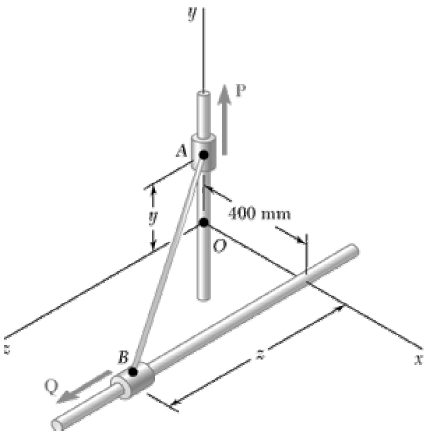
PROBLEM 2.128



Solve Problem 2.127 assuming $y = 550$ mm.

Problem 2.127: Collars *A* and *B* are connected by a 1-m-long wire and can slide freely on frictionless rods. If a force $\mathbf{P} = (680\text{ N})\mathbf{j}$ is applied at *A*, determine (*a*) the tension in the wire when $y = 300$ mm, (*b*) the magnitude of the force **Q** required to maintain the equilibrium of the system.

SOLUTION

From the analysis of Problem 2.127, particularly the results:

$$y^2 + z^2 = 0.84\text{ m}^2$$

$$T_{AB} = \frac{680\text{ N}}{y}$$

$$Q = \frac{680\text{ N}}{y}z$$

With $y = 550\text{ mm} = 0.55\text{ m},$ we obtain:

$$z^2 = 0.84\text{ m}^2 - (0.55\text{ m})^2$$

$$\therefore\ z = 0.733\text{ m}$$

and

(*a*) $$T_{AB} = \frac{680\text{ N}}{0.55} = 1236.4\text{ N}$$

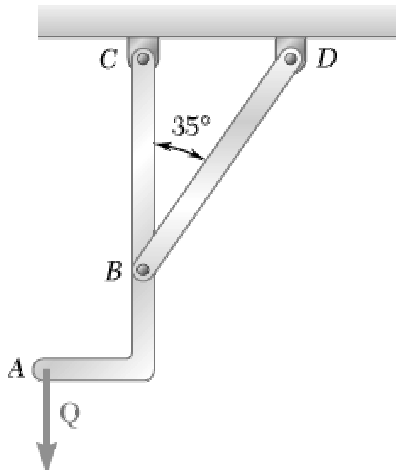
or $$T_{AB} = 1.236\text{ kN} \blacktriangleleft$$

and

(*b*) $$Q = 1236(0.866)\text{ N} = 906\text{ N}$$

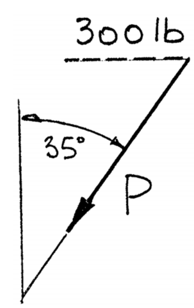
or $$Q = 0.906\text{ kN} \blacktriangleleft$$

PROBLEM 2.129



Member *BD* exerts on member *ABC* a force **P** directed along line *BD*. Knowing that **P** must have a 300-lb horizontal component, determine (*a*) the magnitude of the force **P**, (*b*) its vertical component.

SOLUTION



(*a*)

$$P \sin 35° = 300 \text{ lb}$$

$$P = \frac{300 \text{ lb}}{\sin 35°}$$

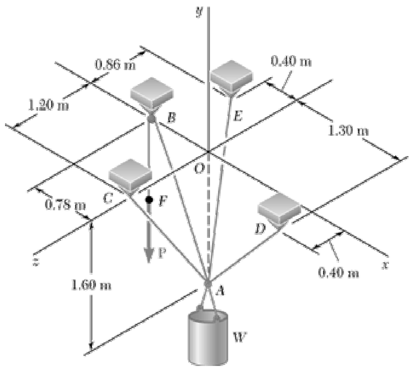
$$P = 523 \text{ lb} \blacktriangleleft$$

(*b*) Vertical Component

$$P_v = P \cos 35°$$

$$= (523 \text{ lb}) \cos 35°$$

$$P_v = 428 \text{ lb} \blacktriangleleft$$



PROBLEM 2.130

A container of weight W is suspended from ring A, to which cables AC and AE are attached. A force **P** is applied to the end F of a third cable which passes over a pulley at B and through ring A and which is attached to a support at D. Knowing that $W = 1000$ N, determine the magnitude of **P**. (*Hint:* The tension is the same in all portions of cable $FBAD$.)

SOLUTION

The (vector) force in each cable can be written as the product of the (scalar) force and the unit vector along the cable. That is, with

$$\overrightarrow{AB} = -(0.78\text{ m})\mathbf{i} + (1.6\text{ m})\mathbf{j} + (0\text{ m})\mathbf{k}$$

$$AB = \sqrt{(-0.78\text{ m})^2 + (1.6\text{ m})^2 + (0)^2} = 1.78\text{ m}$$

$$\mathbf{T}_{AB} = T\boldsymbol{\lambda}_{AB} = T_{AB}\frac{\overrightarrow{AB}}{AB} = \frac{T_{AB}}{1.78\text{ m}}\left[-(0.78\text{ m})\mathbf{i} + (1.6\text{ m})\mathbf{j} + (0\text{ m})\mathbf{k}\right]$$

$$\mathbf{T}_{AB} = T_{AB}(-0.4382\mathbf{i} + 0.8989\mathbf{j} + 0\mathbf{k})$$

and

$$\overrightarrow{AC} = (0)\mathbf{i} + (1.6\text{ m})\mathbf{j} + (1.2\text{ m})\mathbf{k}$$

$$AC = \sqrt{(0\text{ m})^2 + (1.6\text{ m})^2 + (1.2\text{ m})^2} = 2\text{ m}$$

$$\mathbf{T}_{AC} = T\boldsymbol{\lambda}_{AC} = T_{AC}\frac{\overrightarrow{AC}}{AC} = \frac{T_{AC}}{2\text{ m}}\left[(0)\mathbf{i} + (1.6\text{ m})\mathbf{j} + (1.2\text{ m})\mathbf{k}\right]$$

$$\mathbf{T}_{AC} = T_{AC}(0.8\mathbf{j} + 0.6\mathbf{k})$$

and

$$\overrightarrow{AD} = (1.3\text{ m})\mathbf{i} + (1.6\text{ m})\mathbf{j} + (0.4\text{ m})\mathbf{k}$$

$$AD = \sqrt{(1.3\text{ m})^2 + (1.6\text{ m})^2 + (0.4\text{ m})^2} = 2.1\text{ m}$$

$$\mathbf{T}_{AD} = T\boldsymbol{\lambda}_{AD} = T_{AD}\frac{\overrightarrow{AD}}{AD} = \frac{T_{AD}}{2.1\text{ m}}\left[(1.3\text{ m})\mathbf{i} + (1.6\text{ m})\mathbf{j} + (0.4\text{ m})\mathbf{k}\right]$$

$$\mathbf{T}_{AD} = T_{AD}(0.6190\mathbf{i} + 0.7619\mathbf{j} + 0.1905\mathbf{k})$$

PROBLEM 2.130 CONTINUED

Finally,

$$\overrightarrow{AE} = -(0.4\text{ m})\mathbf{i} + (1.6\text{ m})\mathbf{j} - (0.86\text{ m})\mathbf{k}$$

$$AE = \sqrt{(-0.4\text{ m})^2 + (1.6\text{ m})^2 + (-0.86\text{ m})^2} = 1.86\text{ m}$$

$$\mathbf{T}_{AE} = T\boldsymbol{\lambda}_{AE} = T_{AE}\frac{\overrightarrow{AE}}{AE} = \frac{T_{AE}}{1.86\text{ m}}\left[-(0.4\text{ m})\mathbf{i} + (1.6\text{ m})\mathbf{j} - (0.86\text{ m})\mathbf{k}\right]$$

$$\mathbf{T}_{AE} = T_{AE}(-0.2151\mathbf{i} + 0.8602\mathbf{j} - 0.4624\mathbf{k})$$

With the weight of the container $\mathbf{W} = -W\mathbf{j}$, at A we have:

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

Equating the factors of $\mathbf{i}$, $\mathbf{j}$, and $\mathbf{k}$ to zero, we obtain the following linear algebraic equations:

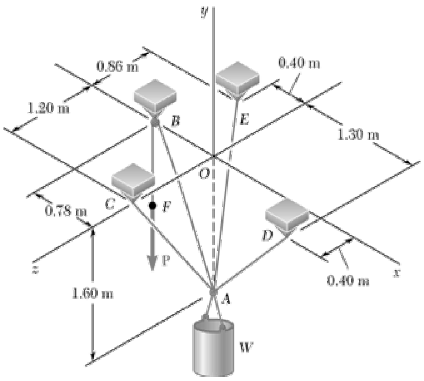
$$-0.4382T_{AB} + 0.6190T_{AD} - 0.2151T_{AE} = 0 \tag{1}$$

$$0.8989T_{AB} + 0.8T_{AC} + 0.7619T_{AD} + 0.8602T_{AE} - W = 0 \tag{2}$$

$$0.6T_{AC} + 0.1905T_{AD} - 0.4624T_{AE} = 0 \tag{3}$$

Knowing that $W = 1000\text{ N}$ and that because of the pulley system at B $T_{AB} = T_{AD} = P$, where P is the externally applied (unknown) force, we can solve the system of linear equations (1), (2) and (3) uniquely for P.

$P = 378\text{ N}$ ◀



PROBLEM 2.131

A container of weight W is suspended from ring A, to which cables AC and AE are attached. A force **P** is applied to the end F of a third cable which passes over a pulley at B and through ring A and which is attached to a support at D. Knowing that the tension in cable AC is 150 N, determine (*a*) the magnitude of the force **P**, (*b*) the weight W of the container. (*Hint:* The tension is the same in all portions of cable $FBAD$.)

SOLUTION

Here, as in Problem 2.130, the support of the container consists of the four cables AE, AC, AD, and AB, with the condition that the force in cables AB and AD is equal to the externally applied force P. Thus, with the condition

$$T_{AB} = T_{AD} = P$$

and using the linear algebraic equations of Problem 2.131 with $T_{AC} = 150$ N, we obtain

(*a*) $P = 454$ N ◀

(*b*) $W = 1202$ N ◀