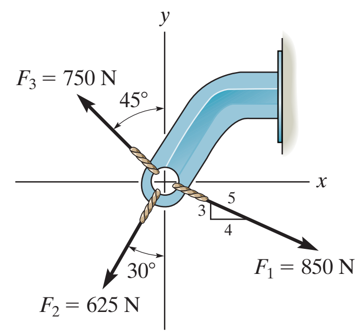
***2–40.**

Determine the magnitude of the resultant force and its direction measured counterclockwise from the positive x axis.



SOLUTION

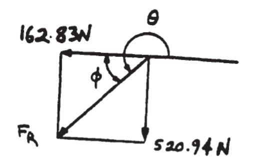
$\xrightarrow{+} F_{Rx} = \Sigma F_x;\quad F_{Rx} = \frac{4}{5}(850) - 625 \sin 30° - 750 \sin 45° = -162.83$ N

$+\uparrow F_{Ry} = \Sigma F_y;\quad F_{Ry} = -\frac{3}{5}(850) - 625 \cos 30° + 750 \cos 45° = -520.94$ N

$$F_R = \sqrt{(-162.83)^2 + (-520.94)^2} = 546 \text{ N} \qquad \textbf{Ans.}$$

$$\phi = \tan^{-1}\left(\frac{520.94}{162.83}\right) = 72.64°$$

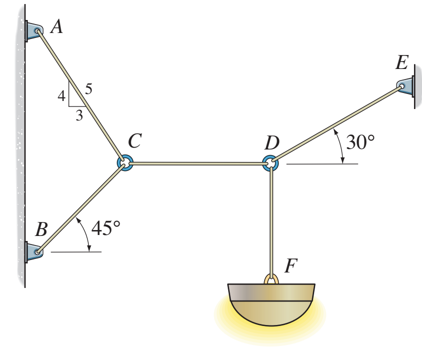
$$\theta = 180° + 72.64° = 253° \qquad \textbf{Ans.}$$



Ans:
$F_R = 546$ N
$\theta = 253°$

***3–32.**

Determine the maximum mass of the lamp that the cord system can support so that no single cord develops a tension exceeding 400 N.

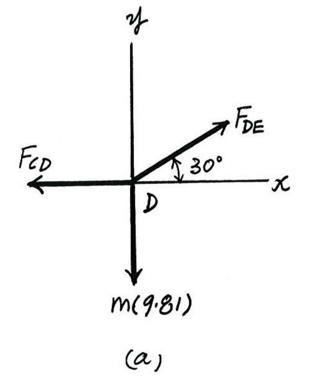


SOLUTION

Equations of Equilibrium: Applying the equations of equilibrium along the x and y axes to the free-body diagram of joint D shown in Fig. a, we have

$$+\uparrow \Sigma F_y = 0; \qquad F_{DE} \sin 30^\circ - m(9.81) = 0 \qquad F_{DE} = 19.62m$$

$$\overset{+}{\rightarrow} \Sigma F_x = 0; \qquad 19.62m \cos 30^\circ - F_{CD} = 0 \qquad F_{CD} = 16.99m$$



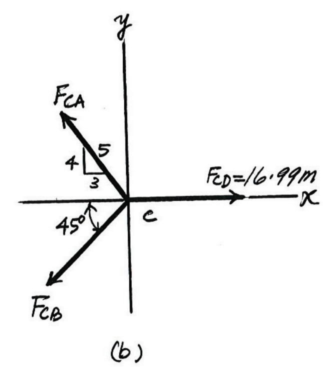
Using the result $F_{CD} = 16.99m$ and applying the equations of equilibrium along the x and y axes to the free-body diagram of joint D shown in Fig. b, we have

$$\overset{+}{\rightarrow} \Sigma F_x = 0; \qquad 16.99m - F_{CA}\left(\frac{3}{5}\right) - F_{CD} \cos 45^\circ = 0 \qquad \textbf{(1)}$$

$$+\uparrow \Sigma F_y = 0; \qquad F_{CA}\left(\frac{4}{5}\right) - F_{CB} \sin 45^\circ = 0 \qquad \textbf{(2)}$$

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

$$F_{CB} = 13.73m \qquad F_{CA} = 12.14m$$



Notice that cord DE is subjected to the greatest tensile force, and so it will achieve the maximum allowable tensile force first. Thus

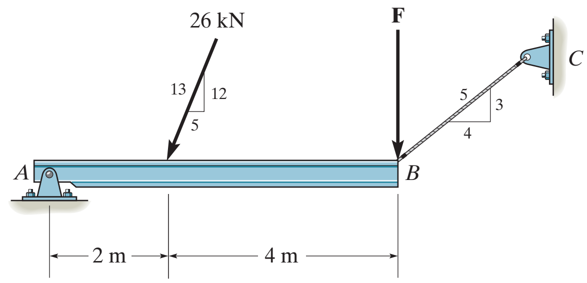
$$F_{DE} = 400 = 19.62m$$

$$m = 20.4 \text{ kg} \qquad \textbf{Ans.}$$

Ans:
$m = 20.4$ kg

***5–48.**

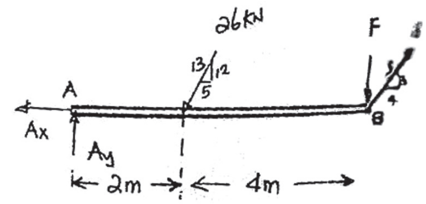
If rope BC will fail when the tension becomes 50 kN, determine the greatest vertical load F that can be applied to the beam at B. What is the magnitude of the reaction at A for this loading? Neglect the thickness of the beam.



SOLUTION

$\circlearrowleft + \Sigma M_A = 0;\qquad -26\left(\frac{12}{13}\right)(2) - F(6) + \frac{3}{5}(50)(6) = 0$

$F = 22\text{ kN}$ **Ans.**



$\overset{+}{\rightarrow} \Sigma F_x = 0;\qquad 50\left(\frac{4}{5}\right) - A_x - 26\left(\frac{5}{13}\right) = 0$

$A_x = 30\text{ kN}$ **Ans.**

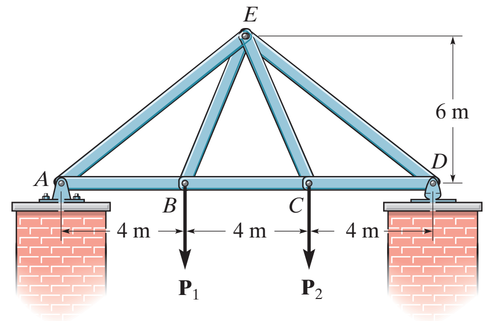
$+\uparrow \Sigma F_y = 0;\qquad A_y - 26\left(\frac{12}{13}\right) - 22 + 50\left(\frac{3}{5}\right) = 0$

$A_y = 16\text{ kN}$ **Ans.**

Ans:
$F = 22\text{ kN}$
$A_x = 30\text{ kN}$
$A_y = 16\text{ kN}$

***6–12.**

Determine the force in each member of the truss and state if the members are in tension or compression. Set $P_1 = 3$ kN, $P_2 = 6$ kN.



SOLUTION

Support Reactions. Referring to the FBD of the entire truss shown in Fig. *a*,

$\zeta + \Sigma M_A = 0; \quad N_D(12) - 3(4) - 6(8) = 0 \quad N_D = 5.00 \text{ kN}$

$\zeta + \Sigma M_D = 0; \quad 6(4) + 3(8) - A_y(12) = 0 \quad A_y = 4.00 \text{ kN}$

$\xrightarrow{+} \Sigma F_x = 0; \quad A_x = 0$

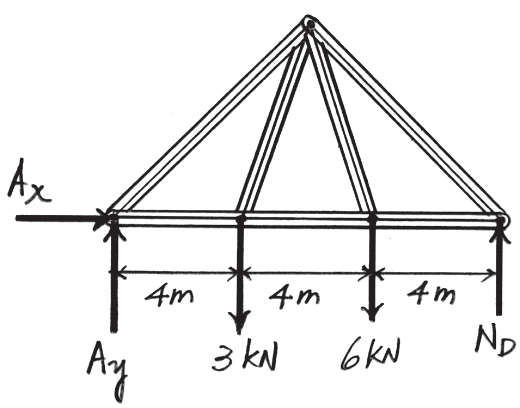
Method of Joints. We will carry out the analysis of joint equilibrium according to the sequence of joints A, D, B and C.

Joint A. Fig. *b*

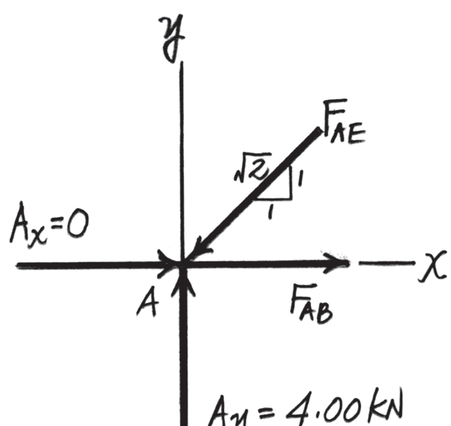
$+\uparrow \Sigma F_y = 0; \quad 4.00 - F_{AE}\left(\frac{1}{\sqrt{2}}\right) = 0$

$F_{AE} = 4\sqrt{2} \text{ kN (C)} = 5.66 \text{ kN (C)}$ **Ans.**

$\xrightarrow{+} \Sigma F_x = 0; \quad F_{AB} - 4\sqrt{2}\left(\frac{1}{\sqrt{2}}\right) = 0 \quad F_{AB} = 4.00 \text{ kN (T)}$ **Ans.**



(a)



(b)

6–12. Continued

Joint *D*. Fig. *c*

$+\uparrow\Sigma F_y = 0;\quad 5.00 - F_{DE}\left(\frac{1}{\sqrt{2}}\right) = 0 \quad F_{DE} = 5\sqrt{2}\text{ kN (C)} = 7.07\text{ kN (C)}$ **Ans.**

$\overset{+}{\rightarrow}\Sigma F_x = 0;\quad 5\sqrt{2}\left(\frac{1}{\sqrt{2}}\right) - F_{DC} = 0 \quad F_{DC} = 5.00\text{ kN (T)}$ **Ans.**

Joint *B*. Fig. *d*

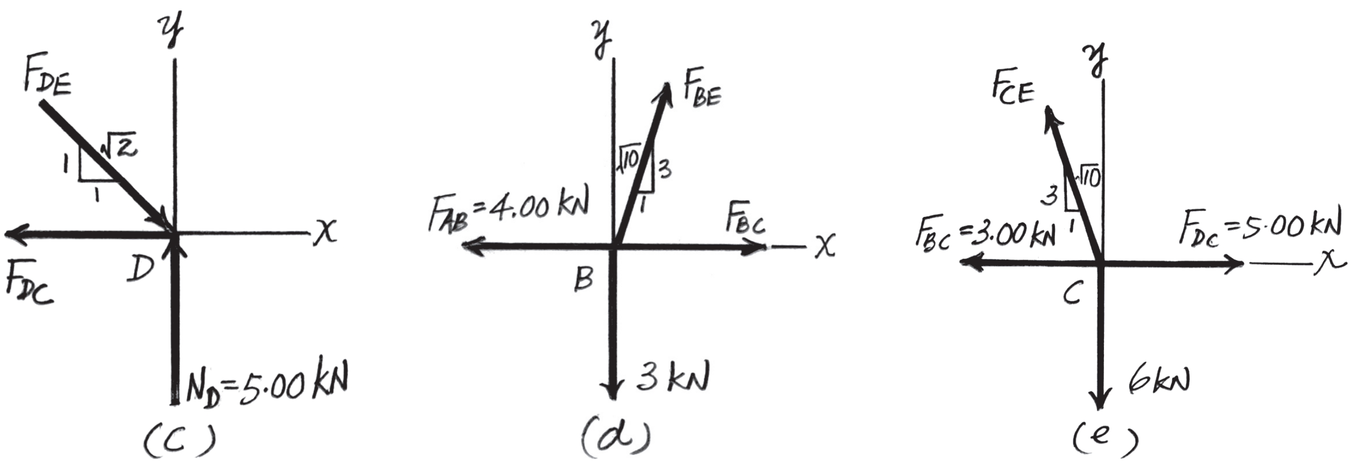
$+\uparrow\Sigma F_y = 0;\quad F_{BE}\left(\frac{3}{\sqrt{10}}\right) - 3 = 0 \quad F_{BE} = \sqrt{10}\text{ kN (T)} = 3.16\text{ kN (T)}$ **Ans.**

$\overset{+}{\rightarrow}\Sigma F_x = 0;\quad F_{BC} + \sqrt{10}\left(\frac{1}{\sqrt{10}}\right) - 4.00 = 0 \quad F_{BC} = 3.00\text{ kN (T)}$ **Ans.**

Joint *C*. Fig. *e*

$+\uparrow\Sigma F_y = 0;\quad F_{CE}\left(\frac{3}{\sqrt{10}}\right) - 6 = 0 \quad F_{CE} = 2\sqrt{10}\text{ kN } (T) = 6.32\text{ kN (T)}$ **Ans.**

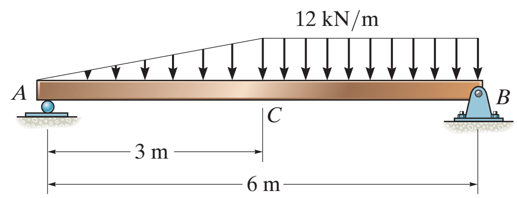
$\overset{+}{\rightarrow}\Sigma F_x = 0;\quad 5.00 - 3.00 - \left(2\sqrt{10}\right)\left(\frac{1}{\sqrt{10}}\right) = 0$ (Check!!)



Ans:
$F_{AE} = 5.66\text{ kN (C)}$
$F_{AB} = 4.00\text{ kN (T)}$
$F_{DE} = 7.07\text{ kN (C)}$
$F_{DC} = 5.00\text{ kN (T)}$
$F_{BE} = 3.16\text{ kN (T)}$
$F_{BC} = 3.00\text{ kN (T)}$
$F_{CE} = 6.32\text{ kN (T)}$

***7–60.**

Draw the shear and moment diagrams for the beam.



SOLUTION

Support Reactions. Referring to the *FBD* of the entire beam shown in Fig. *a*,

$$\circlearrowleft + \Sigma M_B = 0; \quad 12(3)(1.5) + \frac{1}{2}(12)(3)(4) - A_y(6) = 0 \quad A_y = 21.0 \text{ kN}$$

$$\circlearrowleft + \Sigma M_A = 0; \quad B_y(6) - \frac{1}{2}(12)(3)(2) - 12(3)(4.5) = 0 \quad B_y = 33.0 \text{ kN}$$

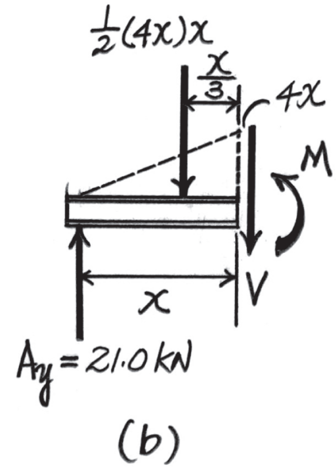
$$\xrightarrow{+} \Sigma F_x = 0; \quad B_x = 0$$

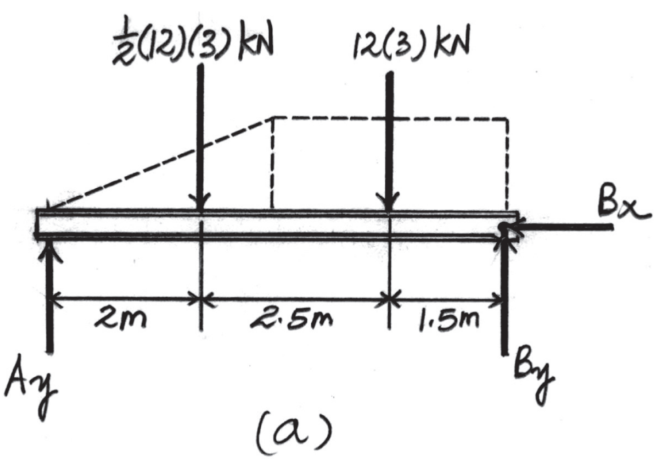
Shear And Moment Functions. The beam will be sectioned at two arbitrary distances x in region AC ($0 \le x$ 3 m) and region CB (3 m $< x \le 6$ m).
For region $0 \le x < 3$ m, Fig. *b*

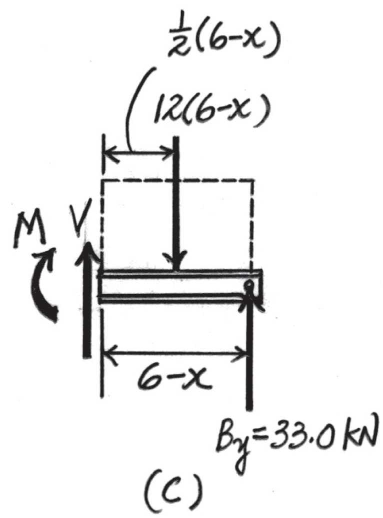
$$+\uparrow \Sigma F_y = 0; \quad 21.0 - \frac{1}{2}(4x)(x) - V = 0 \quad V = \left\{21.0 - 2x^2\right\} \text{ kN} \qquad \textbf{Ans.}$$

$$\circlearrowleft + \Sigma M_O = 0 \quad M + \left[\frac{1}{2}(4x)(x)\right]\left(\frac{x}{3}\right) - 21.0x = 0$$

$$M = \left\{21.0x - \frac{2}{3}x^3\right\} \text{ kN}\cdot\text{m} \qquad \textbf{Ans.}$$







7–60. Continued

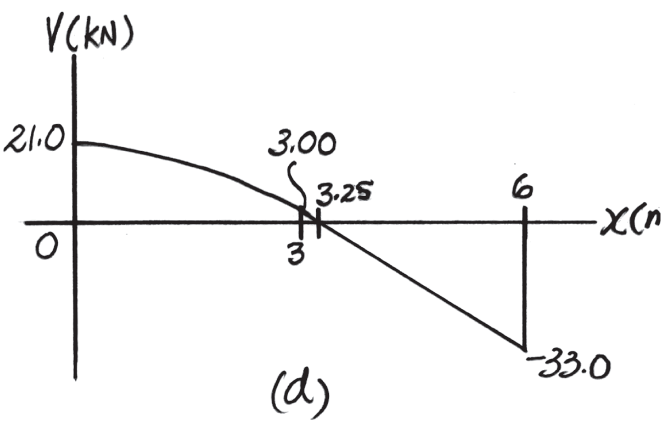
For region 3 m $< x \leq$ 6 m, Fig. *c*

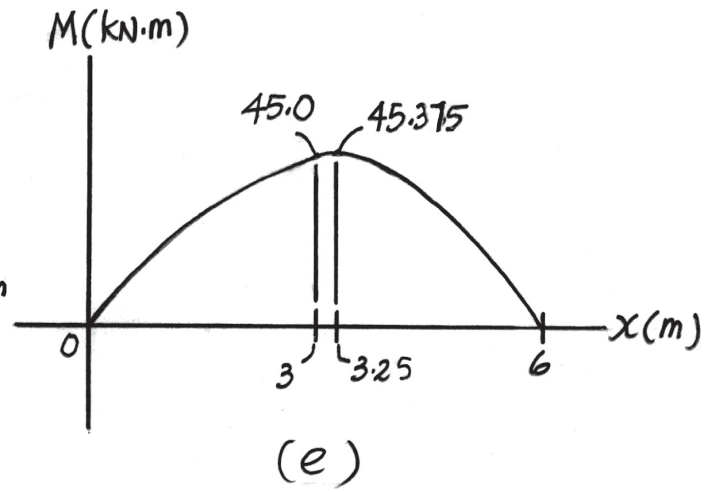
$+\uparrow \Sigma F_y = 0; \qquad V + 33.0 - 12(6 - x) = 0 \qquad V = \{39.0 - 12x\}$ kN **Ans.**

$\circlearrowleft + \Sigma M_O = 0 \qquad 33.0(6 - x) - [12(6 - x)]\left[\frac{1}{2}(6 - x)\right] - M = 0$

$$M = \left\{-6x^2 + 39x - 18\right\} \text{ kN}\cdot\text{m} \qquad \textbf{Ans.}$$

Plotting the shear and moment functions obtained, the shear and moment diagram shown in Fig. *d* and *e* resulted.





Ans:
For $0 \leq x < 3$ m
$V = \left\{21.0 - 2x^2\right\}$ kN
$M = \left\{21.0x - \frac{2}{3}x^3\right\}$ kN·m
For 3 m $< x \leq$ 6 m
$V = \{39.0 - 12x\}$ kN
$M = \left\{-6x^2 + 39x - 18\right\}$ kN·m