2.3.6

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Question

Find the magnitude of each of the vectors **a** and **b**, having the same magnitude such that the angle between them is 60° and their scalar product is $\frac{9}{2}$.

Theoretical Solution

We are given:

- Two vectors $\mathbf{a}$ and $\mathbf{b}$ with the same magnitude.
- The angle between them is 60°.
- Their scalar product is:

$$\mathbf{a}^T\mathbf{b} = \frac{9}{2}. \tag{1}$$

Let the common magnitude be r, so

$$\|\mathbf{a}\| = \|\mathbf{b}\| = r. \tag{2}$$

Theoretical Solution

The formula for the dot product is:

$$\cos\theta = \frac{\mathbf{a}^T\mathbf{b}}{\|\mathbf{a}\|\,\|\mathbf{b}\|}. \tag{3}$$

Since $\|\mathbf{a}\| = \|\mathbf{b}\| = r$, this simplifies to:

$$\cos\theta = \frac{\mathbf{a}^T\mathbf{b}}{r^2}. \tag{4}$$

Given that $\theta = 60^\circ$, we know $\cos 60^\circ = \frac{1}{2}$. Substituting values,

$$\frac{1}{2} = \frac{\frac{9}{2}}{r^2}. \tag{5}$$

Theoretical Solution

Multiply throughout by $2r^2$:

$$r^2 = 9. \tag{6}$$

Taking the positive square root (since magnitude cannot be negative),

$$r = 3. \tag{7}$$

$$\therefore \quad \|\mathbf{a}\| = \|\mathbf{b}\| = 3$$

Thus, the magnitude of each vector is 3.

Two vectors with magnitude 3 and angle 60° between them

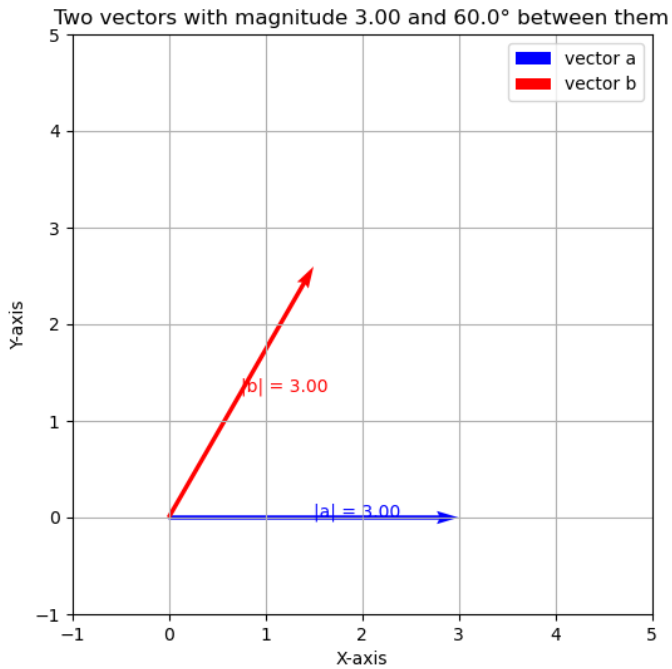

Figure: Figure for 2.3.6