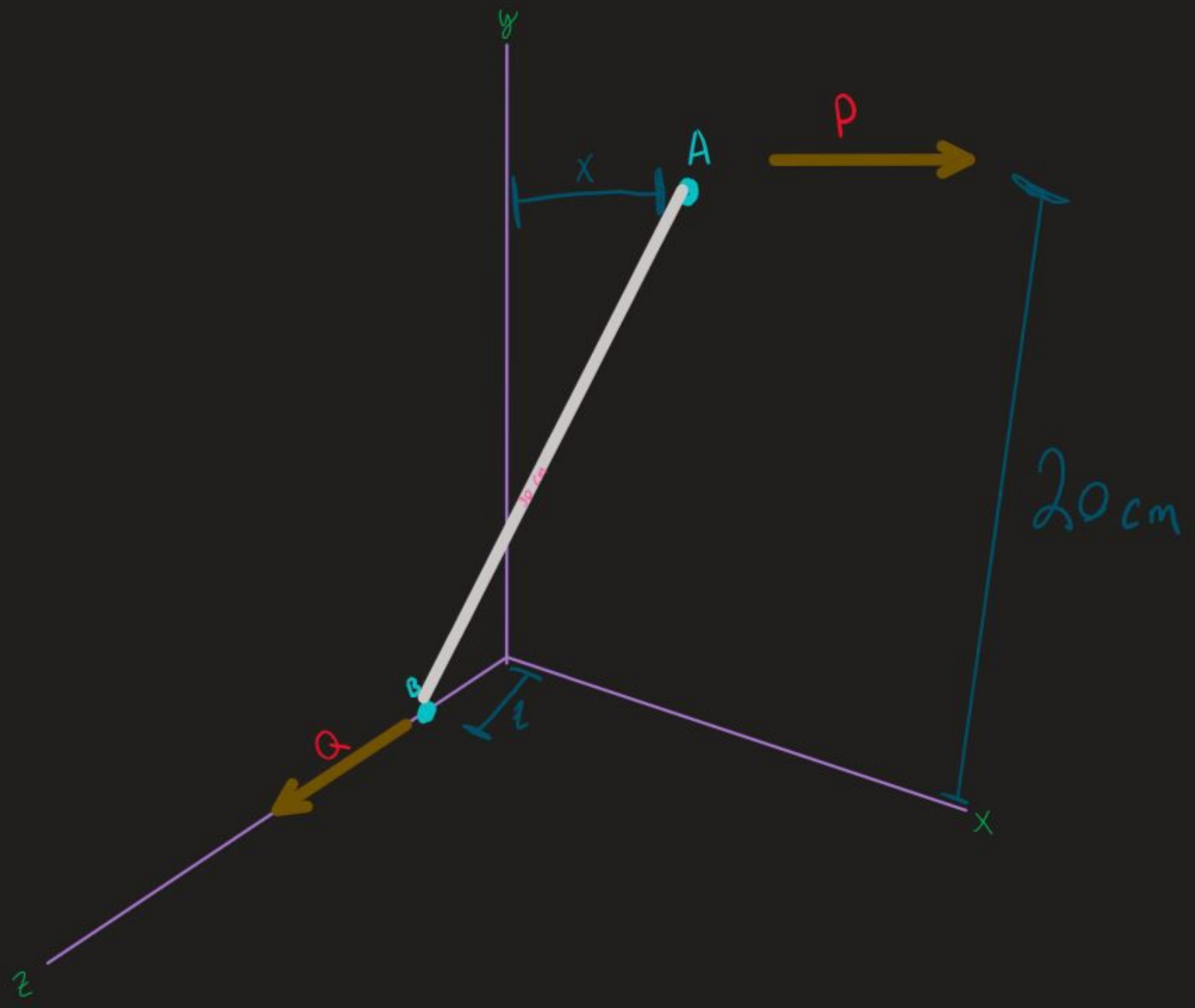
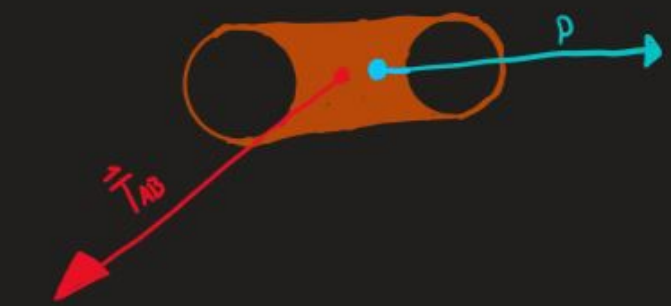
Diagram

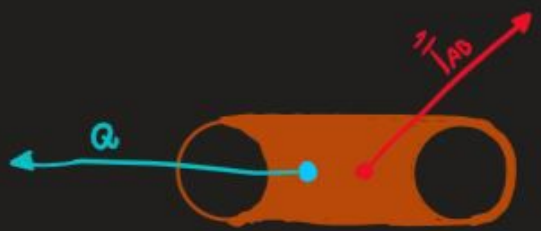


Free Body Diagrams

Collar A



Collar B



Knowns

$$A = \begin{pmatrix} x\hat{i} \\ 20\hat{j} \\ 0\hat{k} \end{pmatrix} \quad B = \begin{pmatrix} 0 \\ 0 \\ z\hat{k} \end{pmatrix}$$

$$\vec{AB} = \begin{pmatrix} 0 - x\hat{i} = -x\hat{i} \\ 0 - 20\hat{j} = -20\hat{j} \\ z\hat{k} - 0 = z\hat{k} \end{pmatrix}$$

$$\text{Unit vector of } \vec{AB} = \left(\frac{-x\hat{i} - 20\hat{j} + z\hat{k}}{30} \right)$$

$P = 100 \rightarrow$ Acting in the $\hat{i}$

$Q = 50 \rightarrow$ Acting in the $\hat{k}$

Relevant Equations

$$\vec{T}_{AB} = T_{AB}(\hat{u})$$

$$\sum F = 0 = \sum T_A + P + Q$$

$$F_x = \sum F_x \text{(components)}$$

$$F_y = \sum F_y \text{(components)}$$

$$F_z = \sum F_z \text{(components)} \qquad x^2 + y^2 + z^2 = T_A^2$$

Calculations

* remembering

$= P\hat{\imath} + Qz + T_{AB}\left(\frac{-x\hat{\imath} - 20\hat{\jmath} + z\hat{k}}{30}\right)$

Brokendown into further components.

x/ $P\hat{\imath} - T_{AB}\left(\frac{-x\hat{\imath}}{30}\right) = 0$ $\quad +T_{AB}\left(\frac{-x\hat{\imath}}{30}\right)$

$P\hat{\imath} = T_{AB}\left(\frac{-x\hat{\imath}}{30}\right)$

$100 = \frac{T_{AB}x}{30}$

$3000 = T_{AB}x$

z/ $Qz + T_{AB}\left(\frac{z\hat{k}}{30}\right) = 0$ $\quad -T_{AB}\left(\frac{z\hat{k}}{30}\right)$

$Qz = -\frac{T_{AB}z\hat{k}}{30}$

$50 = \frac{T_{AB}z\hat{k}}{30}$

$-1500 = T_{AB}z\hat{k}$

With the info I have now, I can get x in terms of z

$$\frac{T_{AB}\left(\frac{-x\hat{i}}{30}\right)}{T_{AB}\left(\frac{z\hat{k}}{30}\right)} = \frac{3000}{-1500}$$

$$\frac{-x}{z} = -2$$

$$\frac{-x}{-1} = \frac{-2z}{-1}$$

$$x = 2z$$

So..

$$x^2 + y^2 + z^2 = T_A^2$$

$$2z^2 - 20y^2 + z^2 = 30^2$$

$$4z^2 + 400 - 400 - 400 = 900 - 400$$

$$\frac{5z^2}{5} = \frac{500}{5}$$

$$\sqrt{z^2} = \sqrt{100}$$

$$z = 10$$

Since before

$x = 2z$

$x = 2(10)$ $\quad x = 20$

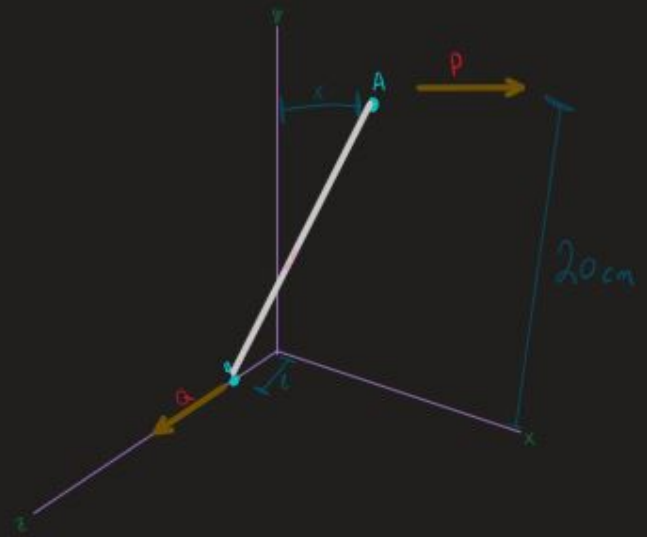
$\therefore$ $x = 20$, $y = -20$, $z = 10$

in cm

$\therefore$ $x = 20$, $y = -20$, $z = 10$

in cm

Diagram



Knowns

$$A = \begin{pmatrix} x\hat{i} \\ 20\hat{j} \\ 0\hat{k} \end{pmatrix} \quad B = \begin{pmatrix} 0 \\ 0 \\ z\hat{k} \end{pmatrix}$$

$$\vec{AB} = \begin{pmatrix} 0 - x\hat{i} = -x\hat{i} \\ 0 - 20\hat{j} = -20\hat{j} \\ z\hat{k} - 0 = z\hat{k} \end{pmatrix}$$

Unit vector of $\vec{AB} = \left(\frac{-x\hat{i} - 20\hat{j} + z\hat{k}}{30}\right)$

$P = 100 \rightarrow$ Acting in the $\hat{i}$

$Q = 50 \rightarrow$ Acting in the $\hat{k}$

Relevant Equations

$$\vec{T}_{AB} = T_{AB}(\vec{u})$$

$$\sum F = 0 = \sum T_{AB} + P + Q$$

$F_x = \sum F_x$ (components)

$F_y = \sum F_y$ (components)

$F_z = \sum F_z$ (components) $\quad x^2 + y^2 + z^2 = r_{AB}^2$

Calculations

*Remembering

$$= P\hat{i} + Q\hat{z} + T_{AB}\left(\frac{-x\hat{i} - 20\hat{j} + z\hat{k}}{30}\right)$$

→ Break down into further components

x: $P_x - T_{AB}\left(\frac{x}{30}\right) = 0$

$P_x = T_{AB}\left(\frac{x}{30}\right)$

$100 = \frac{T_{AB}x}{30}$

$3000 = T_{AB}x$

z: $Q_z + T_{AB}\left(\frac{z\hat{k}}{30}\right) = 0$

$Q_z = -\frac{T_{AB}z\hat{k}}{30}$

$50 = \frac{T_{AB}z\hat{k}}{30}$

$-1500 = T_{AB}z\hat{k}$

With the info I have now, I can get x in terms of z

$$\frac{T_{AB}\left(\frac{x}{30}\right)}{T_{AB}\left(\frac{z\hat{k}}{30}\right)} = \frac{3000}{-1500}$$

$\frac{x}{z} = -2$

$\frac{-x}{-1} = \frac{-2z}{-1}$

$x = 2z$

So..

$x^2 + y^2 + z^2 = r_{AB}^2$

$2z^2 - 20y^2 + z^2 = 30^2$

$4z^2 + 400 + z^2 = 900$

$\frac{5z^2}{5} = \frac{500}{5}$

$\sqrt{z^2} = \sqrt{100}$

$z = 10$

Since before $x = 2z$, $x = 2(10)$, $x = 20$

$x = 20$, $y = 20$, $z = 10$

Free Body Diagrams

Collar A

Collar B