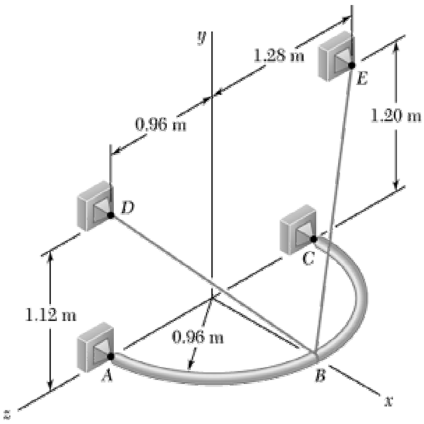


PROBLEM 2.92

A steel rod is bent into a semicircular ring of radius 0.96 m 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 250 N, determine the components of this force exerted by the cable on the support at *E*.

SOLUTION

$$\overrightarrow{EB} = (0.96 \text{ m})\mathbf{i} - (1.20 \text{ m})\mathbf{j} + (1.28 \text{ m})\mathbf{k}$$

$$EB = \sqrt{(0.96 \text{ m})^2 + (-1.20 \text{ m})^2 + (1.28 \text{ m})^2} = 2.00 \text{ m}$$

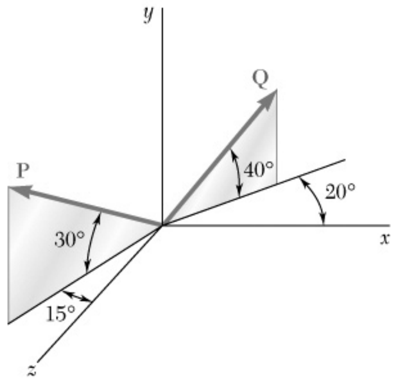
$$\mathbf{T}_{EB} = T\boldsymbol{\lambda}_{EB} = T\frac{\overrightarrow{EB}}{EB} = \frac{250 \text{ N}}{2.00 \text{ m}}\left[(0.96 \text{ m})\mathbf{i} - (1.20 \text{ m})\mathbf{j} + (1.28 \text{ m})\mathbf{k}\right]$$

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

$$(T_{EB})_x = +120.0 \text{ N}, \ (T_{EB})_y = -150.0 \text{ N}, \ (T_{EB})_z = +160.0 \text{ N} \blacktriangleleft$$

PROBLEM 2.93

Find the magnitude and direction of the resultant of the two forces shown knowing that $P = 500$ N and $Q = 600$ N.



SOLUTION

$$\mathbf{P} = (500 \text{ lb})[-\cos 30° \sin 15° \mathbf{i} + \sin 30° \mathbf{j} + \cos 30° \cos 15° \mathbf{k}]$$

$$= (500 \text{ lb})[-0.2241\mathbf{i} + 0.50\mathbf{j} + 0.8365\mathbf{k}]$$

$$= -(112.05 \text{ lb})\mathbf{i} + (250 \text{ lb})\mathbf{j} + (418.25 \text{ lb})\mathbf{k}$$

$$\mathbf{Q} = (600 \text{ lb})[\cos 40° \cos 20° \mathbf{i} + \sin 40° \mathbf{j} - \cos 40° \sin 20° \mathbf{k}]$$

$$= (600 \text{ lb})[0.71985\mathbf{i} + 0.64278\mathbf{j} - 0.26201\mathbf{k}]$$

$$= (431.91 \text{ lb})\mathbf{i} + (385.67 \text{ lb})\mathbf{j} - (157.206 \text{ lb})\mathbf{k}$$

$$\mathbf{R} = \mathbf{P} + \mathbf{Q} = (319.86 \text{ lb})\mathbf{i} + (635.67 \text{ lb})\mathbf{j} + (261.04 \text{ lb})\mathbf{k}$$

$$R = \sqrt{(319.86 \text{ lb})^2 + (635.67 \text{ lb})^2 + (261.04 \text{ lb})^2} = 757.98 \text{ lb}$$

$R = 758$ lb ◀

$$\cos\theta_x = \frac{R_x}{R} = \frac{319.86 \text{ lb}}{757.98 \text{ lb}} = 0.42199$$

$\theta_x = 65.0°$ ◀

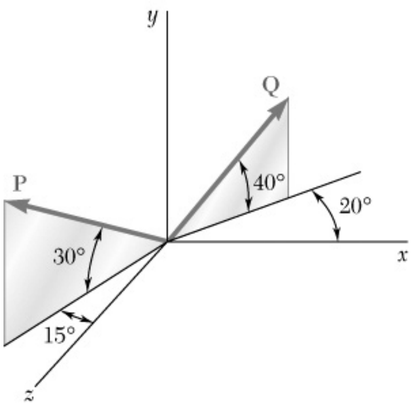
$$\cos\theta_y = \frac{R_y}{R} = \frac{635.67 \text{ lb}}{757.98 \text{ lb}} = 0.83864$$

$\theta_y = 33.0°$ ◀

$$\cos\theta_z = \frac{R_z}{R} = \frac{261.04 \text{ lb}}{757.98 \text{ lb}} = 0.34439$$

$\theta_z = 69.9°$ ◀

PROBLEM 2.94



Find the magnitude and direction of the resultant of the two forces shown knowing that $P = 600$ N and $Q = 400$ N.

SOLUTION

Using the results from 2.93:

$$\mathbf{P} = (600\text{ lb})[-0.2241\mathbf{i} + 0.50\mathbf{j} + 0.8365\mathbf{k}]$$

$$= -(134.46\text{ lb})\mathbf{i} + (300\text{ lb})\mathbf{j} + (501.9\text{ lb})\mathbf{k}$$

$$\mathbf{Q} = (400\text{ lb})[0.71985\mathbf{i} + 0.64278\mathbf{j} - 0.26201\mathbf{k}]$$

$$= (287.94\text{ lb})\mathbf{i} + (257.11\text{ lb})\mathbf{j} - (104.804\text{ lb})\mathbf{k}$$

$$\mathbf{R} = \mathbf{P} + \mathbf{Q} = (153.48\text{ lb})\mathbf{i} + (557.11\text{ lb})\mathbf{j} + (397.10\text{ lb})\mathbf{k}$$

$$R = \sqrt{(153.48\text{ lb})^2 + (557.11\text{ lb})^2 + (397.10\text{ lb})^2} = 701.15\text{ lb}$$

$R = 701$ lb ◀

$$\cos\theta_x = \frac{R_x}{R} = \frac{153.48\text{ lb}}{701.15\text{ lb}} = 0.21890$$

$\theta_x = 77.4°$ ◀

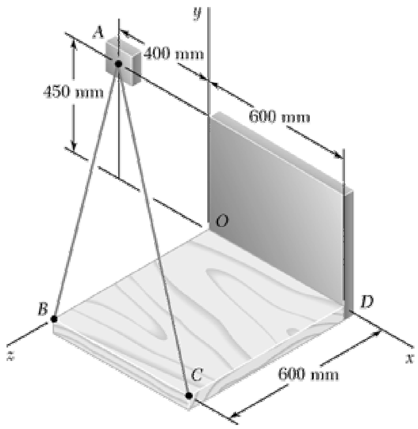
$$\cos\theta_y = \frac{R_y}{R} = \frac{557.11\text{ lb}}{701.15\text{ lb}} = 0.79457$$

$\theta_y = 37.4°$ ◀

$$\cos\theta_z = \frac{R_z}{R} = \frac{397.10\text{ lb}}{701.15\text{ lb}} = 0.56637$$

$\theta_z = 55.5°$ ◀

PROBLEM 2.95



Knowing that the tension is 850 N in cable *AB* and 1020 N in cable *AC*, determine the magnitude and direction of the resultant of the forces exerted at *A* by the two cables.

SOLUTION

$$\overrightarrow{AB} = (400 \text{ mm})\mathbf{i} - (450 \text{ mm})\mathbf{j} + (600 \text{ mm})\mathbf{k}$$

$$AB = \sqrt{(400 \text{ mm})^2 + (-450 \text{ mm})^2 + (600 \text{ mm})^2} = 850 \text{ mm}$$

$$\overrightarrow{AC} = (1000 \text{ mm})\mathbf{i} - (450 \text{ mm})\mathbf{j} + (600 \text{ mm})\mathbf{k}$$

$$AC = \sqrt{(1000 \text{ mm})^2 + (-450 \text{ mm})^2 + (600 \text{ mm})^2} = 1250 \text{ mm}$$

$$\mathbf{T}_{AB} = T_{AB}\boldsymbol{\lambda}_{AB} = T_{AB}\frac{\overrightarrow{AB}}{AB} = (850 \text{ N})\left[\frac{(400 \text{ mm})\mathbf{i} - (450 \text{ mm})\mathbf{j} + (600 \text{ mm})\mathbf{k}}{850 \text{ mm}}\right]$$

$$\mathbf{T}_{AB} = (400 \text{ N})\mathbf{i} - (450 \text{ N})\mathbf{j} + (600 \text{ N})\mathbf{k}$$

$$\mathbf{T}_{AC} = T_{AC}\boldsymbol{\lambda}_{AC} = T_{AC}\frac{\overrightarrow{AC}}{AC} = (1020 \text{ N})\left[\frac{(1000 \text{ mm})\mathbf{i} - (450 \text{ mm})\mathbf{j} + (600 \text{ mm})\mathbf{k}}{1250 \text{ mm}}\right]$$

$$\mathbf{T}_{AC} = (816 \text{ N})\mathbf{i} - (367.2 \text{ N})\mathbf{j} + (489.6 \text{ N})\mathbf{k}$$

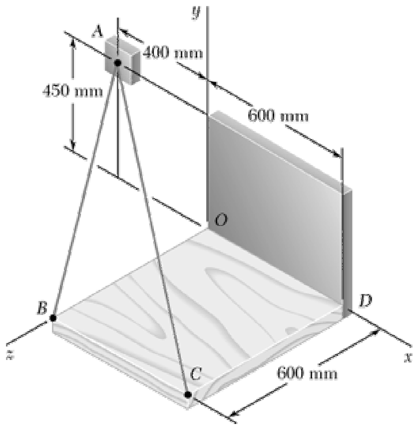
$$\mathbf{R} = \mathbf{T}_{AB} + \mathbf{T}_{AC} = (1216 \text{ N})\mathbf{i} - (817.2 \text{ N})\mathbf{j} + (1089.6 \text{ N})\mathbf{k}$$

Then: $R = 1825.8 \text{ N}$ $\quad R = 1826 \text{ N}$ ◀

and $\cos\theta_x = \dfrac{1216}{1825.8} = 0.66601$ $\quad \theta_x = 48.2°$ ◀

$\cos\theta_y = \dfrac{-817.2}{1825.8} = -0.44758$ $\quad \theta_y = 116.6°$ ◀

$\cos\theta_z = \dfrac{1089.6}{1825.8} = 0.59678$ $\quad \theta_z = 53.4°$ ◀



PROBLEM 2.96

Assuming that in Problem 2.95 the tension is 1020 N in cable *AB* and 850 N in cable *AC*, determine the magnitude and direction of the resultant of the forces exerted at *A* by the two cables.

SOLUTION

$$\overrightarrow{AB} = (400\text{ mm})\mathbf{i} - (450\text{ mm})\mathbf{j} + (600\text{ mm})\mathbf{k}$$

$$AB = \sqrt{(400\text{ mm})^2 + (-450\text{ mm})^2 + (600\text{ mm})^2} = 850\text{ mm}$$

$$\overrightarrow{AC} = (1000\text{ mm})\mathbf{i} - (450\text{ mm})\mathbf{j} + (600\text{ mm})\mathbf{k}$$

$$AC = \sqrt{(1000\text{ mm})^2 + (-450\text{ mm})^2 + (600\text{ mm})^2} = 1250\text{ mm}$$

$$\mathbf{T}_{AB} = T_{AB}\boldsymbol{\lambda}_{AB} = T_{AB}\frac{\overrightarrow{AB}}{AB} = (1020\text{ N})\left[\frac{(400\text{ mm})\mathbf{i} - (450\text{ mm})\mathbf{j} + (600\text{ mm})\mathbf{k}}{850\text{ mm}}\right]$$

$$\mathbf{T}_{AB} = (480\text{ N})\mathbf{i} - (540\text{ N})\mathbf{j} + (720\text{ N})\mathbf{k}$$

$$\mathbf{T}_{AC} = T_{AC}\boldsymbol{\lambda}_{AC} = T_{AC}\frac{\overrightarrow{AC}}{AC} = (850\text{ N})\left[\frac{(1000\text{ mm})\mathbf{i} - (450\text{ mm})\mathbf{j} + (600\text{ mm})\mathbf{k}}{1250\text{ mm}}\right]$$

$$\mathbf{T}_{AC} = (680\text{ N})\mathbf{i} - (306\text{ N})\mathbf{j} + (408\text{ N})\mathbf{k}$$

$$\mathbf{R} = \mathbf{T}_{AB} + \mathbf{T}_{AC} = (1160\text{ N})\mathbf{i} - (846\text{ N})\mathbf{j} + (1128\text{ N})\mathbf{k}$$

Then: $R = 1825.8\text{ N}$ $\quad R = 1826\text{ N}$ ◀

and $\cos\theta_x = \dfrac{1160}{1825.8} = 0.6353$ $\quad \theta_x = 50.6°$ ◀

$\cos\theta_y = \dfrac{-846}{1825.8} = -0.4634$ $\quad \theta_y = 117.6°$ ◀

$\cos\theta_z = \dfrac{1128}{1825.8} = 0.6178$ $\quad \theta_z = 51.8°$ ◀