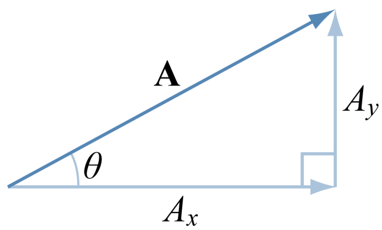
Use vectors to describe position and its variation in 2-d

A directed quantity can be graphically related to its x-component and its y-component using a drawing of a right triangle.

Vectors



Representations of $\vec{\mathbf{A}}$

The defining characteristics of a vector are its magnitude (length) and its direction (angle). Ex. $5\ \mathrm{m}$ in a direction $37°$ above the $+x$ direction

Cartesian components

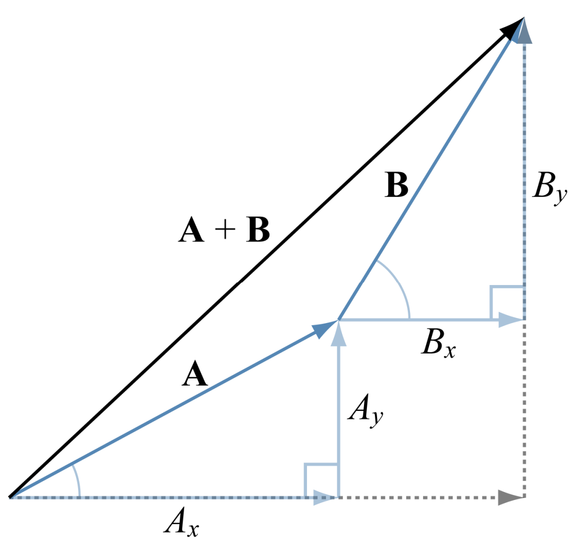
$$\vec{\mathbf{A}} = A_x\hat{\mathbf{x}} + A_y\hat{\mathbf{y}}$$

$$\vec{\mathbf{A}} = A_x\hat{\mathbf{i}} + A_y\hat{\mathbf{j}}$$

$$A = \left|\vec{\mathbf{A}}\right| = \sqrt{A_x^2 + A_y^2}$$

$$\tan\theta = \frac{A_y}{A_x}$$

Vectors can be added



Vector addition is **head-to-tail**

Vector	x-comp.	y-comp.
$\vec{\mathbf{A}}$	A_x	A_y
$\vec{\mathbf{B}}$	B_x	B_y
$\vec{\mathbf{A}} + \vec{\mathbf{B}}$	$A_x + B_x$	$A_y + B_y$

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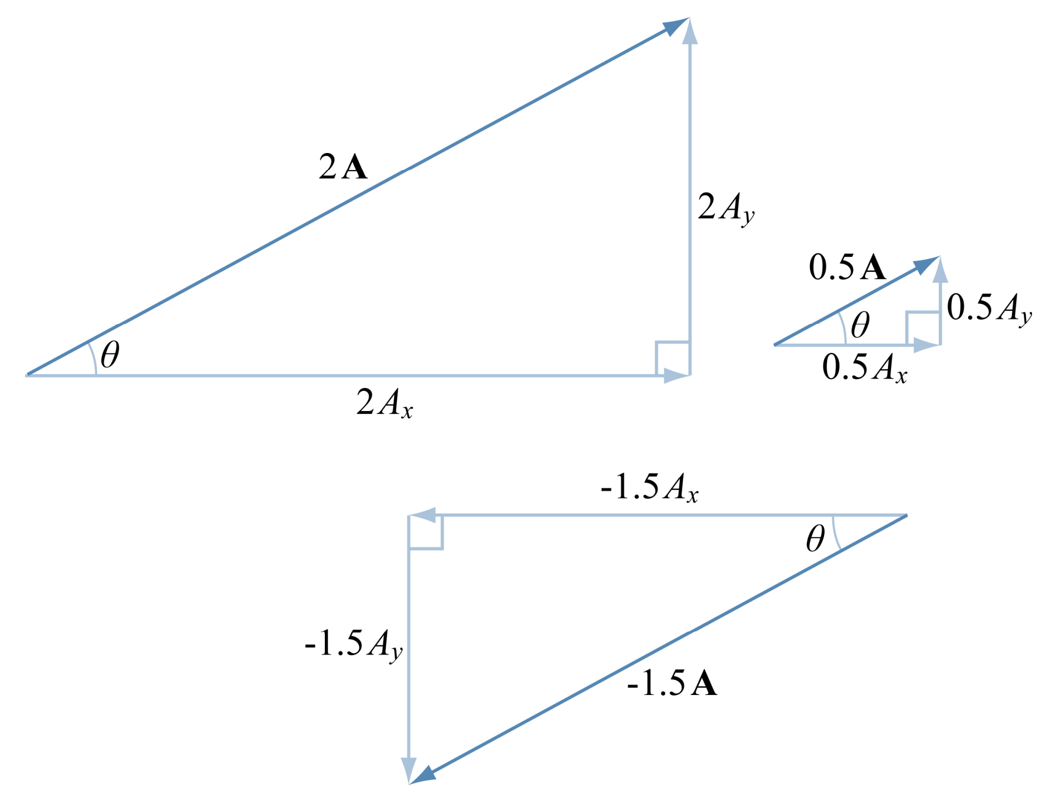
Vectors can be multiplied by scalars

Multiply a vector by a scalar by multiplying its components individually by that scalar. Multiplication by a negative sign reverses the direction of each non-zero component.

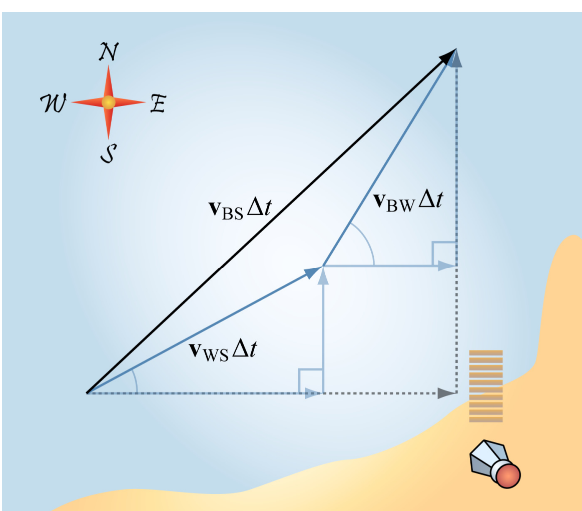


Vectors can be subtracted

Subtract a vector by adding its negative.

$$\vec{\mathbf{A}} - \vec{\mathbf{B}} := \vec{\mathbf{A}} + \left(-\vec{\mathbf{B}}\right)$$

Relative velocity



$$\vec{\mathbf{v}}_{\mathrm{BS}}\Delta t = \vec{\mathbf{v}}_{\mathrm{BW}}\Delta t + \vec{\mathbf{v}}_{\mathrm{WS}}\Delta t$$

$$\vec{\mathbf{v}}_{\mathrm{BS}} = \vec{\mathbf{v}}_{\mathrm{BW}} + \vec{\mathbf{v}}_{\mathrm{WS}}$$

$$\left(\begin{array}{c}\textbf{Velocity}\text{ of}\\ \textbf{b}\text{oat}\\ \text{relative to}\\ \textbf{s}\text{hore}\end{array}\right) = \left(\begin{array}{c}\textbf{Velocity}\text{ of}\\ \textbf{b}\text{oat}\\ \text{relative to}\\ \textbf{w}\text{ater}\end{array}\right) + \left(\begin{array}{c}\textbf{Velocity}\text{ of}\\ \textbf{w}\text{ater}\\ \text{relative to}\\ \textbf{s}\text{hore}\end{array}\right)$$

Velocity	x-comp.	y-comp.
$\vec{\mathbf{v}}_{\mathrm{BW}}$	$v_{\mathrm{BW},x}$	$v_{\mathrm{BW},y}$
$\vec{\mathbf{v}}_{\mathrm{WS}}$	$v_{\mathrm{WS},x}$	$v_{\mathrm{WS},y}$
$\vec{\mathbf{v}}_{\mathrm{BS}}$	$v_{\mathrm{BW},x} + v_{\mathrm{WS},x}$	$v_{\mathrm{BW},y} + v_{\mathrm{WS},y}$