Resultants of Planar Forces Example Problem

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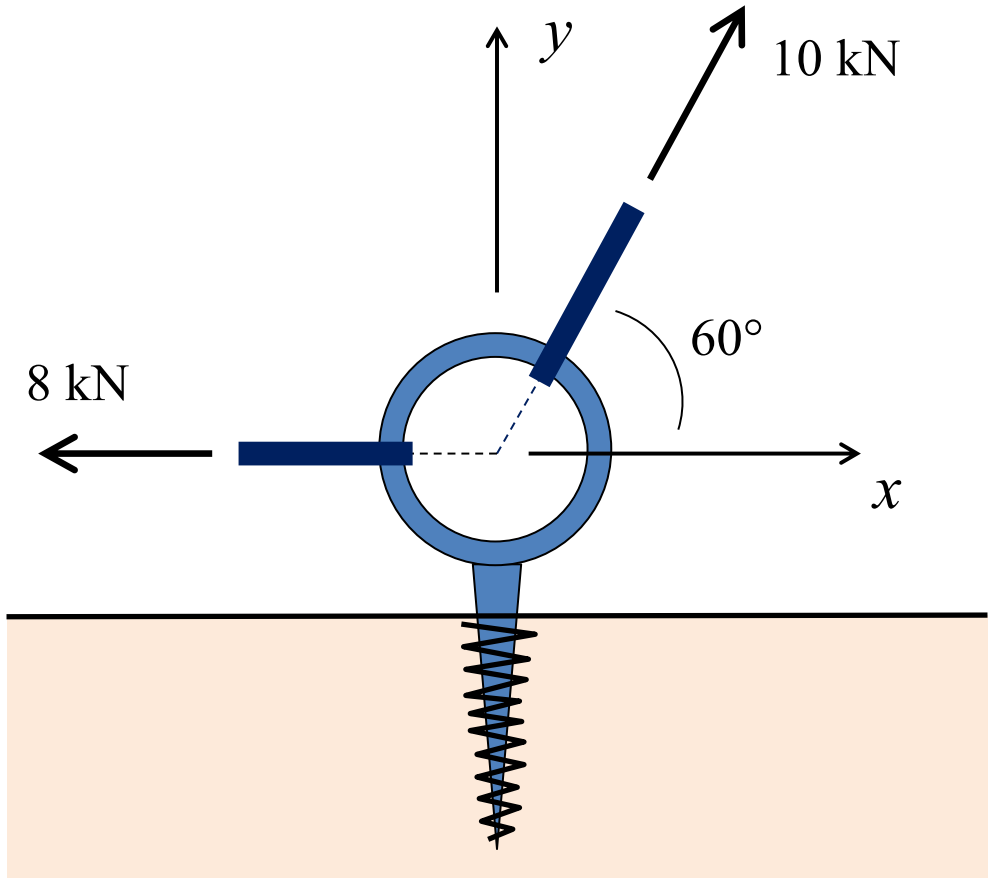
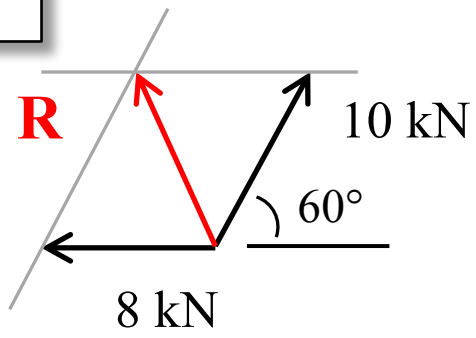
Determine the resultant of the two forces acting on the eye-bolt using:

1. The parallelogram law
2. Summing scalar components

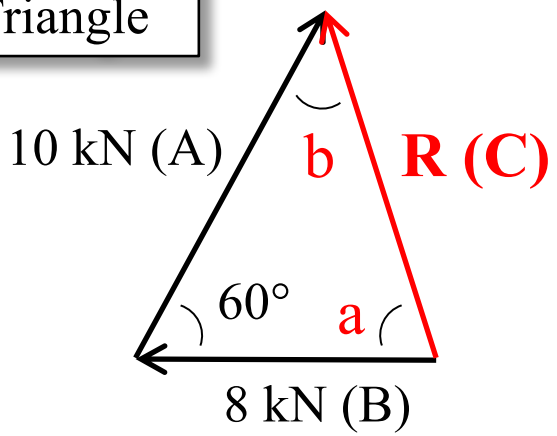


Parallelogram Law/Triangle Rule

Parallelogram Law



Force Triangle



Use the Law of Cosines to find the magnitude of the resultant

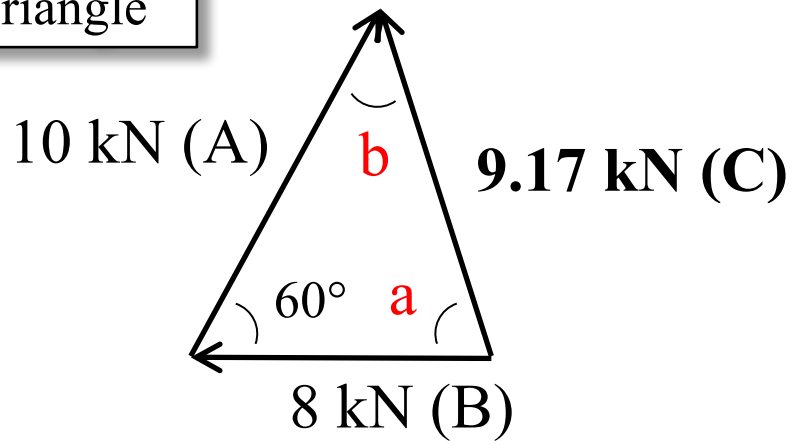
$$C^2 = A^2 + B^2 - 2AB\cos c$$

$$R^2 = (10\ \text{kN})^2 + (8\ \text{kN})^2 - 2(10\ \text{kN})(8\ \text{kN})\cos 60°$$

$$R = 9.17\ kN$$

Parallelogram Law/Triangle Rule

Force Triangle



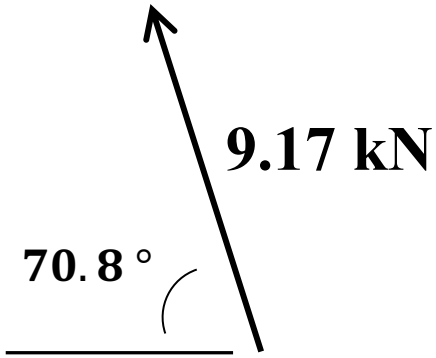
Use the Law of Sines to find the direction of the resultant

$$\frac{A}{\sin a} = \frac{C}{\sin c}$$

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

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

$$a = 70.8\ °$$



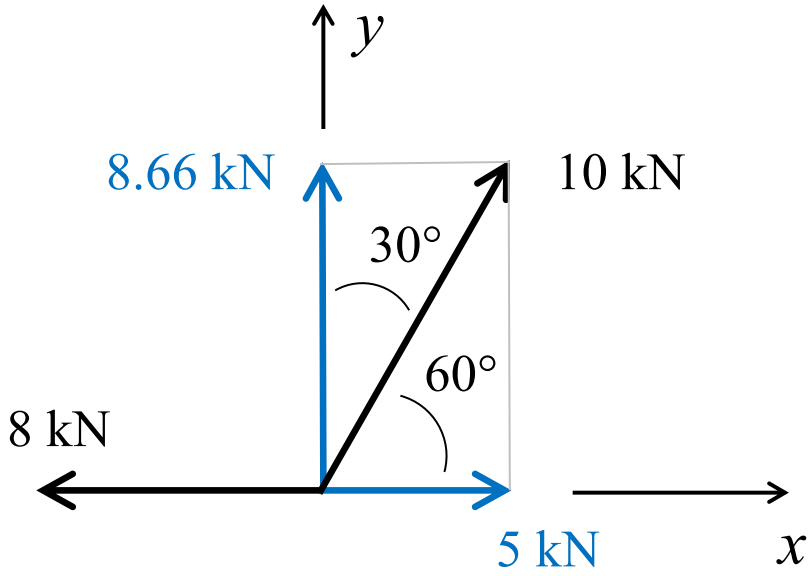
Rectangular Force Components

Express 10 kN force in Cartesian Vector Form

$$F_{10x} = (10\ \text{kN})\cos 60° = 5\ \text{kN}$$

$$F_{10y} = (10\ \text{kN})\cos 30° = (10\ \text{kN})\sin 60° = 8.66\ \text{kN}$$

$$\boldsymbol{F}_{10} = 5\hat{\imath} + 8.66\,\hat{\jmath}\ \text{kN}$$



Express 8 kN force in Cartesian Vector Form

$$\boldsymbol{F}_{8} = -8\hat{\imath}\ \text{kN}$$

Add scalar components

$$\boldsymbol{R} = \left(\sum F_x\right)\hat{\imath} + \left(\sum F_y\right)\hat{\jmath}$$

Compare Results

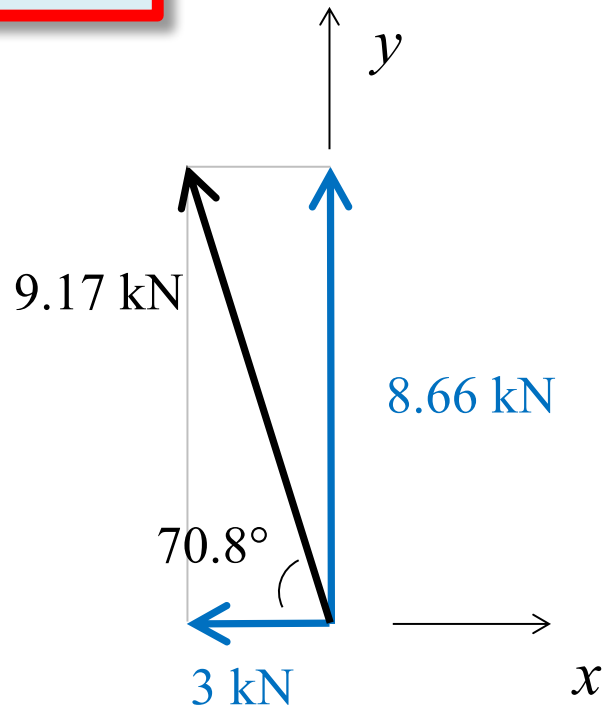
$$\boldsymbol{R} = -3\hat{\imath} + 8.66\hat{\jmath} \text{ kN}$$

Check magnitude and direction with previous result

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

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

$$a = \tan^{-1}\left(\frac{8.66 \text{ kN}}{3 \text{ kN}}\right) = 70.8°$$ OK



Note

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