

Name: \_\_\_\_\_

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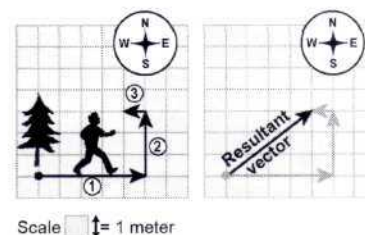
# Adding Displacement Vectors



A displacement vector is a quantity that contains two separate pieces of information: (1) magnitude or size, and (2) direction. When you add displacement vectors, you end up at a certain position. This new position is the total displacement from the original position. A vector that connects the starting position with the final position is called the resultant vector ( $\vec{x}$ ).

## EXAMPLE

Andreas walked 5 meters east away from a tree. Then, he walked 3 meters north. Finally, he walked 1 meter west. Each of these three pathways is a displacement vector. Use these displacement vectors to find Andreas's total displacement from the tree.

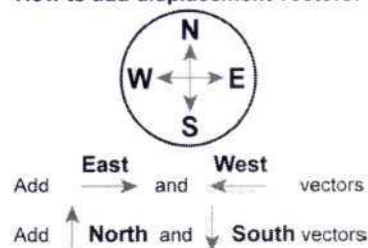


Displacement vector	Direction	Magnitude (meters)	Total magnitude (total meters walked)
1	east	5	5
2	north	3	$5 + 3 = 8$
3	west	1	$8 + 1 = 9$

Andreas's motion can be represented on a graph. To determine his total displacement from the tree, do the following:

- Add the east and west displacement vectors. These are in the  $x$ -axis direction on a graph.  
 $\text{Andreas's walk} = 5 \text{ m east} + (-1) \text{ m west} = 4 \text{ m east}$
- Add the north and south displacement vectors. These are in the  $y$ -axis direction on a graph.  
 $\text{Andreas's walk} = 3 \text{ m north}$

How to add displacement vectors:



The total displacement is 4 meters east and 3 meters north.

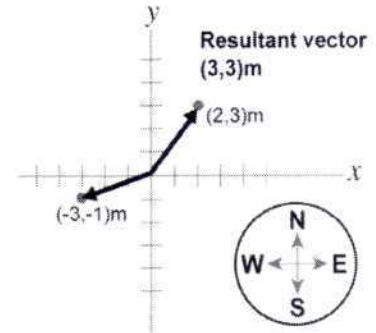
Andreas walked a total of 9 meters. The resultant vector ( $\vec{x}$ ) goes from the starting position to the final position of total displacement.

## PRACTICE 1

- What is the total displacement of a bee that flies 2 meters east, 5 meters north, and 3 meters east?
- What is the total displacement of an ant that walks 2 meters west, 3 meters south, 4 meters east, and 1 meter north?
- A ball is kicked 10 meters north, 5 meters west, 15 meters south, 5 meters east, and 5 meters north. Find the total displacement and the total distance it traveled.

## Adding displacement vectors using x-y coordinates

A resultant vector can be written using x-y coordinates on a graph. The original position is the origin of a graph where the axes represent east-west and north-south positions. For example, (2,3)m is a resultant vector with the following components: 2 meters east and 3 meters north. A resultant vector, (-3,-1)m, has components 3 meters west and 1 meter south. Use this information to solve the following problems. Write your answers using x-y coordinates.



### EXAMPLE

Add the following four vectors to find the resultant vector,  $\vec{x}_R$ :

$$\vec{x}_1 = (5,0)\text{m}, \vec{x}_2 = (0,-5)\text{m}, \vec{x}_3 = (3,0)\text{m}, \vec{x}_4 = (-7,0)\text{m}$$

Add the east-west components: 5 m east + 0 m + 3 m east + (-7) m west = 1 m east

Add the north-south components: 0 m + (-5) m south + 0 m + 0 m = (-5) m south  $\vec{x}_R = (1,-5)\text{m}$ .

### PRACTICE 2

1. Add the following three vectors to find the resultant vector,  $\vec{x}_R$ :

$$\vec{x}_1 = (-2,0)\text{m}, \vec{x}_2 = (0,-5)\text{m}, \vec{x}_3 = (3,0)\text{m}$$

2. Add the following vectors to find the resultant vector. Plot the resultant vector ( $\vec{x}_R$ ) on the grid to the right:

$$\vec{x}_1 = (4,0)\text{m}, \vec{x}_2 = (-1,2)\text{m}, \vec{x}_3 = (0,1)\text{m}$$

3. Add the following three vectors to find the resultant vector,  $\vec{x}_R$ :

$$\vec{x}_1 = (5,3)\text{m}, \vec{x}_2 = (-5,0)\text{m}, \vec{x}_3 = (5,2)\text{m}$$

4. Add the following three vectors to find the resultant vector,  $\vec{x}_R$ :

$$\vec{x}_1 = (6,-2)\text{m}, \vec{x}_2 = (-3,1)\text{m}, \vec{x}_3 = (3,3)\text{m}$$

5. Add the following three vectors to find the resultant vector,  $\vec{x}_R$ :

$$\vec{x}_1 = (4,4)\text{m}, \vec{x}_2 = (-2,-6)\text{m}, \vec{x}_3 = (0,2)\text{m}$$

