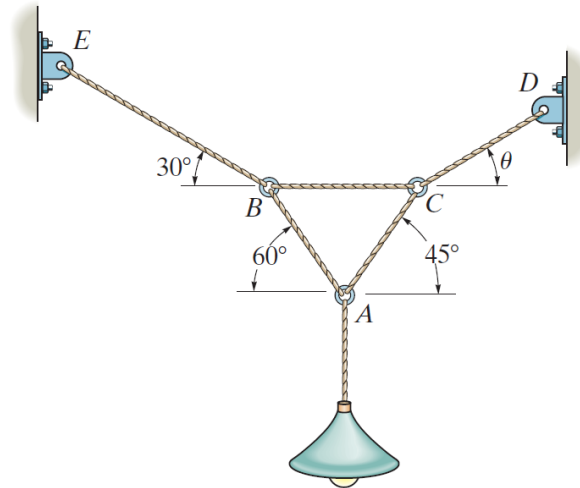


Problem 3-33

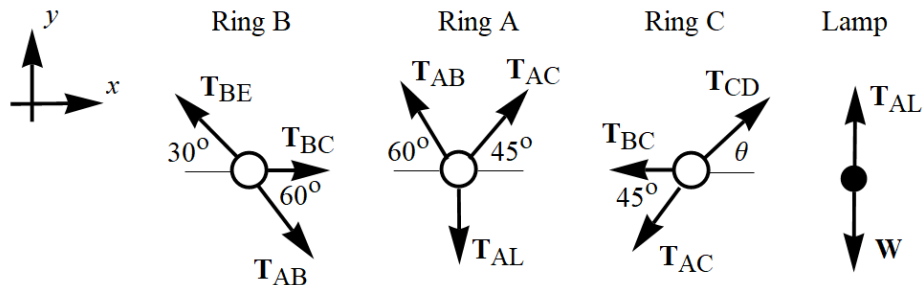
The lamp has a weight of 15 lb and is supported by the six cords connected together as shown. Determine the tension in each cord and the angle θ for equilibrium. Cord BC is horizontal.



Probs. 3-33/34

Solution

Draw one free-body diagram for each of the rings and one for the lamp.



In order for the system to be in equilibrium, the sum of the forces in each direction must be zero. Below are the equations for ring B and ring A .

$$\sum F_x = 0 : \quad T_{AB} \cos 60^\circ + T_{BC} - T_{BE} \cos 30^\circ = 0 \qquad T_{AC} \cos 45^\circ - T_{AB} \cos 60^\circ = 0$$

$$\sum F_y = 0 : \quad T_{BE} \sin 30^\circ - T_{AB} \sin 60^\circ = 0 \qquad T_{AC} \sin 45^\circ + T_{AB} \sin 60^\circ - T_{AL} = 0$$

And below are the equations for ring C and the lamp.

$$\sum F_x = 0 : \quad T_{CD} \cos \theta - T_{BC} - T_{AC} \cos 45^\circ = 0 \qquad 0 = 0$$

$$\sum F_y = 0 : \quad T_{CD} \sin \theta - T_{AC} \sin 45^\circ = 0 \qquad T_{AL} - W = 0$$

Solve these seven equations for the six tensions and θ . Then use the fact that $W = 15$ lb.

$$T_{AB} = (\sqrt{3} - 1)W \approx 11.0 \text{ lb}$$

$$T_{AC} = \sqrt{2 - \sqrt{3}}W \approx 7.76 \text{ lb}$$

$$T_{BC} = (\sqrt{3} - 1)W \approx 11.0 \text{ lb}$$

$$T_{CD} = \sqrt{\frac{5}{2}}(\sqrt{3} - 1)W \approx 17.4 \text{ lb}$$

$$T_{BE} = (3 - \sqrt{3})W \approx 19.0 \text{ lb}$$

$$T_{AL} = W = 15.0 \text{ lb}$$

$$\theta = \cos^{-1}\left(\frac{3}{\sqrt{10}}\right) \approx 18.4^\circ$$