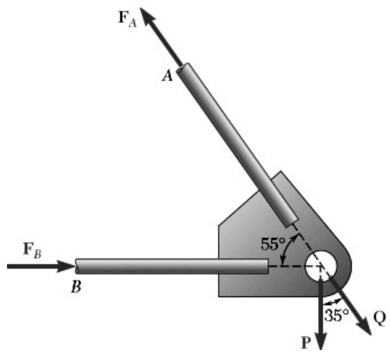
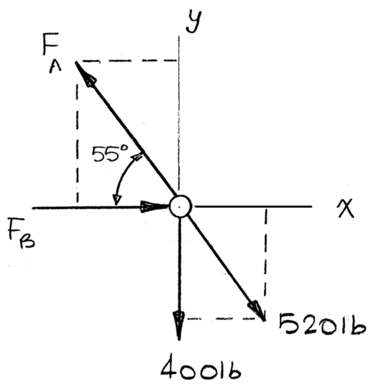
PROBLEM 2.51



Two forces **P** and **Q** are applied as shown to an aircraft connection. Knowing that the connection is in equilibrium and the $P = 400$ lb and $Q = 520$ lb, determine the magnitudes of the forces exerted on the rods A and B.

SOLUTION

Free-Body Diagram



Resolving the forces into x and y directions:

$$\mathbf{R} = \mathbf{P} + \mathbf{Q} + \mathbf{F}_A + \mathbf{F}_B = 0$$

Substituting components:

$$\mathbf{R} = -(400\text{ lb})\mathbf{j} + \left[(520\text{ lb})\cos 55°\right]\mathbf{i} - \left[(520\text{ lb})\sin 55°\right]\mathbf{j}$$

$$+ F_B\mathbf{i} - (F_A\cos 55°)\mathbf{i} + (F_A\sin 55°)\mathbf{j} = 0$$

In the y-direction (one unknown force)

$$-400\text{ lb} - (520\text{ lb})\sin 55° + F_A\sin 55° = 0$$

Thus,

$$F_A = \frac{400\text{ lb} + (520\text{ lb})\sin 55°}{\sin 55°} = 1008.3\text{ lb}$$

$F_A = 1008$ lb ◀

In the x-direction:

$$(520\text{ lb})\cos 55° + F_B - F_A\cos 55° = 0$$

Thus,

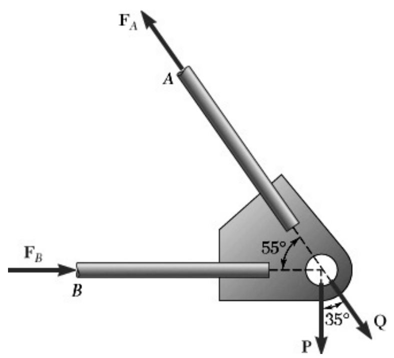
$$F_B = F_A\cos 55° - (520\text{ lb})\cos 55°$$

$$= (1008.3\text{ lb})\cos 55° - (520\text{ lb})\cos 55°$$

$$= 280.08\text{ lb}$$

$F_B = 280$ lb ◀

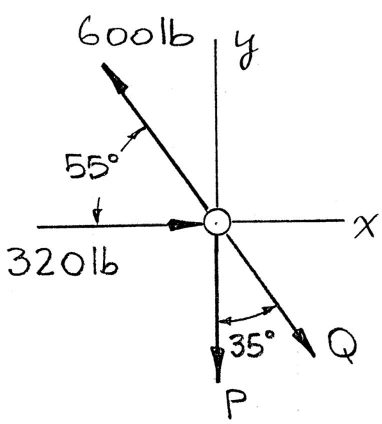
PROBLEM 2.52



Two forces **P** and **Q** are applied as shown to an aircraft connection. Knowing that the connection is in equilibrium and that the magnitudes of the forces exerted on rods A and B are $F_A = 600$ lb and $F_B = 320$ lb, determine the magnitudes of **P** and **Q**.

SOLUTION

Free-Body Diagram



Resolving the forces into x and y directions:

$$\mathbf{R} = \mathbf{P} + \mathbf{Q} + \mathbf{F}_A + \mathbf{F}_B = 0$$

Substituting components:

$$\mathbf{R} = (320 \text{ lb})\mathbf{i} - \left[(600 \text{ lb})\cos 55°\right]\mathbf{i} + \left[(600 \text{ lb})\sin 55°\right]\mathbf{j}$$

$$+ P\mathbf{i} + (Q\cos 55°)\mathbf{i} - (Q\sin 55°)\mathbf{j} = 0$$

In the x-direction (one unknown force)

$$320 \text{ lb} - (600 \text{ lb})\cos 55° + Q\cos 55° = 0$$

Thus,

$$Q = \frac{-320 \text{ lb} + (600 \text{ lb})\cos 55°}{\cos 55°} = 42.09 \text{ lb}$$

$Q = 42.1$ lb ◀

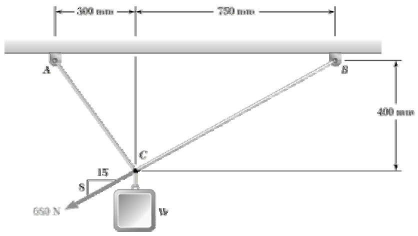
In the y-direction:

$$(600 \text{ lb})\sin 55° - P - Q\sin 55° = 0$$

Thus,

$$P = (600 \text{ lb})\sin 55° - Q\sin 55° = 457.01 \text{ lb}$$

$P = 457$ lb ◀

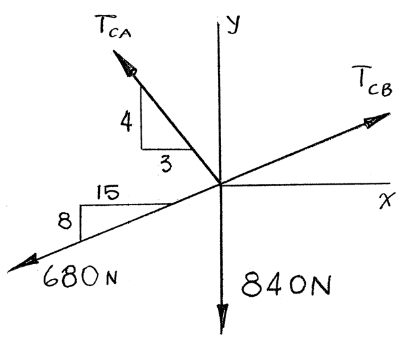


PROBLEM 2.53

Two cables tied together at C are loaded as shown. Knowing that $W = 840$ N, determine the tension (*a*) in cable AC, (*b*) in cable BC.

SOLUTION

Free-Body Diagram



From geometry:

The sides of the triangle with hypotenuse CB are in the ratio 8:15:17.

The sides of the triangle with hypotenuse CA are in the ratio 3:4:5.

Thus:

$$\xrightarrow{+} \Sigma F_x = 0: \quad -\frac{3}{5}T_{CA} + \frac{15}{17}T_{CB} - \frac{15}{17}(680 \text{ N}) = 0$$

or

$$-\frac{1}{5}T_{CA} + \frac{5}{17}T_{CB} = 200 \text{ N} \qquad (1)$$

and

$$+\uparrow \Sigma F_y = 0: \quad \frac{4}{5}T_{CA} + \frac{8}{17}T_{CB} - \frac{8}{17}(680 \text{ N}) - 840 \text{ N} = 0$$

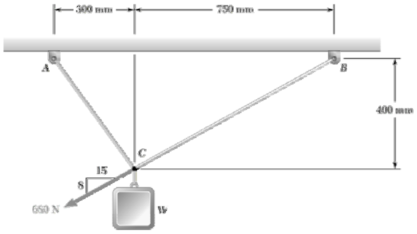
or

$$\frac{1}{5}T_{CA} + \frac{2}{17}T_{CB} = 290 \text{ N} \qquad (2)$$

Solving Equations (1) and (2) simultaneously:

(*a*) $T_{CA} = 750$ N ◀

(*b*) $T_{CB} = 1190$ N ◀

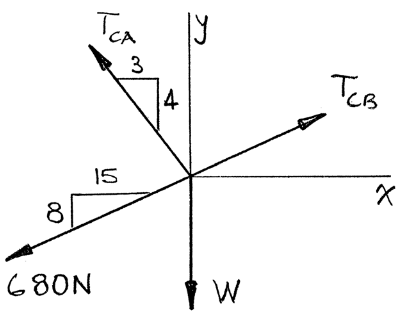


PROBLEM 2.54

Two cables tied together at C are loaded as shown. Determine the range of values of W for which the tension will not exceed 1050 N in either cable.

SOLUTION

Free-Body Diagram



From geometry:

The sides of the triangle with hypotenuse CB are in the ratio 8:15:17.

The sides of the triangle with hypotenuse CA are in the ratio 3:4:5.

Thus:

$$\xrightarrow{+} \Sigma F_x = 0: \quad -\frac{3}{5}T_{CA} + \frac{15}{17}T_{CB} - \frac{15}{17}(680 \text{ N}) = 0$$

or

$$-\frac{1}{5}T_{CA} + \frac{5}{17}T_{CB} = 200 \text{ N} \tag{1}$$

and

$$+\uparrow \Sigma F_y = 0: \quad \frac{4}{5}T_{CA} + \frac{8}{17}T_{CB} - \frac{8}{17}(680 \text{ N}) - W = 0$$

or

$$\frac{1}{5}T_{CA} + \frac{2}{17}T_{CB} = 80 \text{ N} + \frac{1}{4}W \tag{2}$$

Then, from Equations (1) and (2)

$$T_{CB} = 680 \text{ N} + \frac{17}{28}W$$

$$T_{CA} = \frac{25}{28}W$$

Now, with $T \leq 1050$ N

$$T_{CA}: \quad T_{CA} = 1050 \text{ N} = \frac{25}{28}W$$

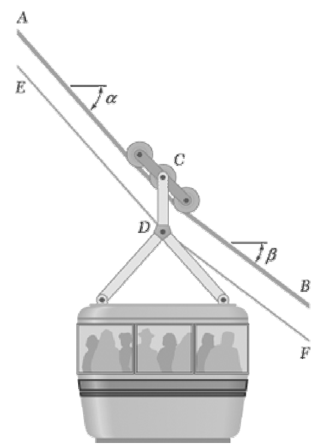
or $\qquad W = 1176 \text{ N}$

and

$$T_{CB}: \quad T_{CB} = 1050 \text{ N} = 680 \text{ N} + \frac{17}{28}W$$

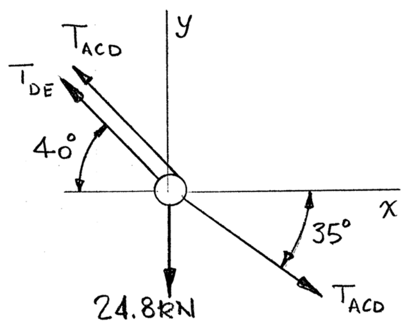
or $\qquad W = 609 \text{ N} \qquad \therefore\ 0 \leq W \leq 609 \text{ N}$ ◀

PROBLEM 2.55



The cabin of an aerial tramway is suspended from a set of wheels that can roll freely on the support cable ACB and is being pulled at a constant speed by cable DE. Knowing that $\alpha = 40°$ and $\beta = 35°$, that the combined weight of the cabin, its support system, and its passengers is 24.8 kN, and assuming the tension in cable DF to be negligible, determine the tension (*a*) in the support cable ACB, (*b*) in the traction cable DE.

SOLUTION



Note: In Problems 2.55 and 2.56 the cabin is considered as a particle. If considered as a rigid body (Chapter 4) it would be found that its center of gravity should be located to the left of the centerline for the line CD to be vertical.

Now

$$\xrightarrow{+} \Sigma F_x = 0: \quad T_{ACB}\left(\cos 35° - \cos 40°\right) - T_{DE}\cos 40° = 0$$

or

$$0.0531T_{ACB} - 0.766T_{DE} = 0 \tag{1}$$

and

$$+\uparrow \Sigma F_y = 0: \quad T_{ACB}\left(\sin 40° - \sin 35°\right) + T_{DE}\sin 40° - 24.8\text{ kN} = 0$$

or

$$0.0692T_{ACB} + 0.643T_{DE} = 24.8\text{ kN} \tag{2}$$

From (1)

$$T_{ACB} = 14.426T_{DE}$$

Then, from (2)

$$0.0692\left(14.426T_{DE}\right) + 0.643T_{DE} = 24.8\text{ kN}$$

and

(*b*) $T_{DE} = 15.1\text{ kN}$ ◀

(*a*) $T_{ACB} = 218\text{ kN}$ ◀