

CRITIQUE & EXPLAIN

Olivia and Benito are taking part in a scavenger hunt. They are given a map that shows the start and finish line. They are also given a list of directions to the finish line. They get to choose how they want to follow the directions, so they took different paths.



Olivia's path:

5 blocks south

7 blocks west

3 blocks north

4 blocks west

Benito's path:

7 blocks west

3 blocks north

4 blocks west

5 blocks south

- A. Will both Olivia and Benito reach the finish line? Explain.
- B. Create a different set of directions that would get someone to the finish line.
- C. **Communicate Precisely** Does the order of the instructions that pair distance and direction affect the outcome? Explain. © MP.6

HABITS OF MIND

Look for Relationships Russel looked at his list of four directions and decided that he could reach the finish line in fewer blocks. What is a possible set of directions for a path he could take? © MP.7

**EXAMPLE 1** **Try It! Represent Vector Quantities**

1. A vector has an initial point at $(8, 2)$ and a terminal point at $(5, 6)$. What is the vector in component form, and what are its magnitude and direction?

EXAMPLE 2 **Try It! Understand Vector Addition**

2. a. If $\overrightarrow{MN} = \langle 9, 12 \rangle$ and $\overrightarrow{NO} = \langle 2, 7 \rangle$, what is $\overrightarrow{MN} + \overrightarrow{NO}$?

- b. If $\vec{v} = \langle -3, 4 \rangle$ and $\vec{w} = \langle 5, -8 \rangle$, what is $\vec{v} + \vec{w}$?

EXAMPLE 3 **Try It! Find the Magnitude and Direction of a Sum**

3. If the engine speed was 9 mph northwest at 135° with the same current, what would be the magnitude and direction of the boat's speed? Round the magnitude and angle of direction to the nearest tenth.

HABITS OF MIND

Reason Let $\vec{v} = \langle -4, 12 \rangle$ and $\vec{w} = \langle -3, 9 \rangle$. Find $|\vec{v}| + |\vec{w}|$ and $|\vec{v} + \vec{w}|$. Does this mean that the sum of the magnitudes of two vectors is equal to the magnitude of their sum? Explain. © MP.2



EXAMPLE 4  **Try It! Understand Vector Subtraction**

4. a. What are the components, magnitude, and direction of $\vec{s} - \vec{t}$, where $\vec{s} = \langle 6, -3 \rangle$ and $\vec{t} = \langle 3, 2 \rangle$?
- b. For $\vec{m} = \langle 1, -3 \rangle$ and $\vec{n} = \langle -2, 7 \rangle$, what is $\vec{m} - \vec{n}$?

EXAMPLE 5  **Try It! Multiply a Vector by a Scalar**

5. a. If $\vec{t} = \langle -5, -7 \rangle$, what are the components, magnitude, and direction of $-4(\vec{t})$?
- b. What are the components, magnitude, and direction of $2\vec{t}$?

HABITS OF MIND

Make Sense and Persevere Suppose you were to multiply a vector by the scalar $\frac{1}{3}$. Subtract this result from the original vector. How would the magnitude and direction of the difference relate to the original magnitude and direction? © MP.1

EXAMPLE 6  **Try It! Use Matrices to Transform a Vector**

6. a. $\vec{EF} = \langle 5, 5 \rangle$. How is \vec{EF} transformed when it is multiplied by the matrix $\begin{bmatrix} -1 & 0 \\ 0 & 1 \end{bmatrix}$?
- b. How is \vec{EF} transformed when it is multiplied by the matrix $\begin{bmatrix} 0 & -1 \\ 1 & 0 \end{bmatrix}$?

HABITS OF MIND

Communicate Precisely How can a matrix and a vector be multiplied? © MP.6

Do You UNDERSTAND?

1. **ESSENTIAL QUESTION** How does including a direction with a quantity affect how you carry out operations on quantities?

2. **Error Analysis** Drew says the sum of the vectors $\vec{AB} = \langle 5, 11 \rangle$ and $\vec{BC} = \langle 2, -4 \rangle$ is $\vec{AC} = \langle 7, 13 \rangle$. Explain and correct Drew's error. © MP.3

3. **Communicate Precisely** Explain the process for vector subtraction. © MP.6

4. **Look for Relationships** Explain why you can use matrix multiplication to perform transformations on vectors. © MP.7

5. **Generalize** A boat is headed 60° north of west. In which quadrant is the boat? © MP.8

Do You KNOW HOW?

Write the component form of the vector, given its initial and terminal points.

6. initial point $(6, 2)$;
terminal point $(3, -5)$

7. initial point $(4, -1)$;
terminal point $(-8, 0)$

8. A vector has an initial point at $(6, 13)$ and a terminal point at $(3, 2)$. What is the vector in component form, and what are its magnitude and direction?

9. A vector has a direction of 235° and a magnitude of 6. What is the component form of the vector? Express your answer to the nearest tenth of a unit.

10. Find $\vec{MN} + \vec{NO}$ and $\vec{MN} - \vec{NO}$ if $\vec{MN} = \langle 6, 10 \rangle$ and $\vec{NO} = \langle -3, 0 \rangle$.