PROBLEM 2.75

The angle between the spring AB and the post DA is 30°. Knowing that the tension in the spring is 220 N, determine (*a*) the x, y, and z components of the force exerted by this spring on the plate, (*b*) the angles θ_x, θ_y, and θ_z that the force forms with the coordinate axes.

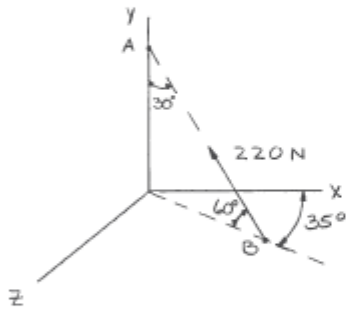
SOLUTION

(*a*)

$$F_x = -(220\text{ N})\cos 60^\circ \cos 35^\circ$$

$$= -90.107\text{ N}$$

$$F_x = -90.1\text{ N} \blacktriangleleft$$



$$F_y = (220\text{ N})\sin 60^\circ$$

$$= 190.526\text{ N}$$

$$F_y = 190.5\text{ N} \blacktriangleleft$$

$$F_z = -(220\text{ N})\cos 60^\circ \sin 35^\circ$$

$$= -63.093\text{ N}$$

$$F_z = -63.1\text{ N} \blacktriangleleft$$

(*b*)

$$\cos\theta_x = \frac{-90.107\text{ N}}{220\text{ N}}$$

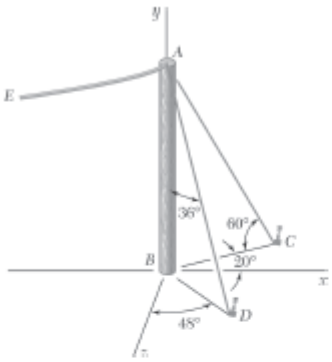
$$\theta_x = 114.2^\circ \blacktriangleleft$$

$$\cos\theta_y = \frac{190.526\text{ N}}{220\text{ N}}$$

$$\theta_y = 30.0^\circ \blacktriangleleft$$

$$\cos\theta_z = \frac{-63.093\text{ N}}{220\text{ N}}$$

$$\theta_z = 106.7^\circ \blacktriangleleft$$



PROBLEM 2.77

The end of the coaxial cable AE is attached to the pole AB, which is strengthened by the guy wires AC and AD. Knowing that the tension in wire AC is 120 N, determine (*a*) the components of the force exerted by this wire on the pole, (*b*) the angles θ_x, θ_y, and θ_z that the force forms with the coordinate axes.

SOLUTION

(*a*)

$$F_x = (120\text{ N})\cos 60^\circ \cos 20^\circ$$

$$F_x = 56.382\text{ N} \qquad F_x = +56.4\text{ N} \blacktriangleleft$$

$$F_y = -(120\text{ N})\sin 60^\circ$$

$$F_y = -103.923\text{ N} \qquad F_y = -103.9\text{ N} \blacktriangleleft$$

$$F_z = -(120\text{ N})\cos 60^\circ \sin 20^\circ$$

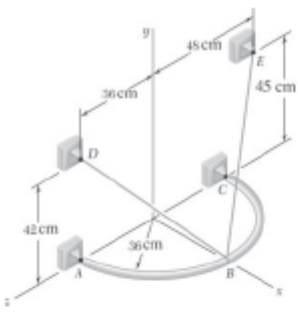
$$F_z = -20.521\text{ N} \qquad F_z = -20.5\text{ N} \blacktriangleleft$$

(*b*)

$$\cos\theta_x = \frac{F_x}{F} = \frac{56.382\text{ N}}{120\text{ N}} \qquad \theta_x = 62.0^\circ \blacktriangleleft$$

$$\cos\theta_y = \frac{F_y}{F} = \frac{-103.923\text{ N}}{120\text{ N}} \qquad \theta_y = 150.0^\circ \blacktriangleleft$$

$$\cos\theta_z = \frac{F_z}{F} = \frac{-20.52\text{ N}}{120\text{ N}} \qquad \theta_z = 99.8^\circ \blacktriangleleft$$



PROBLEM 2.86

A steel rod is bent into a semicircular ring of radius 36 cm and is supported in part by cables *BD* and *BE* which are attached to the ring at *B*. Knowing that the tension in cable *BE* is 60 N, determine the components of the force exerted by the cable on the support at *E*.

SOLUTION

$$\overrightarrow{EB} = (36\text{ cm})\mathbf{i} - (45\text{ cm})\mathbf{j} + (48\text{ cm})\mathbf{k}$$

$$EB = \sqrt{(36\text{ cm})^2 + (-45\text{ cm})^2 + (48\text{ cm})^2} = 75\text{ cm}$$

$$\mathbf{T}_{EB} = T_{EB}\boldsymbol{\lambda}_{EB} = T_{EB}\frac{\overrightarrow{EB}}{EB}$$

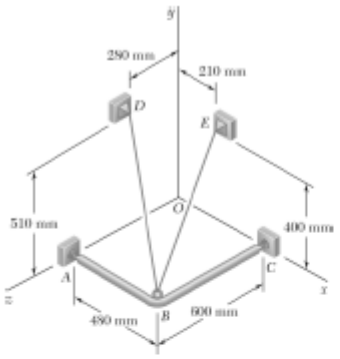
$$\mathbf{T}_{EB} = \frac{60\text{ N}}{75\text{ cm}}\left[(36\text{ cm})\mathbf{i} - (45\text{ cm})\mathbf{j} + (48\text{ cm})\mathbf{k}\right]$$

$$= (28.8\text{ N})\mathbf{i} - (36\text{ N})\mathbf{j} + (38.4\text{ N})\mathbf{k}$$

$$\therefore (T_{EB})_x = 28.8\text{ N} \blacktriangleleft$$

$$(T_{EB})_y = -36.0\text{ N} \blacktriangleleft$$

$$(T_{EB})_z = 38.4\text{ N} \blacktriangleleft$$



PROBLEM 2.89

A frame *ABC* is supported in part by cable *DBE* that passes through a frictionless ring at *B*. Knowing that the tension in the cable is 385 N, determine the components of the force exerted by the cable on the support at *D*.

SOLUTION

$$\overrightarrow{DB} = (480\text{ mm})\mathbf{i} - (510\text{ mm})\mathbf{j} + (320\text{ mm})\mathbf{k}$$

$$DB = \sqrt{(480\text{ mm})^2 + (510\text{ mm}^2) + (320\text{ mm})^2}$$

$$= 770\text{ mm}$$

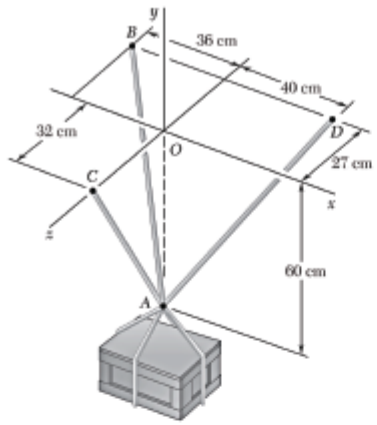
$$\mathbf{F} = F\boldsymbol{\lambda}_{DB}$$

$$= F\frac{\overrightarrow{DB}}{DB}$$

$$= \frac{385\text{ N}}{770\text{ mm}}[(480\text{ mm})\mathbf{i} - (510\text{ mm})\mathbf{j} + (320\text{ mm})\mathbf{k}]$$

$$= (240\text{ N})\mathbf{i} - (255\text{ N})\mathbf{j} + (160\text{ N})\mathbf{k}$$

$$F_x = +240\text{ N}, \quad F_y = -255\text{ N}, \quad F_z = +160.0\text{ N} \blacktriangleleft$$



PROBLEM 2.103

A crate is supported by three cables as shown. Determine the weight of the crate knowing that the tension in cable *AB* is 750 N.

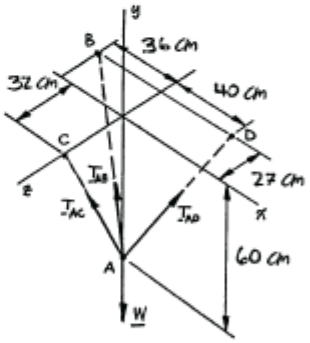
SOLUTION

The forces applied at *A* are:

$$\mathbf{T}_{AB}, \mathbf{T}_{AC}, \mathbf{T}_{AD} \text{ and } \mathbf{W}$$

where $\mathbf{W} = W\mathbf{j}$. To express the other forces in terms of the unit vectors **i**, **j**, **k**, we write

$$\overrightarrow{AB} = -(36\text{ cm})\mathbf{i} + (60\text{ cm})\mathbf{j} - (27\text{ cm})\mathbf{k}$$
$$AB = 75\text{ cm}$$
$$\overrightarrow{AC} = (60\text{ cm})\mathbf{j} + (32\text{ cm})\mathbf{k}$$
$$AC = 68\text{ cm}$$
$$\overrightarrow{AD} = (40\text{ cm})\mathbf{i} + (60\text{ cm})\mathbf{j} - (27\text{ cm})\mathbf{k}$$
$$AD = 77\text{ cm}$$



and

$$\mathbf{T}_{AB} = T_{AB}\boldsymbol{\lambda}_{AB} = T_{AB}\frac{\overrightarrow{AB}}{AB}$$
$$= (-0.48\mathbf{i} + 0.8\mathbf{j} - 0.36\mathbf{k})T_{AB}$$
$$\mathbf{T}_{AC} = T_{AC}\boldsymbol{\lambda}_{AC} = T_{AC}\frac{\overrightarrow{AC}}{AC}$$
$$= (0.88235\mathbf{j} + 0.47059\mathbf{k})T_{AC}$$
$$\mathbf{T}_{AD} = T_{AD}\boldsymbol{\lambda}_{AD} = T_{AD}\frac{\overrightarrow{AD}}{AD}$$
$$= (0.51948\mathbf{i} + 0.77922\mathbf{j} - 0.35065\mathbf{k})T_{AD}$$

Equilibrium Condition with $\mathbf{W} = -W\mathbf{j}$

$$\Sigma F = 0: \quad \mathbf{T}_{AB} + \mathbf{T}_{AC} + \mathbf{T}_{AD} - W\mathbf{j} = 0$$

PROBLEM 2.103 (Continued)

Substituting the expressions obtained for $\mathbf{T}_{AB}$, $\mathbf{T}_{AC}$, and $\mathbf{T}_{AD}$ and factoring **i**, **j**, and **k**:

$$(-0.48T_{AB} + 0.51948T_{AD})\mathbf{i} + (0.8T_{AB} + 0.88235T_{AC} + 0.77922T_{AD} - W)\mathbf{j}$$
$$+(-0.36T_{AB} + 0.47059T_{AC} - 0.35065T_{AD})\mathbf{k} = 0$$

Equating to zero the coefficients of **i**, **j**, **k**:

$$-0.48T_{AB} + 0.51948T_{AD} = 0 \quad (1)$$
$$0.8T_{AB} + 0.88235T_{AC} + 0.77922T_{AD} - W = 0 \quad (2)$$
$$-0.36T_{AB} + 0.47059T_{AC} - 0.35065T_{AD} = 0 \quad (3)$$

Substituting $T_{AB} = 750$ N in Equations (1), (2), and (3) and solving the resulting set of equations, using conventional algorithms for solving linear algebraic equations, gives:

$$T_{AC} = 1090.1\,\text{N}$$
$$T_{AD} = 693\,\text{N} \qquad W = 2102\,\text{N} \blacktriangleleft$$