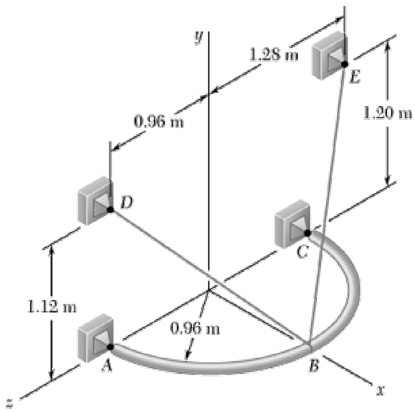


PROBLEM 2.97

For the semicircular ring of Problem 2.91, determine the magnitude and direction of the resultant of the forces exerted by the cables at *B* knowing that the tensions in cables *BD* and *BE* are 220 N and 250 N, respectively.

SOLUTION

For the solutions to Problems 2.91 and 2.92, we have

$$\mathbf{T}_{BD} = -(120\text{ N})\mathbf{i} + (140\text{ N})\mathbf{j} + (120\text{ N})\mathbf{k}$$

$$\mathbf{T}_{BE} = -(120\text{ N})\mathbf{i} + (150\text{ N})\mathbf{j} - (160\text{ N})\mathbf{k}$$

Then:

$$\mathbf{R}_B = \mathbf{T}_{BD} + \mathbf{T}_{BE}$$

$$= -(240\text{ N})\mathbf{i} + (290\text{ N})\mathbf{j} - (40\text{ N})\mathbf{k}$$

and $R = 378.55\text{ N}$ $\qquad R_B = 379\text{ N}$ ◀

$$\cos\theta_x = -\frac{240}{378.55} = -0.6340$$

$\theta_x = 129.3°$ ◀

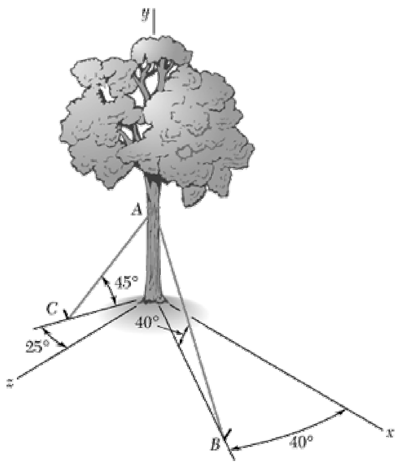
$$\cos\theta_y = \frac{290}{378.55} = -0.7661$$

$\theta_y = 40.0°$ ◀

$$\cos\theta_z = -\frac{40}{378.55} = -0.1057$$

$\theta_z = 96.1°$ ◀

PROBLEM 2.98



To stabilize a tree partially uprooted in a storm, cables *AB* and *AC* are attached to the upper trunk of the tree and then are fastened to steel rods anchored in the ground. Knowing that the tension in *AB* is 920 lb and that the resultant of the forces exerted at *A* by cables *AB* and *AC* lies in the *yz* plane, determine (*a*) the tension in *AC*, (*b*) the magnitude and direction of the resultant of the two forces.

SOLUTION

Have

$$\mathbf{T}_{AB} = (920 \text{ lb})(\sin 50° \cos 40° \mathbf{i} - \cos 50° \mathbf{j} + \sin 50° \sin 40° \mathbf{j})$$

$$\mathbf{T}_{AC} = T_{AC}(-\cos 45° \sin 25° \mathbf{i} - \sin 45° \mathbf{j} + \cos 45° \cos 25° \mathbf{j})$$

(*a*)

$$\mathbf{R}_A = \mathbf{T}_{AB} + \mathbf{T}_{AC}$$

$$(R_A)_x = 0$$

$$\therefore \ (R_A)_x = \Sigma F_x = 0: \ (920 \text{ lb})\sin 50° \cos 40° - T_{AC} \cos 45° \sin 25° = 0$$

or

$$T_{AC} = 1806.60 \text{ lb} \qquad T_{AC} = 1807 \text{ lb} ◀$$

(*b*)

$$(R_A)_y = \Sigma F_y: \ -(920 \text{ lb})\cos 50° - (1806.60 \text{ lb})\sin 45°$$

$$(R_A)_y = -1868.82 \text{ lb}$$

$$(R_A)_z = \Sigma F_z: \ (920 \text{ lb})\sin 50° \sin 40° + (1806.60 \text{ lb})\cos 45° \cos 25°$$

$$(R_A)_z = 1610.78 \text{ lb}$$

$$\therefore \ R_A = -(1868.82 \text{ lb})\mathbf{j} + (1610.78 \text{ lb})\mathbf{k}$$

Then:

$$R_A = 2467.2 \text{ lb} \qquad R_A = 2.47 \text{ kips} ◀$$

PROBLEM 2.98 CONTINUED

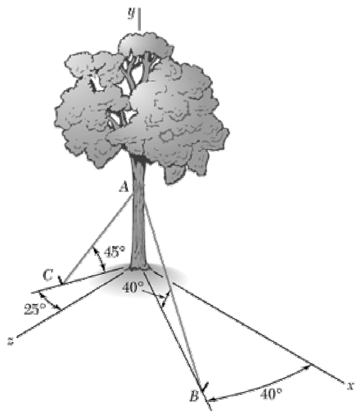
and

$$\cos\theta_x = \frac{0}{2467.2} = 0 \qquad \theta_x = 90.0° \blacktriangleleft$$

$$\cos\theta_y = \frac{-1868.82}{2467.2} = -0.7560 \qquad \theta_y = 139.2° \blacktriangleleft$$

$$\cos\theta_z = \frac{1610.78}{2467.2} = 0.65288 \qquad \theta_z = 49.2° \blacktriangleleft$$

PROBLEM 2.99



To stabilize a tree partially uprooted in a storm, cables *AB* and *AC* are attached to the upper trunk of the tree and then are fastened to steel rods anchored in the ground. Knowing that the tension in *AC* is 850 lb and that the resultant of the forces exerted at *A* by cables *AB* and *AC* lies in the *yz* plane, determine (*a*) the tension in *AB*, (*b*) the magnitude and direction of the resultant of the two forces.

SOLUTION

Have

$$\mathbf{T}_{AB} = T_{AB}\left(\sin 50^\circ \cos 40^\circ \mathbf{i} - \cos 50^\circ \mathbf{j} + \sin 50^\circ \sin 40^\circ \mathbf{j}\right)$$

$$\mathbf{T}_{AC} = (850 \text{ lb})\left(-\cos 45^\circ \sin 25^\circ \mathbf{i} - \sin 45^\circ \mathbf{j} + \cos 45^\circ \cos 25^\circ \mathbf{j}\right)$$

(*a*)

$$(R_A)_x = 0$$

$$\therefore \quad (R_A)_x = \Sigma F_x = 0: \quad T_{AB} \sin 50^\circ \cos 40^\circ - (850 \text{ lb})\cos 45^\circ \sin 25^\circ = 0$$

$$T_{AB} = 432.86 \text{ lb} \qquad\qquad T_{AB} = 433 \text{ lb} \blacktriangleleft$$

(*b*)

$$(R_A)_y = \Sigma F_y: \quad -(432.86 \text{ lb})\cos 50^\circ - (850 \text{ lb})\sin 45^\circ$$

$$(R_A)_y = -879.28 \text{ lb}$$

$$(R_A)_z = \Sigma F_z: \quad (432.86 \text{ lb})\sin 50^\circ \sin 40^\circ + (850 \text{ lb})\cos 45^\circ \cos 25^\circ$$

$$(R_A)_z = 757.87 \text{ lb}$$

$$\therefore \quad \mathbf{R}_A = -(879.28 \text{ lb})\mathbf{j} + (757.87 \text{ lb})\mathbf{k}$$

$$R_A = 1160.82 \text{ lb} \qquad\qquad R_A = 1.161 \text{ kips} \blacktriangleleft$$

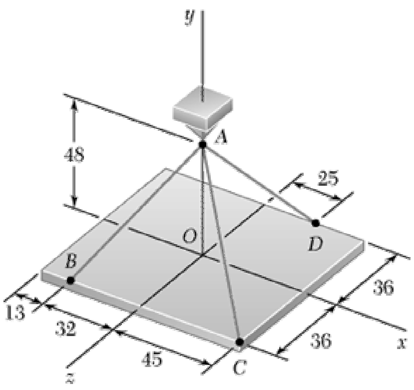
$$\cos\theta_x = \frac{0}{1160.82} = 0 \qquad\qquad \theta_x = 90.0^\circ \blacktriangleleft$$

$$\cos\theta_y = \frac{-879.28}{1160.82} = -0.75746 \qquad\qquad \theta_y = 139.2^\circ \blacktriangleleft$$

$$\cos\theta_z = \frac{757.87}{1160.82} = 0.65287 \qquad\qquad \theta_z = 49.2^\circ \blacktriangleleft$$

PROBLEM 2.100

For the plate of Problem 2.89, determine the tension in cables *AB* and *AD* knowing that the tension if cable *AC* is 27 lb and that the resultant of the forces exerted by the three cables at *A* must be vertical.



Dimensions in inches

SOLUTION

With:

$$\overrightarrow{AC} = (45\text{ in.})\mathbf{i} - (48\text{ in.})\mathbf{j} + (36\text{ in.})\mathbf{k}$$

$$AC = \sqrt{(45\text{ in.})^2 + (-48\text{ in.})^2 + (36\text{ in.})^2} = 75\text{ in.}$$

$$\mathbf{T}_{AC} = T_{AC}\lambda_{AC} = T_{AC}\frac{\overrightarrow{AC}}{AC} = \frac{27\text{ lb}}{75\text{ in.}}\left[(45\text{ in.})\mathbf{i} - (48\text{ in.})\mathbf{j} + (36\text{ in.})\mathbf{k}\right]$$

$$\mathbf{T}_{AC} = (16.2\text{ lb})\mathbf{i} - (17.28\text{ lb})\mathbf{j} + (12.96)\mathbf{k}$$

and

$$\overrightarrow{AB} = -(32\text{ in.})\mathbf{i} - (48\text{ in.})\mathbf{j} + (36\text{ in.})\mathbf{k}$$

$$AB = \sqrt{(-32\text{ in.})^2 + (-48\text{ in.})^2 + (36\text{ in.})^2} = 68\text{ in.}$$

$$\mathbf{T}_{AB} = T_{AB}\lambda_{AB} = T_{AB}\frac{\overrightarrow{AB}}{AB} = \frac{T_{AB}}{68\text{ in.}}\left[(-32\text{ in.})\mathbf{i} - (48\text{ in.})\mathbf{j} + (36\text{ in.})\mathbf{k}\right]$$

$$\mathbf{T}_{AB} = T_{AB}\left(-0.4706\mathbf{i} - 0.7059\mathbf{j} + 0.5294\mathbf{k}\right)$$

and

$$\overrightarrow{AD} = (25\text{ in.})\mathbf{i} - (48\text{ in.})\mathbf{j} - (36\text{ in.})\mathbf{k}$$

$$AD = \sqrt{(25\text{ in.})^2 + (-48\text{ in.})^2 + (36\text{ in.})^2} = 65\text{ in.}$$

$$\mathbf{T}_{AD} = T_{AD}\lambda_{AD} = T_{AD}\frac{\overrightarrow{AD}}{AD} = \frac{T_{AD}}{65\text{ in.}}\left[(25\text{ in.})\mathbf{i} - (48\text{ in.})\mathbf{j} - (36\text{ in.})\mathbf{k}\right]$$

$$\mathbf{T}_{AD} = T_{AD}\left(0.3846\mathbf{i} - 0.7385\mathbf{j} - 0.5538\mathbf{k}\right)$$

PROBLEM 2.100 CONTINUED

Now

$$\mathbf{R} = \mathbf{T}_{AB} + \mathbf{T}_{AD} + \mathbf{T}_{AD}$$

$$= T_{AB}\left(-0.4706\mathbf{i} - 0.7059\mathbf{j} + 0.5294\mathbf{k}\right) + \left[\left(16.2\text{ lb}\right)\mathbf{i} - \left(17.28\text{ lb}\right)\mathbf{j} + \left(12.96\right)\mathbf{k}\right]$$

$$+ T_{AD}\left(0.3846\mathbf{i} - 0.7385\mathbf{j} - 0.5538\mathbf{k}\right)$$

Since R must be vertical, the **i** and **k** components of this sum must be zero.

Hence:

$$-0.4706T_{AB} + 0.3846T_{AD} + 16.2\text{ lb} = 0 \qquad (1)$$

$$0.5294T_{AB} - 0.5538T_{AD} + 12.96\text{ lb} = 0 \qquad (2)$$

Solving (1) and (2), we obtain:

$$T_{AB} = 244.79\text{ lb}, \qquad T_{AD} = 257.41\text{ lb}$$

$T_{AB} = 245\text{ lb}$ ◀

$T_{AD} = 257\text{ lb}$ ◀