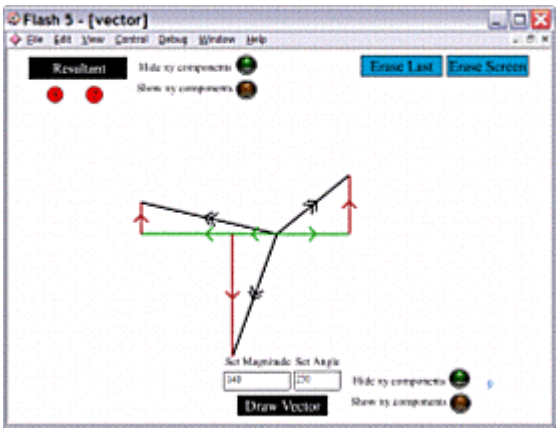
Vector Addition

Activity Overview



This activity uses a Flash simulation to graphically represent vector addition without the necessity of using trigonometry. The activity seeks to develop conceptual understanding of both the component method and the graphical (head-to-tail) method of adding vectors.

Advantages of Technology

This interactive simulation allows students to easily manipulate and visualize the vectors in a way that is difficult to do when drawing vectors by hand. It allows students to understand and use the concepts of vectors without having to first learn the mathematics that are used to perform the operations.

Educational Standards

Virginia Science Standards of Learning addressed in this activity include:

PH.2 The student will investigate and understand how to analyze and interpret data. Key concepts include analysis of systems employing vector quantities utilizing trigonometric and graphical methods.

Materials

Technology:

- Computer connected to the Internet with a web browser and Flash Plug-In installed.
- The Flash vector simulation: www.teacherlink.org\content\science\instructional\activities\vectoraddition\images\vectors.html

Procedure

NOTE TO TEACHERS:
These procedures are written to show you how you might use these technologies to teach science concepts. Suggested questions, approaches, and expected answers are all provided. Therefore, these activity descriptions should be used as a guide for your instructional planning, rather than as step-by-step directions for students.

Getting Started

Three tugboats are pulling a cruise ship in different directions. In which direction will the cruise ship move?

Let's say, specifically, the three forces applied by the tugboats are 100 Newtons (N) at 39°, 150N at 167° and 140N at 250°.

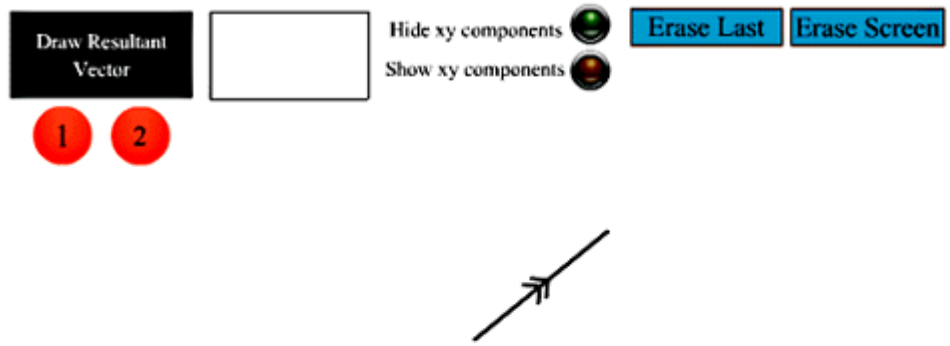
To figure out in which direction the cruise ship will move, you could (1) go see a trigonometry teacher or (2) open the vector simulation.

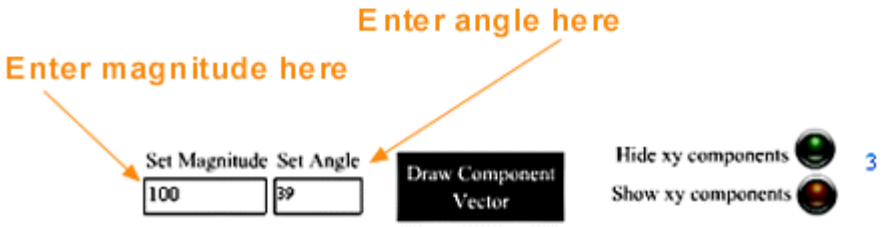
Method 1: Adding Components

Remember, the three forces applied by the tugboats are 100N at 39°, 150N at 167°, and 140N at 250°.

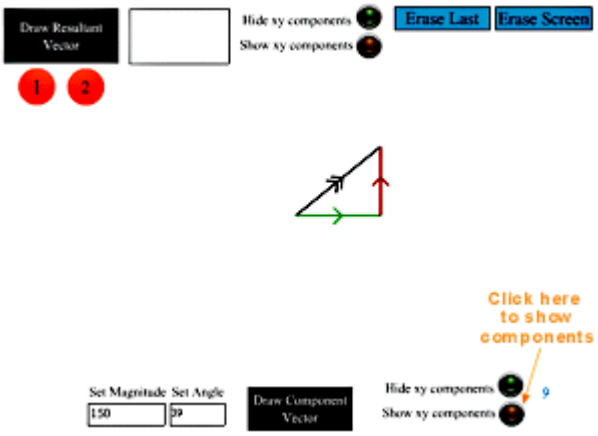
Create the first vector by typing its magnitude (numeral only) in the **Set Magnitude** box at the bottom of the screen and the direction in the **Set Angle** box. Then click the **Draw Vector** button.

The vector is a black line with a double arrow on it.

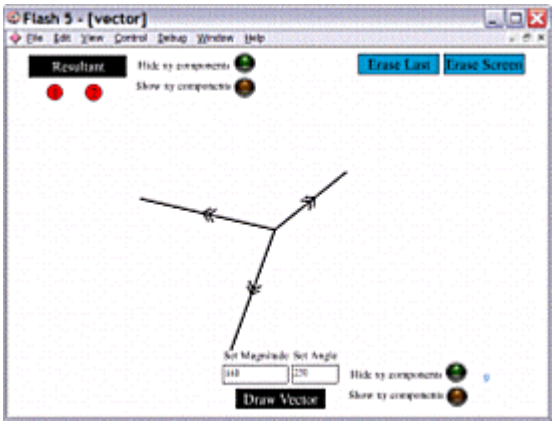




Click on the **Show xy components** button to see that each vector is made up of two components, horizontal and vertical.



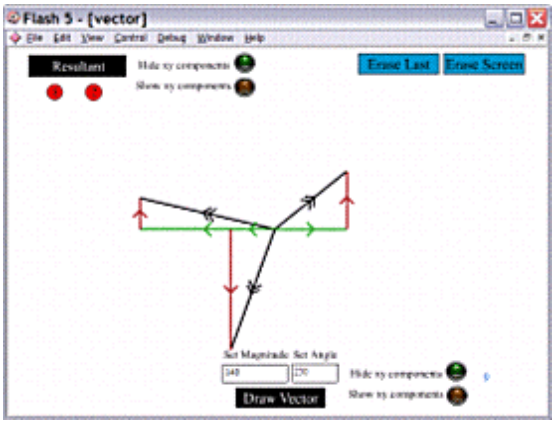
To make the screen less cluttered, click on **Hide xy components**. Then enter the information for the other two vectors.



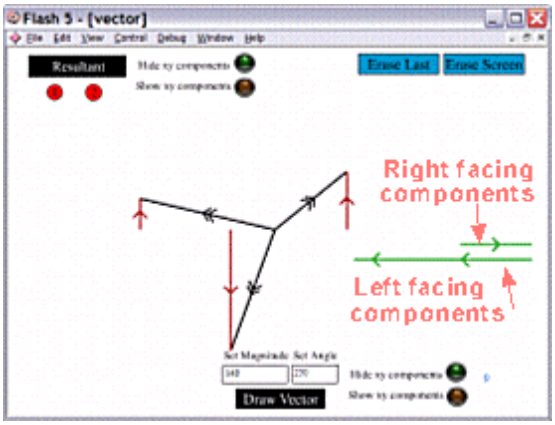
These three lines represent the magnitude and direction of the three tugboats' forces on the cruise ship.

Now, to find the solution to the problem, you will need to use the horizontal and vertical components of these three vectors. Click again on **Show xy components**.

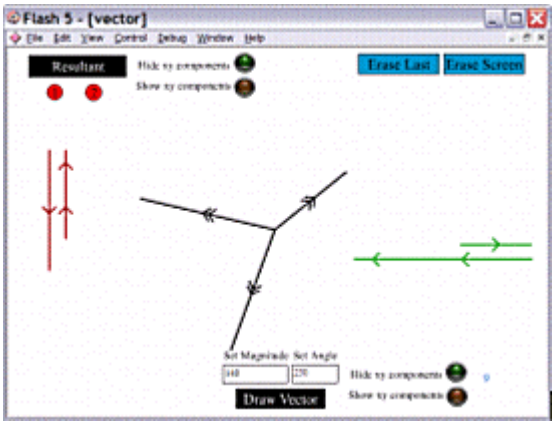
Looking at the diagram below, can you predict in which direction the ship will travel?



To answer this question, you can drag all the horizontal, or *x*, components (click and hold on each as you move them) to the right of the screen. Group the components pointing to the left in a head-to-tail arrangement, and all the components pointing to the right (if any) in a head-to-tail arrangement.



Move the vertical, or *y*, components to the left of the screen in the same way. Group the vectors pointing up in a head to tail arrangement, as in the diagram below.

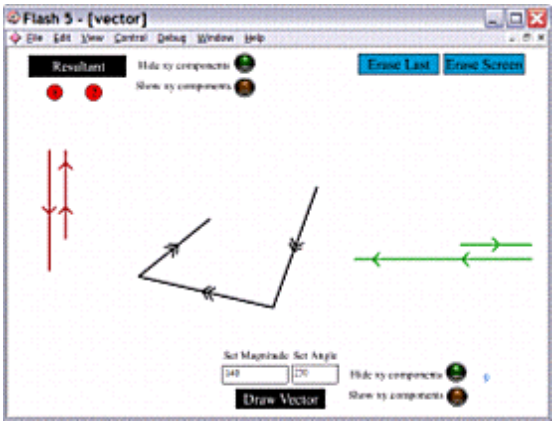


Now, using the net vertical (*x*) and horizontal (*y*) components, you can estimate the direction and magnitude of the resultant vector.

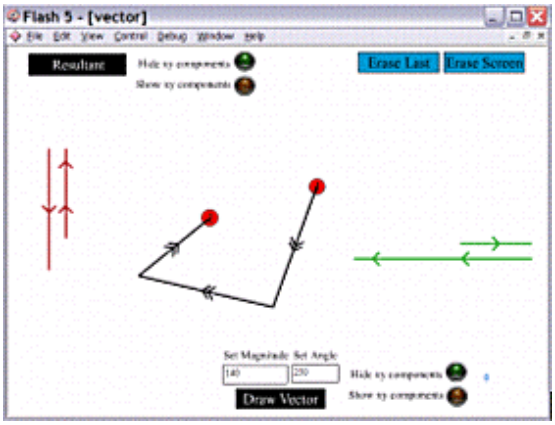
You can check the accuracy of your estimate by using the head-to-tail method of adding vectors.

Method 2: Graphical (Head-to-Tail)

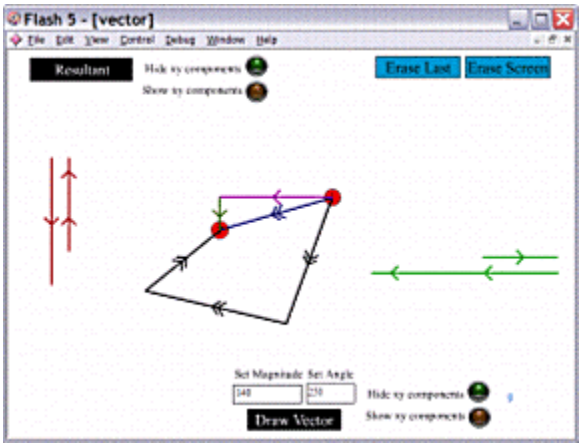
Arrange the vectors (the black arrows) head to tail, as in the diagram below.



Drag and drop the first point of the resultant vector (the red circle with a 1 in it at the top left of the screen) to the beginning of the chain and the second point to the end of the vector chain.

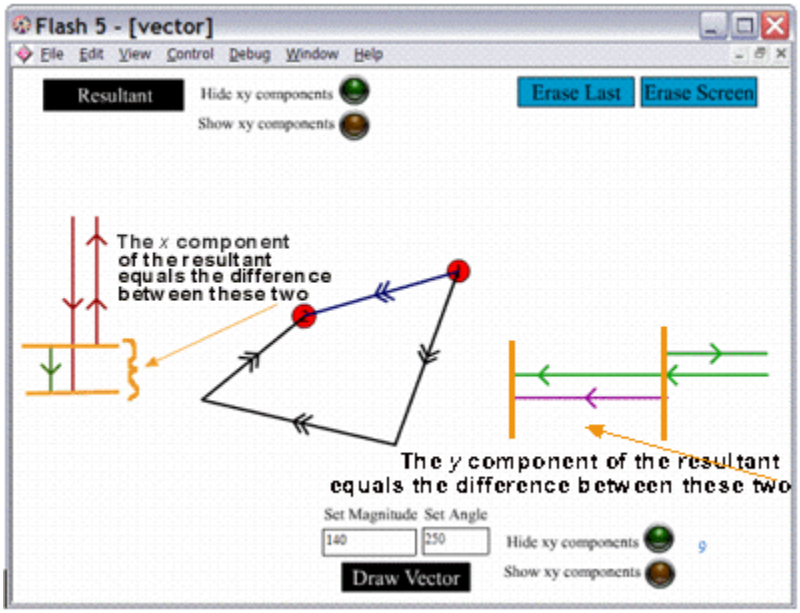


Click on the **Resultant** button in the top left corner of the screen to create the resultant vector.



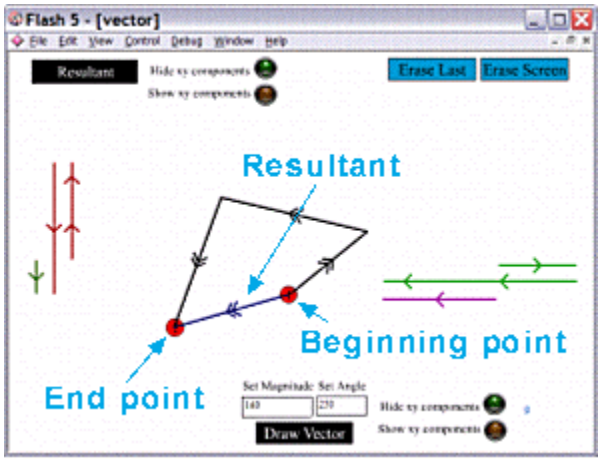
Does the resultant makes sense based on what the x and y components are indicating?

Compare the *x* and *y* components of the resultant vector with the *x* and *y* components you moved to either side of the screen.



The Additive Property of Vectors

To explore the additive property of vectors, line up the vectors in a different order and recheck the resultant. Remember to place the first point of the vector chain at the beginning and the second point at the end of the chain before clicking the **Resultant** button.



Is the resultant is still the same?

Assessment Strategies

Have students translate and solve other word problems into vector representations using the simulation. This will give them a solid understanding of the different applications of vectors and how they are added. Examples of problems given to the students are the final position of a person who walks in several different directions (i.e., 100m N, 189m SW etc.), or the final position of a person swimming across a stream with the water flowing one way and the person swimming another way. In some of the questions, the resultant vector could be provided and students could be asked to solve for one of the added vectors. These exercises will give students a good framework in which to introduce the geometric, algebraic, and trigonometric skills needed to perform the same procedures mathematically.

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