Resultants of Planar Forces
Example Problem
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Determine the resultant of the two forces acting on the eye-bolt using:
1. The parallelogram law
2. Summing scalar components

- Force 1: 8 kN at 60°
- Force 2: 10 kN in the y-direction
Use the Law of Cosines to find the magnitude of the resultant

\[ C^2 = A^2 + B^2 - 2AB \cos c \]

\[ R^2 = (10 \text{ kN})^2 + (8 \text{ kN})^2 - 2(10 \text{ kN})(8 \text{ kN}) \cos 60^\circ \]

\[ R = 9.17 \text{ kN} \]
Parallelogram Law/Triangle Rule

Force Triangle

**Use the Law of Sines to find the direction of the resultant**

\[
\frac{A}{\sin a} = \frac{C}{\sin c}
\]

\[
\frac{10 \text{ kN}}{\sin a} = \frac{9.17 \text{ kN}}{\sin 60°}
\]

\[
\sin a = \frac{(10 \text{ kN})(\sin 60°)}{9.17 \text{ kN}}
\]

\[
a = 70.8°
\]
Rectangular Force Components

Express 10 kN force in Cartesian Vector Form

\[ F_{10x} = (10 \text{ kN}) \cos 60^\circ = 5 \text{ kN} \]
\[ F_{10y} = (10 \text{ kN}) \cos 30^\circ = (10 \text{ kN}) \sin 60^\circ = 8.66 \text{ kN} \]
\[ F_{10} = 5\hat{i} + 8.66\hat{j} \text{ kN} \]

Express 8 kN force in Cartesian Vector Form

\[ F_8 = -8\hat{i} \text{ kN} \]

Add scalar components

\[ R = \left( \sum F_x \right) \hat{i} + \left( \sum F_y \right) \hat{j} \]
\[
R = -3\hat{i} + 8.66\hat{j} \text{ kN}
\]

Check magnitude and direction with previous result

\[
R = \sqrt{(R_x)^2 + (R_y)^2}
\]

\[
R = \sqrt{(-3)^2 + (8.66)^2} = 9.17 \text{ kN}
\]

\[
a = \tan^{-1}\left(\frac{8.66 \text{ kN}}{3 \text{ kN}}\right) = 70.8^\circ
\]

Note

In practice, using components is almost always the most efficient, particularly when the resultant of more than two forces is required.