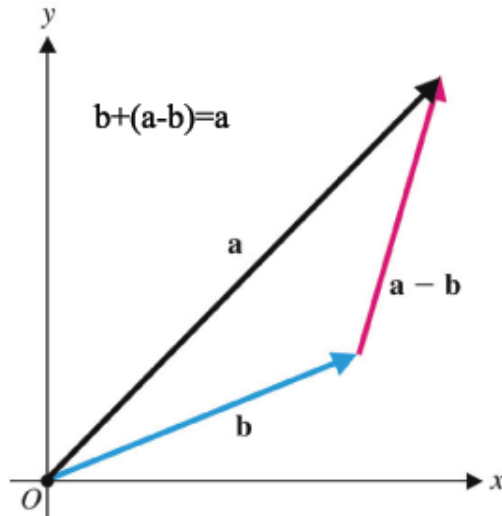


Subtraction:

$$\langle a_1, a_2 \rangle - \langle b_1, b_2 \rangle = \langle a_1 - b_1, a_2 - b_2 \rangle.$$



For direction of difference vector, make sure $\mathbf{b} + (\mathbf{a} - \mathbf{b}) = \mathbf{a}$.

Zero vector:

$$\mathbf{0} = \langle 0, 0 \rangle$$

$\|\mathbf{0}\| = 0$ and the zero vector has all directions.

Scalar multiplication:

$$c\mathbf{a} = c\langle a_1, a_2 \rangle = \langle ca_1, ca_2 \rangle$$

Thus $c\mathbf{a}$ is a vector and

$$\begin{aligned} \|c\mathbf{a}\| &= \|\langle ca_1, ca_2 \rangle\| = \sqrt{(ca_1)^2 + (ca_2)^2} = \sqrt{c^2a_1^2 + c^2a_2^2} = \\ &= \sqrt{c^2(a_1^2 + a_2^2)} = \sqrt{c^2} \sqrt{a_1^2 + a_2^2} = |c| \cdot \|\mathbf{a}\|. \end{aligned}$$