January 30, Week 3

Today: Chapter 1, Vectors

Homework Assignment #2 due Today
Mastering Physics: 1.6, 2.4, 2.59, and 3 special Mastering Physics problems.
Written Problem: 2.75.
Please write your box number on your homework before turning it in.

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

Please see website for your homework box number.

Review

When the acceleration is unchanging with time:

$$\boxed{v = v_o + at}$$

Review

When the acceleration is unchanging with time:

$$\boxed{v = v_o + at}$$

$$\boxed{x = x_o + +v_o t + \frac{1}{2}at^2}$$

Review

When the acceleration is unchanging with time:

$$v = v_o + at$$

$$x = x_o + +v_o t + \frac{1}{2}at^2$$

$$v^2 = v_o^2 + 2a\left(x - x_o\right)$$

Challenge Example

Example: A man is in a hot-air balloon which takes off and rises with a constant $2\,m/s$ speed. Just after take off, the man notices that he forgot his camera. A “friend" throws the camera up to him with a speed of $10\,m/s$. If the man is $3\,m$ above the camera when it is thrown, how high will he be when he caches his camera?

Vectors

To describe two-dimensional (and three-dimensional) motion completely, we need to be able to indicate any arbitrary direction. We do this through the use of vectors.

Vectors

To describe two-dimensional (and three-dimensional) motion completely, we need to be able to indicate any arbitrary direction. We do this through the use of vectors.

- Vector - Any physical quantity which has a magnitude and direction associated with it.

Vectors

To describe two-dimensional (and three-dimensional) motion completely, we need to be able to indicate any arbitrary direction. We do this through the use of vectors.

- Vector - Any physical quantity which has a magnitude and direction associated with it.
- Magnitude - Positive number along with unit that expresses the “amount" of the vector.

Vectors

To describe two-dimensional (and three-dimensional) motion completely, we need to be able to indicate any arbitrary direction. We do this through the use of vectors.

- Vector - Any physical quantity which has a magnitude and direction associated with it.
- Magnitude - Positive number along with unit that expresses the “amount" of the vector.
- Examples = position, velocity, acceleration.

Vectors

To describe two-dimensional (and three-dimensional) motion completely, we need to be able to indicate any arbitrary direction. We do this through the use of vectors.

- Vector - Any physical quantity which has a magnitude and direction associated with it.
- Magnitude - Positive number along with unit that expresses the “amount" of the vector.
- Examples = position, velocity, acceleration.
- Scalar - Physical quantity which has no associated direction.

Vectors

To describe two-dimensional (and three-dimensional) motion completely, we need to be able to indicate any arbitrary direction. We do this through the use of vectors.

- Vector - Any physical quantity which has a magnitude and direction associated with it.
- Magnitude - Positive number along with unit that expresses the “amount" of the vector.
- Examples = position, velocity, acceleration.
- Scalar - Physical quantity which has no associated direction.
- Examples = time, temperature, mass.

Writing Vectors

Vector Quantities are written using the arrow symbol and in bold face.

$$\vec{\mathbf{A}} \quad \text{or} \quad \vec{\mathbf{A}}$$

Writing Vectors

Vector Quantities are written using the arrow symbol and in bold face.

$$\vec{\mathbf{A}} \quad \text{or} \quad \vec{\mathbf{A}}$$

Magnitudes are written without the arrow and in italics.

$$A \quad \text{or} \quad |\vec{\mathbf{A}}|$$

Writing Vectors

Vector Quantities are written using the arrow symbol and in bold face.

$$\vec{\mathbf{A}} \quad \text{or} \quad \vec{\mathbf{A}}$$

Magnitudes are written without the arrow and in italics.

$$A \quad \text{or} \quad |\vec{\mathbf{A}}|$$

Example:

$5\,m/s$ at 37°

Writing Vectors

Vector Quantities are written using the arrow symbol and in bold face.

$$\vec{\mathbf{A}} \quad \text{or} \quad \vec{\mathbf{A}}$$

Magnitudes are written without the arrow and in italics.

$$A \quad \text{or} \quad |\vec{\mathbf{A}}|$$

Example:

$5\,m/s$ at 37°

Magnitude

Direction given as angle

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.

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

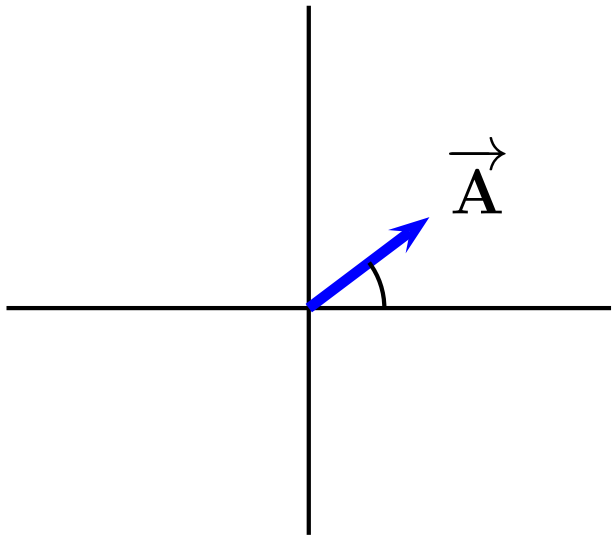
$\overrightarrow{\mathbf{D}} = 10\,m/s$ at $-30°$, $\overrightarrow{\mathbf{E}} = 10\,m/s$ at $200°$

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.

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

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

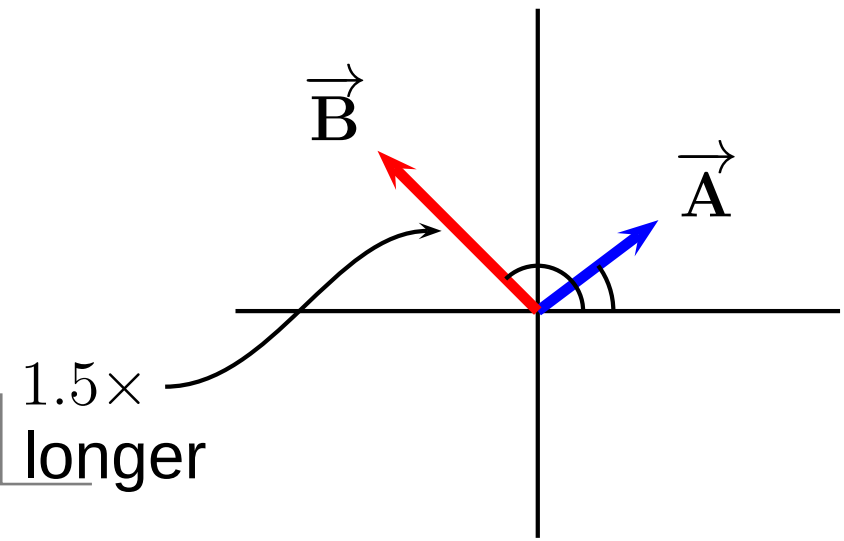


Example I

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.

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

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

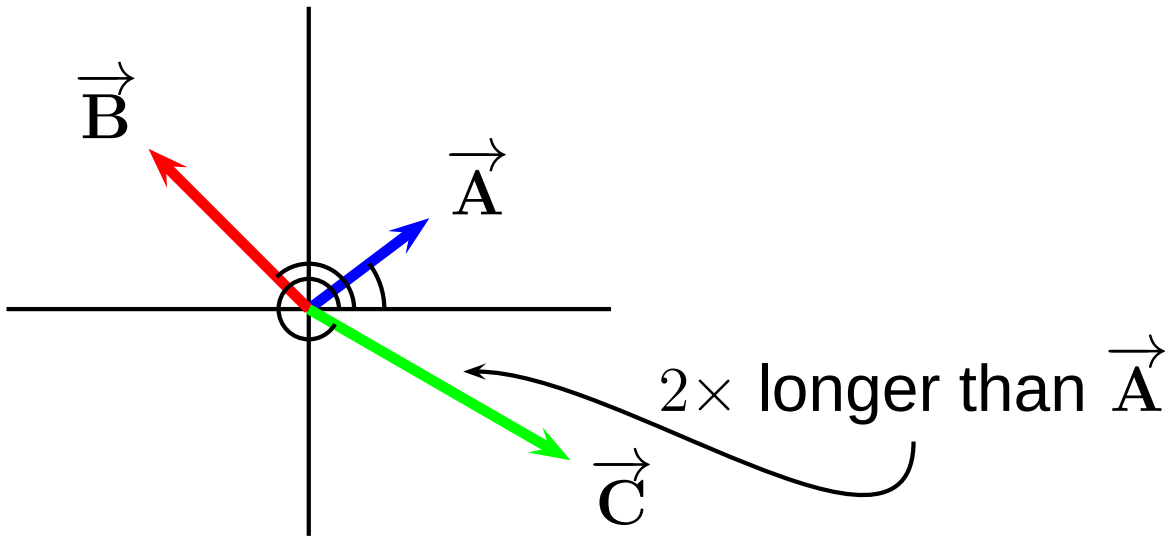


Example I

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.

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

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

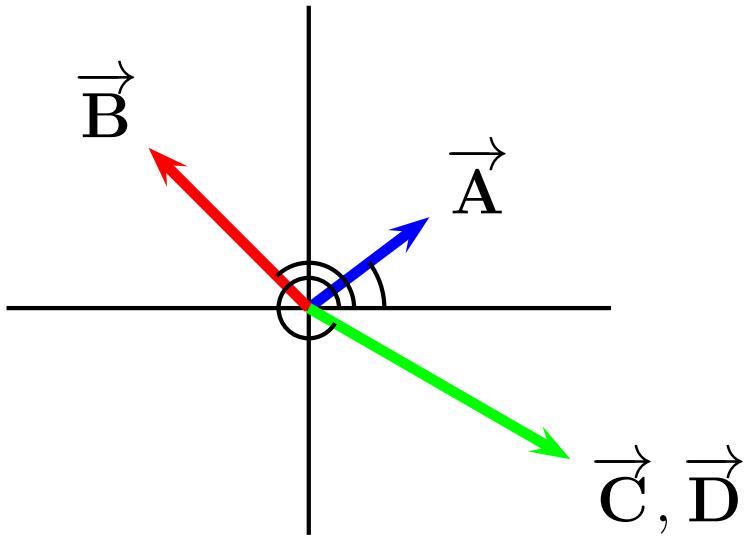


Example I

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.

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

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



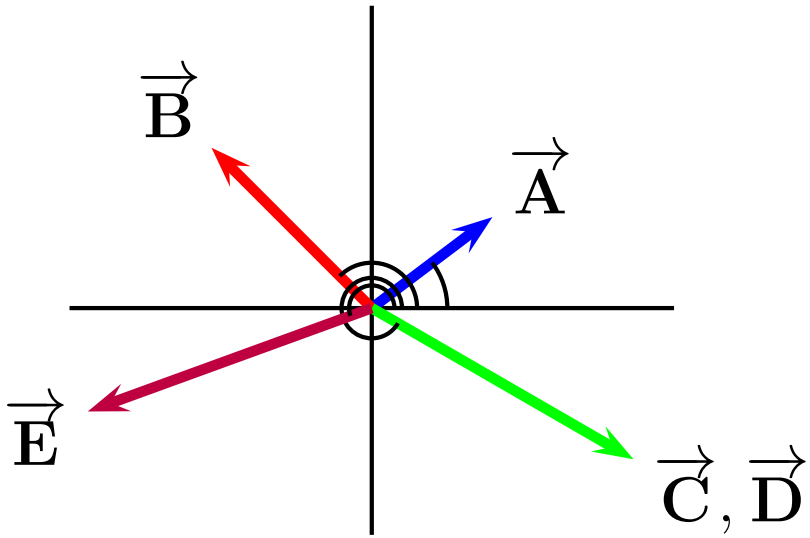
$\overrightarrow{\mathbf{C}}, \overrightarrow{\mathbf{D}}$ have same magnitude and direction $\Rightarrow \overrightarrow{\mathbf{C}} = \overrightarrow{\mathbf{D}}$

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.

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

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



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

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

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

Scalar Multiplication

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

Scalar Multiplication

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

Example: $\overrightarrow{\mathbf{A}} = 5\,m/s$ at $37°$, $3\overrightarrow{\mathbf{A}} = ?$

Scalar Multiplication

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

Example: $\overrightarrow{\mathbf{A}} = 5\,m/s$ at $37°$, $3\overrightarrow{\mathbf{A}} = 15\,m/s$ at $37°$

Scalar Multiplication

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

Example: $\overrightarrow{\mathbf{A}} = 5\,m/s$ at $37°$, $3\overrightarrow{\mathbf{A}} = 15\,m/s$ at $37°$

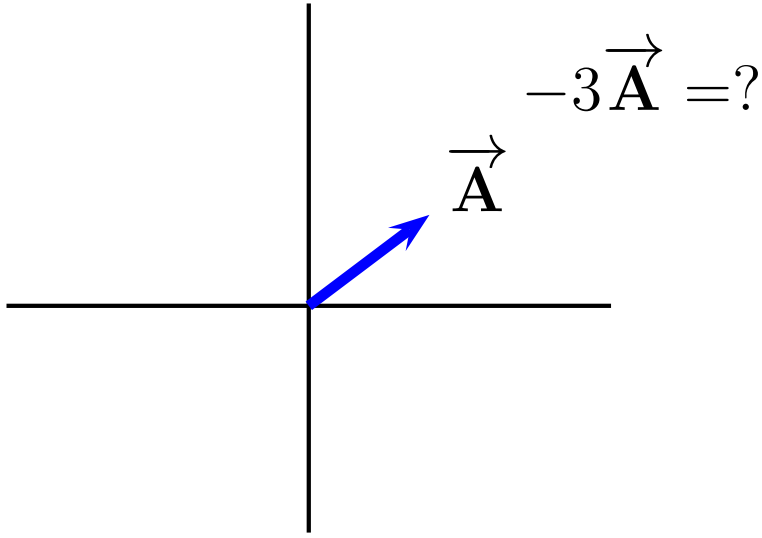
One “exception": Negative numbers change magnitude and flip direction by $180°$.

Scalar Multiplication

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

Example: $\overrightarrow{\mathbf{A}} = 5\,m/s$ at $37°$, $3\overrightarrow{\mathbf{A}} = 15\,m/s$ at $37°$

One “exception": Negative numbers change magnitude and flip direction by $180°$.

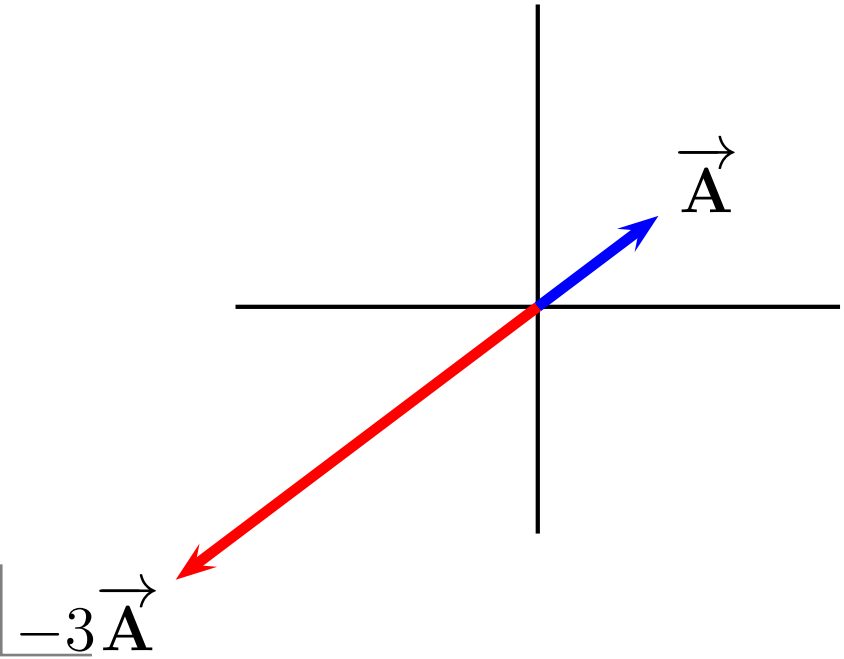


Scalar Multiplication

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

Example: $\overrightarrow{\mathbf{A}} = 5\,m/s$ at $37°$, $3\overrightarrow{\mathbf{A}} = 15\,m/s$ at $37°$

One “exception": Negative numbers change magnitude and flip direction by $180°$.

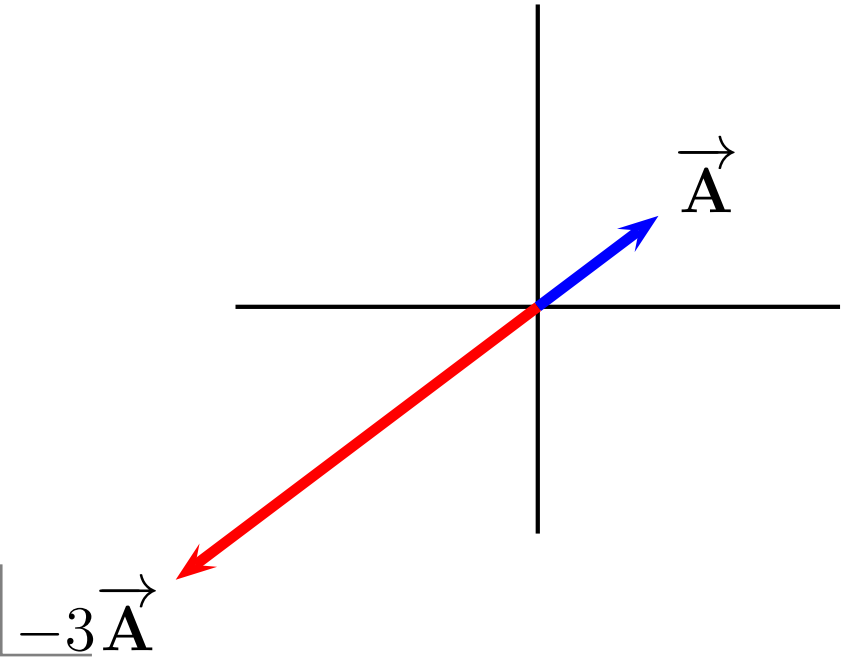


Scalar Multiplication

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

Example: $\overrightarrow{\mathbf{A}} = 5\,m/s$ at $37°$, $3\overrightarrow{\mathbf{A}} = 15\,m/s$ at $37°$

One “exception": Negative numbers change magnitude and flip direction by $180°$.



Of particular interest:
$\overrightarrow{\mathbf{A}} = -\overrightarrow{\mathbf{B}}$
$\Rightarrow$ equal magnitude
but opposite direction
- equal but opposite

Vector Addition

Vector Addition - The net result of two or more vectors, *i.e.*, taking direction into account while adding.

Vector Addition

Vector Addition - The net result of two or more vectors, *i.e.*, taking direction into account while adding.

There are two methods of adding vectors - the graphical and component methods.

Vector Addition

Vector Addition - The net result of two or more vectors, *i.e.*, taking direction into account while adding.

There are two methods of adding vectors - the graphical and component methods.

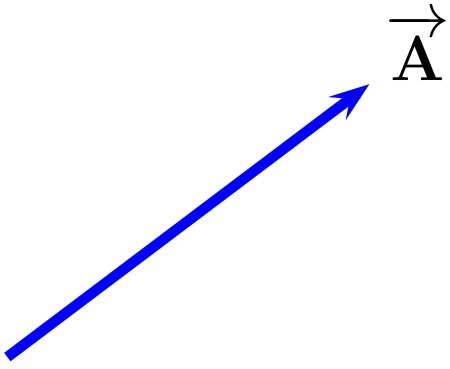
Graphical Addition - Drawing pictures and placing the vectors, “tip-to-tail" in order to determine the vector sum.

Example II

Add the following vectors.

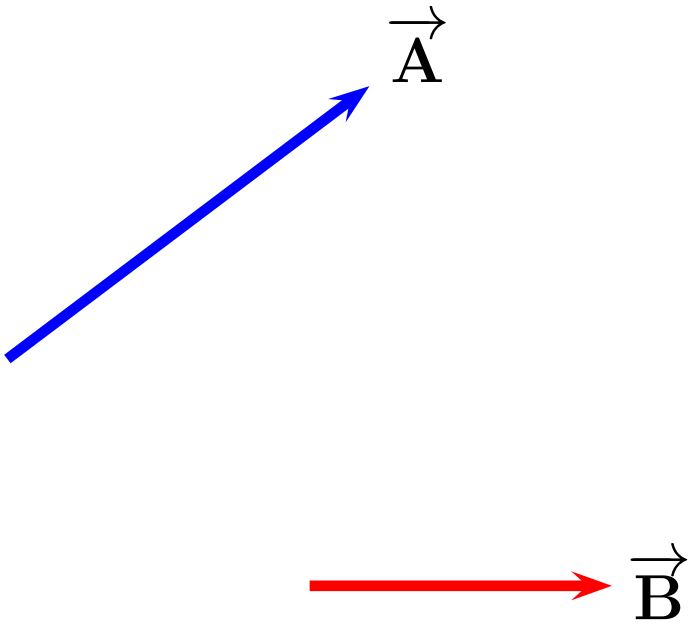
Example II

Add the following vectors.



Example II

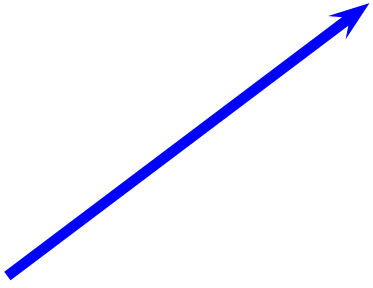
Add the following vectors.



Vectors can be drawn at any point. As long as the magnitude and direction don't change.

Example II

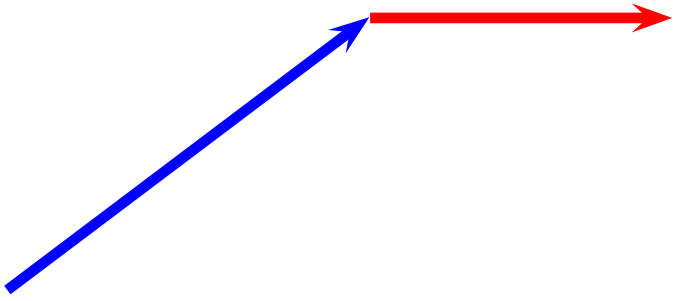
Add the following vectors.



First draw $\overrightarrow{\mathbf{A}}$.

Example II

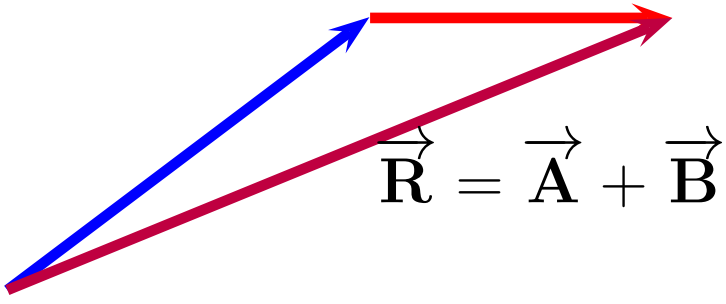
Add the following vectors.



Then draw $\overrightarrow{\mathrm{B}}$
at the front of $\overrightarrow{\mathrm{A}}$.

Example II

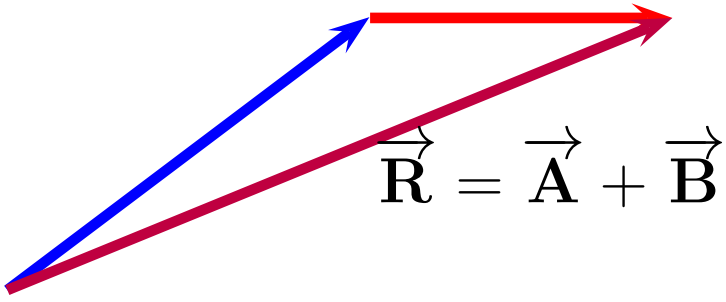
Add the following vectors.



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

Example II

Add the following vectors.

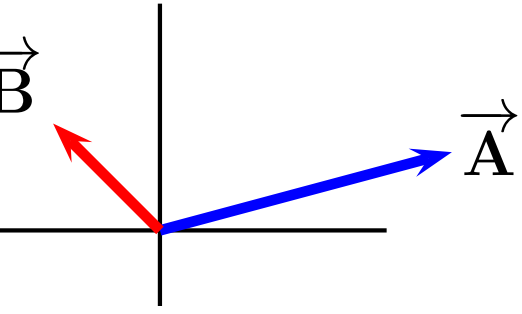


The vector sum
or resultant, $\vec{\mathbf{R}}$
goes from the remaining
tail to tip.

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

Clicker Quiz

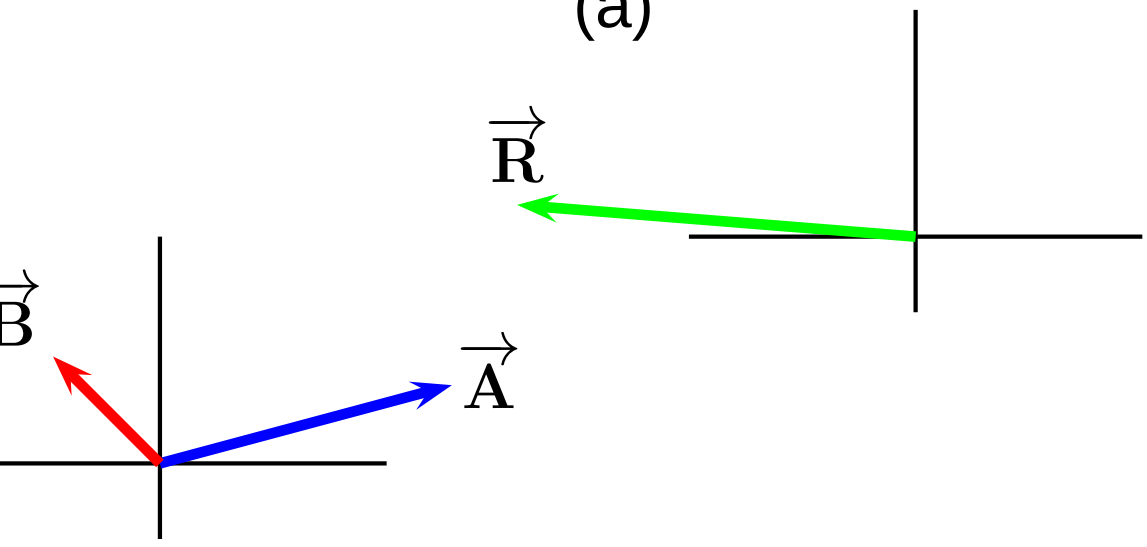
For the vectors $\vec{\mathbf{A}}$ and $\vec{\mathbf{B}}$, which of the following correctly shows $\vec{\mathbf{R}}$, where $\vec{\mathbf{R}} = \vec{\mathbf{A}} + \vec{\mathbf{B}}$?



Clicker Quiz

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

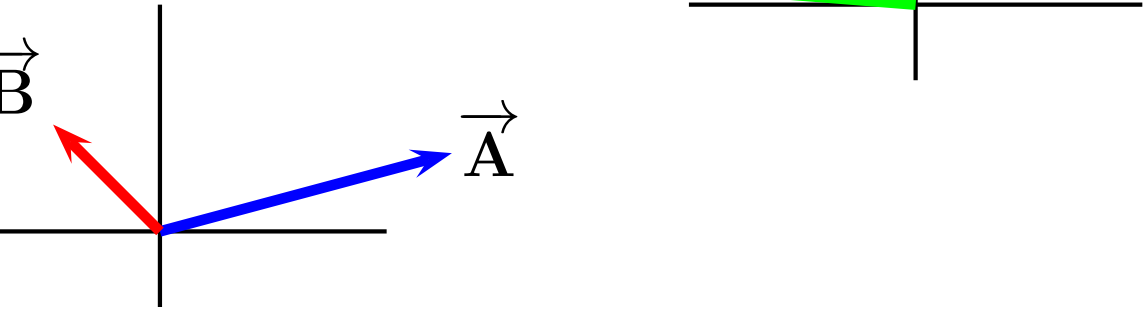
(a)



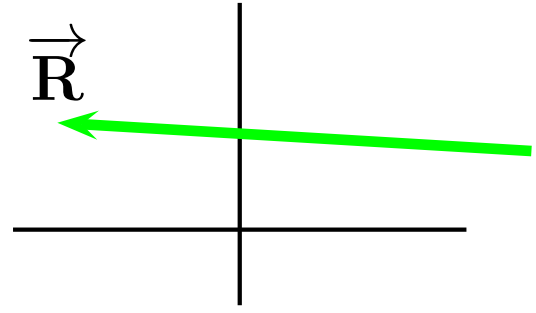
Clicker Quiz

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)



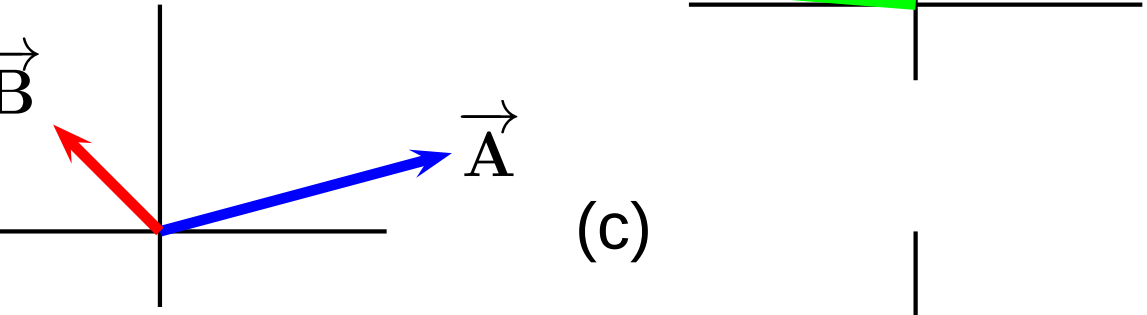
(b)



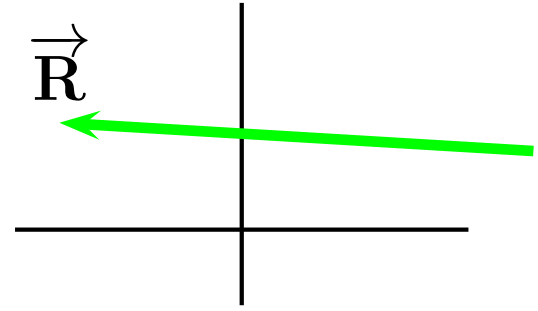
Clicker Quiz

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

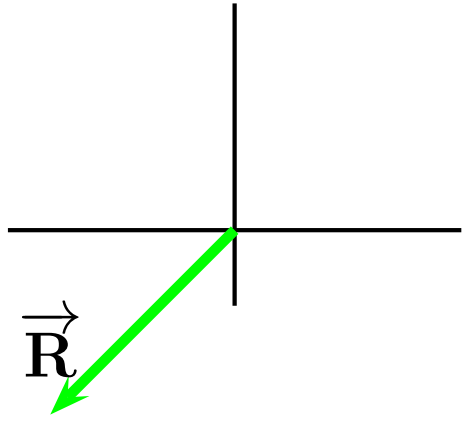
(a)



(b)

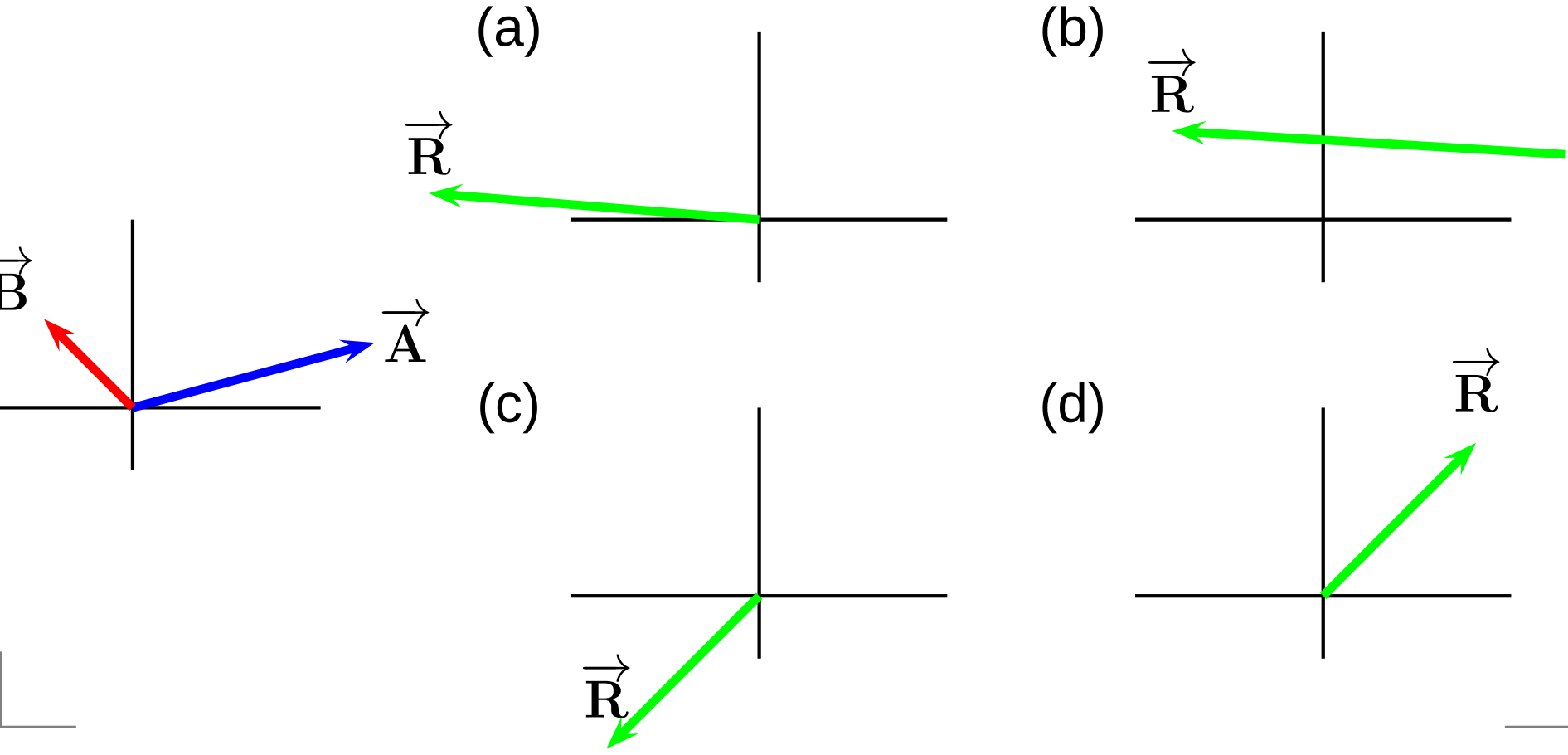


(c)



Clicker Quiz

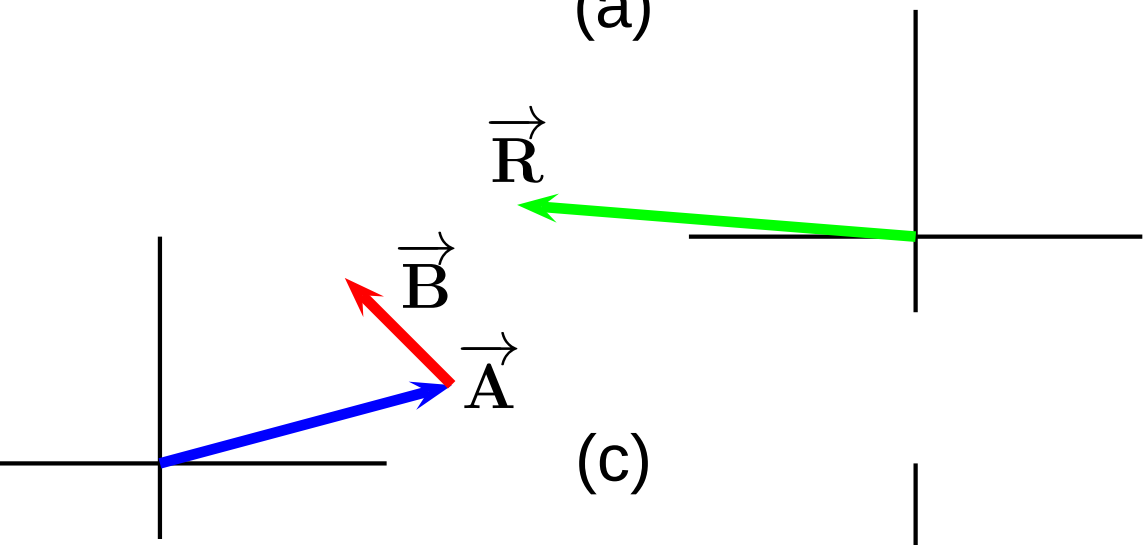
For the vectors $\vec{\mathbf{A}}$ and $\vec{\mathbf{B}}$, which of the following correctly shows $\vec{\mathbf{R}}$, where $\vec{\mathbf{R}} = \vec{\mathbf{A}} + \vec{\mathbf{B}}$?



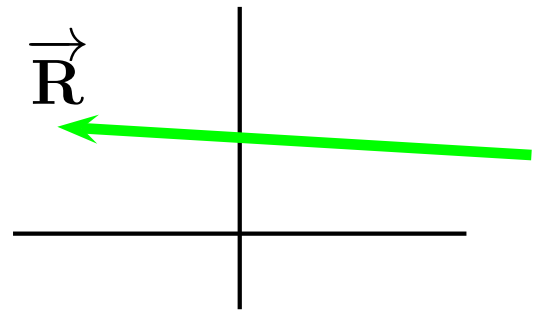
Clicker Quiz

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

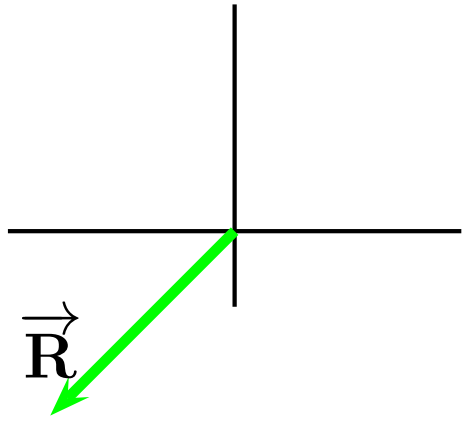
(a)



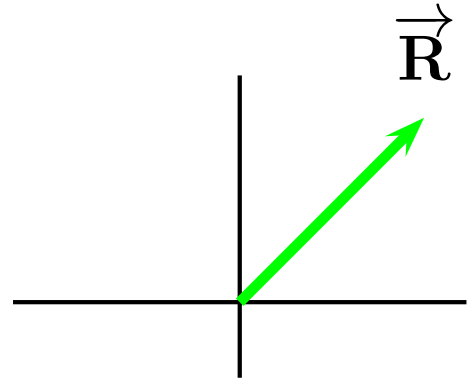
(b)



(c)



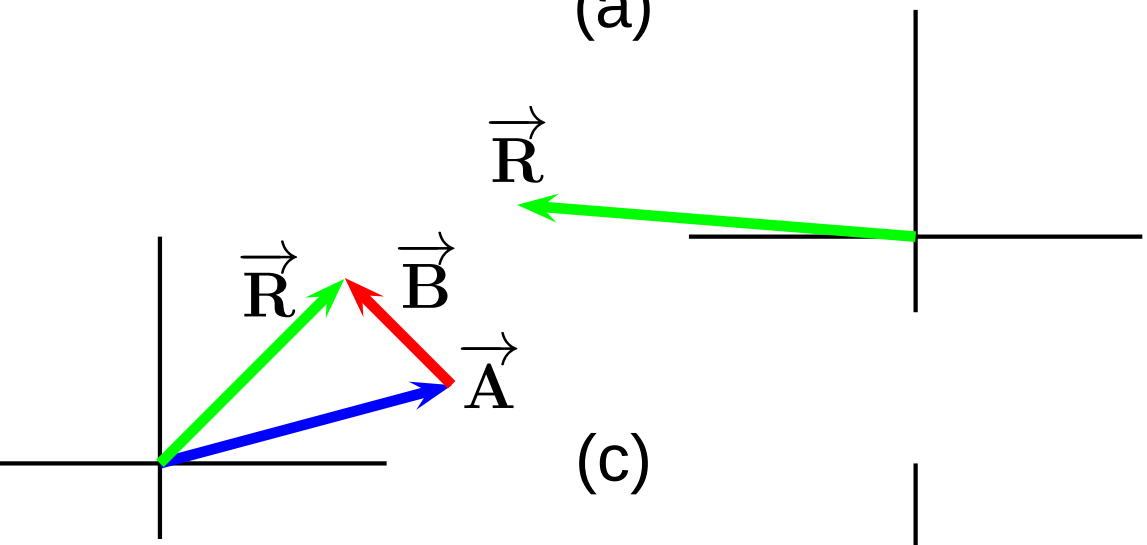
(d)



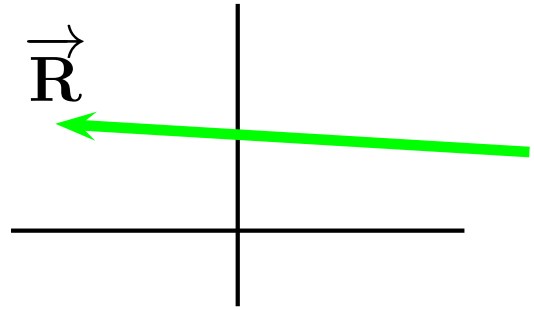
Clicker Quiz

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

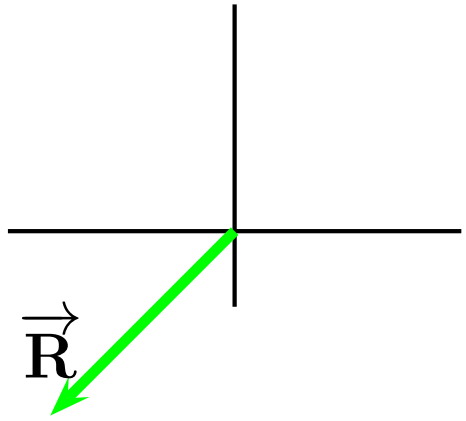
(a)



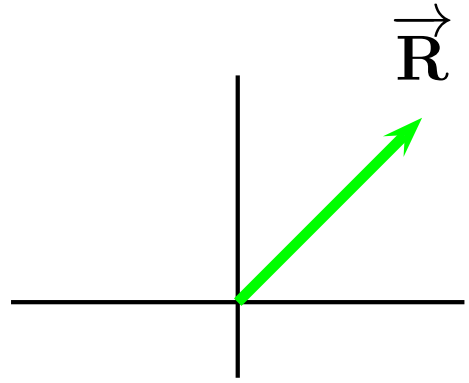
(b)



(c)

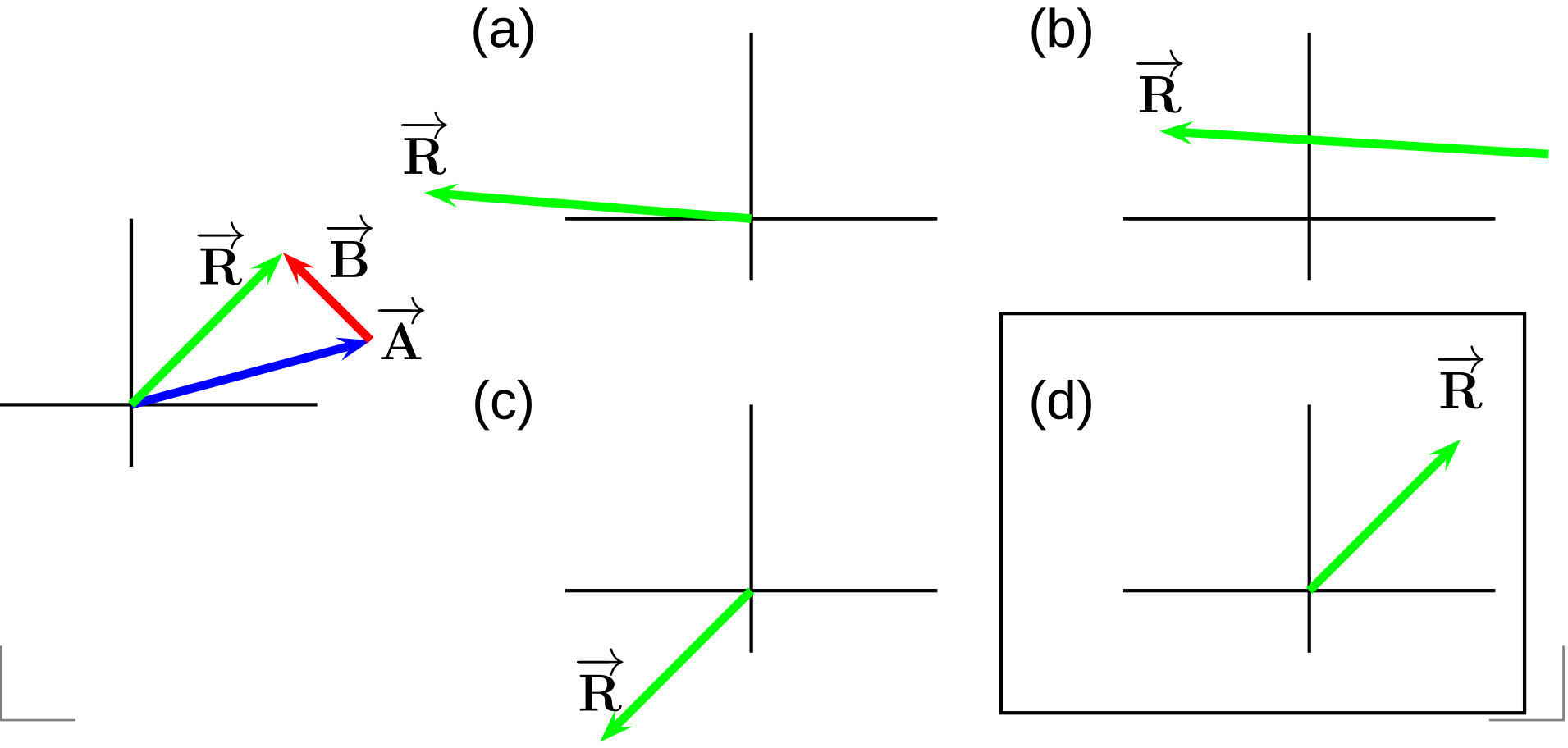


(d)



Clicker Quiz

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



Clicker Quiz

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