February 4, Week 4

Today: Chapter 1, Vectors

Homework Assignment #4 - Due February 8

Mastering Physics: 8 problems from chapters 1 and 3.

Written Question: 3.65

Exam #1: Wednesday, February 13

No Reading Quiz due Tuesday

Help sessions with Jonathan:

M: 1000-1100, RH 111
T: 1000-1100, RH 114
Th: 0900-1000, RH 114

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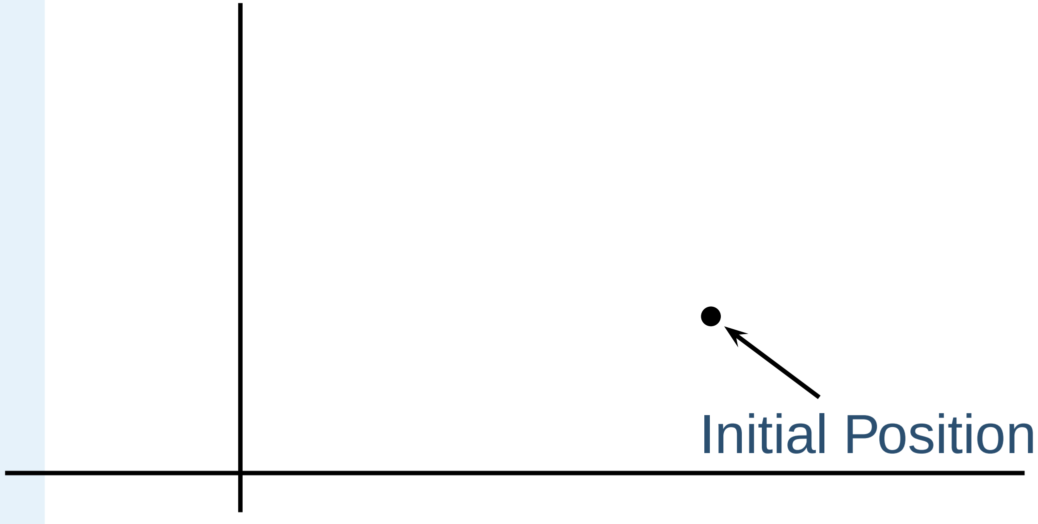

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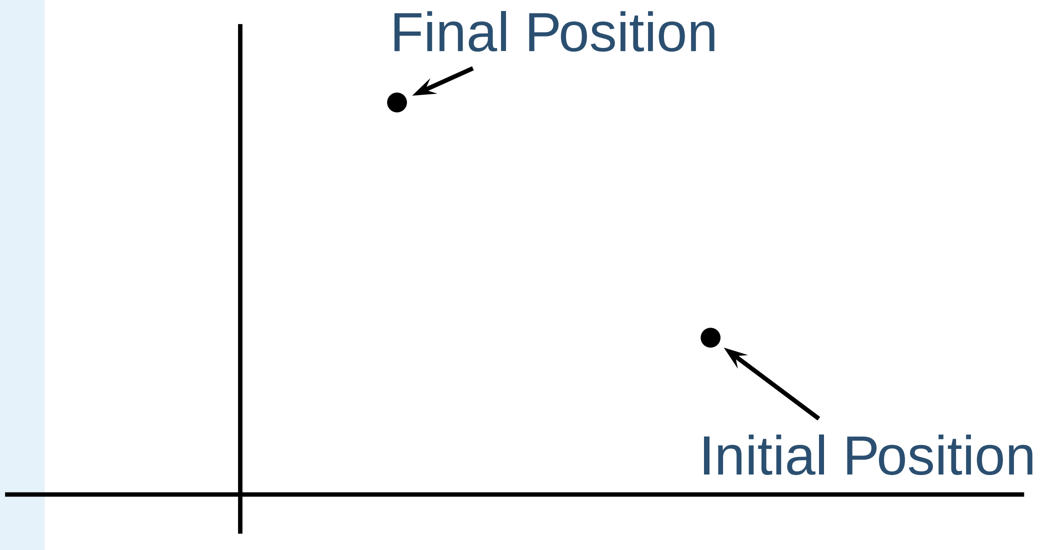

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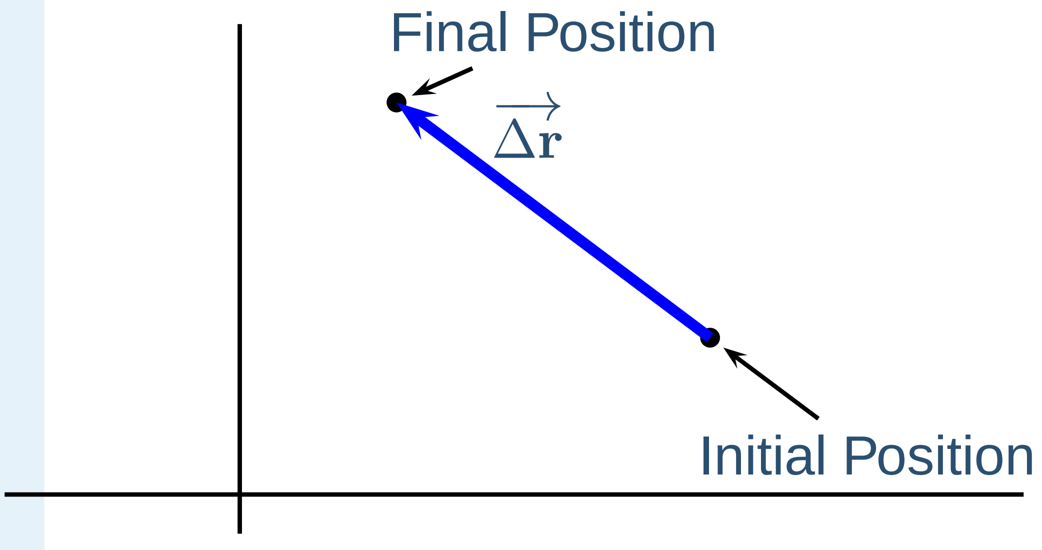

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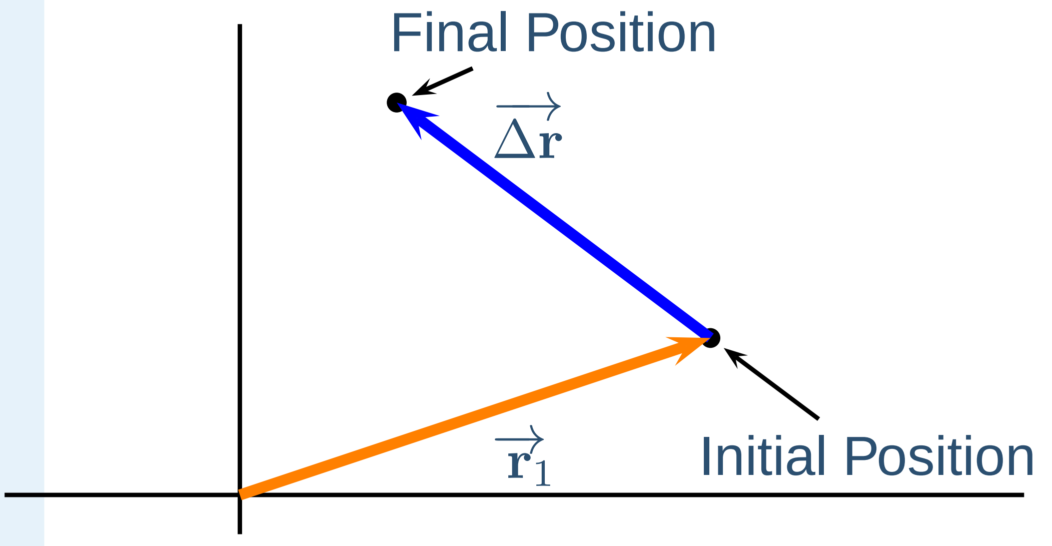

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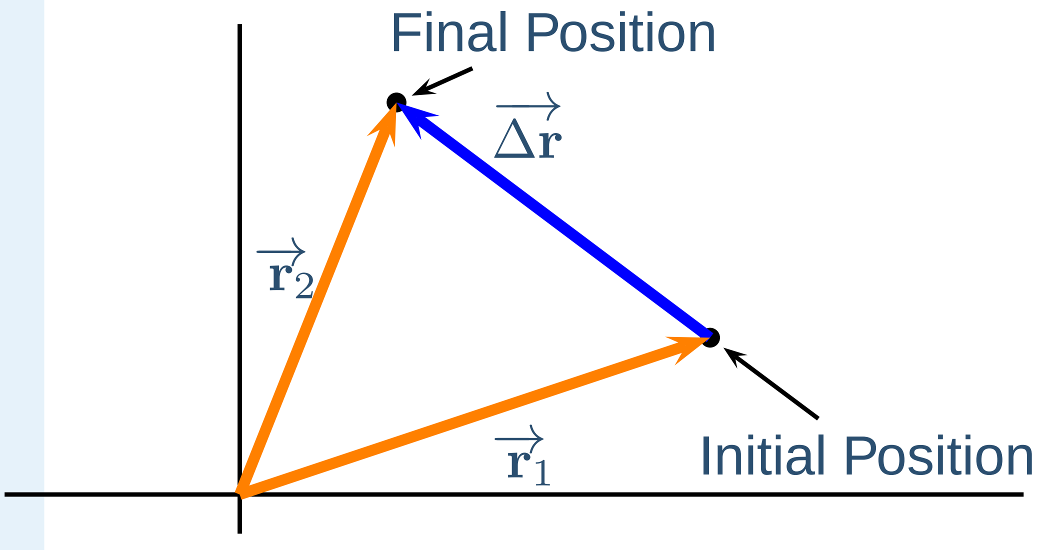

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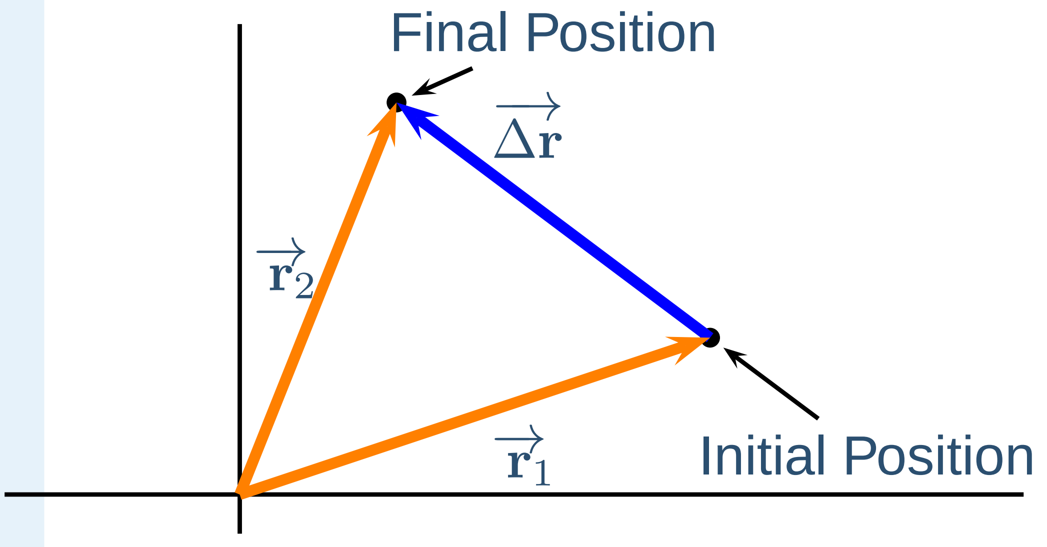

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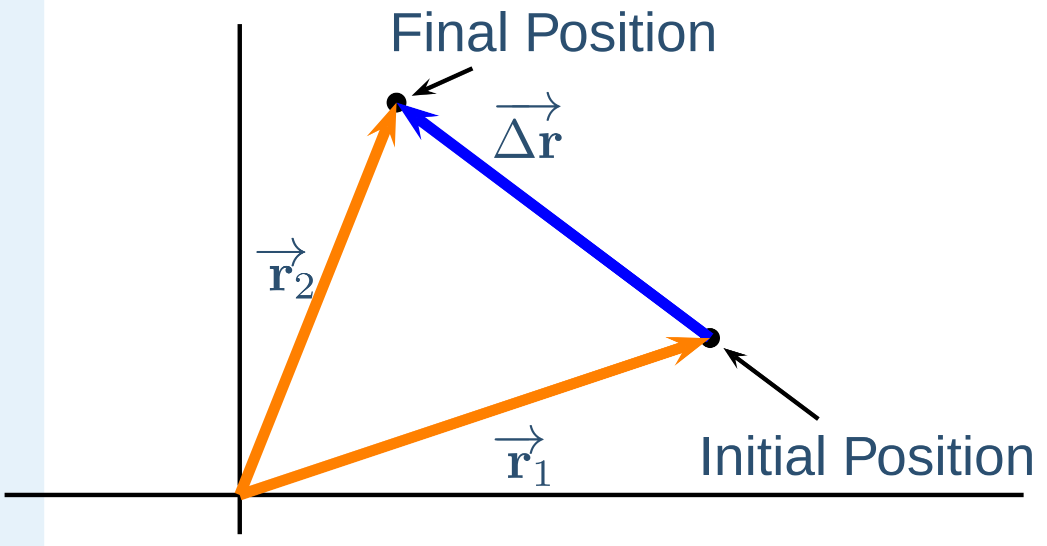

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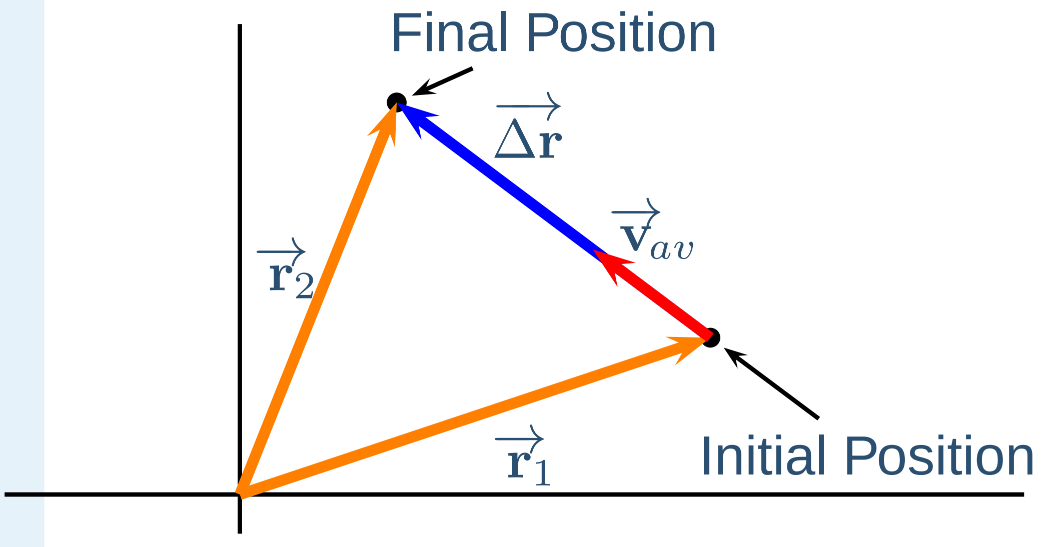

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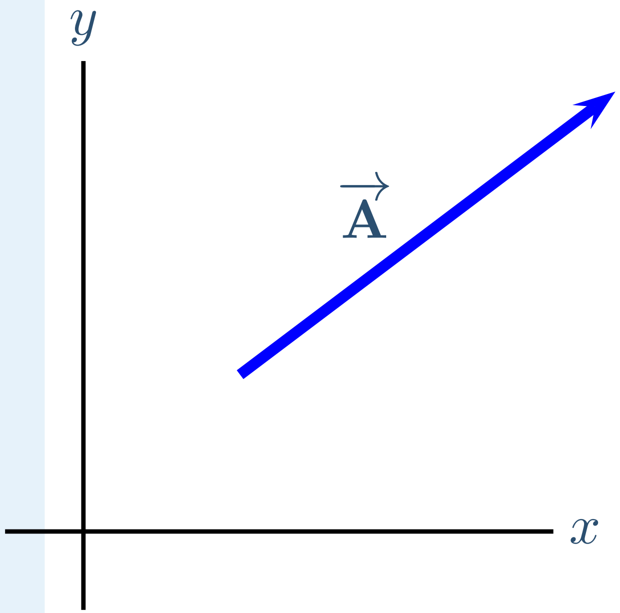

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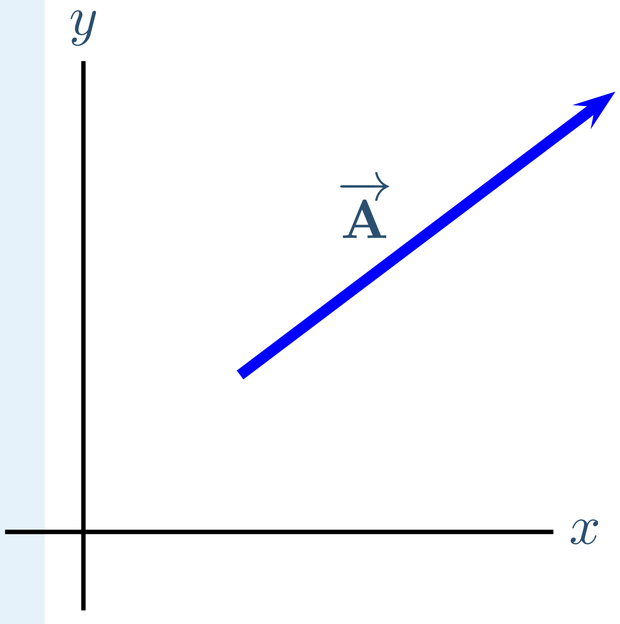

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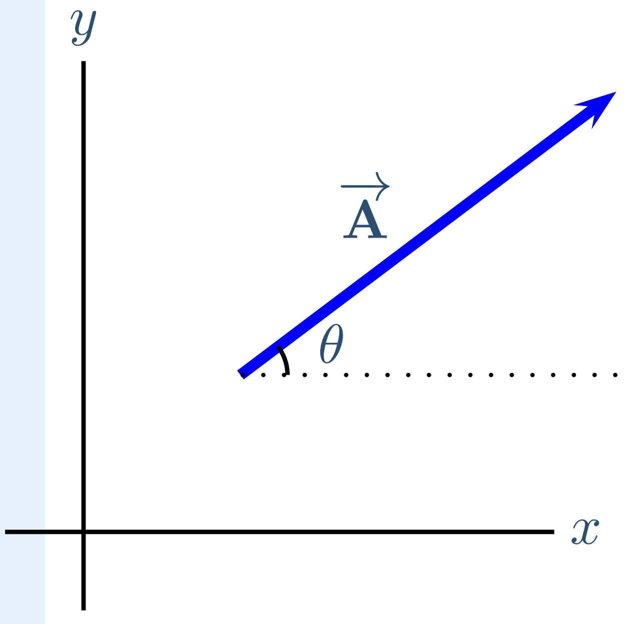

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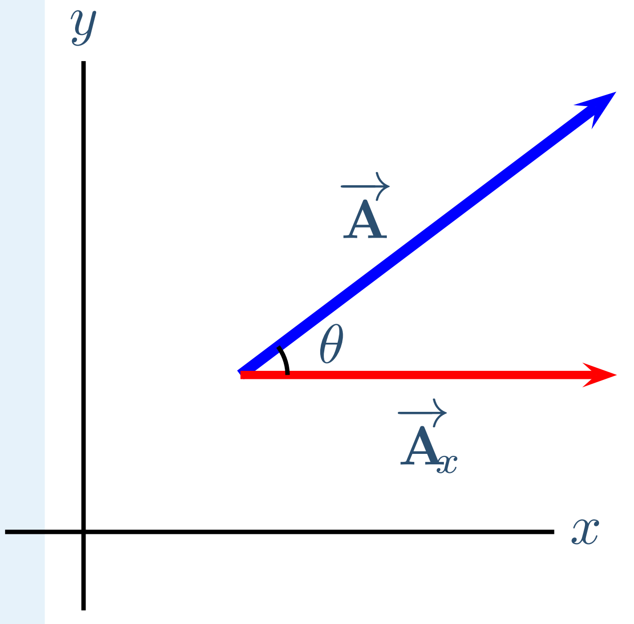

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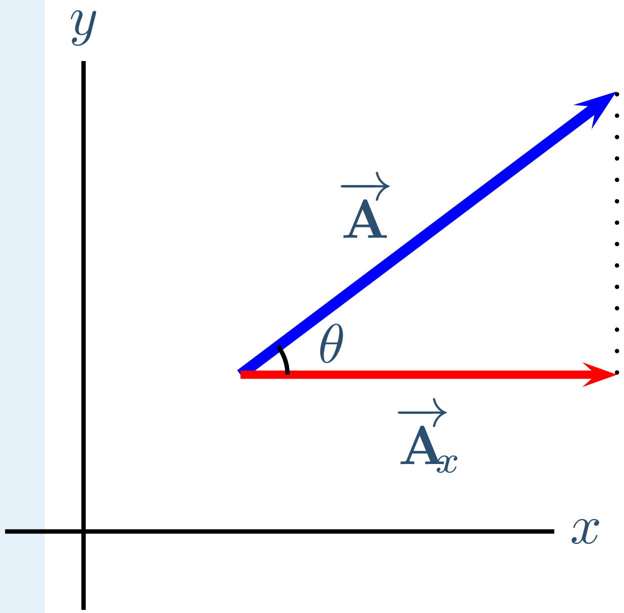

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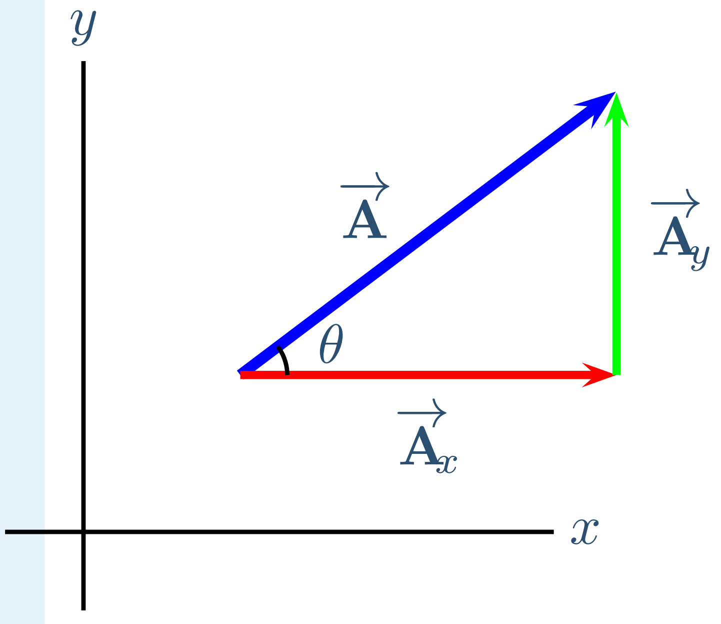

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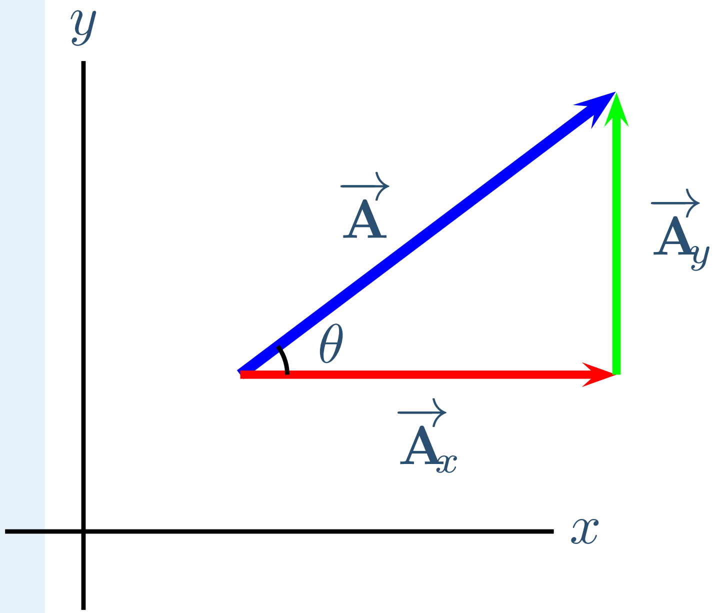

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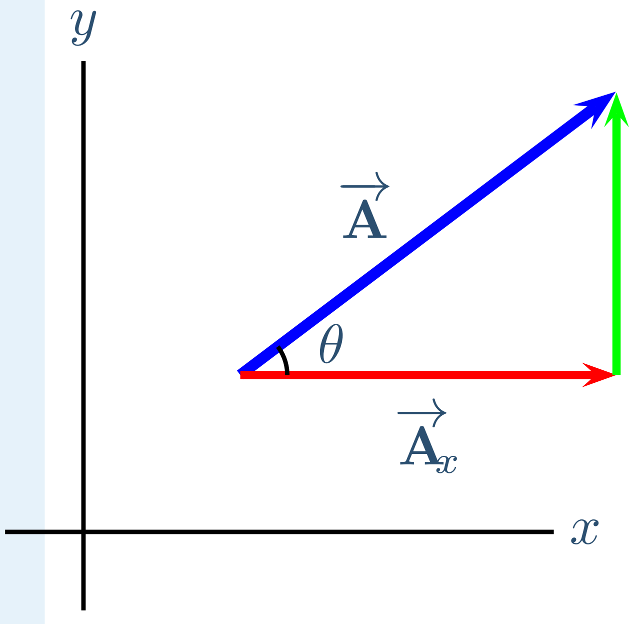

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The components and the original vector are related by vector addition: $\overrightarrow{\mathbf{A}}_x + \overrightarrow{\mathbf{A}}_y = \overrightarrow{\mathbf{A}}$.

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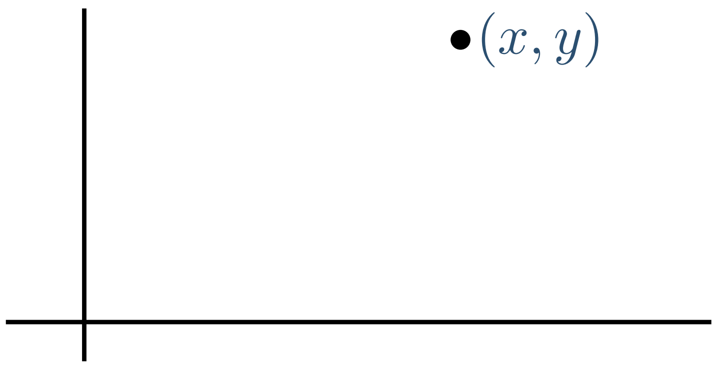
Example: the components of the position vector are the x and y cartesian coordinates.



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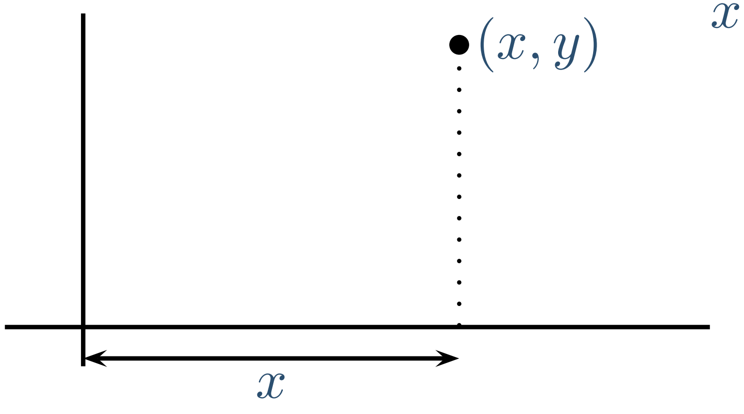

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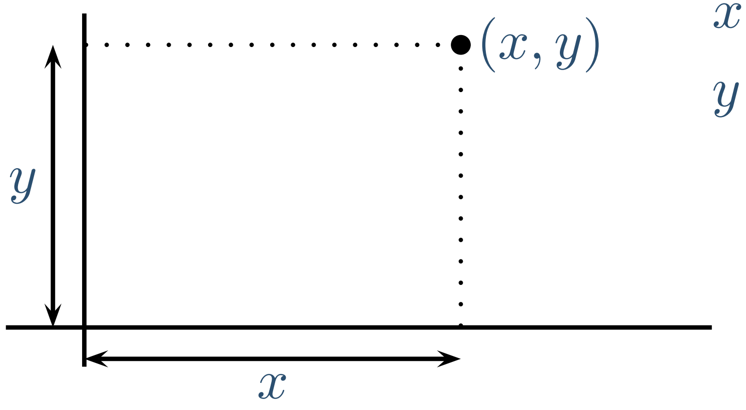

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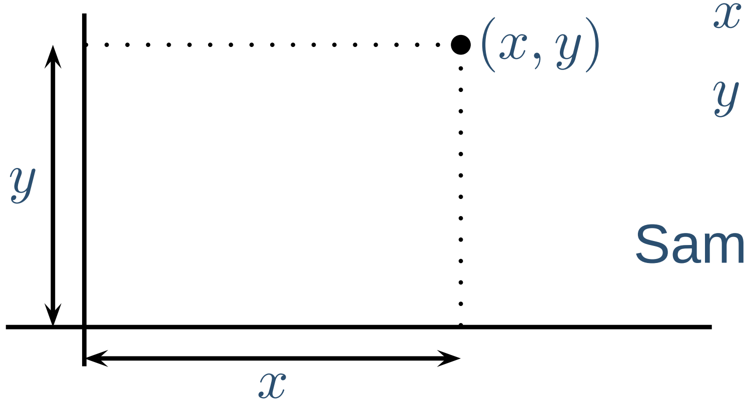

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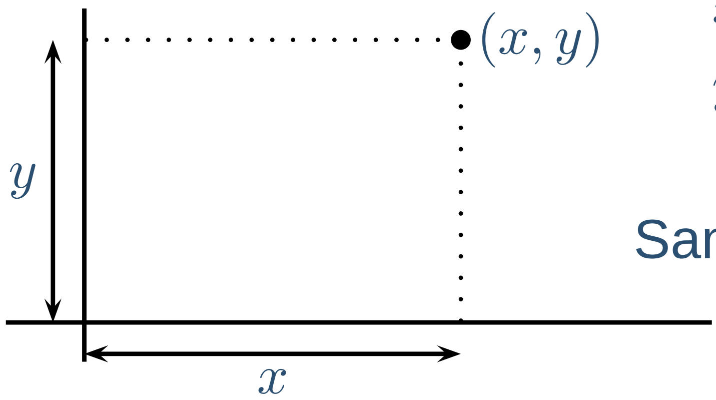

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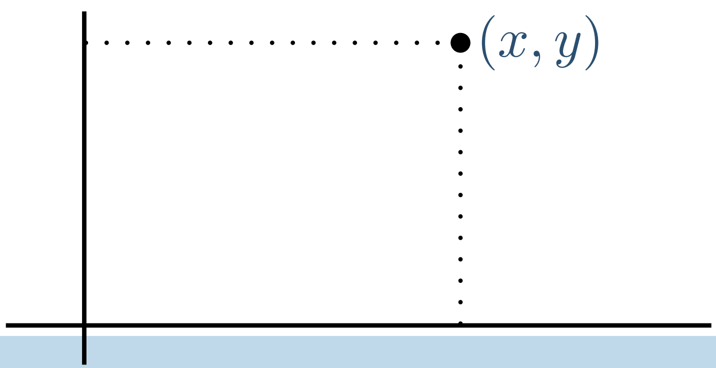

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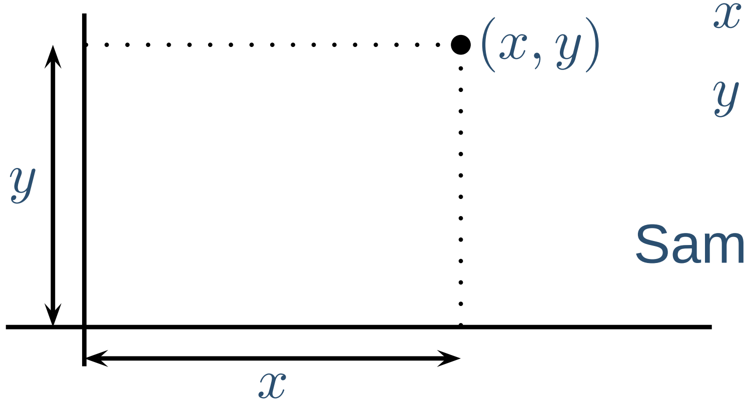

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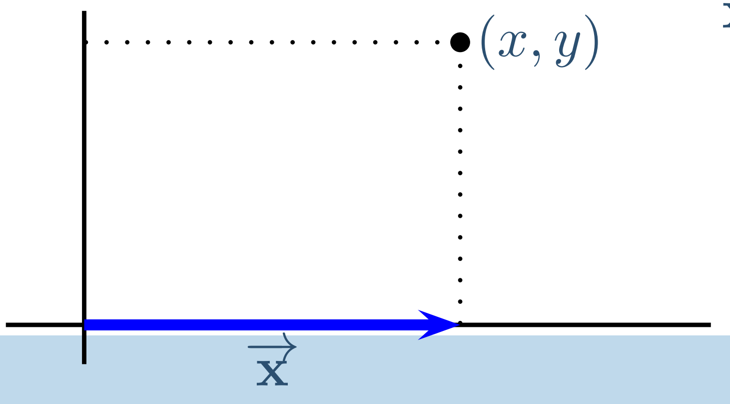

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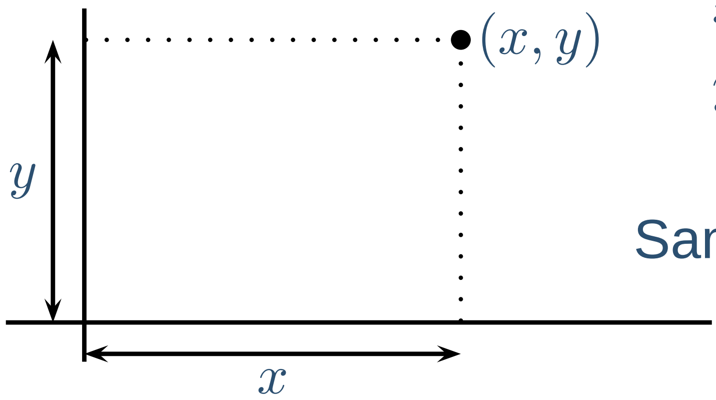

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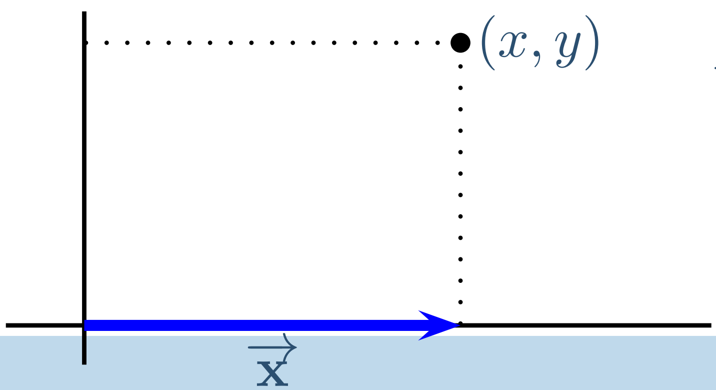

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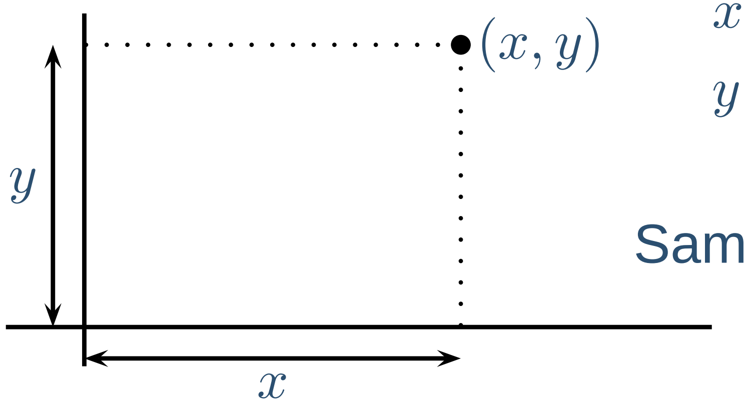

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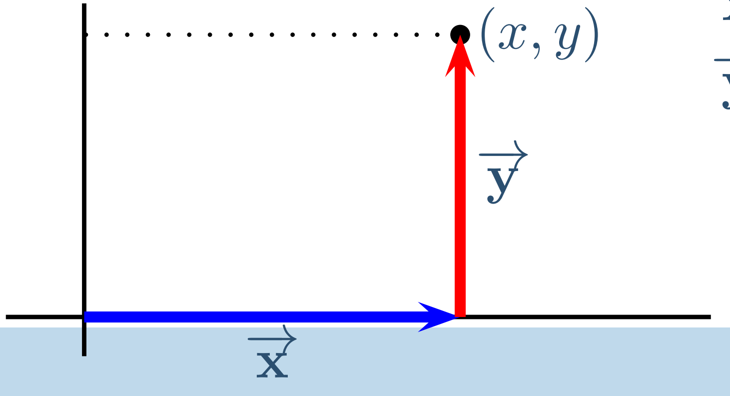

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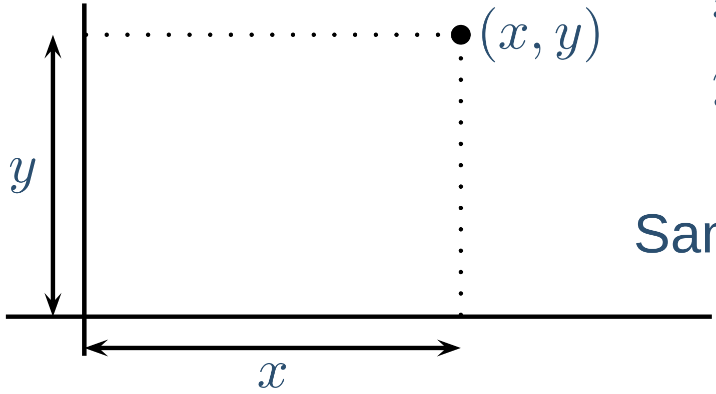

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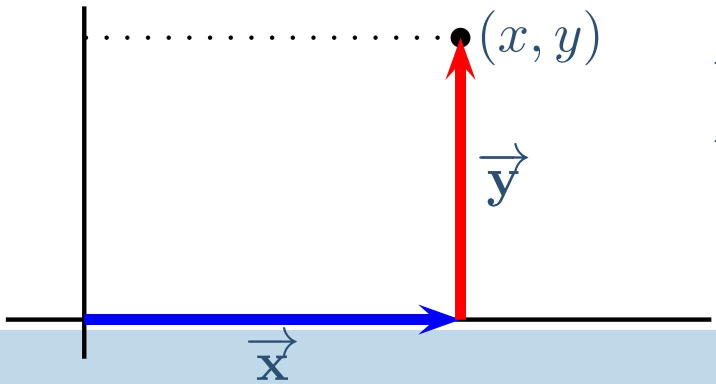

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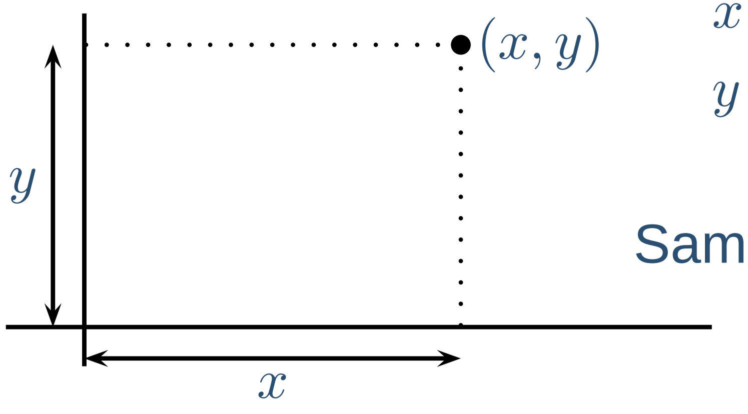

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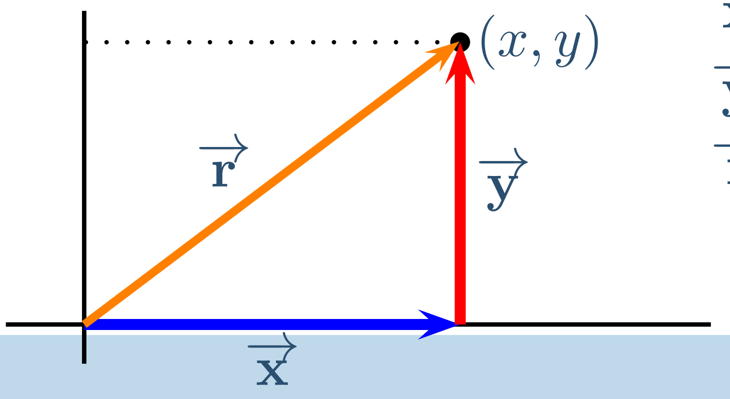

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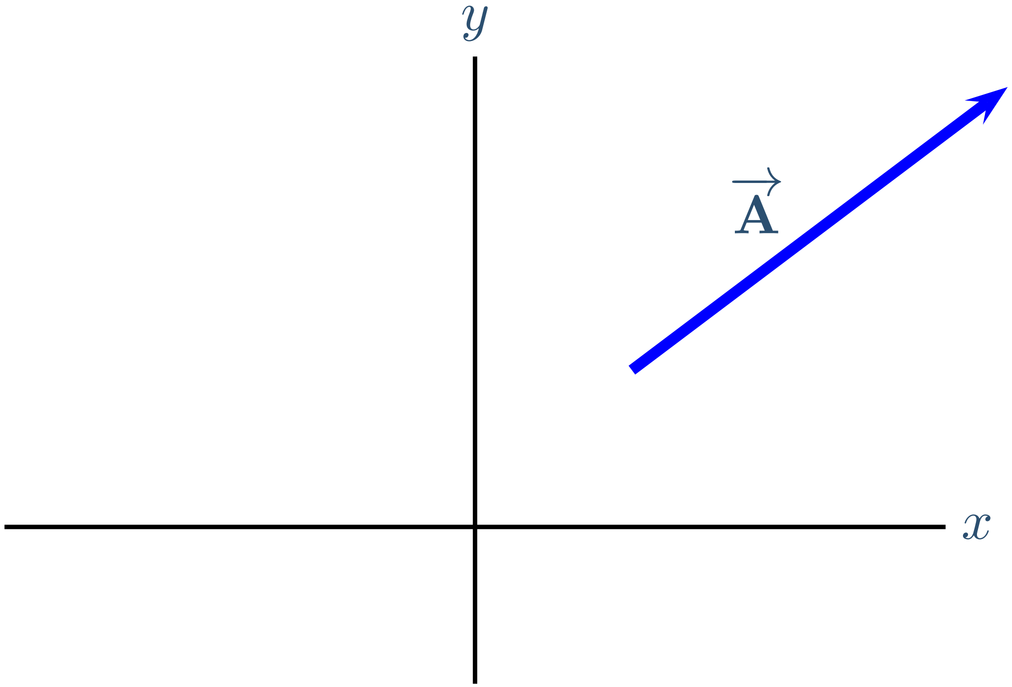

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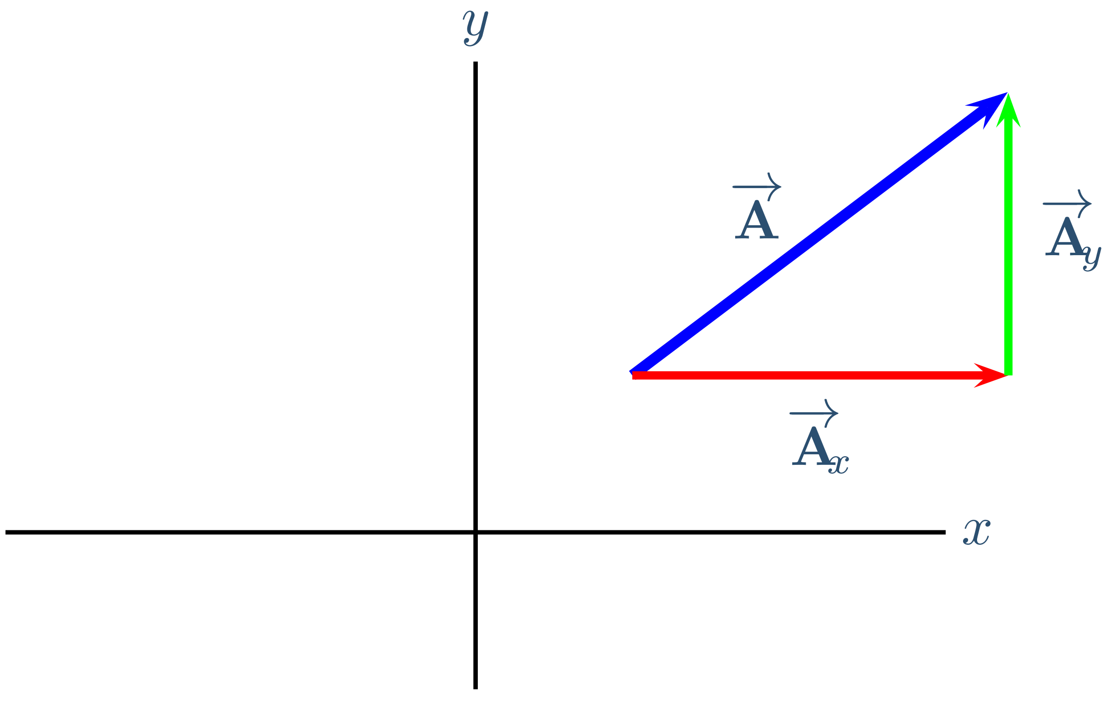

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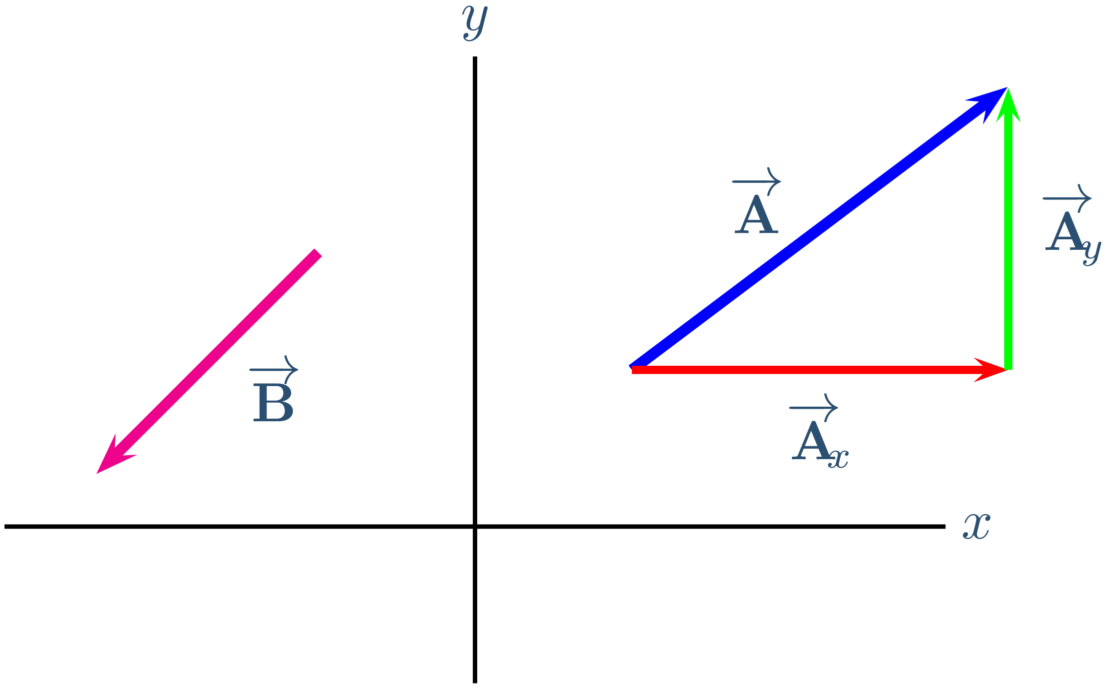

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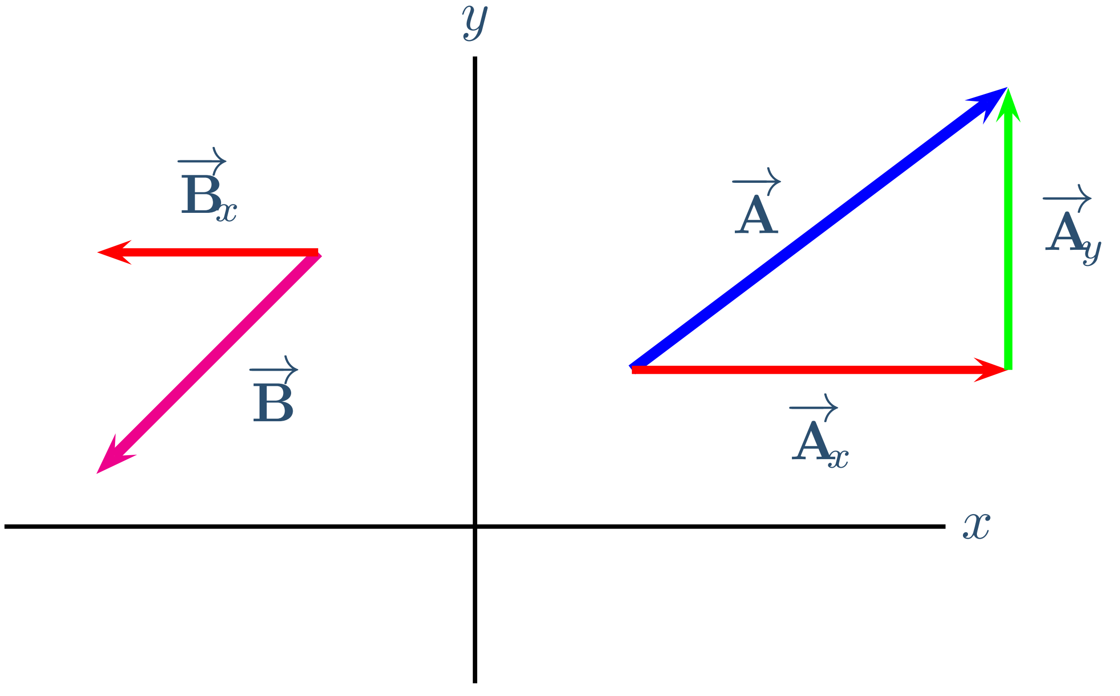

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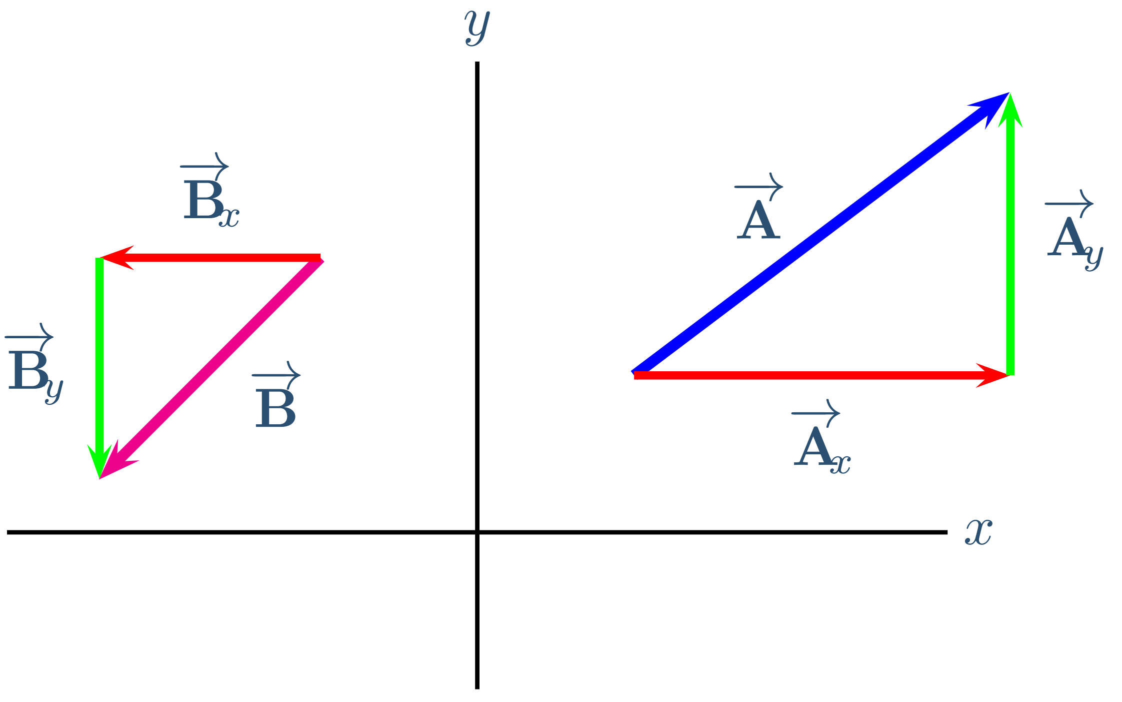

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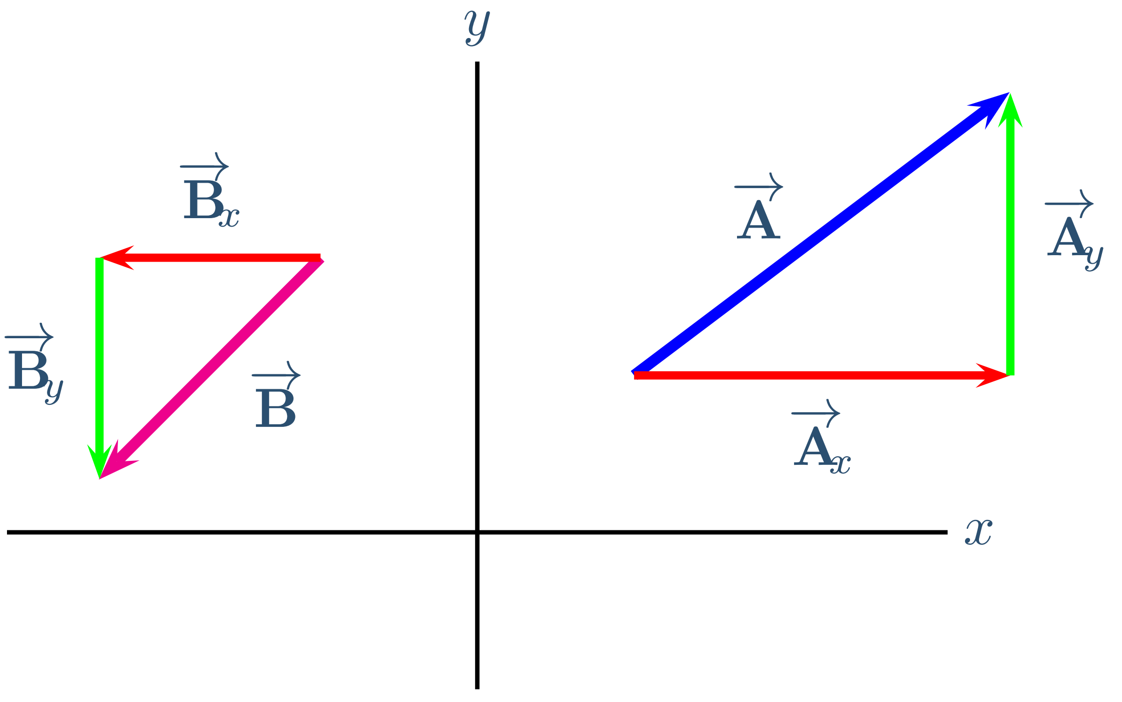

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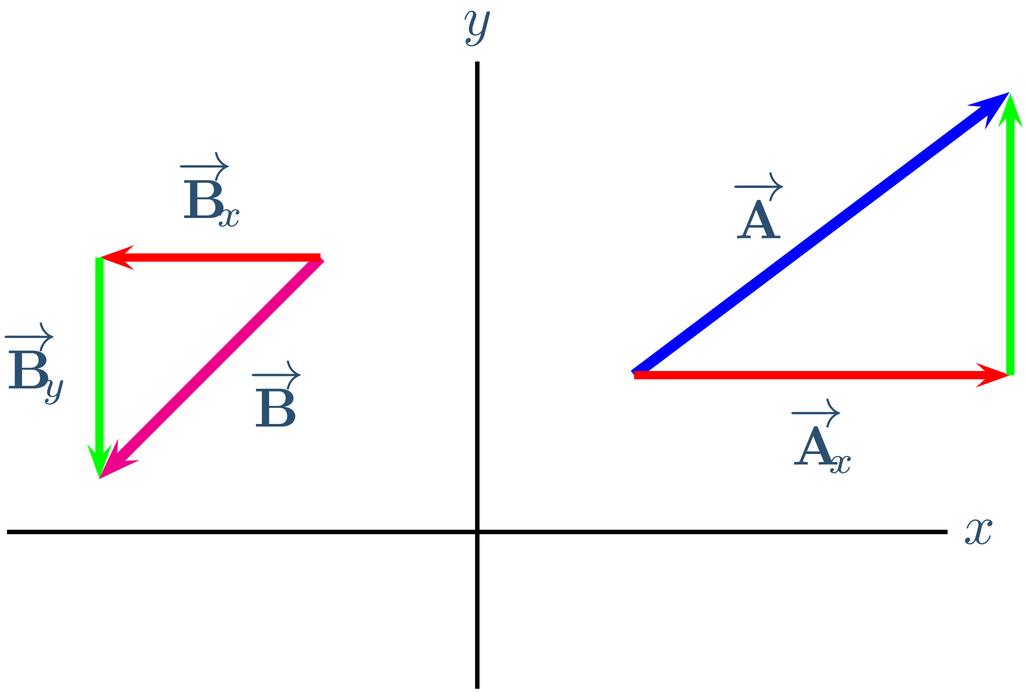

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A_x, A_y, B_x, B_y and their signs $=$ Scalar Components

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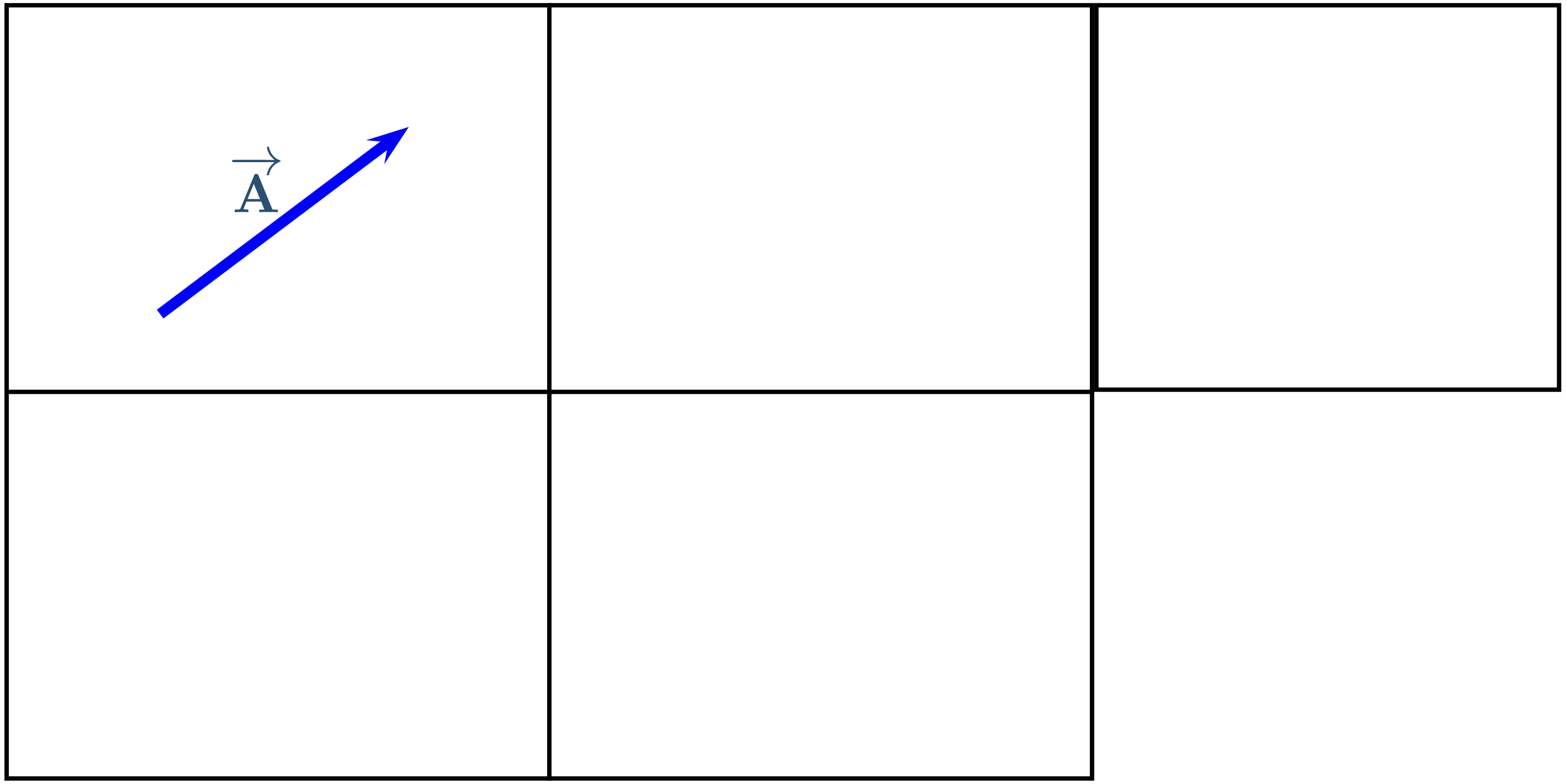

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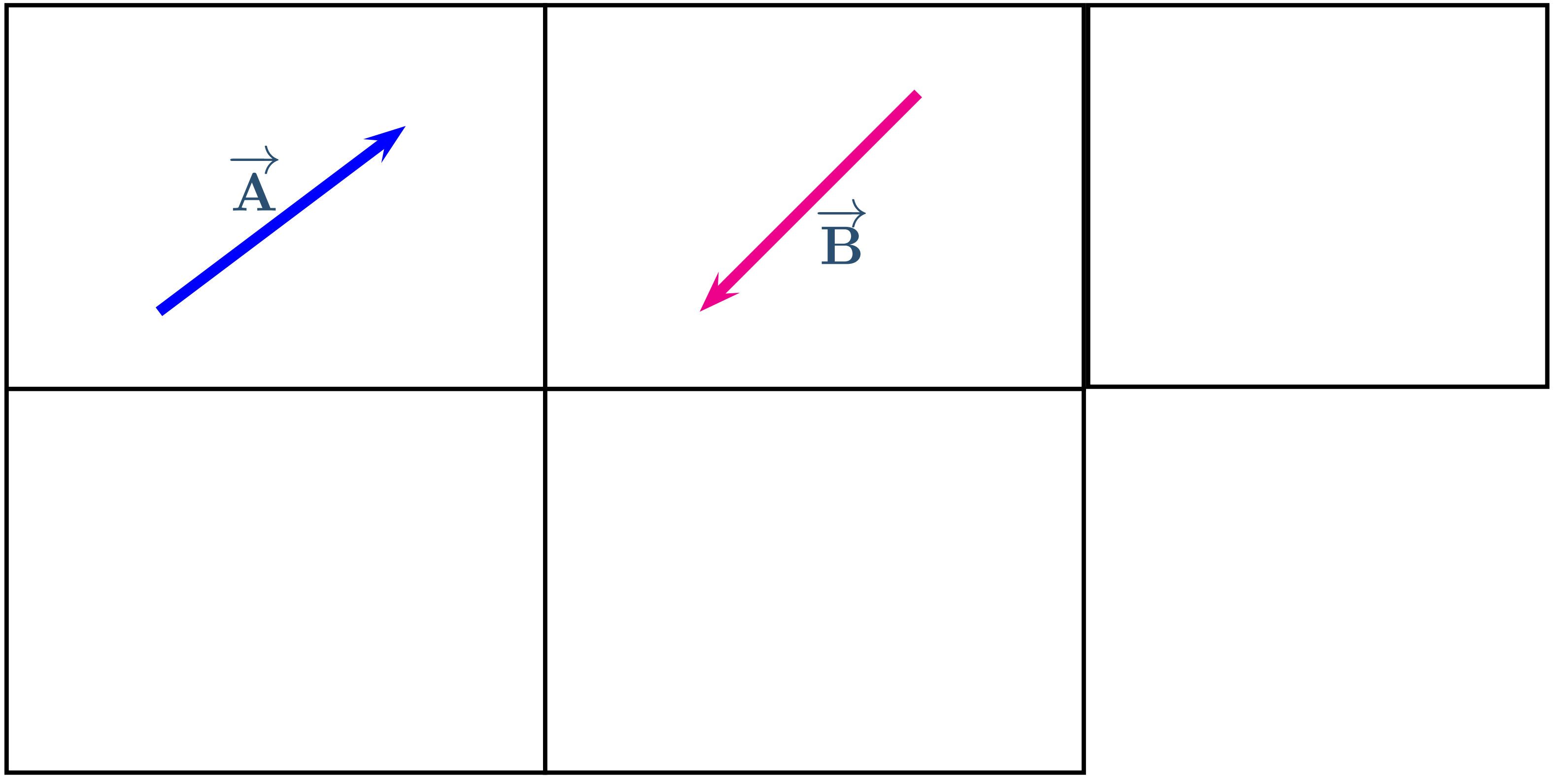

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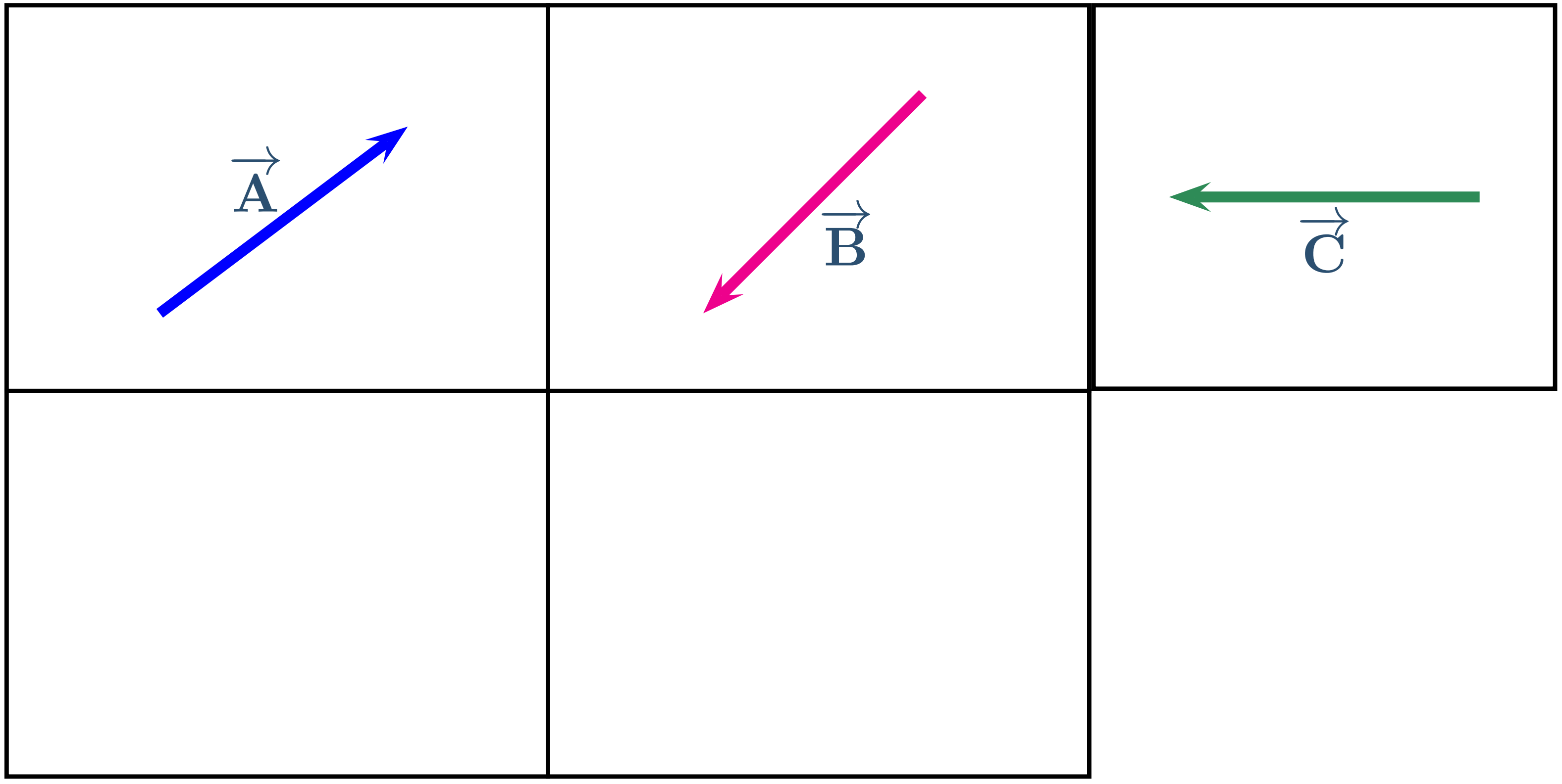

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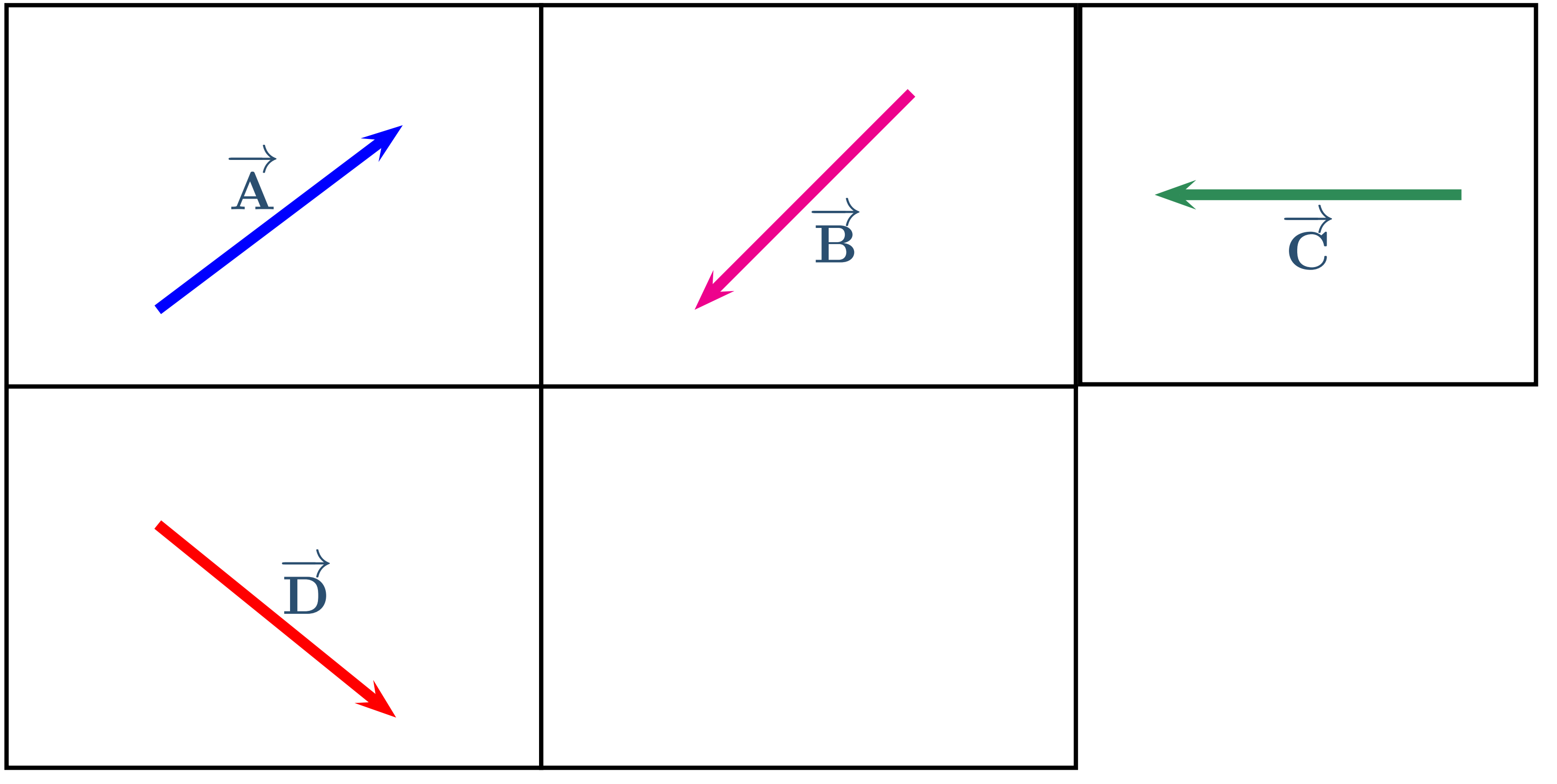

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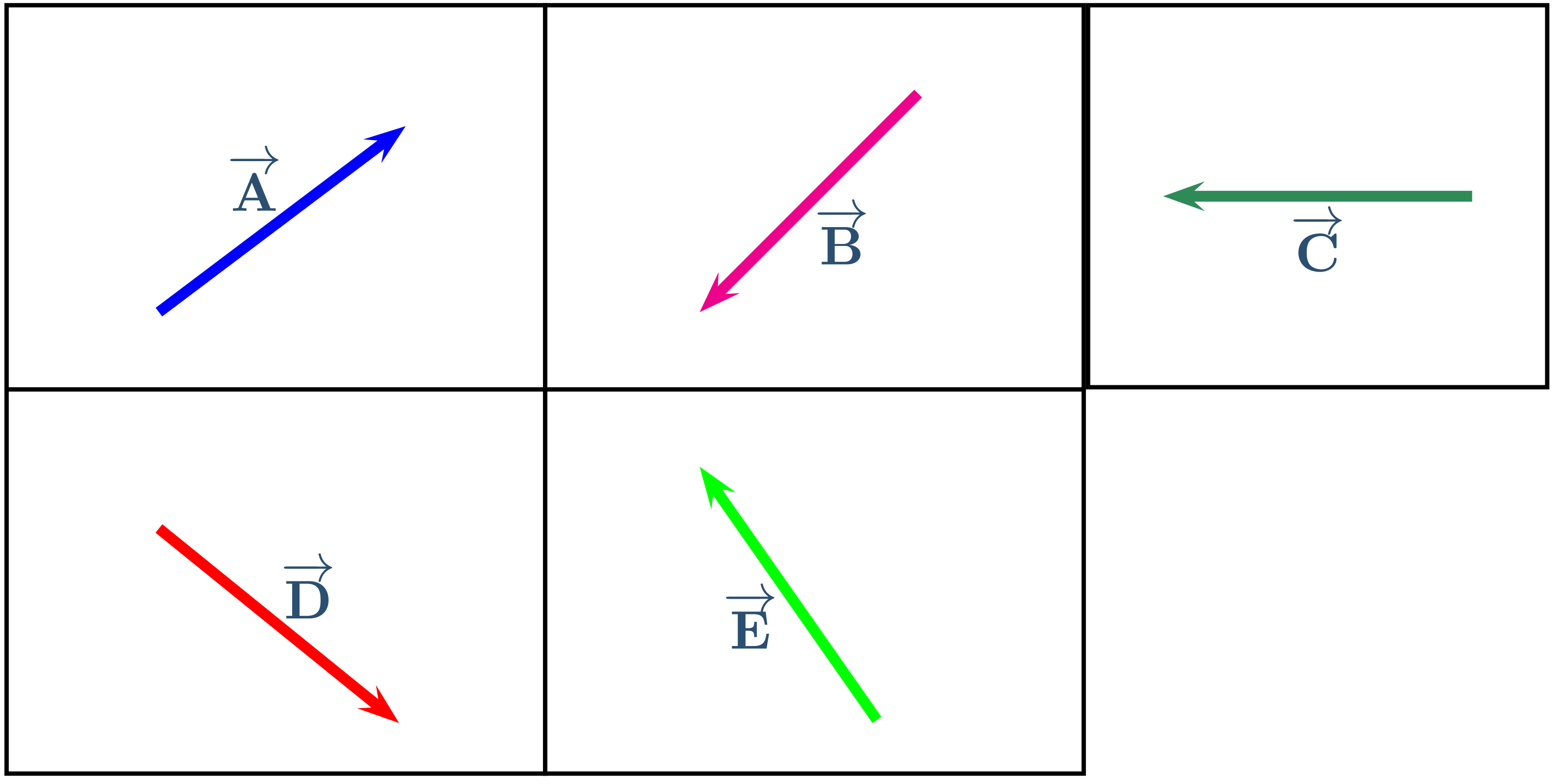

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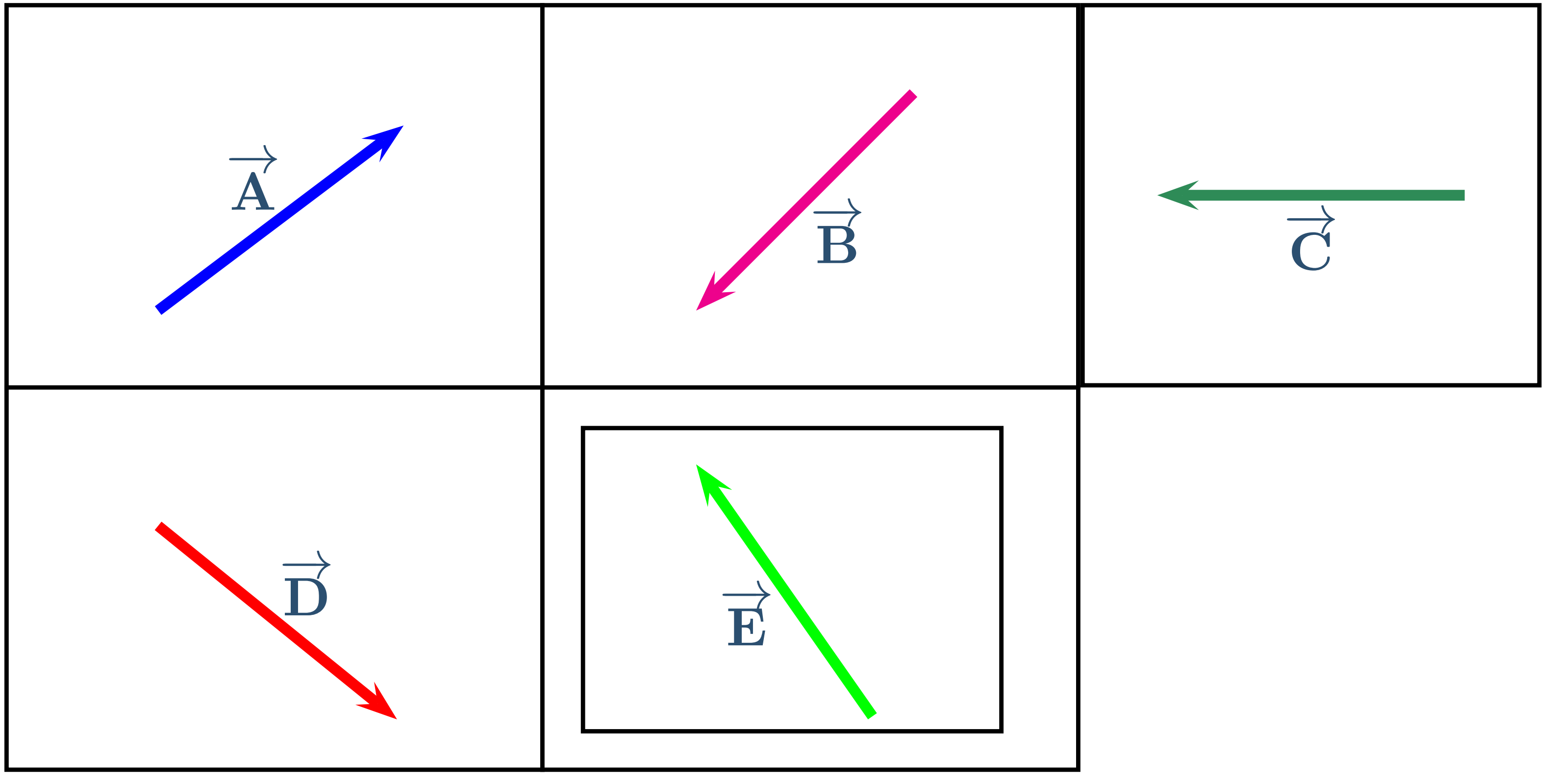

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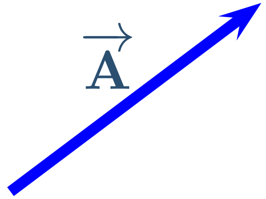

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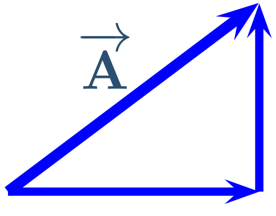

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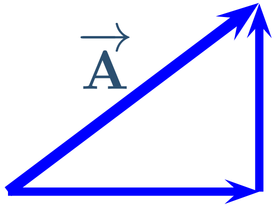

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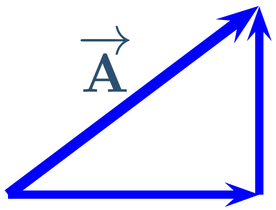

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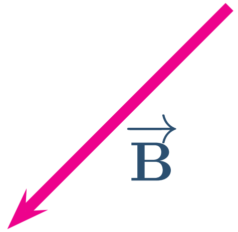

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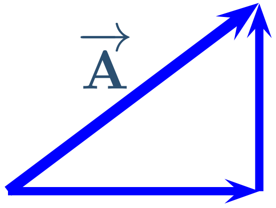
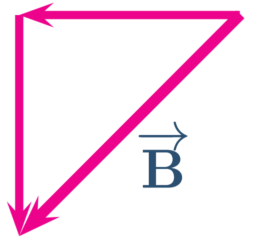
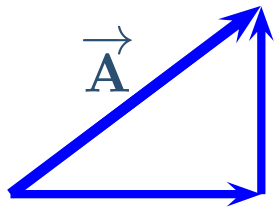


A_x positive

A_y positive



Scalar Component Followup



A_x positive
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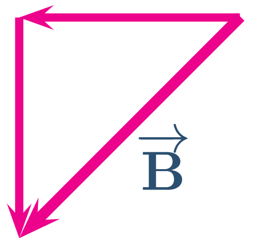
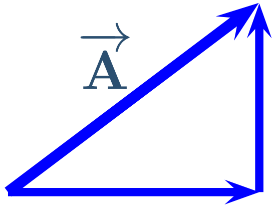


B_x negative
B_y negative

Scalar Component Followup



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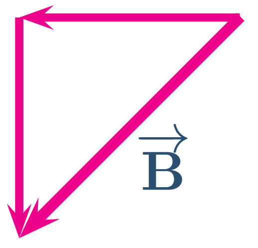

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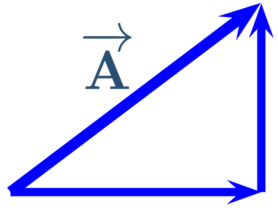

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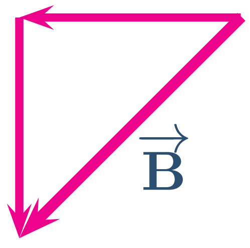
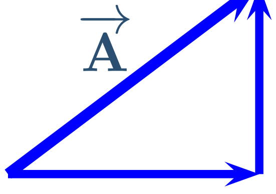


B_x negative
B_y negative

C_x negative
C_y zero

Scalar Component Followup



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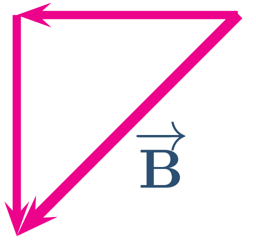

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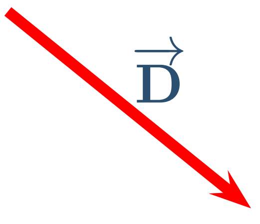

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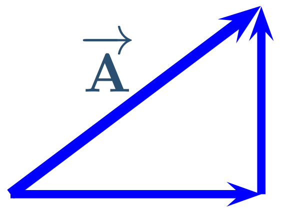

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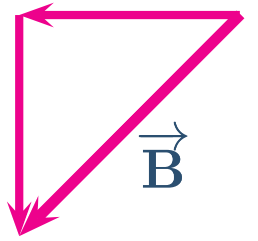

B_x negative
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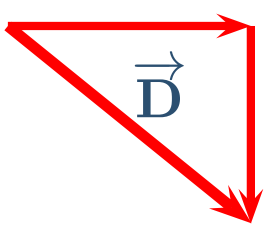

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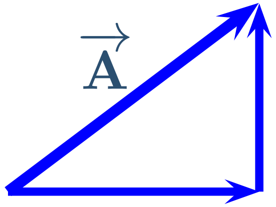

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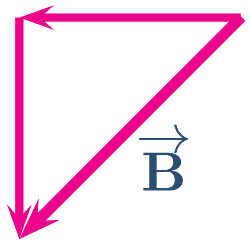

B_x negative
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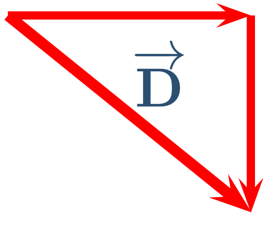
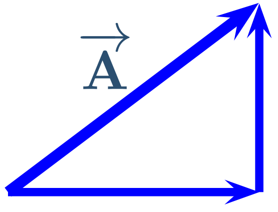
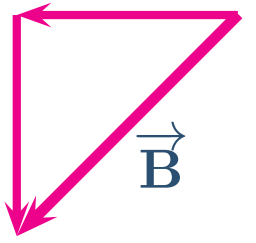


D_x positive
D_y negative

Scalar Component Followup



A_x positive
A_y positive



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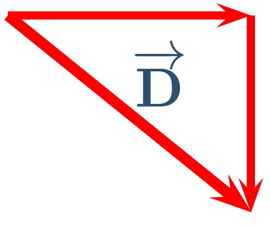

D_x positive
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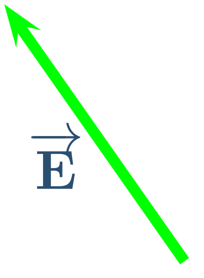

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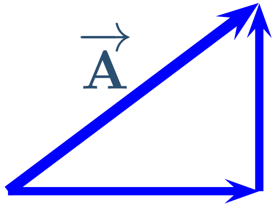

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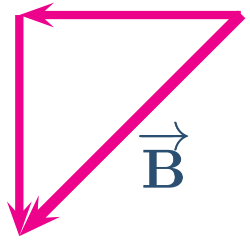

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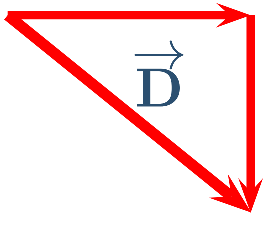

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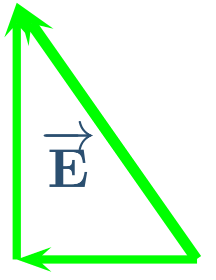

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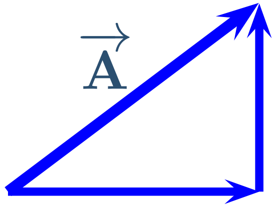

A_x positive
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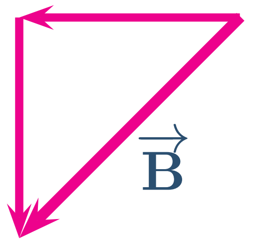

B_x negative
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C_x negative
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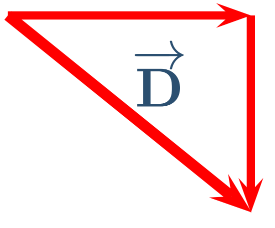
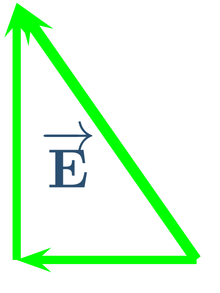


D_x positive
D_y negative



E_x negative
E_y positive

Trigonometry

The scalar components' numerical values are found using trigonometry since the magnitude and the scalar components always form a right triangle.

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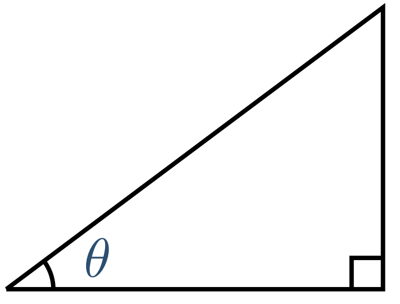

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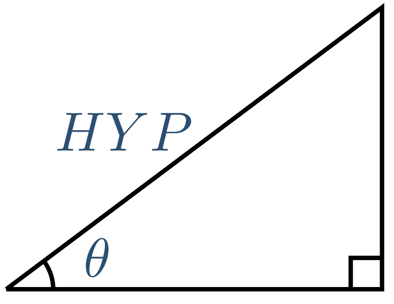

$HYP =$ Length of the Hypotenuse

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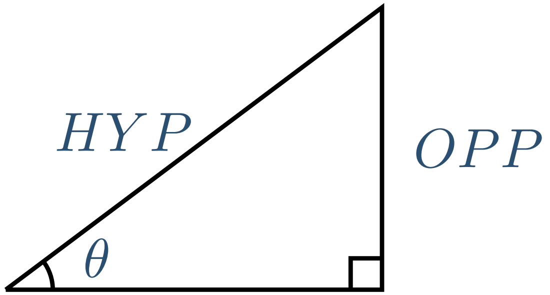

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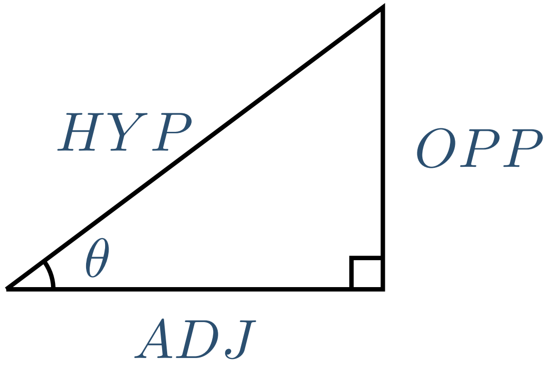

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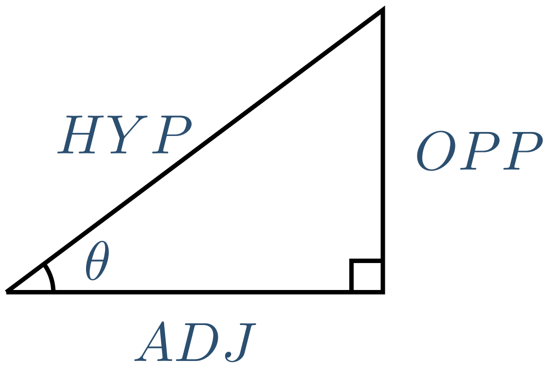

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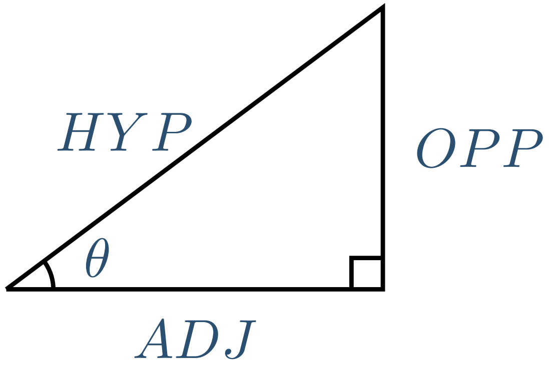

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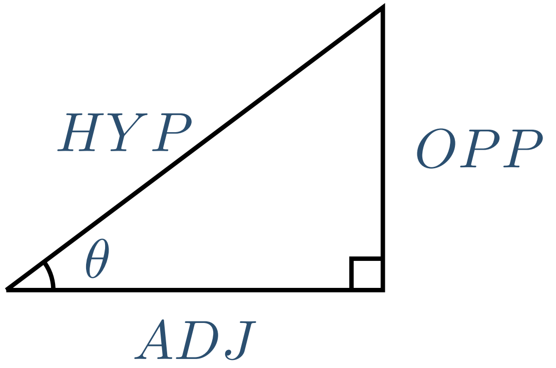

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Tangent Function: $\tan\theta = \frac{OPP}{ADJ}$

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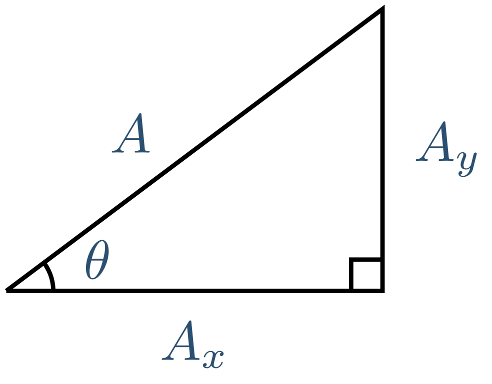

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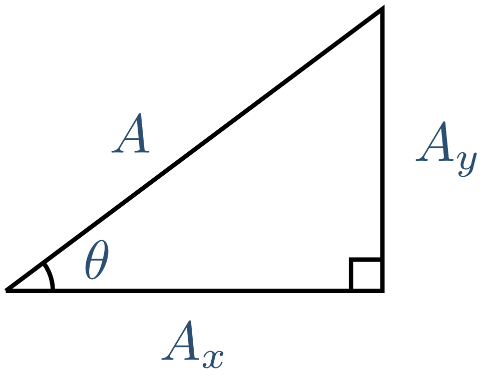

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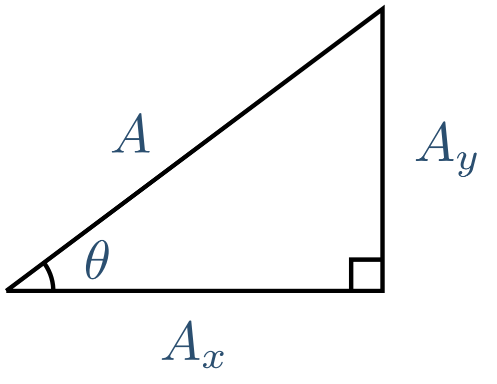

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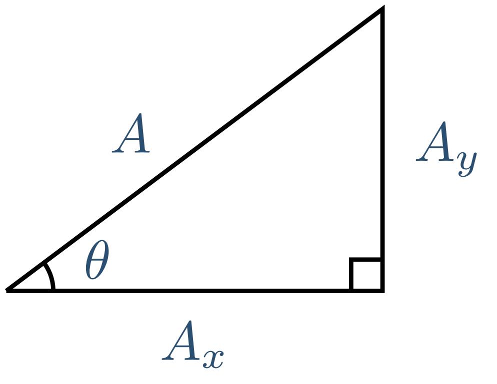

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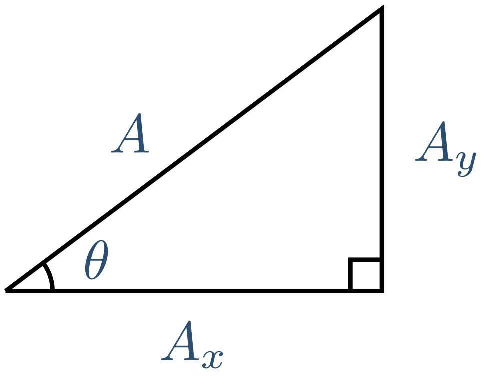

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Component Exercise

Find the components of the vector $\overrightarrow{\mathbf{r}} = 5\,m$ at $110°$.

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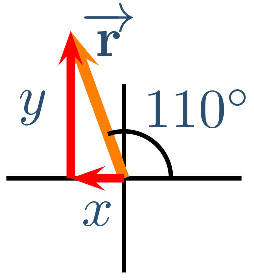


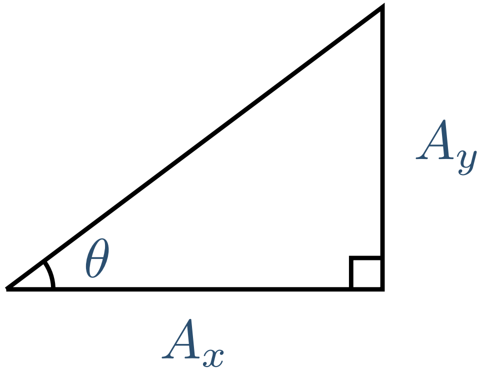
Using the standard angle automatically gives correct signs:

$x = (5\,m)\cos 110° = -1.71\,m$

$y = (5\,m)\sin 110° = 4.7\,m$

Scalar Components II

To find the magnitude and the angle *from* the components:



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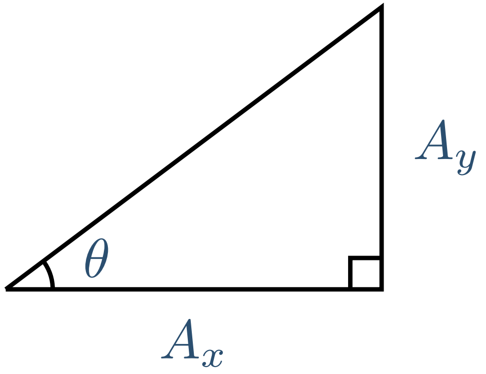

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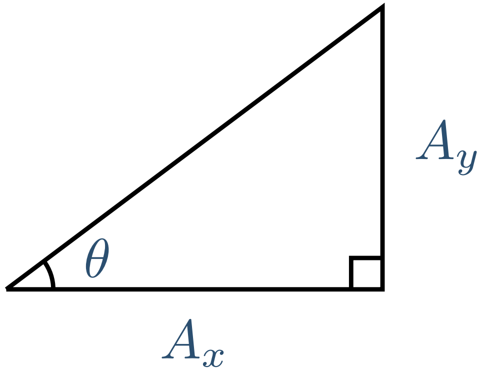

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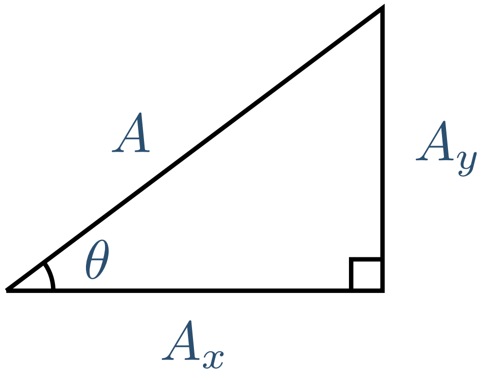

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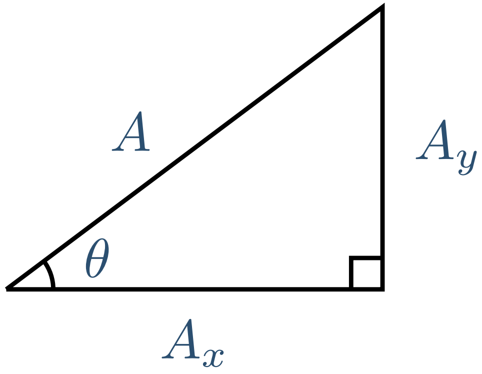

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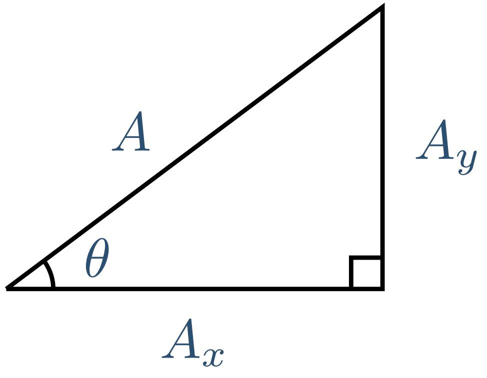

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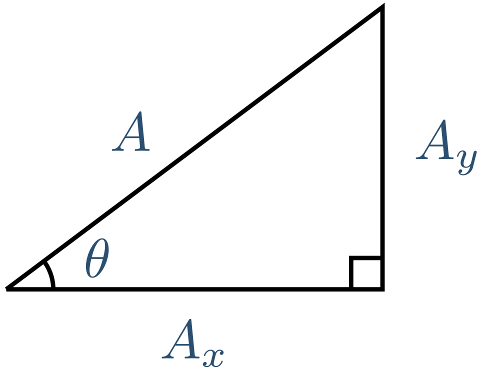

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Example: Find the magnitude and direction for the vector with components $A_x = 1\,m$ and $A_y = 1\,m$.

Quadrants

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Example: Find the magnitude and direction for the vector with components $A_x = -1\,m$ and $A_y = -1\,m$.

Quadrants

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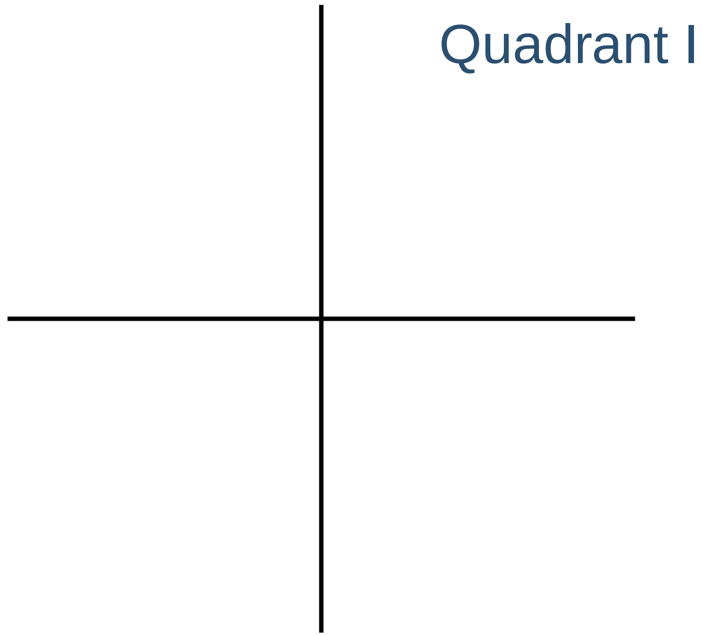
Example: Find the magnitude and direction for the vector with components $A_x = -1\,m$ and $A_y = -1\,m$.



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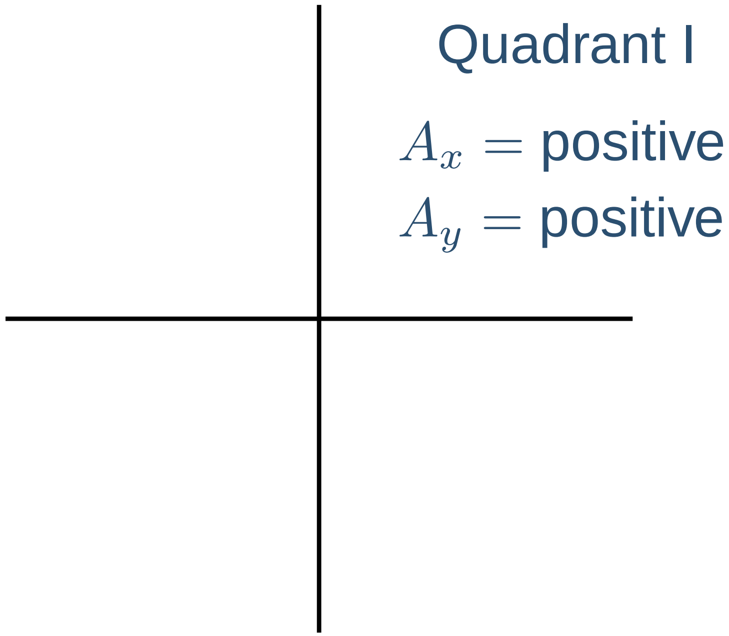

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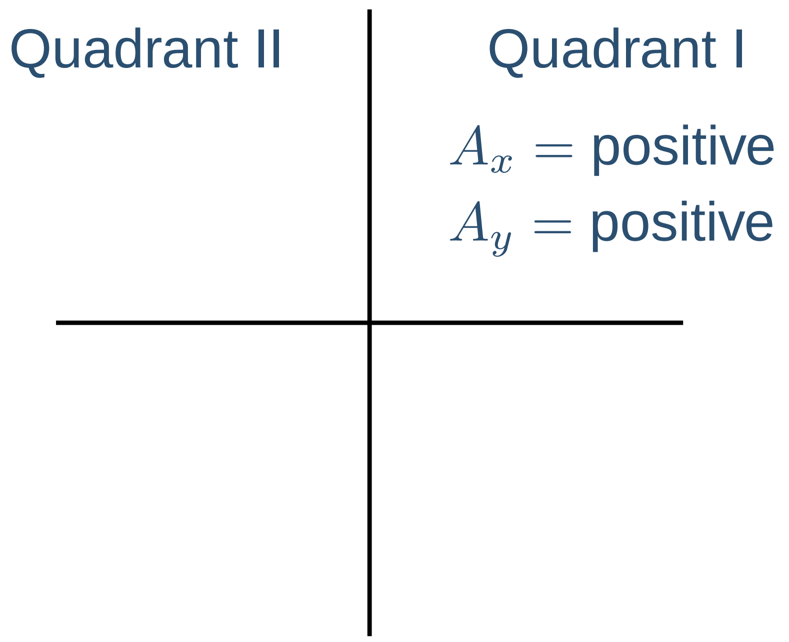

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Example: Find the magnitude and direction for the vector with components $A_x = -1\,m$ and $A_y = -1\,m$.

Quadrant II

$A_x =$ negative
$A_y =$ positive

Quadrant I

$A_x =$ positive
$A_y =$ positive

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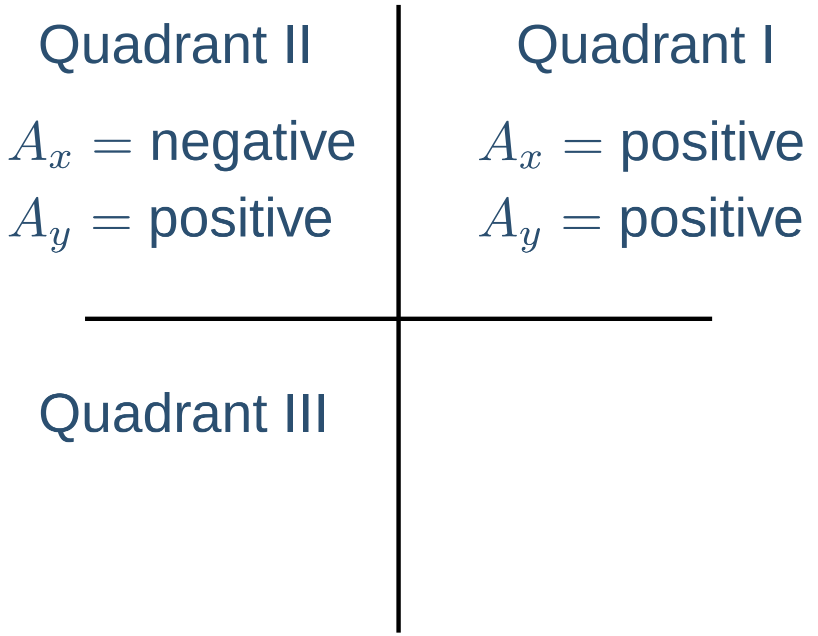

Quadrants

Sometimes your calculator will be wrong in finding angles!

Example: Find the magnitude and direction for the vector with components $A_x = -1\,m$ and $A_y = -1\,m$.

Quadrant II	Quadrant I
$A_x =$ negative $A_y =$ positive	$A_x =$ positive $A_y =$ positive
Quadrant III	
$A_x =$ negative $A_y =$ negative	

Quadrants

Sometimes your calculator will be wrong in finding angles!

Example: Find the magnitude and direction for the vector with components $A_x = -1\,m$ and $A_y = -1\,m$.

Quadrant II $A_x =$ negative $A_y =$ positive	Quadrant I $A_x =$ positive $A_y =$ positive
Quadrant III $A_x =$ negative $A_y =$ negative	Quadrant IV

Quadrants

Sometimes your calculator will be wrong in finding angles!

Example: Find the magnitude and direction for the vector with components $A_x = -1\,m$ and $A_y = -1\,m$.

Quadrant II $A_x =$ negative $A_y =$ positive	Quadrant I $A_x =$ positive $A_y =$ positive
Quadrant III $A_x =$ negative $A_y =$ negative	Quadrant IV $A_x =$ positive $A_y =$ negative

Component Exercise

Which of the following is the correct standard angle for the vector with components $x = -3\,m$, $y = 4\,m$?

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(a) $\theta = 127°$

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(c) $\theta = 307°$

Component Exercise

Which of the following is the correct standard angle for the vector with components $x = -3\,m$, $y = 4\,m$?

(a) $\theta = 127°$

(b) $\theta = -53°$

(c) $\theta = 307°$

(d) $\theta = 233°$

Component Exercise

Which of the following is the correct standard angle for the vector with components $x = -3\,m$, $y = 4\,m$?

(a) $\theta = 127°$

(b) $\theta = -53°$

(c) $\theta = 307°$

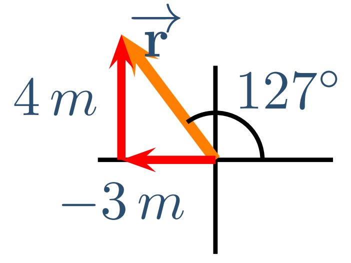
(d) $\theta = 233°$

(e) $\theta = 53°$

Component Exercise

Which of the following is the correct standard angle for the vector with components $x = -3\,m$, $y = 4\,m$?

(a) $\theta = 127°$



(b) $\theta = -53°$

$\tan^{-1}(-4/3) = -53° \leftarrow$ wrong quadrant

$\theta = -53° + 180° = 127°$

(c) $\theta = 307°$

(d) $\theta = 233°$

(e) $\theta = 53°$

Component Addition

While we **cannot** add the magnitudes of vectors. We can add the components.

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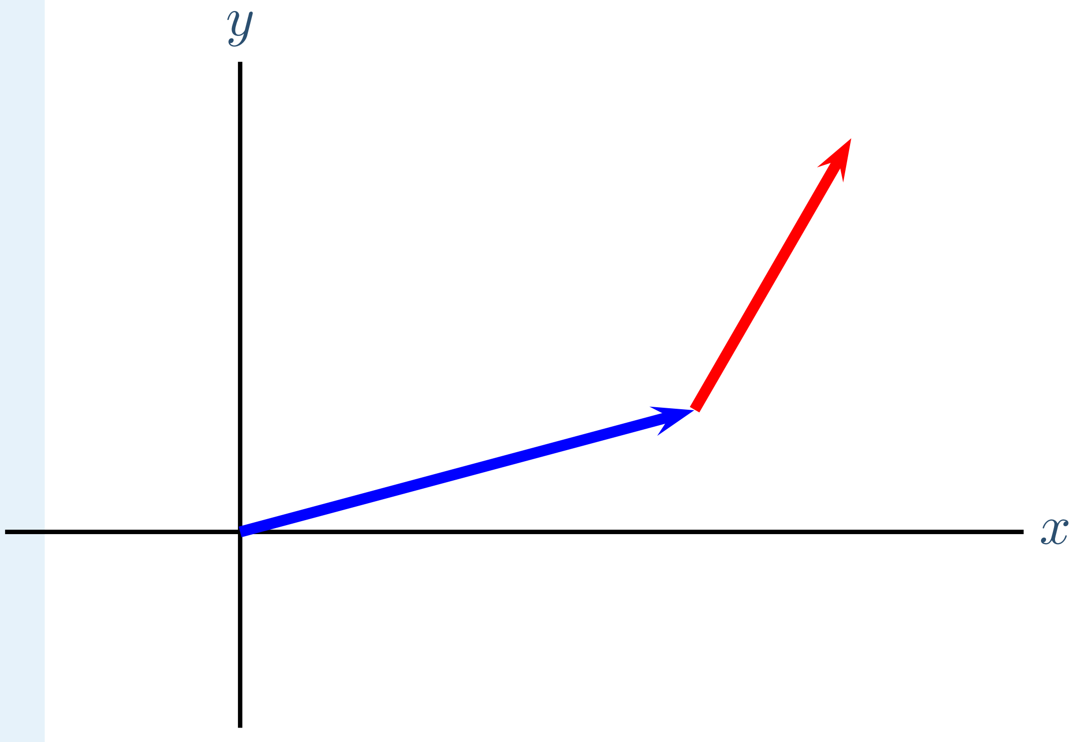

Assume:

$\overrightarrow{\mathbf{A}}$

$\overrightarrow{\mathbf{B}}$

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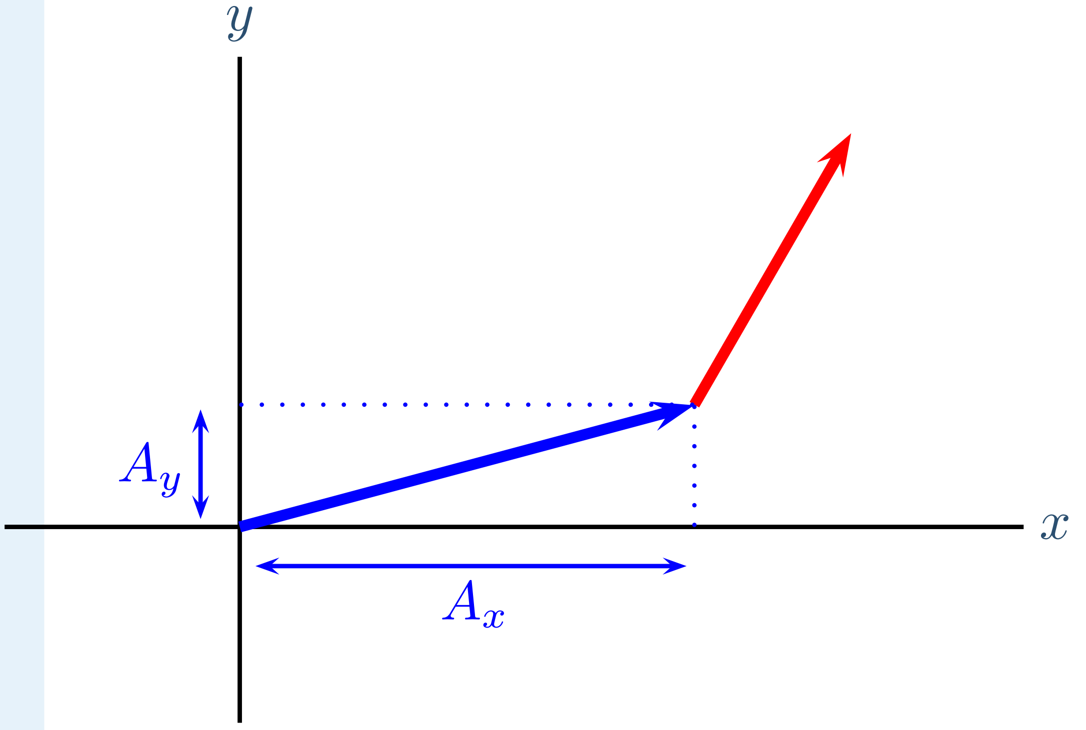

Find the components of $\vec{\mathbf{A}}$

Component Addition

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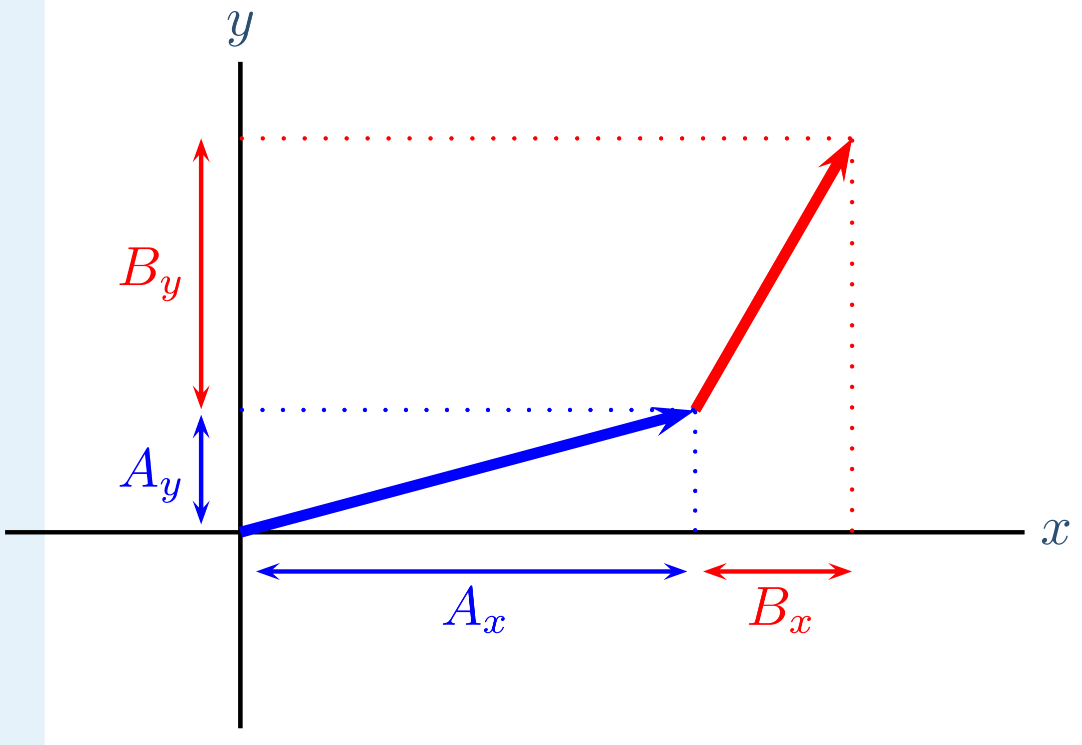

Find the components of $\vec{\mathbf{B}}$

Component Addition

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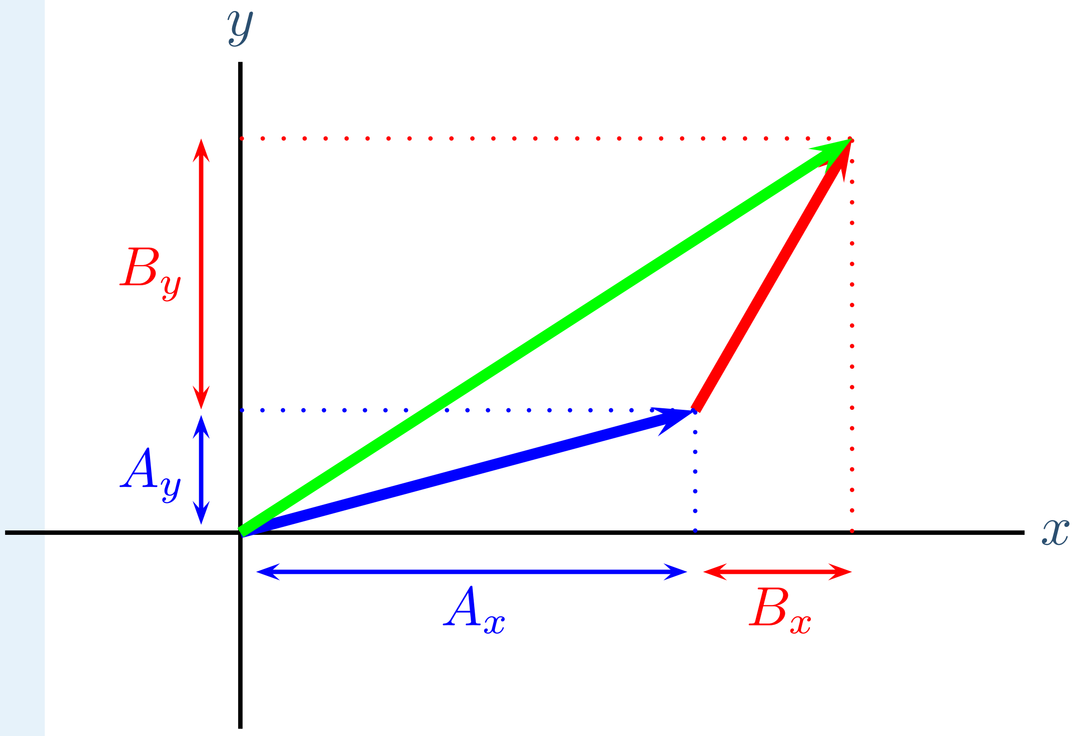

Find the vector sum $\overrightarrow{\mathbf{R}}$

Component Addition

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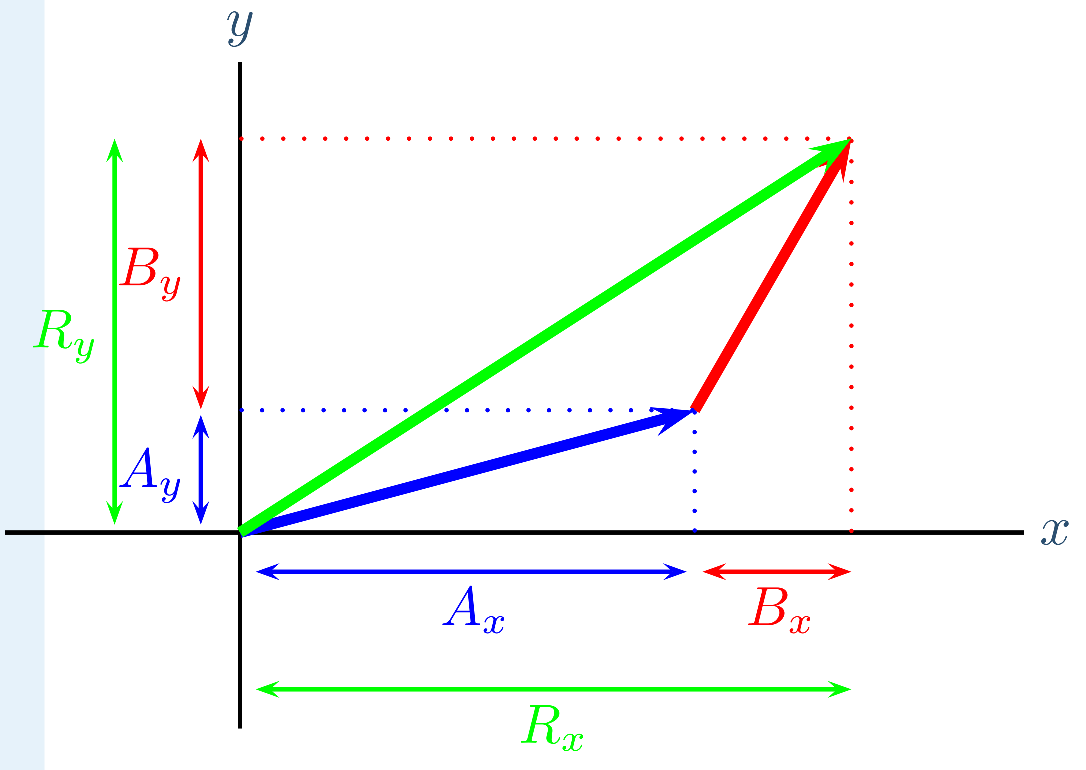


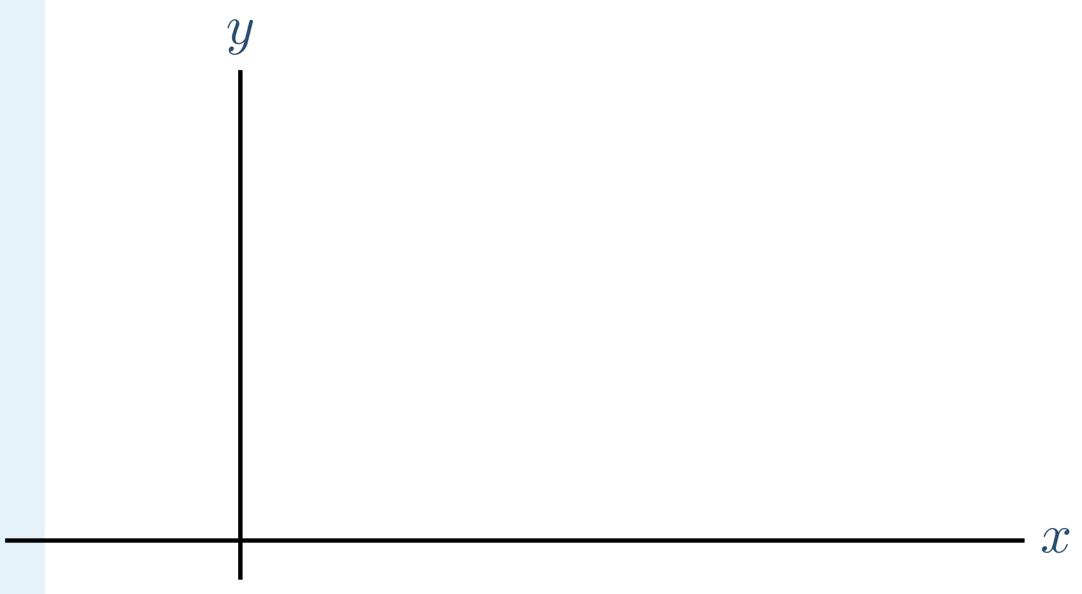
The components of $\overrightarrow{\mathbf{R}}$:

$$R_x = A_x + B_x$$
$$R_y = A_y + B_y$$

Unit Vectors

A compact and efficient way of expressing a vector in terms of its components is to use unit vectors.

Each unit vector has magnitude 1 and points along each axis. We use the symbols $\hat{\imath}$, $\hat{\jmath}$, and $\hat{\mathbf{k}}$ for the unit vectors along the x, y, and z axes.



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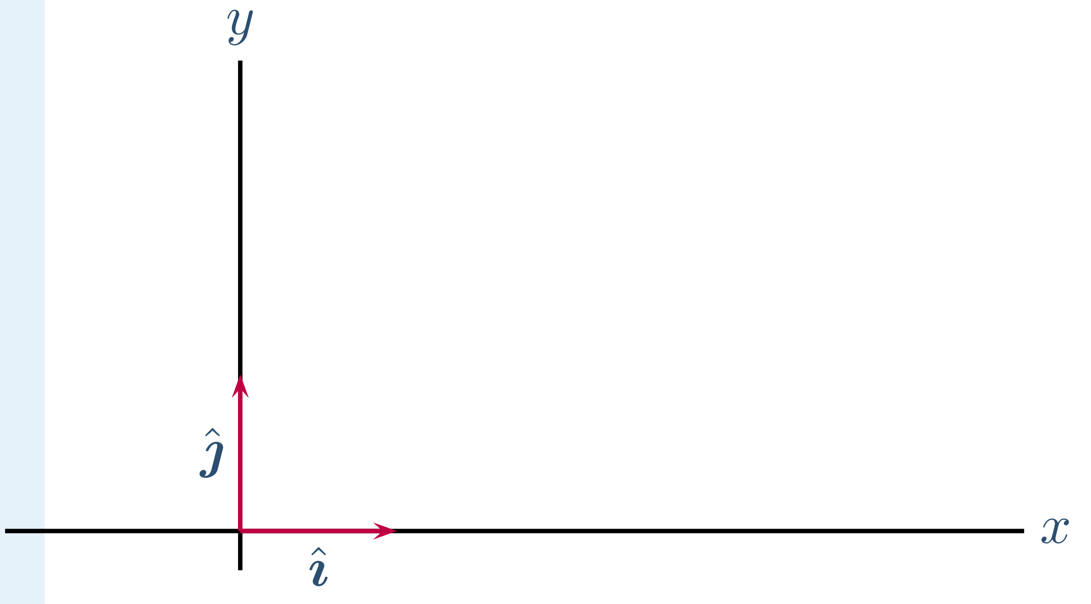

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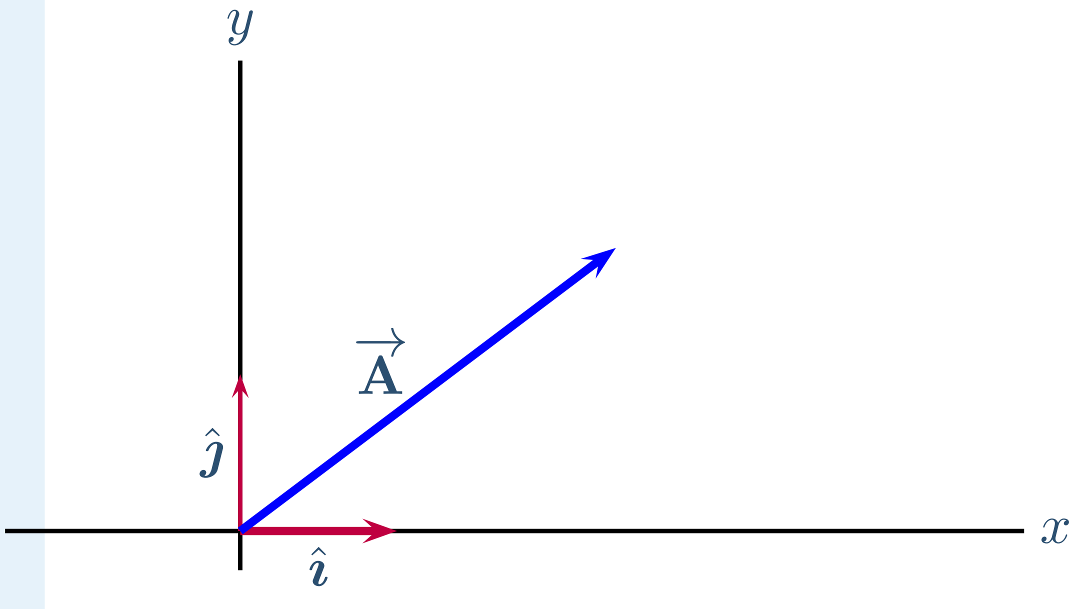

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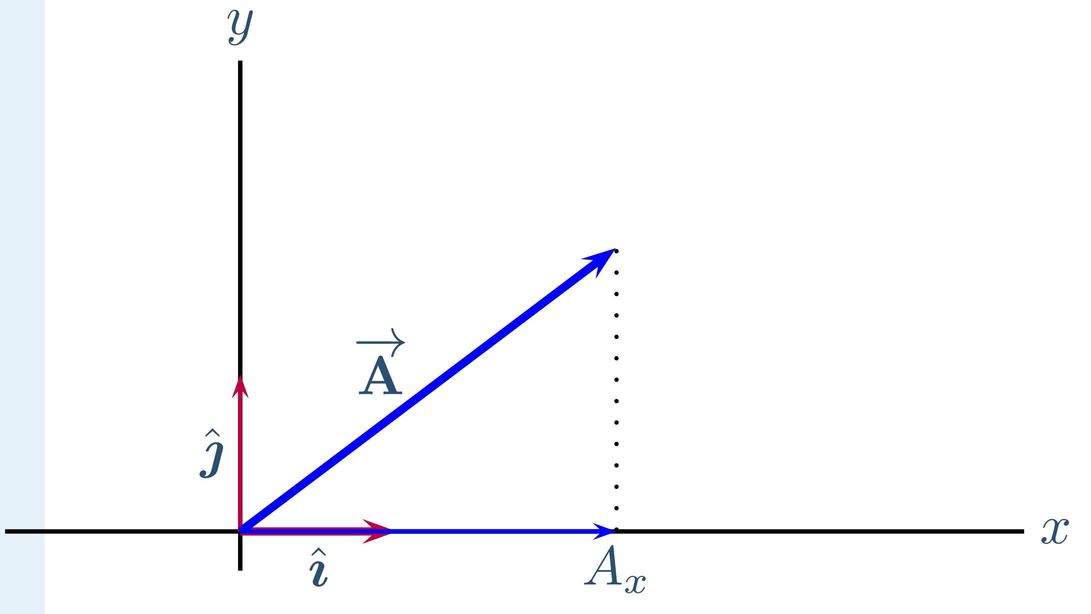

$$\overrightarrow{\mathbf{A}}_x = A_x \hat{\boldsymbol{\imath}}$$

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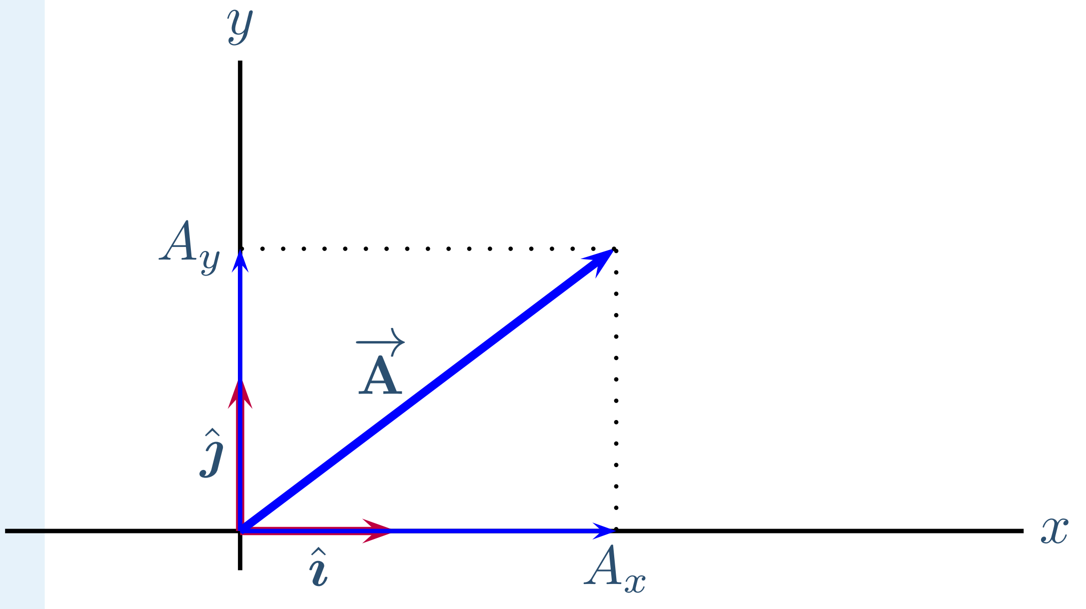

$$\overrightarrow{\mathbf{A}}_x = A_x \hat{\boldsymbol{\imath}}$$

$$\overrightarrow{\mathbf{A}}_y = A_y \hat{\boldsymbol{\jmath}}$$

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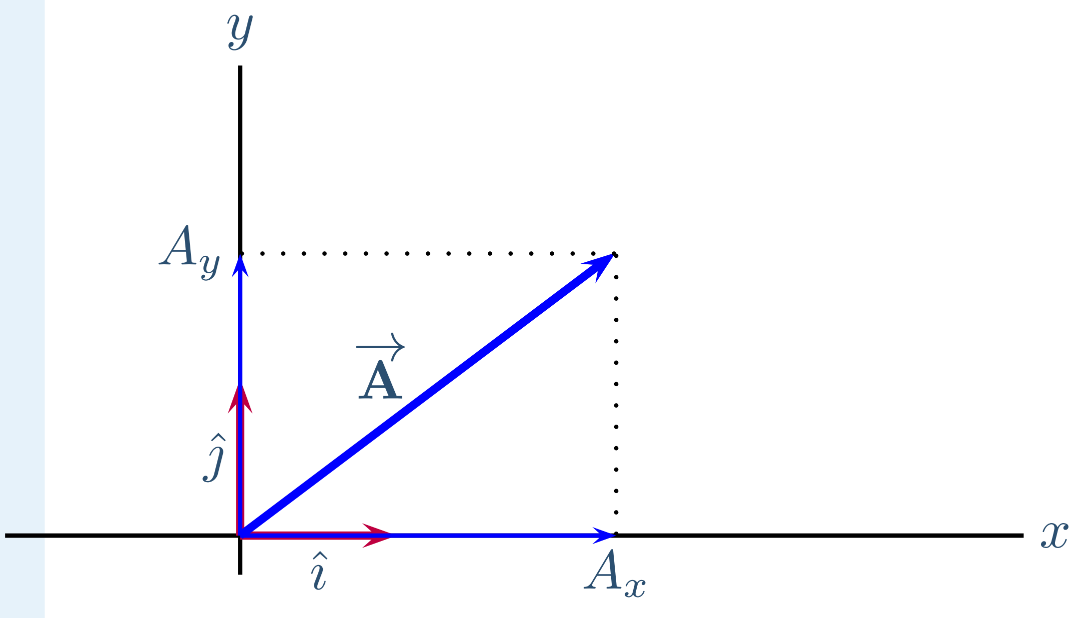

$$\overrightarrow{\mathbf{A}}_x = A_x \hat{\boldsymbol{\imath}}$$

$$\overrightarrow{\mathbf{A}}_y = A_y \hat{\boldsymbol{\jmath}}$$

$$\overrightarrow{\mathbf{A}} = \overrightarrow{\mathbf{A}}_x + \overrightarrow{\mathbf{A}}_y$$

$$\Rightarrow \boxed{\overrightarrow{\mathbf{A}} = A_x \hat{\boldsymbol{\imath}} + A_y \hat{\boldsymbol{\jmath}}}$$