February 1, Week 3

Today: Chapter 1, Vectors

Homework Assignment #3 due February 6
Mastering Physics: 3 Mastering Physics problems, 2.77, 2.85, 2.93.
Written Problem: 2.88.

Exam #1 Friday, February 10.

Practice Exam available on website.

Review

Vector - $\vec{\mathbf{A}}$, Any physical quantity which has a magnitude and direction associated with it.

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Magnitude — Direction given as angle

Review Example I

Example: Sketch the following vectors. Start all vectors at the origin. Also, assume all direction are given by the “standard" angle - from the $+x$-axis.

$$\overrightarrow{\mathbf{A}} = 5\,m/s \text{ at } 37^\circ, \overrightarrow{\mathbf{B}} = 7.5\,m/s \text{ at } 135^\circ, \overrightarrow{\mathbf{C}} = 10\,m/s \text{ at } 330^\circ$$

$$\overrightarrow{\mathbf{D}} = 10\,m/s \text{ at } -30^\circ, \overrightarrow{\mathbf{E}} = 10\,m/s \text{ at } 200^\circ$$

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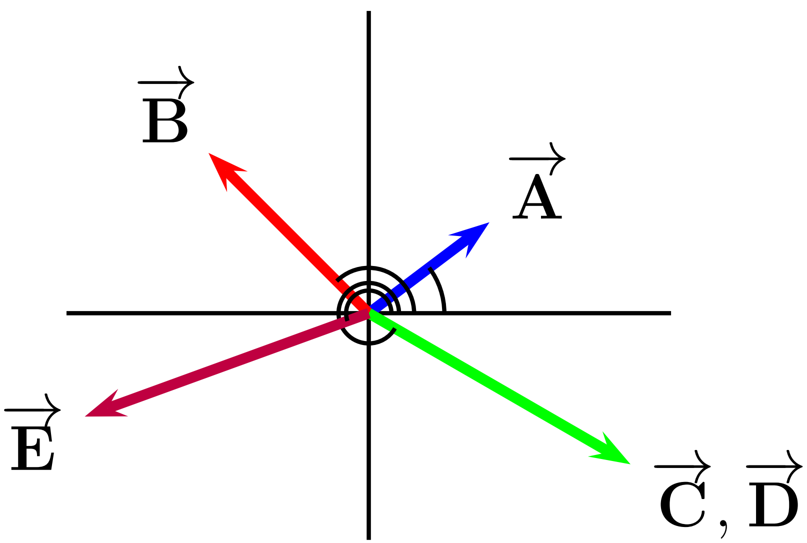


$\overrightarrow{\mathbf{C}}, \overrightarrow{\mathbf{D}}$ have same magnitude and direction

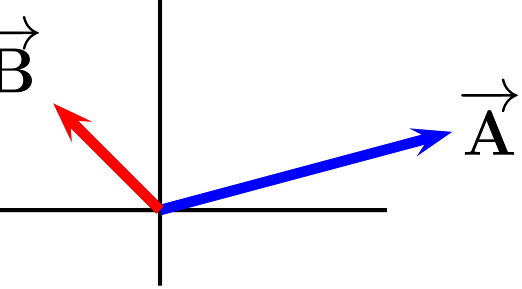
$\Rightarrow \overrightarrow{\mathbf{C}} = \overrightarrow{\mathbf{D}}$

but $\overrightarrow{\mathbf{D}} \neq \overrightarrow{\mathbf{E}}$

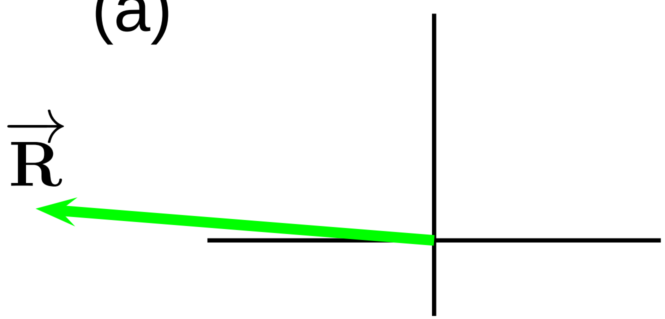
while $D = E$

Vector Addition Review

For the vectors $\vec{\mathbf{A}}$ and $\vec{\mathbf{B}}$, which of the following correctly shows $\vec{\mathbf{R}}$, where $\vec{\mathbf{R}} = \vec{\mathbf{A}} + \vec{\mathbf{B}}$?



(a)



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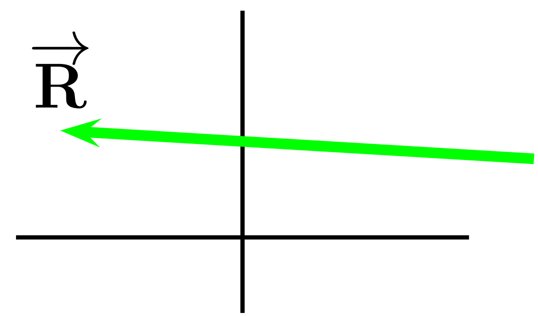

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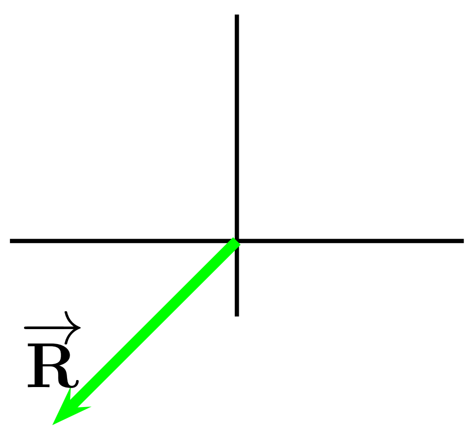

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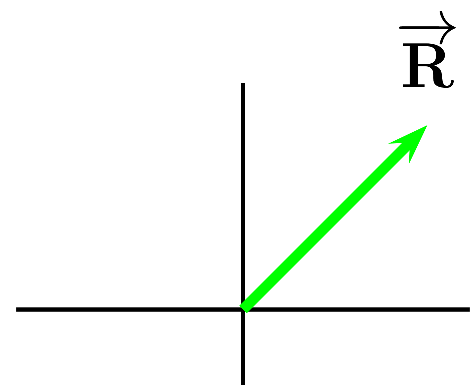

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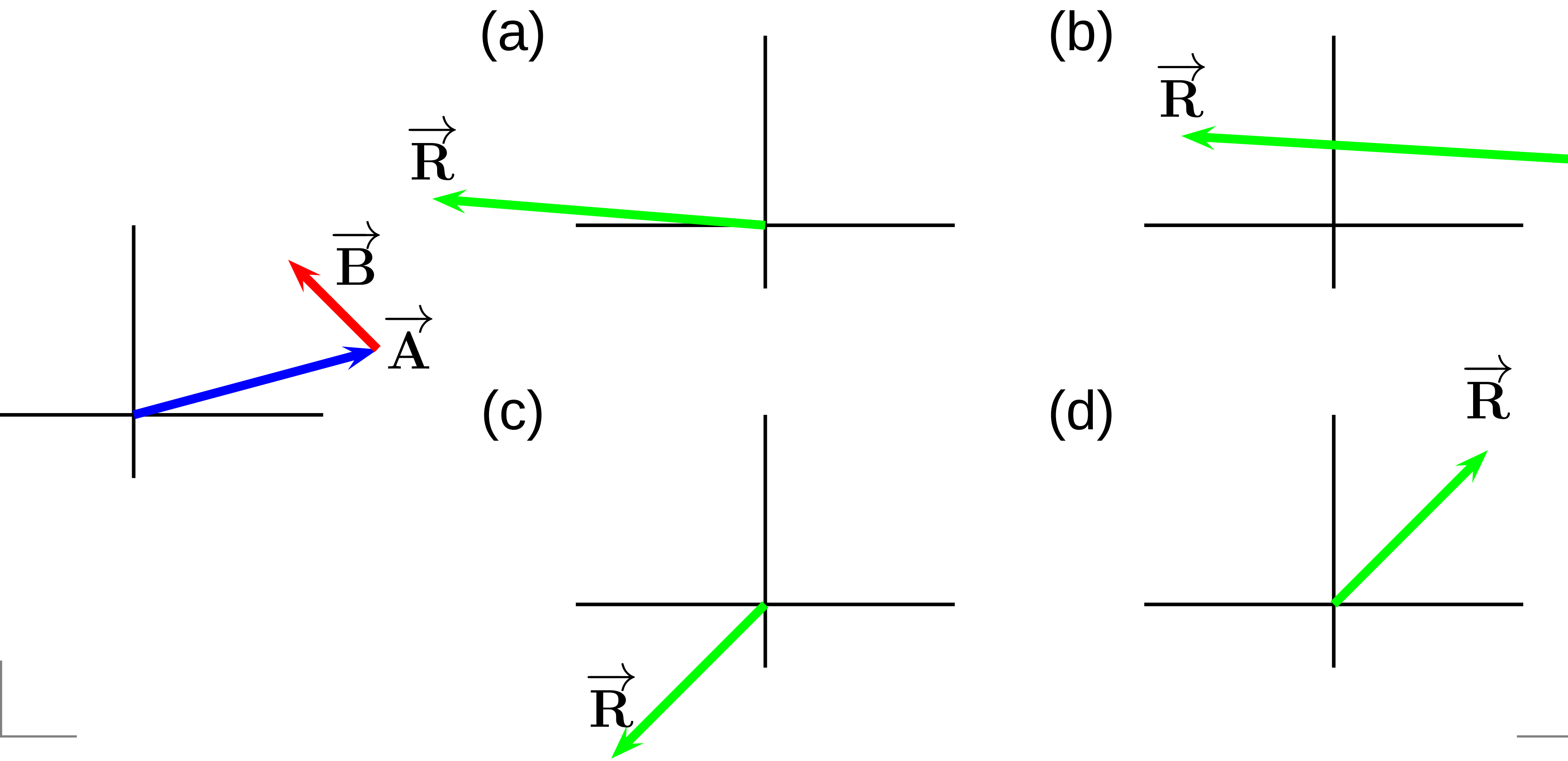

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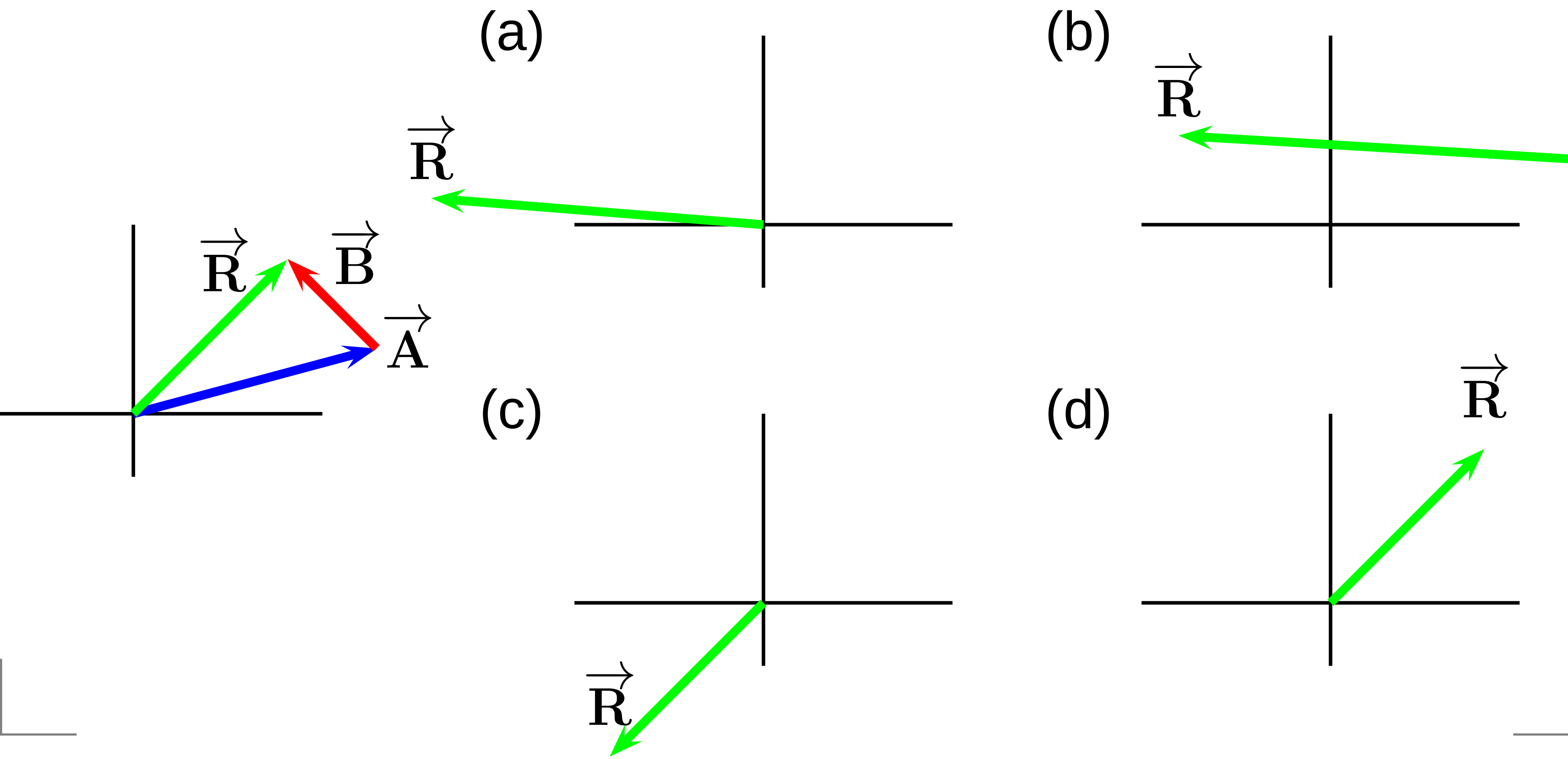

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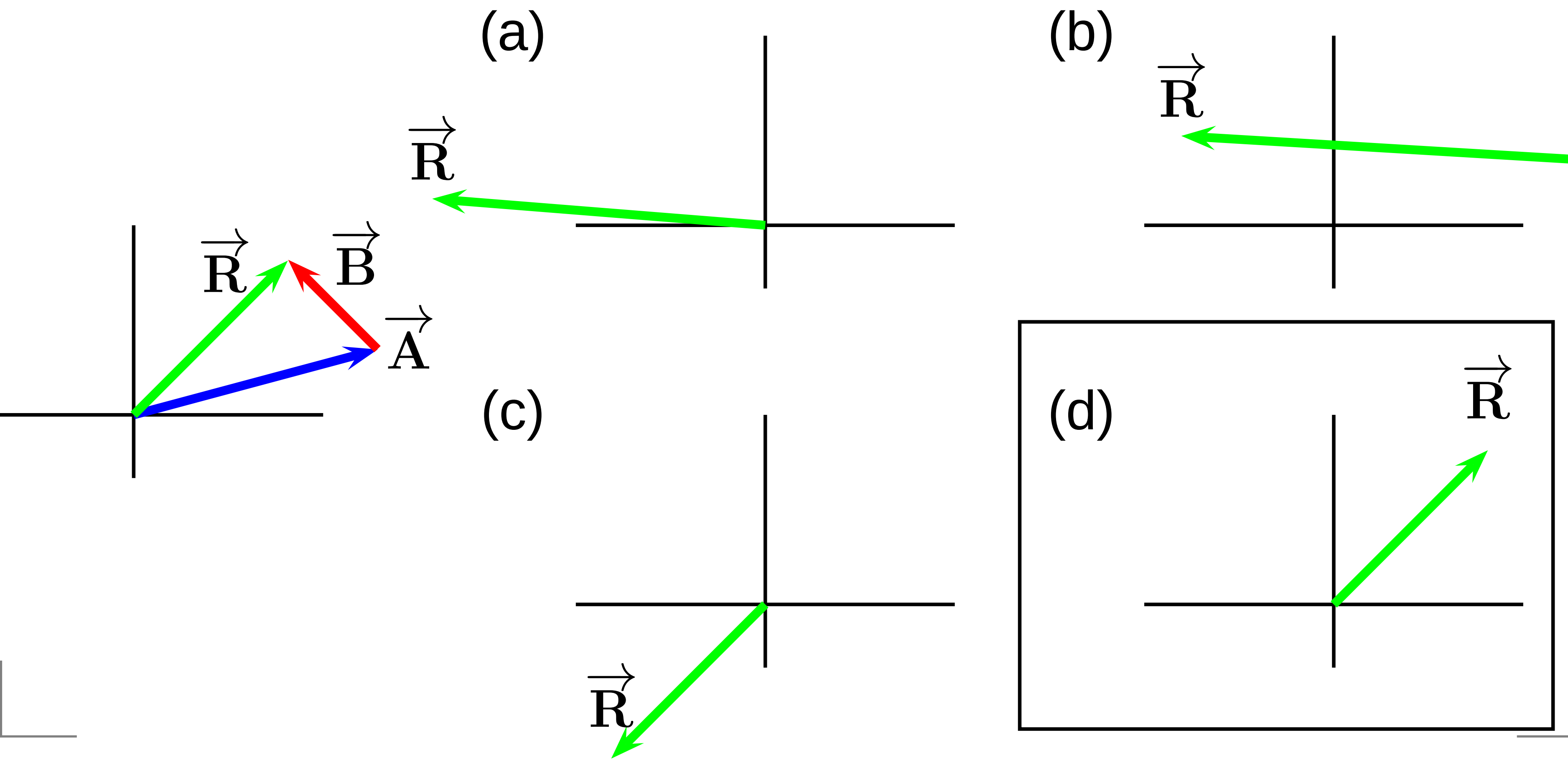

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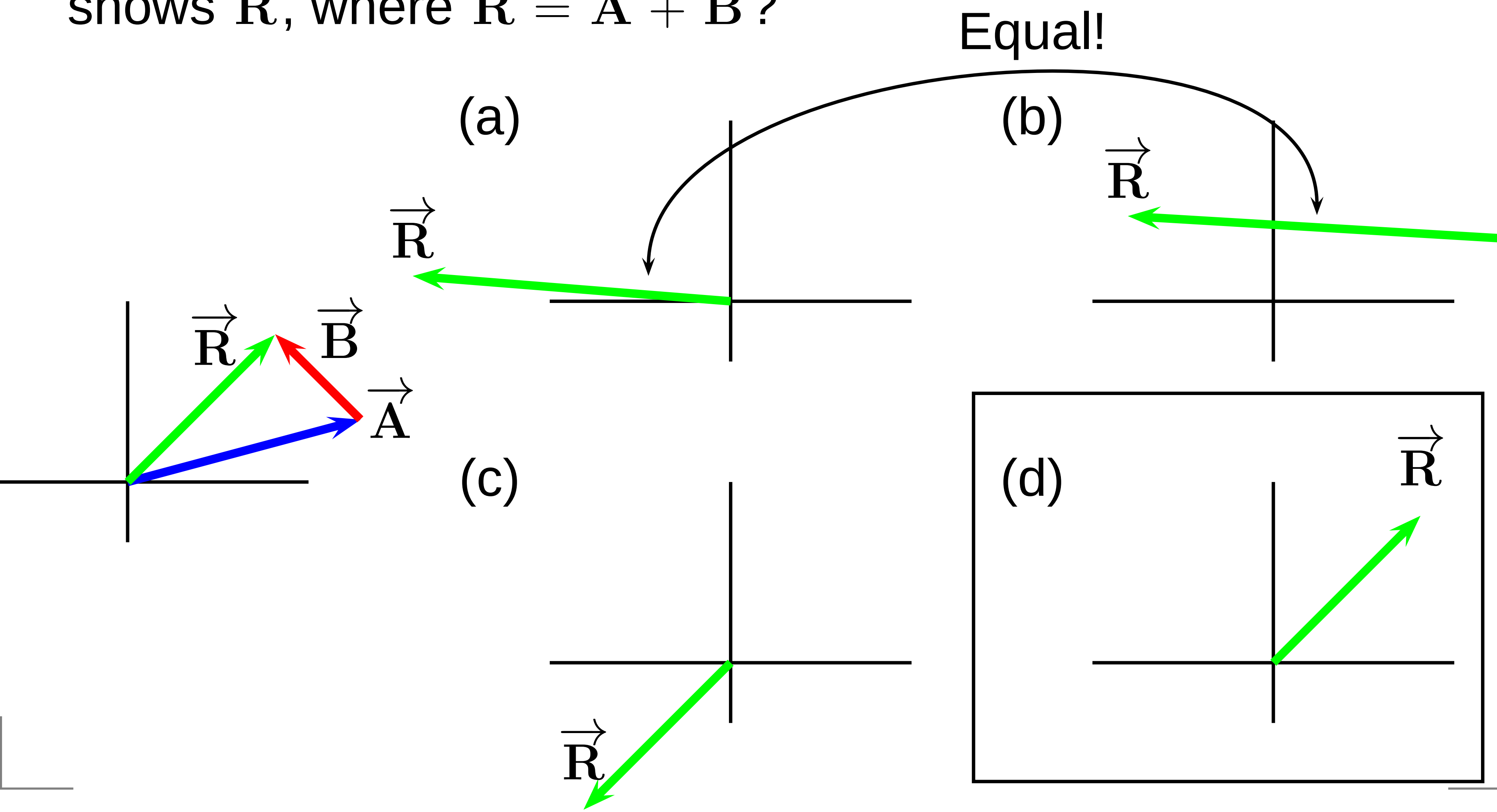

Vector Addition is commutative

You can add vectors in either order and the answer is the same!

$$\overrightarrow{\mathbf{R}} = \overrightarrow{\mathbf{A}} + \overrightarrow{\mathbf{B}} = \overrightarrow{\mathbf{B}} + \overrightarrow{\mathbf{A}}$$

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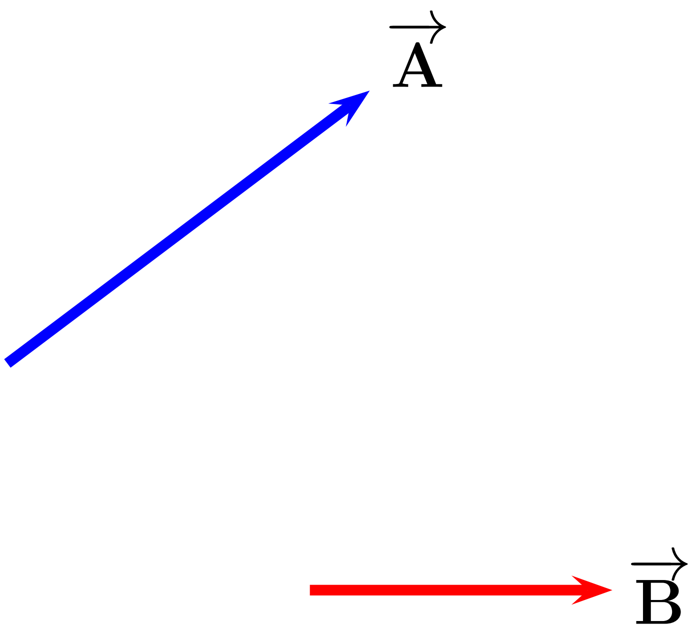

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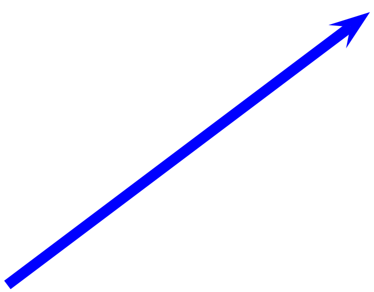

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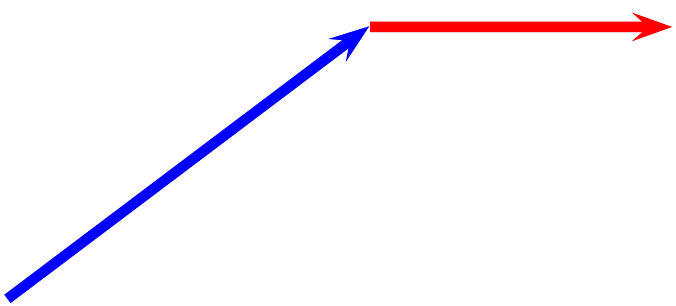

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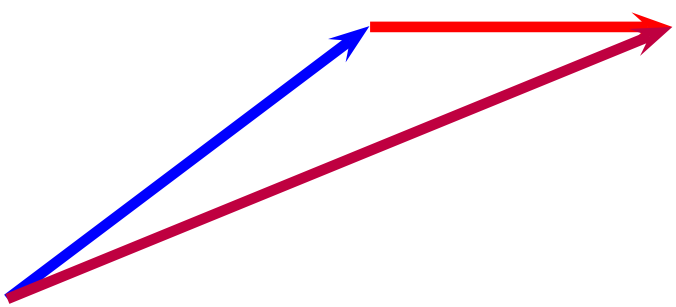

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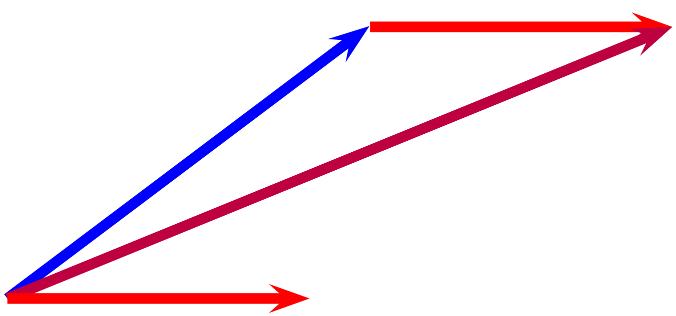

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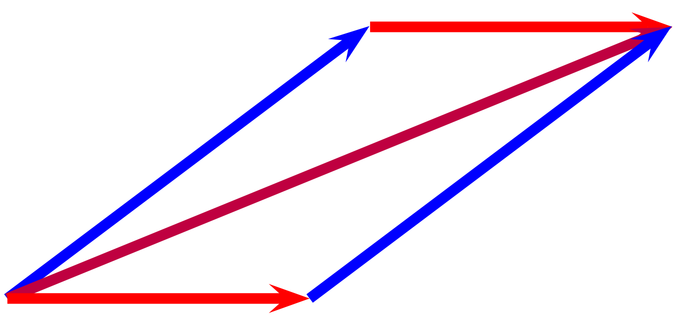

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From now on, we'll use the familiar Cartesian co-ordinate system, (x, y).

The components of a vector are the “pieces" of the vector parallel to the x and y axes.

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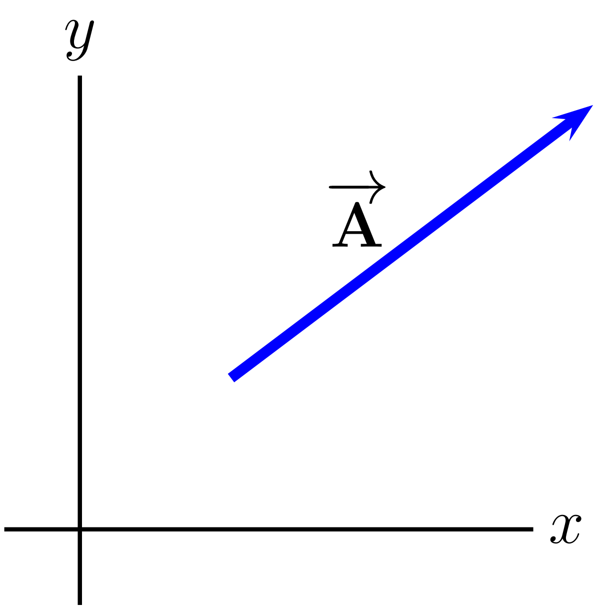

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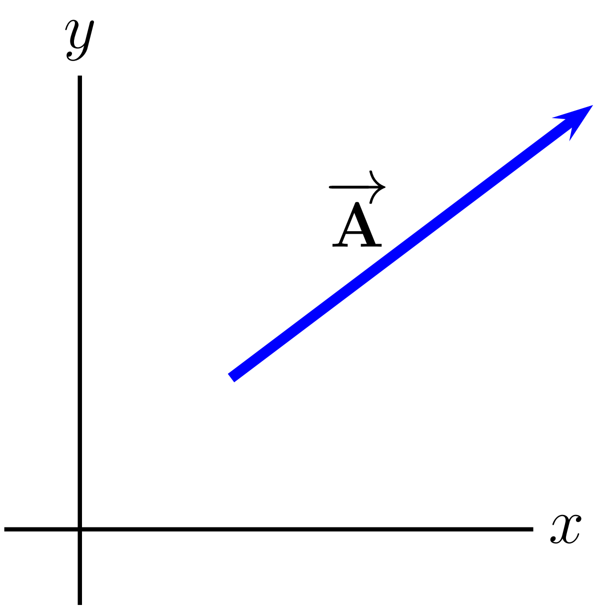

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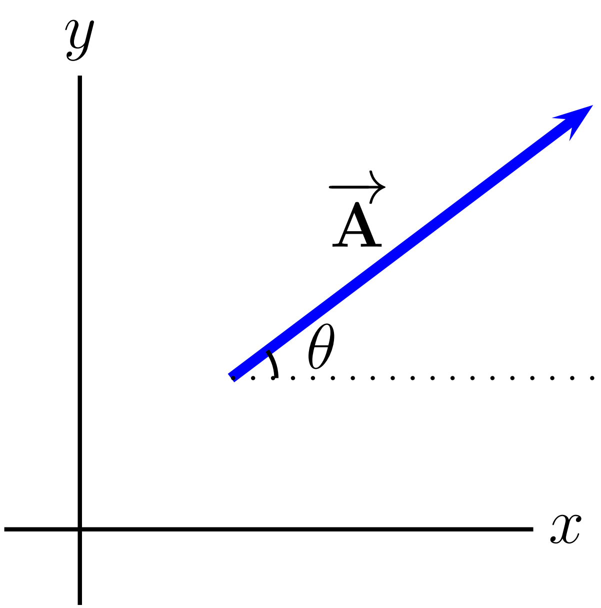

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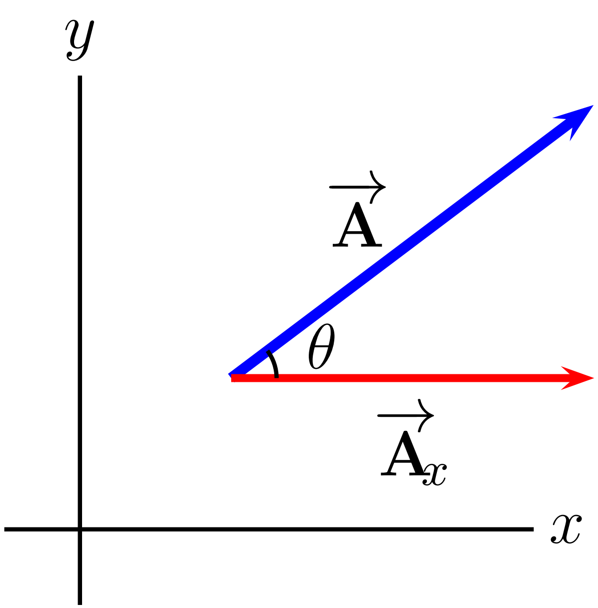

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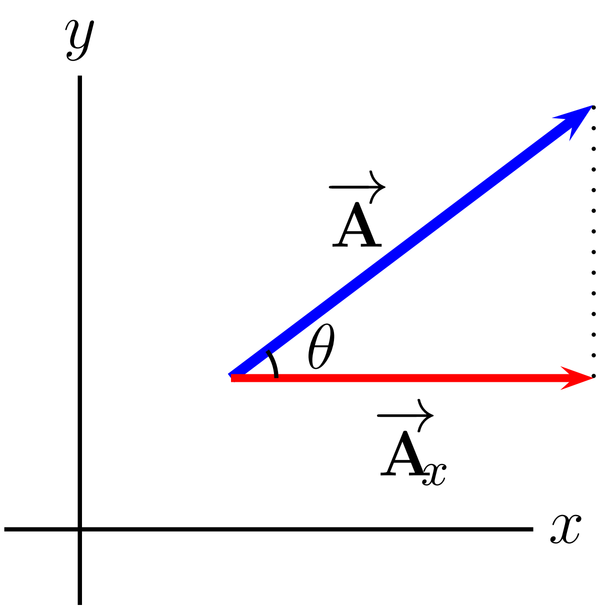

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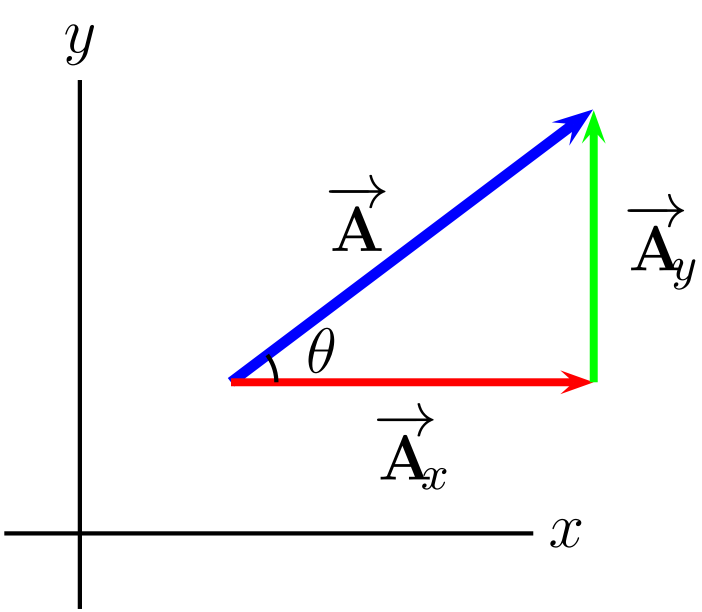

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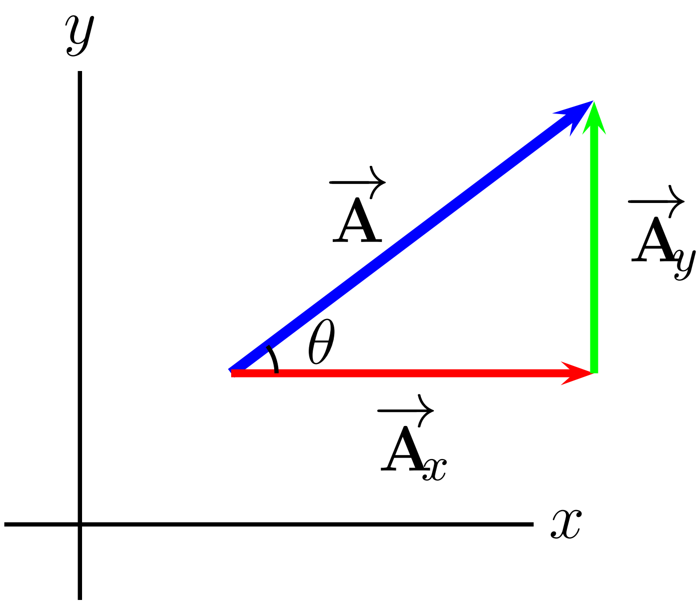

$\overrightarrow{\mathbf{A}}_x$, $\overrightarrow{\mathbf{A}}_y$ are the vector components.

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

A_x, A_y and their signs are the scalar components

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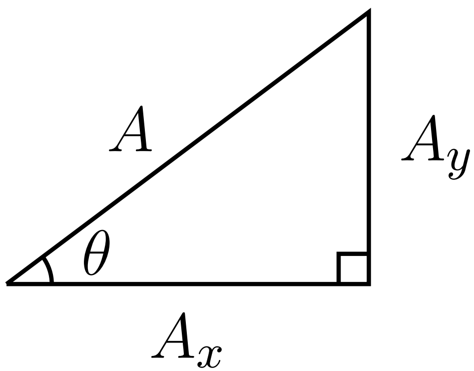

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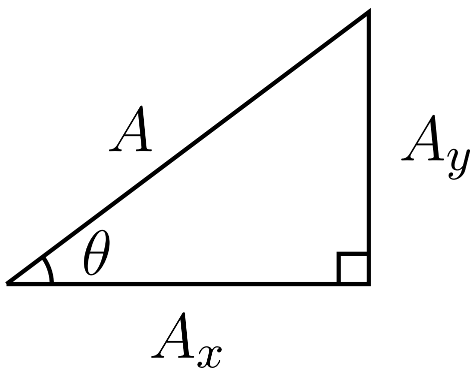

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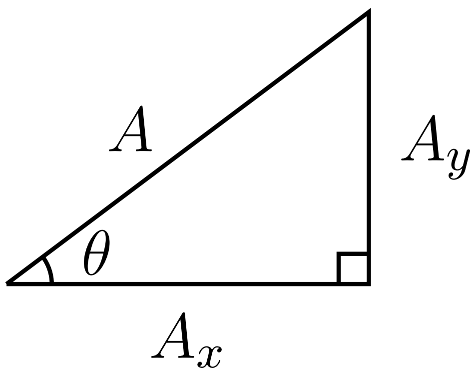

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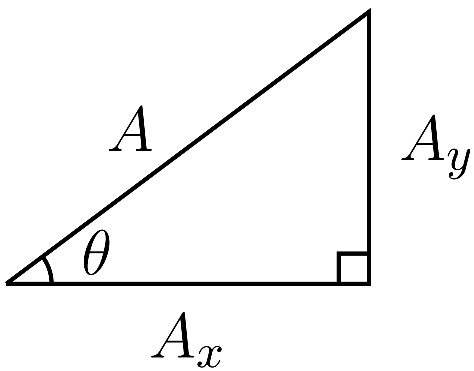

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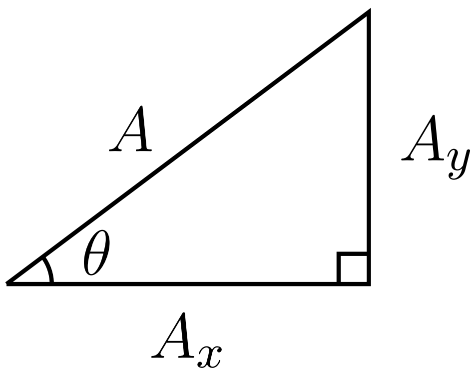

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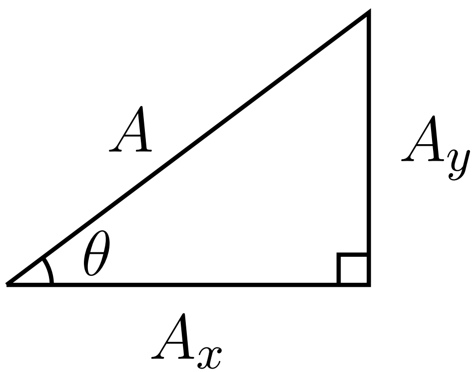

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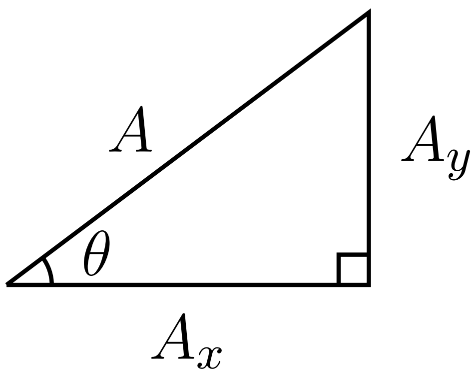

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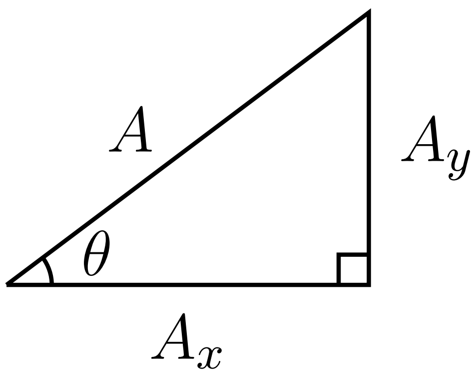

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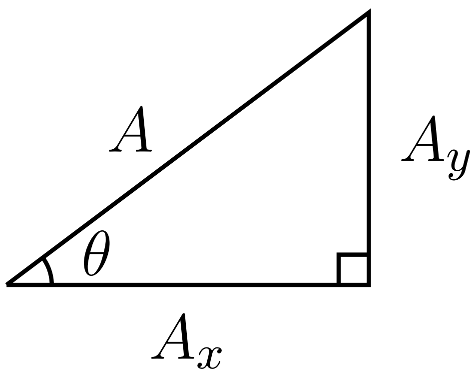

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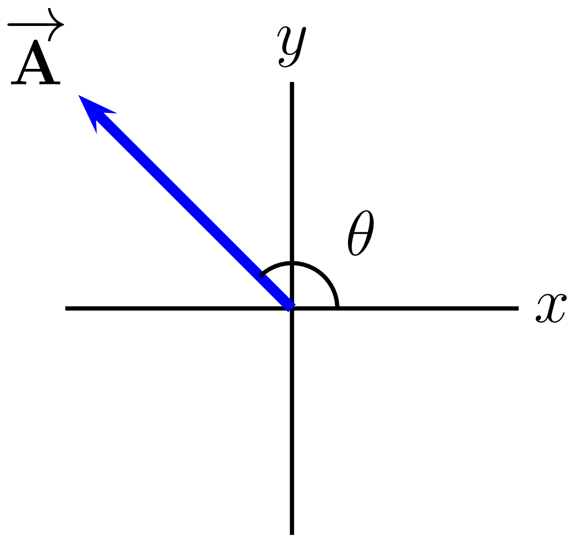

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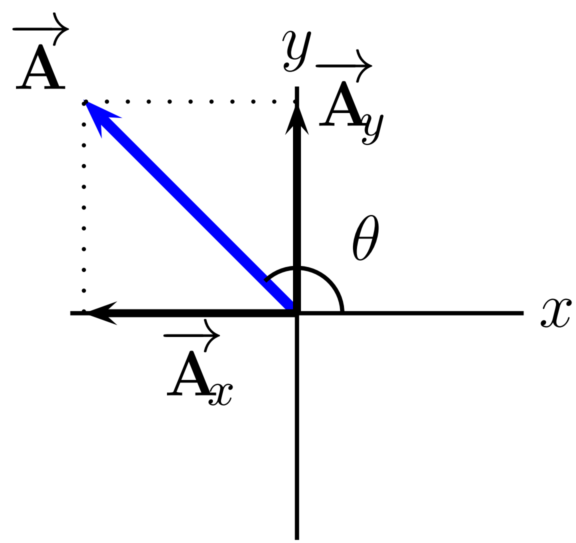

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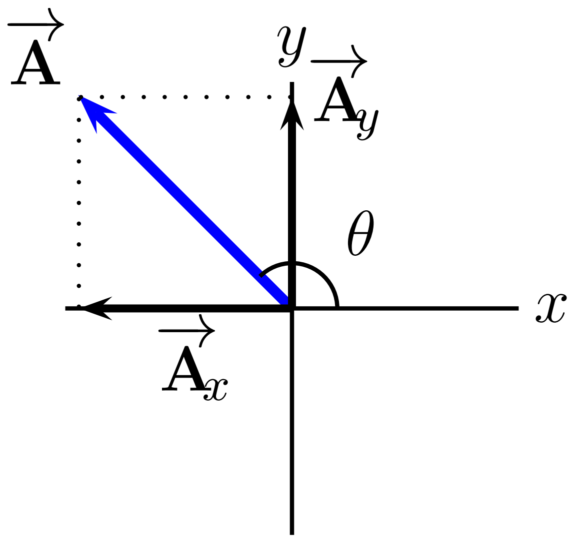
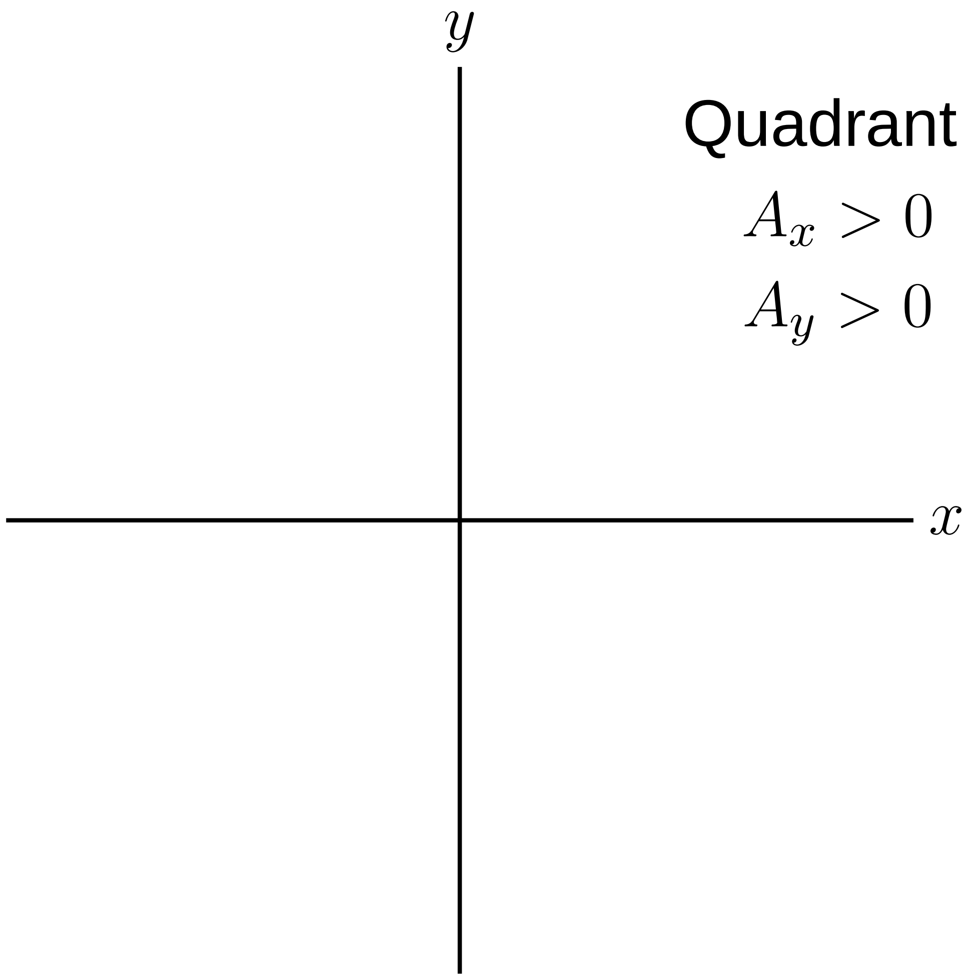


$$A_x < 0$$

$$A_y > 0$$

Quadrants II



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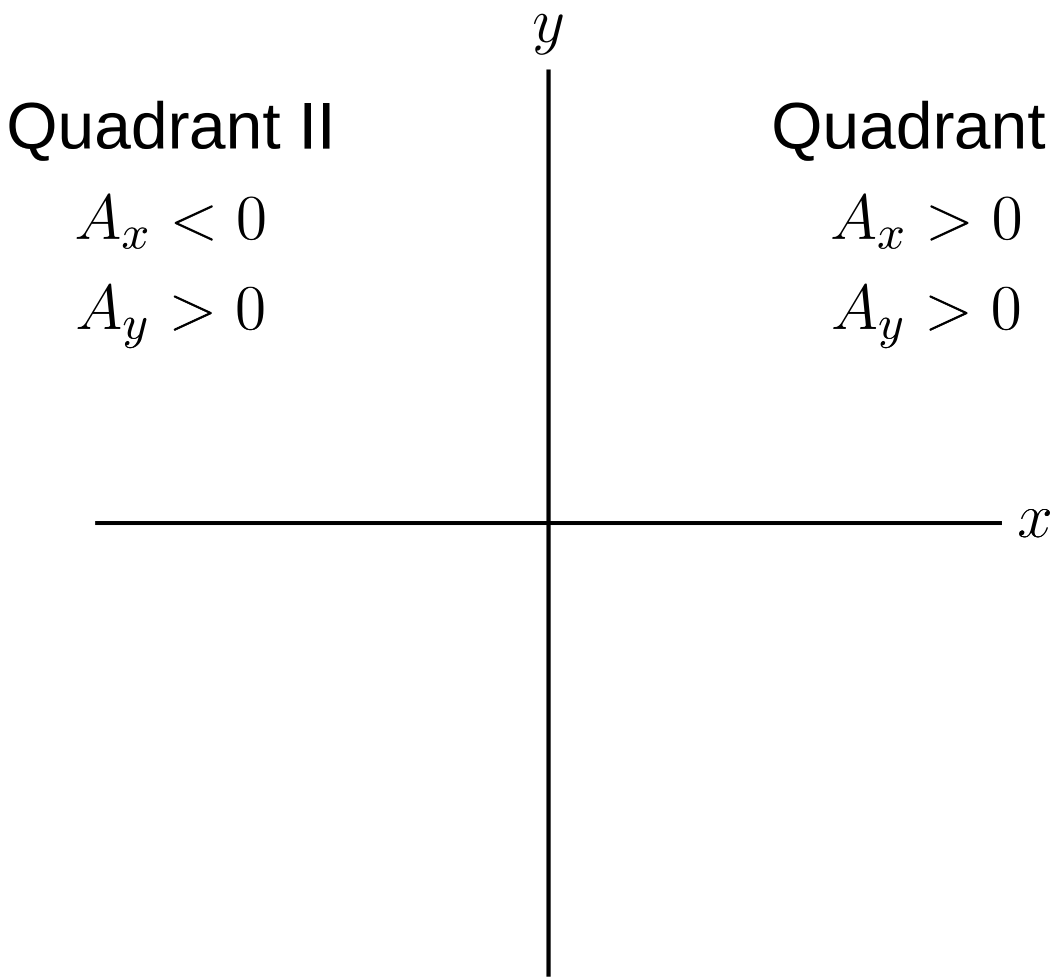

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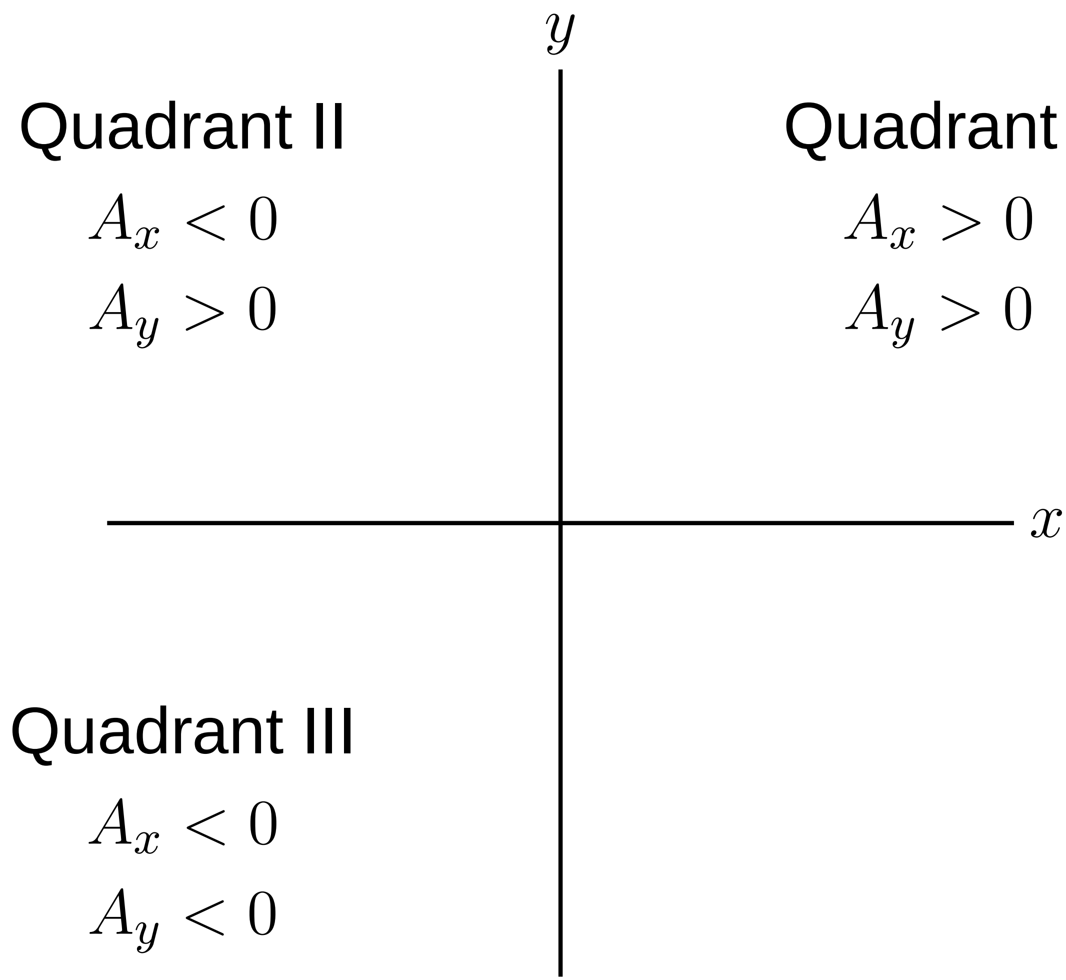

Quadrants II

y

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$A_x < 0$

$A_y > 0$

Quadrant I

$A_x > 0$

$A_y > 0$

x

Quadrant III

$A_x < 0$

$A_y < 0$

Quadrant IV

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Clicker Quiz

What is the standard-angle direction for the velocity vector with components $v_x = -3\,m/s$, $v_y = -4\,m/s$? **HINT:** $\tan^{-1}\left(\frac{4}{3}\right) = 53.13^{\circ}$.

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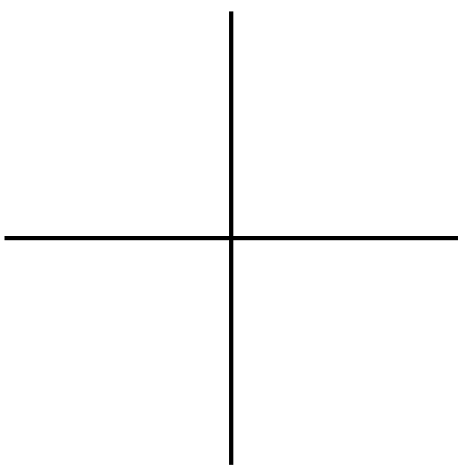

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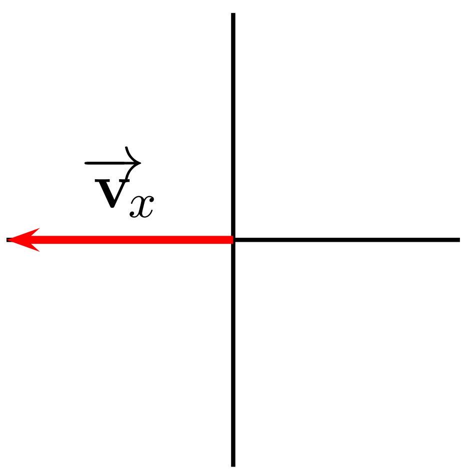

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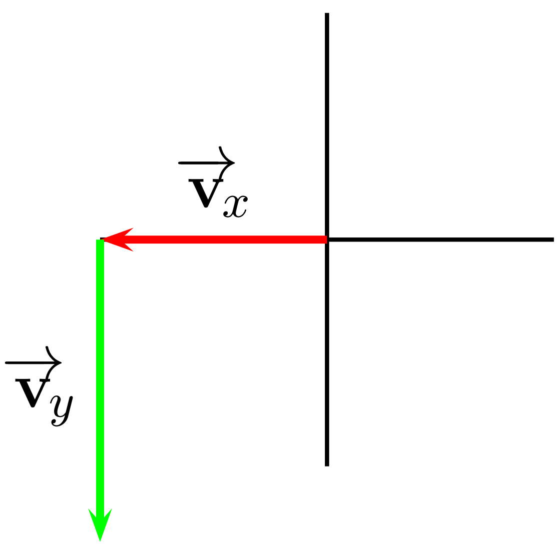

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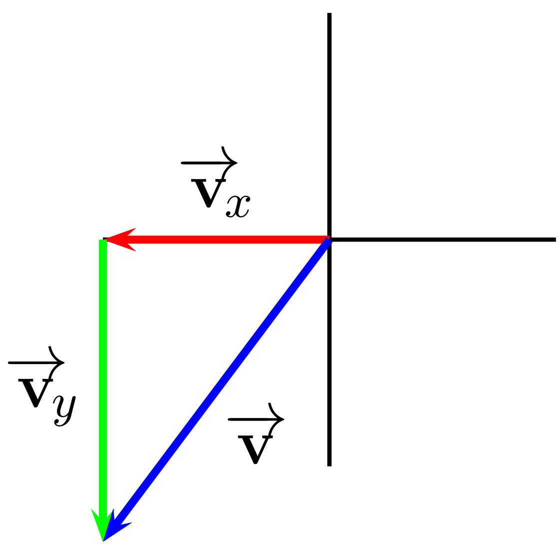

(a) 53.13°

(b) 126.87°

(c) 233.13°

(d) 306.87°

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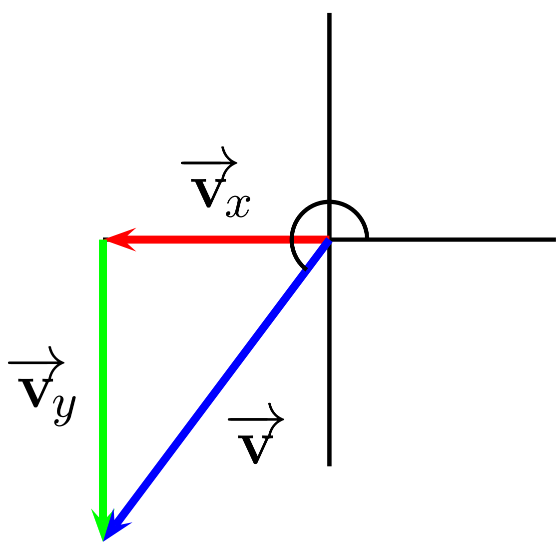

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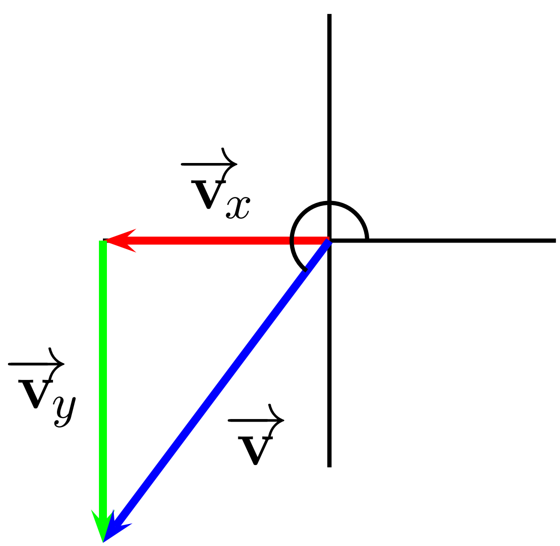

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Component Addition

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

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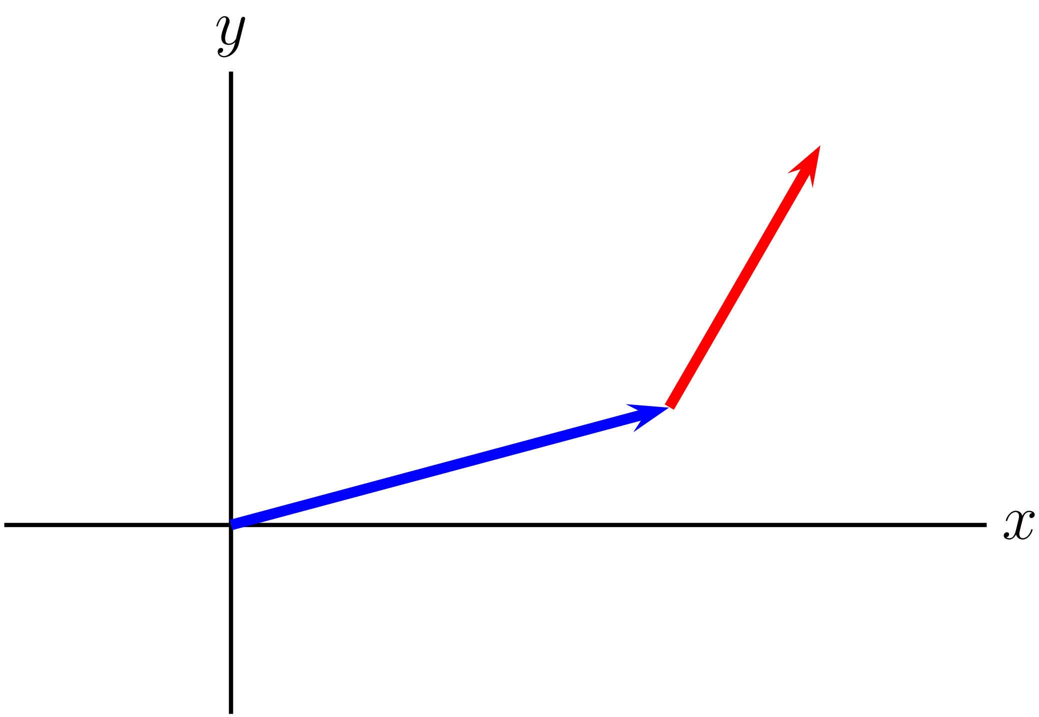

Assume:

$\overrightarrow{\mathbf{A}}$

$\overrightarrow{\mathbf{B}}$

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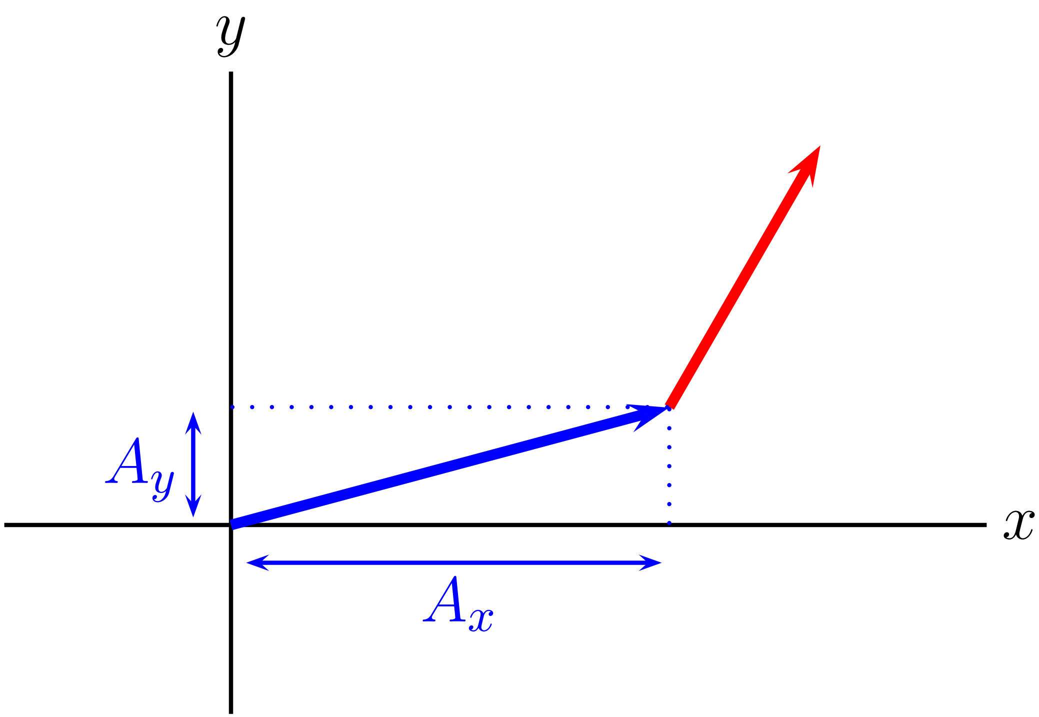

Find the components of $\overrightarrow{\mathbf{A}}$

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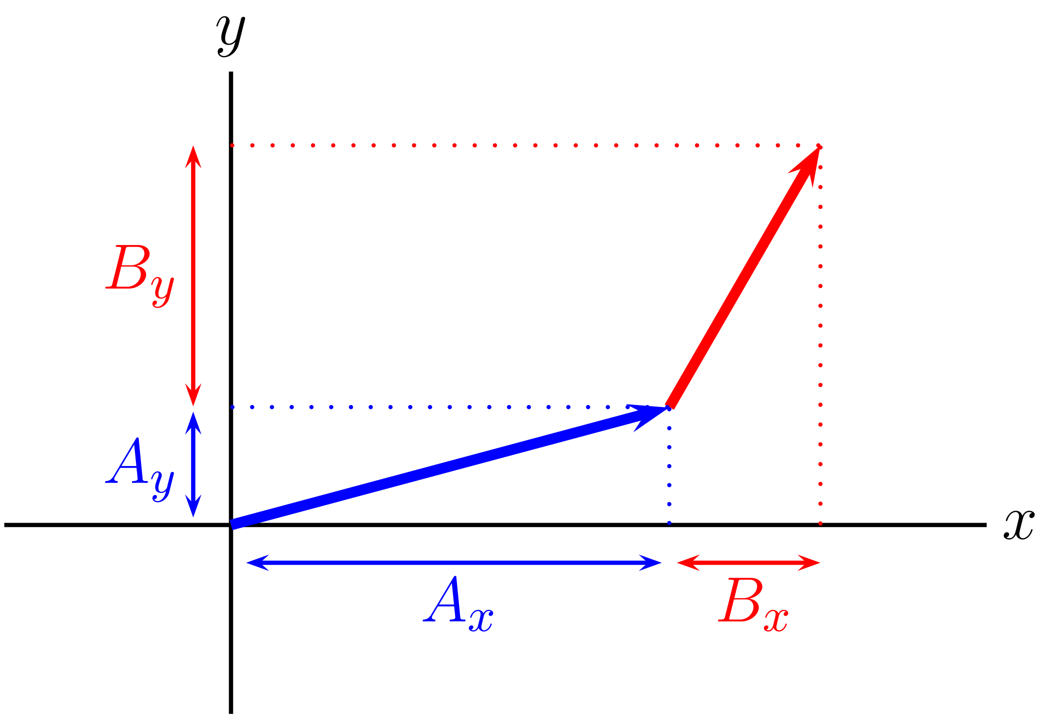

Find the components of $\vec{\mathbf{B}}$

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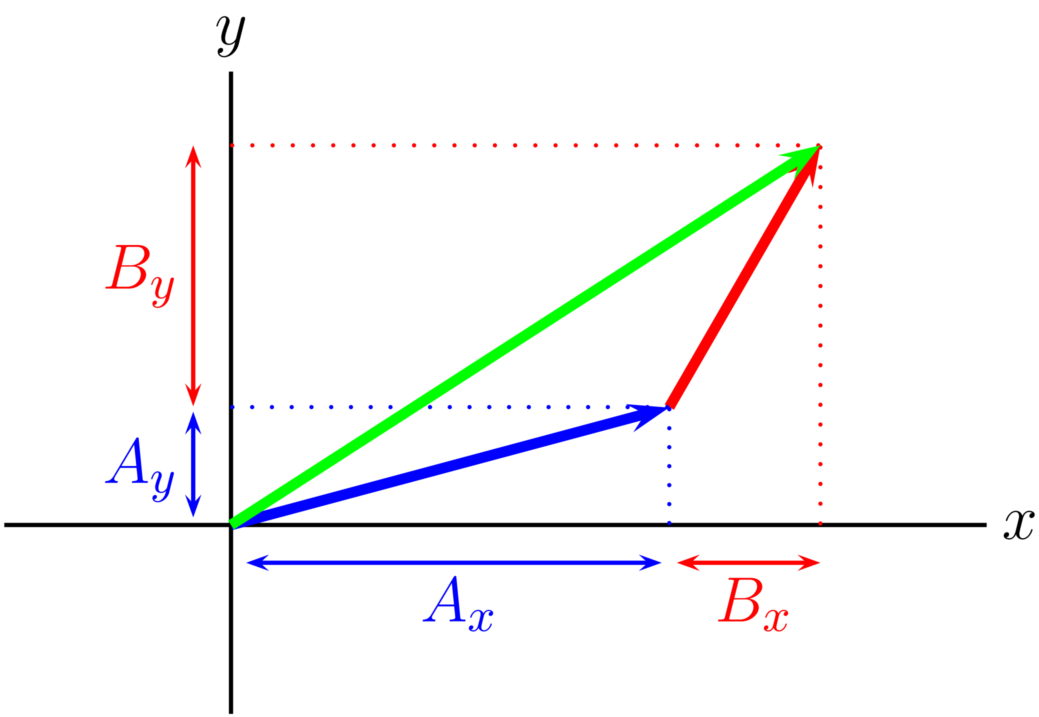

Find the vector sum $\vec{\mathbf{R}}$

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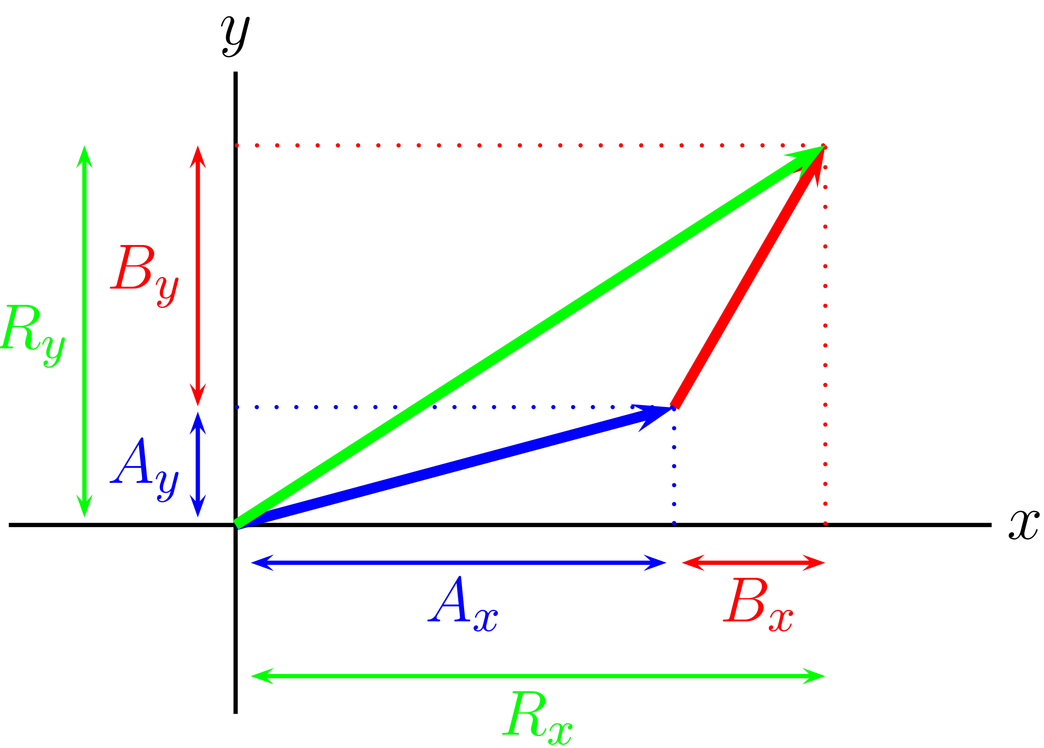


The components of $\overrightarrow{\mathbf{R}}$:

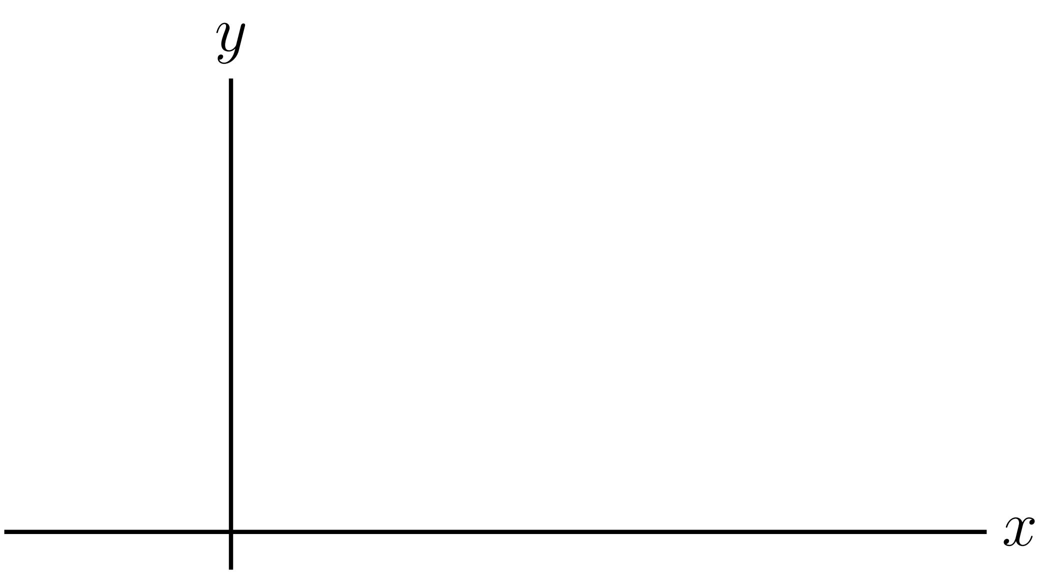
$$R_x = A_x + B_x$$

$$R_y = A_y + B_y$$

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 $\hat{\boldsymbol{\imath}}$, $\hat{\boldsymbol{\jmath}}$, and $\hat{\mathbf{k}}$ for the unit vectors along the x, y, and z axes.



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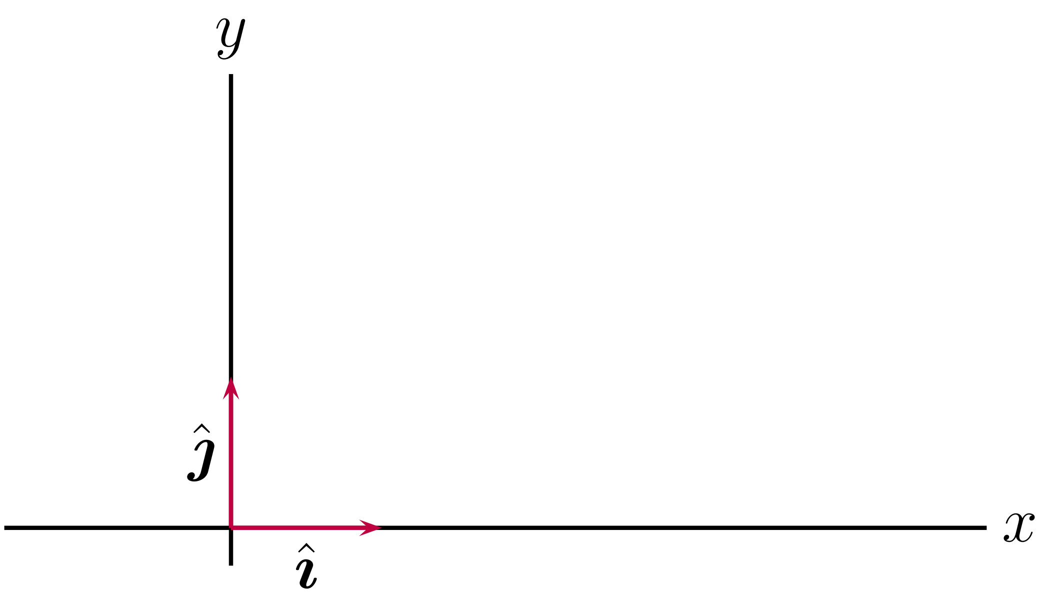

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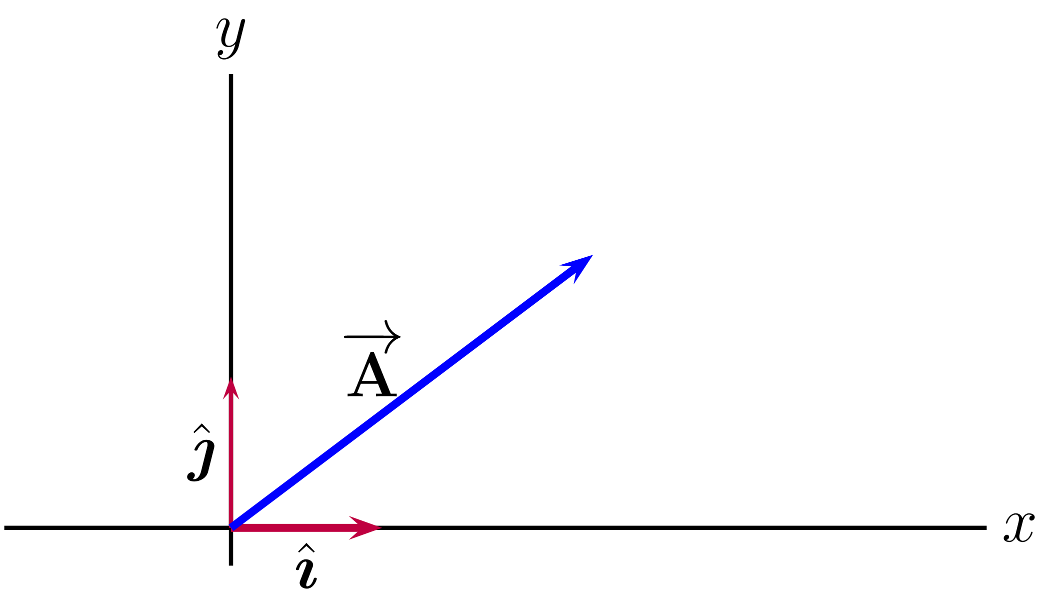

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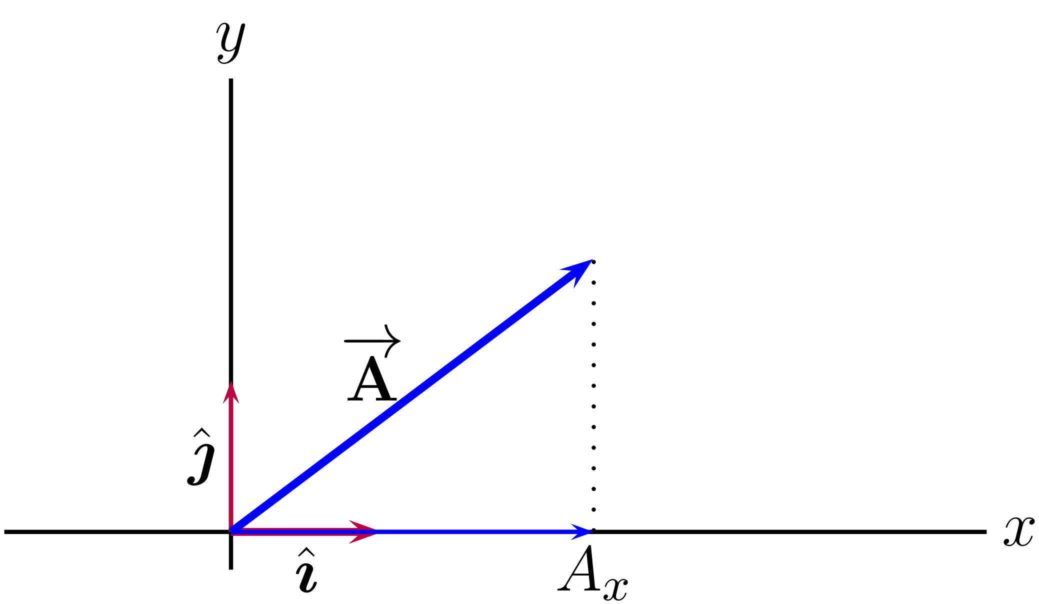

$$\vec{\mathbf{A}}_x = A_x \hat{\boldsymbol{\imath}}$$

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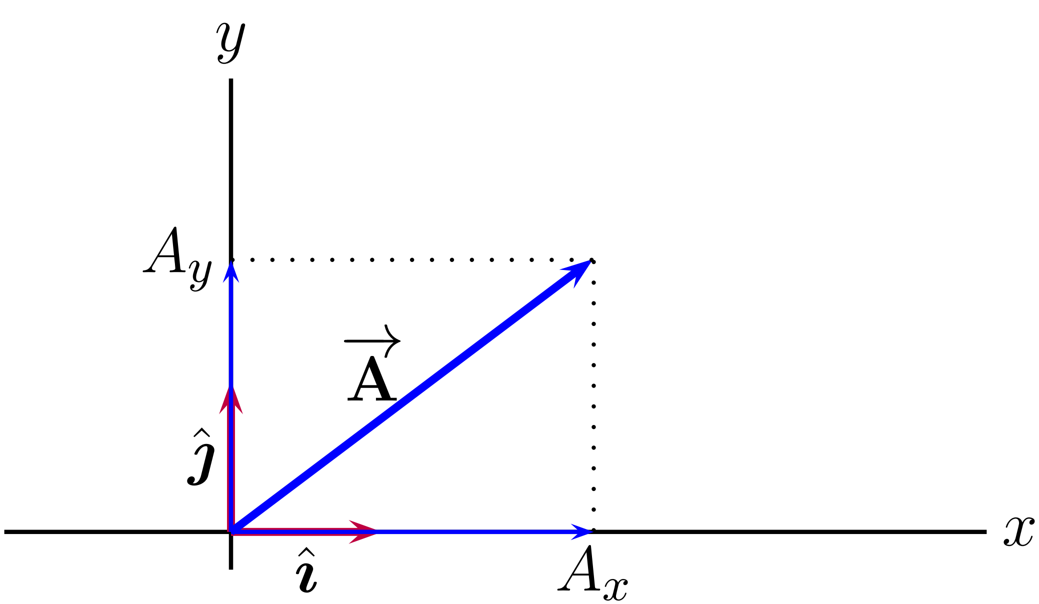

$$\vec{\mathbf{A}}_x = A_x \hat{\boldsymbol{\imath}}$$

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

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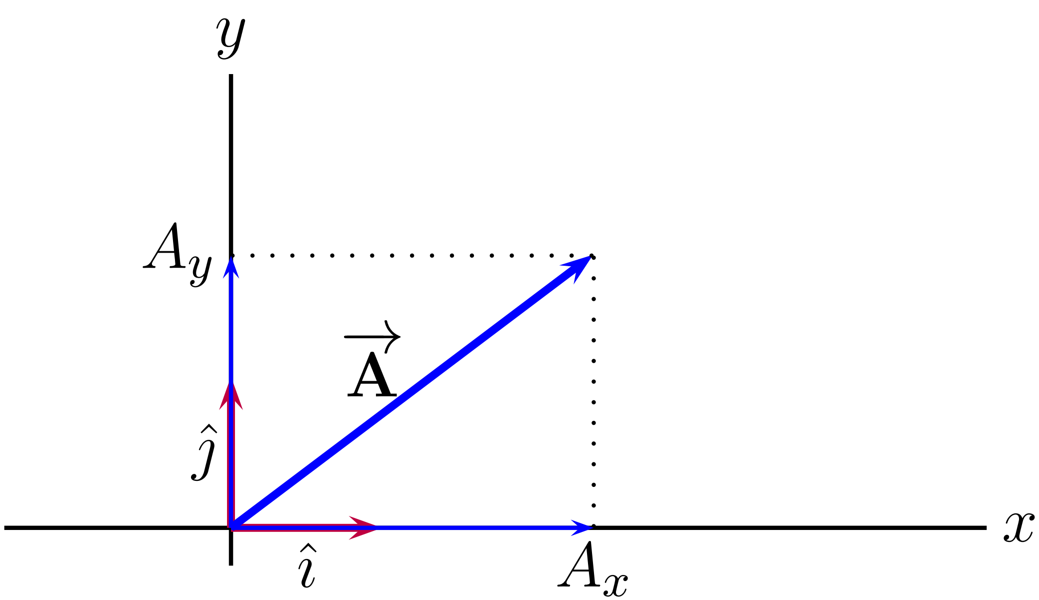

$$\overrightarrow{\mathbf{A}}_x = A_x \hat{\boldsymbol{\imath}}$$

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

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

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