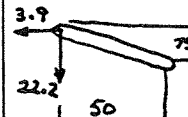
$$\sum F_y = 0$$

$$D_y = 65 \sin 20 = 22.2 \text{ N}$$

$$\sum F_x = 0$$

$$D_x + 65 \cos 20 = 65$$

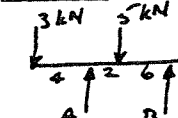
$$D_x = 3.9 \text{ N}$$



$$M_B = 3.9(.075) + 22.2(.050)$$

$$M_B = 1.4 \text{ N}\cdot\text{m} \curvearrowright$$

4-49



$$\sum M_A = 0$$

$$5(2) + 4(9) = 3(4) + B(8)$$

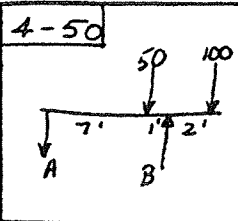
$$B = 4.25 \text{ kN} \uparrow$$

$$\sum F_y = 0$$

$$4.25 + A = 3 + 5 + 4$$

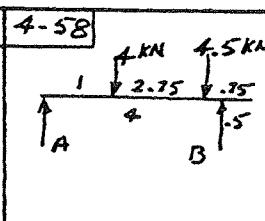
$$A = 7.75 \text{ kN} \uparrow$$

4-50



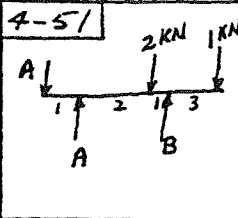
$\sum M_A = 0$
 $BB = 50(7) + 100(10)$
 $B = 169 \text{ lb } \uparrow$
 $\sum F_y = 0$
 $A + 50 + 100 = 169$
 $A = 19 \text{ lb } \downarrow$

4-58



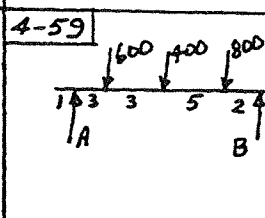
$\sum M_A = 0$
 $4B = 4(1) + 4.5(3.75)$
 $B = 5.22 \text{ kN } \uparrow$
 $\sum F_y = 0$
 $A + 5.22 = 4 + 4.5$
 $A = 3.28 \text{ kN } \uparrow$

4-51



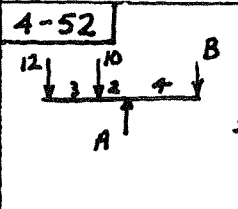
$\sum M_A = 0$
 $B(1) + 4B = 2(3) + 1(7)$
 $B = 3.05 \text{ kN } \uparrow$
 $\sum F_y = 0$
 $A + 2 + 1 = 0.8 + 3.05$
 $A = 0.85 \text{ kN } \downarrow$

4-59



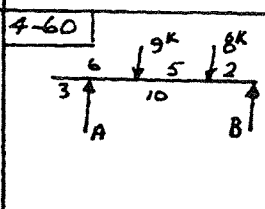
$\sum M_B = 0$
 $13A = 800(2) + 400(7) + 600(10)$
 $A = 800 \text{ lb } \uparrow$
 $\sum M_A = 0$
 $13B = 600(3) + 400(6) + 800(11)$
 $B = 1000 \text{ lb } \uparrow$

4-52



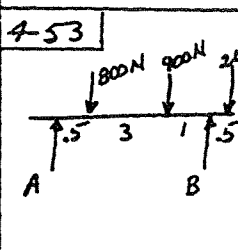
$\sum M_B = 0$
 $4A = 10 \times 6 + 9 \times 12$
 $A = 42 \text{ kN } \uparrow$
 $\sum M_A = 0$
 $4B = 2 \times 10 + 12 \times 5$
 $B = 20 \text{ kN } \downarrow$

4-60



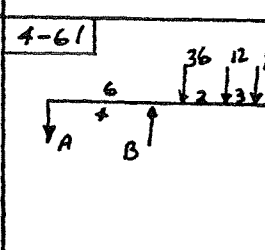
$\sum M_A = 0$
 $10B = 9(3) + 8(8)$
 $B = 9.1 \text{ kips } \uparrow$
 $\sum F_y = 0$
 $A = 17 - 9.1$
 $A = 7.9 \text{ kips } \uparrow$

4-53



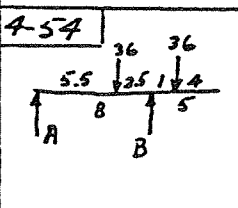
$\sum M_A = 0$
 $800(1.5) + 900(3.5) + 200(5) = B(4.5)$
 $B = 1.01 \text{ kN } \uparrow$
 $\sum F_y = 0$
 $800 + 900 + 200 = 1010 + A$
 $A = 890 \text{ N} = 0.89 \text{ kN } \uparrow$

4-61



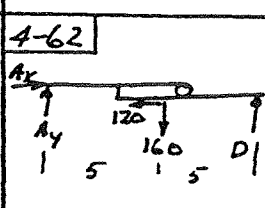
$\sum M_A = 0$
 $4B = 30(5) + 12(8) + 14(11)$
 $B = 100 \text{ kN } \uparrow$
 $\sum F_y = 0$
 $A + 30 + 12 + 14 = 100$
 $A = 44 \text{ kN } \downarrow$

4-54



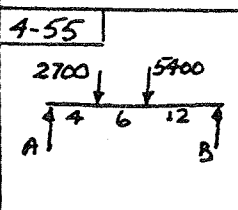
$\sum M_A = 0$
 $8B = 36(5.5) + 36(9)$
 $B = 65.2 \text{ kN } \uparrow$
 $\sum M_B = 0$
 $BA + 36(1) = 36(2.5)$
 $A = 6.8 \text{ kN } \uparrow$

4-62



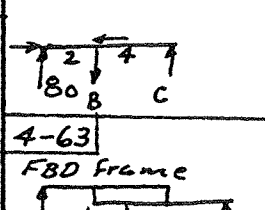
$\sum M_D = 0$
 $A_y(10) = 5(160)$
 $A_y = 80 \text{ lb}$
 $\sum M_C = 0$
 $4B = 80(6)$
 $B = 120 \text{ lb } \uparrow$

4-55



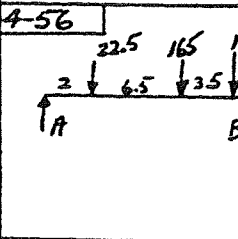
$\sum M_A = 0$
 $22B = 2700(4) + 5400(10)$
 $B = 2950 \text{ N } \uparrow$
 $\sum M_B = 0$
 $22A = 5400(12) + 2700(18)$
 $A = 5150 \text{ N } \uparrow$

4-63



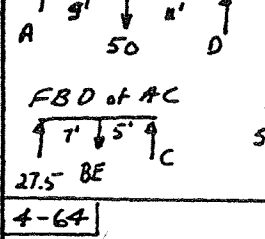
$\sum M_D = 0$
 $50(11) = A(20)$
 $A = 27.5 \text{ lb}$
 $\sum M_C = 0$
 $5BE = 12(27.5)$
 $BE = 66 \text{ lb } \uparrow$

4-56



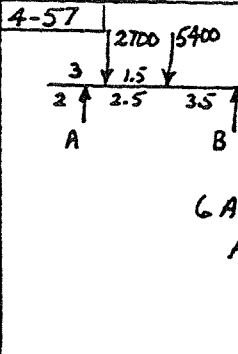
$\sum M_A = 0$
 $14B = 22.5(2) + 165(8.5) + 15(12)$
 $B = 116 \text{ kN } \uparrow$
 $\sum F_y = 0$
 $A + 116 = 22.5 + 165 + 15$
 $A = 86.5 \text{ kN } \uparrow$

4-64



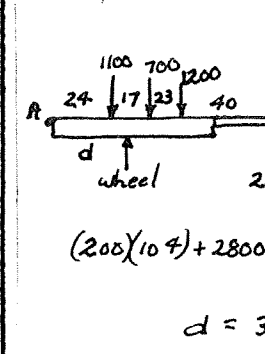
$\sum F_y = 0$
 $\text{Wheel} + 200 = 3000$
 $\text{Wheel} = 2800 \text{ lb}$
 $\sum M_A = 0$
 $(200)(104) + 2800d = (1100)(24) + 700(41) + 1200(64)$
 $d = 39.7 \text{ in.}$

4-57



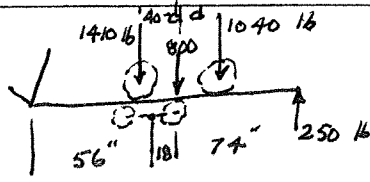
$\sum M_A = 0$
 $2700(1) + 5400(2.5) = 6B$
 $B = 2.7 \text{ kN } \uparrow$
 $\sum M_B = 0$
 $6A = 5400(3.5) + 2700(1.5)$
 $A = 5.4 \text{ kN } \uparrow$

4-64



$\sum F_y = 0$
 $\text{Wheel} + 200 = 3000$
 $\text{Wheel} = 2800 \text{ lb}$
 $\sum M_A = 0$
 $(200)(104) + 2800d = (1100)(24) + 700(41) + 1200(64)$
 $d = 39.7 \text{ in.}$

4-65

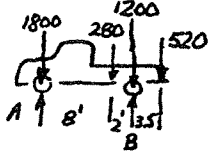


$$\sum M_A = 0$$

$$(800)(18) + 1040d = 1410(40-d) + 250(92)$$

$$d = 26.5"$$

4-66



$$\sum M_A = 0$$

$$10B = (280)8 + (1200)10 + (520)13.5$$

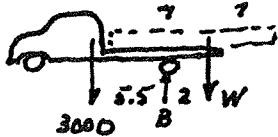
$$B = 2130 \text{ lb} \uparrow$$

$$\sum M_B = 0$$

$$10A + (520)3.5 = (280)2 + (800)10$$

$$A = 1670 \text{ lb} \uparrow$$

4-67



$$\sum M_B = 0$$

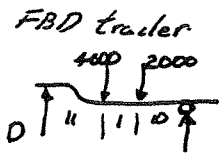
$$3000 \times 5.5 = W \times 2$$

$$W = 8250 \text{ lb}$$

$$\frac{8250}{800} = 10.3$$

wheels lift @ 11

4-68



$$\sum M_D = 0$$

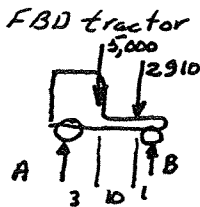
$$22C = 4000(11) + 2000(12)$$

$$C = 3090 \text{ lb} \uparrow$$

$$\sum F_y = 0$$

$$D + 3090 = 6000$$

$$D = 2910 \text{ lb} \uparrow$$



$$\sum M_A = 0$$

$$15B = 5000(3) + 2910(13)$$

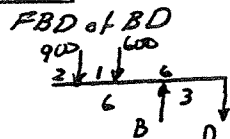
$$B = 3520 \text{ lb} \uparrow$$

$$\sum F_y = 0$$

$$A + 3520 = 5000 + 2910$$

$$A = 4390 \text{ lb}$$

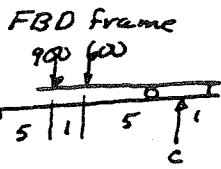
4-69



$$\sum M_D = 0$$

$$3B = 600(6) + 900(7)$$

$$B = 3300 \text{ lb} \uparrow$$

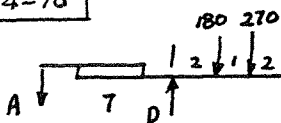


$$\sum M_A = 0$$

$$11C = 900(5) + 600(6)$$

$$C = 736 \text{ lb} \uparrow$$

4-70



$$\sum M_D = 0$$

$$7A = 180(2) + 270(3)$$

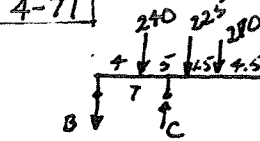
$$A = 167 \text{ lb} \downarrow$$

$$\sum M_B = 0$$

$$3C = 167(2)$$

$$C = 111 \text{ lb} \uparrow$$

4-71



$$\sum M_B = 0$$

$$7C = 240(4) + 225(9) + 270(10.5)$$

$$C = 831 \text{ lb}$$

$$\sum F_y = 0$$

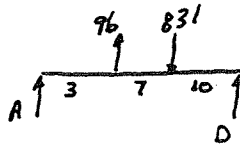
$$831 = 240 + 225 + 270 + B$$

$$B = 96 \text{ lb} \downarrow$$

$$\sum M_A = 0$$

$$20D + 96(3) = 831(10)$$

$$D = 401 \text{ lb} \uparrow$$

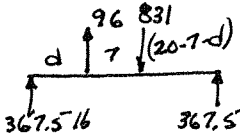


$$\sum F_y = 0$$

$$A + 401 + 96 = 831$$

$$A = 334 \text{ lb} \uparrow$$

4-72



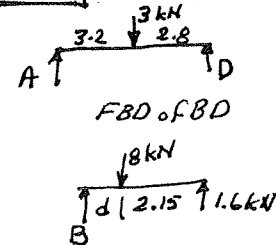
From 4-71 $A + D = 334 + 401 = 735$
 $\therefore A = D = 367.5 \text{ lb}$

$$\sum M_A = 0$$

$$96d + 367.5(20) = 831(d+7)$$

$$d = 2.09 \text{ ft}$$

4-73



$$\sum M_A = 0$$

$$6D = 3(3.2)$$

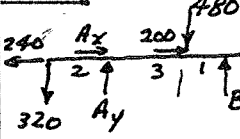
$$D = 1.6 \text{ kN} \uparrow$$

$$\sum M_B = 0$$

$$8d = 1.6(2.15+d)$$

$$d = 0.538 \text{ m}$$

4-74



$$\sum F_x = 0$$

$$A_x + 200 = 240$$

$$A_x = 40 \text{ N} \rightarrow$$

$$\sum M_A = 0$$

$$320(2) + B(4) = 480(3)$$

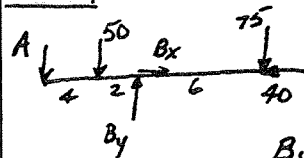
$$B = 200 \text{ N} \uparrow$$

$$\sum F_y = 0$$

$$A_y + 200 = 480 + 320$$

$$A_y = 600 \text{ N} \uparrow$$

4-75



$$\sum M_B = 0$$

$$6A + 50(2) = 75(6)$$

$$A = 58.3 \text{ kN} \downarrow$$

$$\sum F_y = 0$$

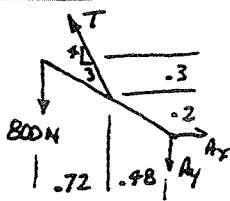
$$B_y = 58.3 + 50 + 75$$

$$B_y = 183 \text{ kN} \uparrow$$

$$\sum F_x = 0$$

$$B_x = 40 \text{ kN} \rightarrow$$

4-76



$$\sum M_A = 0$$

$$800(1.2) + \frac{3}{5}T(2) = \frac{4}{5}T(.98)$$

$$T = 3640 \text{ N}$$

$$\sum F_x = 0$$

$$A_x = \frac{3}{5}(3640)$$

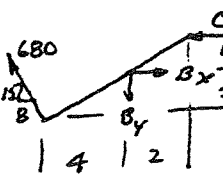
$$= 2180 \text{ N} \rightarrow$$

$$\sum F_y = 0$$

$$A_y + 800 = \frac{4}{5}(3640)$$

$$A_y = 2110 \text{ N} \downarrow$$

4-77



$$\sum F_y = 0$$

$$B_y = \frac{15}{17}(680) = 600 \text{ N} \downarrow$$

$$\sum M_B = 0$$

$$C(1) = \frac{15(680)(4) + 6(680)(2)}{17}$$

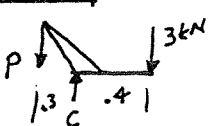
$$C = 3040 \text{ N} \leftarrow$$

$$\sum F_x = 0$$

$$B_x = 3040 + \frac{6}{17}(680)$$

$$B_x = 3360 \text{ N} \rightarrow$$

4-78

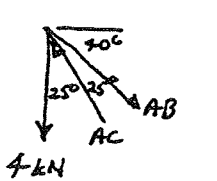


$$\sum M_C = 0$$

$$P(3) = 3(4)$$

$$P = 4 \text{ kN} \downarrow$$

FBD of A



$$\frac{AC}{\sin 30} = \frac{4}{\sin 25}$$

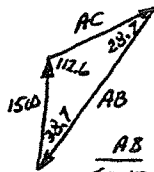
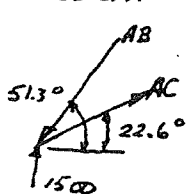
$$AC = 7.25 \text{ kN C}$$

$$\frac{AB}{\sin 25} = \frac{4}{\sin 25}$$

$$AB = 4 \text{ kN T}$$

4-79

FBD of A



$$\frac{AC}{\sin 38.7} = \frac{1500}{\sin 28.7}$$

$$AC = 1950 \text{ lb T}$$

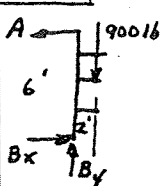
$$CE = 1950 \text{ lb T}$$

$$\frac{AB}{\sin 12.6} = \frac{1500}{\sin 28.7}$$

$$AB = 2880 \text{ lb C}$$

$$DE = 2880 \text{ lb C}$$

4-80



$$\sum F_y = 0$$

$$B_y = 900 \text{ lb} \uparrow$$

$$\sum M_B = 0$$

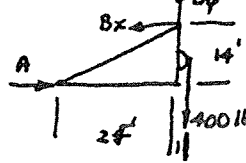
$$A(6) = 900(2)$$

$$A = 300 \text{ lb} \leftarrow$$

$$\sum F_x = 0$$

$$B_x = 300 \text{ lb} \rightarrow$$

4-81



$$\sum F_y = 0$$

$$B_y = 400 \text{ lb} \uparrow$$

$$\sum M_B = 0$$

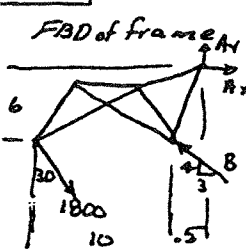
$$A(14) = 400(1)$$

$$A = 28.6 \text{ lb} \rightarrow$$

$$\sum F_x = 0$$

$$B_x = 28.6 \text{ lb} \leftarrow$$

4-82



$$\sum M_A = 0$$

$$\frac{3}{5}B(6) + \frac{4}{5}B(5) = 1800 \sin 30(6)$$

$$+ 1800 \cos 30(10.5)$$

$$B = 5440 \text{ lb} \nearrow$$

$$\sum F_x = 0$$

$$900 + A_x = \frac{3}{5}(5440)$$

$$A_x = 2370 \text{ lb} \rightarrow$$

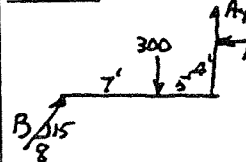
$$\sum F_y = 0$$

$$A_y + \frac{4}{5}(5440) = 1800 \cos 30$$

$$A_y = -2790$$

$$A_y = 2790 \text{ lb} \downarrow$$

4-83



$$\sum M_A = 0$$

$$\frac{15}{17}B(12) = 300(5) + \frac{8}{17}B(4)$$

$$B = 172 \text{ lb} \nearrow$$

$$\sum F_x = 0$$

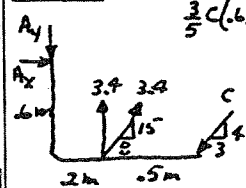
$$A_x = \frac{8}{17}(172) = 81.1 \text{ lb} \leftarrow$$

$$\sum F_y = 0$$

$$A_y + \frac{15}{17}(172) = 300$$

$$A_y = 148 \text{ lb} \uparrow$$

4-84



$$\sum M_A = 0$$

$$\frac{3}{5}C(6) + \frac{4}{5}C(7) = 3.4(2) + \frac{15}{17}(3.4)(2) + \frac{8}{17}(3.4)(6)$$

$$C = 2.43 \text{ kN} \nearrow$$

$$\sum F_x = 0$$

$$A_x + \frac{8}{17}(3.4) = \frac{3}{5}(2.43)$$

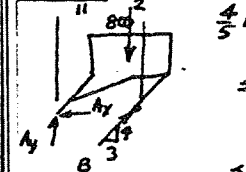
$$A_x = -0.139 = 0.139 \text{ kN} \leftarrow$$

$$\sum F_y = 0$$

$$A_y + \frac{4}{5}(2.43) = 3.4 + \frac{15}{17}(3.4)$$

$$A_y = 4.45 \text{ kN} \downarrow$$

4-85



$$\sum M_A = 0$$

$$\frac{4}{5}B(13) = 800(11)$$

$$B = 846 \text{ lb} \nearrow$$

$$\sum M_B = 0$$

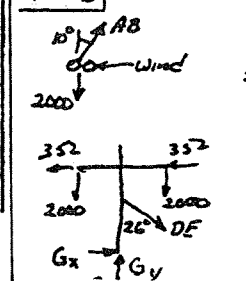
$$A_y(13) = 800(2)$$

$$A_y = 123 \text{ lb} \uparrow$$

$$\sum F_x = 0$$

$$A_x = \frac{3}{5} \times 846 = 508 \text{ lb} \leftarrow$$

4-86



$$\sum F_y = 0$$

$$AB \cos 10 = 2000$$

$$AB = 2030 \text{ lb T}$$

$$\sum F_x = 0$$

$$\text{Wind force} = 2030 \sin 10$$

$$= 352 \text{ lb} \leftarrow$$

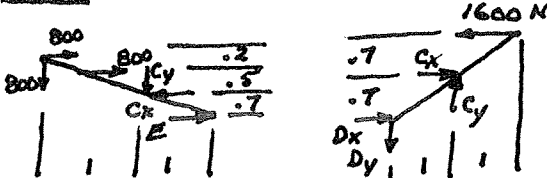
$$\sum M_G = 0$$

$$2(352)(13) + 2000(22)$$

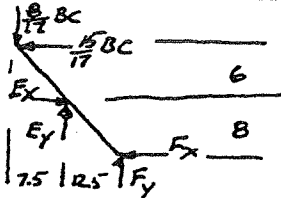
$$= 2000(22) + DE \sin 26(123)$$

$$DE = 1790 \text{ lb T}$$

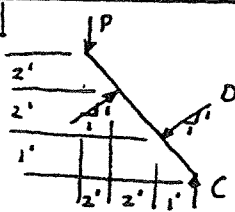
R4-1



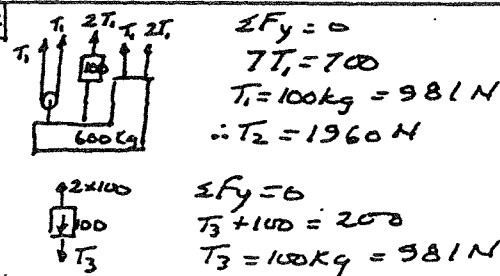
R4-2



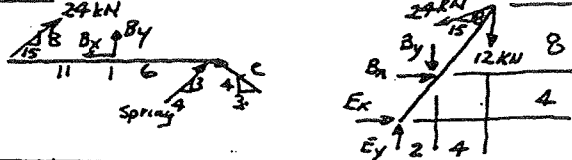
R4-3



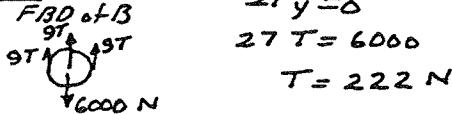
R4-4



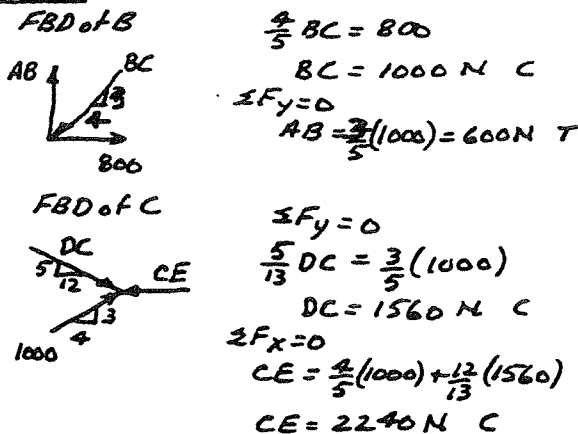
R4-5



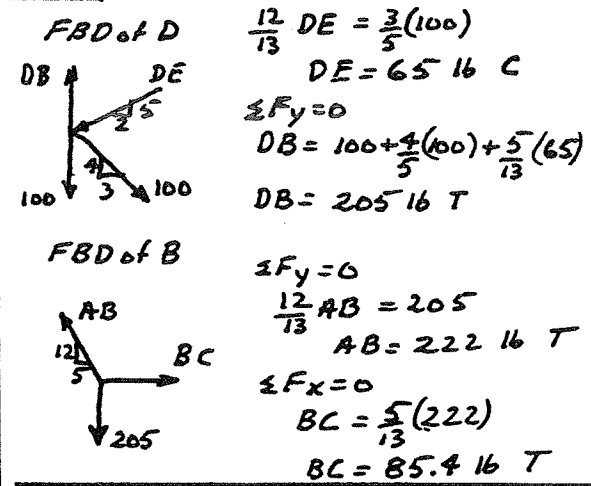
R4-6



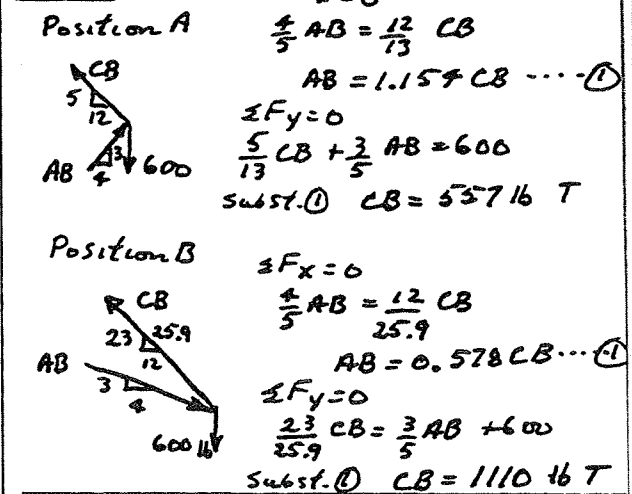
R4-7



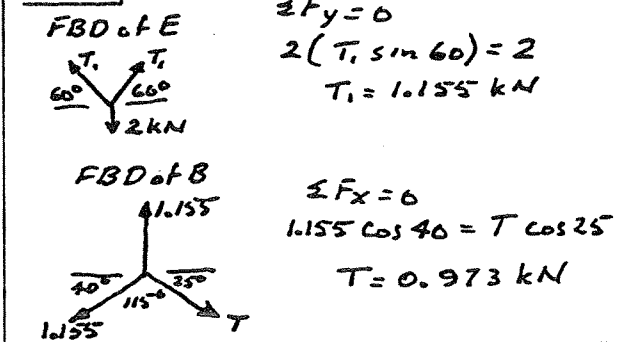
R4-8



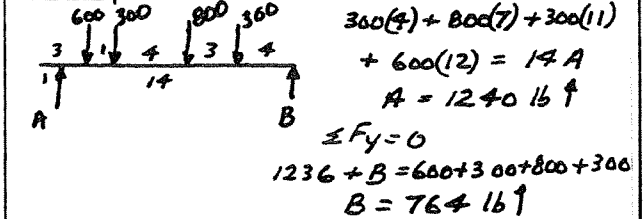
R4-9



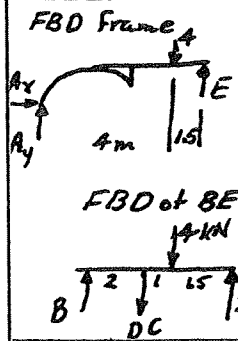
R4-10



R4-11

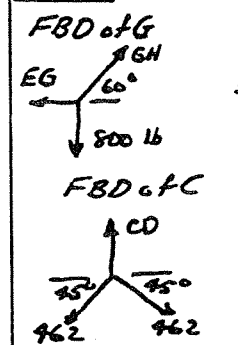


R4-12



$$\begin{aligned} \sum M_A &= 0 \\ E(5.5) &= 4(4) \\ E &= 2.91 \text{ kN} \\ \sum M_B &= 0 \\ DC(2) + 4(3) &= 2.91(4.5) \\ DC &= 0.55 \text{ kN T} \end{aligned}$$

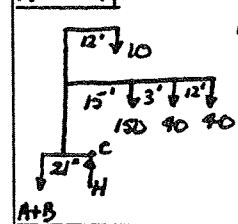
R4-13



$$\begin{aligned} \sum F_y &= 0 \\ GH \sin 60 &= 800 \\ GH &= 924 \text{ lb} \\ \sum F_x &= 0 \\ EG &= 924 \cos 60 = 462 \text{ lb T} \end{aligned}$$

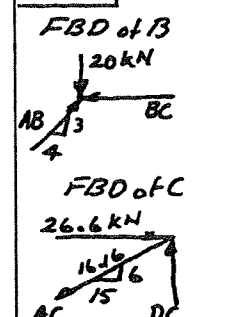
$$\begin{aligned} \sum F_y &= 0 \\ CD &= 2(462 \sin 45) \\ CD &= 653 \text{ lb T} \\ \therefore P &= 653 \text{ lb} \downarrow \end{aligned}$$

R4-14



$$\begin{aligned} \sum M_C &= 0 \\ (A+B)\left(\frac{21}{12}\right) &= 10(11) + 150(14) \\ &\quad + 40(17) + 40(29) \\ A+B &= 2314 \\ \therefore A=B &= 1160 \text{ lb T} \end{aligned}$$

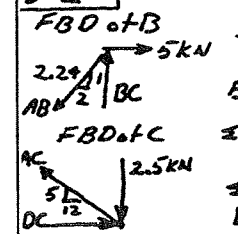
5-1



$$\begin{aligned} \sum F_y &= 0 \\ \frac{3}{5} AB &= 20 \\ AB &= 33.3 \text{ kN C} \\ \sum F_x &= 0 \\ BC &= \frac{4}{5}(33.3) = 26.6 \text{ kN C} \end{aligned}$$

$$\begin{aligned} \sum F_x &= 0 \\ \frac{15}{16.16} AC &= 26.6 \\ AC &= 28.6 \text{ kN T} \end{aligned}$$

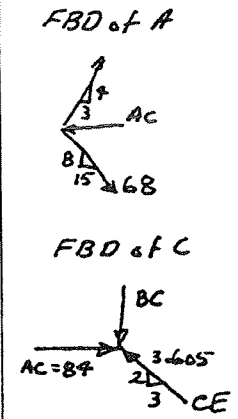
5-2



$$\begin{aligned} \sum F_x &= 0 \\ \frac{2}{2.24} AB &= 5 \\ AB &= 5.6 \text{ kN T} \\ \sum F_y &= 0 \\ BC &= \frac{1}{2.24}(5.6) = 2.5 \text{ kN C} \end{aligned}$$

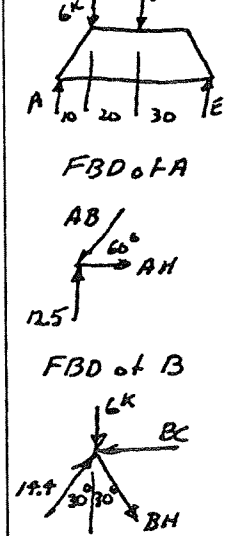
$$\begin{aligned} \sum F_y &= 0 \\ \frac{5}{13} AC &= 2.5 \\ AC &= 6.5 \text{ kN T} \\ \sum F_x &= 0 \\ DC &= \frac{12}{13}(6.5) = 6 \text{ kN C} \end{aligned}$$

5-3



$$\begin{aligned} \sum F_y &= 0 \\ \frac{8}{17}(68) &= \frac{4}{5} AB \\ AB &= 40 \text{ kN T} \\ \sum F_x &= 0 \\ AC &= \frac{15}{17}(68) + \frac{3}{5}(40) \\ AC &= 84 \text{ kN C} \\ \sum F_x &= 0 \\ \frac{3}{3.605} CE &= 84 \\ CE &= 101 \text{ kN C} \\ \sum F_y &= 0 \\ BC &= \frac{2}{3.605}(101) = 56 \text{ kN C} \end{aligned}$$

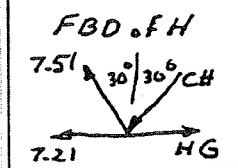
5-4



$$\begin{aligned} \sum M_A &= 0 \\ 60E &= 6(10) + 15(30) \\ E &= 8.5 \text{ kips} \uparrow \\ \sum F_y &= 0 \\ A &= 21 - 8.5 = 12.5 \text{ kips} \uparrow \end{aligned}$$

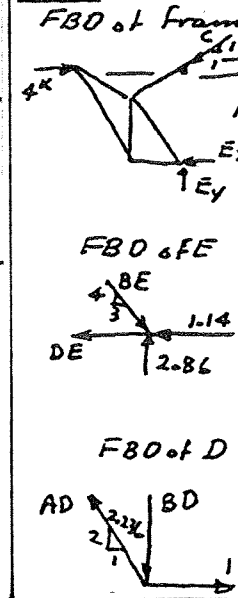
$$\begin{aligned} \sum F_y &= 0 \\ AB \sin 60 &= 12.5 \\ AB &= 14.4 \text{ kips C} \\ \sum F_x &= 0 \\ AH &= 14.4 \cos 60 \\ AH &= 7.21 \text{ kips T} \end{aligned}$$

$$\begin{aligned} \sum F_y &= 0 \\ BH \cos 30 + 6 &= 14.4 \cos 30 \\ BH &= 7.51 \text{ kips T} \\ \sum F_x &= 0 \\ BC &= 14.4 \sin 30 + 7.51 \sin 30 \\ BC &= 11 \text{ kN C} \end{aligned}$$



$$\begin{aligned} \sum F_y &= 0 \\ CH &= 7.51 \text{ kips C} \end{aligned}$$

5-5

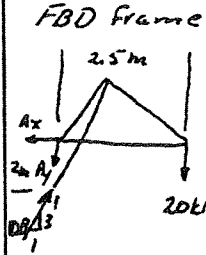


$$\begin{aligned} \sum M_C &= 0 \\ 14E_x &= 4(4) \\ E_x &= 1.14 \text{ kips} \\ \sum F_x &= 0 \\ C_x &= 4 - 1.14 \\ C_x &= 2.86 \text{ kips} \\ \sum F_y &= 0 \\ E_y &= 2.86 \text{ kips} \end{aligned}$$

$$\begin{aligned} \sum F_y &= 0 \\ \frac{4}{5} BE &= 2.86 \\ BE &= 3.57 \text{ kips} \\ \sum F_x &= 0 \\ DE &= \frac{3}{5}(3.57) - 1.14 \\ DE &= 1 \text{ kip} \end{aligned}$$

$$\begin{aligned} \sum F_x &= 0 \\ \frac{1}{2.236} AD &= 1 \\ AD &= 2.24 \text{ kips T} \\ \sum F_y &= 0 \\ BD &= 2 \text{ kips C} \end{aligned}$$

5-6



$$\sum M_A = 0$$

$$\frac{1}{3.16} DB(2) = 20(2.5)$$

$$DB = 79 \text{ kN C}$$

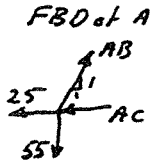
$$\sum F_y = 0$$

$$A_y + 20 = \frac{3}{3.16}(79)$$

$$A_y = 55 \text{ kN } \downarrow$$

$$\sum F_x = 0$$

$$A_x = \frac{1}{3.16}(79) = 25 \text{ kN } \leftarrow$$



$$\sum F_y = 0$$

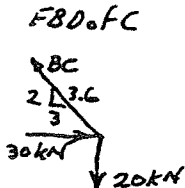
$$0.707 AB = 55$$

$$AB = 77.8 \text{ kN T}$$

$$\sum F_x = 0$$

$$AC + 25 = 0.707(77.8)$$

$$AC = 30 \text{ kN C}$$

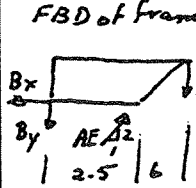


$$\sum F_x = 0$$

$$\frac{3}{3.6} BC = 30$$

$$BC = 36 \text{ kN T}$$

5-7



$$\sum M_B = 0$$

$$\frac{2}{2.236} AE(2.5) = 20(8.5)$$

$$AE = 76 \text{ kN C}$$

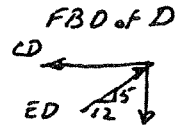
$$\sum F_x = 0$$

$$B_x = \frac{1}{2.236}(76) = 34 \text{ kN } \leftarrow$$

$$\sum F_y = 0$$

$$B_y + 20 = \frac{2}{2.236}(76)$$

$$B_y = 48 \text{ kN } \downarrow$$

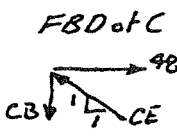


$$\sum F_y = 0$$

$$\frac{5}{13} ED = 20 \quad ED = 52 \text{ kN C}$$

$$\sum F_x = 0$$

$$CD = \frac{12}{13}(52) = 48 \text{ kN T}$$

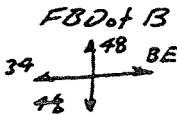


$$\sum F_x = 0$$

$$0.707 CE = 48 \quad CE = 67.8 \text{ kN C}$$

$$\sum F_y = 0$$

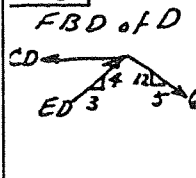
$$CB = 0.707(67.8) = 48 \text{ kN T}$$



$$\sum F_x = 0$$

$$BE = 34 \text{ kN T}$$

5-8



$$\sum F_y = 0$$

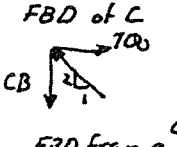
$$\frac{12}{13}(650) = \frac{5}{13} ED$$

$$ED = 750 \text{ lb C}$$

$$\sum F_x = 0$$

$$CD = \frac{3}{5}(750) + \frac{5}{13}(650)$$

$$CD = 700 \text{ lb T}$$

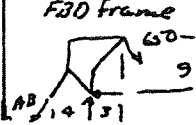


$$\sum F_x = 0$$

$$\frac{1}{2.236} CE = 700 \quad CE = 1570 \text{ lb C}$$

$$\sum F_y = 0$$

$$CB = \frac{2}{2.236}(1570) = 1400 \text{ lb T}$$

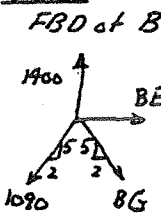


$$\sum M_G = 0$$

$$\frac{5}{5.385} AB(9) = 200(9) + 60(3)$$

$$AB = 1090 \text{ lb T}$$

5-8 cont.



$$\sum F_y = 0$$

$$\frac{5}{5.385} BG + \frac{5}{5.385}(1090) = 1400$$

$$BG = 418 \text{ lb T}$$

$$\sum F_x = 0$$

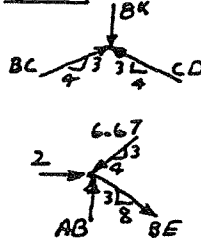
$$BE + \frac{2}{5.385}(418) = \frac{2}{5.385}(1090)$$

$$BE = 250 \text{ lb T}$$

5-9

- Joint C: $BC = 3.33 \text{ kips T}$, $DC = 2.66 \text{ kips C}$
- Joint B: $AB = 2.66 \text{ kips T}$, $BD = 2 \text{ kips C}$
- Joint D: $AD = 11.4 \text{ kips T}$, $ED = 13.3 \text{ kips C}$
- Joint E: $AE = 3.33 \text{ kips T}$, $FE = 16 \text{ kips C}$
- Joint F: $AF = 0$

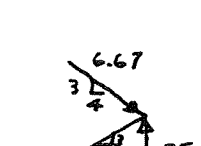
5-10



$$\sum F_y = 0$$

$$\frac{3}{5}(BC) + \frac{3}{5}CD = 8 \text{ but } BC = CD$$

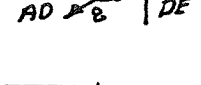
$$CD = BC = 6.67 \text{ kN C}$$



$$\sum F_x = 0$$

$$\frac{8}{8.54} BE + 2 = \frac{4}{5}(6.67)$$

$$BE = 3.55 \text{ kN T}$$



$$\sum F_y = 0$$

$$AB = \frac{3}{5}(6.67) + \frac{3}{8.54}(3.55)$$

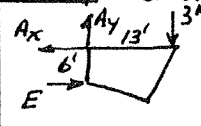
$$AB = 5.25 \text{ kN C}$$

$$\sum F_x = 0$$

$$\frac{8}{8.54} AD = \frac{4}{5}(6.67)$$

$$AD = 5.69 \text{ kN T}$$

5-11



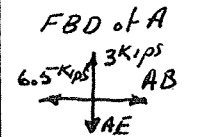
$$\sum F_y = 0$$

$$A_y = 3 \text{ kips}$$

$$\sum M_E = 0$$

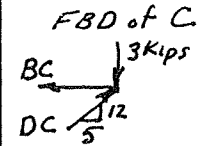
$$6A_x = 3(13)$$

$$A_x = 6.5 \text{ kips}$$



$$\sum F_y = 0$$

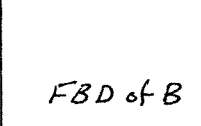
$$AB = 6.5 \text{ kips T}$$



$$\sum F_y = 0$$

$$\frac{12}{13} DC = 3$$

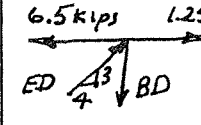
$$DC = 3.25 \text{ kips C}$$



$$\sum F_x = 0$$

$$BC = \frac{5}{13}(3.25)$$

$$BC = 1.25 \text{ kips T}$$



$$\sum F_x = 0$$

$$\frac{4}{5} EB + 1.25 = 6.5$$

$$EB = 6.56 \text{ kips C}$$



$$\sum F_y = 0$$

$$BD = \frac{3}{5}(6.56)$$

$$BD = 3.94 \text{ kips T}$$

5-12

$\sum F_y = 0$
 $DE = CF = 1570 \text{ lb C}$
 $\sum F_y = 0$
 $AD = 1570 \text{ lb C}$
 $\sum F_x = 0$
 $CD = (2) \frac{3}{3.14} (1570) = 3000 \text{ lb T}$

5-13

Joint B $AB = 0$ $BD = 4 \text{ kips C}$
 Joint A $AD = 3.75 \text{ kips C}$ $AC = 2.25 \text{ kips T}$
 Joint D $CD = 3 \text{ kips T}$ $DG = 6.25 \text{ kips C}$
 Joint C $CG = 3.75 \text{ kips C}$ $CE = 4.5 \text{ kips T}$

5-14 FBD of E

$\sum F_y = 0$
 $\frac{5}{13} DE = 600$
 $DE = 1560 \text{ lb C}$
 $\sum F_x = 0$
 $0.707 CD = \frac{12}{13} (1560)$
 $CD = 2037$
 $\sum F_y = 0$
 $BD = 0.707(2037) + \frac{5}{13} (1560)$
 $BD = 2040 \text{ lb T}$

FBD of Frame

$\sum M_B = 0$
 $T A_y = 600(12)$
 $A_y = 1029 \text{ lb}$
 FBD of A
 $\sum F_y = 0$
 $\frac{5}{13} CA = 1029$
 $CA = 2670 \text{ lb T}$

5-15

Joint C $CE = 0$
 Joint D $AD = 450 \text{ lb T}$
 Joint A $AB = 649 \text{ lb T}$ $AC = 810 \text{ lb C}$

5-16

$\sum F_y = 0$
 $\frac{5}{13} AB = 2$ $AB = 5.2 \text{ kips T}$
 $\sum F_x = 0$
 $AG = \frac{12}{13} (5.2) = 4.8 \text{ kips C}$
 $\sum F_y = 0$ $BG = 0$
 $\sum F_x = 0$ $GE = 4.8 \text{ kips}$
 $BC = 5.2 \text{ kips T}$
 $\sum M_D = 0$
 $9E = 2(16)$
 $E = 3.56 \text{ kips}$
 $\sum F_x = 0$
 $\frac{4}{6.4} CE + 3.56 = 4.8$
 $CE = 1.99 \text{ kips T}$

5-17 FBD of Frame

$\sum F_y = 0$
 $A_y = 3 \text{ kips}$
 $\sum M_D = 0$
 $4 A_x = 3(2)$
 $A_x = 1.5 \text{ kips}$
 FBD of D
 $\sum F_y = 0$
 $AD = 0$
 FBD of A
 $\sum F_y = 0$
 $\frac{1}{2.236} AC = 3 \text{ kips}$
 $AC = 6.71 \text{ kips T}$

5-18

Joint E $BE = 50 \text{ kN T}$ $ED = 56 \text{ kN C}$
 Joints D & B $BD = 0$ $BC = 0$ $AB = 50 \text{ kN T}$
 $DC = 56 \text{ kN C}$
 Joint C $AC = 0$

5-19

Joint D $CD = 46.6 \text{ kN T}$ $ED = 45 \text{ kN C}$
 Joint C $CE = BE = BG = AG = 0$
 $AB = BC = 46.6 \text{ kN T}$
 $HG = GE = 45 \text{ kN C}$
 Joint H $AH = 0$

5-20

FBD of B $BE = 0$
 FBD of E $CE = 0$
 FBD of C
 $\sum F_x = 0$
 $\frac{2}{2.236} CD = \frac{3}{5} BC$
 $CD = 0.671 BC \dots \dots \dots (1)$
 $\sum F_y = 0$
 $\frac{1}{5} BC + \frac{1}{2.236} CD = 3$ subst. (1)
 $BC = 2.73 \text{ kN C}$ $CD = 1.83 \text{ kN C}$
 FBD of B $AB = 2.73 \text{ kN C}$
 FBD of A
 $\sum F_x = 0$
 $\frac{12}{13} AE = 3(2.73)$
 $AE = 1.77 \text{ kN T}$

FBD of E $ED = 1.77 \text{ kN T}$

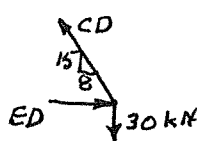
5-21 All internal members including CG have zero load

$\sum M_E = 0$
 $20 D_x = 15(40)$
 $D_x = 30 \text{ kips}$
 $\sum F_y = 0$ $D_y = 15 \text{ kips}$
 FBD of D
 $\sum F_x = 0$
 $\frac{4}{4.12} CD = 30$
 $CD = 30.9 \text{ kips T}$
 $\therefore BC = 30.9 \text{ kips T}$

5-22

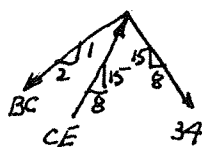
FBD of G
 $\sum F_x = 0$
 $\sum F_y = 0$

FBD of D



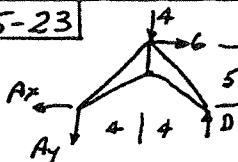
$\sum F_y = 0$
 $\frac{15}{17} CD = 30$
 $CD = 34 \text{ kN T}$

FBC of C

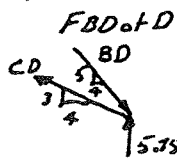


$\sum F_y = 0$
 $\frac{15}{17}(34) + \frac{1}{2.235} BC = \frac{15}{17} CE$
 $BC = 1.9676 CE - 66.9 \dots (1)$
 $\sum F_x = 0$
 $\frac{2}{2.235} BC = \frac{8}{17} CE + \frac{8}{17}(34)$
 $BC = 0.5427 CE + 17.84 \dots (2)$
 Equating (1) & (2)
 $CE = 58.7 \text{ kN C}$

5-23



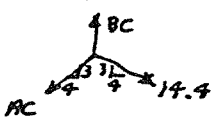
$\sum M_A = 0$
 $D(8) = 4(6) + 6(5)$
 $D = 5.75 \text{ kN } \uparrow$



$\sum F_x = 0$
 $\frac{4}{5} CD = \frac{4}{6.4} BD$
 $CD = 0.78125 BD \dots (1)$

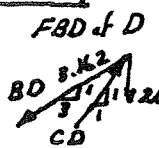
$\sum F_y = 0$
 $\frac{5}{6.4} BD = \frac{3}{5} CD + 5.75$
 Subst. (1) $BD = 18.5 \text{ kN C}$
 $CD = 14.4 \text{ kN T}$

FBD of C



$\sum F_x = 0$
 $AC = CD = 14.4 \text{ kN T}$
 $\sum F_y = 0$
 $BC = 2(\frac{3}{5}(14.4)) = 17.3 \text{ kN T}$

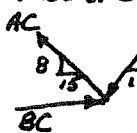
5-24



$\sum F_x = 0$
 $\frac{3}{3.162} BD = .707 CD$
 $BD = .745 CD \dots (1)$

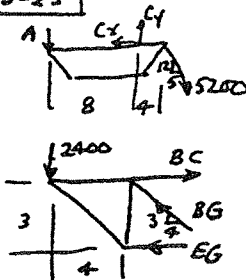
$\sum F_y = 0$
 $\frac{1}{3.162} BD + 20 = .707 CD$
 Subst. (1)
 $CD = 42.4 \text{ kN C}$

FBD of C



$\sum F_y = 0$
 $\frac{8}{17} AC = .707 \times 42.4$
 $AC = 63.8 \text{ kN T}$

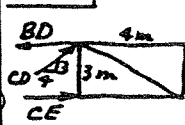
5-25



$\sum M_C = 0$
 $8A = \frac{12}{13}(5200)(4)$
 $A = 2400 \text{ N } \downarrow$
 $\sum M_G = 0$
 $EG(3) = 2400(4)$
 $EG = 3200 \text{ N C}$
 $\sum F_y = 0$
 $\frac{3}{5} BG = 2400$
 $BG = 4000 \text{ N C}$

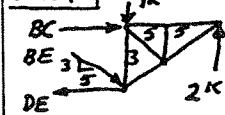
$\sum F_x = 0$
 $BC = \frac{4}{5}(4000) + 3200 = 6400 \text{ N T}$

5-26



$5.2 \text{ kN } \sum F_y = 0$
 $\frac{3}{5} CD = 2$
 $CD = 3.33 \text{ kN C}$
 $\sum M_D = 0$
 $3CE = 24$
 $CE = 2.67 \text{ kN C}$
 $\sum F_x = 0$
 $BD + 8 = 2.67 + \frac{4}{5}(3.33)$
 $BD = 0.537 \text{ kN T}$

5-27

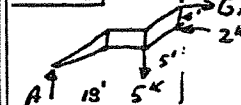


$\sum M_E = 0$
 $BC(3) = 2(10)$
 $BC = 6.67 \text{ kips C}$
 $\sum F_y = 0$
 $\frac{3}{5.83} BE + 1 = 2$
 $BE = 1.94 \text{ kips C}$
 $\sum F_x = 0$
 $DE = \frac{2}{5.83}(1.94) + 6.67$
 $DE = 8.33 \text{ kips T}$

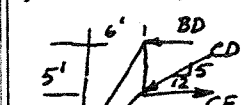
FBD of D

$\therefore BD = 0$

5-28

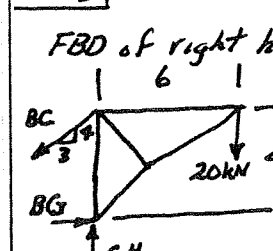


$\sum M_G = 0$
 $2(4) + 23A = 5(5)$
 $A = 0.739 \text{ kips}$



$\sum F_y = 0$
 $\frac{3}{13} CD = 0.739$
 $CD = 1.92 \text{ kips C}$
 $\sum M_C = 0$
 $0.739(6) = 5BD$
 $BD = 0.887 \text{ kips T}$
 $\sum F_x = 0$
 $CE = 0.887 + \frac{12}{13}(1.92) = 2.66 \text{ kips T}$

5-29



FBD of right half
 $\sum M_G = 0$
 $\frac{3}{5} BC \times 4 = 20 \times 6$
 $BC = 50 \text{ kN T}$

$\sum F_x = 0$
 $BG = \frac{3}{5} \times 50$
 $BG = 30 \text{ kN C}$

5-30 FBD frame - $\sum M_H = 0$ $A = 2.17 \text{ kN}$

$\sum M_B = 0$
 $9.17(6) = EG(4)$
 $EG = 13.7 \text{ kN T}$
 9.17

5-31 FBD frame $\sum M_A = 0$ $G = 5.29 \text{ kips}$

$\sum M_D = 0$
 $\frac{3}{5}CE(14) + \frac{4}{5}CE(2) = 5.29(3)$
 $CE = 1.59 \text{ kips T}$
 $\sum F_y = 0$
 $\frac{3}{5}CD = \frac{4}{5}(1.59) + 5.29$
 $CD = 10.9 \text{ kips T}$

5-32 $\sum M_C = 0$

$\frac{4}{5}BD(3) = 6(3)$
 $BD = 7.5 \text{ kN T}$
 $\sum F_y = 0$
 $\frac{2}{2.24}CE = 6 + \frac{3}{5}(7.5)$
 $CE = 11.8 \text{ kN C}$
 $\sum F_x = 0$
 $\frac{4}{5}(7.5) = CD + \frac{1}{2.24}(11.76)$
 $CD = 0.75 \text{ kN C}$
 $\sum M_E = 0$
 $\frac{2}{2.24}DG(4) = 6(5)$
 $DG = 8.4 \text{ kN T}$
 $\sum F_x = 0$
 $\frac{1}{2.24}(8.4) + \frac{1}{2.24}ED = \frac{1}{2.24}(11.76)$
 $ED = 3.36 \text{ kN C}$

5-33 $\sum M_B = 0$

$10 JH = 2(10)$
 $JH = 2 \text{ kips T}$
 $\sum M_H = 0$
 $\frac{2}{2.24}BC(15) + 1(10) = 2(20)$
 $BC = 2.24 \text{ kips C}$
 $\sum F_x = 0$
 $JH + .707 BH = \frac{2}{2.24}(2.24)$
 $BH = 0$

5-34 FBD frame $\sum M_H = 0$ $A = 20.4 \text{ kN}$

$\sum M_D = 0$
 $15(3.46) + CE \sin 60(4) = 20.4(4)$
 $CE = 8.57 \text{ kN C}$
 $\sum M_E = 0$
 $15(3.46) + DG \sin 60(4) = 20.4(8)$
 $DG = 32.1 \text{ kN T}$
 $\sum F_x = 0$
 $DE + 32.1 \cos 60 = 8.57 \cos 60 + 15$
 $DE = 3.22 \text{ kN T}$

5-35 $\sum M_E = 0$

$\frac{12}{13}CB(2.5) = 2(6)$
 $CB = 5.2 \text{ kN C}$
 $\sum F_x = 0$
 $\frac{5}{13}(5.2) + \frac{3.75}{4.8}(BE) = 2 + 3$
 $BE = 3.84 \text{ kN C}$
 FBD of G $BG = 0$

5-36 FBD of frame

$\sum F_x = 0$ $B_x = 1000 \text{ lb}$
 $\sum M_H = 0$
 $1000(9.5) + 4B_y = 600(8) + 800(15.5) + 200(8)$
 $B_y = -175 \text{ lb} = +175 \text{ lb}$
 FBD top half $\sum M_D = 0$
 $\frac{15}{17}CE(8) = 1000(4)$ $CE = 567 \text{ lb T}$
 $\sum F_x = 0$
 $\frac{8}{17}ED + 800 = 1000 + \frac{8}{17}(567)$
 $ED = 992 \text{ lb T}$
 $\sum F_y = 0$
 $DG = 175 + \frac{15}{17}(992) + \frac{15}{17}(567)$
 $DG = 1550 \text{ lb C}$

5-37 $\sum M_A = 0$

FBD of frame $H = 7.875 \text{ kN}$
 FBD of right half $\sum M_C = 0$
 $\frac{4}{5}BD \times 4 + 7.875 \times 4 = 5 \times 7$
 $BD = 1.09 \text{ kN T}$
 $\sum M_D = 0$
 $\frac{2}{2.24}CE \times 3 = 5 \times 3$ $CE = 5.59 \text{ kN C}$
 $\sum F_x = 0$
 $CD = 4.25 \text{ kN T}$

5-38 $\sum M_C = 0$

$5BD = 24(2)$ $BD = 9.6 \text{ kN T}$
 $\sum M_D = 0$
 $\frac{2}{2.24}CE(5) = 24(7)$
 $CE = 37.6 \text{ kN C}$
 $\sum F_x = 0$
 $\frac{3}{5}ED = \frac{1}{2.24}(37.6) + 10$
 $ED = 44.7 \text{ kN C}$

5-39 $\sum M_G = 0$

$.707CD(4) = 40(5)$
 $CD = 70.7 \text{ kN T}$
 $\sum F_x = 0$
 $\frac{2}{2.24}JG = .707HG + .707(70.7)$
 $JG = .792HG + 56 \dots \textcircled{1}$
 $\sum F_y = 0$
 $\frac{1}{2.24}JG + 40 = .707HG + .707(70.7)$
 Subst. $\textcircled{1}$
 $HG = 40.6 \text{ kN T}$
 $JG = 88.2 \text{ kN C}$

5-52

$\sum M_C = 0$
 $\frac{1}{7.616} 1800 \times 1.6 + \frac{3}{7.616} 1800 \times 0.3 = 1800 \times 2.3$
 $BD = 6180 \text{ N C}$
 $\sum F_y = 0$
 $C_y + 1800 = \frac{7}{7.616} \times 6180$
 $C_y = 3880 \text{ N}$
 $\sum F_x = 0$
 $C_x = 2440 \text{ N}$

5-57 cont.

$\sum M_A = 0$
 $CB \sin 30 (22.5) + CB \cos 30 (12) + 96.2 (16) = 275 (30)$
 $CB = 310 \text{ lb C}$
 $\sum F_x = 0$
 $P = 310 \cos 30 = 268.16 \leftarrow$

5-53

$\sum M_D = 0$
 $2E_y = 800 \times 0.2$
 $E_y = 80 \text{ N}$
 $\sum F_y = 0$
 $C_y = 880 \text{ N}$
 $\sum M_E = 0$
 $C_x \times 7 + 800 \times 2 = 880 \times 1 + 800 \times 1.2 + 800 \times 1.4$
 $C_x = 1940 \text{ N}$

5-58

FBD of AC $A_y = C_y = 375 \text{ lb}$
 $\sum M_B = 0$
 $15E = 750 (6.25)$
 $E = 312.5 \text{ lb}$
 $\sum F_y = 0$
 $D_y = 375 \text{ lb}$
 $\sum M_A = 0$
 $5D_x + 5(375) = 312.5 (10)$
 $D_x = 250 \text{ lb}$
 $\sum F_x = 0$
 $A_x + 250 = 312.5$
 $A_x = 62.5 \text{ lb}$

5-54

$\sum M_G = 0$
 $400(450) + .707 DE(200) + .707 DE(150) = 400 \sin 40(450) + 400 \cos 40(500)$
 $DE = 359 \text{ N T}$

5-59

$\sum M_A = 0$
 $4C_y + \frac{1}{2.24} (981)(3) = 981 (3)$
 $C_y = 407 \text{ N}$
 $\sum M_E = 0$
 $4C_x + \frac{2}{2.24} (981)(5) = \frac{1}{2.24} (981)(5) + 407(4) + 981(5)$
 $C_x = 1090 \text{ N}$

5-55

$\sum F_y = 0$
 $C_y = 3.5 \text{ kN}$
 $\sum M_C = 0$
 $400 B_x = 3.5 (250)$
 $B_x = 2.19 \text{ kN} \therefore A_x = 2.19 \text{ kN}$
 $\sum F_x = 0$
 $C_x = 2.19 \text{ kN}$
 $\sum F_x = 0$
 $E_x = 2.19 \text{ kN}$
 $\sum M_D = 0$
 $200 E_y = 250 (3.5)$
 $E_y = 4.37 \text{ kN}$
 $\sum F_y = 0$
 $D = 4.37 + 3.5 = 7.87 \text{ kN}$

5-60

$\sum M_A = 0$
 $\frac{3}{5} C(3) = 3(5)$
 $C = 8.33 \text{ kN}$
 $\sum F_y = 0$
 $A_y = \frac{4}{5} (8.33) = 6.67 \text{ kN} \uparrow$
 $\sum F_x = 0$
 $A_x + 3 = \frac{3}{5} (8.33)$
 $A_x = 2 \text{ kN} \rightarrow$
 $\sum M_B = 0$
 $8P = 8.33(5)$
 $P = 5.21 \text{ kN} \downarrow$
 $\sum F_y = 0$
 $B_y + 5.21 - \frac{4}{5} (8.33) = 0$
 $B_y = 1.96 \text{ kN} \downarrow$
 $\sum F_x = 0$
 $B_x = \frac{3}{5} (8.33) = 5 \text{ kN} \leftarrow$

5-56

$\sum M_A = 0$
 $2T + 2(.707T) = 5P + 40(2.5)$
 $T = 131 \text{ lb}$
 $\sum F_y = 0$
 $P = 200 - T$
 Subst. into (1)
 $T = 131 \text{ lb}$

5-61

$\sum M_B = 0$
 $\frac{4}{5} G(4.67) = 20(9)$
 $G = 21.41 \text{ kN}$
 $\sum F_x = 0$
 $B_x = \frac{4}{5} (21.41) = 17.1 \text{ kN}$
 $\sum F_y = 0$
 $B_y + \frac{3}{5} (21.41) = 20$
 $B_y = 7.15 \text{ kN}$
 $\sum M_C = 0$
 $4P = 17.13(2) + 7.15(2)$
 $P = 12.1 \text{ kN} \uparrow$

5-57

$\sum M_E = 0$
 $\frac{15}{17} DG(10) = \frac{3}{5} (200)(18)$
 $DG = 245 \text{ lb}$
 $\sum F_y = 0$
 $\frac{4}{5} (200) + \frac{8}{17} (245) = E_y$
 $E_y = 275 \text{ lb}$
 $\sum F_x = 0$
 $E_x + \frac{3}{5} (200) = \frac{15}{17} (245)$
 $E_x = 96.2 \text{ lb}$

5-62

$\sum M_B = 0$
 $2.33(7.07E) = 30(4)$
 $E = 72.84 \text{ kN}$
 $\sum F_y = 0$
 $.707(72.84) = 30 + B_y$
 $B_y = 21.5 \text{ kN}$
 $\sum F_x = 0$
 $B_x = .707(72.84) = 51.5 \text{ kN}$
 $\sum M_C = 0$
 $3P = 72.84(4.88)$
 $P = 45.6 \text{ kN}$

5-63

$\sum M_A = 0$
 $33H = 900 \times 11$
 $H = 300 \text{ lb}$
 $\sum M_E = 0$
 $900 \times 8 + \frac{21}{21.59} AG \times 9$
 $+ \frac{5}{21.59} AG \times 18 = 300 \times 30$
 $AG = 139 \text{ lb}$
 $\sum F_x = 0 \quad E_x = 135 \text{ lb}$
 $\sum F_y = 0 \quad E_y = 632 \text{ lb}$
 $\sum M_C = 0$
 $\frac{3}{7.31} BD \times 2.67 + \frac{6.67}{7.31} BD \times 1$
 $= 632 \times 3 + 135 \times 8$
 $BD = 1490 \text{ lb C}$

5-64

$\sum M_A = 0$
 $4B_y = 160(4) + 120(4)$
 $B_y = 680 \text{ lb}$
 $\sum F_x = 0$
 $.707D = 680$
 $D = 962 \text{ lb}$
 $\sum M_B = 0$
 $7.07(962) = 7P$
 $P = 971 \text{ lb}$

5-65

$\sum M_B = 0$
 $\frac{11}{32.9} AD \times 6 + \frac{31}{32.9} AD \times 11$
 $= 500 \times 31$
 $AD = 1253 \text{ lb}$
 $\sum M_G = 0$
 $\frac{10}{12.2} EL \times 15 = (180 \times 10) + 419 \times 8$
 $EL = 1230 \text{ lb}$
 $\sum F_y = 0$
 $G_y + \frac{1}{12.2} \times 1230 = 1180$
 $G_y = 473 \text{ lb}$
 $\sum F_x = 0$
 $G_x + 419 = \frac{10}{12.2} \times 1230$
 $G_x = 591 \text{ lb}$

5-66

$\sum M_D = 0$
 $10T = 50(20) + 5P \dots \textcircled{1}$
 $\sum M_A = 0$
 $5P = (T + \frac{3}{5}T)4 + \frac{4}{5}T(3)$
 $5P = 8.8T \dots \textcircled{2}$
 $T = 1833 \text{ lb}$
 $P = 1467 \text{ lb}$

5-67 FBD of cylinder

$\sum F_x = 0$
 $.707CD = 5$
 $CD = 7.07 \text{ lb}$
 $\sum M_E$
 $\text{torque} = (5)(\frac{1}{2}) + 5(1\frac{1}{4})$
 $= 8.75 \text{ lb-in}$

5-68 FBD of pivot handle

$\sum M_B = 0$
 $19A = 300(6.9)$
 $A = 1089 \text{ N}$
 $\sum F_x = 0$
 $B_x = 1089 \text{ N}$
 $\sum F_x = 0$
 $P = 1089 \text{ N}$
 $\sum M_C = 0$
 $50D = 1089(3) + 1089(4.5)$
 $D = 1045 \text{ N}$
 $\sum F_y = 0$
 $C = 1045 \text{ N}$

5-69

$\sum M_B = 0$
 $13GH + \frac{4}{5}DE(\frac{1}{4}) = \frac{3}{5}DE(3)$
 $GH = 0.123DE \dots \textcircled{1}$
 $\sum M_C = 0$
 $GH(12.5) + 100(8.5) = \frac{3}{5}DE(6.5)$
 $\text{Subst. } \textcircled{1}$
 $GH = 44.3 \text{ lb}$

5-70

$\sum M_C = 0$
 $D_x(3) + \frac{3}{2}D_x(6) = 150(30)$
 $D_x = 375 \text{ lb}$
 $\therefore D_y = 562 \text{ lb}$
 $\sum F_x = 0$
 $EH = 750 \text{ lb}$

5-71

$AB = CD$
 $\sum F_y = 0$
 $2(\frac{3}{2.25} AB) + 390 + 1600 = 6000$
 $AB = CD = 2.25 \text{ kN T}$

5-72

$\sum M_E = 0$
 $8(6) = \frac{12}{13} AB(5)$
 $AB = 10.4 \text{ kN T}$
 $\sum F_x = 0$
 $\frac{5}{13}(10.4) + 8 = E_x$
 $E_x = 12 \text{ kN}$

$\sum F_y = 0$
 $E_y = \frac{12}{13}(10.4) = 9.6 \text{ kN}$
 $\sum M_C = 0$
 $\frac{10}{10.03} BD(4.18) + \frac{0.833}{10.03} BD(10)$
 $+ 9.6(5) = 12(12)$
 $BD = 19.2 \text{ kN T}$

5-73

$\sum M_D = 0$
 $\frac{2}{2.24} BE(40) = 200(95)$
 $BE = 532 \text{ N C}$
 $\sum F_y = 0$
 $D_y = \frac{1}{2.24}(532) = 238 \text{ N } \uparrow$
 $\sum F_x = 0$
 $D_x + 200 = \frac{2}{2.24}(532)$
 $D_x = 275 \text{ N } \leftarrow$

$\sum M_C = 0$
 $P(60) + \frac{2}{2.24}(532)(50)$
 $= \frac{1}{2.24}(532)(120)$
 $P = 29.7 \text{ N } \downarrow$
 $\sum F_x = 0$
 $C_x = \frac{2}{2.24}(532) = 475 \text{ N } \rightarrow$
 $\sum F_y = 0$
 $C_y + 29.7 = \frac{1}{2.24}(532)$
 $C_y = 208 \text{ N } \downarrow$

5-74

$\sum M_A = 0$
 $\frac{2}{5} BC(2) = 1000(1.5)$
 $BC = 937 \text{ lb T}$
 $\sum F_y = 0$
 $A_y = 1000 - \frac{3}{5}(937) = 438 \text{ lb } \uparrow$
 $\sum F_x = 0$
 $A_x = \frac{4}{5}(937) = 750 \text{ lb } \leftarrow$

$\sum M_E = 0$
 $7.7 D = 937(19.2)$
 $D = 2340 \text{ lb T}$

$\sum M_G = 0$
 $\frac{1}{2.24} E(5) + 1000(3.5) = \frac{2}{2.24} E(3.75)$
 $E = 8510 \text{ lb C}$

5-75

$\sum M_D = 0$
 $4A = 300(3)$
 $A = 225 \text{ lb}$
 $\sum F_x = 0$ $H_x = 0$
 $\sum M_E = 0$
 $4H_y = 300(1)$
 $H_y = 75 \text{ lb}$

$\sum M_C = 0$
 $\frac{1.5}{1.64} 8G(6.7) + \frac{6.7}{1.64} BG(5)$
 $= 225(2) + 75(2)$
 $BG = 734 \text{ lb C}$

5-76

$\sum M_D = 0$
 $\frac{5}{13} B(95) + \frac{3}{5} AC(40) = 800(20)$
 $+ \frac{5}{13} B(55)$
 $AC = 667 - 0.672B \dots \textcircled{1}$
 $\sum M_H = 0$
 $\frac{12}{13} B(120) + \frac{5}{13} B(50) + \frac{3}{5} AC(25) = \frac{4}{5} AC(60)$
 $AC = 3.94 B \dots \textcircled{2}$
 Equating
 $B = 146 \text{ N}$
 $AC = 573 \text{ N T}$

5-77

$\sum M_B = 0$
 $2.5A + 9.63(6) = 37.8(30)$
 $A = 430 \text{ lb } \uparrow$
 $\sum F_x = 0$
 $B_x = 9.63 \text{ lb } \nearrow$
 $\sum F_y = 0$
 $B_y + 37.8 = 430$
 $B_y = 392 \text{ lb } \searrow$

5-78

5-79

Slope of AC
 $\sin \theta = \frac{1.125}{1.5}$
 $\theta = 48.6^\circ$
 $\sum M_D = 0$
 $AC \sin 48.6(1) + AC \cos 48.6(.75)$
 $D_y = 30 \sin 21.1(22.75) + 30 \cos 21.1(25.28)$
 $AC = 765 \text{ lb C}$
 $\sum F_y = 0$
 $D_y + 30 \cos 21.1 = 765 \sin 48.6$
 $D_y = 546 \text{ lb}$
 $\sum F_x = 0$
 $D_x = 765 \cos 48.6 - 30 \sin 21.1 = 495 \text{ lb}$
 $\sum M_B = 0$
 $E \sin 30(.25) + E \cos 30(3.5)$
 $= 765 \sin 21.1(1.75) + 765 \cos 21.1(1.75)$
 $E = 527 \text{ lb}$
 $\sum F_y = 0$
 $B_y = 527 \cos 30 + 765 \cos 21.1$
 $B_y = 1170 \text{ lb}$
 $\sum F_x = 0$
 $B_x = 527 \sin 30 + 765 \sin 21.1$
 $B_x = 539 \text{ lb}$