Engineering Calculation Report: Problem 2-17

December 01, 2025

1 Known Variables

Vector	F_x (N)	F_y (N)	$\lvert\vec{F}\rvert$ (N)	θ (deg)	Reference
$\vec{F_1}$	-24.0	18.0	30.0	-36.9	-x
$\vec{F_2}$	-6.8	-18.8	20.0	-20.0	-y
$\vec{F_3}$	50.0	0.0	50.0	0.0	+x

2 Unknown Variables

Vector	F_x (N)	F_y (N)	$\lvert\vec{F}\rvert$ (N)	θ (deg)	Reference
$\vec{F_R}$	?	?	?	?	+x

3 Equations Used

1. $|F'|^2 = |\vec{F_1}|^2 + |\vec{F_2}|^2 + 2 \cdot |\vec{F_1}| \cdot |\vec{F_2}| \cdot \cos(\angle(\vec{F_1}, \vec{F_2}))$
2. $\dfrac{\sin(\angle(\vec{F_1}, \vec{F'}))}{|\vec{F_2}|} = \dfrac{\sin(\angle(\vec{F_1}, \vec{F_2}))}{|F'|}$
3. $|\vec{F_R}|^2 = |F'|^2 + |\vec{F_3}|^2 + 2 \cdot |F'| \cdot |\vec{F_3}| \cdot \cos(\angle(\vec{F'}, \vec{F_3}))$
4. $\dfrac{\sin(\angle(\vec{F'}, \vec{F_R}))}{|\vec{F_3}|} = \dfrac{\sin(\angle(\vec{F'}, \vec{F_3}))}{|\vec{F_R}|}$

4 Step-by-Step Solution

Step 1: Solve for $\angle(\vec{F_1}, \vec{F_2})$

$$\begin{aligned}
\angle(\vec{F_1}, \vec{F_2}) &= \angle(\vec{y}, \vec{F_1}) + |\angle(-\vec{y}, \vec{F_2})| \\
&= (90^\circ - |\angle(-\vec{x}, \vec{F_1})|) + 20^\circ \\
&= (90^\circ - 37^\circ) + 20^\circ \\
&= 53^\circ + 20^\circ \\
&= 73^\circ
\end{aligned}$$

Step 2: Solve for $|\vec{F'}|$ using Eq 1

$$\begin{aligned}|F'| &= \sqrt{(30.0)^2 + (20.0)^2 + 2(30.0)(20.0)\cos(73^\circ)} \\ &= 30.9 \text{ N}\end{aligned}$$

Step 3: Solve for $\angle(\vec{F_1}, \vec{F'})$ using Eq 2

$$\begin{aligned}\angle(\vec{F_1}, \vec{F'}) &= \sin^{-1}(20.0 \cdot \frac{\sin(73^\circ)}{30.9}) \\ &= 38.3^\circ\end{aligned}$$

Step 4: Solve for $\angle(\vec{x}, \vec{F'})$ with respect to +x

$$\begin{aligned}\angle(\vec{x}, \vec{F'}) &= \angle(\vec{x}, -\vec{x}) + \angle(-\vec{x}, \vec{F_1}) + \angle(\vec{F_1}, \vec{F'}) \\ &= 180.0^\circ + -36.9^\circ + 38.3^\circ \\ &= 181.5^\circ\end{aligned}$$

Step 5: Solve for $\angle(\vec{F'}, \vec{F_3})$

$$\begin{aligned}\angle(\vec{F'}, \vec{F_3}) &= |\angle(-\vec{x}, \vec{F'})| \\ &= |181^\circ - 180^\circ| \\ &= 1^\circ\end{aligned}$$

Step 6: Solve for $|\vec{F_R}|$ using Eq 3

$$\begin{aligned}|\vec{F_R}| &= \sqrt{(30.9)^2 + (50.0)^2 + 2(30.9)(50.0)\cos(1^\circ)} \\ &= 19.2 \text{ N}\end{aligned}$$

Step 7: Solve for $\angle(\vec{F'}, \vec{F_R})$ using Eq 4

$$\begin{aligned}\angle(\vec{F'}, \vec{F_R}) &= \sin^{-1}(50.0 \cdot \frac{\sin(1^\circ)}{19.2}) \\ &= 176.2^\circ\end{aligned}$$

Step 8: Solve for $\angle(\vec{x}, \vec{F_R})$ with respect to +x

$$\begin{aligned}\angle(\vec{x}, \vec{F_R}) &= \angle(\vec{x}, \vec{F'}) + \angle(\vec{F'}, \vec{F_R}) - 360^\circ \\ &= 181.5^\circ + 176.2^\circ - 360^\circ \\ &= -2.4^\circ\end{aligned}$$

5 Summary of Results

Vector	F_x (N)	F_y (N)	$\lvert\vec{F}\rvert$ (N)	θ (deg)	Reference
$\vec{F_R}$	19.2	-0.8	19.2	-2.4	+x

Disclaimer

While every effort has been made to ensure the accuracy and reliability of the calculations provided, we do not guarantee that the information is complete, up-to-date, or suitable for any specific purpose. Users must independently verify the results and assume full responsibility for any decisions or actions taken based on its output. Use of this calculator is entirely at your own risk, and we expressly disclaim any liability for errors or omissions in the information provided.

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