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Online Instructor's Solutions Manual
to accompany

Applied Mechanics for Engineering Technology

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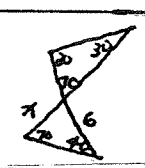
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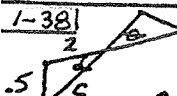
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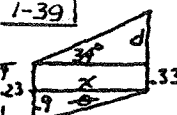
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ISBN-10: 0-13-173455-5

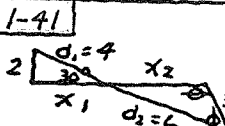
1-1	$24 + 8x - 12x = 8x$ $8x - 12x - 8x = -24$ $x = 2$	1-17	$R = 5m \quad \theta = 36.9^\circ$ $R = 13m \quad \theta = 67.4^\circ$ $R = 17 \quad \theta = 28.1^\circ$
1-2	$12 + 6x + 3 = 27$ $6x = 27 - 12 - 3$ $x = 2$	1-18	$\tan 20 = \frac{A}{6} \quad A = 2.18in$ $\tan 40 = \frac{A}{4} \quad A = 3.36ft$ $\tan 55 = \frac{20}{A} \quad A = 14in.$
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	$\begin{array}{rcl} ① \times 5 & 10x + 40y = 100 \\ ② \times -2 & -10x + 6y = -20 \\ \hline & 46y = 80 \\ & y = 1.74 \end{array}$	1-20	$\tan 65 = \frac{y}{4} \quad y = 8.58mm$
1-5	$\begin{array}{rcl} ① \times 8 & 176x + 24y = 968 \\ ② \times 3 & 39x - 24y = 168 \\ \hline & 215x + 0 = 1136 \\ & x = 5.28 \end{array}$	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	$a = 35^\circ \text{ opposite angle}$ $b = 180 - 35 - 90 = 55^\circ$ $c = 180 - 55 = 125^\circ$	1-24	$(5.5)^2 = 3^2 + 4^2 - 2(3)(4)\cos \theta$ $\theta = 77.36^\circ (2^{nd} \text{ Quadrant})$ $\text{or } \theta = 102.6^\circ$
1-9	$a = 80^\circ \text{ opposite angle}$ $b = 180 - 80 = 100^\circ$ $c = 100^\circ \text{ opposite angle}$	1-25	$(CB)^2 = 55^2 + 90^2 - 2(55)(90)\cos 25$ $CB = 46.2in.$
1-10	$a = 90 - 40 = 50^\circ$ $b = 15^\circ \text{ opposite angle}$ $c = 180 - 50 - 15 = 115^\circ$ $d = 180 - 115 = 65^\circ$ $e = 65^\circ \text{ opposite angle}$	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	$\tan \theta = \frac{1}{10} \quad \theta = 5.7^\circ$ $\text{included angle} = 11.4^\circ$	1-33	$\tan \theta = \frac{1}{10} \quad \theta = 5.7^\circ$ $\text{included angle} = 11.4^\circ$
1-18	$\cos 50 = \frac{y}{10} \quad y = 6.43in.$ $h = 10 - 6.43 = 3.57m.$	1-34	$\cos 50 = \frac{y}{10} \quad y = 6.43in.$ $h = 10 - 6.43 = 3.57m.$
1-19	$x = 3.3 \cos 55 = 1.9m.$ $y = 3.3 \sin 55 = 2.7in.$	1-35	$x = 3.3 \cos 55 = 1.9m.$ $y = 3.3 \sin 55 = 2.7in.$
1-20	$\text{Corner width} = 1.875 / \cos 30 = 2.17in.$	1-36	$\text{Corner width} = 1.875 / \cos 30 = 2.17in.$

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

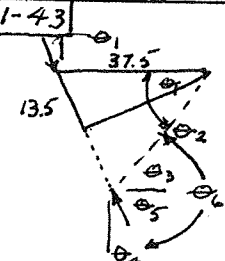
1-38 
 $C^2 = 2^2 + 5^2 - 2(2)(5) \cos 105$
 $C = 2.18 \text{ m}$
 $\frac{2.18}{\sin 105} = \frac{5}{\sin \phi} \quad \phi = 12.8^\circ$
 $\therefore \theta = 12.8^\circ$

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 
 $X_1 = \frac{2}{\tan 30} = 3.47$
 $d_1 = \frac{2}{\sin 30} = 4$
 $\frac{6}{\sin \theta} = \frac{3.25}{\sin 30} \quad \therefore \theta = 112.7^\circ$
 $\phi = 37.3^\circ$
 $\frac{X_2}{\sin 37.3} = \frac{3.25}{\sin 30} \quad X_2 = 3.94$
 $\text{horiz. dist.} = 3.47 + 3.94 = 7.41 \text{ m.}$

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

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 $X = 15 \cos 25 = 13.6 \text{ m}$
 $Y = 15 \sin 25 = 6.34 \text{ m}$

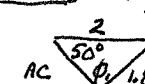
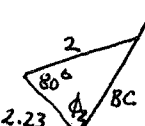
R1-2 $\cos 18 = \frac{4.5}{B} \quad B = 4.73 \text{ m}$
 $\tan 18 = \frac{A}{4.5} \quad A = 1.46 \text{ m}$

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

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

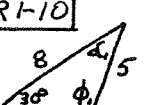
R1-6 $\frac{5}{\sin 40} = \frac{3}{\sin \theta} \quad \theta = 22.69^\circ$
 $\phi = 180 - 22.69 - 40 = 117.3^\circ$
 $\frac{R}{\sin 117.3} = \frac{5}{\sin 40} \quad R = 6.91 \text{ m}$

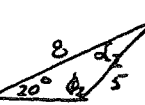
R1-7 original triangle ABC

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


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

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

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

R1-10 
 $\frac{8}{\sin \phi_1} = \frac{5}{\sin 30} \quad \phi_1 = 126.87^\circ$
 $\therefore \alpha_1 = 23.13^\circ$
 $\frac{X_1}{\sin 23.13} = \frac{5}{\sin 30} \quad X_1 = 3.928$


 $\frac{8}{\sin \phi_2} = \frac{5}{\sin 20} \quad \phi_2 = 146.82^\circ$
 $\therefore \alpha_2 = 13.18^\circ$

$\frac{X_2}{\sin 13.18} = \frac{5}{\sin 20} \quad X_2 = 3.333$
 $\text{horiz. dist. of C} = 3.928 - 3.333 = 0.595 \text{ m}$

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

$R1-12$ $AC^2 = 4^2 + 5^2 - 2 \times 4 \times 5 \cos 143.1$
 $AC = 8.54$
 $h = 5 \sin 36.9 = 3$
 $\cos \theta = \frac{3}{4}$ $\theta = 60^\circ$
 $(AC')^2 = 4^2 + 5^2 - 2 \times 4 \times 5 \cos 60$
 $AC' = 4.58$
 $\Delta AC = 3.96 \text{ m}$

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

$2-2$ 60.2 lb 126 lb 1060 lb

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

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

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

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

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

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

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

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

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

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

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

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

$2-15$ $\sin \theta = \frac{2.5}{6.5}$ $\theta = 22.6^\circ$
 $\frac{R}{\sin 134.8} = \frac{100}{\sin 22.6}$
 $R = 185 \text{ lb}$
 $\frac{R}{\sin 157.4} = \frac{100}{\sin 11.3}$
 $R = 196 \text{ lb}$

$2-16$ $\tan \theta = \frac{3}{4}$ $\theta = 36.9^\circ$
 $180 - 55 - 36.9 = 88.1^\circ$
 $R = 5 \text{ kips}$

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

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

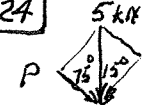
$2-19$ $F_y = 30 \text{ lb}$ $F_x = 52 \text{ lb}$
 $F_y = 75.2 \text{ kips}$ $F_x = 27.4 \text{ kips}$
 $v_y = 400 \text{ ft/sec}$ $v_x = 300 \text{ ft/sec}$
 $v_y = 16 \text{ mph}$ $v_x = 30 \text{ mph}$

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

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

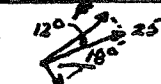
$2-22$ $A_x = 637.6 \cos 45 = 451 \text{ N}$
 $A_y = 451 \text{ N}$

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

2-24  $\cos 75 = \frac{P}{5}$
 $P = 1.29 \text{ kN}$

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 $R_y = \frac{3}{5} \times 50 + \frac{1}{4.12} \times 100 = 54.3 \text{ lb} \uparrow$
 $R_x = \frac{4}{5} \times 50 + 65 - 25 - \frac{4}{4.12} \times 100 = 17 \text{ lb} \leftarrow$
 $R = 56.9 \text{ lb} \nearrow 20^\circ$

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

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

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 $R_x = -40 \sin 20 - 20 \cos 40 + \frac{12}{13}(39)$
 $= +6.99$
 $R_y = 40 \cos 20 - 20 \sin 40 - \frac{5}{13} \times 39$
 $= 9.73$
 $R = 12 \text{ lb} \nearrow 54.3^\circ$

R2-1 $R = 65 \text{ N} \nearrow 12.5^\circ$
 $R = 8.54 \text{ kN} \nearrow 8^\circ$ $R = 102 \text{ N} \nearrow 15^\circ$

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

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 $F_x = 3 \cos 15 = 2.9 \text{ kN} \nearrow 40^\circ$

$$\begin{aligned} R2-1 \quad F_x &= -400 \cos 10 + 150 \cos 50 + 200 \sin 15 \\ &= -245.7 \\ F_y &= +300 + 400 \sin 10 + 150 \sin 50 - 200 \cos 15 \\ &= +291.2 \\ R &= 381 \text{ N } \angle 49.8^\circ \end{aligned}$$

$$\begin{aligned} R2-8 \quad R_x &= 120 - \frac{12}{13}(26) - \frac{8}{17}(170) \\ &= +16 \\ R_y &= -90 - \frac{5}{13}(26) + \frac{15}{17}(170) \\ &= +50 \\ R &= 52.5 \text{ N } \angle 72.3^\circ \end{aligned}$$

$$\begin{aligned} 3-1 \quad M_A &= -12 \times 2 - 9 \times 1 - 24 \times 2 + 10 \times 4 \\ &\quad + 30 \times 3 - 16 \times 3 \\ M_A &= 1 \text{ lb-ft} \end{aligned}$$

$$\begin{aligned} 3-2 \quad M_A &= -48 \times 2 + 36 \times 1 - 20 \times 4 + 15 \times 3 \\ M_A &= 95 \text{ N}\cdot\text{m} \end{aligned}$$

$$\begin{aligned} 3-3 \quad M_A &= +(60)(20) + (36)(32) \\ M_A &= 2350 \text{ lb}\cdot\text{in} \end{aligned}$$

$$\begin{aligned} 3-4 \quad M_A &= -5.66(.5) - 3(.5) - 5.2(.3) - 4(.4) \\ M_A &= 7.49 \text{ N}\cdot\text{m} \end{aligned}$$

$$\begin{aligned} 3-5 \quad M_A &= -160(7) + 400(10) - 800(2) \\ M_A &= 1280 \text{ lb}\cdot\text{ft} \end{aligned}$$

$$\begin{aligned} 3-6 \quad M_A &= -800(5 \sin 38) \\ &= 2460 \text{ N}\cdot\text{m} \end{aligned}$$

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

$$\begin{aligned} 3-8 \quad M_C &= 1800 \times 2.3 = 4140 \text{ N}\cdot\text{m} \\ M_B &= (1800)(1.7) = 3060 \text{ N}\cdot\text{m} \end{aligned}$$

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

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

$$\begin{aligned} 3-11 \quad M_A &= F \times d \\ 500 &= P \cos 28(1.8) \quad P = 315 \text{ N } \angle 75^\circ \end{aligned}$$

$$\begin{aligned} 3-12 \quad M_A &= 200(3) + 360(6) - 150(4) \\ &= 2160 \text{ N}\cdot\text{m} \end{aligned}$$

$$\begin{aligned} 3-13 \quad M_A &= 90(.1) - 120(.24) \\ &= 19.8 \text{ N}\cdot\text{m} \end{aligned}$$

$$\begin{aligned} 3-14 \quad M_A &= -60(3) + 240(1) + 200(0) + 80(0) \\ &= 60 \text{ kN}\cdot\text{m} \end{aligned}$$

$$\begin{aligned} 3-15 \quad M_A &= (1200 \cos 20)1 - (1200 \sin 20)9.5 + (600)4.5 \\ &\quad + (160)1.5 + (120)6 \\ &= 889 \text{ lb}\cdot\text{ft} \end{aligned}$$

$$\begin{aligned} 3-16 \quad M_B &= (500 \sin 15)(2 \cos 25) \\ &\quad + (500 \cos 15)(2 \sin 25) \\ &= 643 \text{ N}\cdot\text{m} \\ 643 &= F \times .8 \cos 25 \\ F &= 887 \text{ N} \end{aligned}$$

$$\begin{aligned} 3-17 \quad M_A &= -4000(8) - 1500(68) \\ &= -134,000 \text{ lb}\cdot\text{in} \\ &= 11.2 \text{ Kip}\cdot\text{ft} \\ M_B &= 4000(38) - 1500(22) \\ &= 119,000 \text{ lb}\cdot\text{in} \\ &= 9.92 \text{ Kip}\cdot\text{ft} \end{aligned}$$

$$\begin{aligned} 3-18 \quad \text{Moment about wheels} &= \text{hitch load} \times 2 \\ &= 45 \times 2 \\ &= 90 \text{ N}\cdot\text{m} \\ \text{Moment about wheels} &= \text{dolly load} \times 1.5 \\ 90 &= \text{dolly load} \times 1.5 \\ \text{dolly load} &= 60 \text{ N} \end{aligned}$$

$$\begin{aligned} 3-19 \quad \text{Top Arm } M_B &= (30 \cos 21.1)(34) \\ &= 952 \text{ lb}\cdot\text{in} \\ \text{Bottom Arm } M_C &= (30 \cos 21.1)(32.77) \\ &= 917 \text{ lb}\cdot\text{in} \\ \therefore \text{greater moment in upper arm} \end{aligned}$$

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

$$\begin{aligned} 3-21 \quad M_A &= 1.294(.3) - 2(.5) \\ &= 0.612 \text{ kN}\cdot\text{m} \end{aligned}$$

$$\begin{aligned} 3-22 \quad M_A &= -10(4 \cos 10) + 8(6) \\ &= 8.6 \text{ lb}\cdot\text{ft} \end{aligned}$$

$$\begin{aligned} 3-23 \quad M_A &= -80(2) - 60(4.2) = -412 \\ &= 412 \text{ lb}\cdot\text{ft} \end{aligned}$$

$$\begin{aligned} 3-24 \quad M_A &= 30 \times .376 \\ &= 11.3 \text{ N}\cdot\text{m} \end{aligned}$$

$$\begin{aligned} 3-25 \quad M_A &= 10(8) - 25(15) \\ &= 280 \text{ lb}\cdot\text{in} \end{aligned}$$

$$\begin{aligned} 3-26 \quad 500(4) &= F \times .15 \\ F &= 13,300 \\ \therefore A &= 13,300 \text{ lb} \\ B &= 13,300 \text{ lb} \end{aligned}$$

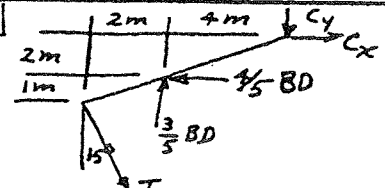
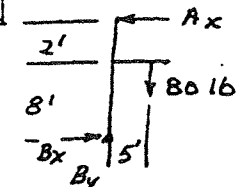
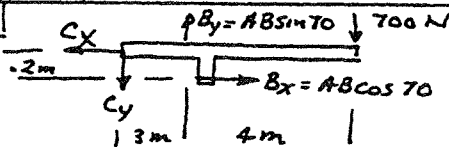
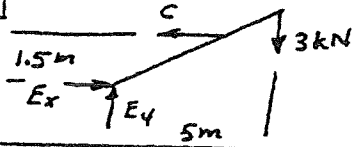
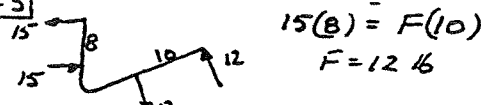
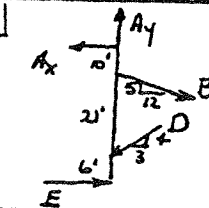
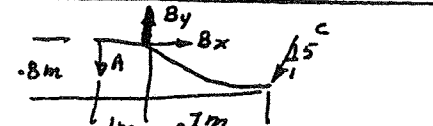
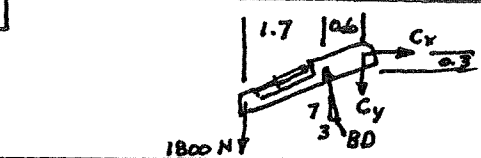
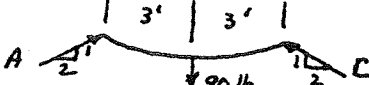
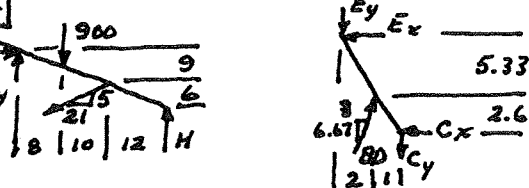
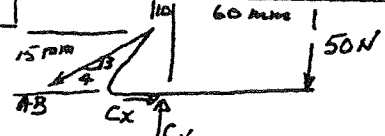
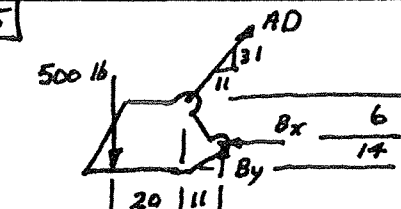
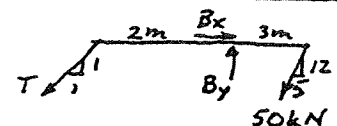
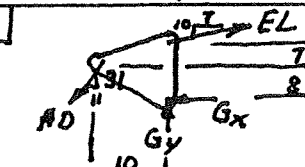
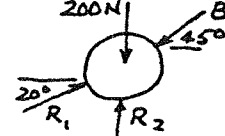
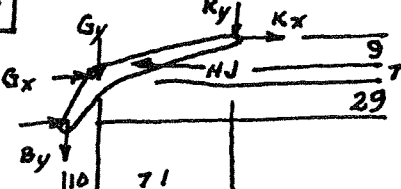
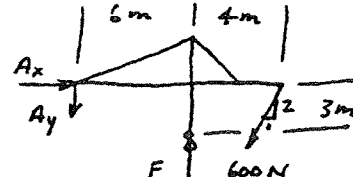
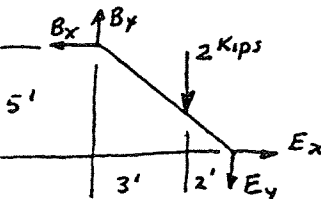
$$\begin{aligned} 3-27 \quad M &= 20 \times 8 \\ &= 160 \end{aligned}$$

$$\begin{aligned} 3-28 \quad 6 \times 3 &= F(4) \\ F &= 4.5 \text{ N} \end{aligned}$$

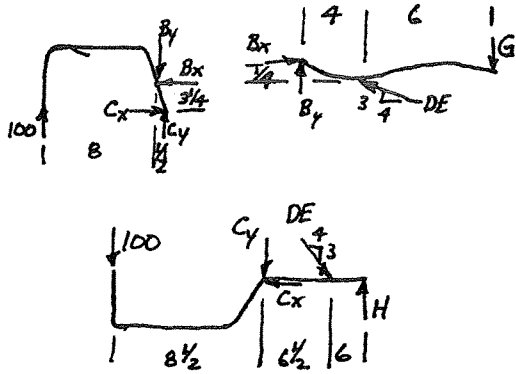
$$\begin{aligned} 3-29 \quad 0.4(8) &= F(.25) \\ F &= 12.8 \text{ kN} \end{aligned}$$

$$\begin{aligned} 3-30 \quad 4(2000) &= F(300) \\ F &= 26.7 \text{ N} \end{aligned}$$

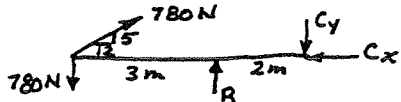
$$\begin{aligned} 3-31 \quad 4(2000) &= 50 F \\ F &= 160 \text{ N} \end{aligned}$$

R3-1 $M_A = -24(4) + 10(0) - 30(1) + 16(3)$ $-6(1) - 8(2) + 8(1)$ $= 92 \text{ N}\cdot\text{m}$	4-8 
R3-2 $M_A = 1200(15 \cos 18) = 17,120 \text{ lb}\cdot\text{ft}$ $17,120 = B(8 \sin 20)$ $B = 6260 \text{ lb}$ $\uparrow 38^\circ$	4-9 
R3-3  $M_A = 140 \times 1.5 = 21 \text{ N}\cdot\text{m}$ $M_A = 140 \times 1.65 = 91 \text{ N}\cdot\text{m}$	4-10 
R3-4 $M_A = -10(1.5) - 30(1) = 45 \text{ N}\cdot\text{m}$ $M_B = -10(1.5) - 30(1) = 45 \text{ N}\cdot\text{m}$	4-11 
R3-5  $15(B) = F(10)$ $F = 12 \text{ lb}$	4-12 
4-1 	4-13 
4-2 	4-14 
4-3 	4-15 
4-4 	4-16 
4-5 	4-17 
4-6 	
4-7 	

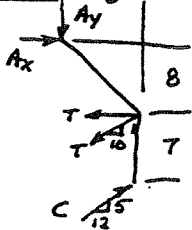
4-18



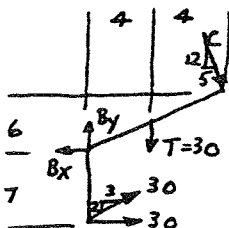
4-19



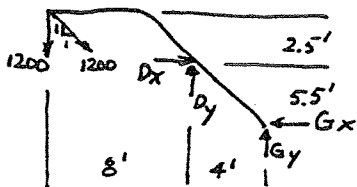
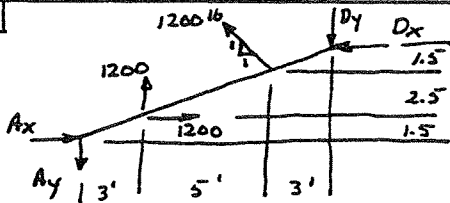
4-20



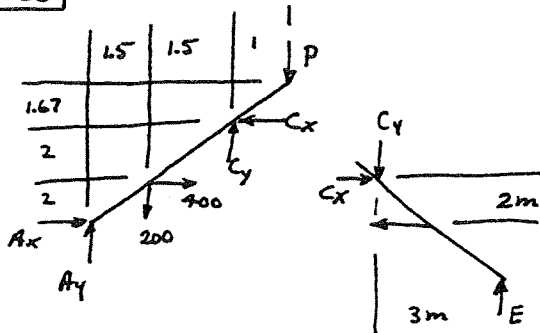
4-21



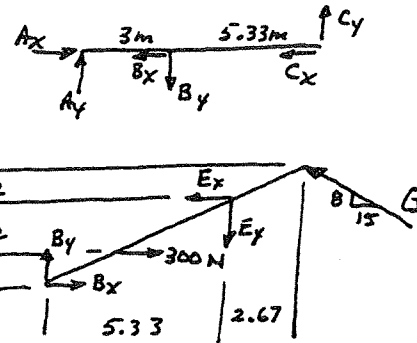
4-22



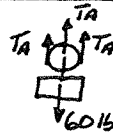
4-23



4-24

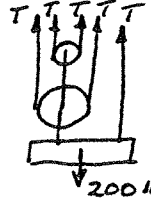


4-25



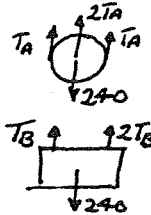
$$\begin{aligned} \Sigma F_y &= 0 \\ 3T_A &= 60 \\ T_A &= 20 \text{ lb} \end{aligned}$$

4-26



$$\begin{aligned}\sum F_y &= 0 \\ 5T &= 200 \\ T &= 40 \text{ lb}\end{aligned}$$

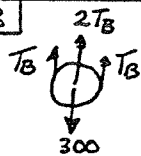
4-27



$$\begin{aligned} \sum F_y &= 0 \\ 4T_A &= 240 \\ T_A &= 60 \text{ lb} \end{aligned}$$

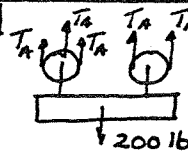
$$\begin{aligned}\Sigma F_y &= 0 \\ 3T_B &= 240 \\ T_B &= 80 \text{ lb}\end{aligned}$$

4-28



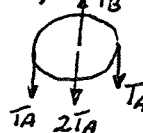
$$\begin{aligned} \sum F_y &= 0 \\ 4T_B &= 300 \\ T_B &= 75 \text{ kg} \end{aligned}$$

4-29



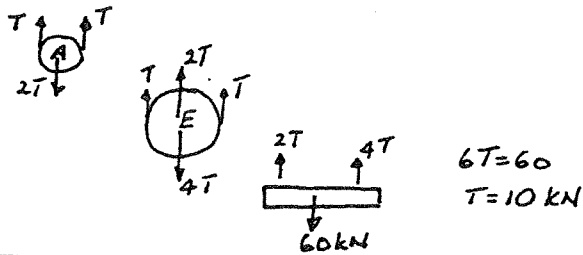
$$\begin{aligned} \sum F_y &= 0 \\ \uparrow T_A &= 200 \\ T_A &= 40 \text{ lb} \end{aligned}$$

Top Pulley

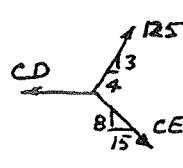


$$\begin{aligned} \Sigma F_y &= 0 \\ T_B &= 4T_A = 4 \times 40 \\ T_B &= 160 \text{ lb} \end{aligned}$$

4-30



FBD of C



$$\sum F_y = 0$$

$$\frac{8}{17} CE = \frac{3}{5} \times 125$$

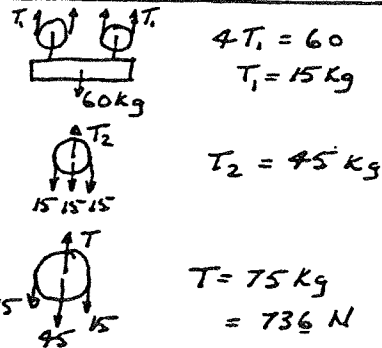
$$CE = 160 \text{ lb T}$$

$$\sum F_x = 0$$

$$CD = \frac{4}{5} (125) + \frac{15}{17} (160)$$

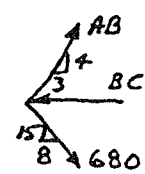
$$CD = 241 \text{ lb T}$$

4-31



4-37

FBD of B



$$\sum F_y = 0$$

$$\frac{4}{5} AB - \frac{15}{17} (680) = 0$$

$$AB = 750 \text{ N T}$$

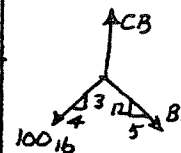
$$\sum F_x = 0$$

$$BC = \frac{8}{17} (680) + \frac{3}{5} (750)$$

$$BC = 770 \text{ N C}$$

4-38

FBD of B

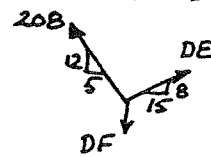


$$\sum F_x = 0$$

$$\frac{5}{13} BD = \frac{4}{5} (100)$$

$$BD = 208 \text{ lb T}$$

FBD of D



$$\sum F_x = 0$$

$$\frac{15}{17} DE = \frac{5}{13} (208)$$

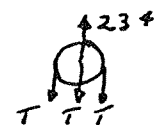
$$DE = 90.7 \text{ lb T}$$

$$\sum F_y = 0$$

$$DF = \frac{8}{17} (90.7) + \frac{12}{13} (208)$$

$$DF = 234 \text{ lb T}$$

FBD of F

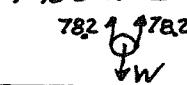


$$\sum F_y = 0$$

$$3T = 234$$

$$T = 78.2 \text{ lb}$$

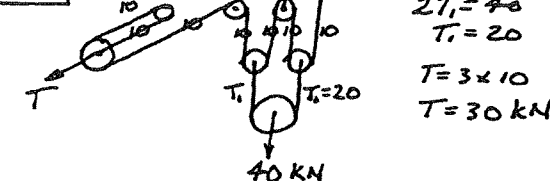
FBD of G



$$\sum F_y = 0$$

$$W = 156 \text{ lb}$$

4-33



$$2T_1 = 40$$

$$T_1 = 20$$

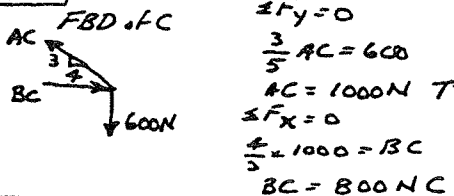
$$T_2 = 2 \times 20$$

$$T_2 = 40$$

$$T_3 = 4T_1 \text{ or } 2T_2$$

$$T_3 = 320 \text{ lb}$$

4-34



$$\sum F_y = 0$$

$$\frac{3}{5} AC = 600$$

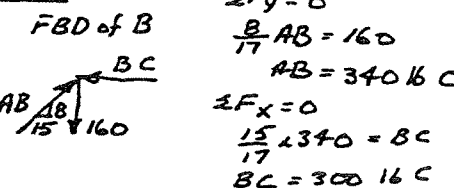
$$AC = 1000 \text{ N T}$$

$$\sum F_x = 0$$

$$\frac{4}{5} \times 1000 = BC$$

$$BC = 800 \text{ N C}$$

4-35



$$\sum F_y = 0$$

$$\frac{8}{17} AB = 160$$

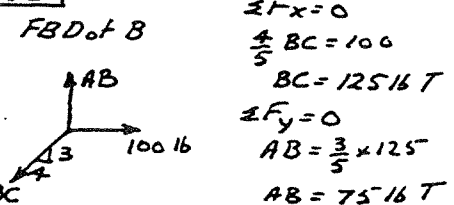
$$AB = 340 \text{ lb C}$$

$$\sum F_x = 0$$

$$\frac{15}{17} \times 340 = BC$$

$$BC = 300 \text{ lb C}$$

4-36



$$\sum F_x = 0$$

$$\frac{4}{5} BC = 100$$

$$BC = 125 \text{ lb T}$$

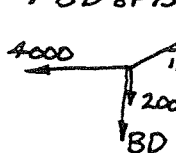
$$\sum F_y = 0$$

$$AB = \frac{3}{5} \times 125$$

$$AB = 75 \text{ lb T}$$

4-39

FBD of B



$$\sum F_x = 0$$

$$\frac{15}{17} BC = 4000$$

$$BC = 4530 \text{ lb T}$$

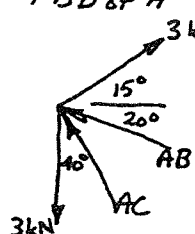
$$\sum F_y = 0$$

$$BD + 2000 = \frac{8}{17} (4530)$$

$$BD = 130 \text{ lb T}$$

4-40

FBD of A



$$\sum F_y = 0$$

$$AC \sin 50 + AB \sin 20 + 3 \sin 15 = 3$$

$$AC = 2.9 - .446 AB \dots (1)$$

$$\sum F_x = 0$$

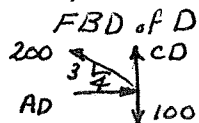
$$3 \cos 15 = AB \cos 20 - AC \cos 50$$

$$\text{Subst. (1)}$$

$$AB = 1.59 \text{ kN C}$$

$$\therefore AC = 2.19 \text{ kN C}$$

4-41



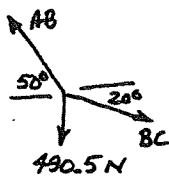
$$\sum F_x = 0$$

$$AD = \frac{1}{5}(200)$$

$$= 160 \text{ lb}$$

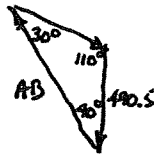
4-42

FBD of B



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

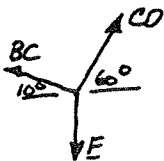
$$AB = 922 \text{ N T}$$



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

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

FBD of C



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

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

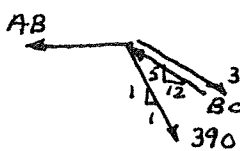
$$\frac{E}{\sin 80} = \frac{631}{\sin 30}$$

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

$$= 126 \text{ kg}$$

4-43

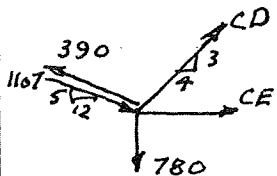
FBD of B



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

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

FBD of C



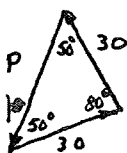
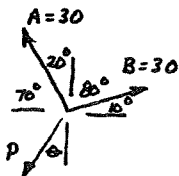
$$\sum F_y = 0$$

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

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

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

4-44

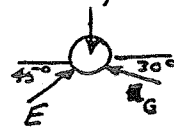


$$\frac{P}{\sin 80} = \frac{30}{\sin 50}$$

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

4-45

FBD Top roller



$$\sum F_x = 0$$

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

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

$$\sum F_y = 0$$

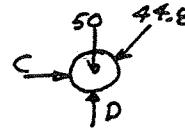
$$E \sin 45 + G \sin 30 = 50$$

Subst. (1)

$$G = 36.6$$

$$E = 44.8$$

FBD middle roller

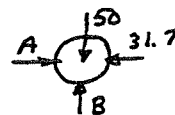


$$\sum F_x = 0$$

$$C = 44.8 \cos 45$$

$$= 31.7 \text{ lb}$$

FBD left roller



$$\sum F_x = 0$$

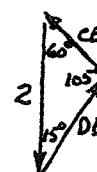
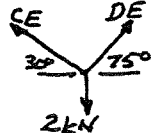
$$A = 31.7 \text{ lb} \rightarrow$$

$$\sum F_y = 0$$

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

4-46

FBD of E



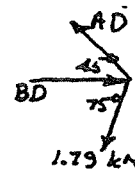
$$\frac{CE}{\sin 15} = \frac{2}{\sin 105}$$

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

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

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

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



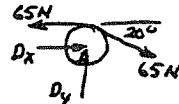
$$\sum F_y = 0$$

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

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

4-48

FBD of pulley



$$\sum F_y = 0$$

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

$$\sum F_x = 0$$

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

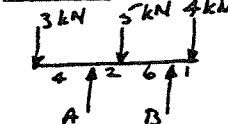
$$D_x = 3.9 \text{ N}$$



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

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

4-49



$$\sum M_A = 0$$

$$5(2) + 4(9) = 3(4) + B(6)$$

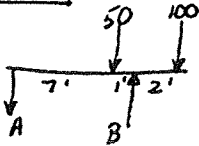
$$B = 4.25 \text{ kN} \uparrow$$

$$\sum F_y = 0$$

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

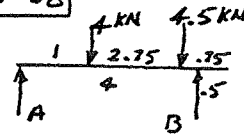
$$A = 7.75 \text{ kN} \uparrow$$

4-50



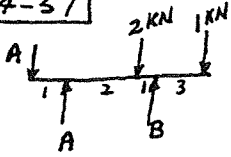
$$\begin{aligned}\sum M_A &= 0 \\ 8B &= 50(7) + 100(10) \\ B &= 169 \text{ lb} \uparrow \\ \sum F_y &= 0 \\ A + 50 + 100 &= 169 \\ A &= 19 \text{ lb} \downarrow\end{aligned}$$

4-58



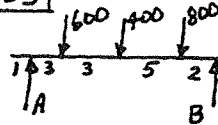
$$\begin{aligned}\sum M_A &= 0 \\ 4B &= 4(1) + 4.5(3.75) \\ B &= 5.22 \text{ kN} \uparrow \\ \sum F_y &= 0 \\ A + 5.22 &= 4 + 4.5 \\ A &= 3.28 \text{ kN} \uparrow\end{aligned}$$

4-51



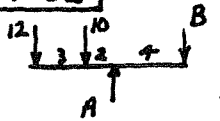
$$\begin{aligned}\sum M_A &= 0 \\ 3B &= 2(1) + 1(3) \\ B &= 3.05 \text{ kN} \uparrow \\ \sum F_y &= 0 \\ A + 2 + 1 &= 3.05 + 3.05 \\ A &= 0.85 \text{ kN} \downarrow\end{aligned}$$

4-59



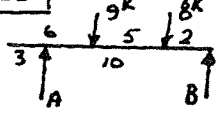
$$\begin{aligned}\sum M_B &= 0 \\ 12A &= 800(2) + 400(7) + 600(10) \\ A &= 800 \text{ lb} \uparrow \\ \sum M_A &= 0 \\ 12B &= 600(3) + 400(6) + 800(11) \\ B &= 1000 \text{ lb} \uparrow\end{aligned}$$

4-52



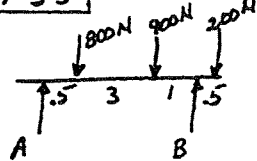
$$\begin{aligned}\sum M_B &= 0 \\ 4A &= 10 \times 6 + 9 \times 12 \\ A &= 42 \text{ kN} \uparrow \\ \sum M_A &= 0 \\ 4B &= 2 \times 10 + 12 \times 5 \\ B &= 20 \text{ kN} \downarrow\end{aligned}$$

4-60



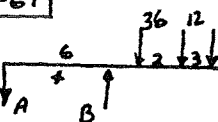
$$\begin{aligned}\sum M_A &= 0 \\ 10B &= 9(3) + 8(8) \\ B &= 9.1 \text{ Kips} \uparrow \\ \sum F_y &= 0 \\ A &= 17 - 9.1 \\ A &= 7.9 \text{ Kips} \uparrow\end{aligned}$$

4-53



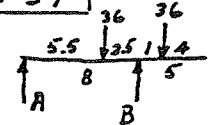
$$\begin{aligned}\sum M_A &= 0 \\ 800(1.5) + 900(3.5) + 200(5) &= B(4.5) \\ B &= 1.01 \text{ kN} \uparrow \\ \sum F_y &= 0 \\ 800 + 900 + 200 &= 1010 + A \\ A &= 890 \text{ N} = 0.89 \text{ kN} \uparrow\end{aligned}$$

4-61



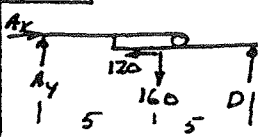
$$\begin{aligned}\sum M_A &= 0 \\ 4B &= 30(5) + 12(8) + 14(11) \\ B &= 100 \text{ kN} \uparrow \\ \sum F_y &= 0 \\ A + 30 + 12 + 14 &= 100 \\ A &= 44 \text{ kN} \downarrow\end{aligned}$$

4-54



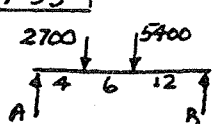
$$\begin{aligned}\sum M_A &= 0 \\ 8B &= 36(5.5) + 36(9) \\ B &= 65.2 \text{ kN} \uparrow \\ \sum M_B &= 0 \\ BA + 36(1) &= 36(2.5) \\ A &= 6.8 \text{ kN} \uparrow\end{aligned}$$

4-62



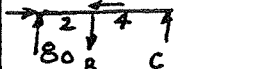
$$\begin{aligned}\sum M_D &= 0 \\ A_y(10) &= 5(160) \\ A_y &= 80 \text{ lb}\end{aligned}$$

4-55



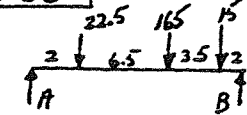
$$\begin{aligned}\sum M_A &= 0 \\ 22B &= 2700(4) + 5400(10) \\ B &= 2950 \text{ N} \uparrow \\ \sum M_B &= 0 \\ 22A &= 5400(12) + 2700(18) \\ A &= 5150 \text{ N} \uparrow\end{aligned}$$

4-63



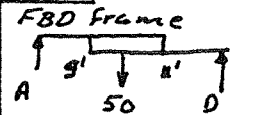
$$\begin{aligned}\sum M_C &= 0 \\ 4B &= 80(6) \\ B &= 120 \text{ lb} \uparrow\end{aligned}$$

4-56



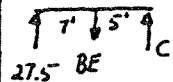
$$\begin{aligned}\sum M_A &= 0 \\ 14B &= 22.5(2) + 165(8.5) + 15(12) \\ B &= 116 \text{ kN} \uparrow \\ \sum F_y &= 0 \\ A + 116 &= 22.5 + 165 + 15 \\ A &= 86.5 \text{ kN} \uparrow\end{aligned}$$

4-64



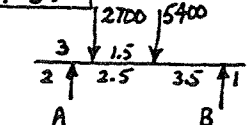
$$\begin{aligned}\sum M_D &= 0 \\ 50(11) &= A(20) \\ A &= 27.5 \text{ lb}\end{aligned}$$

FBD of AC



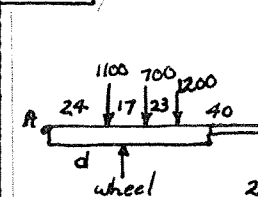
$$\begin{aligned}\sum M_C &= 0 \\ 5BE &= 12(27.5) \\ BE &= 66 \text{ lb} \uparrow\end{aligned}$$

4-57



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

4-64

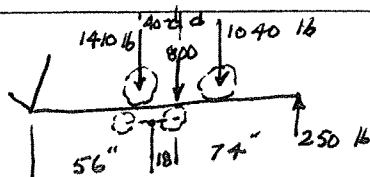


$$\begin{aligned}\sum F_y &= 0 \\ \text{Wheel} + 200 &= 3000 \\ \text{Wheel} &= 2800 \text{ lb} \\ \sum M_A &= 0\end{aligned}$$

$$(200)(10.4) + 2800d = (1100)(24) + 700(41) + 1200(64)$$

$$d = 39.7 \text{ in.}$$

4-65

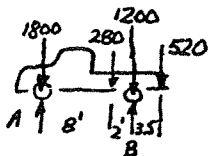


$$\sum M_A = 0$$

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

$$d = 26.5"$$

4-66



$$\sum M_A = 0$$

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

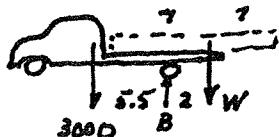
$$B = 2130 \text{ lb} \uparrow$$

$$\sum M_B = 0$$

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

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

4-67



$$\sum M_B = 0$$

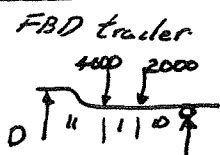
$$3000 \times 5.5 = W \times 2$$

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

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

wheels lift @ 11

4-68



$$\sum M_D = 0$$

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

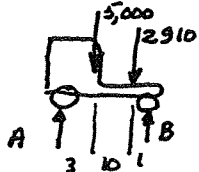
$$C = 3090 \text{ lb} \uparrow$$

$$\sum F_y = 0$$

$$D + 3090 = 6000$$

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

FBD tractor



$$\sum M_A = 0$$

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

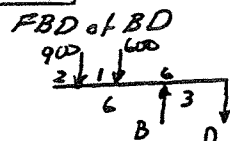
$$B = 3520 \text{ lb} \uparrow$$

$$\sum F_y = 0$$

$$A + 3520 = 5000 + 2910$$

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

4-69

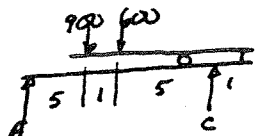


$$\sum M_D = 0$$

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

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

FBD frame

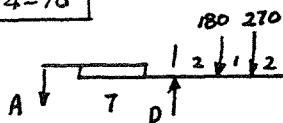


$$\sum M_A = 0$$

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

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

4-70



$$\sum M_D = 0$$

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

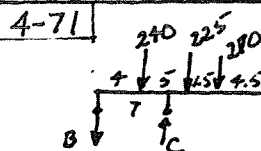
$$A = 167 \text{ lb} \downarrow$$

$$\sum M_B = 0$$

$$3C = 167(2)$$

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

4-71



$$\sum M_B = 0$$

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

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

$$\sum F_y = 0$$

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

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

$$\sum M_A = 0$$

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

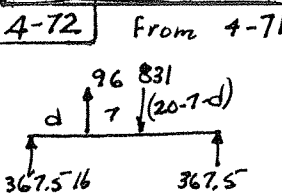
$$D = 401 \text{ lb} \uparrow$$

$$\sum F_y = 0$$

$$A + 401 + 96 = 831$$

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

4-72



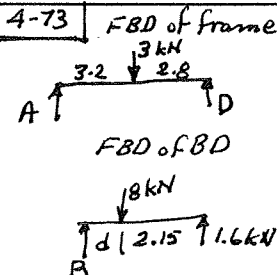
From 4-71 $A + D = 334 + 401 = 735$
 $\therefore A = D = 367.5 \text{ lb}$

$$\sum M_A = 0$$

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

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

4-73



$$\sum M_A = 0$$

$$6D = 3(3.2)$$

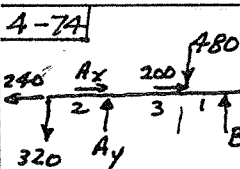
$$D = 1.6 \text{ kN} \uparrow$$

$$\sum M_B = 0$$

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

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

4-74



$$\sum F_x = 0$$

$$A_x + 200 = 240$$

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

$$\sum M_A = 0$$

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

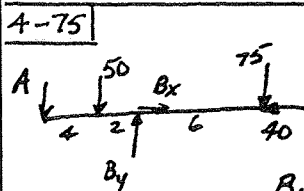
$$B = 200 \text{ N} \uparrow$$

$$\sum F_y = 0$$

$$A_y + 200 = 480 + 320$$

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

4-75



$$\sum M_B = 0$$

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

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

$$\sum F_y = 0$$

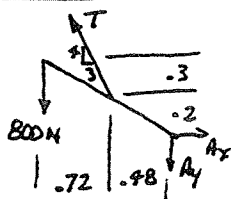
$$B_y = 58.3 + 50 + 75$$

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

$$\sum F_x = 0$$

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

4-76



$$\sum M_A = 0$$

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

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

$$\sum F_x = 0$$

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

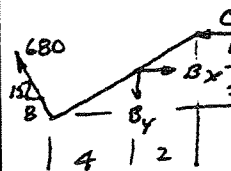
$$= 2180 \text{ N} \rightarrow$$

$$\sum F_y = 0$$

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

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

4-77



$$\sum F_y = 0$$

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

$$\sum M_B = 0$$

$$C(1) = \frac{15}{17}(680)(4) + \frac{8}{17}(680)(2)$$

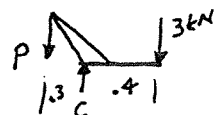
$$C = 3040 \text{ N} \leftarrow$$

$$\sum F_x = 0$$

$$B_x = 3040 + \frac{8}{17}(680)$$

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

4-78

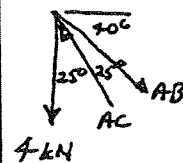


$$\sum M_C = 0$$

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

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

FBD of A

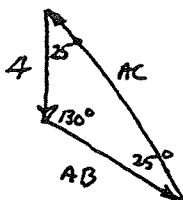


$$\frac{AC}{\sin 30^\circ} = \frac{4}{\sin 25^\circ}$$

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

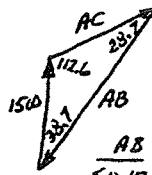
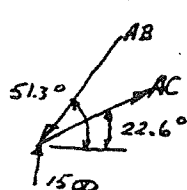
$$\frac{AB}{\sin 25^\circ} = \frac{4}{\sin 25^\circ}$$

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



4-79

FBD of A



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

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

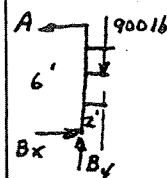
$$DE = 2880 \text{ lb} \text{ C}$$

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

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

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

4-80



$$\sum F_y = 0$$

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

$$\sum M_B = 0$$

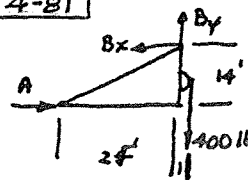
$$A(6) = 900(2)$$

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

$$\sum F_x = 0$$

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

4-81



$$\sum F_y = 0$$

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

$$\sum M_B = 0$$

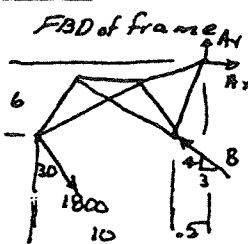
$$A(1) = 400(1)$$

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

$$\sum F_x = 0$$

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

4-82



$$\sum M_A = 0$$

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

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

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

$$\sum F_x = 0$$

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

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

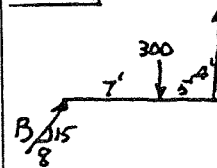
$$\sum F_y = 0$$

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

$$A_y = -2790$$

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

4-83



$$\sum M_A = 0$$

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

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

$$\sum F_x = 0$$

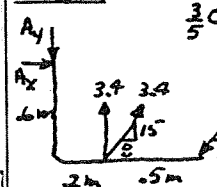
$$A_x = \frac{8}{17}(172) = 81.1 \text{ lb} \leftarrow$$

$$\sum F_y = 0$$

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

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

4-84



$$\sum M_A = 0$$

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

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

$$\sum F_x = 0$$

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

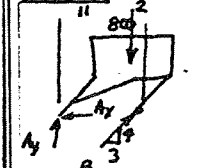
$$A_x = -0.139 = -139 \text{ N} \leftarrow$$

$$\sum F_y = 0$$

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

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

4-85



$$\sum M_A = 0$$

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

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

$$\sum M_B = 0$$

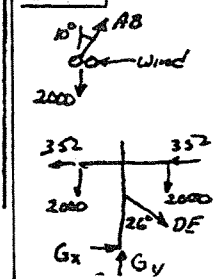
$$A_y(13) = 800(2)$$

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

$$\sum F_x = 0$$

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

4-86



$$\sum F_y = 0$$

$$AB \cos 10^\circ = 2000$$

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

$$\sum F_x = 0$$

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

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

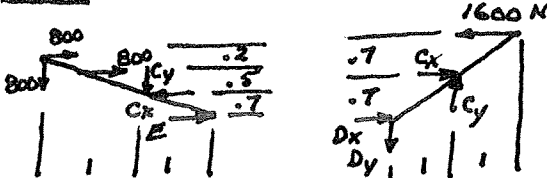
$$\sum M_G = 0$$

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

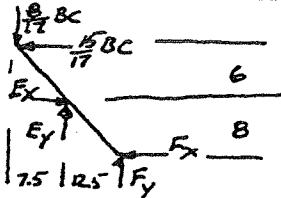
$$= 2000(22) + DE \sin 26^\circ(123)$$

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

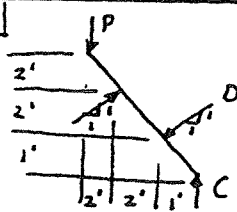
R4-1



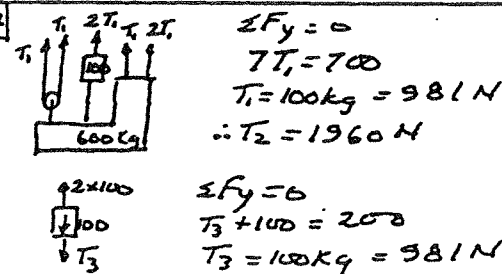
R4-2



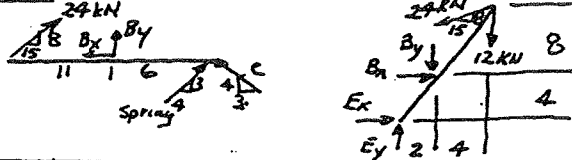
R4-3



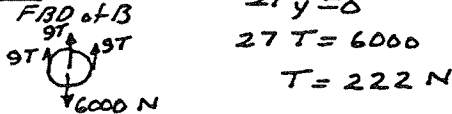
R4-4



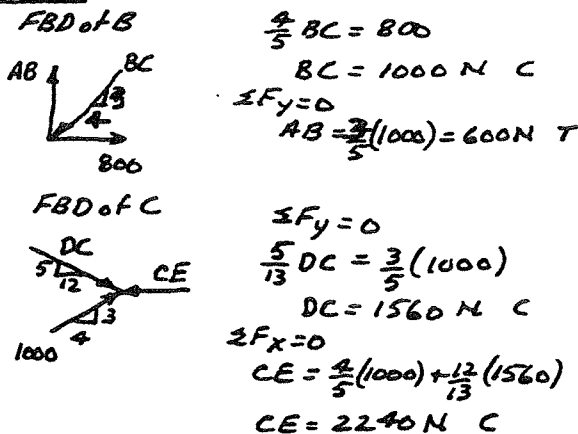
R4-5



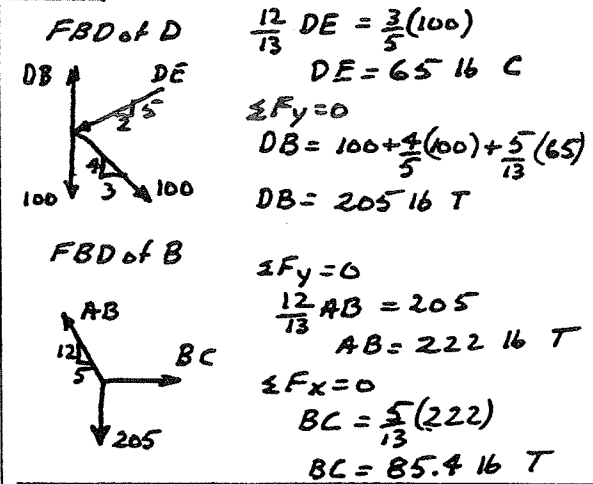
R4-6



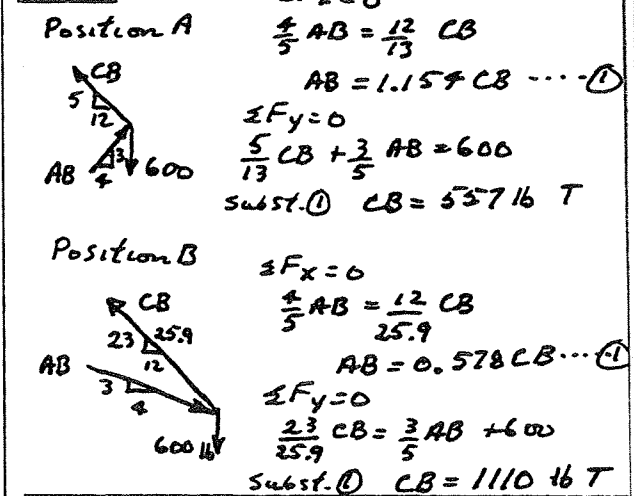
R4-7



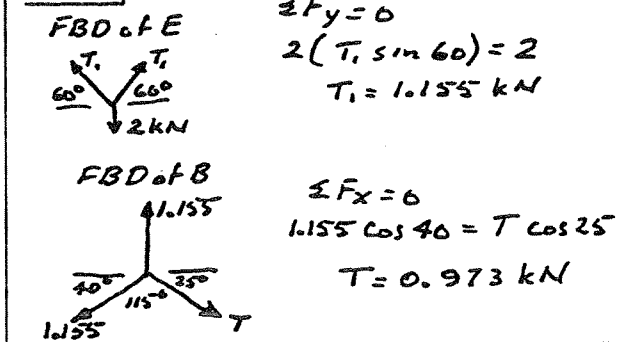
R4-8



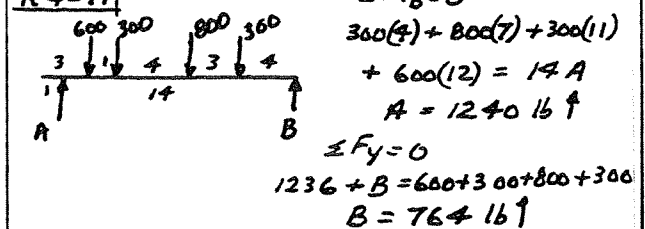
R4-9



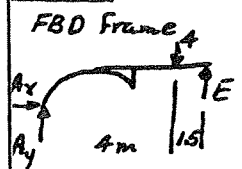
R4-10



R4-11

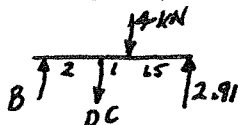


R4-12



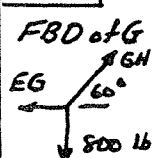
$$\begin{aligned}\sum M_A &= 0 \\ E(5.5) &= 4(4) \\ E &= 2.91 \text{ kN}\end{aligned}$$

FBD of BE



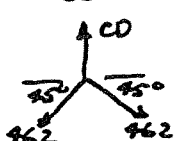
$$\begin{aligned}\sum M_B &= 0 \\ DC(2) + 4(3) &= 2.91(4.5) \\ DC &= 0.55 \text{ kN T}\end{aligned}$$

R4-13



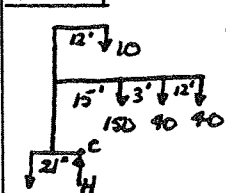
$$\begin{aligned}\sum F_y &= 0 \\ GH \sin 60 &= 800 \\ GH &= 924 \text{ lb} \\ \sum F_x &= 0 \\ EG &= 924 \cos 60 = 462 \text{ lb T}\end{aligned}$$

FBD of C



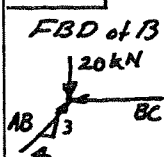
$$\begin{aligned}\sum F_y &= 0 \\ CD &= 2(462 \sin 45) \\ CD &= 653 \text{ lb T} \\ \therefore P &= 653 \text{ lb}\end{aligned}$$

R4-14



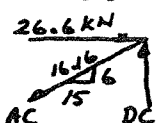
$$\begin{aligned}\sum M_C &= 0 \\ (A+B)\left(\frac{21}{12}\right) &= 10(11) + 150(14) \\ &\quad + 40(17) + 40(29) \\ A+B &= 2314 \\ \therefore A=B &= 1160 \text{ lb T}\end{aligned}$$

5-1



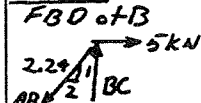
$$\begin{aligned}\sum F_y &= 0 \\ \frac{3}{5} AB &= 20 \\ AB &= 33.3 \text{ kN C} \\ \sum F_x &= 0 \\ BC &= \frac{4}{5} (33.3) = 26.6 \text{ kN C}\end{aligned}$$

FBD of C



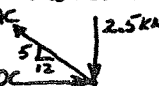
$$\begin{aligned}\sum F_x &= 0 \\ \frac{15}{16.16} AC &= 26.6 \\ AC &= 28.6 \text{ kN T}\end{aligned}$$

5-2



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

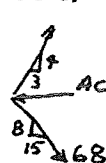
FBD of C



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

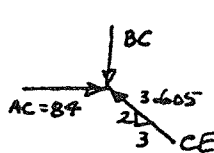
5-3

FBD of A



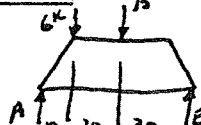
$$\begin{aligned}\sum F_y &= 0 \\ \frac{8}{17} (68) &= \frac{4}{5} AB \\ AB &= 40 \text{ kN T} \\ \sum F_x &= 0 \\ AC &= \frac{15}{17} (68) + \frac{3}{5} (40) \\ AC &= 84 \text{ kN C}\end{aligned}$$

FBD of C



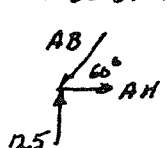
$$\begin{aligned}\sum F_x &= 0 \\ \frac{3}{3.605} CE &= 84 \\ CE &= 101 \text{ kN C} \\ \sum F_y &= 0 \\ BC &= \frac{2}{3.605} (101) = 56 \text{ kN C}\end{aligned}$$

5-4



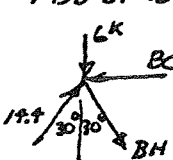
$$\begin{aligned}\sum M_A &= 0 \\ 60E &= 6(10) + 15(30) \\ E &= 8.5 \text{ kips} \\ \sum F_y &= 0 \\ A &= 21 - 8.5 = 12.5 \text{ kips}\end{aligned}$$

FBD of A



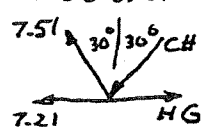
$$\begin{aligned}\sum F_y &= 0 \\ AB \sin 60 &= 12.5 \\ AB &= 14.4 \text{ kips C} \\ \sum F_x &= 0 \\ AH &= 14.4 \cos 60 \\ AH &= 7.21 \text{ kips T}\end{aligned}$$

FBD of B



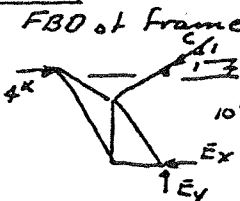
$$\begin{aligned}\sum F_y &= 0 \\ BH \cos 30 + 6 &= 14.4 \cos 30 \\ BH &= 7.51 \text{ kips T} \\ \sum F_x &= 0 \\ BC &= 14.4 \sin 30 + 7.51 \sin 30 \\ BC &= 11 \text{ kips C}\end{aligned}$$

FBD of H



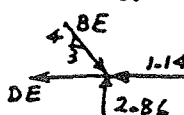
$$\begin{aligned}\sum F_y &= 0 \\ CH &= 7.51 \text{ kips C}\end{aligned}$$

5-5



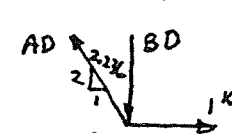
$$\begin{aligned}\sum M_C &= 0 \\ 14 E_x &= 4(4) \\ E_x &= 1.14 \text{ kips} \\ \sum F_x &= 0 \\ C_x &= 4 - 1.14 \\ C_x &= 2.86 \text{ kips} \\ \sum F_y &= 0 \\ E_y &= 2.86 \text{ kips}\end{aligned}$$

FBD of E



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

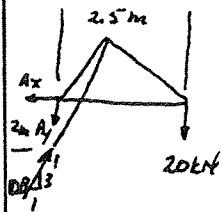
FBD of D



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

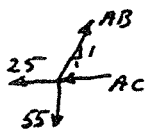
5-6

FBD frame



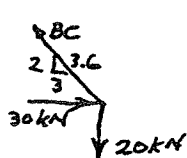
$$\begin{aligned}\sum M_A &= 0 \\ \frac{1}{3.16} (20)(2.5) &= 20(2.5) \\ DB &= 79 \text{ kN C} \\ \sum F_y &= 0 \\ A_y + 20 &= \frac{3}{3.16} (79) \\ A_y &= 55 \text{ kN } \downarrow \\ \sum F_x &= 0 \\ A_x &= \frac{1}{3.16} (79) = 25 \text{ kN } \leftarrow\end{aligned}$$

FBD of A



$$\begin{aligned}\sum F_y &= 0 \\ 0.707 AB &= 55 \\ AB &= 77.8 \text{ kN T} \\ \sum F_x &= 0 \\ AC + 25 &= 0.707 (77.8) \\ AC &= 30 \text{ kN C}\end{aligned}$$

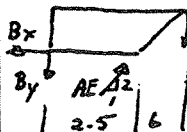
FBD of C



$$\begin{aligned}\sum F_x &= 0 \\ \frac{3}{3.6} BC &= 30 \\ BC &= 36 \text{ kN T}\end{aligned}$$

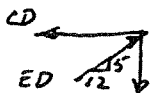
5-7

FBD of frame



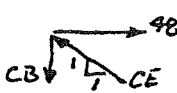
$$\begin{aligned}\sum M_B &= 0 \\ \frac{2}{2.236} AE(2.5) &= 20(8.5) \\ AE &= 76 \text{ kN C} \\ \sum F_x &= 0 \\ B_x &= \frac{1}{2.236} (76) = 34 \text{ kN } \leftarrow \\ \sum F_y &= 0 \\ B_y + 20 &= \frac{2}{2.236} (76) \\ B_y &= 48 \text{ kN } \downarrow\end{aligned}$$

FBD of D



$$\begin{aligned}\sum F_y &= 0 \\ \frac{5}{13} ED &= 20 \quad ED = 52 \text{ kN C} \\ \sum F_x &= 0 \\ CD &= \frac{12}{13} (52) = 48 \text{ kN T}\end{aligned}$$

FBD of C



$$\begin{aligned}\sum F_x &= 0 \\ 0.707 CE &= 48 \quad CE = 67.8 \text{ kN C} \\ \sum F_y &= 0 \\ CB &= 0.707 (67.8) = 48 \text{ kN T}\end{aligned}$$

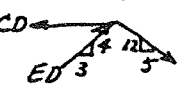
FBD of B



$$\begin{aligned}\sum F_x &= 0 \\ BE &= 34 \text{ kN T}\end{aligned}$$

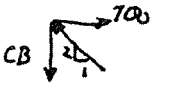
5-8

FBD of D



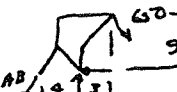
$$\begin{aligned}\sum F_y &= 0 \\ \frac{12}{13} (150) &= \frac{4}{5} ED \\ ED &= 750 \text{ lb C} \\ \sum F_x &= 0 \\ CD &= \frac{3}{5} (750) + \frac{5}{13} (150) \\ CD &= 700 \text{ lb T}\end{aligned}$$

FBD of C



$$\begin{aligned}\sum F_x &= 0 \\ \frac{1}{2.236} CE &= 700 \quad CE = 1570 \text{ lb C} \\ \sum F_y &= 0 \\ CB &= \frac{2}{2.236} (1570) = 1400 \text{ lb T}\end{aligned}$$

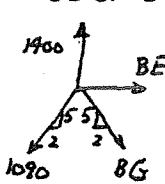
FBD frame



$$\begin{aligned}\sum M_G &= 0 \\ \frac{5}{5.385} AB(9) &= 200(9) + 60(3) \\ AB &= 1090 \text{ lb T}\end{aligned}$$

5-8 cont.

FBD of B



$$\begin{aligned}\sum F_y &= 0 \\ \frac{5}{5.385} BG + \frac{5}{5.385} (1090) &= 1400 \\ BG &= 418 \text{ lb T} \\ \sum F_x &= 0 \\ BE + \frac{2}{5.385} (418) &= \frac{2}{5.385} (1090) \\ BE &= 250 \text{ lb T}\end{aligned}$$

5-9

Joint C

$$BC = 3.33 \text{ kips T} \quad DC = 2.66 \text{ kips C}$$

Joint B

$$AB = 2.66 \text{ kips T} \quad BD = 2 \text{ kips C}$$

Joint D

$$AD = 11.4 \text{ kips T} \quad ED = 13.3 \text{ kips C}$$

Joint E

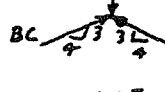
$$AE = 3.33 \text{ kips T} \quad FE = 16 \text{ kips C}$$

Joint F

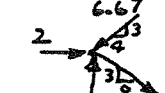
$$AF = 0$$

5-10

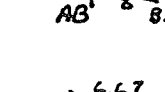
FBD of frame



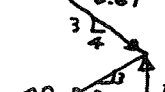
$$\begin{aligned}\sum F_y &= 0 \\ \frac{3}{5} (BC) + \frac{3}{5} CD &= 8 \text{ but } BC = CD \\ CD &= BC = 6.67 \text{ kN C}\end{aligned}$$



$$\begin{aligned}\sum F_x &= 0 \\ \frac{8}{8.54} BE + 2 &= \frac{4}{5} (6.67) \\ BE &= 3.55 \text{ kN T}\end{aligned}$$



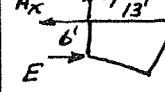
$$\begin{aligned}\sum F_y &= 0 \\ AB &= \frac{3}{5} (6.67) + \frac{3}{8.54} (3.55) \\ AB &= 5.25 \text{ kN C}\end{aligned}$$



$$\begin{aligned}\sum F_x &= 0 \\ \frac{8}{8.54} AD &= \frac{4}{5} (6.67) \quad AD = 5.69 \text{ kN T} \\ \sum F_y &= 0 \\ DE &= \frac{3}{5} (6.67) + \frac{3}{8.54} (5.69) = 6 \text{ kN C}\end{aligned}$$

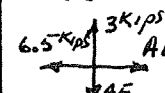
5-11

FBD of frame



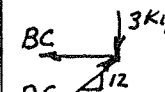
$$\begin{aligned}\sum F_y &= 0 \\ A_y &= 3 \text{ kips} \\ \sum M_E &= 0 \\ 6 A_x &= 3(13) \\ A_x &= 6.5 \text{ kips}\end{aligned}$$

FBD of A



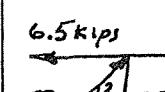
$$\begin{aligned}\sum F_y &= 0 \\ AB &= 6.5 \text{ kips T}\end{aligned}$$

FBD of C

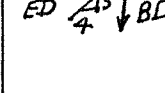


$$\begin{aligned}\sum F_y &= 0 \\ \frac{12}{13} DC &= 3 \quad DC = 3.25 \text{ kips C} \\ \sum F_x &= 0 \\ BC &= \frac{5}{13} (3.25) \\ BC &= 1.25 \text{ kips T}\end{aligned}$$

FBD of B



$$\begin{aligned}\sum F_x &= 0 \\ \frac{4}{5} EB + 1.25 &= 6.5 \\ EB &= 6.56 \text{ kips C}\end{aligned}$$



$$\begin{aligned}\sum F_y &= 0 \\ BD &= \frac{3}{5} (6.56) \\ BD &= 3.94 \text{ kips T}\end{aligned}$$

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

$\sum F_y = 0$
 $\frac{5}{13} DE = 600$
 $DE = 1560 \text{ lb C}$

FBD of D

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

FBD of Frame

$\sum M_B = 0$
 $T Ay = 600(12)$
 $Ay = 1029 \text{ lb}$

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

$\sum F_y = 0$
 $Ay = 3 \text{ kips}$
 $\sum M_D = 0$
 $4 Ax = 3(2)$
 $Ax = 1.5 \text{ kips}$

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 $\sum F_x = 0$
 $\frac{2}{2.236} CD = \frac{3}{5} BC$
 $CD = 0.671 BC \dots\dots\dots (1)$
 $\sum F_y = 0$
 $\frac{4}{5} BC + \frac{1}{2.236} CD = 3$ 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

$\sum F_x = 0$
 $\frac{12}{13} AE = \frac{3}{5} (2.73)$
 $AE = 1.77 \text{ kN T}$

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

5-21 All internal members including CG have zero load

$\sum M_E = 0$
 $20 Dx = 15(40)$
 $Dx = 30 \text{ kips}$
 $\sum F_y = 0$ $Dy = 15 \text{ kips}$

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

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

5-23

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

FBD of D
 $\sum F_x = 0$
 $\frac{4}{5} CD = \frac{4}{5} BD$
 $CD = 0.7818 BD \dots (1)$
 $\sum F_y = 0$
 $\frac{5}{6.4} BD = \frac{3}{5} CD + 5.75$

Subst. (1)
 $BD = 18.5 \text{ kN C}$
 $CD = 14.4 \text{ kN T}$

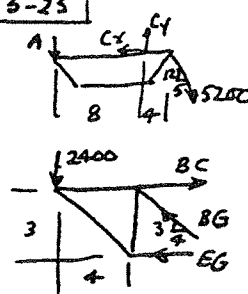
FBD of C
 $\sum F_x = 0$
 $AC = CD = 14.4 \text{ kN T}$
 $\sum F_y = 0$
 $BC = 2\left(\frac{3}{5}(14.4)\right) = 17.3 \text{ kN T}$

5-24

FBD of D
 $\sum F_x = 0$
 $\frac{3}{3.162} BD = .707 CD$
 $BD = .745 CD \dots (1)$
 $\sum F_y = 0$
 $\frac{1}{3.162} BD + 20 = .707 CD$
 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

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

5-27

$\sum M_E = 0$
 $BC(3) = 2(10)$
 $BC = 6.67 \text{ kips C}$
 $\sum F_y = 0$
 $\frac{3}{5.83} BE + 1 = 2$
 $BE = 1.94 \text{ kips C}$
 $\sum F_x = 0$
 $DE = \frac{5}{5.83}(1.94) + 6.67$
 $DE = 8.33 \text{ kips T}$

FBD of D
 $\therefore BD = 0$

5-28

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

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

5-29

FBD of right half
 $\sum M_G = 0$
 $\frac{3}{5} BC \times 4 = 20 \times 6$
 $BC = 50 \text{ kN T}$
 $\sum F_x = 0$
 $BG = \frac{3}{5} \times 50$
 $BG = 30 \text{ kN C}$

5-40 FBD frame $\sum M_A = 0$ $E = 3.69 \text{ Kips} \uparrow$

$\sum M_G = 0$
 $CD(6.67) + 2(8) = 3.69(8.67)$
 $CD = 2.4 \text{ Kips C}$
 $\sum F_y = 0$
 $3.69 + \frac{12}{13} CG + \frac{5}{13}(2.4) = \frac{12}{13}(2)$
 $CG = -3 = 3 \text{ Kips C}$

5-46 $\sum M_C = 0$

$B_y(12) = 100(20)$
 $B_y = 167 \text{ lb} \uparrow$
 $B_x = \frac{6}{5}(167) = 200 \text{ lb} \leftarrow$
 $\sum F_x = 0$
 $C_x = 200 + 100 = 300 \text{ lb} \rightarrow$
 $\sum F_y = 0$
 $C_y = 167 - 100 = 67 \text{ lb} \downarrow$

5-41 FBD frame $\sum M_D = 0$ $A = 70 \text{ Kips} \uparrow$

$\sum M_G = 0$
 $\frac{25}{25.18} BC(33) + 30(25) + 30(50) = 70(75)$
 $BC = 91.6 \text{ Kips C}$
 $\sum F_y = 0$
 $70 + \frac{6}{7.81} BG = \frac{3}{25.18} (91.6) + 30 + 30$
 $BG = 1.19 \text{ Kips C}$

5-47 $\sum M_B = 0$

$4D_y = 1200(10)$
 $D_y = 3000 \text{ lb}$
 $\therefore D_x = 3000 \text{ lb}$
 $C_x = C_y = 3000 \text{ lb}$
 $\sum F_x = 0$ $B_x = 3000 \text{ lb}$
 $\sum F_y = 0$ $B_y = 4200 \text{ lb}$

5-42 FBD frame $\sum M_P = 0$ $A = 3.5 \text{ kN} \uparrow$

$\sum M_E = 0$
 $8KH + 2(6.75) = 3.5(9)$
 $KH = 2.25 \text{ kN T}$
 $\sum M_H = 0$
 $\frac{9}{12.04} DE(8) + 2(3.75) = 3.5(6) + \frac{8}{12.04} DE(3)$
 $DE = 3.39 \text{ kN C}$
 $\sum F_x = 0$
 $\frac{9}{12.04} (3.39) = \frac{3}{8.54} JE + 2.25$
 $JE = 0.81 \text{ kN T}$
 $\sum M = \sum N = 0$

5-48 $\sum M_E = 0$

$40(8) = \frac{12}{17.69} AC(13)$
 $AC = 36.3 \text{ kN T}$

5-49 $\sum M_D = 0$

$\frac{4}{5} E(10) + \frac{3}{5} E(4) = 500(24)$
 $E = 1157 \text{ lb}$
 $\sum M_B = 0$
 $\frac{3}{5} AC(28) + 500(4) = \frac{3}{5} (1157)(14)$
 $AC = 160 \text{ lb T}$
 $\sum F_y = 0$
 $B_y = \frac{3}{5} (1157) + 500 + \frac{3}{5} (160)$
 $B_y = 1290 \text{ lb}$
 $\sum F_x = 0$
 $B_x + \frac{4}{5} (160) = \frac{4}{5} (1157)$
 $B_x = 795 \text{ lb}$

5-43 $\sum M_D = 0$

$C_x(4) = 5(6)$
 $C_x = 7.5 \text{ Kips}$
 $\sum F_y = 0$
 $D_y = 5 \text{ Kips} \uparrow$ on DC
 $\sum F_x = 0$
 $D_x = 7.5 \text{ Kips} \rightarrow$ on DC
 $B_x = 7.5 \text{ Kips} \leftarrow$ on BC

5-50 $\sum M_C = 0$

$3.3 D_x = 10.2(40)$
 $D_x = 124 \text{ N}$
 $\sum M_A = 0$
 $7G = 40(3)$
 $G = 17.1 \text{ N}$
 $\sum M_E = 0$
 $124(15) + 17.1(2) = D_y(2)$
 $D_y = 110 \text{ N}$

5-44 $\sum M_B = 0$

$D_y(1.7) = \frac{15}{17} (34)(2.7)$
 $D_y = 47.6 \text{ kN}$
 $\sum M_A = 0$
 $2.5G + \frac{8}{17} (34)(.3) = \frac{15}{17} (34)(.5)$
 $G = 4.08 \text{ kN}$
 $\sum M_C = 0$
 $(47.6)(.5) = (4.08)(1) + 1.2 D_x$
 $D_x = 16.5 \text{ kN}$

5-51 $\sum M_B = 0$

$6T + T \sin 30(2) = 4.2(10)$
 $T = 6 \text{ Kips}$
 $\sum F_y = 0$
 $B_y + 6 \sin 30 = 4.2$
 $B_y = 1.2 \text{ Kips} \uparrow$
 $\sum F_x = 0$
 $B_x = 6 + 6 \cos 30 = 11.2 \text{ Kips}$
 $\therefore B = 11.3 \text{ Kips} \angle 6.1^\circ$

5-45 $\sum M_C = 0$

$4B = 60(5) + 32(7)$
 $B = 131 \text{ lb}$
 $\sum F_y = 0$ $C_y = 60 \text{ lb} \uparrow$
 $\sum F_x = 0$
 $C_x + 32 = 131$ $C_x = 99 \text{ lb} \leftarrow$

5-52

$$\sum M_C = 0$$

$$Cx \frac{7}{7.616} \cdot 80 \times 0.6 + \frac{3}{7.616} \cdot 80 \times 0.3 = 1800 \times 2.3$$

$$BD = 6180 \text{ N C}$$

$$\sum F_y = 0$$

$$Cy + 1800 = \frac{7}{7.616} \times 6180$$

$$Cy = 3880 \text{ N}$$

$$\sum F_x = 0$$

$$Cx = 2440 \text{ N}$$

5-53

$$\sum M_D = 0$$

$$2E_y = 800 \times 0.2$$

$$E_y = 80 \text{ N}$$

$$\sum F_y = 0 \quad Cy = 880 \text{ N}$$

$$\sum M_E = 0$$

$$Cx \cdot 0.7 + 800 \times 0.2 = 880 \times 0.1 + 800 \times 0.2 + 800 \times 0.1$$

$$Cx = 1940 \text{ N}$$

5-54

$$\sum M_G = 0$$

$$400(450) + .707 DE(200) + .707 DE(150) = 400 \sin 40(450) + 400 \cos 40(500)$$

$$DE = 359 \text{ N T}$$

5-55

$$\sum F_y = 0 \quad Cy = 3.5 \text{ kN}$$

$$\sum M_C = 0$$

$$400 B_x = 3.5(250)$$

$$B_x = 2.19 \text{ kN} \therefore A_x = 2.19 \text{ kN}$$

$$\sum F_x = 0 \quad Cx = 2.19 \text{ kN}$$

$$\sum F_x = 0 \quad Ex = 2.19 \text{ kN}$$

$$\sum M_D = 0$$

$$200 E_y = 250(3.5)$$

$$E_y = 4.37 \text{ kN}$$

$$\sum F_y = 0 \quad D = 4.37 + 3.5 = 7.87 \text{ kN}$$

5-56

$$\sum M_A = 0$$

$$2T + 2(.707T) = 5P + 40(2.5)$$

$$2T = 5P + 100$$

$$\sum F_y = 0 \quad P = 200 - T$$

$$\text{Subst. into (1)}$$

$$T = 131 \text{ lb}$$

5-57

$$\sum M_E = 0$$

$$\frac{15}{17} DG(10) = \frac{3}{5}(200)(18)$$

$$DG = 245 \text{ lb}$$

$$\sum F_y = 0$$

$$\frac{4}{5}(200) + \frac{8}{17}(245) = E_y$$

$$E_y = 275 \text{ lb}$$

$$\sum F_x = 0$$

$$Ex + \frac{3}{5}(200) = \frac{15}{17}(245)$$

$$Ex = 96.2 \text{ lb}$$

5-57 cont.

$$\sum M_A = 0$$

$$CB \sin 30(22.5) + CB \cos 30(12) + 96.2(16) = 275(30)$$

$$CB = 310 \text{ lb C}$$

$$\sum F_x = 0$$

$$P = 310 \cos 30 = 268 \text{ lb} \leftarrow$$

5-58

$$FBD \text{ of } AC \quad A_y = C_y = 375 \text{ lb}$$

$$\sum M_B = 0$$

$$15E = 750(6.25)$$

$$E = 312.5 \text{ lb}$$

$$\sum F_y = 0 \quad D_y = 375 \text{ lb}$$

$$\sum M_A = 0$$

$$5D_x + 5(375) = 312.5(10)$$

$$D_x = 250 \text{ lb}$$

$$\sum F_x = 0$$

$$A_x + 250 = 312.5$$

$$A_x = 62.5 \text{ lb}$$

5-59

$$\sum M_A = 0$$

$$4C_y + \frac{1}{2.24}(981)(3) = 981(3)$$

$$C_y = 407 \text{ N}$$

$$\sum M_E = 0$$

$$4C_x + \frac{2}{2.24}(981)(5) = \frac{1}{2.24}(981)(5) + 407(4) + 981(5)$$

$$C_x = 1090 \text{ N}$$

5-60

$$\sum M_A = 0$$

$$\frac{3}{5}C(3) = 3(5) \quad C = 8.33 \text{ kN}$$

$$\sum F_y = 0$$

$$A_y = \frac{4}{5}(8.33) = 6.67 \text{ kN} \uparrow$$

$$\sum F_x = 0$$

$$A_x + 3 = \frac{3}{5}(8.33) \quad A_x = 2 \text{ kN} \rightarrow$$

$$\sum M_B = 0$$

$$8P = 8.33(5) \quad P = 5.21 \text{ kN} \downarrow$$

$$\sum F_y = 0$$

$$B_y + 5.21 - \frac{4}{5}(8.33) = 0 \quad B_y = 1.6 \text{ kN} \downarrow$$

$$\sum F_x = 0$$

$$B_x = \frac{3}{5}(8.33) = 5 \text{ kN} \leftarrow$$

5-61

$$\sum M_B = 0$$

$$\frac{4}{5}G(4.67) = 20(9)$$

$$G = 21.41 \text{ kN}$$

$$\sum F_x = 0$$

$$B_x = \frac{4}{5}(21.41) = 17.1 \text{ kN}$$

$$\sum F_y = 0$$

$$B_y + \frac{3}{5}(21.41) = 20$$

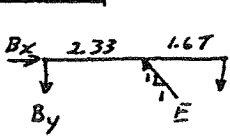
$$B_y = 7.15 \text{ kN}$$

$$\sum M_C = 0$$

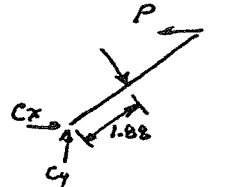
$$4P = 17.13(2) + 7.15(2)$$

$$P = 12.1 \text{ kN} \uparrow$$

5-62



$$\begin{aligned}\sum M_B &= 0 \\ 2.33(7.07E) &= 30(4) \\ E &= 72.84 \text{ kN} \\ \sum F_y &= 0 \\ .707(72.84) &= 30 + B_y \\ B_y &= 21.5 \text{ kN} \\ \sum F_x &= 0 \\ B_x &= .707(72.84) = 51.5 \text{ kN}\end{aligned}$$

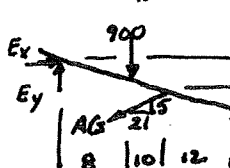


$$\begin{aligned}\sum M_C &= 0 \\ 3P &= 72.84(4.88) \\ P &= 45.6 \text{ kN}\end{aligned}$$

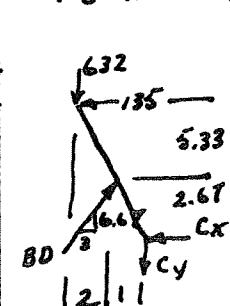
5-63



$$\begin{aligned}\sum M_A &= 0 \\ 33H &= 900 \times 11 \\ H &= 300 \text{ lb}\end{aligned}$$

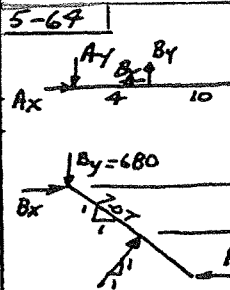


$$\begin{aligned}\sum M_E &= 0 \\ 900 \times 8 + \frac{21}{21.59} AG \times 9 \\ + \frac{5}{21.59} AG \times 18 &= 300 \times 30 \\ AG &= 139 \text{ lb}\end{aligned}$$



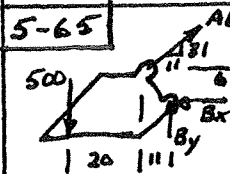
$$\begin{aligned}\sum F_x &= 0 \quad E_x = 135 \text{ lb} \\ \sum F_y &= 0 \quad E_y = 632 \text{ lb} \\ \sum M_C &= 0 \\ \frac{3}{7.31} BD \times 2.67 + \frac{6.67}{7.31} BD \times 1 \\ &= 632 \times 3 + 135 \times 8 \\ BD &= 1490 \text{ lb C}\end{aligned}$$

5-64

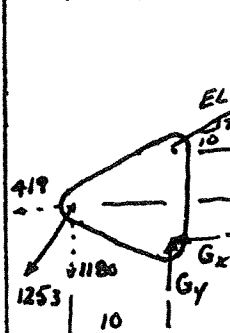


$$\begin{aligned}\sum M_A &= 0 \\ 4B_y &= 160(4) + 120(7) \\ B_y &= 680 \text{ lb} \\ \sum F_x &= 0 \\ .707D &= 680 \\ D &= 962 \text{ lb} \\ \sum M_B &= 0 \\ 7.07(962) &= 7P \\ P &= 971 \text{ lb}\end{aligned}$$

5-65



$$\begin{aligned}\sum M_B &= 0 \\ \frac{11}{32.9} AD \times 6 + \frac{31}{32.9} AD \times 11 \\ &= 500 \times 31 \\ AD &= 1253 \text{ lb}\end{aligned}$$

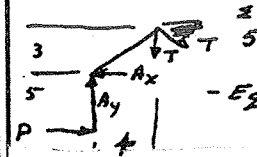


$$\begin{aligned}\sum M_G &= 0 \\ \frac{10}{12.2} EL \times 15 &= (180 \times 10) + 419 \times 8 \\ EL &= 1230 \text{ lb} \\ \sum F_y &= 0 \\ G_y + \frac{1}{12.2} \times 1230 &= 1180 \\ G_y &= 473 \text{ lb} \\ \sum F_x &= 0 \\ G_x + 419 &= \frac{10}{12.2} \times 1230 \\ G_x &= 591 \text{ lb}\end{aligned}$$

5-66

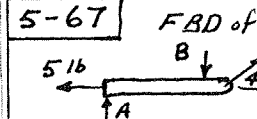


$$\begin{aligned}\sum M_D &= 0 \\ 10T &= 50(20) + 5P \dots \textcircled{1}\end{aligned}$$

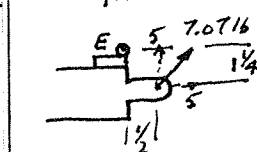


$$\begin{aligned}\sum M_A &= 0 \\ 5P &= (T + \frac{3}{5}T)4 + \frac{4}{5}T(3) \\ 5P &= 8.8T \dots \textcircled{2} \\ -E_{\text{reacting}} \\ T &= 1833 \text{ lb} \\ P &= 1467 \text{ lb}\end{aligned}$$

5-67

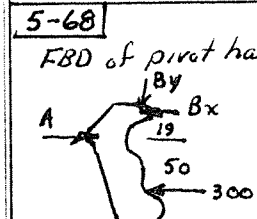


$$\begin{aligned}\sum F_x &= 0 \\ .707CD &= 5 \\ CD &= 7.07 \text{ lb}\end{aligned}$$

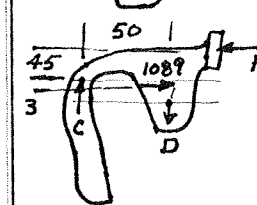


$$\begin{aligned}\sum M_E &= 0 \\ \text{torque} &= (5)(\frac{1}{2}) + 5(\frac{1}{4}) \\ &= 8.75 \text{ lb-in}\end{aligned}$$

5-68

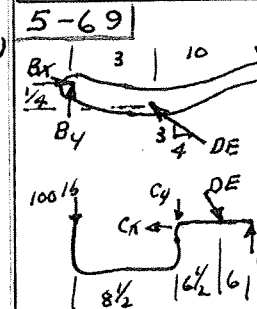


$$\begin{aligned}\sum M_B &= 0 \\ 19A &= 300(6.9) \\ A &= 1089 \text{ N} \\ \sum F_x &= 0 \\ B_x &= 1089 \text{ N}\end{aligned}$$



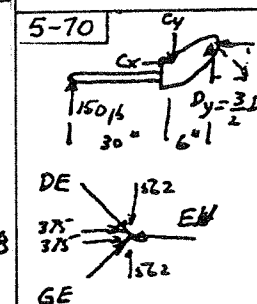
$$\begin{aligned}\sum F_x &= 0 \\ P &= 1089 \text{ N} \\ \sum M_C &= 0 \\ 50D &= 1089(3) + 1089(4.5) \\ D &= 1045 \text{ N} \\ \sum F_y &= 0 \\ C &= 1045 \text{ N}\end{aligned}$$

5-69

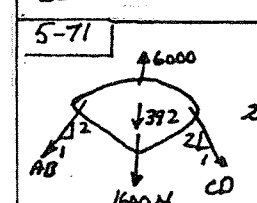


$$\begin{aligned}\sum M_B &= 0 \\ 13GH + \frac{4}{5}DE(\frac{1}{4}) &= \frac{3}{5}DE(3) \\ GH &= 0.123DE \dots \textcircled{1} \\ \sum M_C &= 0 \\ GH(12.5) + 100(8.5) &= \frac{3}{5}DE(6.5) \\ \text{Subst. } \textcircled{1} \\ GH &= 44.3 \text{ lb}\end{aligned}$$

5-70

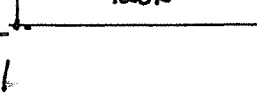


$$\begin{aligned}\sum M_C &= 0 \\ D_x(3) + \frac{3}{2}D_x(6) &= 150(30) \\ D_x &= 375 \text{ lb} \\ \therefore D_y &= 562 \text{ lb}\end{aligned}$$



$$\begin{aligned}\sum F_x &= 0 \\ EH &= 750 \text{ lb}\end{aligned}$$

5-71



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

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

$$\sum M_A = 0$$

$$\frac{4}{5} BC(2) = 1000(1.5)$$

$$BC = 937 \text{ lb T}$$

$$\sum F_y = 0$$

$$A_y = 1000 - \frac{3}{5}(937) = 438 \text{ lb } \uparrow$$

$$\sum F_x = 0$$

$$A_x = \frac{4}{5}(937) = 750 \text{ lb } \leftarrow$$

$$\sum M_F = 0$$

$$7.7 D = 937(19.2)$$

$$D = 2340 \text{ lb T}$$

$$\sum M_G = 0$$

$$\frac{1}{2.24} E(5) + 1000(3.5) = \frac{2}{2.24} E(3.75)$$

$$E = 8510 \text{ lb C}$$

5-75

$$\sum M_D = 0$$

$$4A = 300(3)$$

$$A = 225 \text{ lb}$$

$$\sum F_x = 0 \quad H_x = 0$$

$$\sum M_E = 0$$

$$4H_y = 300(1)$$

$$H_y = 75 \text{ lb}$$

$$\sum M_C = 0$$

$$\frac{1.5}{1.64} BG(0.67) + \frac{0.67}{1.64} BG(5)$$

$$= 225(2) + 75(2)$$

$$BG = 734 \text{ lb C}$$

5-76

$$\sum M_D = 0$$

$$\frac{5}{13} B(95) + \frac{3}{5} AC(40) = 800(20)$$

$$+ \frac{5}{13} B(55)$$

$$AC = 667 - 0.672B \quad \text{--- (1)}$$

$$\sum M_H = 0$$

$$\frac{12}{13} B(120) + \frac{5}{13} B(50) + \frac{3}{5} AC(25) = \frac{4}{5} AC(60)$$

$$AC = 3.94 B \quad \text{--- (2)}$$

$$\text{Equating}$$

$$B = 146 \text{ N}$$

$$AC = 573 \text{ N T}$$

5-77

$$\sum M_B = 0$$

$$2.5A + 9.63(6) = 37.9(30)$$

$$A = 430 \text{ lb } \nearrow \frac{4}{3}$$

$$\sum F_x = 0$$

$$B_x = 9.63 \text{ lb } \nearrow \frac{4}{3}$$

$$\sum F_y = 0$$

$$B_y + 37.8 = 430$$

$$B_y = 392 \text{ lb } \nearrow \frac{4}{3}$$

5-78

5-79

Slope of AC

$$\sin \theta = \frac{1.125}{1.5}$$

$$\theta = 48.6^\circ$$

$$\sum M_D = 0$$

$$AC \sin 48.6(1) + AC \cos 48.6(.75)$$

$$D_y = 30 \sin 21.1(22.75) + 30 \cos 21.1(25.28)$$

$$AC = 765 \text{ lb C}$$

$$\sum F_y = 0$$

$$D_y + 30 \cos 21.1 = 765 \sin 48.6$$

$$D_y = 546 \text{ lb}$$

$$\sum F_x = 0$$

$$D_x = 765 \cos 48.6 - 30 \sin 21.1 = 495 \text{ lb}$$

$$\sum M_B = 0$$

$$E \sin 30(.25) + E \cos 30(3.5)$$

$$= 765 \sin 21.1(1\frac{1}{2}) + 765 \cos 21.1(1\frac{3}{4})$$

$$E = 527 \text{ lb}$$

$$\sum F_y = 0$$

$$B_y = 527 \cos 30 + 765 \cos 21.1$$

$$B_y = 1170 \text{ lb}$$

$$\sum F_x = 0$$

$$B_x = 527 \sin 30 + 765 \sin 21.1$$

$$B_x = 539 \text{ lb}$$