Engineering Calculation Report: Problem 2-14

November 30, 2025

1 Known Variables

Vector	F_a (lbf)	F_b (lbf)	$\lvert\vec{F}\rvert$ (lbf)	θ (deg)	Reference
$\vec{F_a}$	30.0	0.0	30.0	0.0	+a

2 Unknown Variables

Vector	F_a (lbf)	F_b (lbf)	$\lvert\vec{F}\rvert$ (lbf)	θ (deg)	Reference
$\vec{F}$	?	?	?	80.0	-b
$\vec{F_b}$	?	?	?	0.0	-b

3 Equations Used

1. $\dfrac{|\vec{F_b}|}{\sin(\angle(\vec{F_a}, \vec{F}))} = \dfrac{|\vec{F_a}|}{\sin(\angle(\vec{F_b}, \vec{F}))}$
2. $\dfrac{|\vec{F}|}{\sin(\angle(\vec{F_a}, \vec{F_b}))} = \dfrac{|\vec{F_a}|}{\sin(\angle(\vec{F_b}, \vec{F}))}$

4 Step-by-Step Solution

Step 1: Solve for triangle angles

$$\begin{aligned}
\angle(\vec{F_b}, \vec{F}) &= |\angle(-\vec{b}, \vec{F_b}) - \angle(-\vec{b}, \vec{F})| \\
&= |0^\circ - 80^\circ| \\
&= 80^\circ \\
\angle(\vec{F_a}, \vec{F}) &= \angle(\vec{a}, -\vec{b}) - |\angle(-\vec{b}, \vec{F})| \\
&= 140^\circ - 80^\circ \\
&= 60^\circ \\
\angle(\vec{F_a}, \vec{F_b}) &= 180^\circ - 80^\circ - 60^\circ \\
&= 40^\circ
\end{aligned}$$

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

$$|\vec{F}_b| = 30 \cdot \frac{\sin(60°)}{\sin(80°)}$$
$$= 26 \text{ lbf}$$

Step 3: Solve for $|\vec{F}|$ using Eq 2

$$|\vec{F}| = 30 \cdot \frac{\sin(40°)}{\sin(80°)}$$
$$= 20 \text{ lbf}$$

5 Summary of Results

Vector	F_a (lbf)	F_b (lbf)	$\lvert\vec{F}\rvert$ (lbf)	θ (deg)	Reference
$\vec{F}$	30.0	-26.4	19.6	80.0	-b
$\vec{F}_b$	0.0	-26.4	26.4	0.0	-b

Disclaimer

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