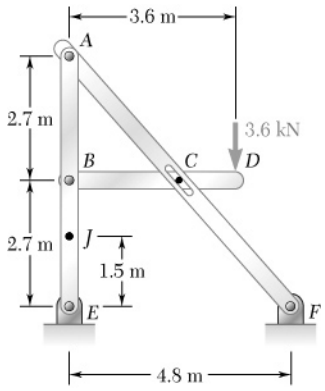
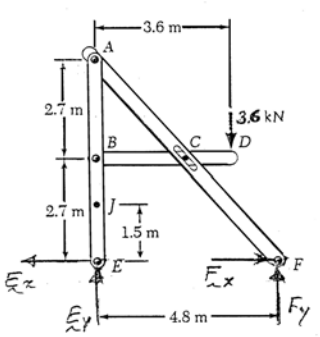
PROBLEM 6.98



For the frame and loading shown, determine the components of all forces acting on member *ABE*.

SOLUTION

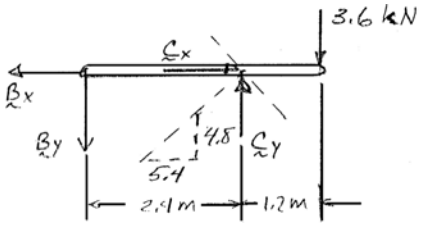
FBD Frame:



$$\circlearrowleft \Sigma M_F = 0: (1.2\text{ m})(3.6\text{ kN}) - (4.8\text{ m})E_y = 0$$

$$\mathbf{E}_y = 0.9\text{ kN} \uparrow \blacktriangleleft$$

FBD member BC:



$$C_y = \frac{4.8}{5.4}C_x = \frac{8}{9}C_x$$

$$\circlearrowleft \Sigma M_C = 0: (2.4\text{ m})B_y - (1.2\text{ m})(3.6\text{ kN}) = 0 \qquad B_y = 1.8\text{ kN} \downarrow$$

on *ABE*: $\mathbf{B}_y = 1.800\text{ kN} \uparrow \blacktriangleleft$

$$\uparrow \Sigma F_y = 0: -1.8\text{ kN} + C_y - 3.6\text{ kN} = 0 \qquad C_y = 5.40\text{ kN} \uparrow$$

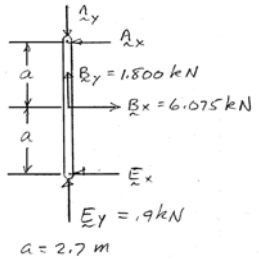
so $$C_x = \frac{9}{8}C_y \qquad C_x = 6.075\text{ kN} \rightarrow$$

$$\rightarrow \Sigma F_x = 0: -B_x + C_x = 0 \qquad B_x = 6.075\text{ kN} \leftarrow \text{ on } BC$$

on *ABE*: $\mathbf{B}_x = 6.08\text{ kN} \rightarrow \blacktriangleleft$

PROBLEM 6.98 CONTINUED

FBD member AB0E:



$$\circlearrowleft \Sigma M_A = 0: a\left(6.075\text{ kN}\right) - 2aE_x = 0$$

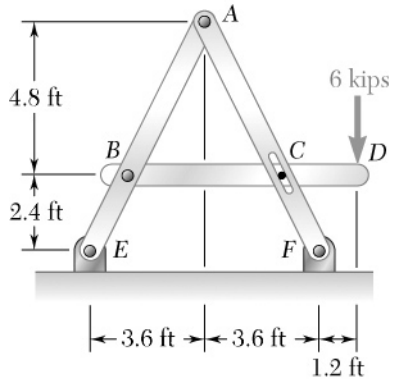
$$E_x = 3.038\text{ kN} \qquad \mathbf{E}_x = 3.04\text{ kN} \leftarrow \blacktriangleleft$$

$$\rightarrow \Sigma F_x = 0: -A_x + \left(6.075 - 3.038\right)\text{kN} = 0$$

$$\mathbf{A}_x = 3.04\text{ kN} \leftarrow \blacktriangleleft$$

$$\uparrow \Sigma F_y = 0: 0.9\text{ kN} + 1.8\text{ kN} - A_y = 0 \qquad \mathbf{A}_y = 2.70\text{ kN} \downarrow \blacktriangleleft$$

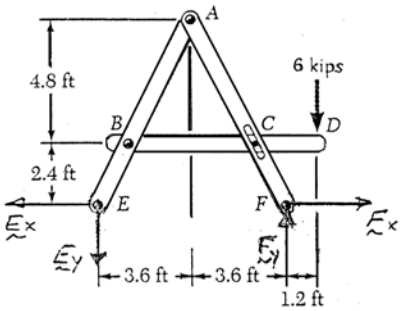
PROBLEM 6.99



For the frame and loading shown, determine the components of all forces acting on member *ABE*.

SOLUTION

FBD Frame:

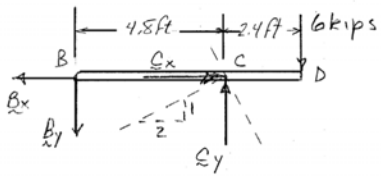


$\circlearrowleft \Sigma M_F = 0: (7.2\text{ ft})F_y - (1.2\text{ ft})(6\text{ kips}) = 0$

$\mathbf{E}_y = 1.000\text{ kip} \downarrow$ ◀

$\circlearrowleft \Sigma M_B = 0: (4.8\text{ ft})C_y - (7.2\text{ ft})(6\text{ kips}) = 0 \qquad C_y = 9\text{ kips}$

FBD member BCD:



But **C** is $\perp$ *ACF*, so $C_x = 2C_y$; $C_x = 18\text{ kips} \rightarrow$

$\rightarrow \Sigma F_x = 0: -B_x + C_x = 0 \qquad B_x = C_x = 18\text{ kips}$

$B_x = 18.00\text{ kips} \leftarrow$ on *BCD*

$\uparrow \Sigma F_y = 0: -B_y + 9\text{ kips} - 6\text{ kips} = 0 \qquad B_y = 3\text{ kips} \downarrow$ on *BCD*

On *ABE*: $\mathbf{B}_x = 18.00\text{ kips} \rightarrow$ ◀

$\mathbf{B}_y = 3.00\text{ kips} \uparrow$ ◀

$\circlearrowleft \Sigma M_A = 0: (4.8\text{ ft})(18\text{ kips}) - (2.4\text{ ft})(3\text{ kips}) + (3.6\text{ ft})(1\text{ kip}) - (7.2\text{ ft})(E_x) = 0$

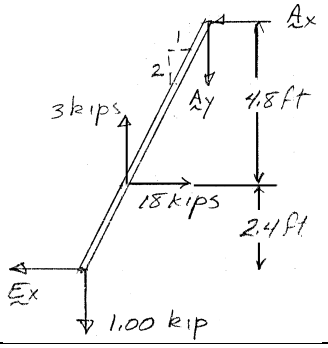
$\mathbf{E}_x = 11.50\text{ kips} \leftarrow$ ◀

$\rightarrow \Sigma F_x = 0: -11.50\text{ kips} + 18\text{ kips} - A_x = 0$

$\mathbf{A}_x = 6.50\text{ kips} \leftarrow$ ◀

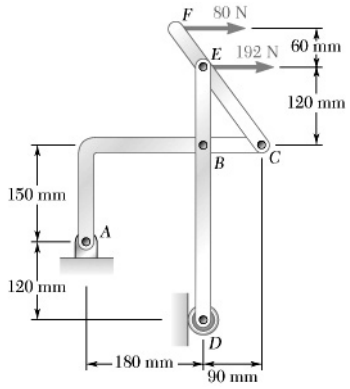
PROBLEM 6.99 CONTINUED

FBD member ABE:



$\uparrow \Sigma F_y = 0$: $-1.00 \text{ kip} + 3.00 \text{ kips} - A_y = 0$

$\mathbf{A}_y = 2.00 \text{ kips} \downarrow$ ◀

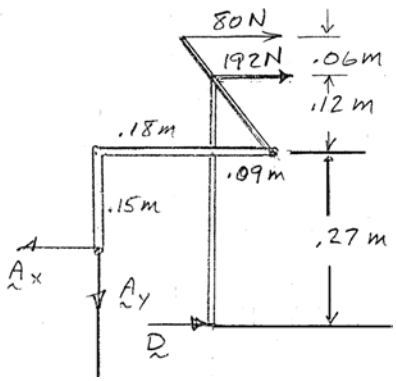


PROBLEM 6.100

For the frame and loading shown, determine the components of the forces acting on member *ABC* at *B* and *C*.

SOLUTION

FBD Frame:

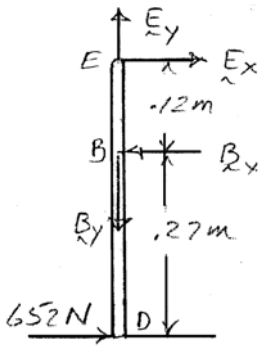


$$\circlearrowleft \Sigma M_A = 0: (0.12\text{ m})D - (0.27\text{ m})(192\text{ N}) - (0.33\text{ m})(80\text{ N}) = 0$$

$$\mathbf{D} = 652\text{ N} \rightarrow$$

$$\uparrow \Sigma F_y = 0: \mathbf{A}_y = 0$$

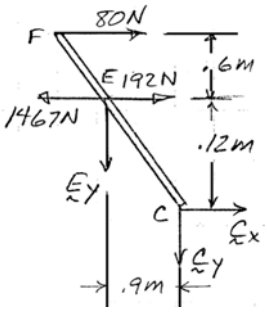
FBD members:



$$\circlearrowleft \Sigma M_E = 0: (0.39\text{ m})(652\text{ N}) - (0.12\text{ m})B_x = 0 \qquad B_x = 2119\text{ N} \leftarrow$$

$$\rightarrow \Sigma F_x = 0: E_x - 2119\text{ N} + 652\text{ N} = 0 \qquad E_x = 1467\text{ N} \rightarrow$$

PROBLEM 6.100 CONTINUED



$\rightarrow \Sigma F_x = 0$: $80\text{ N} + 192\text{ N} - 1467\text{ N} + C_x = 0$ $\qquad C_x = 1195\text{ N} \rightarrow$

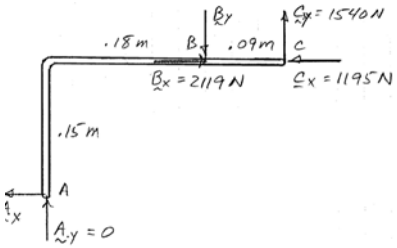
$\circlearrowleft \Sigma M_E = 0$: $-(0.9\text{ m})C_y + (0.12\text{ m})(1195\text{ N}) - (0.6\text{ m})(80\text{ N}) = 0$

$C_y = 1540\text{ N} \downarrow$

From above, on *ABC* $\qquad \mathbf{C}_x = 1.195\text{ kN} \leftarrow$ ◀

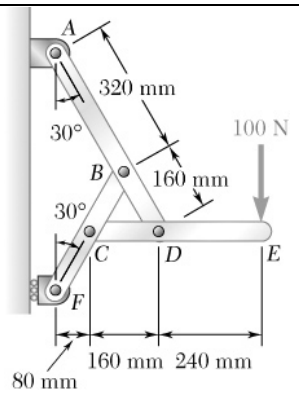
$\mathbf{C}_y = 1.540\text{ kN} \uparrow$ ◀

$\mathbf{B}_x = 2.12\text{ kN} \rightarrow$ ◀



$\uparrow \Sigma F_y = 0$: $-B_y + 1540\text{ N} = 0$ $\qquad B_y = 1540\text{ N}$

$\mathbf{B}_y = 1.540\text{ kN} \downarrow$ ◀

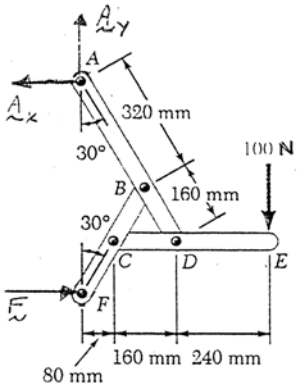


PROBLEM 6.101

For the frame and loading shown, determine the components of the forces acting on member *CDE* at *C* and *D*.

SOLUTION

FBD Frame:



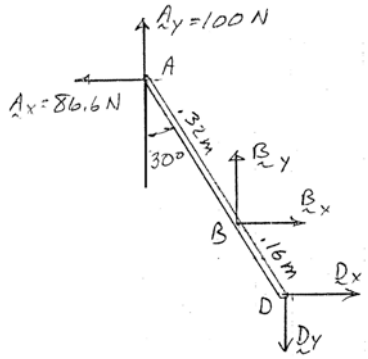
Note: $\widehat{AF} = 2(0.32\text{ m})\cos 30° = 0.5543\text{ m}$

$$\circlearrowleft \Sigma M_F = 0: (0.5543\text{ m})A_x - (0.48\text{ m})(100\text{ N}) = 0$$

$$\mathbf{A}_x = 86.603\text{ N} \leftarrow$$

$$\uparrow \Sigma F_y = 0: A_y - 100\text{ N} = 0 \qquad \mathbf{A}_y = 100\text{ N} \uparrow$$

FBD members:



$$\circlearrowleft \Sigma M_B = 0: (0.32\text{ m})(\cos 30°)(86.603\text{ N}) + (0.16\text{ m})(\cos 30°)D_x$$

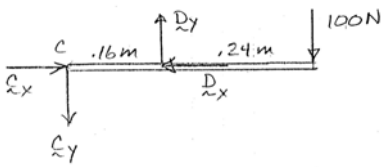
$$-(0.32\text{ m})(\sin 30°)(100\text{ N}) - (0.16\text{ m})(\sin 30°)D_y = 0$$

$$D_x = D_y \tan 30° - 57.736\text{ N}$$

$$\circlearrowleft \Sigma M_C = 0: (0.16\text{ m})D_y - (0.40\text{ m})(100\text{ N}) = 0 \qquad D_y = 250\text{ N}$$

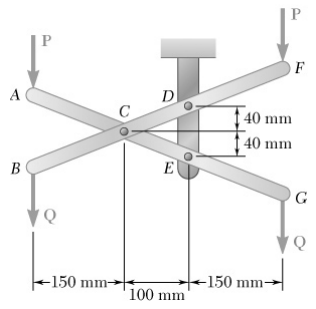
$$\mathbf{D}_y = 250\text{ N} \uparrow \blacktriangleleft$$

Then, from above $D_x = 86.6\text{ N}$ $\qquad \mathbf{D}_x = 86.6\text{ N} \leftarrow \blacktriangleleft$



$$\rightarrow \Sigma F_x = 0: C_x - 86.6\text{ N} = 0 \qquad \mathbf{C}_x = 86.6\text{ N} \rightarrow \blacktriangleleft$$

$$\uparrow \Sigma F_y = 0: -C_y + 250\text{ N} - 100\text{ N} = 0 \qquad \mathbf{C}_y = 150.0\text{ N} \downarrow \blacktriangleleft$$

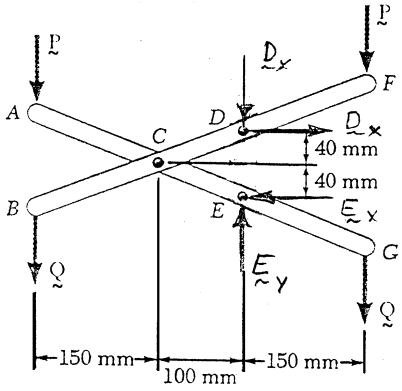


PROBLEM 6.102

Knowing that $P = 15$ N and $Q = 65$ N, determine the components of the forces exerted (*a*) on member *BCDF* at *C* and *D*, (*b*) on member *ACEG* at *E*.

SOLUTION

FBD Frame:



$$P = 15 \text{ N} \downarrow \qquad Q = 65 \text{ N} \downarrow$$

$$\curvearrowleft \Sigma M_D = 0: (0.25 \text{ m})(P+Q) - (.15 \text{ m})(P+Q) - (0.08 \text{ m})E_x = 0$$

$$E_x = 1.2(P+Q) = 100 \text{ N} \leftarrow \qquad \mathbf{E}_x = 100.0 \text{ N} \leftarrow \blacktriangleleft$$

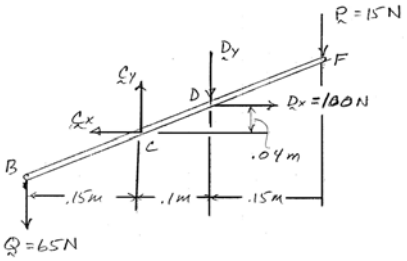
$$\rightarrow \Sigma F_x = 0: D_x - E_x = 0 = D_x - 100 \text{ N} \qquad D_x = 100 \text{ N} \rightarrow$$

$$\mathbf{D}_x = 100.0 \text{ N} \rightarrow \blacktriangleleft$$

$$\uparrow \Sigma F_y = 0: E_y - D_y - 2P - 2Q = 0$$

$$E_y = D_y + 2(P+Q) = D_y + 160 \text{ N}$$

FBD member BF:



$$\curvearrowleft \Sigma M_C = 0: (0.15 \text{ m})(65 \text{ N}) - (0.1 \text{ m})D_y - (0.04 \text{ m})(100 \text{ N}) - (0.25 \text{ m})(15 \text{ N}) = 0$$

$$D_y = 20 \text{ N} \qquad \mathbf{D}_y = 20.0 \text{ N} \downarrow \blacktriangleleft$$

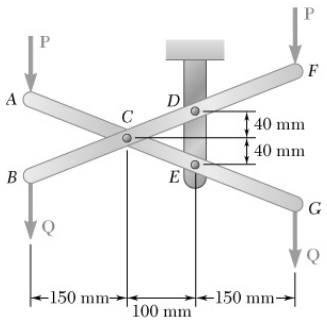
From above $\qquad E_y = 20 \text{ N} + 160 \text{ N} = 180 \text{ N} \qquad \mathbf{E}_y = 180.0 \text{ N} \uparrow \blacktriangleleft$

$$\rightarrow \Sigma F_x = 0: -C_x + 100 \text{ N} = 0$$

$$\mathbf{C}_x = 100.0 \text{ N} \leftarrow \blacktriangleleft$$

$$\uparrow \Sigma F_y = 0: -65 \text{ N} + C_y - 20 \text{ N} - 15 \text{ N} = 0$$

$$\mathbf{C}_y = 100.0 \text{ N} \uparrow \blacktriangleleft$$

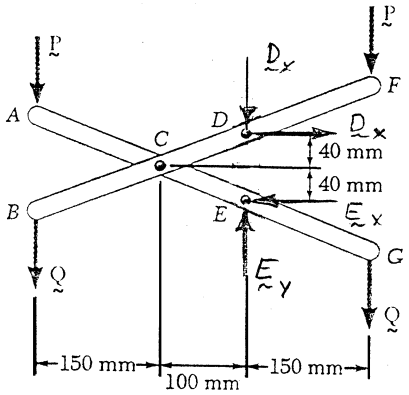


PROBLEM 6.103

Knowing that $P = 25$ N and $Q = 55$ N, determine the components of the forces exerted (*a*) on member *BCDF* at *C* and *D*, (*b*) on member *ACEG* at *E*.

SOLUTION

FBD Frame:



$P = 25$ N ↓ $\quad Q = 55$ N ↓

$$\circlearrowleft \Sigma M_D = 0: (0.25\text{ m})(P+Q) - (0.15\text{ m})(P+Q) - (0.08\text{ m})E_x = 0$$

$$E_x = 1.20(P+Q) = 100\text{ N}$$

$$\mathbf{E}_x = 100.0\text{ N} \leftarrow \blacktriangleleft$$

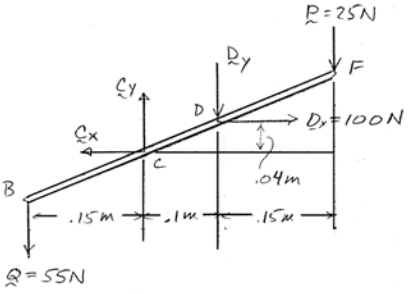
$$\Sigma F_x = D_x - 100\text{ N} = 0$$

$$\mathbf{D}_x = 100.0\text{ N} \rightarrow \blacktriangleleft$$

$$\Sigma F_y = E_y - D_y - 2P - 2Q = 0$$

$$E_y = D_y + 2(P+Q) = D_y + 160\text{ N}$$

FBD member BF:



$$\circlearrowleft \Sigma M_C = 0: (0.15\text{ m})(55\text{ N}) - (0.1\text{ m})D_y - (0.04)(100\text{ N})$$

$$- (0.25\text{ m})(25\text{ N}) = 0$$

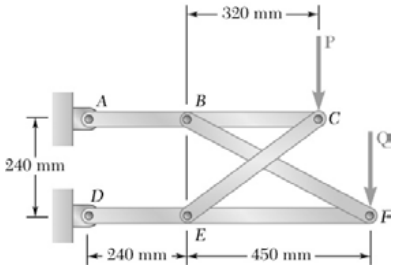
$$D_y = -20\text{ N} \qquad \mathbf{D}_y = 20.0\text{ N} \uparrow \blacktriangleleft$$

From above $\quad E_y = -20\text{ N} + 160\text{ N} = 140\text{ N} \qquad \mathbf{E}_y = 140.0\text{ N} \uparrow \blacktriangleleft$

$$\rightarrow \Sigma F_x = 0: -C_x + 100\text{ N} = 0 \qquad \mathbf{C}_x = 100.0\text{ N} \leftarrow \blacktriangleleft$$

$$\uparrow \Sigma F_y = 0: -55\text{ N} + C_y - (-20\text{ N}) - 25\text{ N} = 0$$

$$\mathbf{C}_y = 60.0\text{ N} \uparrow \blacktriangleleft$$

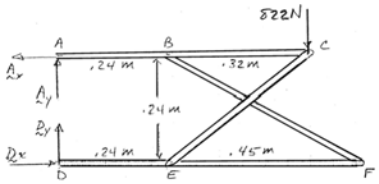


PROBLEM 6.104

Knowing that P = 822 N and Q = 0, determine for the frame and loading shown (*a*) the reaction at *D*, (*b*) the force in member *BF*.

SOLUTION

FBD Frame:



$$\circlearrowleft \Sigma M = 0: (0.24\text{ m})D_x - (0.56\text{ m})(822\text{ N}) = 0 \qquad D_x = 1918\text{ N}$$

$$\mathbf{D}_x = 1.918\text{ kN} \rightarrow$$

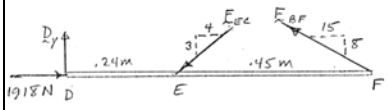
FBD member DF:

$$\circlearrowleft \Sigma M_D = 0: (0.69\text{ m})\frac{8}{17}F_{BF} - (0.24\text{ m})\frac{3}{5}F_{EC} = 0$$

$$0.3247F_{BF} - 0.144F_{EC} = 0$$

$$\rightarrow \Sigma F_x = 0: 1918\text{ N} - \frac{15}{17}F_{BF} - \frac{4}{5}F_{EC} = 0$$

$$0.8824F_{BF} + 0.800F_{EC} = 1918\text{ N}$$



Solving: $F_{BF} = 714\text{ N T} \blacktriangleleft$

$$\circlearrowleft \Sigma M_E = 0: (0.45\text{ m})\frac{8}{17}(714\text{ N}) - (0.24\text{ m})D_y = 0$$

$$D_y = 630\text{ N} \uparrow$$

so $\mathbf{D} = 2.02\text{ kN} \angle 18.18° \blacktriangleleft$