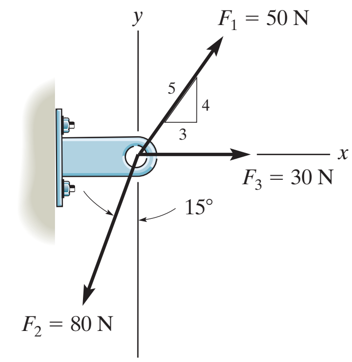
2–45.

Express each of the three forces acting on the support in Cartesian vector form and determine the magnitude of the resultant force and its direction, measured clockwise from positive x axis.



SOLUTION

Cartesian Notation. Referring to Fig. a,

$$\mathbf{F}_1 = (F_1)_x\,\mathbf{i} + (F_1)_y\,\mathbf{j} = 50\left(\frac{3}{5}\right)\mathbf{i} + 50\left(\frac{4}{5}\right)\mathbf{j} = \{30\,\mathbf{i} + 40\,\mathbf{j}\}\text{ N} \qquad \textbf{Ans.}$$

$$\mathbf{F}_2 = -(F_2)_x\,\mathbf{i} - (F_2)_y\,\mathbf{j} = -80\sin 15°\,\mathbf{i} - 80\cos 15°\,\mathbf{j}$$

$$= \{-20.71\,\mathbf{i} - 77.27\,\mathbf{j}\}\text{ N}$$

$$= \{-20.7\,\mathbf{i} - 77.3\,\mathbf{j}\}\text{ N} \qquad \textbf{Ans.}$$

$$F_3 = (F_3)_x\,\mathbf{i} = \{30\,\mathbf{i}\} \qquad \textbf{Ans.}$$

Thus, the resultant force is

$$\mathbf{F}_R = \Sigma\mathbf{F}; \qquad \mathbf{F}_R = \mathbf{F}_1 + \mathbf{F}_2 + \mathbf{F}_3$$

$$= (30\mathbf{i} + 40\,\mathbf{j}) + (-20.71\mathbf{i} - 77.27\mathbf{j}) + 30\mathbf{i}$$

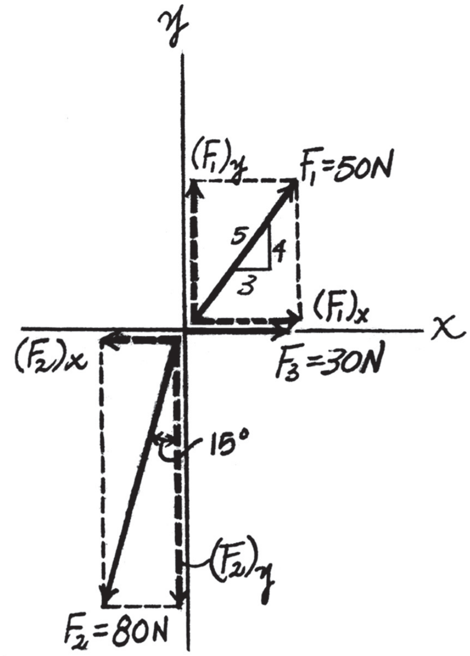
$$= \{39.29\,\mathbf{i} - 37.27\,\mathbf{j}\}\text{ N}$$

Referring to Fig. b, the magnitude of $\mathbf{F}_R$ is

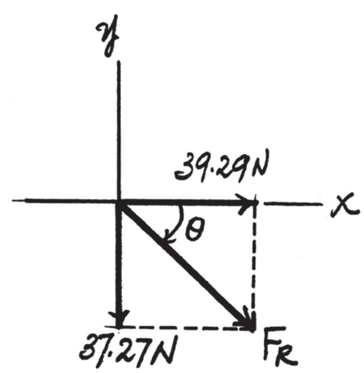
$$F_R = \sqrt{39.29^2 + 37.27^2} = 54.16\text{ N} = 54.2\text{ N} \qquad \textbf{Ans.}$$

And its directional angle θ measured clockwise from the positive x axis is

$$\theta = \tan^{-1}\left(\frac{37.27}{39.29}\right) = 43.49° = 43.5° \qquad \textbf{Ans.}$$



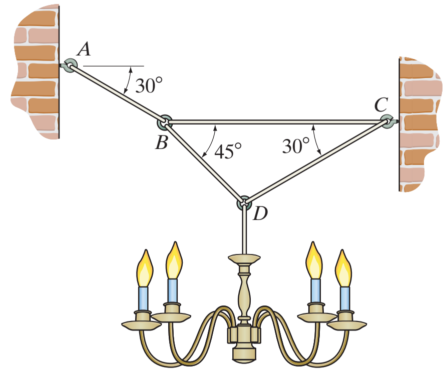
(a)



(b)

Ans:
$\mathbf{F}_1 = \{30\mathbf{i} + 40\mathbf{j}\}$ N
$\mathbf{F}_2 = \{-20.7\,\mathbf{i} - 77.3\,\mathbf{j}\}$ N
$\mathbf{F}_3 = \{30\,\mathbf{i}\}$
$F_R = 54.2$ N
$\theta = 43.5°$

3–19. Determine the tension developed in each wire used to support the 50-kg chandelier.



SOLUTION

Equations of Equilibrium: First, we will apply the equations of equilibrium along the x and y axes to the free-body diagram of joint D shown in Fig. (a).

$$\overset{+}{\rightarrow}\Sigma F_x = 0; \quad F_{CD}\cos 30^\circ - F_{BD}\cos 45^\circ = 0 \qquad (1)$$

$$+\uparrow\Sigma F_y = 0; \quad F_{CD}\sin 30^\circ + F_{BD}\sin 45^\circ - 50(9.81) = 0 \qquad (2)$$

Solving Eqs. (1) and (2), yields

$$F_{CD} = 359 \text{ N} \quad F_{BD} = 439.77 \text{ N} = 440 \text{ N} \qquad \textbf{Ans.}$$

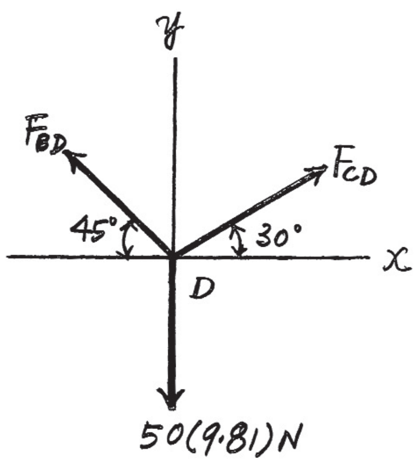
Using the result $F_{BD} = 439.77$ N and applying the equations of equilibrium along the x and y axes to the free-body diagram of joint B shown in Fig. (b),

$$+\uparrow\Sigma F_y = 0; \quad F_{AB}\sin 30^\circ - 439.77\sin 45^\circ = 0$$

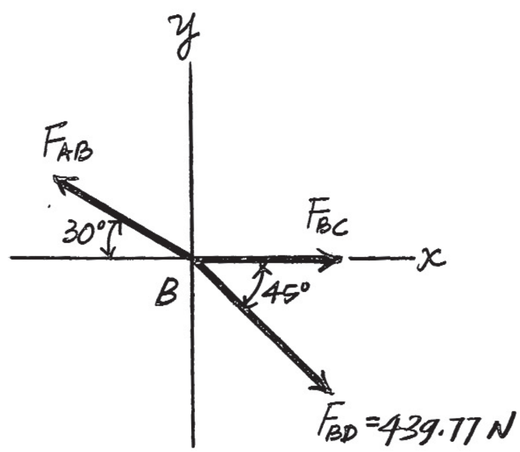
$$F_{AB} = 621.93\text{N} = 622 \text{ N} \qquad \textbf{Ans.}$$

$$\overset{+}{\rightarrow}\Sigma F_x = 0; \quad F_{BC} + 439.77\cos 45^\circ - 621.93\cos 30^\circ = 0$$

$$F_{BC} = 228 \text{ N} \qquad \textbf{Ans.}$$



(a)

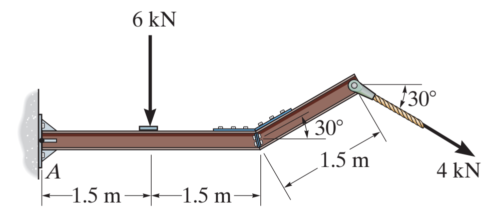


(b)

Ans:
$F_{BD} = 440$ N
$F_{AB} = 622$ N
$F_{BC} = 228$ N

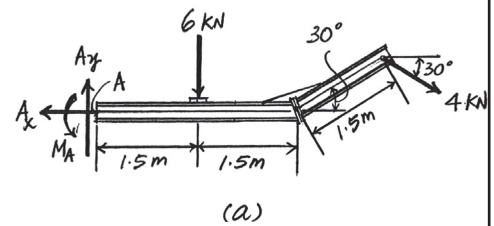
5–13.

Determine the components of the support reactions at the fixed support A on the cantilevered beam.



SOLUTION

Equations of Equilibrium: From the free-body diagram of the cantilever beam, Fig. *a*, A_x, A_y, and M_A can be obtained by writing the moment equation of equilibrium about point A.



(a)

$\xrightarrow{+} \Sigma F_x = 0;\quad 4\cos 30° - A_x = 0$

$A_x = 3.46 \text{ kN}$ **Ans.**

$+\uparrow \Sigma F_y = 0;\quad A_y - 6 - 4\sin 30° = 0$

$A_y = 8 \text{ kN}$ **Ans.**

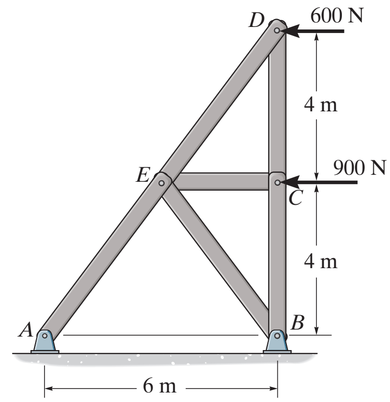
$\circlearrowleft + \Sigma M_A = 0; M_A - 6(1.5) - 4\cos 30°\,(1.5\sin 30°) - 4\sin 30°(3 + 1.5\cos 30°) = 0$

$M_A = 20.2 \text{ kN}\cdot\text{m}$ **Ans.**

Ans:
$A_x = 3.46 \text{ kN}$
$A_y = 8 \text{ kN}$
$M_A = 20.2 \text{ kN}\cdot\text{m}$

6–14.

Determine the force in each member of the truss, and state if the members are in tension or compression.



SOLUTION

Method of Joints: We will begin by analyzing the equilibrium of joint D, and then proceed to analyze joints C and E.

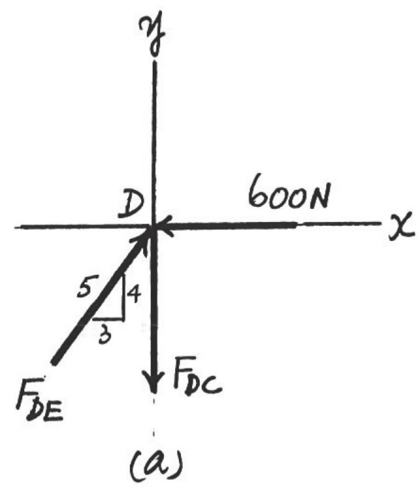
Joint D: From the free-body diagram in Fig. *a,*

$\xrightarrow{+} \Sigma F_x = 0;\quad F_{DE}\left(\frac{3}{5}\right) - 600 = 0$

$F_{DE} = 1000\text{ N} = 1.00\text{ kN (C)}$ **Ans.**

$+\uparrow \Sigma F_y = 0;\quad 1000\left(\frac{4}{5}\right) - F_{DC} = 0$

$F_{DC} = 800\text{ N (T)}$ **Ans.**



Joint C: From the free-body diagram in Fig. *b,*

$\xrightarrow{+} \Sigma F_x = 0;\quad F_{CE} - 900 = 0$

$F_{CE} = 900\text{ N (C)}$ **Ans.**

$+\uparrow \Sigma F_y = 0;\quad 800 - F_{CB} = 0$

$F_{CB} = 800\text{ N (T)}$ **Ans.**

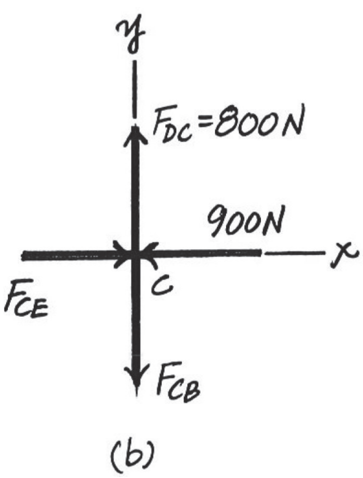
Joint E: From the free-body diagram in Fig. *c,*

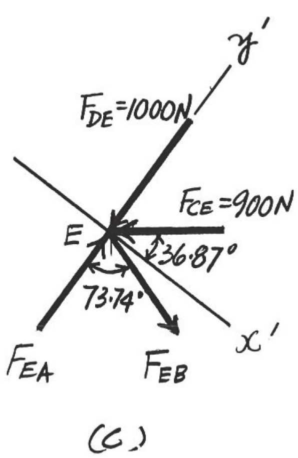
$\searrow + \Sigma F_{x'} = 0;\quad -900\cos 36.87^\circ + F_{EB}\sin 73.74^\circ = 0$

$F_{EB} = 750\text{ N (T)}$ **Ans.**

$\nearrow + \Sigma F_{y'} = 0;\quad F_{EA} - 1000 - 900\sin 36.87^\circ - 750\cos 73.74^\circ = 0$

$F_{EA} = 1750\text{ N} = 1.75\text{ kN (C)}$ **Ans.**

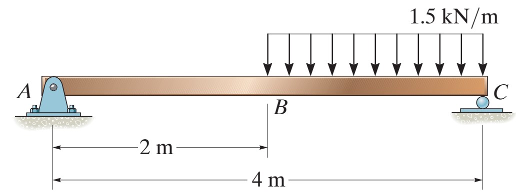




Ans:
$F_{DE} = 1.00\text{ kN (C)}$
$F_{DC} = 800\text{ N (T)}$
$F_{CE} = 900\text{ N (C)}$
$F_{CB} = 800\text{ N (T)}$
$F_{EB} = 750\text{ N (T)}$
$F_{EA} = 1.75\text{ kN (C)}$

7–50.

Draw the shear and moment diagrams for the beam.

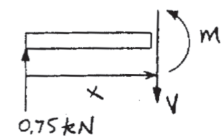


SOLUTION

$0 \le x \le 2$ m:

$+\uparrow \Sigma F_y = 0; \qquad 0.75 - V = 0$

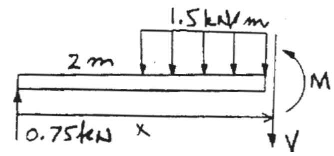
$V = 0.75 \text{ kN}$ **Ans.**



$\zeta + \Sigma M = 0; \qquad M - 0.75x = 0$

$M = 0.75\,x \text{ kN} \cdot \text{m}$ **Ans.**

$2 \text{ m} < x < 4$ m:

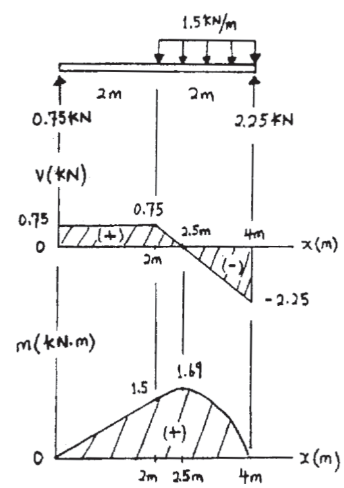


$+\uparrow \Sigma F_y = 0; \qquad 0.75 - 1.5\,(x - 2) - V = 0$

$V = 3.75 - 1.5\,x \text{ kN}$ **Ans.**

$\zeta + \Sigma M = 0; \qquad M + \dfrac{1.5}{2}\,(x - 2)^2 - 0.75\,x = 0$

$M = -0.75\,x^2 + 3.75\,x - 3 \text{ kN} \cdot \text{m}$ **Ans.**



Ans:
$V = 0.75$ kN
$M = 0.75\,x$ kN · m
$V = 3.75 - 1.5\,x$ kN
$M = -0.75x^2 + 3.75x - 3$ kN · m