June 12, Week 2

Today: Chapter 3, Vectors

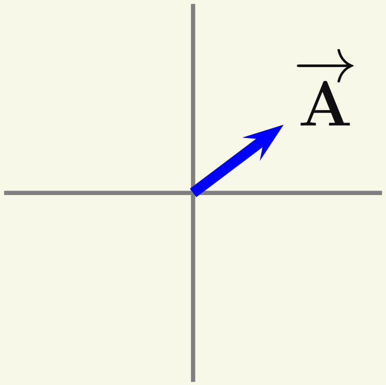
Homework #2 due tomorrow

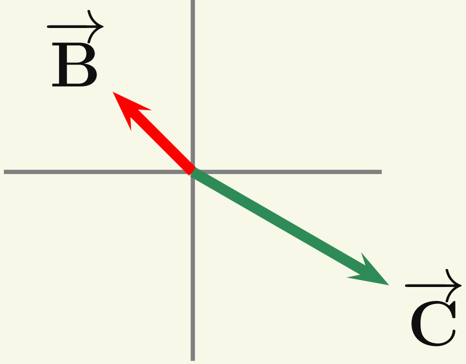
No reading quiz for Monday

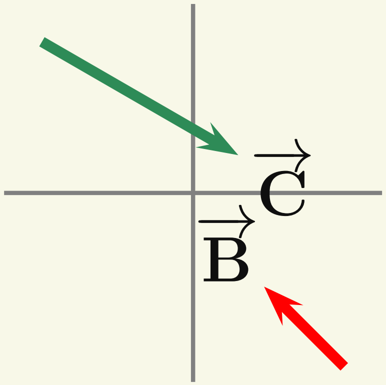
Please register your clicker. (There are 2 students without registered clickers.)

Vector-Exercise Followup

If $\overrightarrow{\mathbf{A}} = 5\,m/s$ at $37°$, which of the following drawing correctly shows $\overrightarrow{\mathbf{B}} = 5\,m/s$ at $135°$ and $\overrightarrow{\mathbf{C}} = 10\,m/s$ at $330°$?







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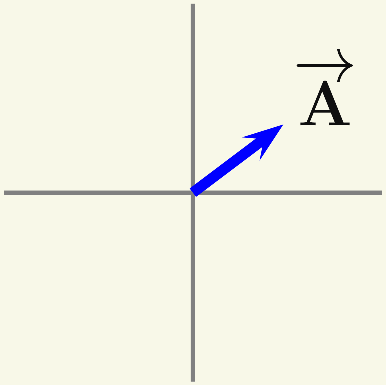

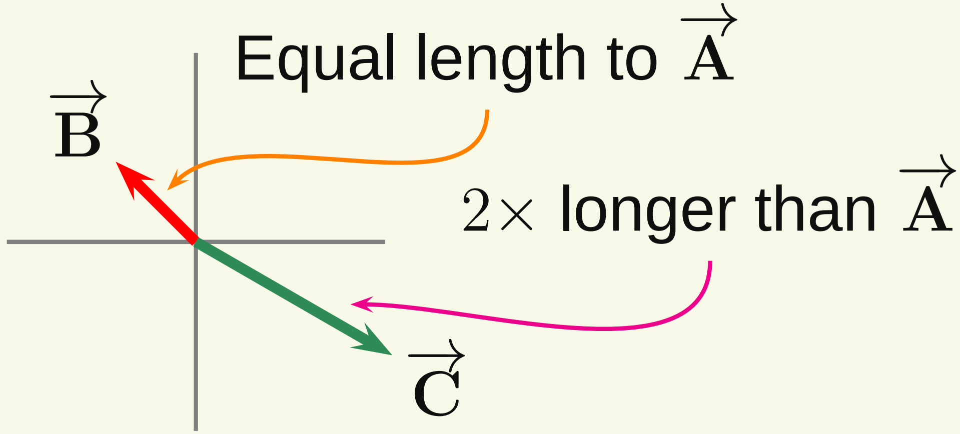

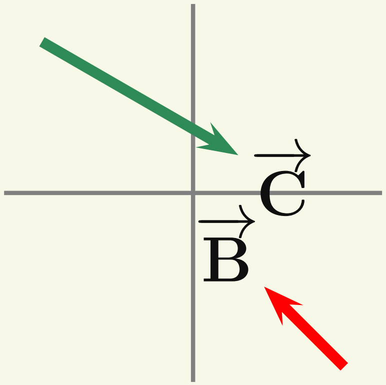

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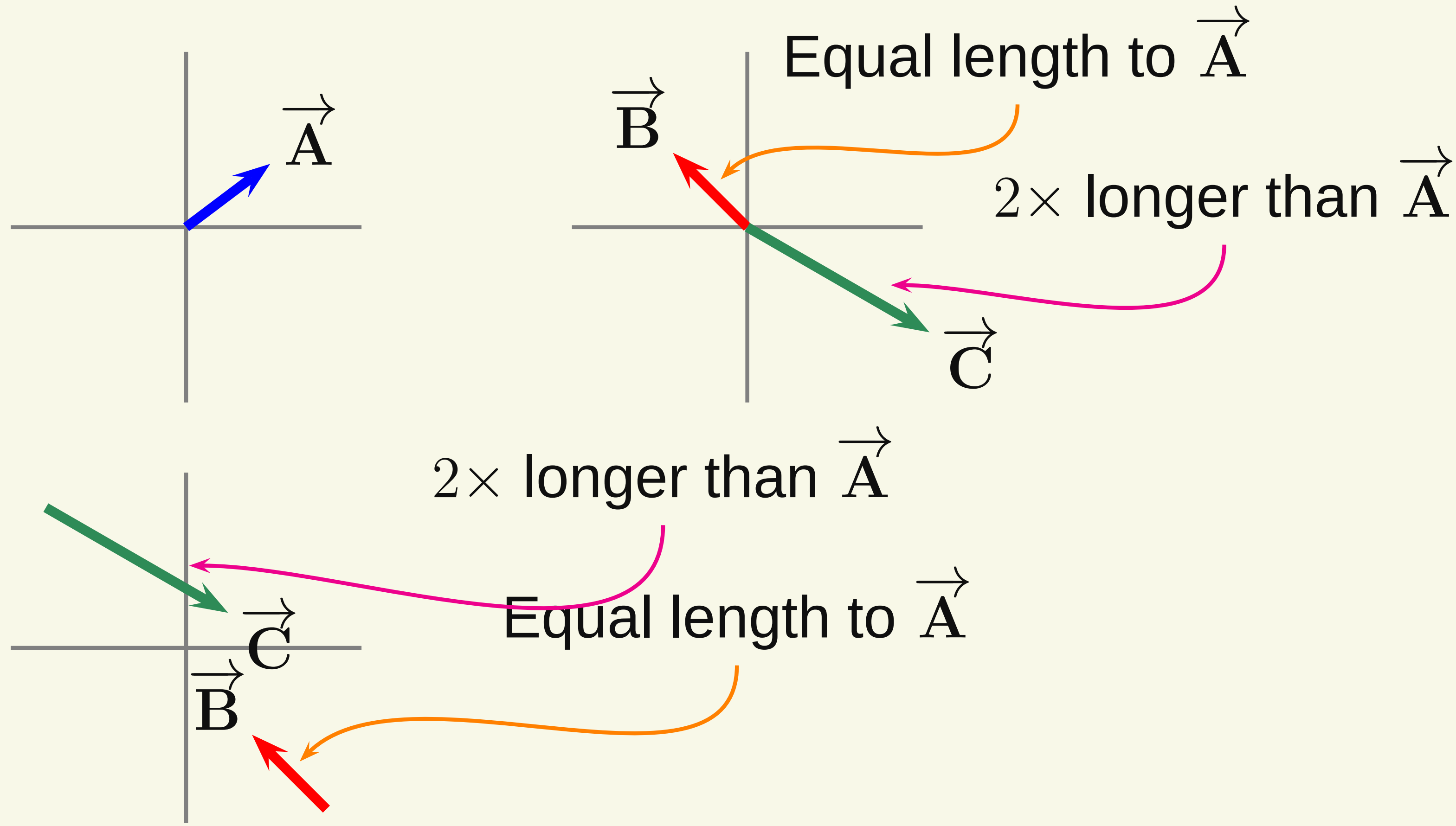

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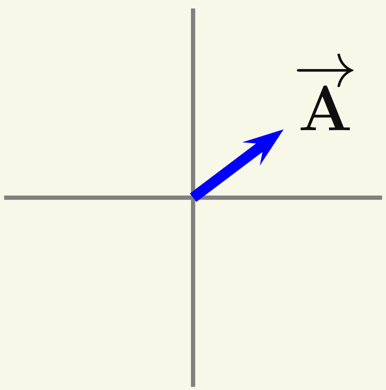

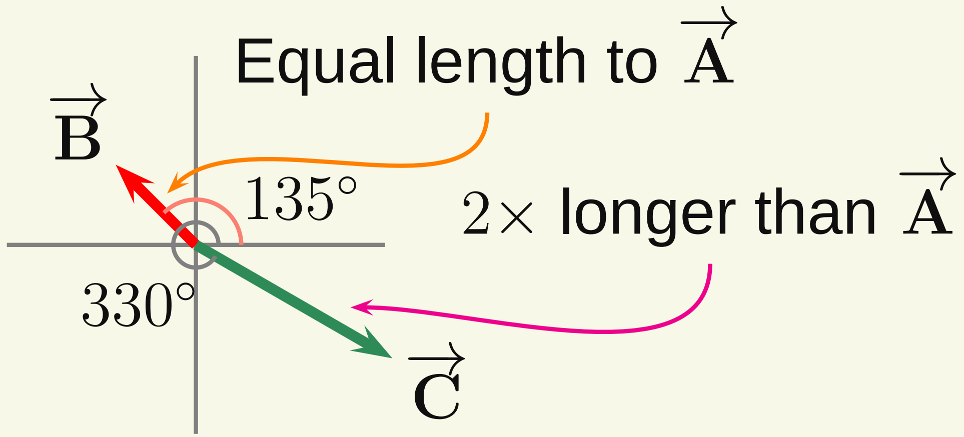

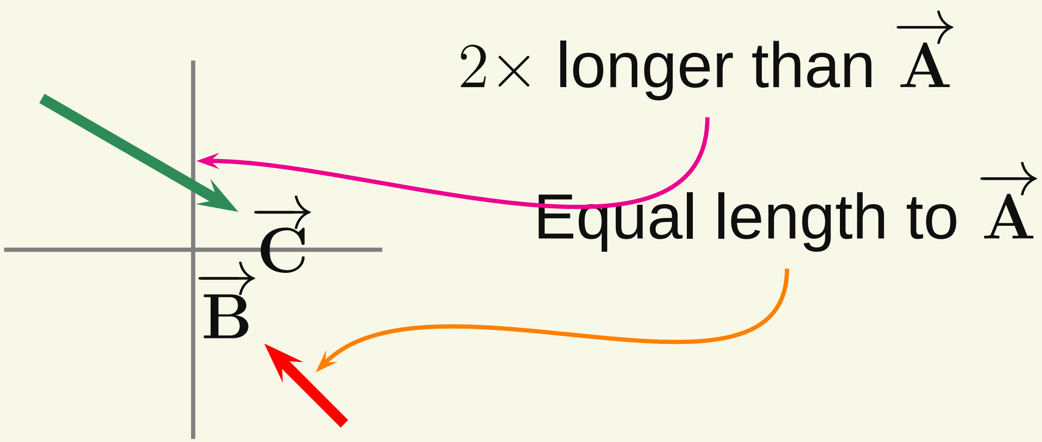

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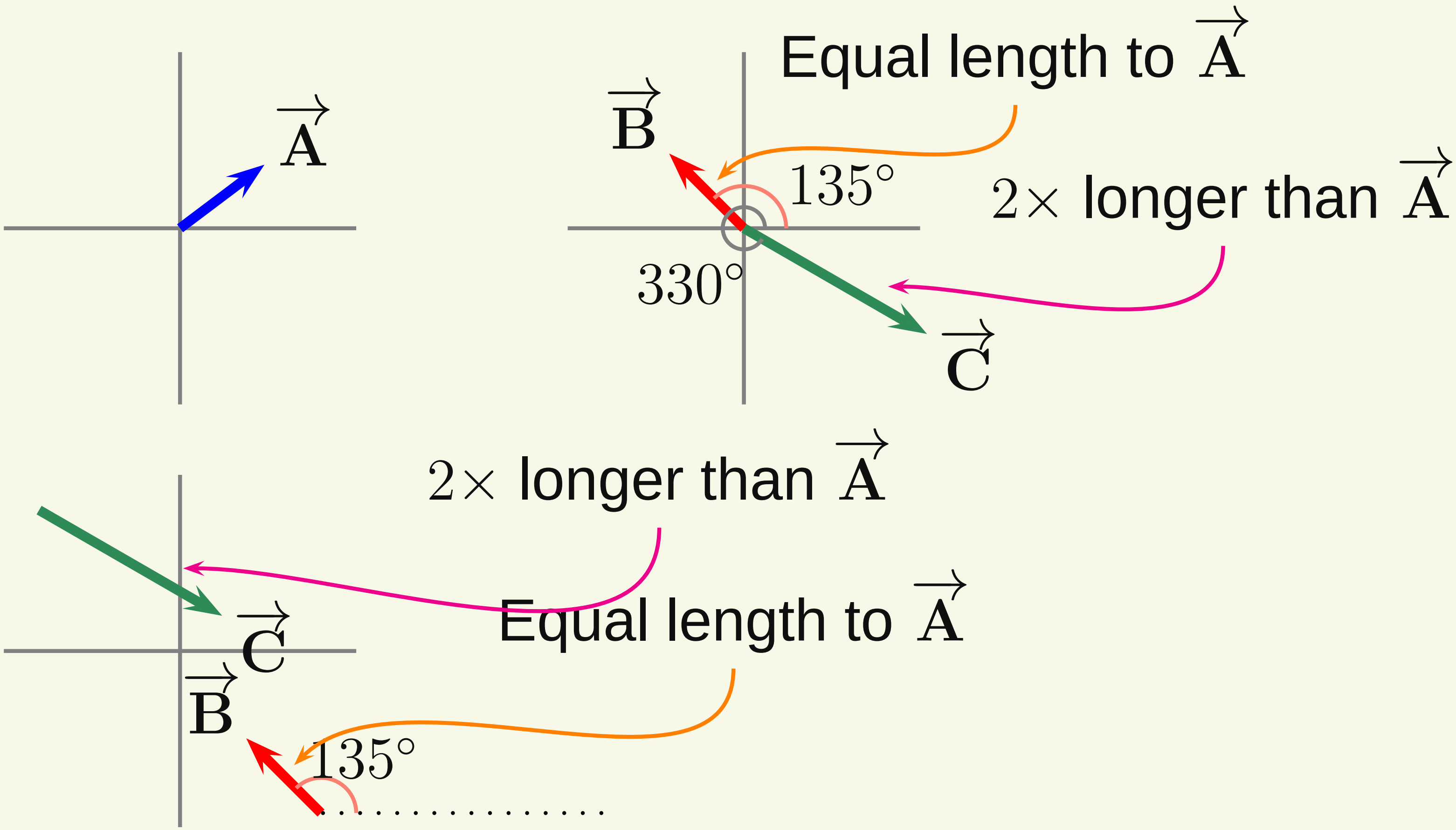

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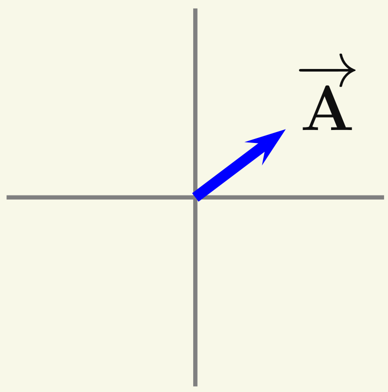

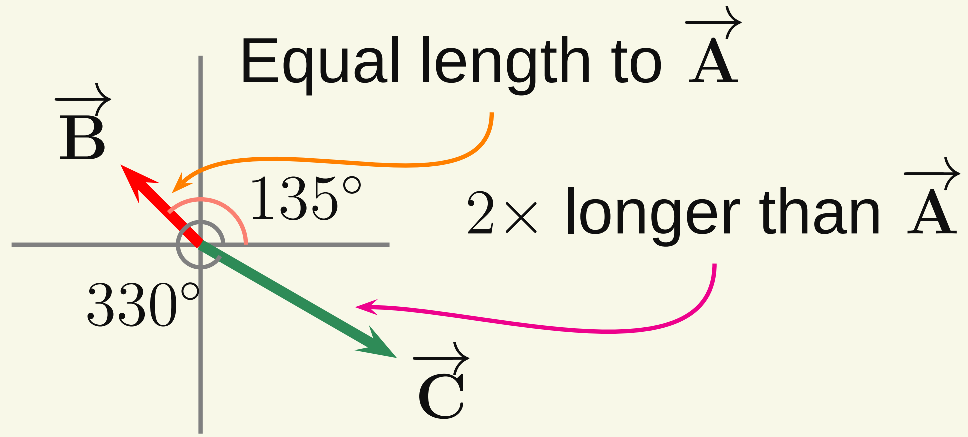

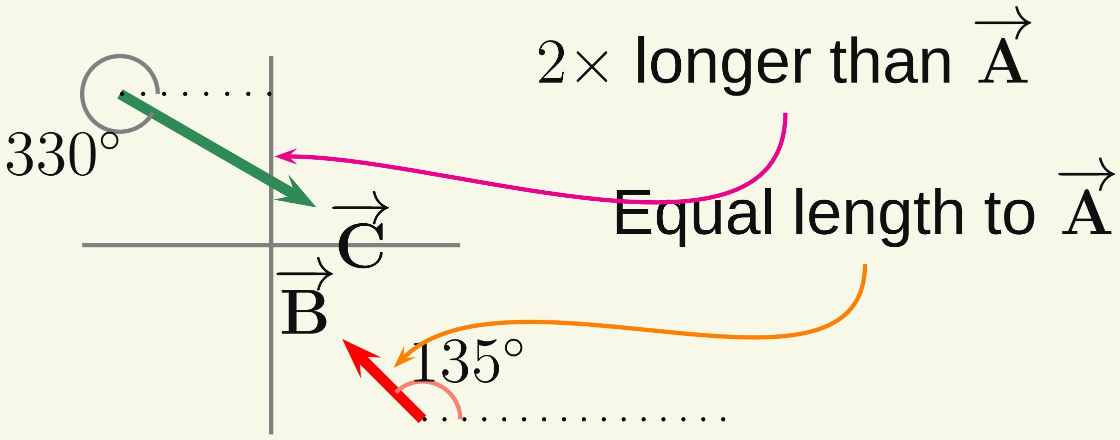

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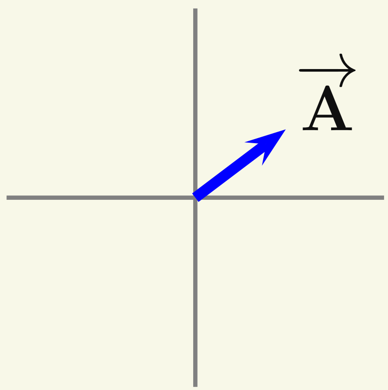

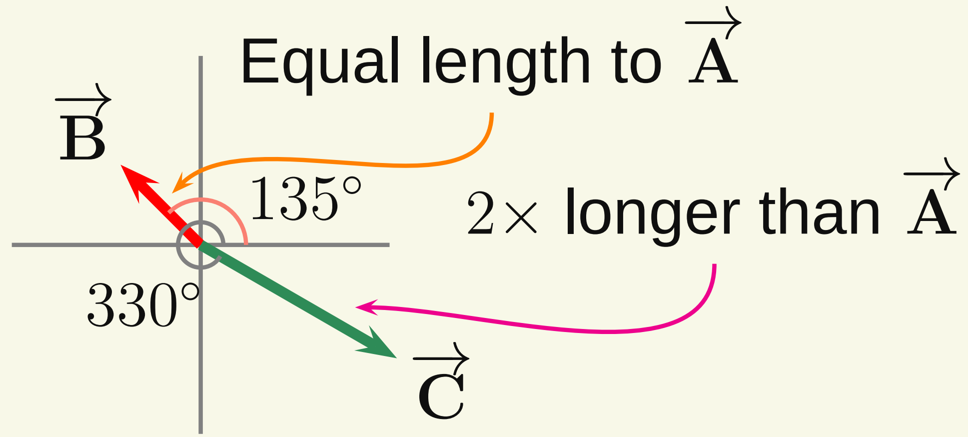

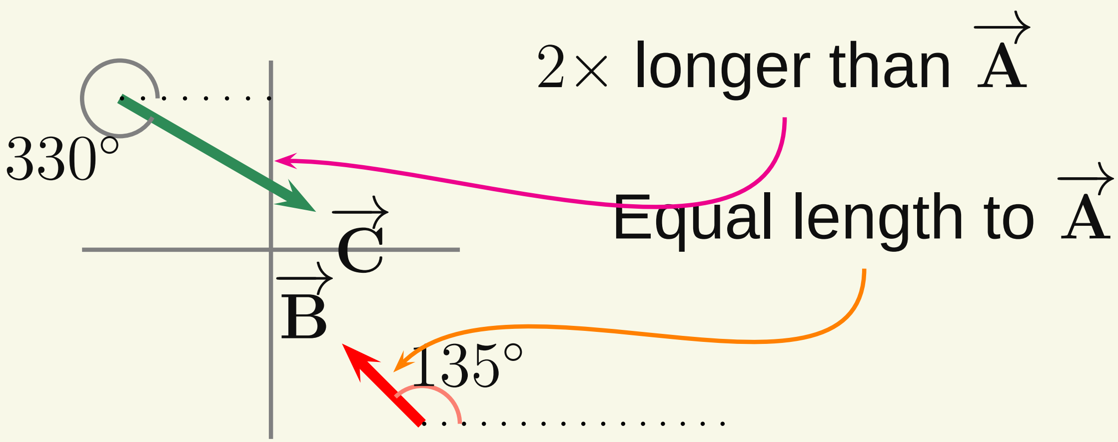

Two vectors are equal when they have the same magnitude and angle, regardless of where they are drawn

Scalar Multiplication

Multiplying a vector by a scalar changes the magnitude but not the direction of a vector.

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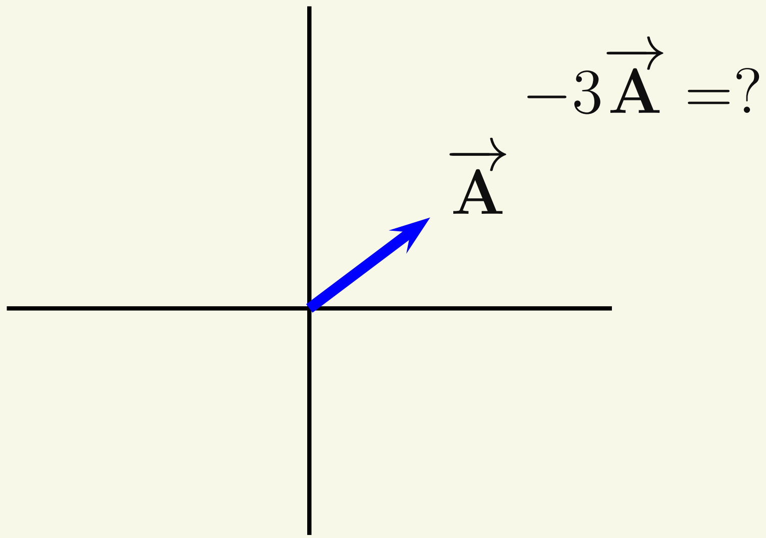

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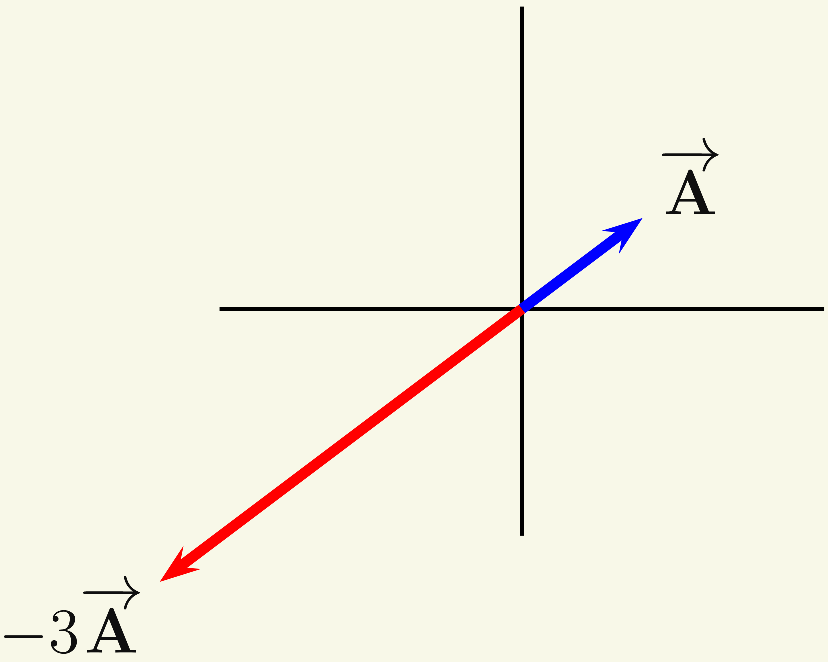

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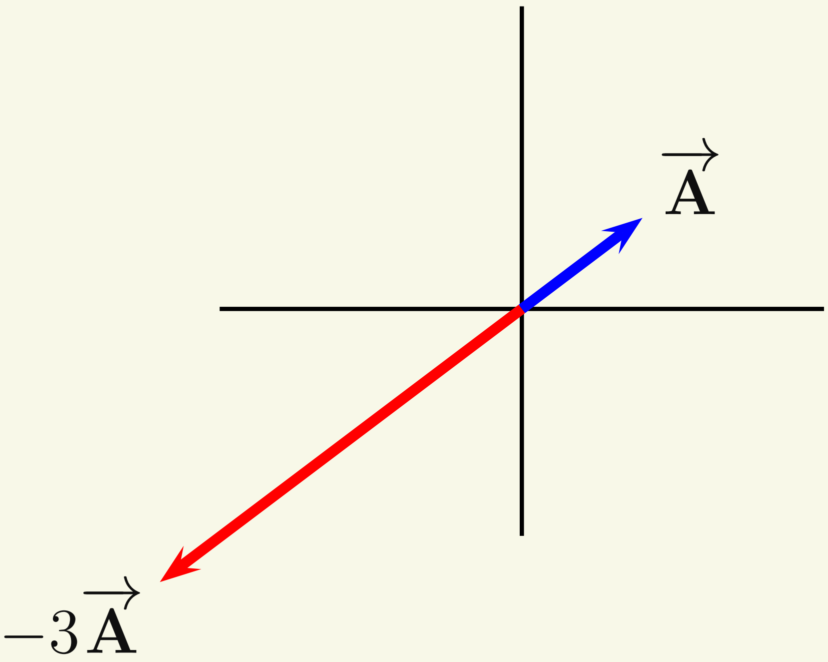

Of particular interest:

$\overrightarrow{\mathbf{A}} = -\overrightarrow{\mathbf{B}}$

$\Rightarrow$ equal magnitude but opposite direction

- equal but opposite

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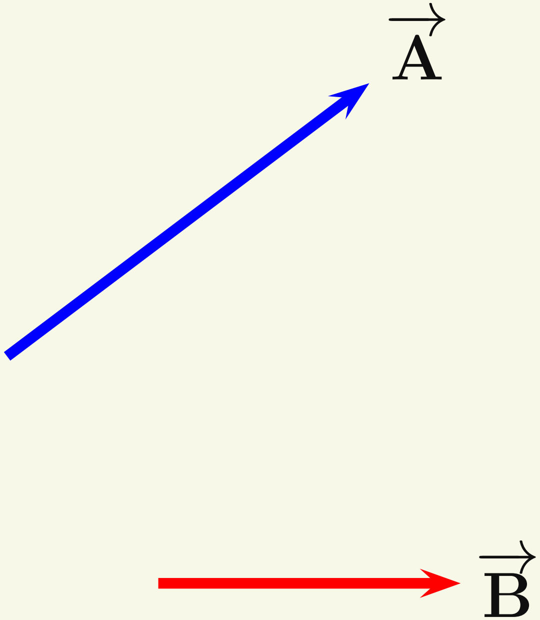
Component Addition - Uses trigonometry to calculate the vector sum.

Graphical Addition Example

Add the following vectors.



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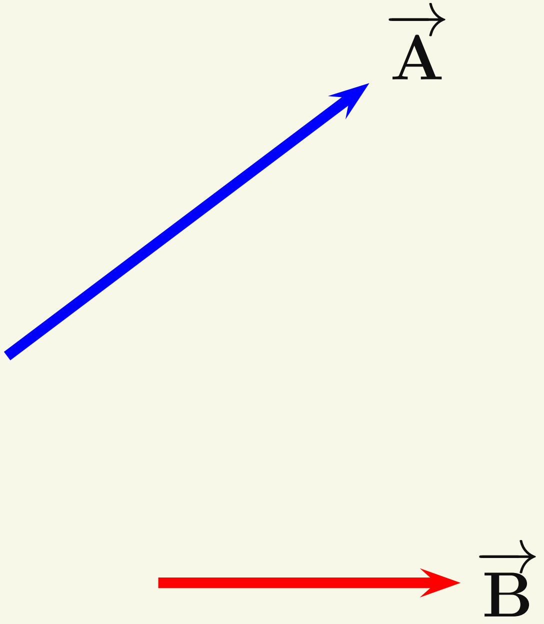

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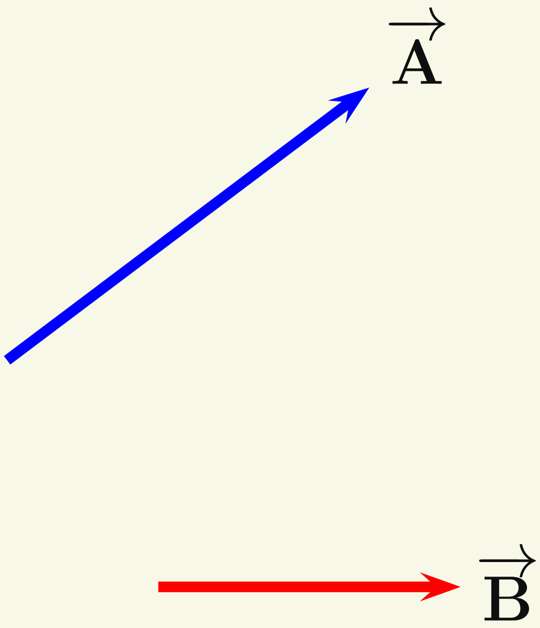

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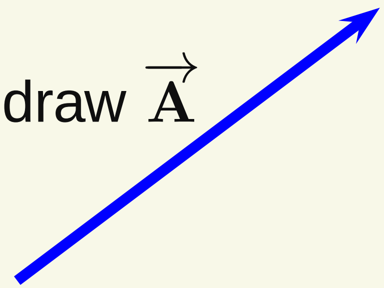
First redraw $\overrightarrow{\mathbf{A}}$



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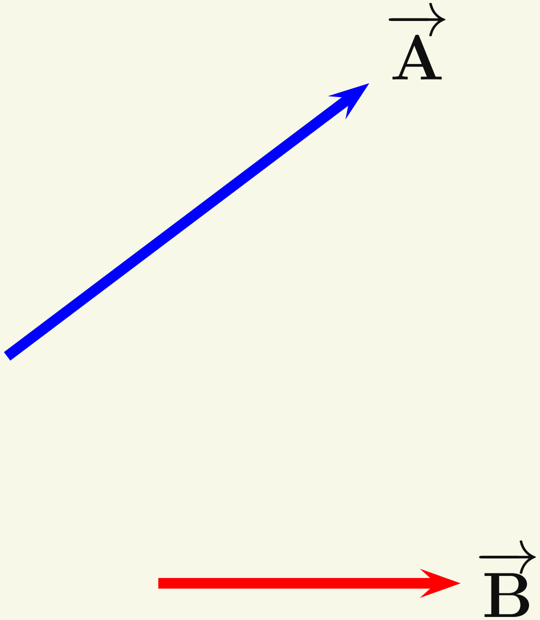

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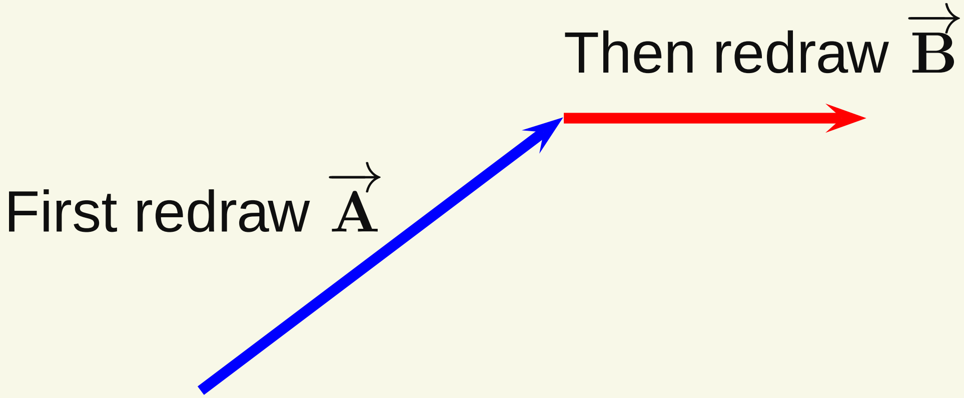

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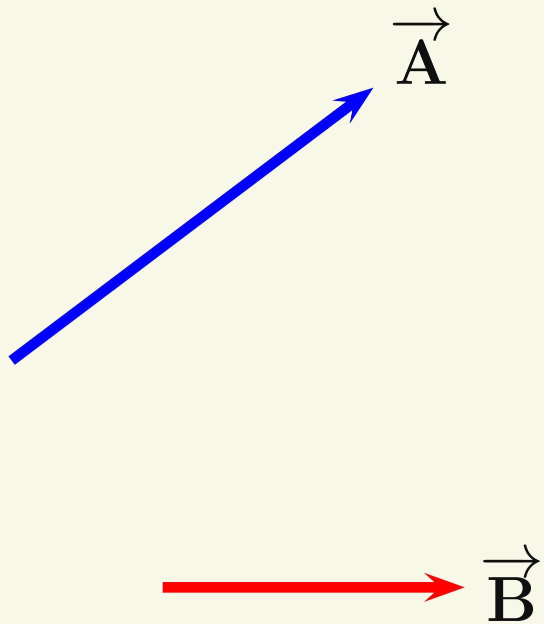

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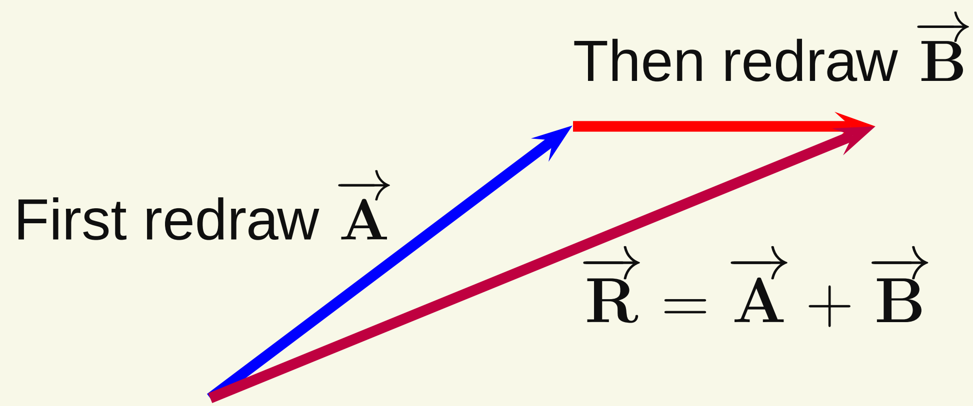

The vector sum or resultant, $\vec{\mathbf{R}}$, goes from the remaining tail to tip.

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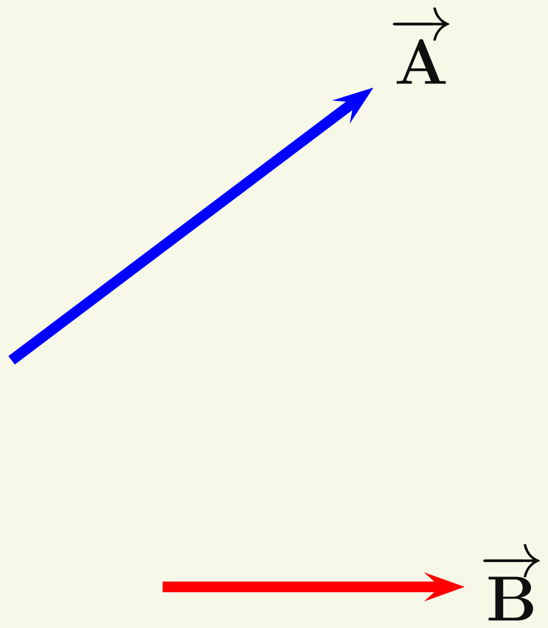

A carefully drawn picture can give magnitude and direction of $\overrightarrow{\mathbf{R}}$. Simply use a ruler and protractor

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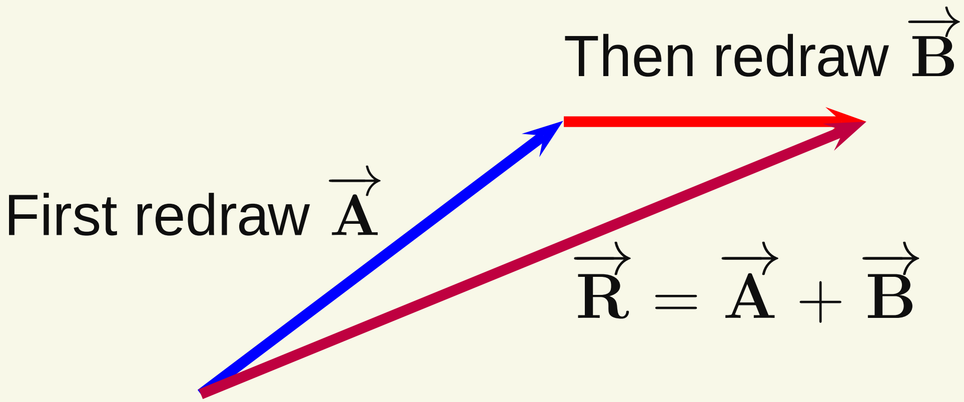

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You can add vectors in either order and the answer is the same!

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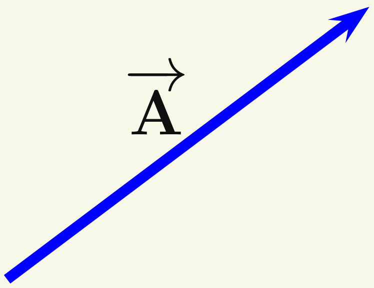

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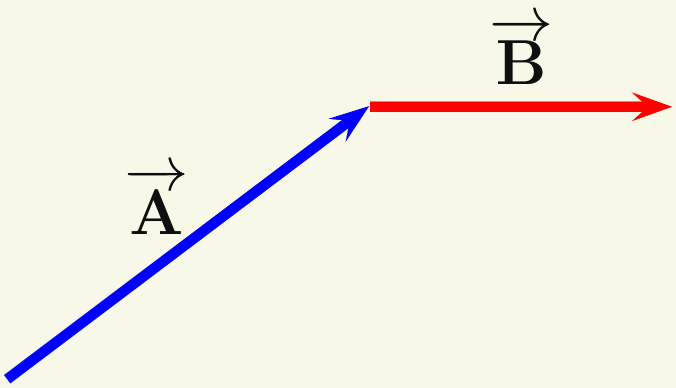

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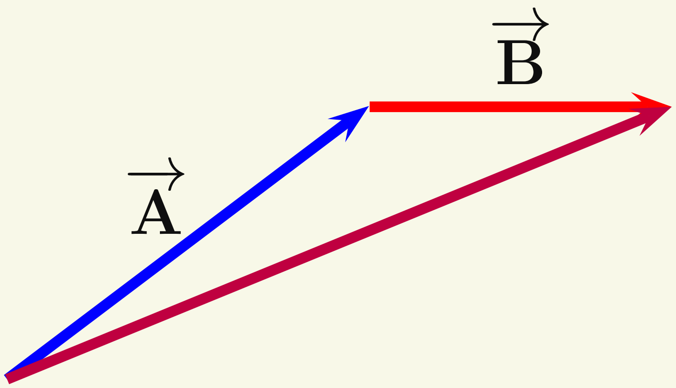

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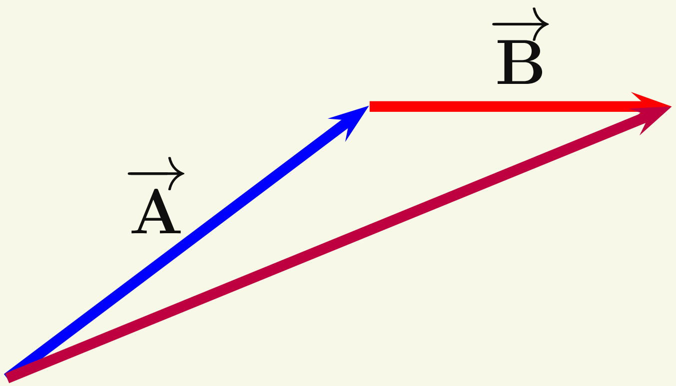

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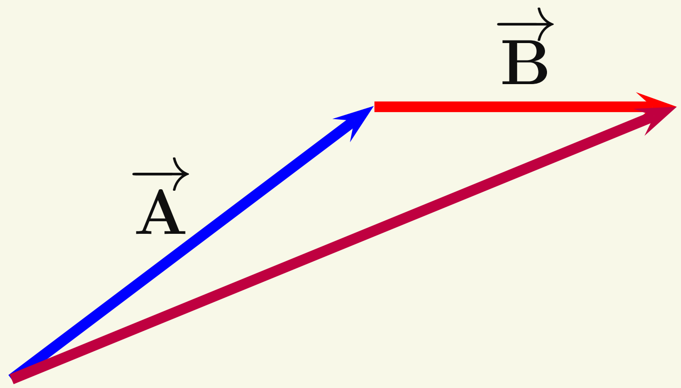

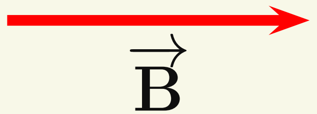

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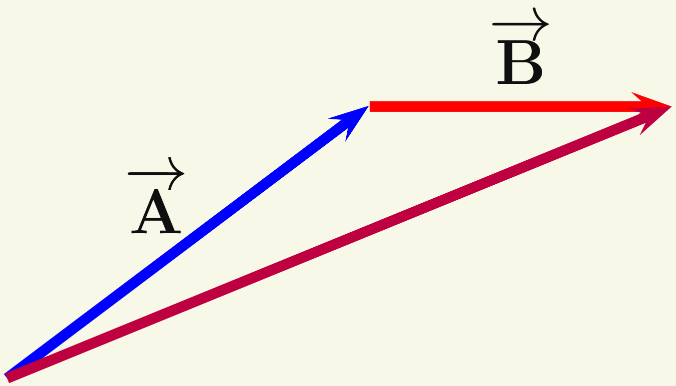

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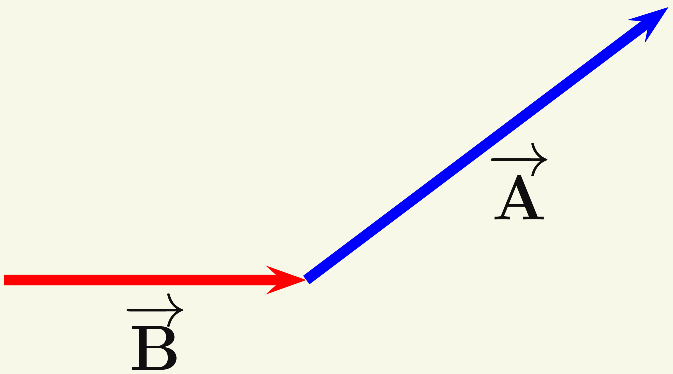

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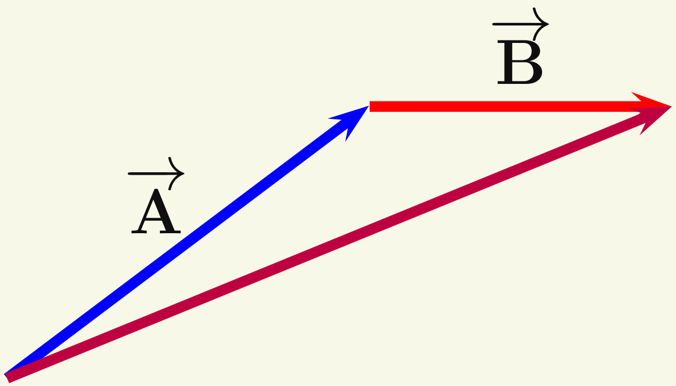

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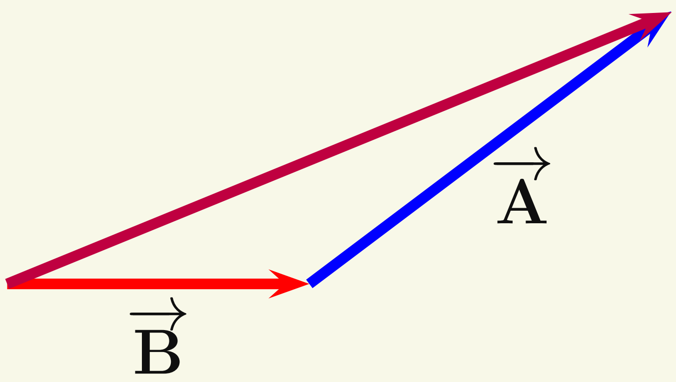

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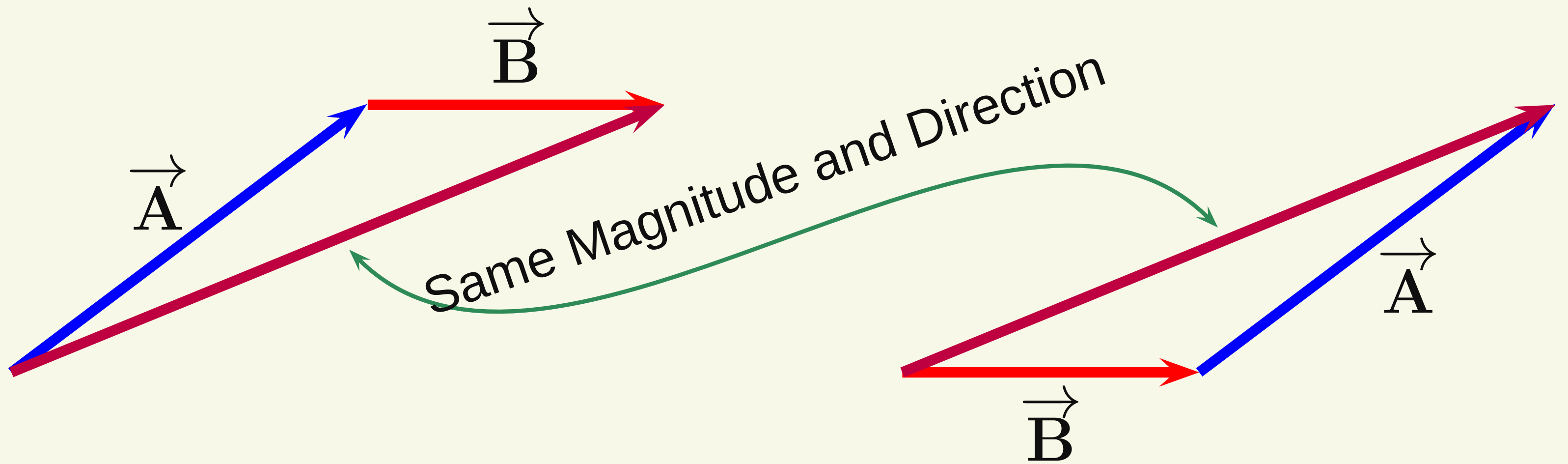

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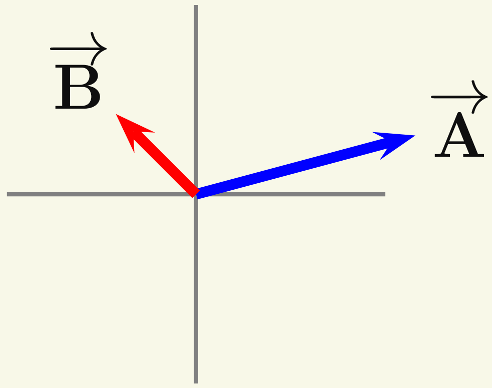

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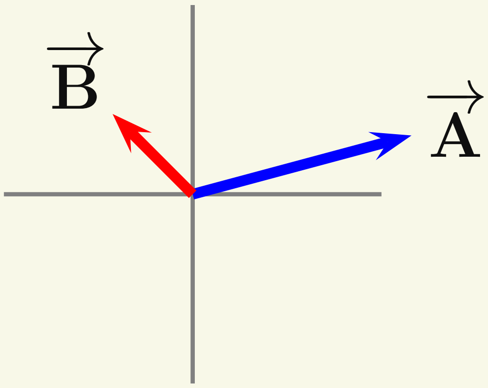

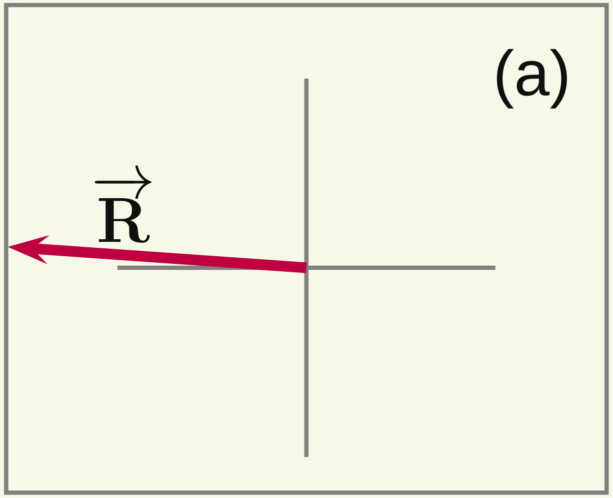

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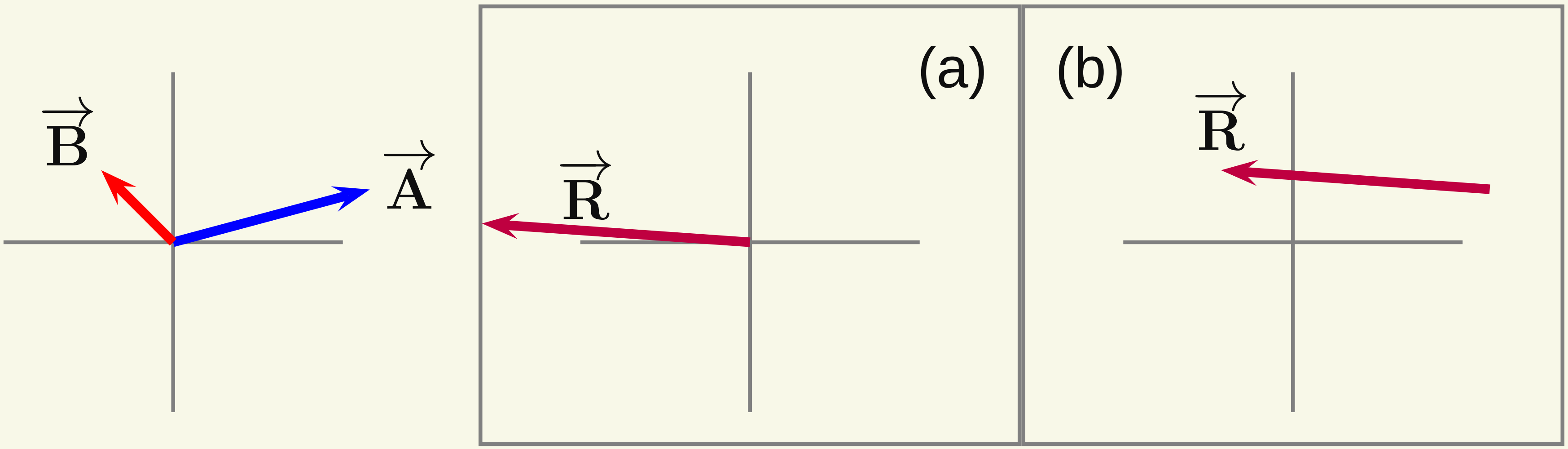

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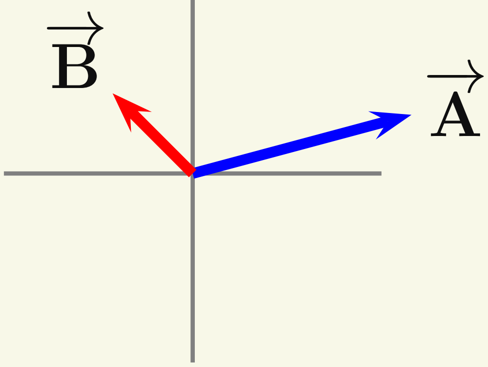

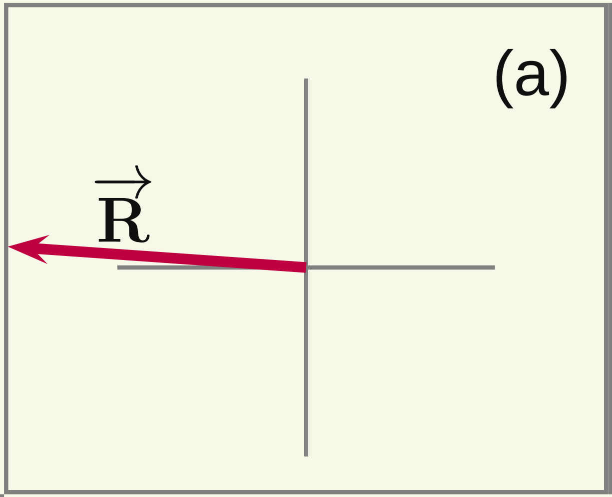

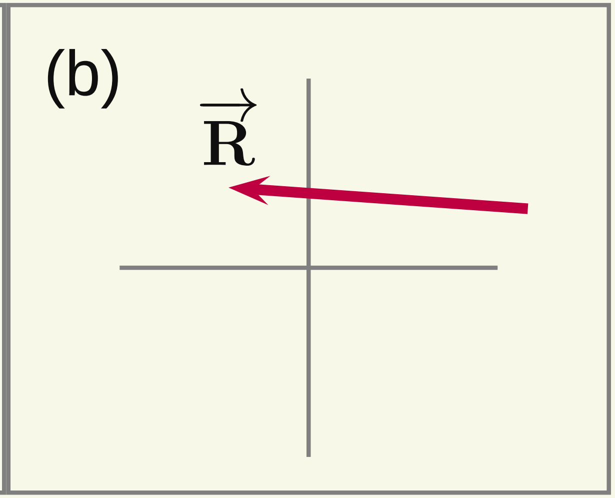

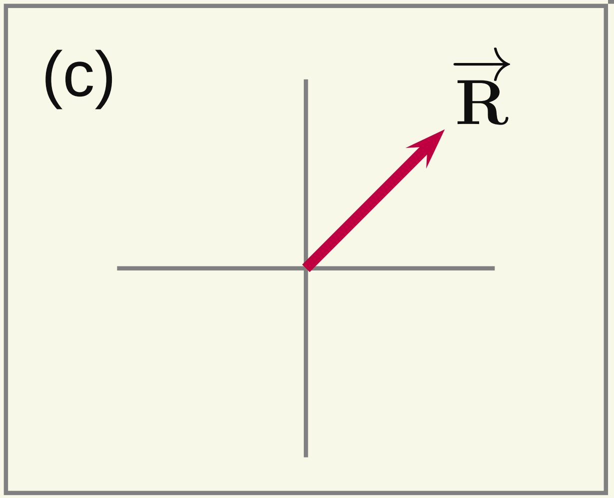

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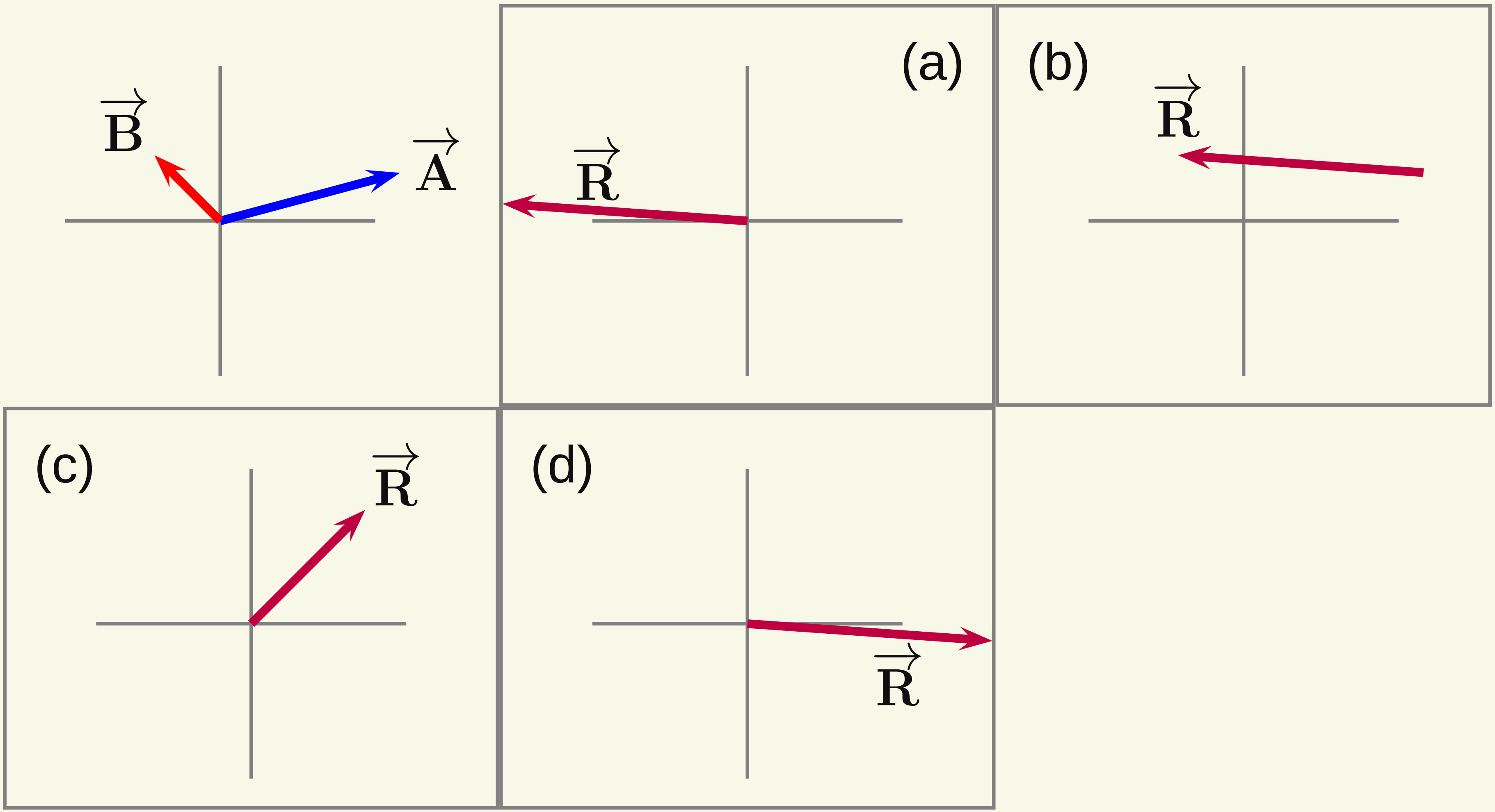

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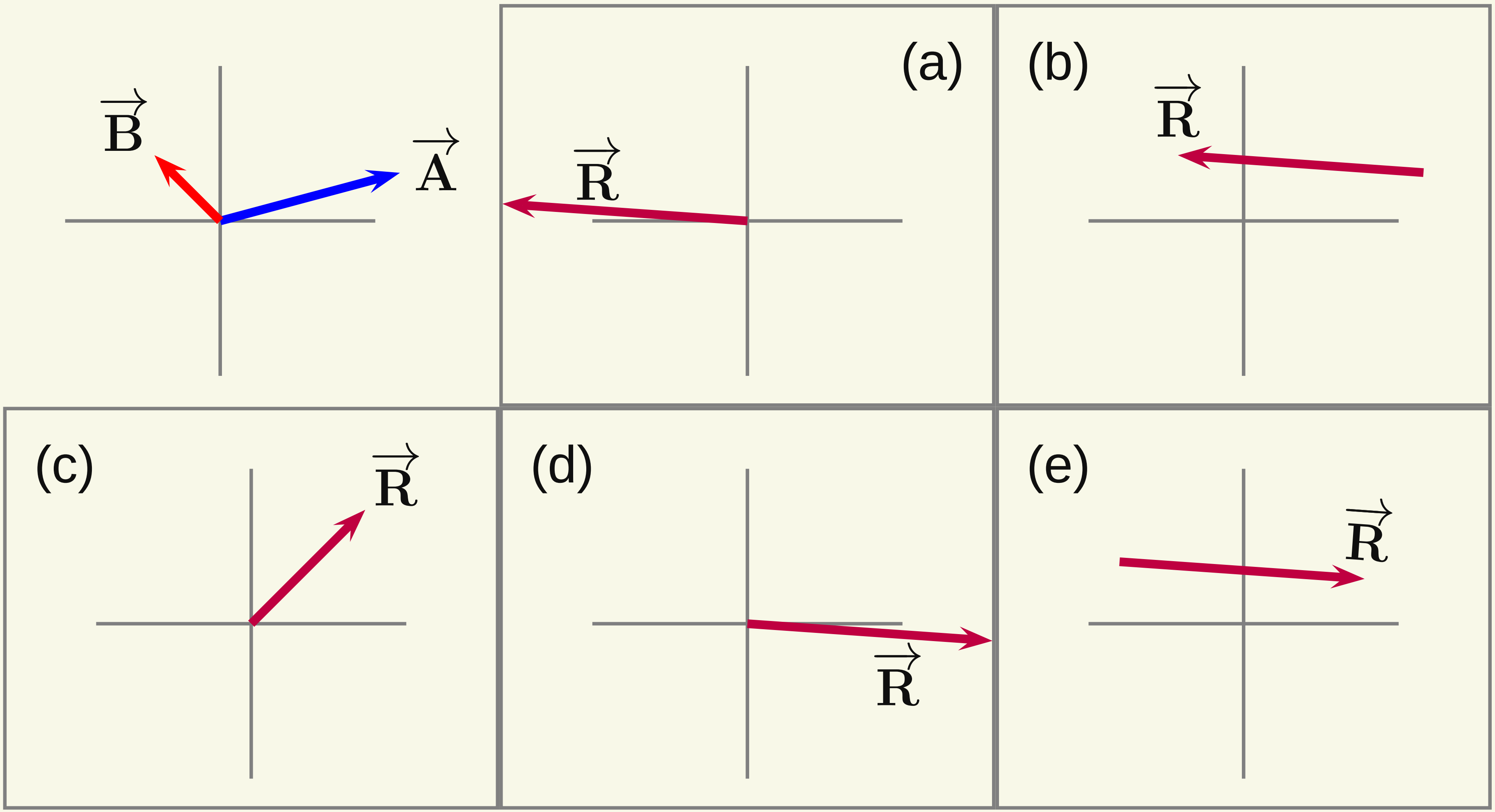

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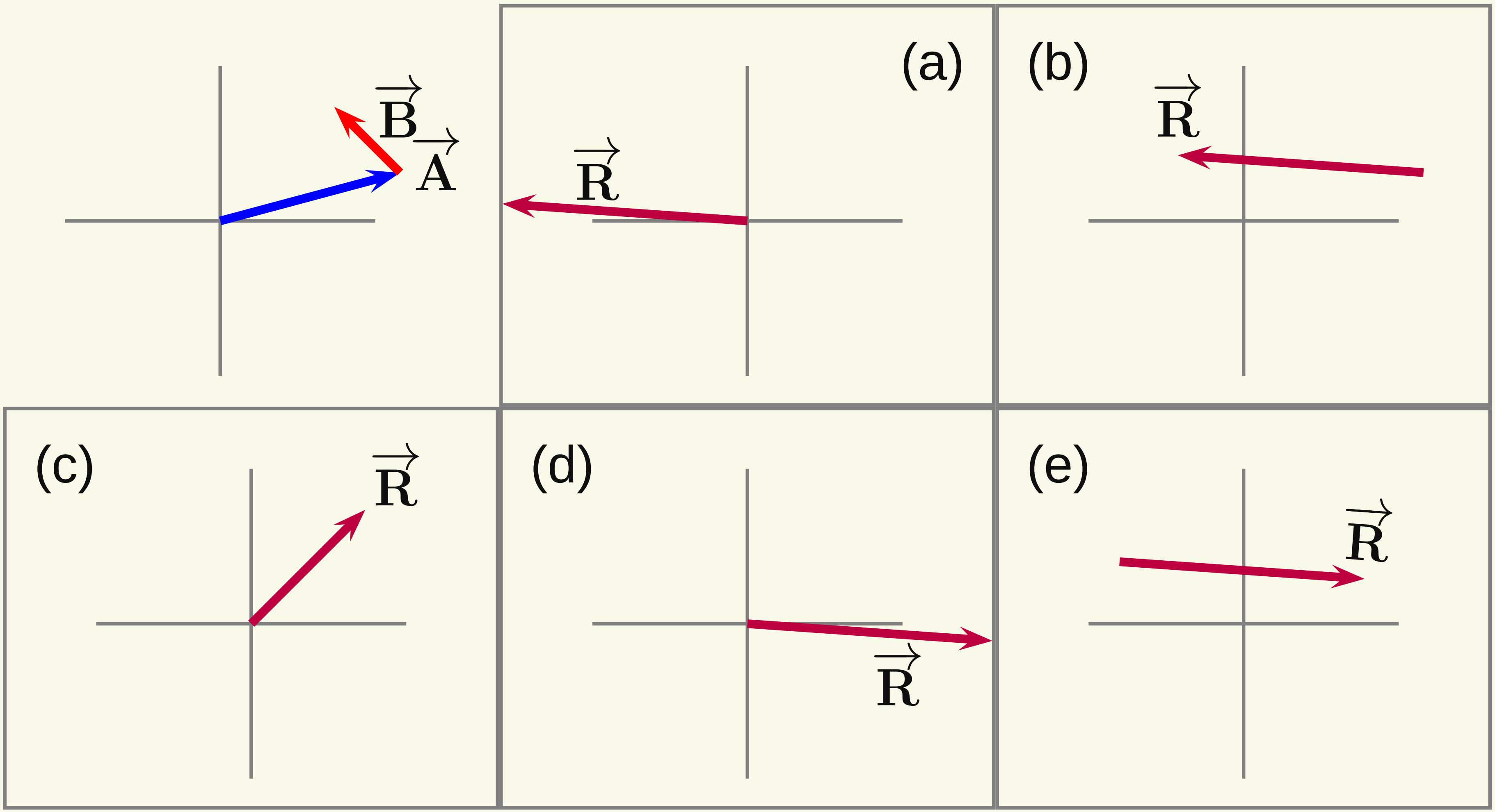

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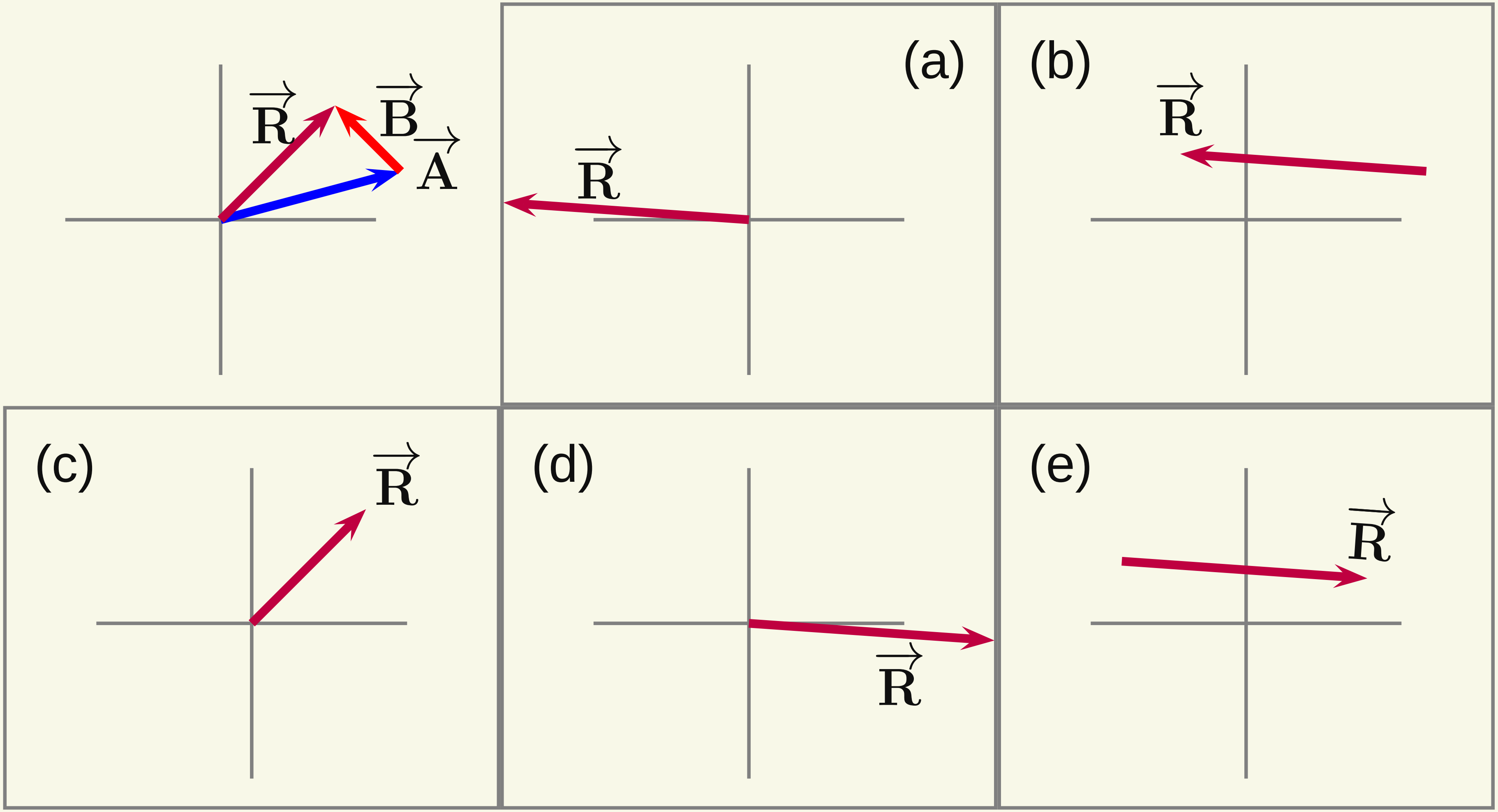

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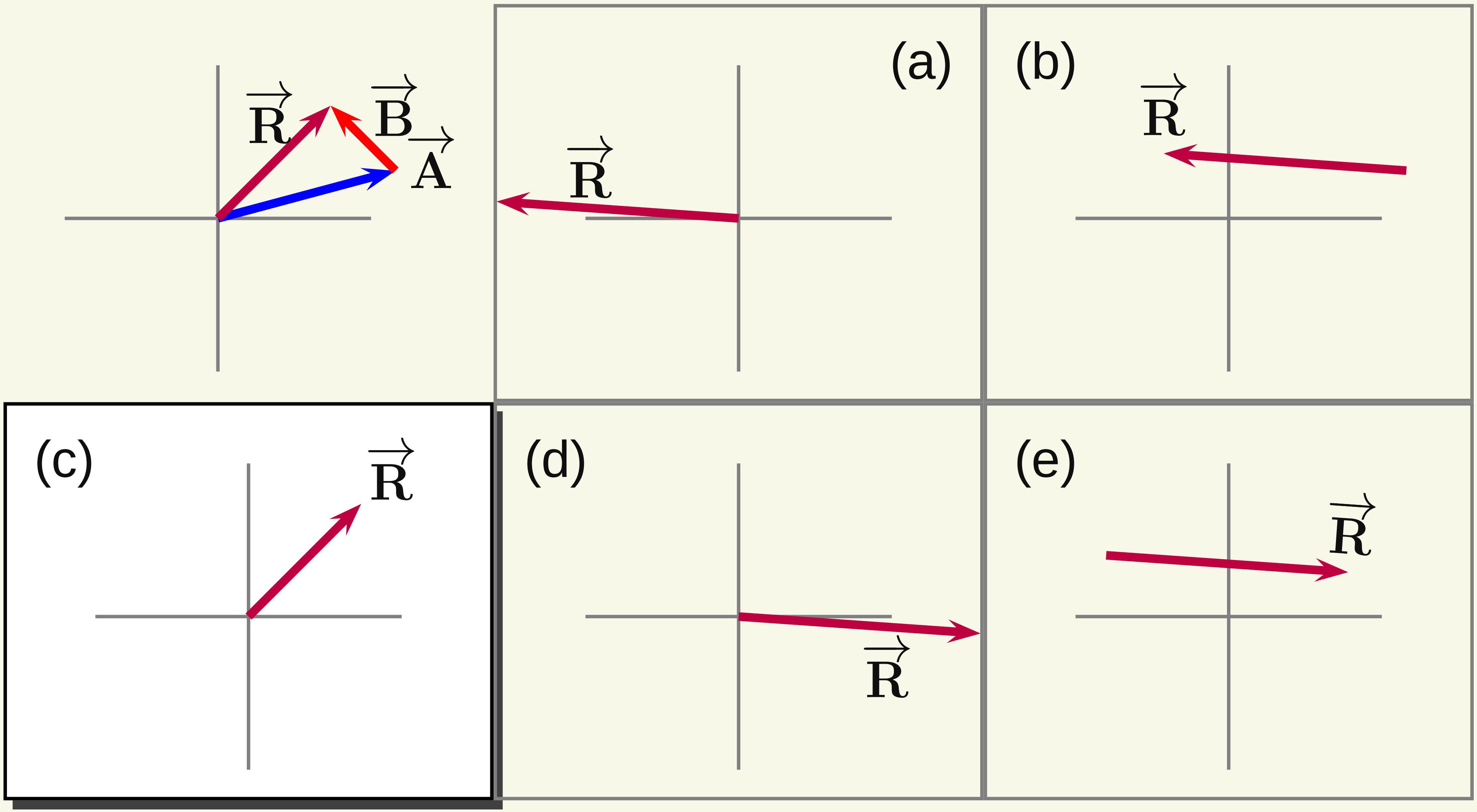

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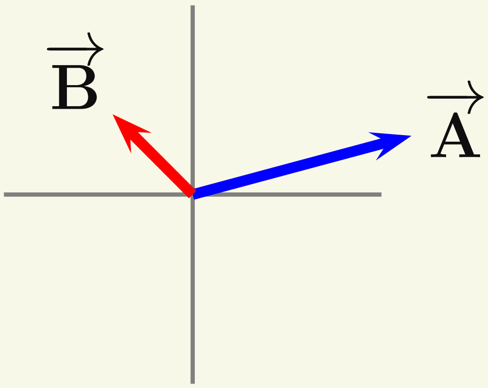

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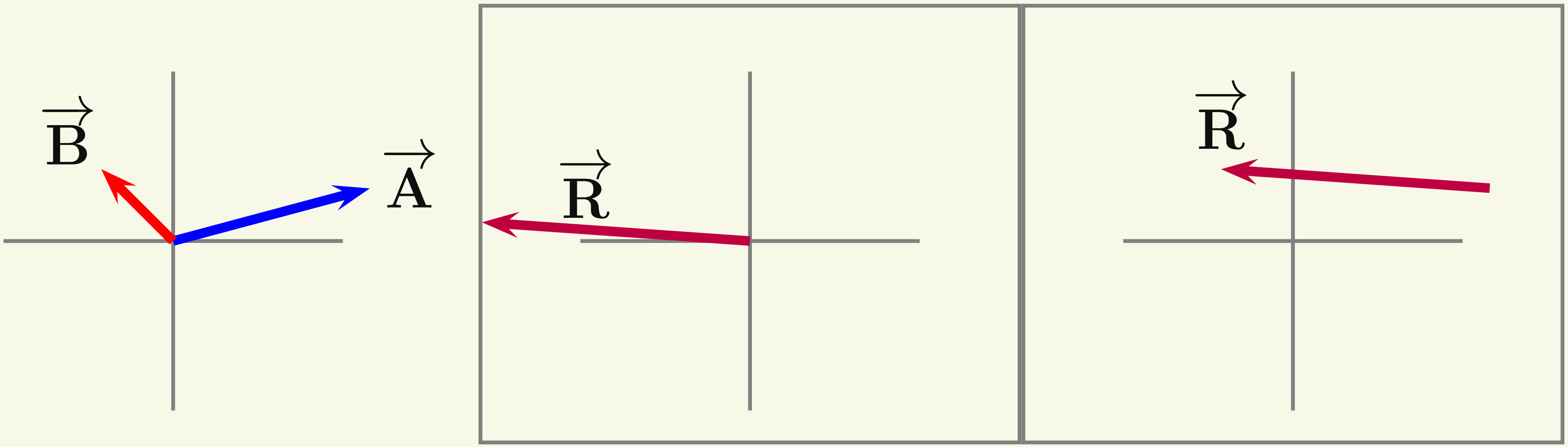

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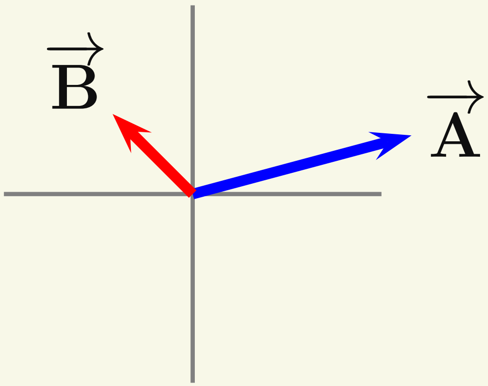

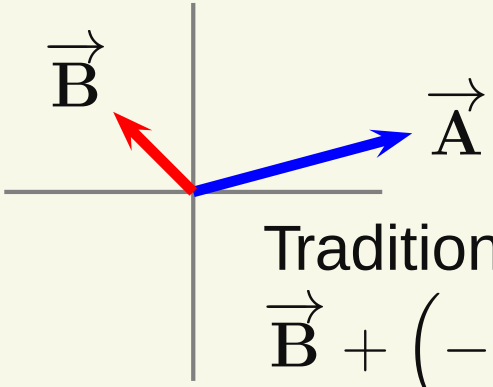

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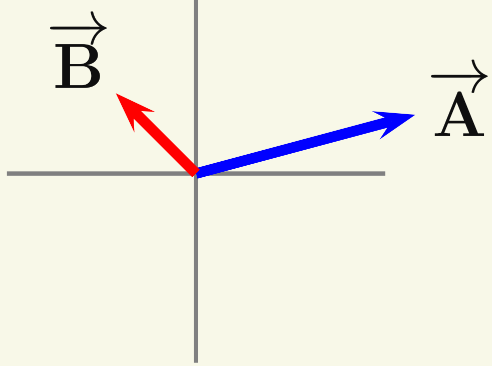

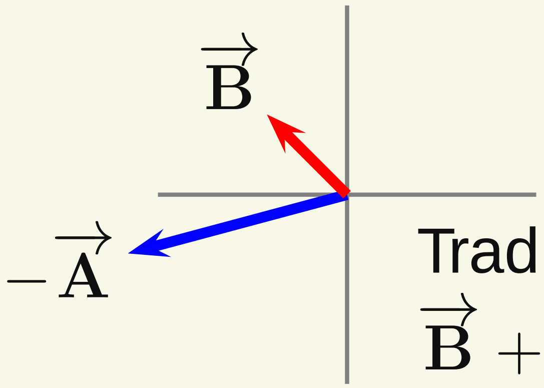

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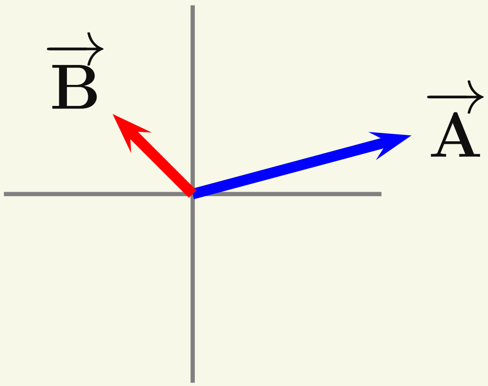

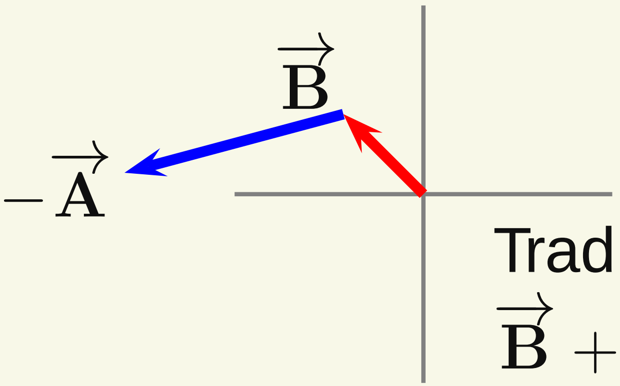

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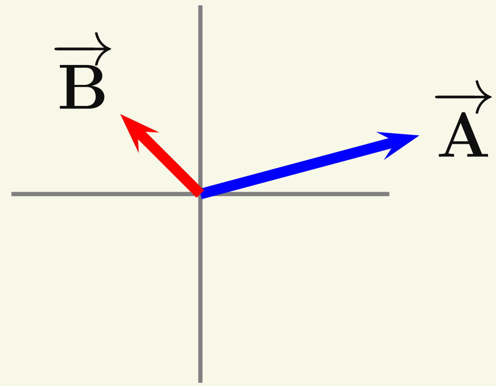

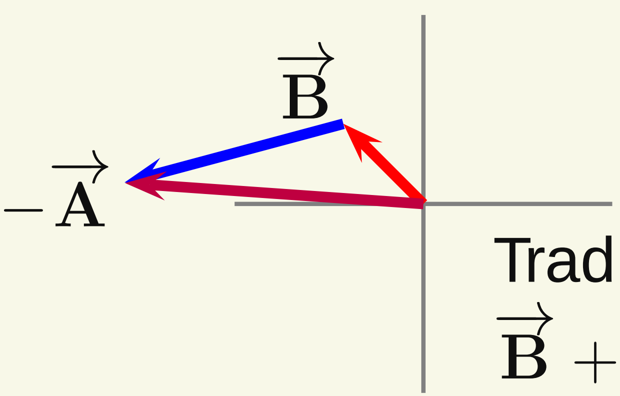

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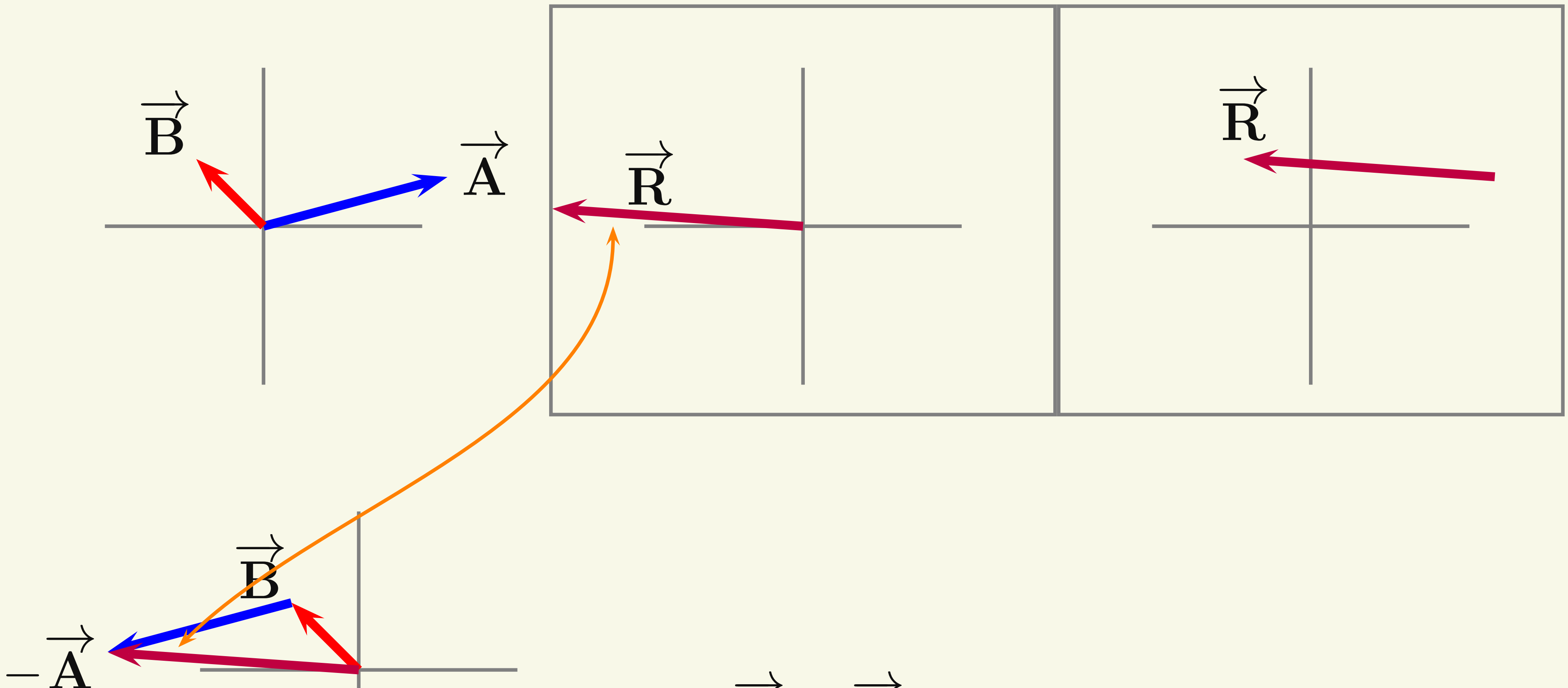

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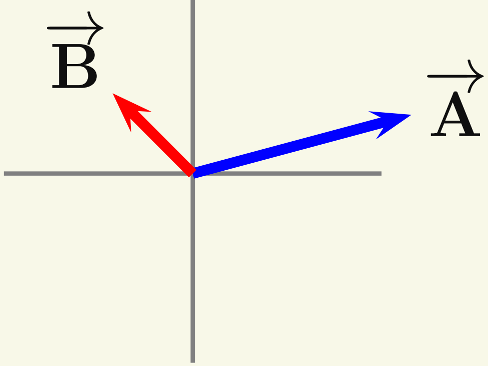

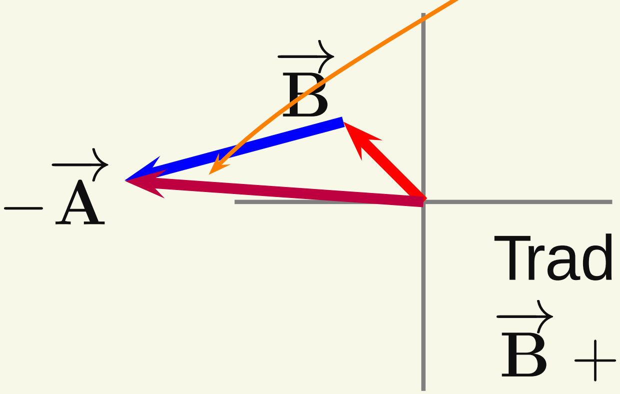

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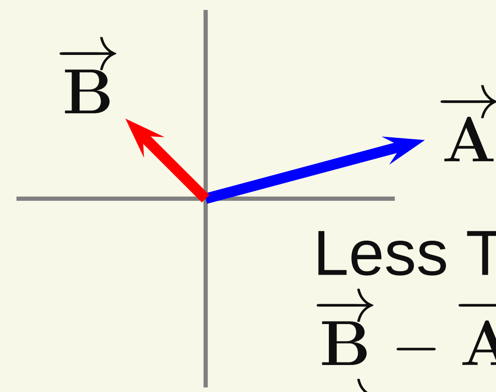

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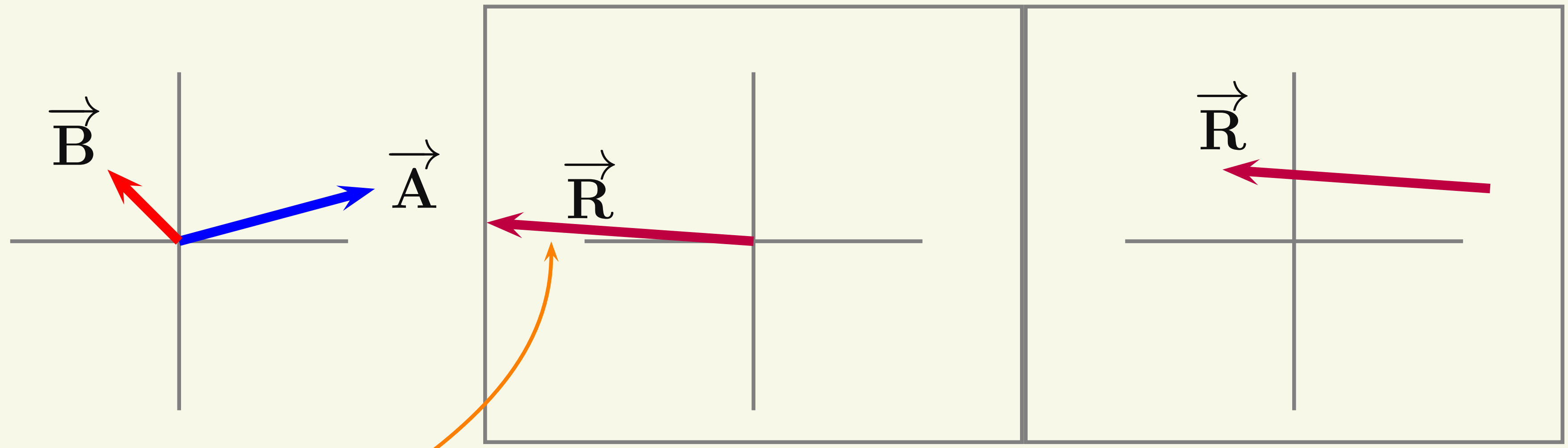

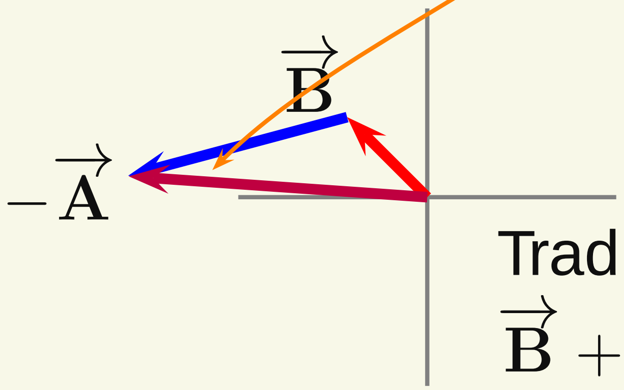

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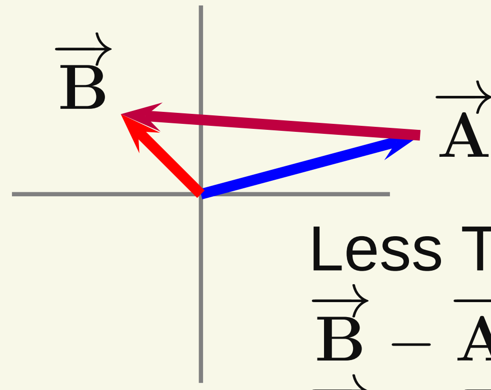

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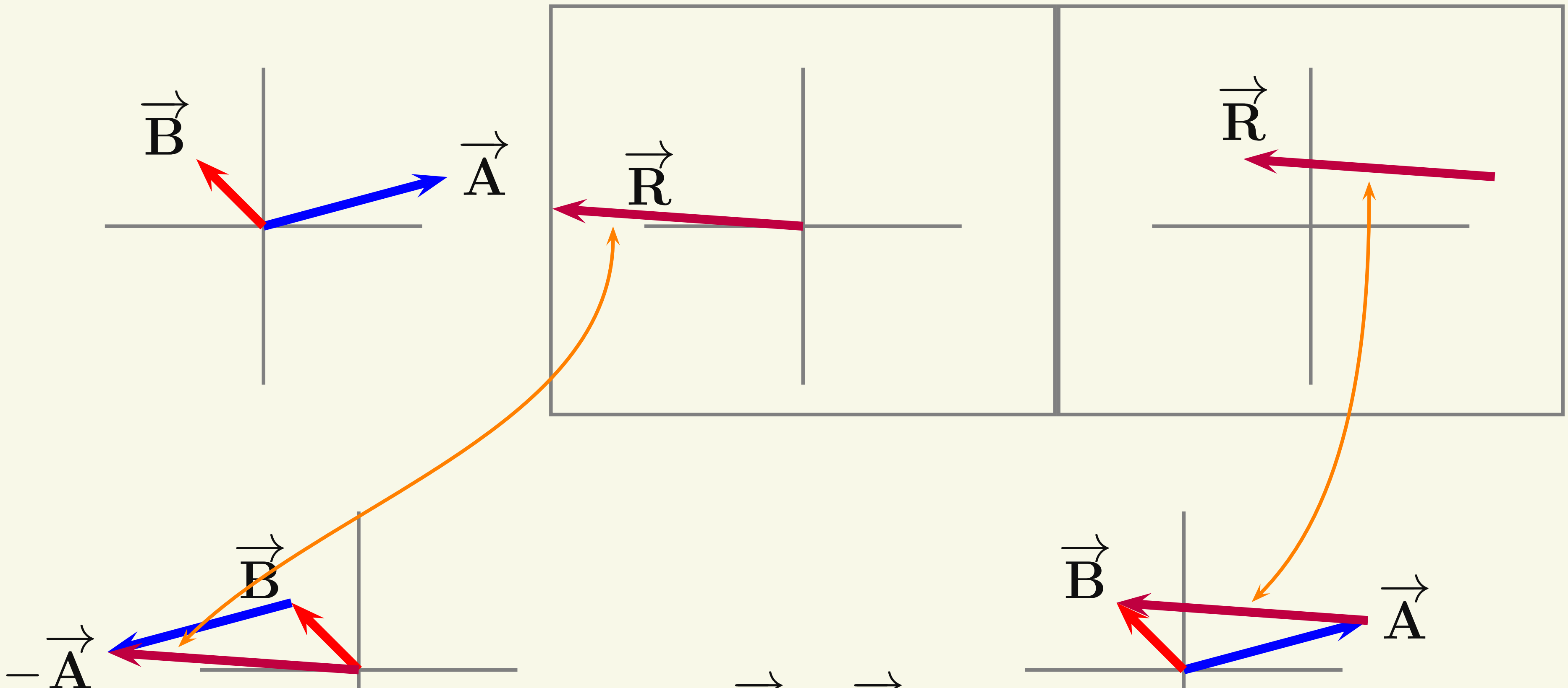

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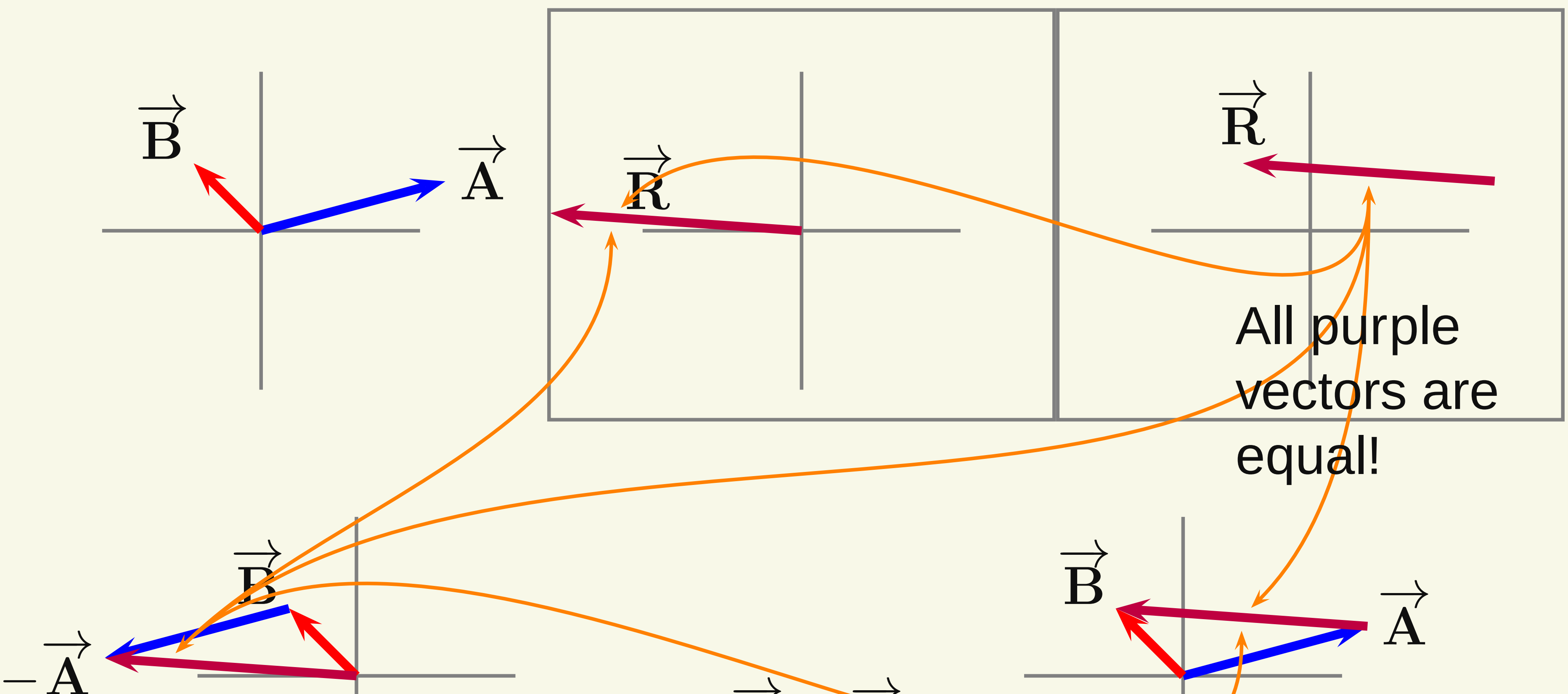

All purple vectors are equal!

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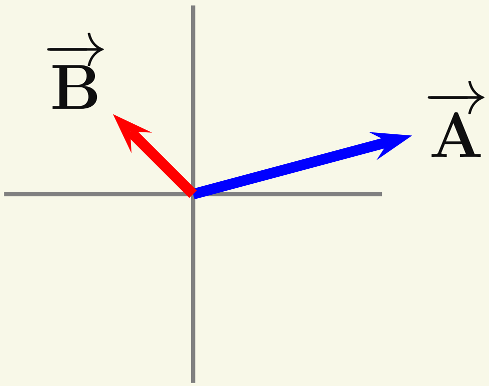

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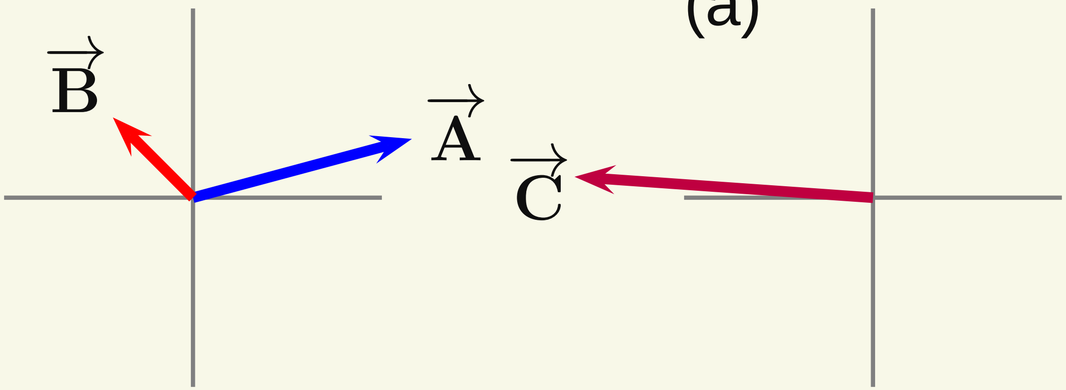

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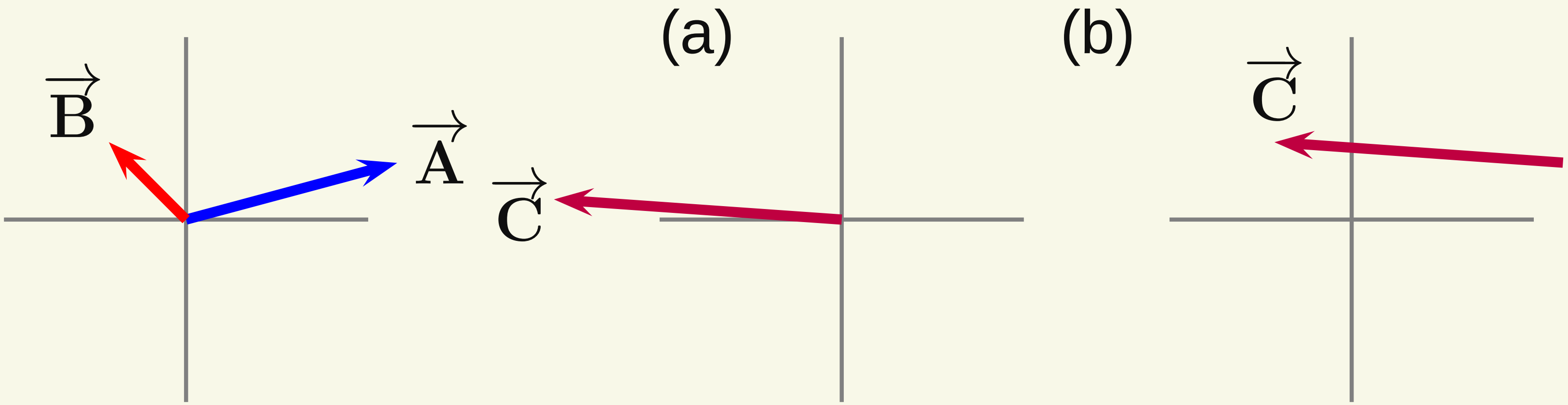

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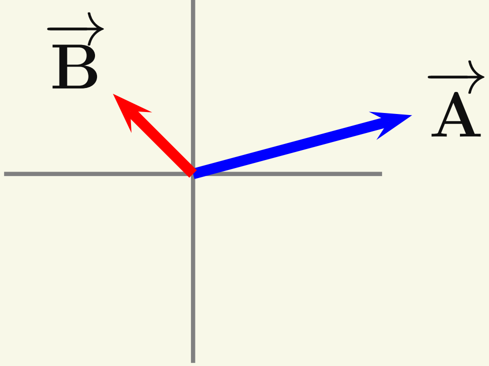

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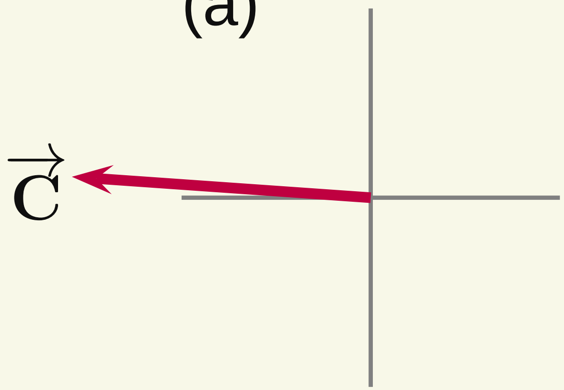

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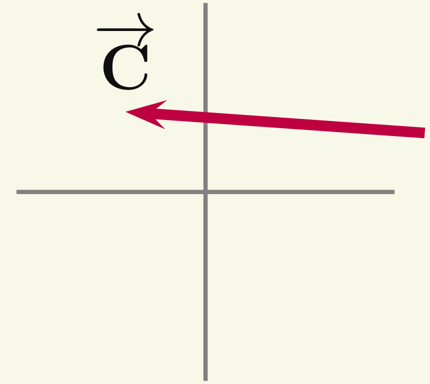

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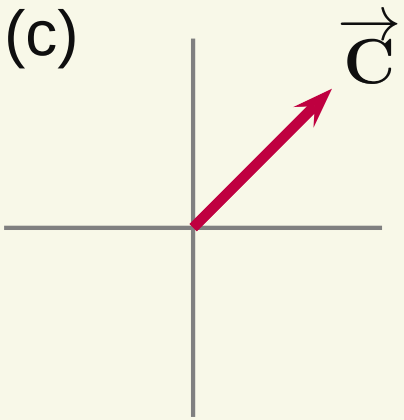

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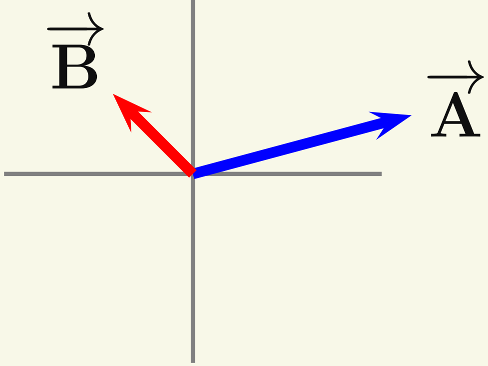

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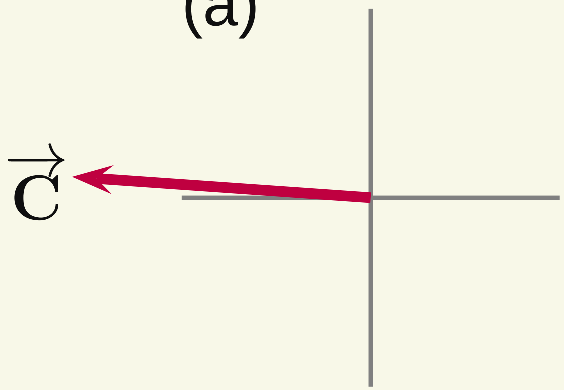

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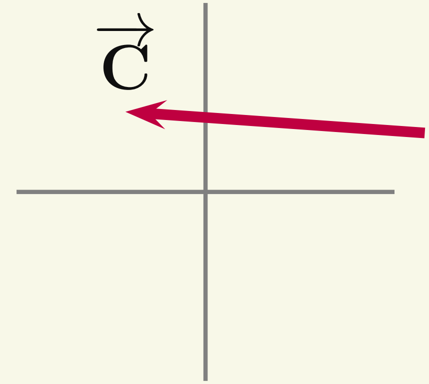

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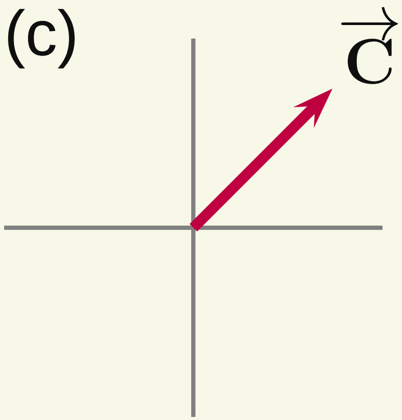

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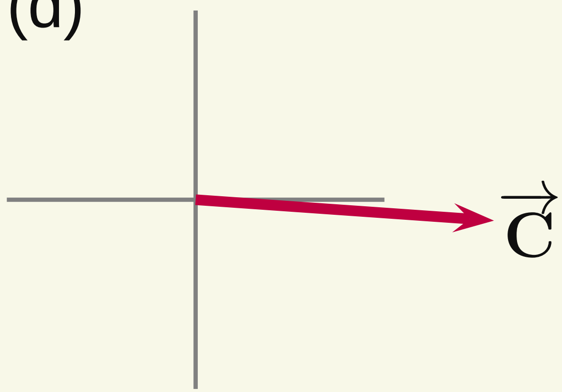

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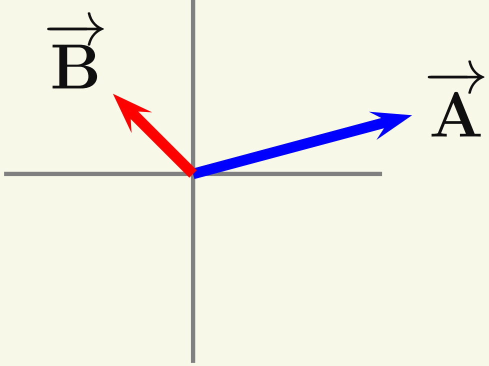

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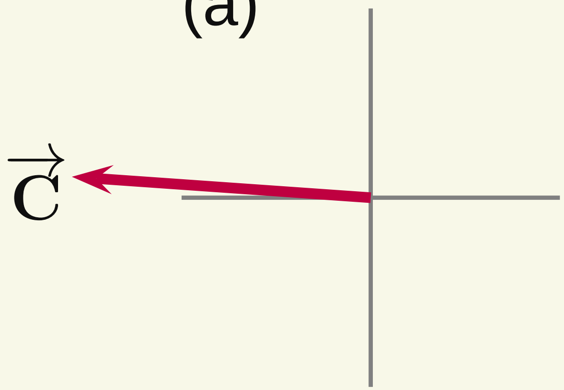

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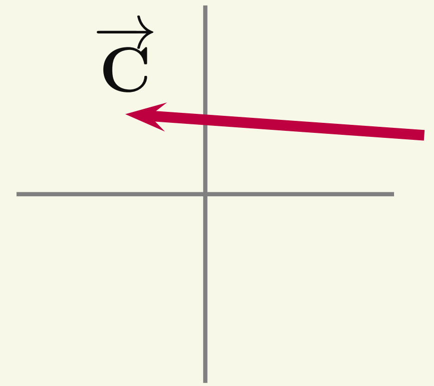

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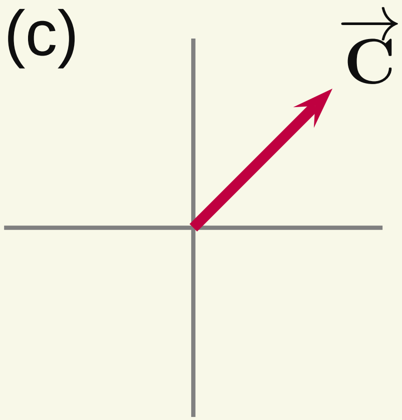

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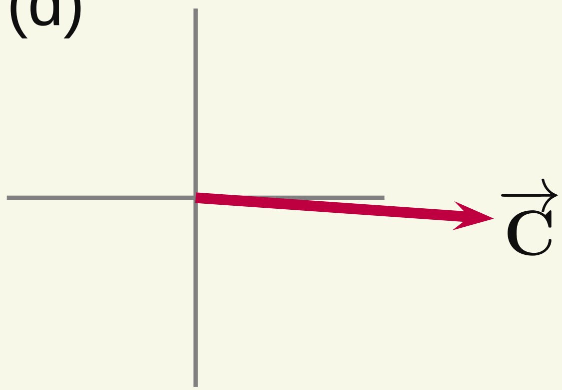

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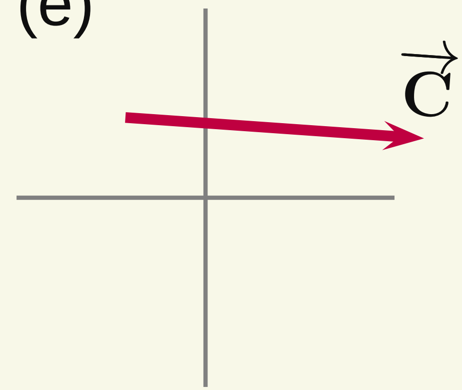

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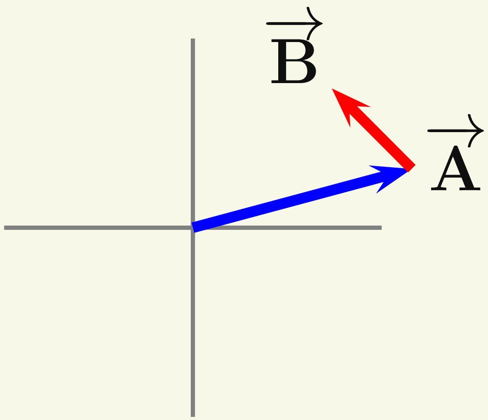

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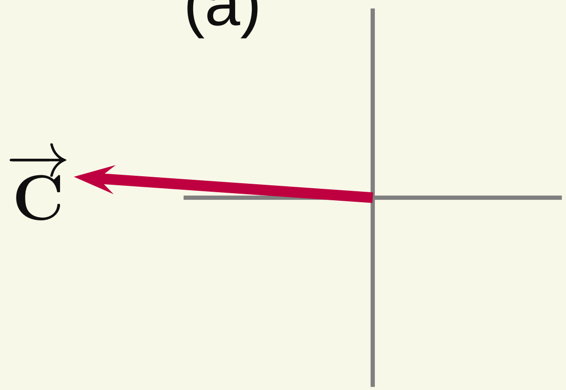

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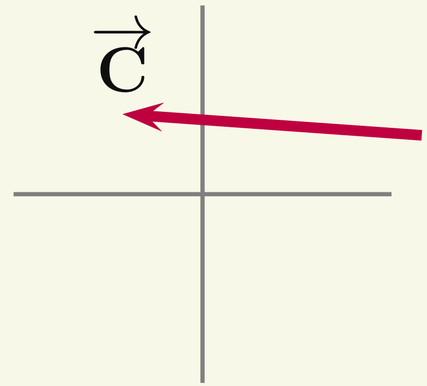

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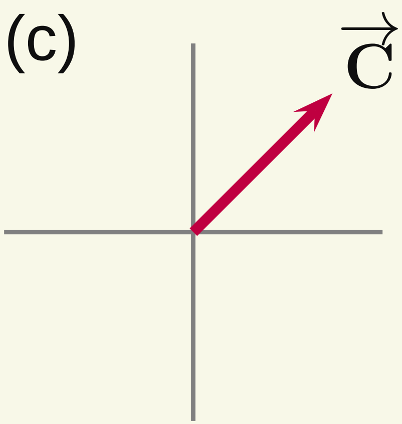

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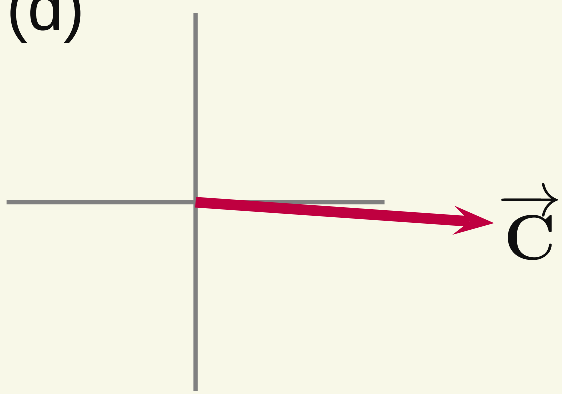

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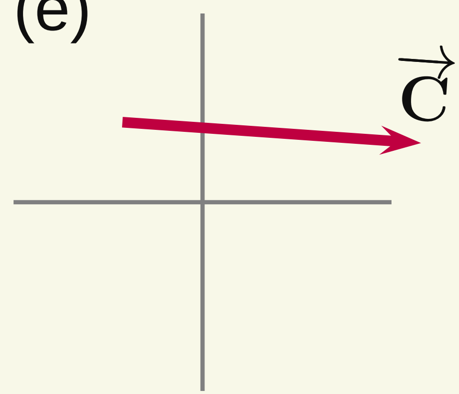

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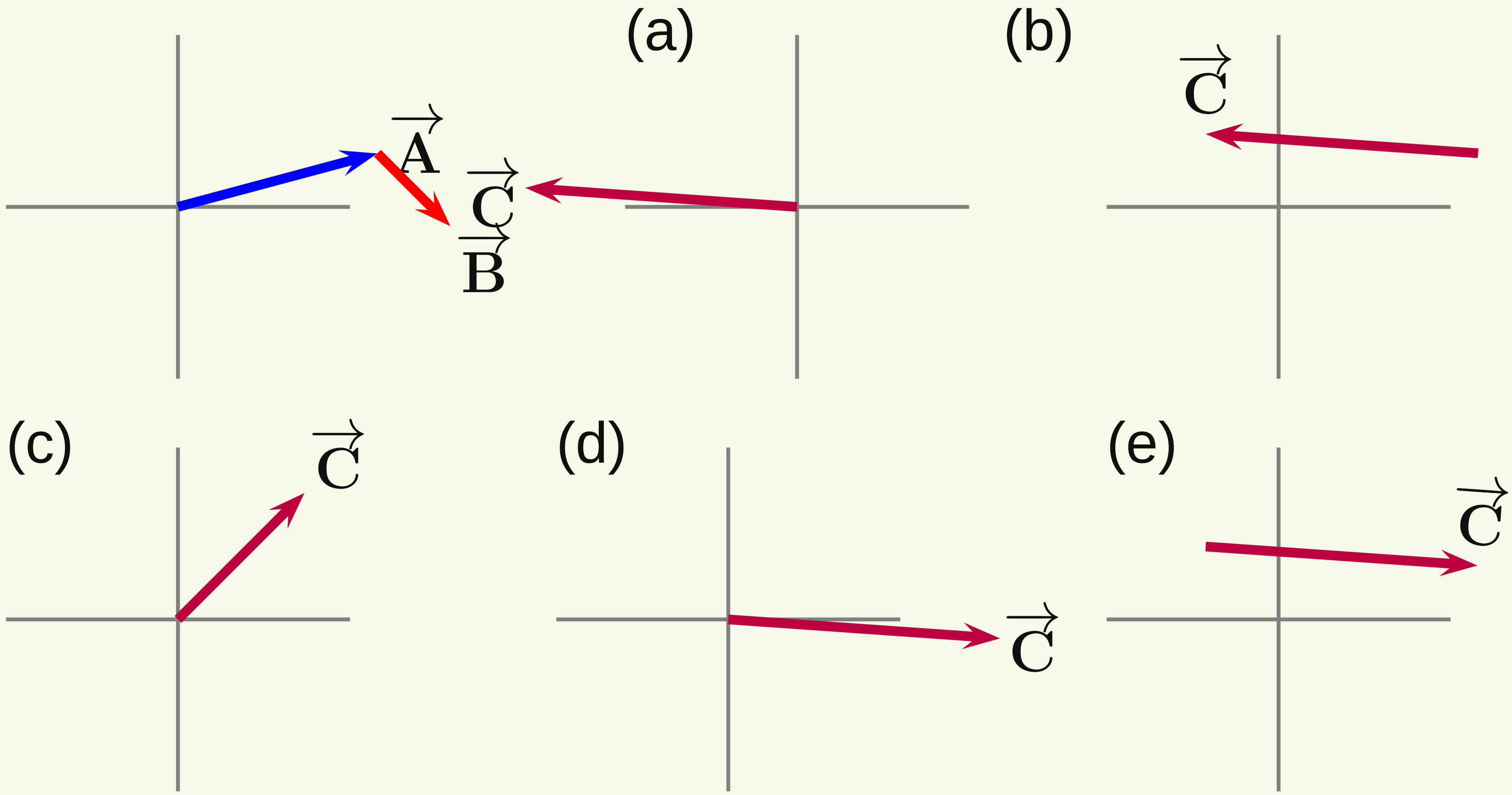

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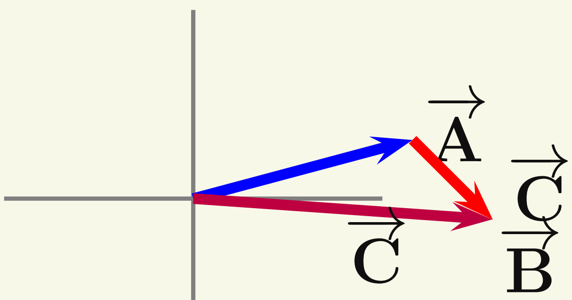

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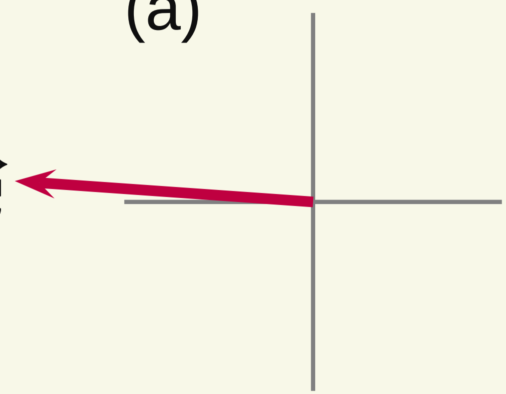

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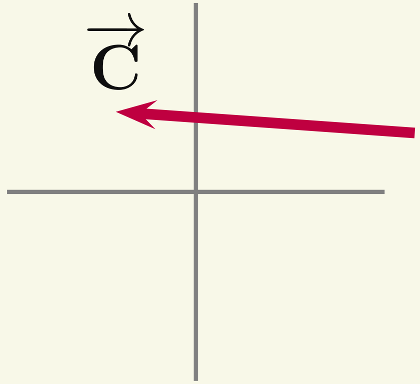

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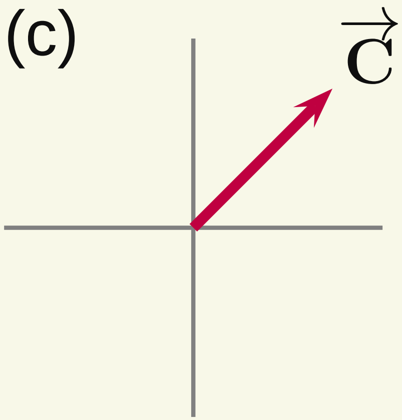

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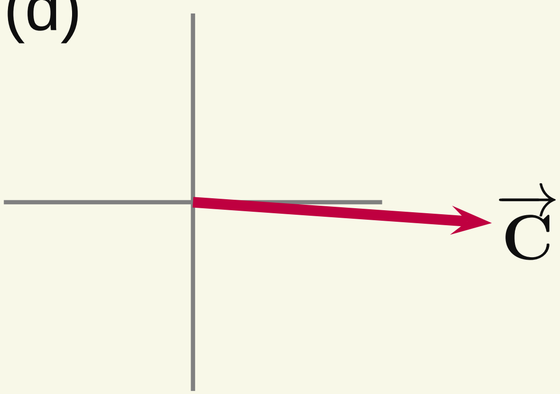

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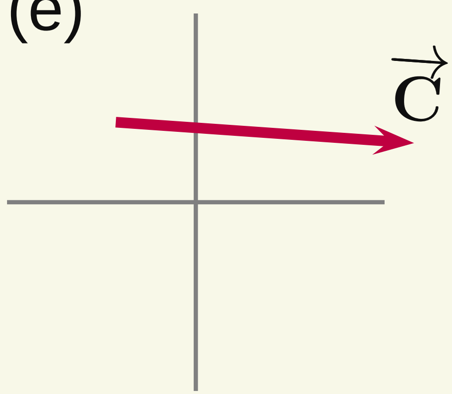

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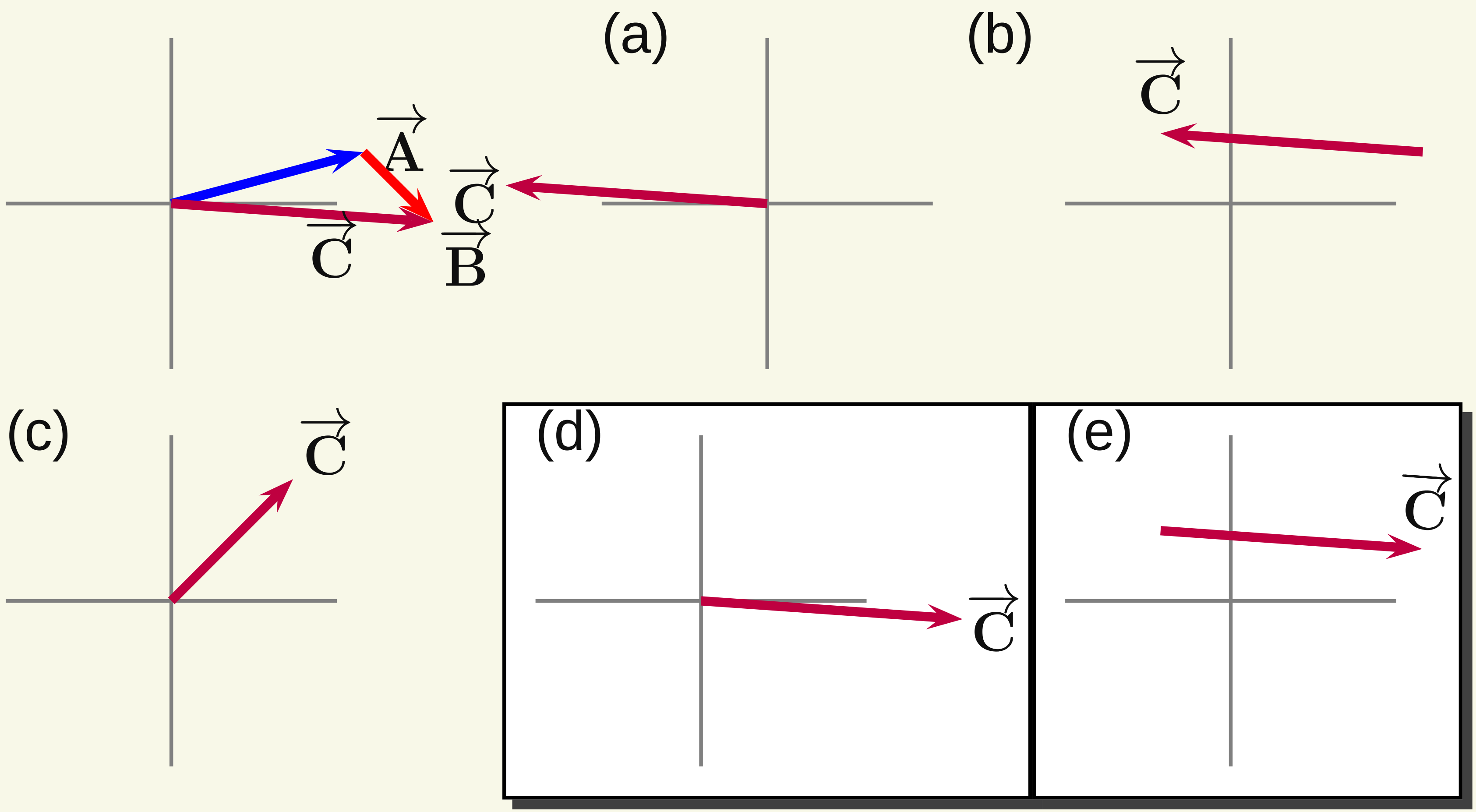

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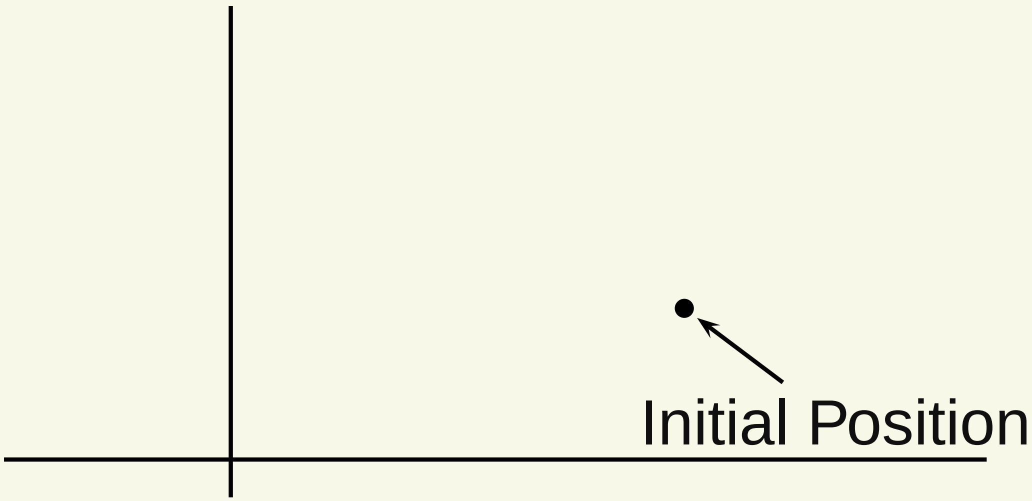

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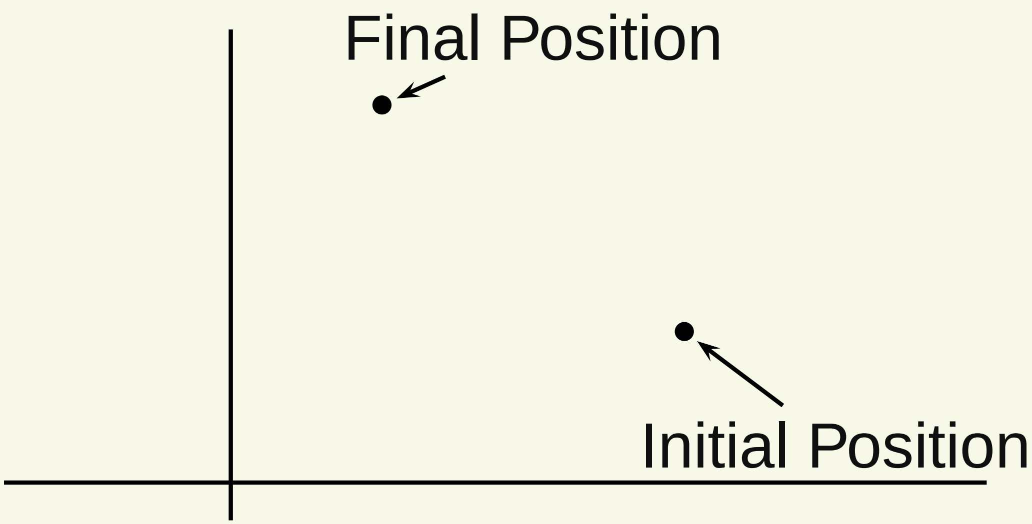

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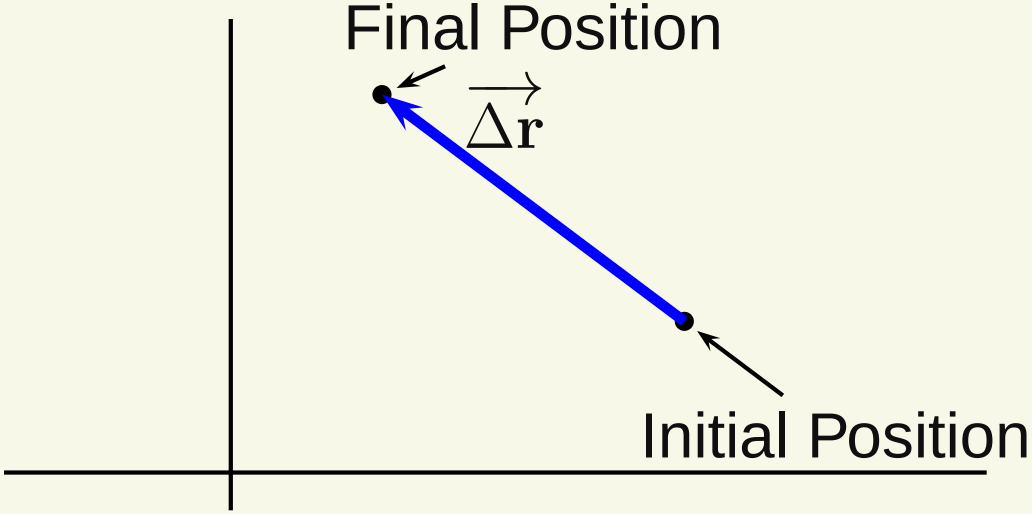

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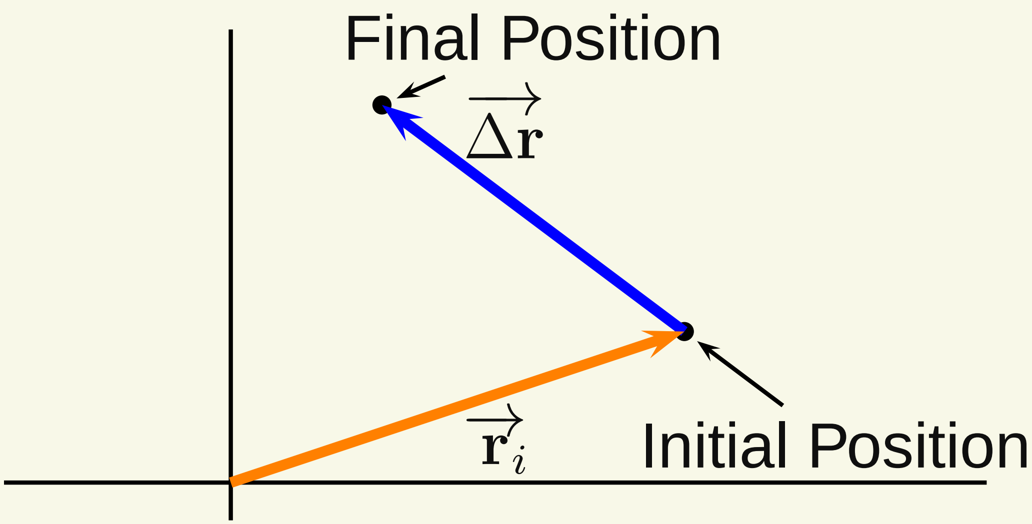

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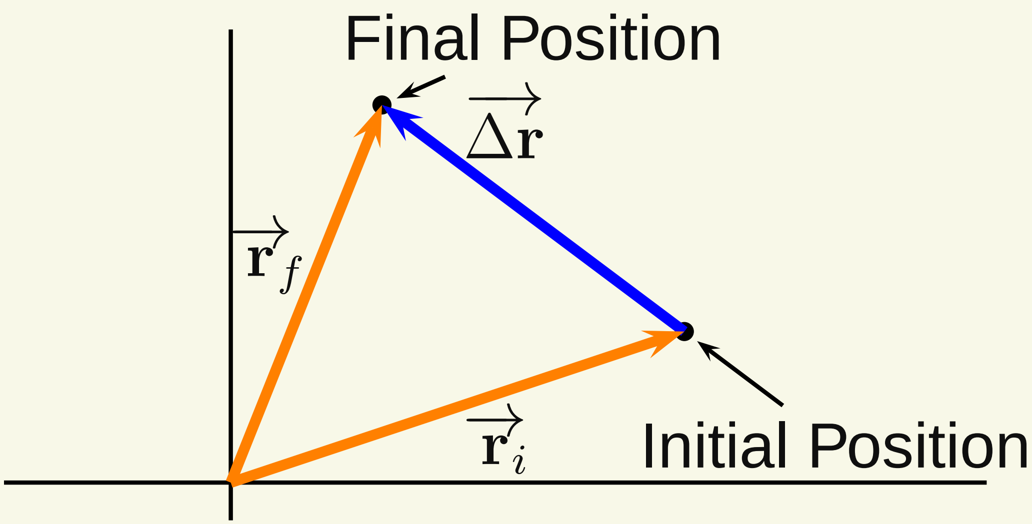

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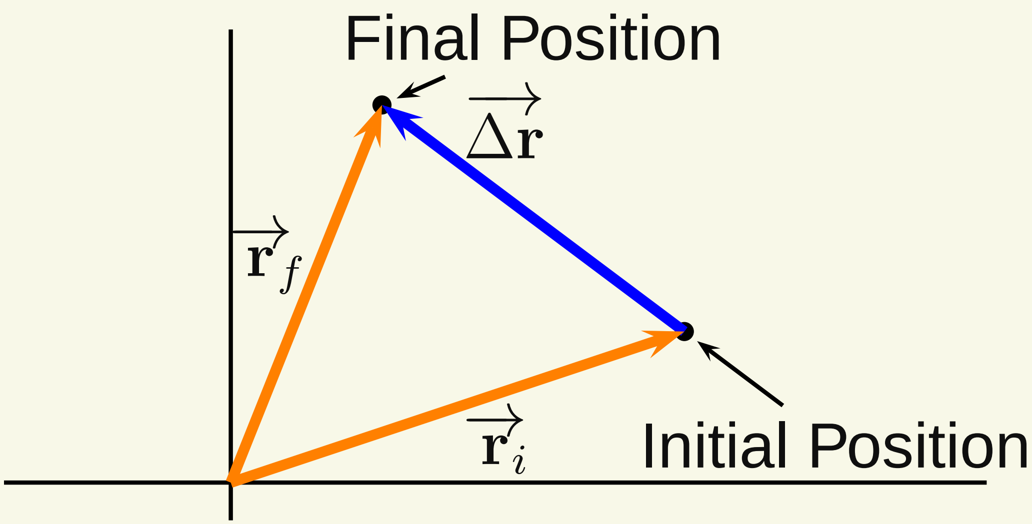

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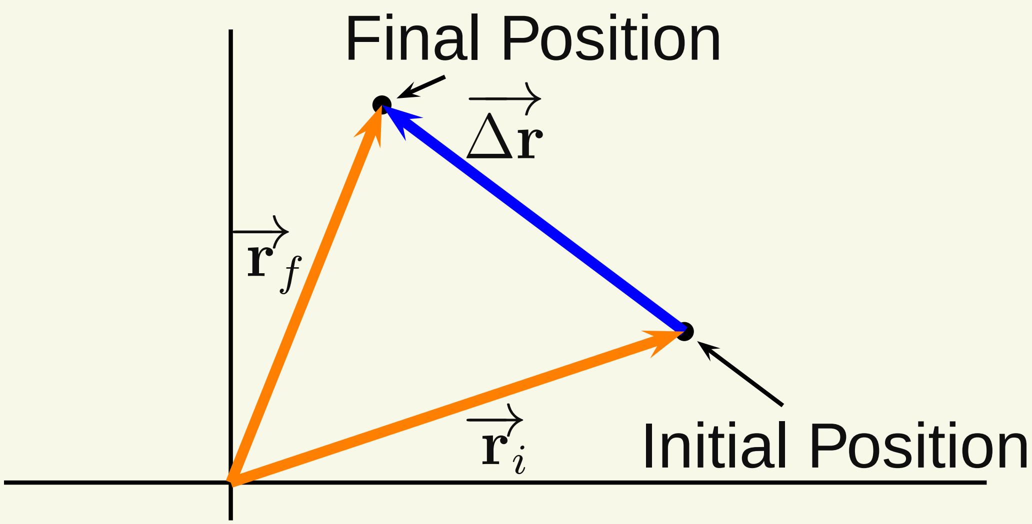

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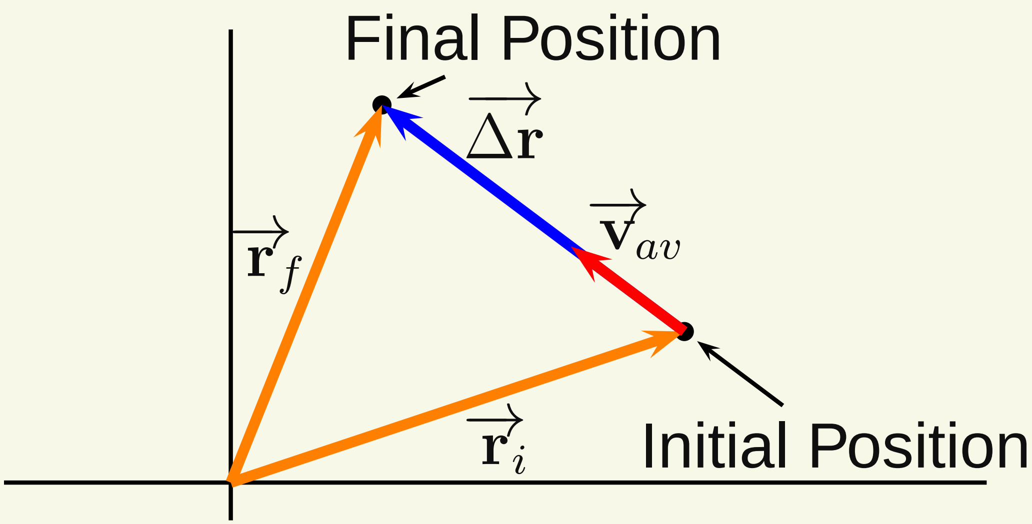

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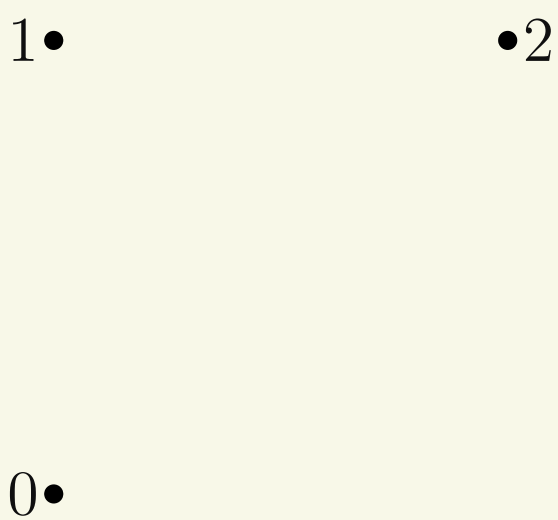

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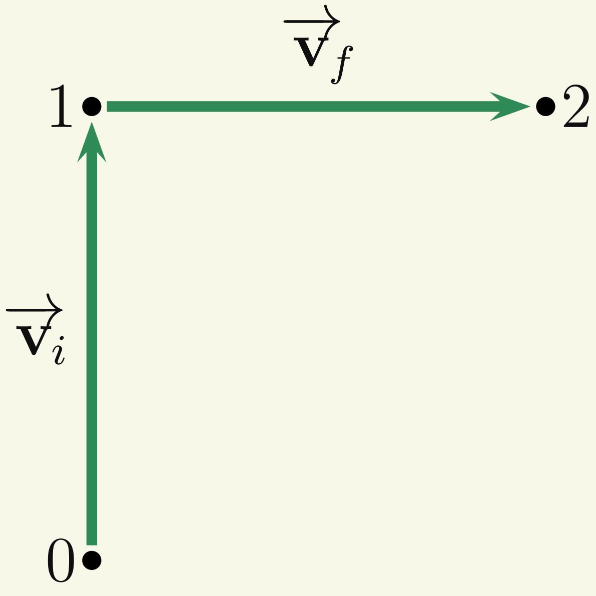

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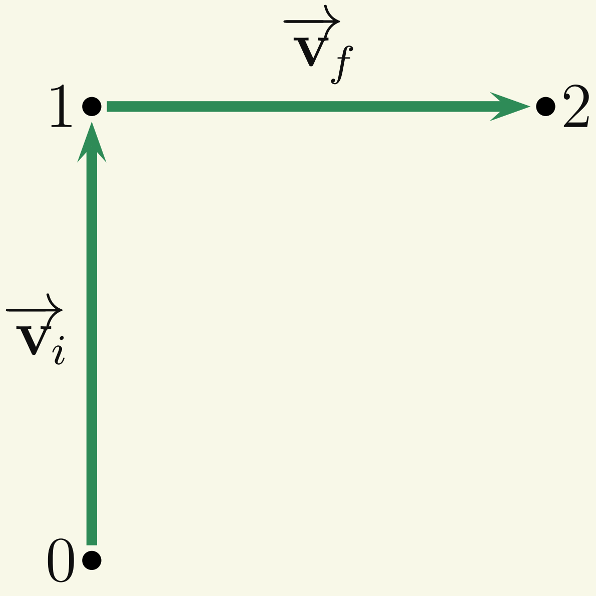

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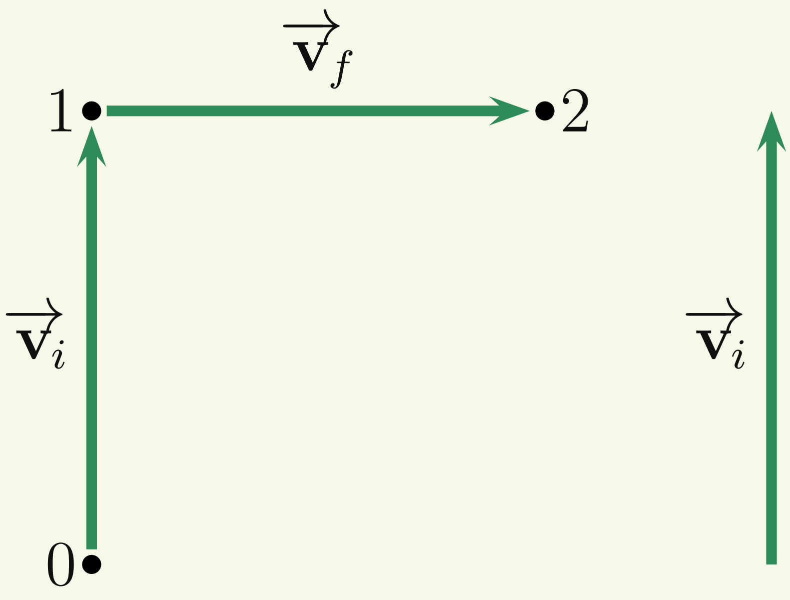

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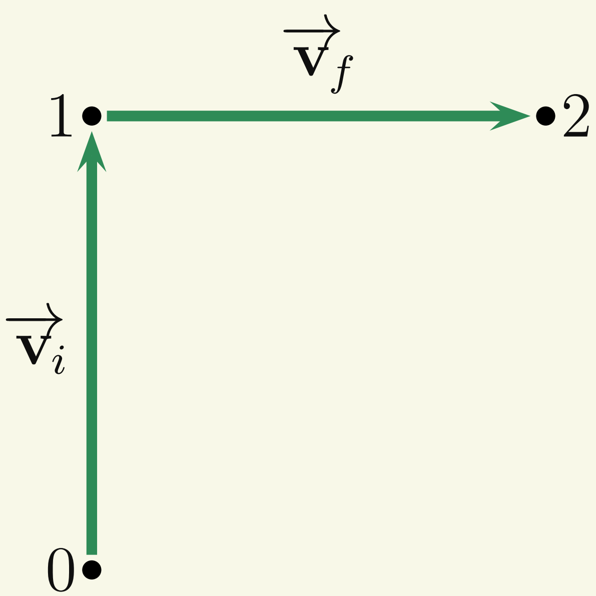

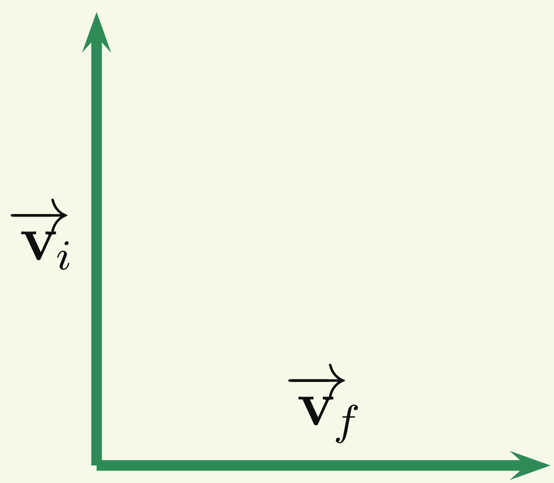

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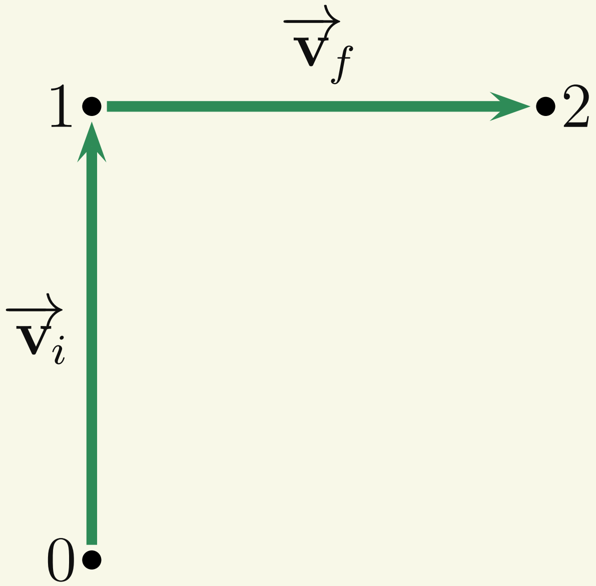

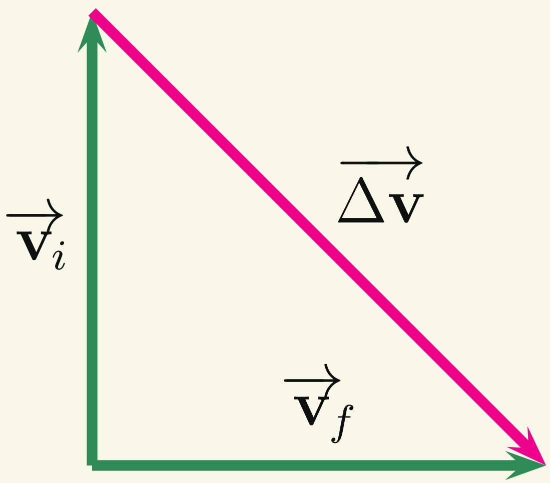

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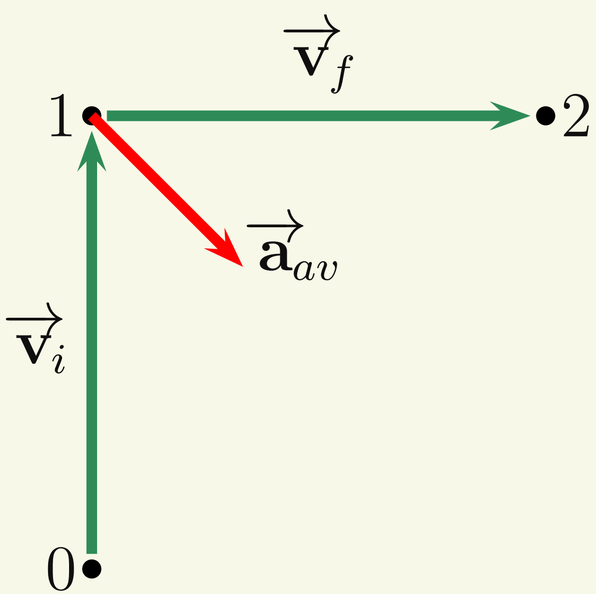

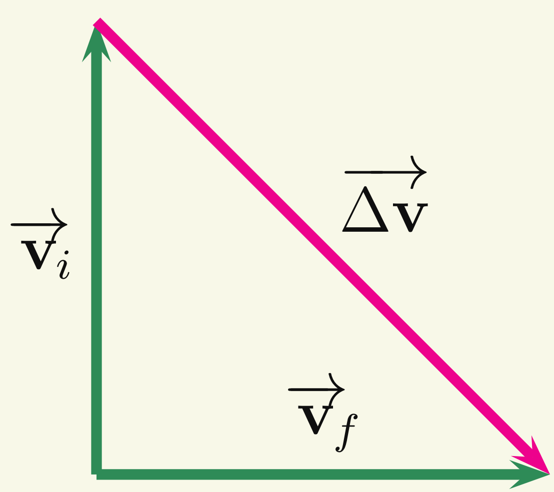

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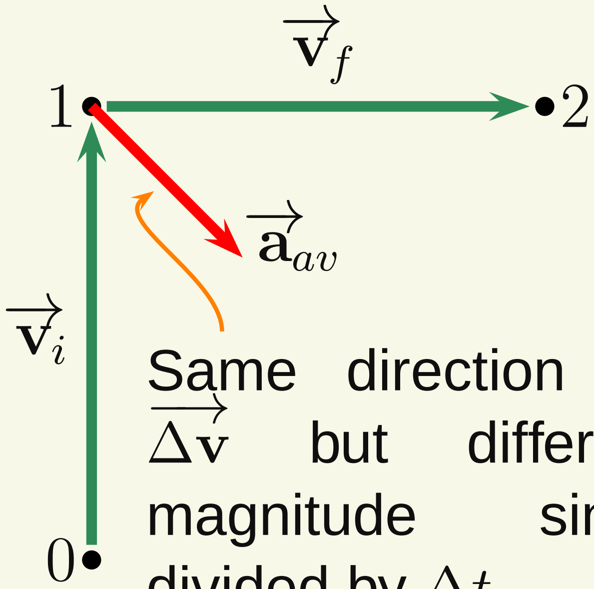

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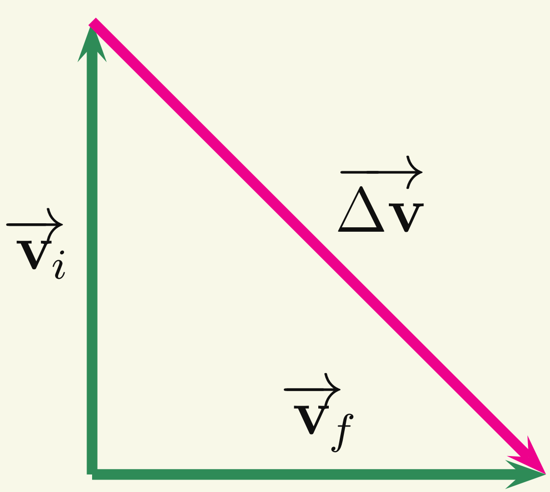

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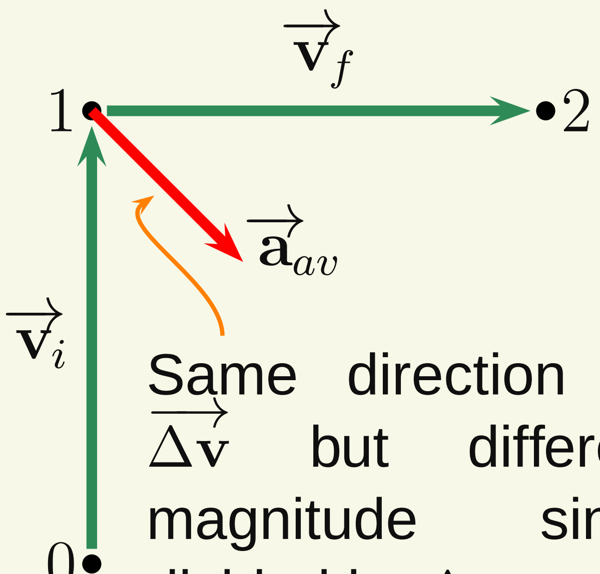

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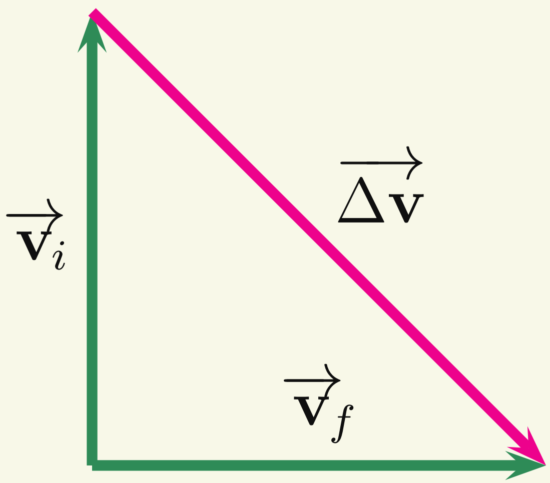

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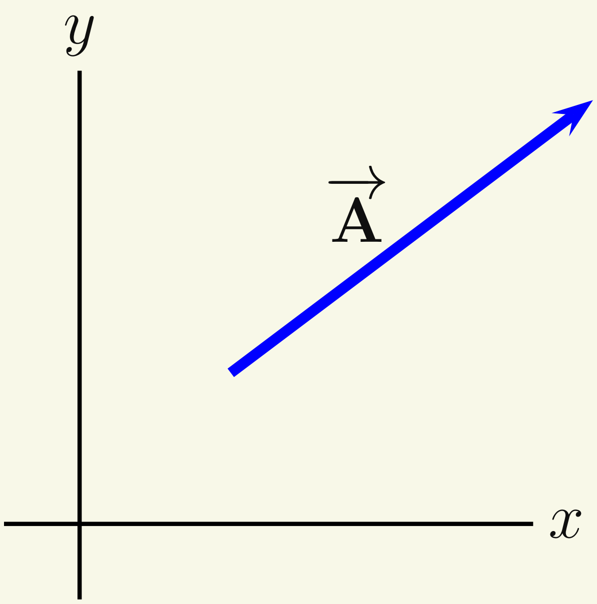

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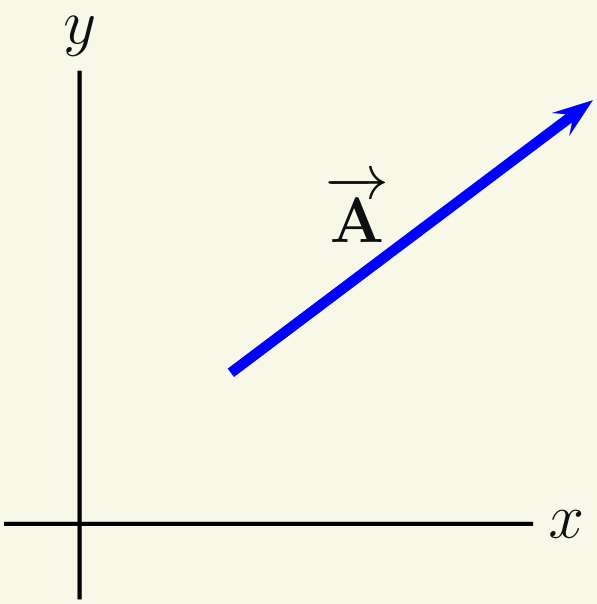

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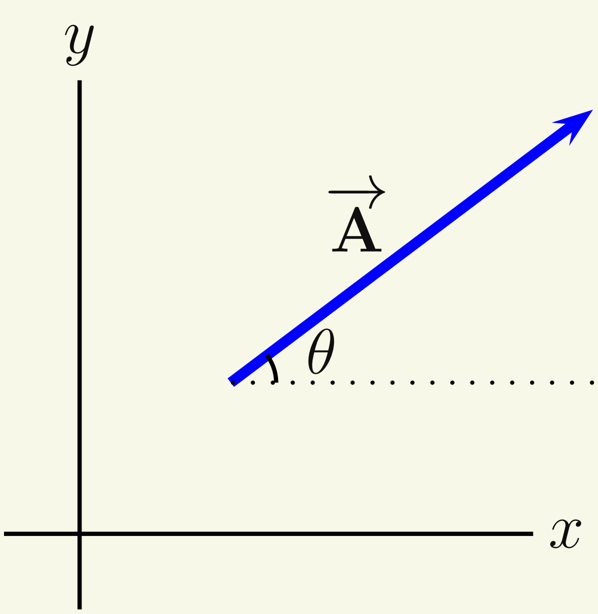

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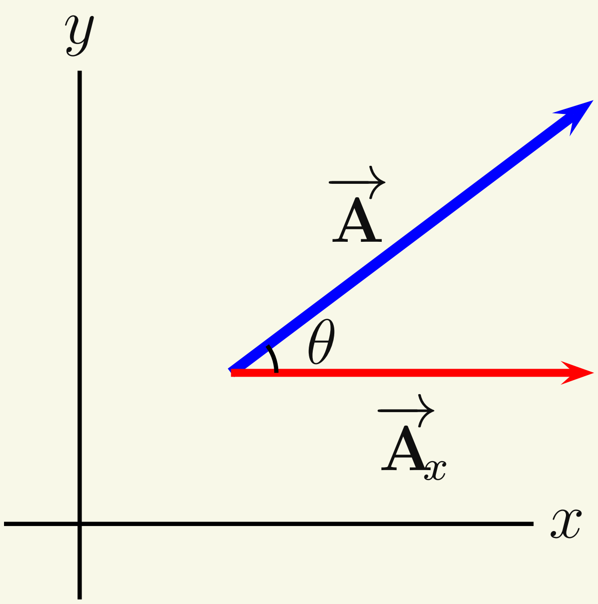

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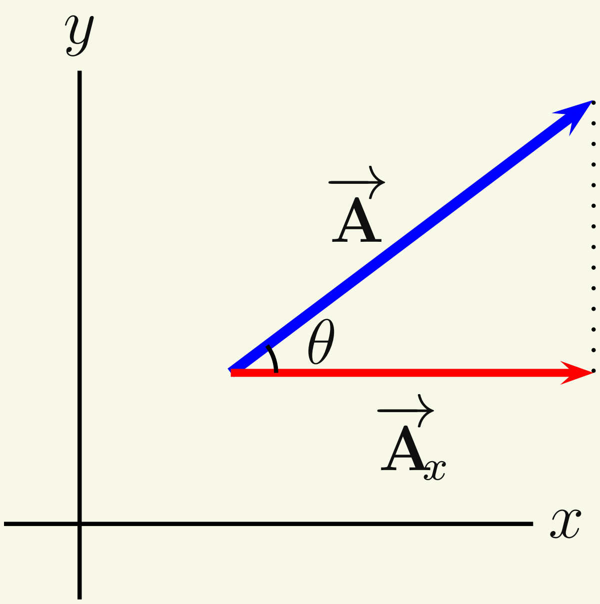

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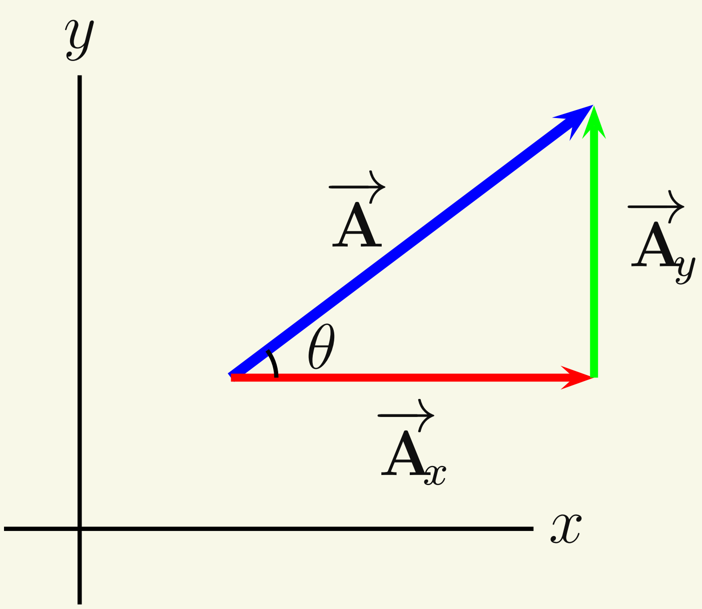

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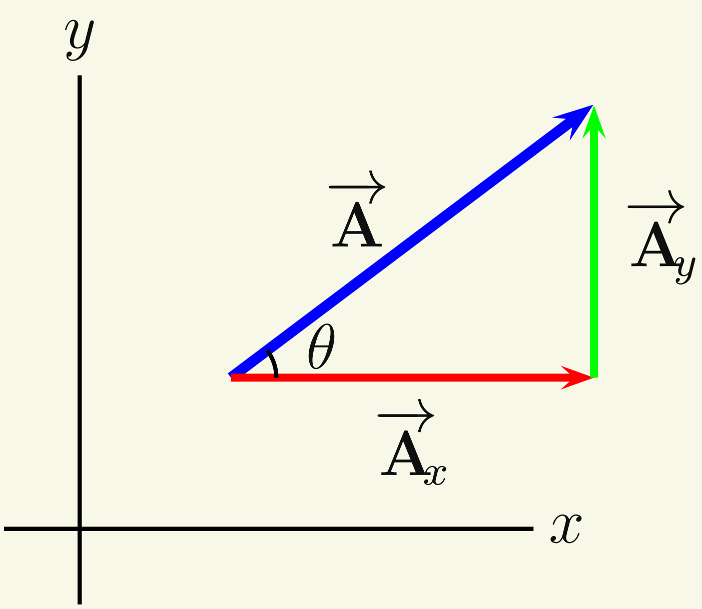

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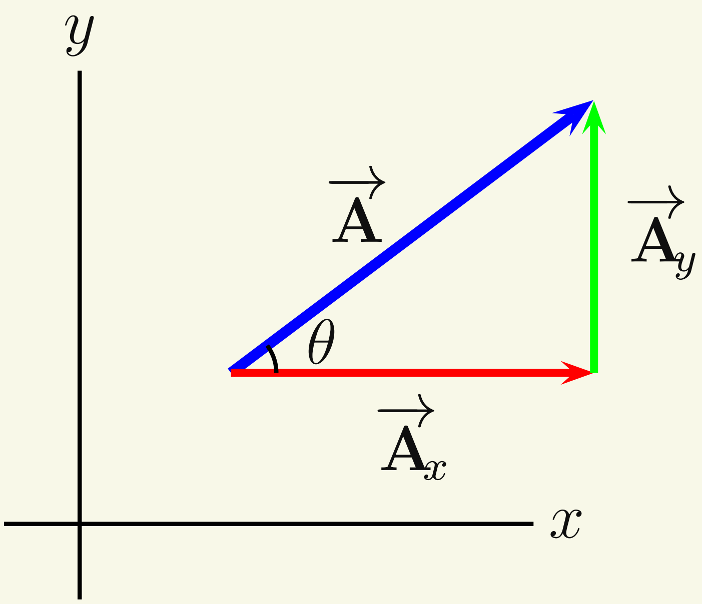

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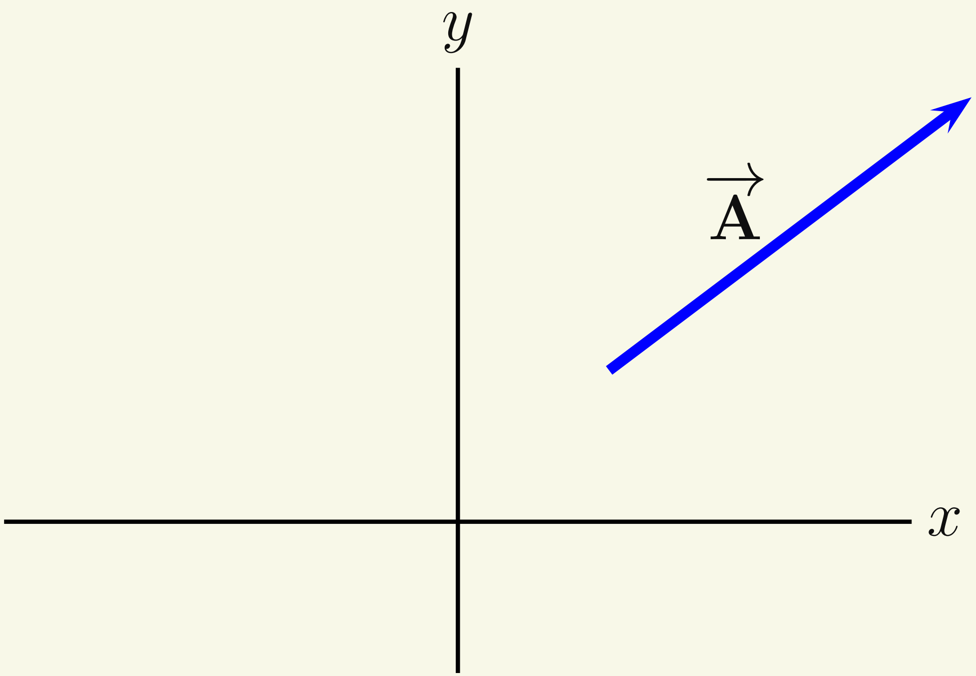
The components and the original vector are related by vector addition: $\vec{\mathbf{A}}_x + \vec{\mathbf{A}}_y = \vec{\mathbf{A}}$.

Vector and Scalar Components



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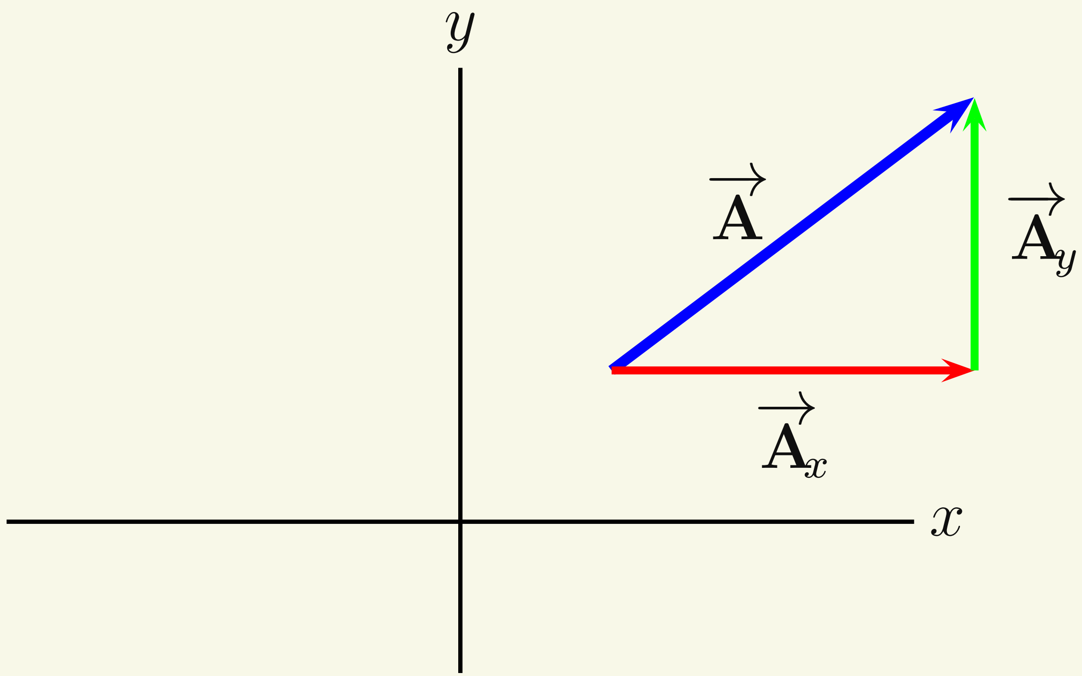

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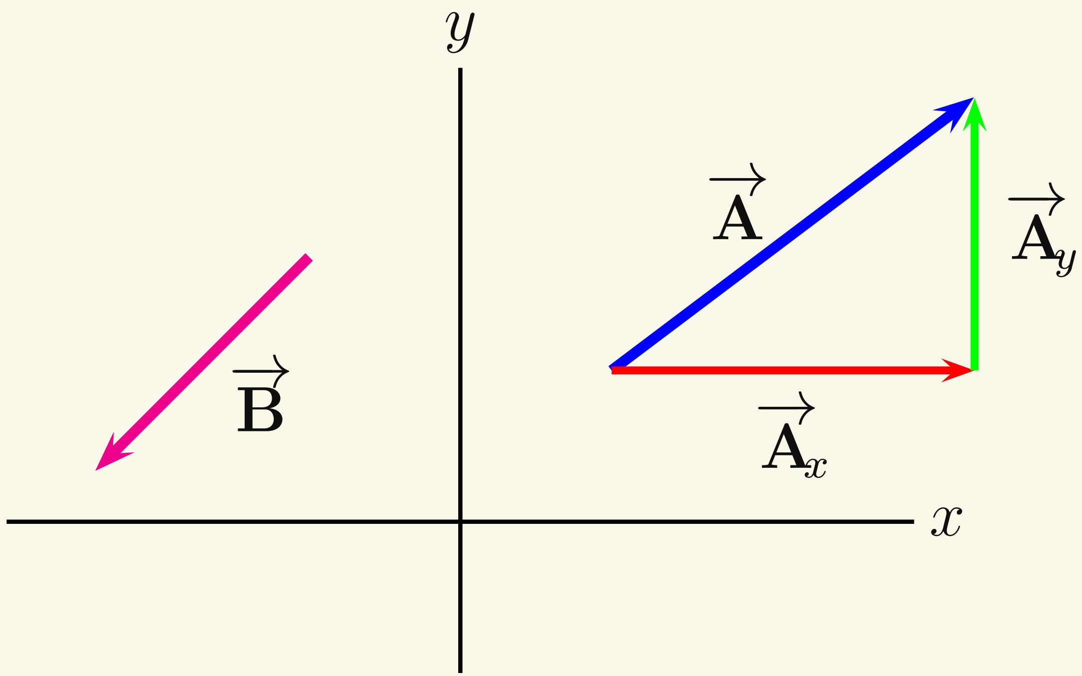

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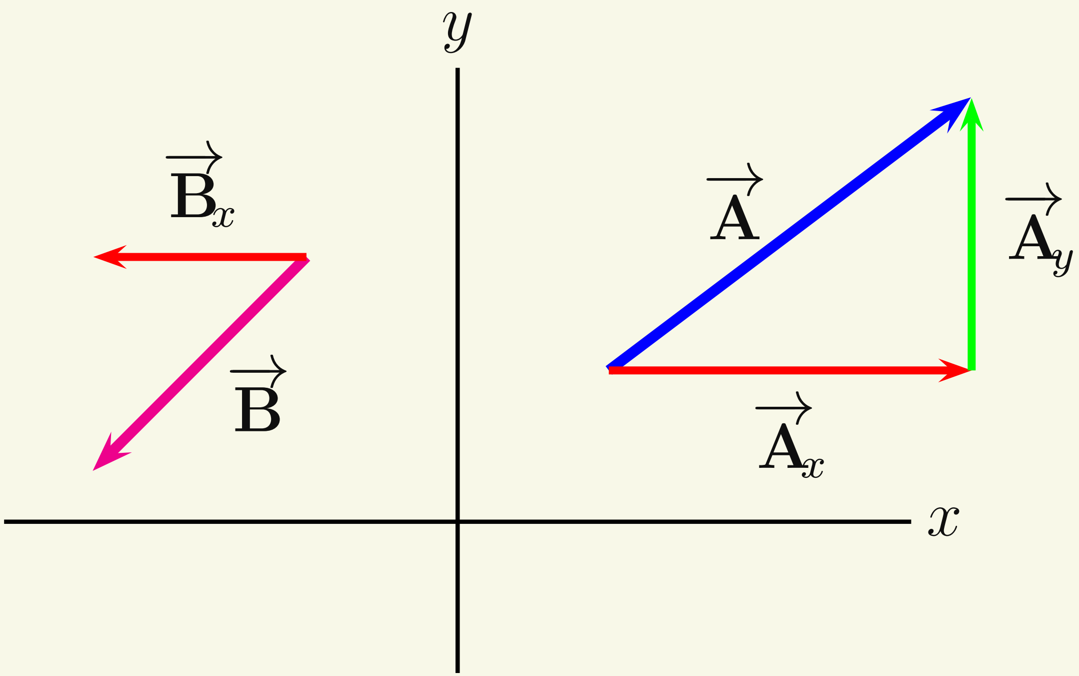

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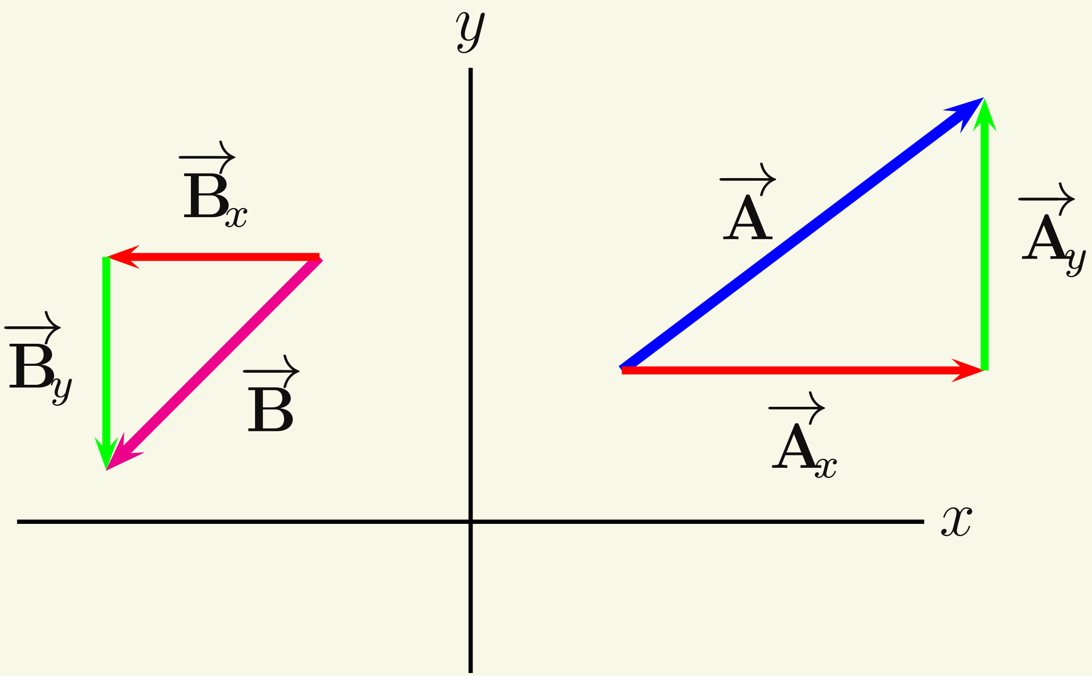

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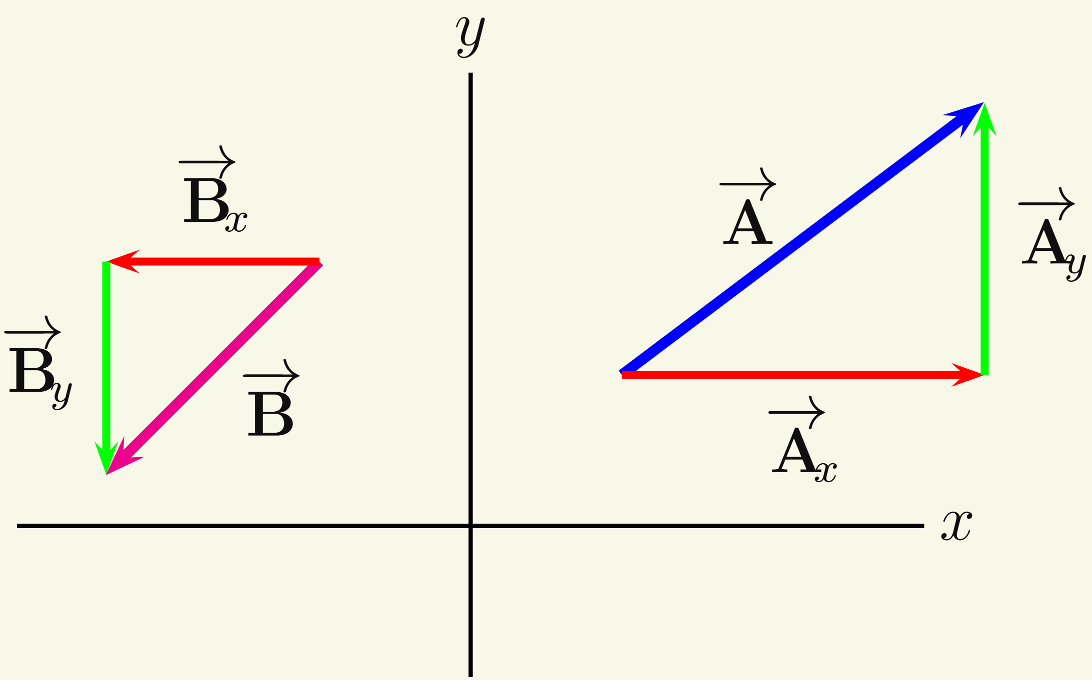

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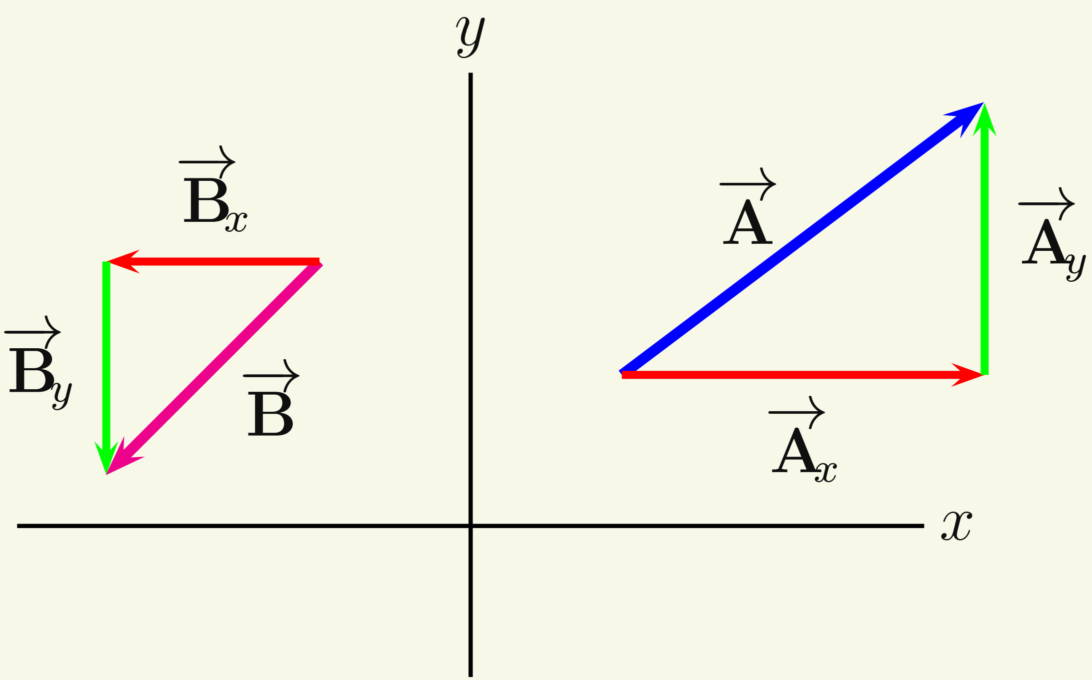

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A_x, A_y, B_x, B_y and their signs $=$ Scalar Components

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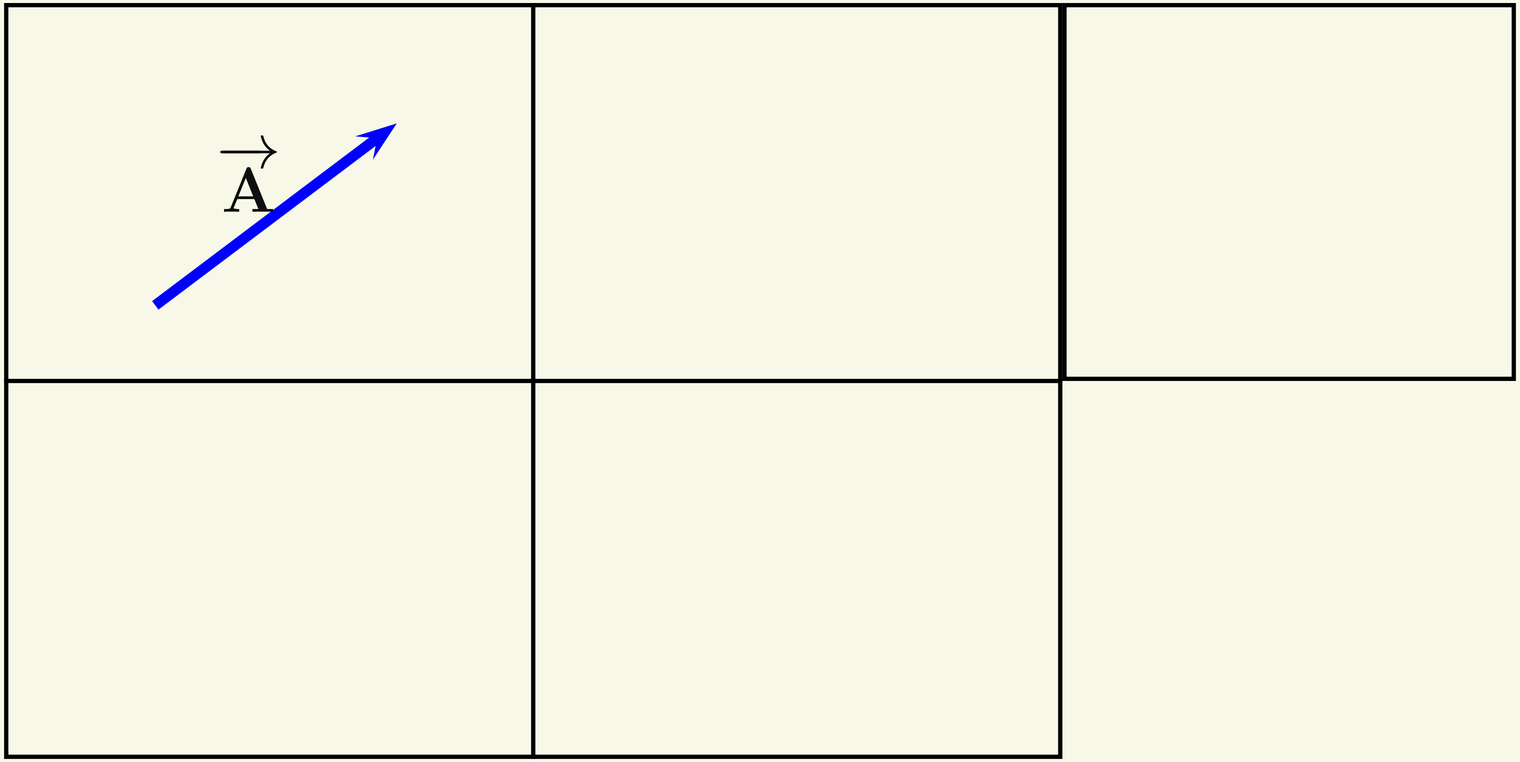

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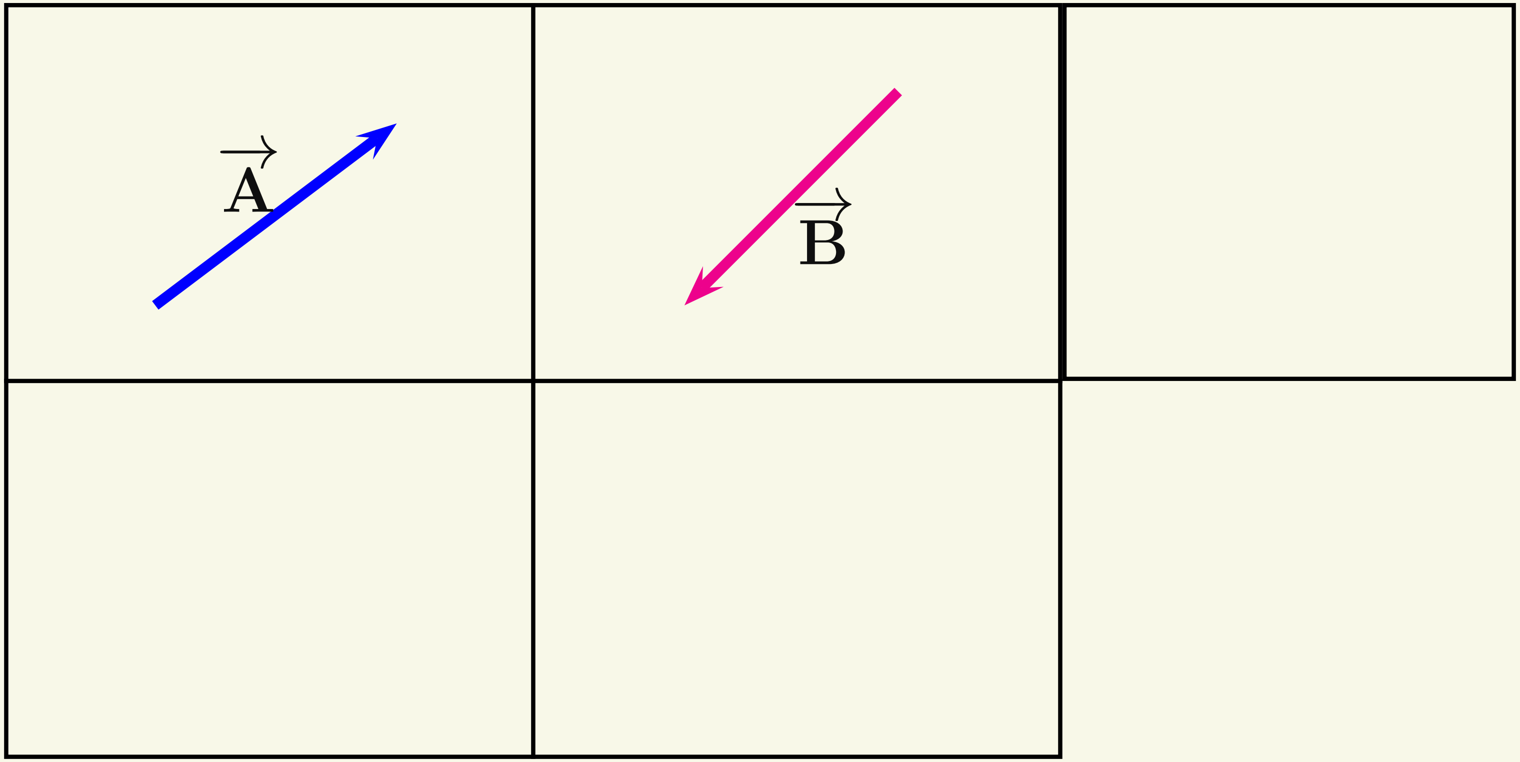

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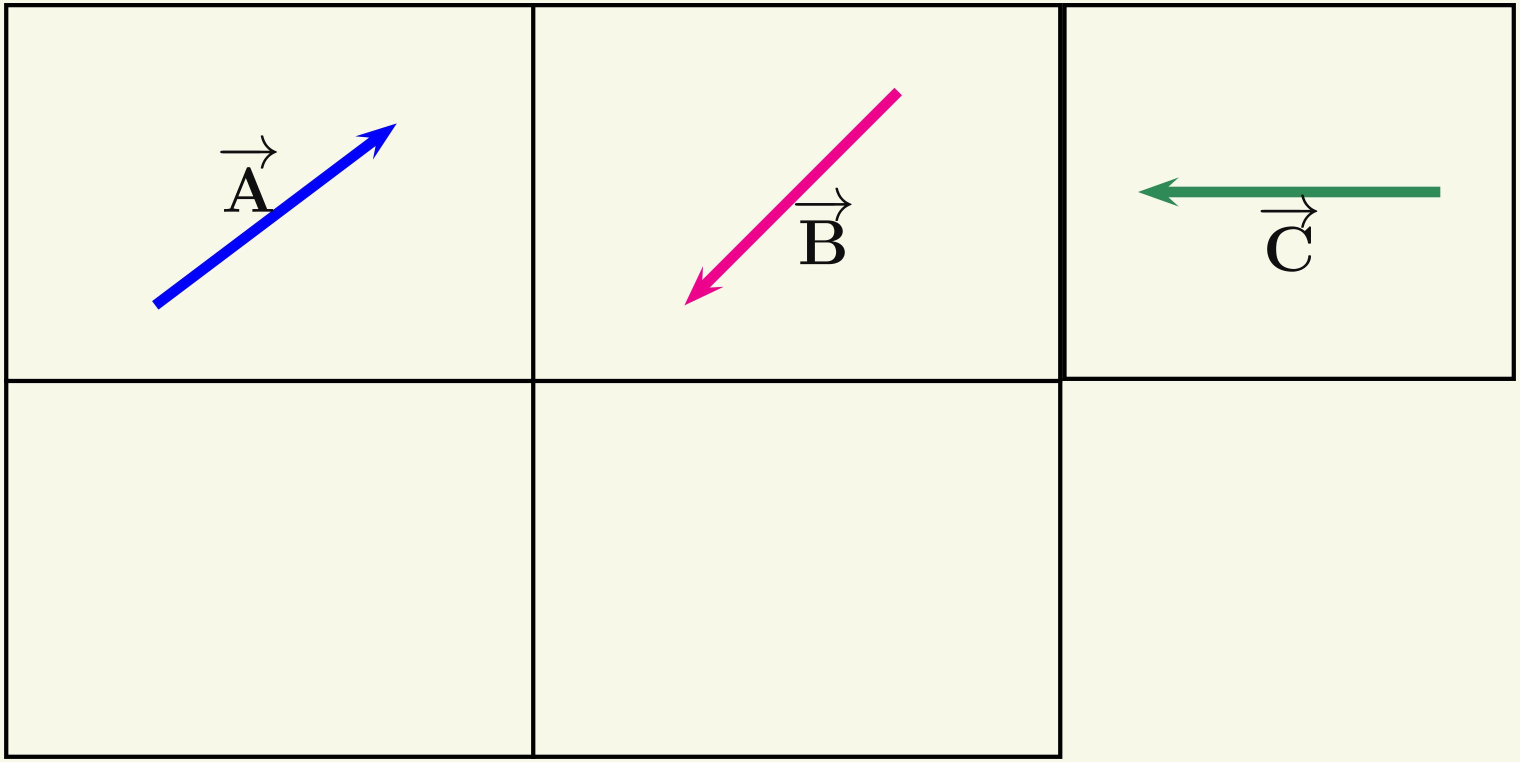

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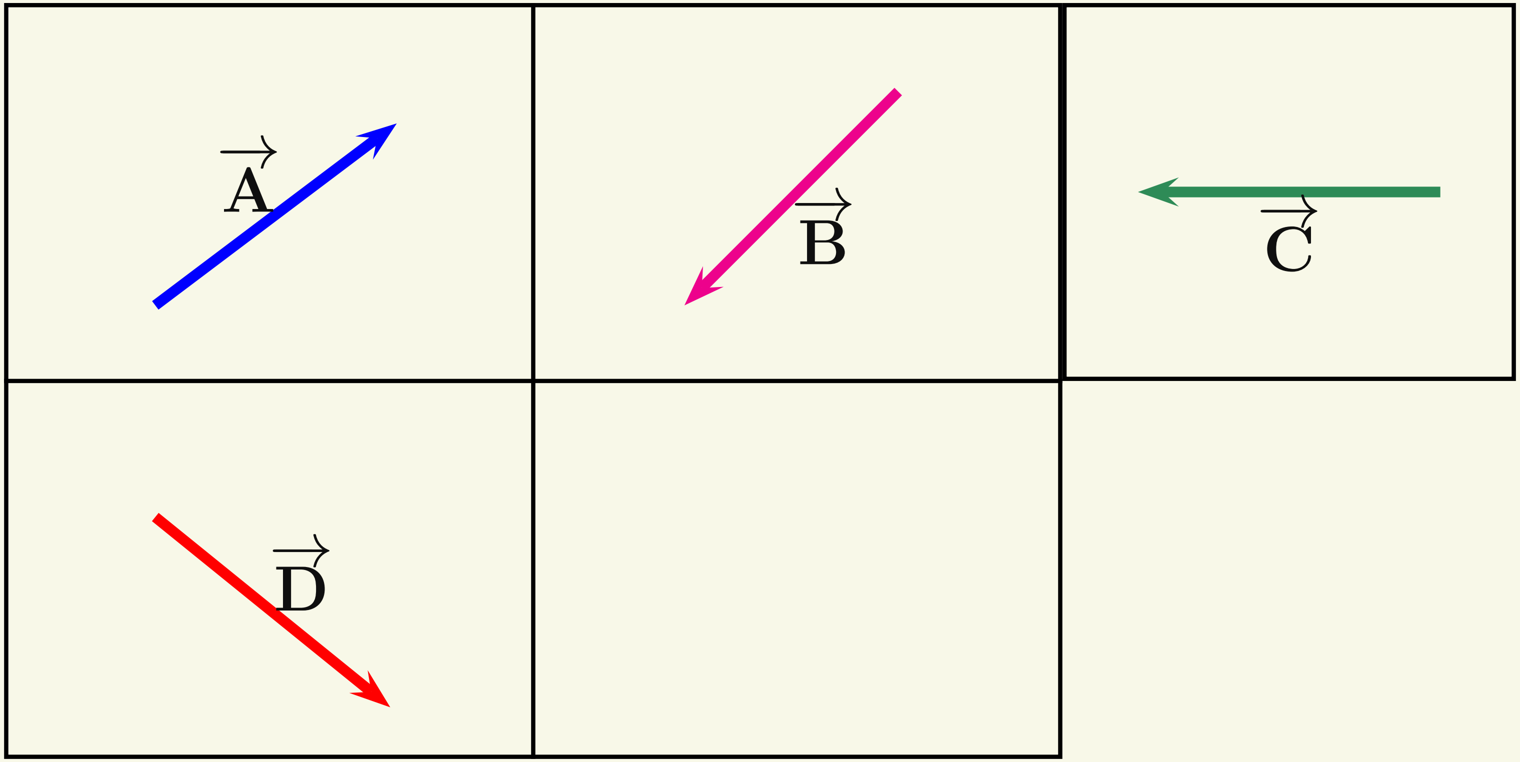

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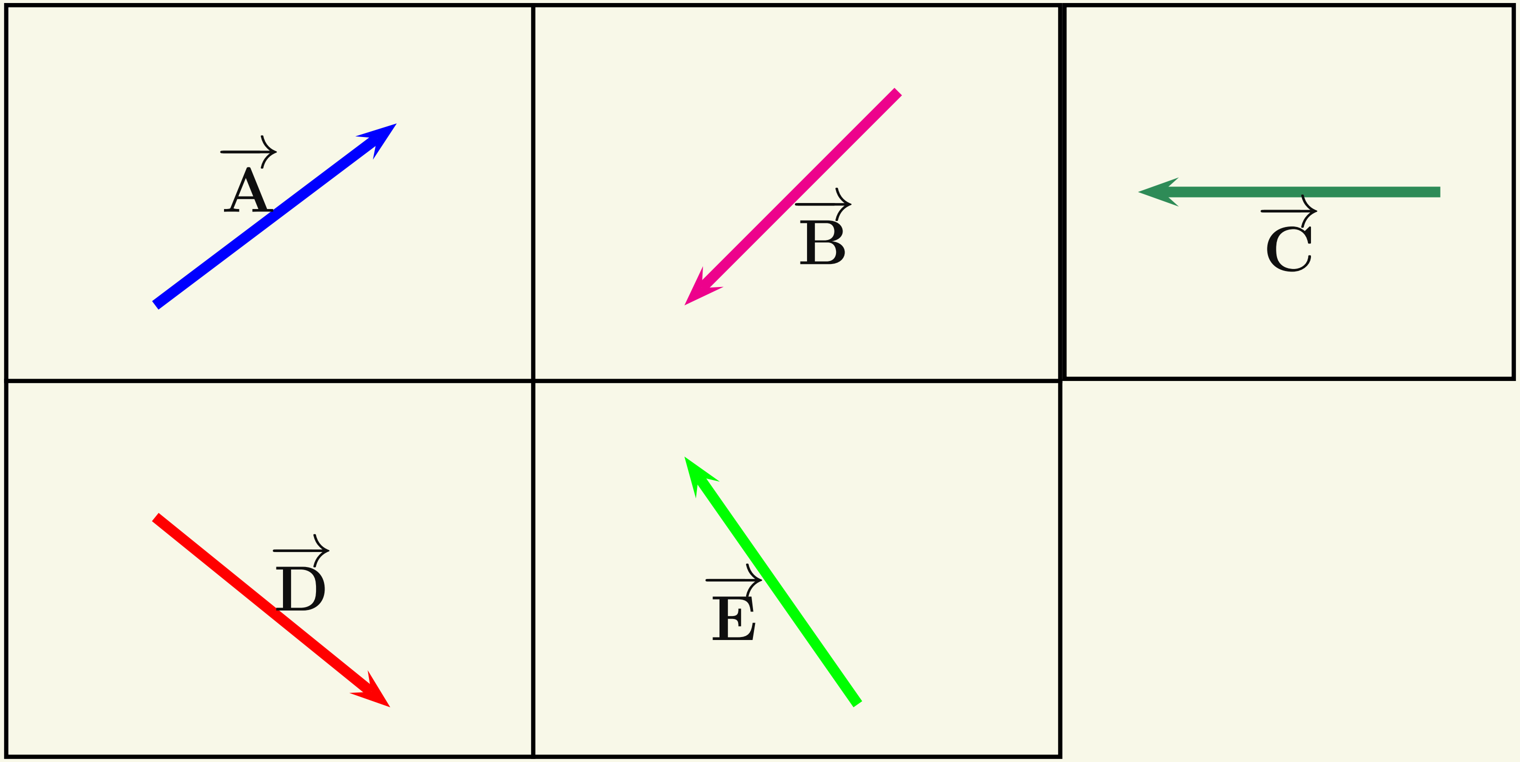

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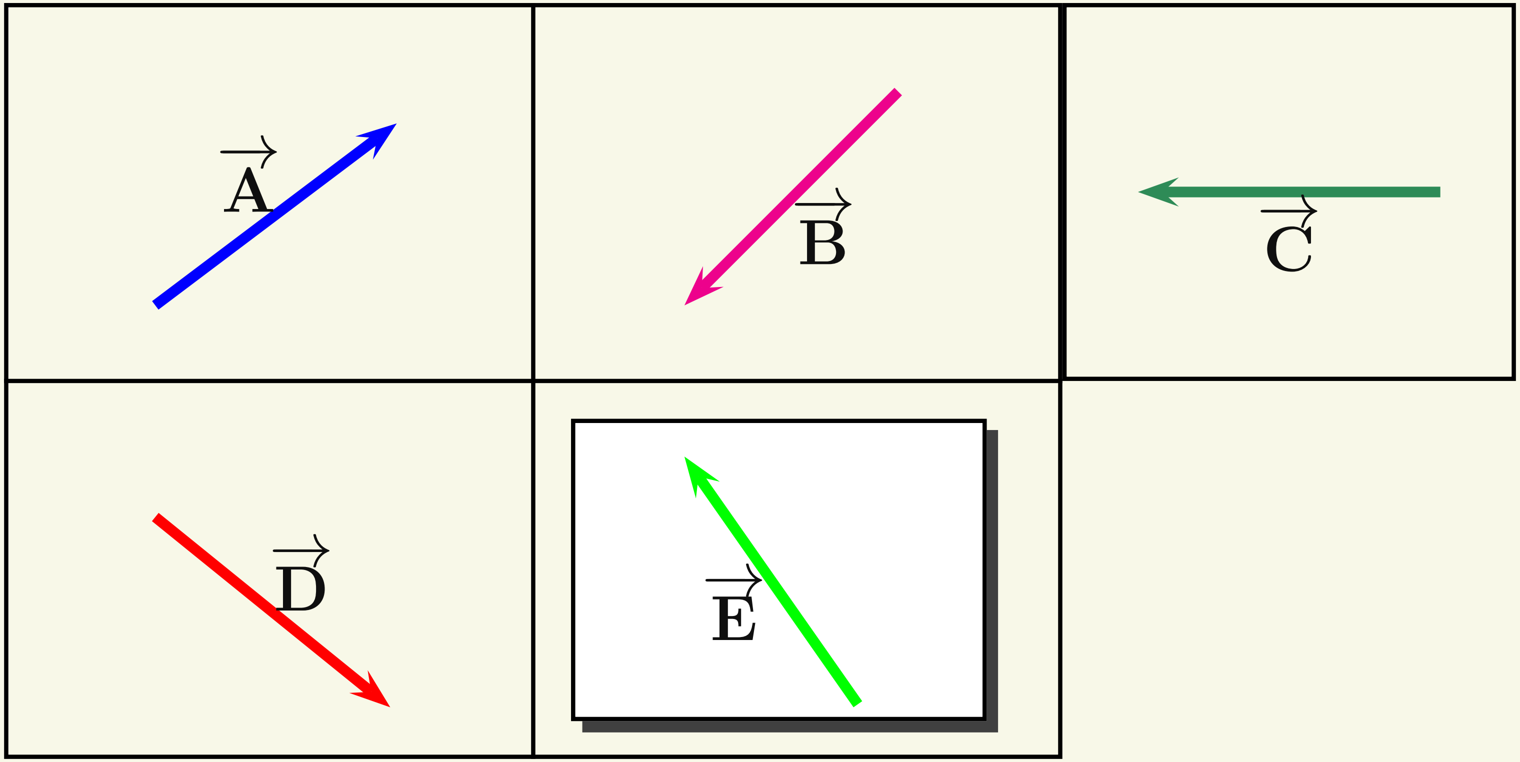

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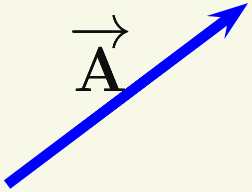

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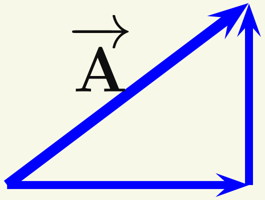

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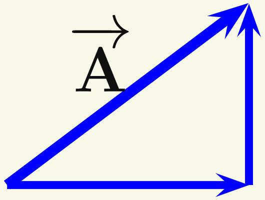

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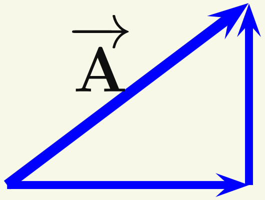

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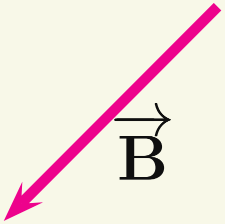

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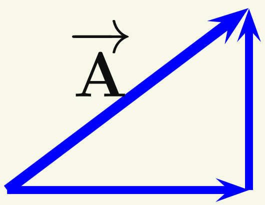

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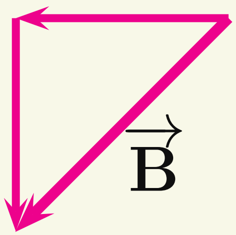

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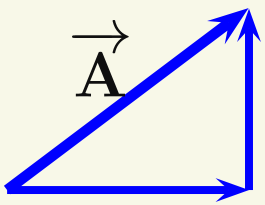

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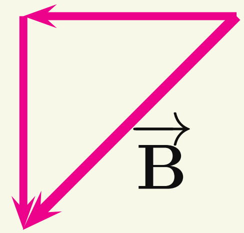
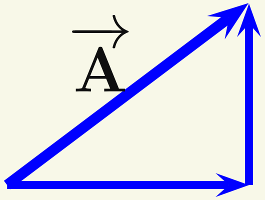


B_x negative
B_y negative

Scalar Component Followup



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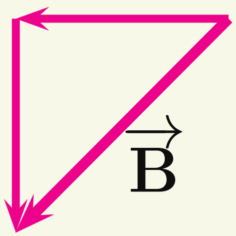

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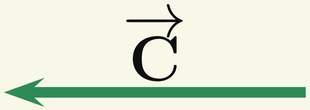

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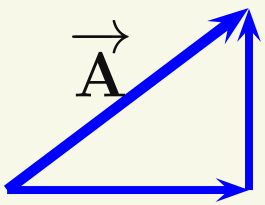

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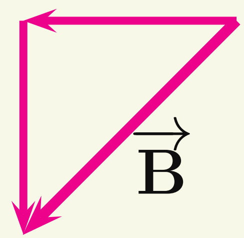

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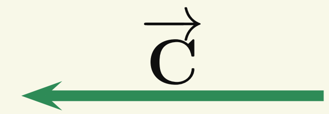
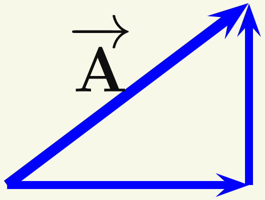


C_x negative
C_y zero

Scalar Component Followup



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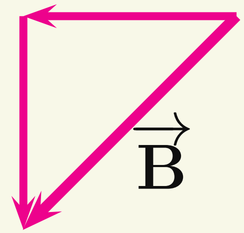

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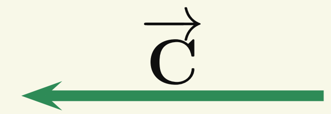

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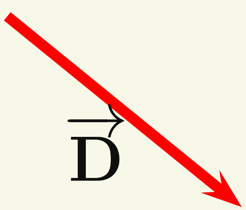

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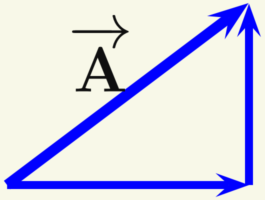

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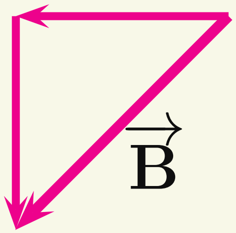

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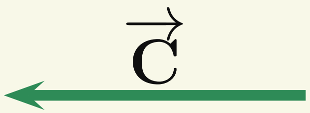

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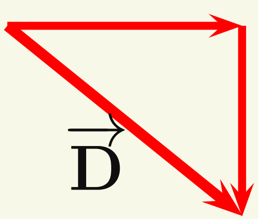

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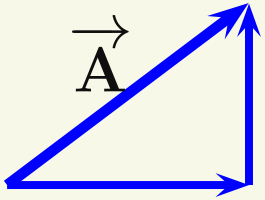

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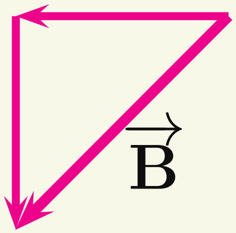

B_x negative
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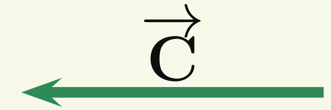
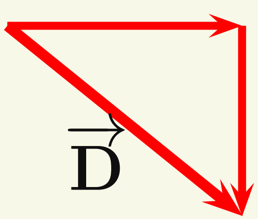
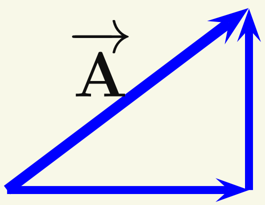


C_x negative
C_y zero



D_x positive
D_y negative

Scalar Component Followup



A_x positive
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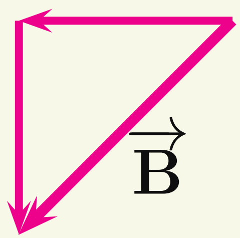
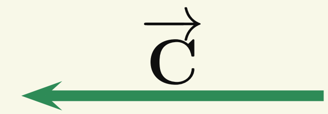
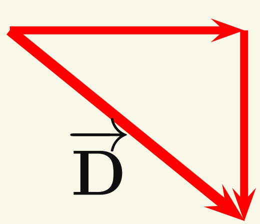


B_x negative
B_y negative



C_x negative
C_y zero



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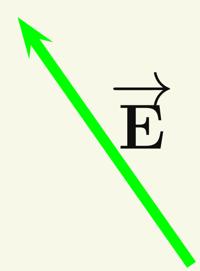

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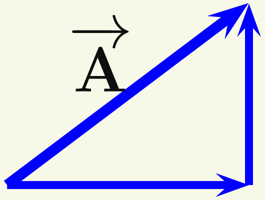

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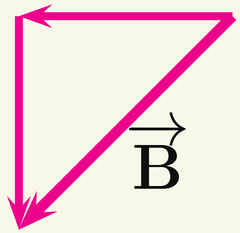

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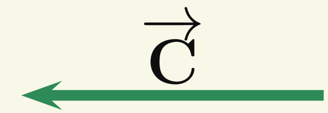
B_y negative



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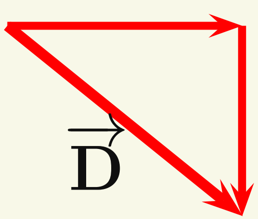

D_x positive
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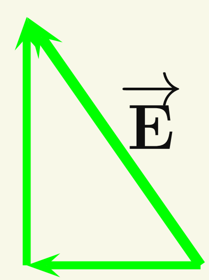

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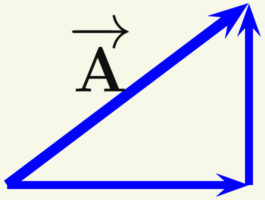

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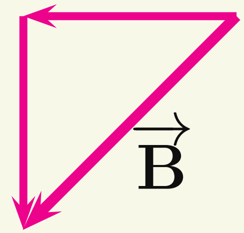

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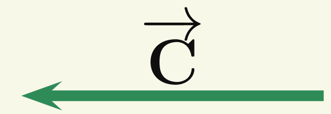

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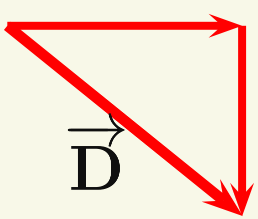
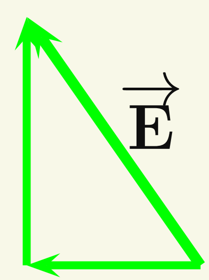


D_x positive
D_y negative



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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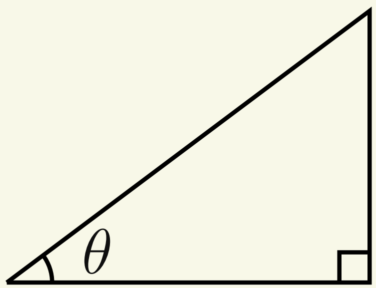

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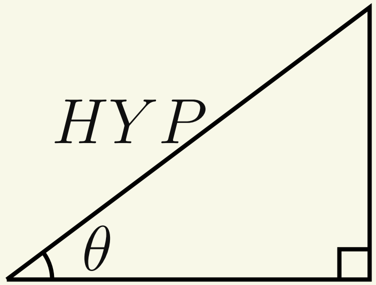

$HYP =$ Length of the Hypotenuse

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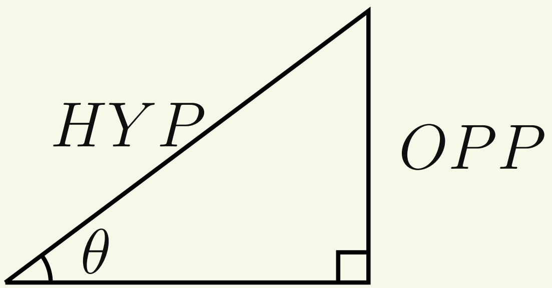

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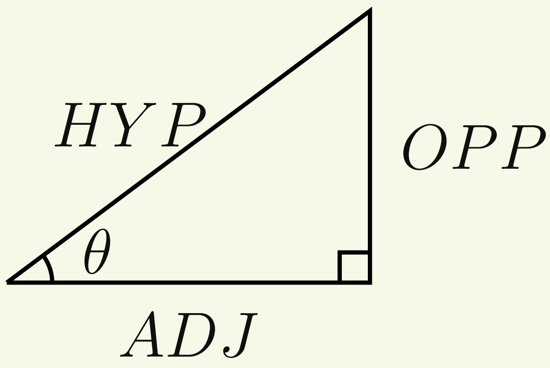

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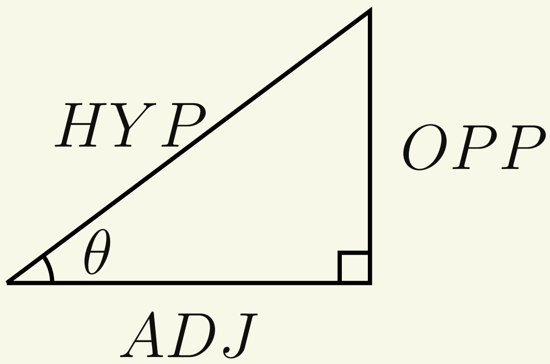

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Sine Function: $\sin\theta = \dfrac{OPP}{HYP}$

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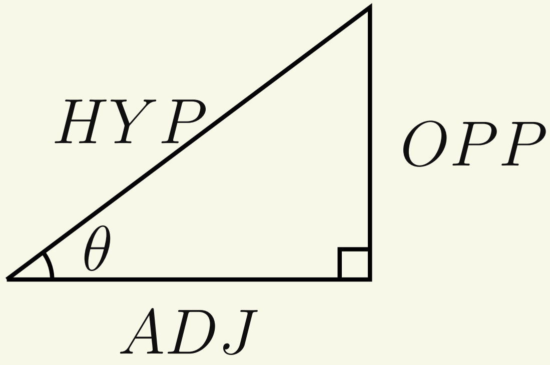

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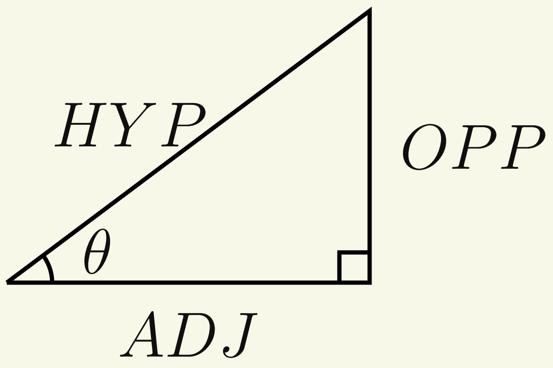

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Tangent Function: $\tan\theta = \dfrac{OPP}{ADJ}$

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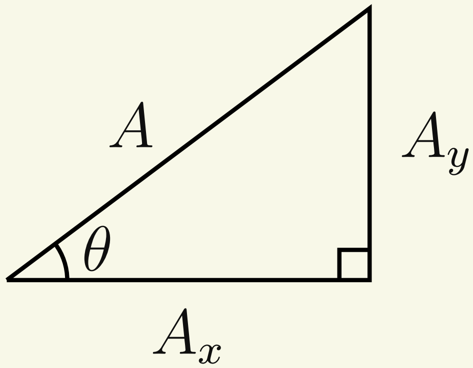

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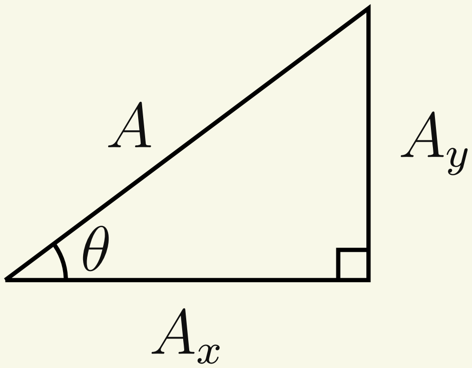

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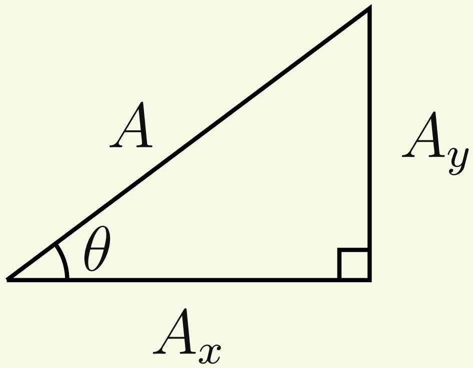

$$\cos\theta = \frac{A_x}{A} \quad \Rightarrow \quad \boxed{A_x = A\cos\theta}$$

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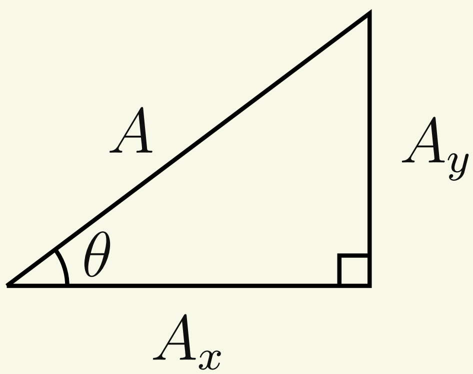

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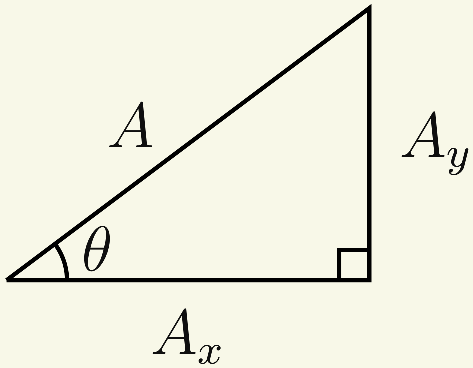

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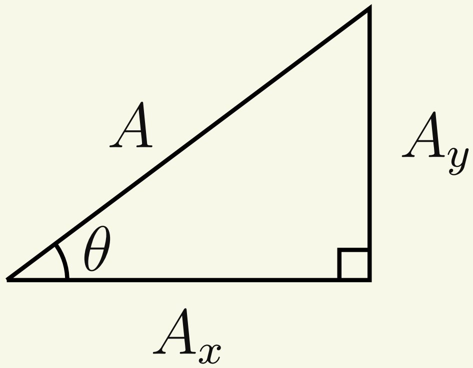

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Only guaranteed to work for the standard angle

Component Exercise

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

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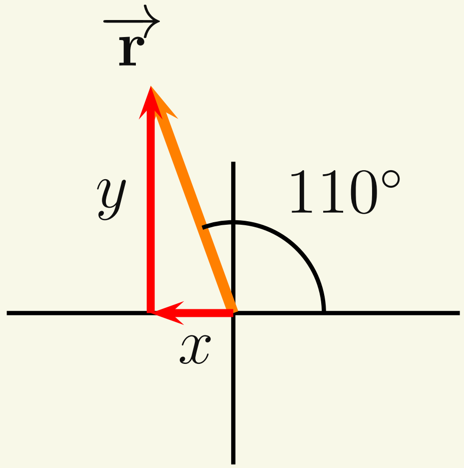


$\boxed{\text{(c)} \quad x = -1.71\,m, y = 4.7\,m}$

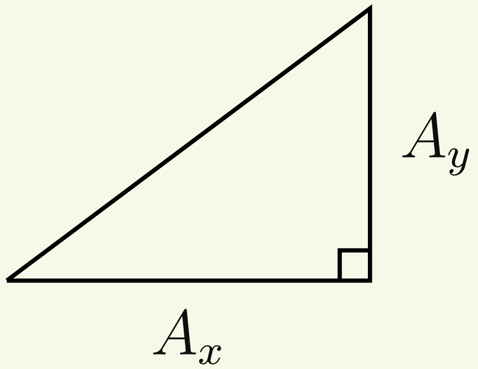
Using the standard angle automatically gives correct signs:

$x = (5\,m)\cos 110° = -1.71\,m$

$y = (5\,m)\sin 110° = 4.7\,m$

Scalar Components II

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



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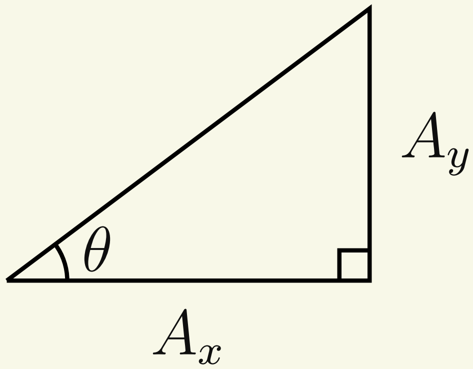

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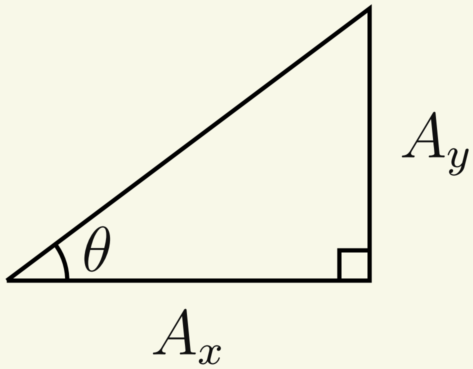

$$\tan\theta = \frac{A_y}{A_x} \Rightarrow \boxed{\theta = \tan^{-1}\left(\frac{A_y}{A_x}\right)}$$

Arctangent

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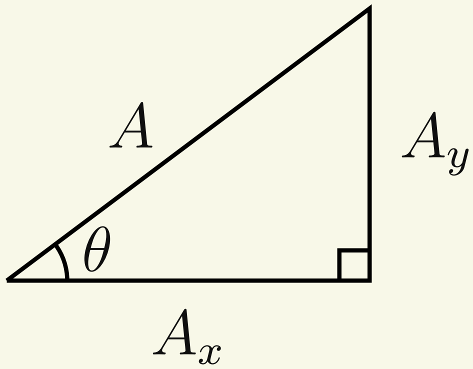

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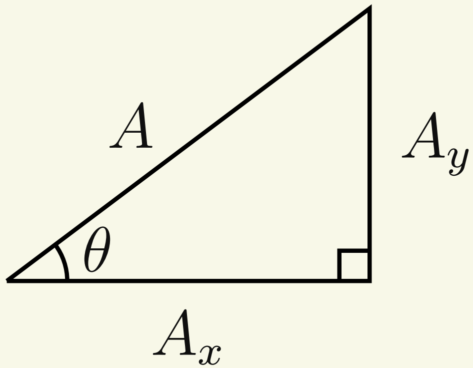
Scalar Components II

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



$$\tan\theta = \frac{A_y}{A_x} \Rightarrow \boxed{\theta = \tan^{-1}\left(\frac{A_y}{A_x}\right)}$$

Arctangent

$$A^2 = A_x^2 + A_y^2$$

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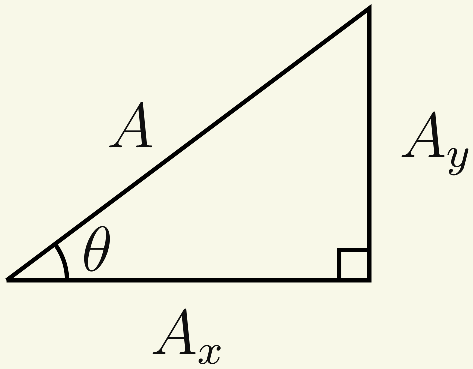

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Pythagorean Theorem

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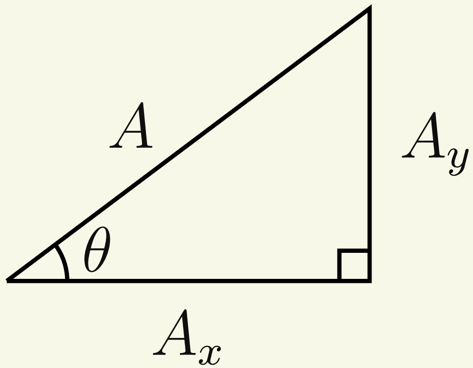

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Pythagorean Theorem

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