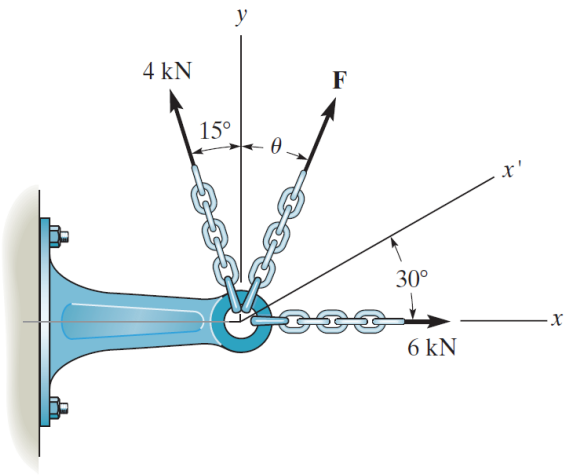
Problem 2-58

Three forces act on the bracket. Determine the magnitude and direction θ of $\mathbf{F}$ so that the resultant force is directed along the positive x' axis and has a magnitude of 8 kN.



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Solution

Write each of the forces in component form.

$$\mathbf{F}_1 = 4\,\langle -\sin 15°, \cos 15°\rangle \text{ kN}$$

$$\mathbf{F}_2 = 6\,\langle 1, 0\rangle \text{ kN}$$

$$\mathbf{F} = F\,\langle \sin\theta, \cos\theta\rangle \text{ kN}$$

$$\mathbf{F}_R = 8\,\langle \cos 30°, \sin 30°\rangle \text{ kN}$$

Add them together to get the resultant force.

$$\mathbf{F}_R = \mathbf{F}_1 + \mathbf{F}_2 + \mathbf{F}$$

$$\langle 8\cos 30°, 8\sin 30°\rangle \text{ kN} = \langle -4\sin 15° + 6 + F\sin\theta, 4\cos 15° + F\cos\theta\rangle \text{ kN}$$

Match the components to get a system of equations.

$$8\cos 30° = -4\sin 15° + 6 + F\sin\theta$$

$$8\sin 30° = 4\cos 15° + F\cos\theta$$

Solve this second equation for F

$$F = \frac{8\sin 30° - 4\cos 15°}{\cos\theta}$$

and substitute it into the first equation.

$$8\cos 30^\circ = -4\sin 15^\circ + 6 + \left(\frac{8\sin 30^\circ - 4\cos 15^\circ}{\cos\theta}\right)\sin\theta$$

$$8\cos 30^\circ = -4\sin 15^\circ + 6 + (8\sin 30^\circ - 4\cos 15^\circ)\tan\theta$$

$$\tan\theta = \frac{8\cos 30^\circ + 4\sin 15^\circ - 6}{8\sin 30^\circ - 4\cos 15^\circ}$$

$$\theta \approx 86.0^\circ$$

Plug this value of θ into the formula for F.

$$F = \frac{8\sin 30^\circ - 4\cos 15^\circ}{\cos\theta} \approx 1.97 \text{ kN}$$