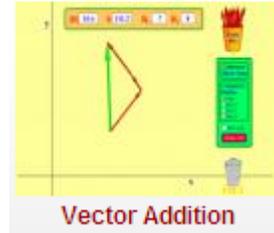


## PhET Simulation

Go to <http://phet.colorado.edu/en/simulation/vector-addition>

or

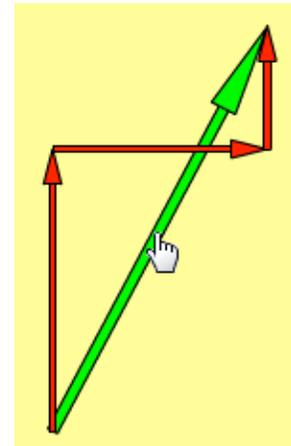
Go to [phet.colorado.edu](http://phet.colorado.edu) and click on “Play with Sims” button. From the side menu bar select “Math” and then select Vector Addition Simulation. Select the “Run Now” button and a new window should pop up.



Begin making your tip-to-tail diagrams by selecting a vector arrow from the bucket. Drag and drop the vector into the space provided.

### Changing The Vector Arrow

You can change the length and direction of the arrow by clicking on the tip and dragging it to the direction you choose or extend or compress it in size. Notice the box on the top has symbols and numbers. These will change when you change the length or direction of your arrow. Click on another arrow and it will display its values. Align the vector arrows so they are tip to tail. To get the resultant, click on “Show Sum” and a green arrow will appear in the space. Drag the arrow over to your diagram so that the Resultant (green) arrow’s tail is at the **origin** and the tip of the Resultant is at the **last arrow tip**. You have just made a tip-to-tail vector diagram.



**NOTE:** When doing this by hand, you will label the vector’s magnitude (size) and direction next to the vector itself. The Resultant will be represented by a dotted line instead of a green line and the components will be solid lines.

**Answer the following questions using the simulation.**

1. You take a walk and travel 20 meters in the north direction ( $90^\circ$ ).
  - a) Could this arrow represent another type of vector, like “20 m/s North” or “200 N  $290^\circ$ ”? Explain.
  - b) Next, you turn left and walk 10 meters to the west ( $180^\circ$ ). Click “show sum” to find the resultant of these vectors. Arrange the vectors to display a tip-to-tail vector diagram. How far are you from your initial position? In which direction is the resultant? In what direction would you have to travel to get from your **end point back to your starting point**?
  - c) Your friend says that you will get different answers if you set up your vectors in the wrong order, so you need to be extra careful. Do you agree with your friend? Support your answer with evidence.
2. On the weekend, you decide to run a couple of errands for your parents (the holidays will be here in no time!) on your way to your friend’s house. You travel East on Rt. 571 driving 15 m/s, then travel North on Rt. 1 moving 21 m/s, and then take the back roads traveling 11 m/s at  $328^\circ$  to your friend’s house. What was the resultant velocity for your trip?

For this next problem, select “Style 2” so that you can see the x and y components of a vector at an angle and use a scale to convert the units associated with the arrow’s length to the force in your force diagram.

3. A boy pulls his sled across newly fallen snow. The Force the Earth exerts on the sled (it’s weight) is 150 N and the boy pulls the sled with a constant velocity with a rope that makes a  $45^\circ$  angle with the ground. The ground exerts an upward force of 100 N and a horizontal force (friction) of 40 N. Draw a force diagram to represent this situation. What is the force the rope exerts on the sled?