



# Vector Components and Vector Addition

## Student Activity

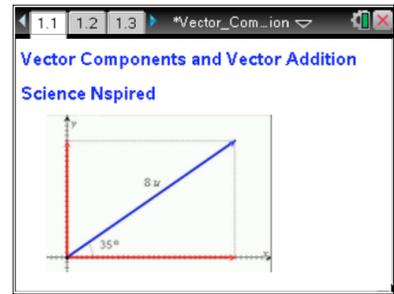
Name \_\_\_\_\_

Class \_\_\_\_\_

Open the TI-Nspire document

*Vector\_Components\_and\_Vector\_Addition.tns.*

Many quantities in physics such as displacement, velocity, force, and momentum are described by both a magnitude and a direction. These vector quantities require special skills to manipulate. In this activity you will explore concepts related to the components of a vector and the addition of vectors to find a resultant.



**Move to pages 1.2–1.4.**

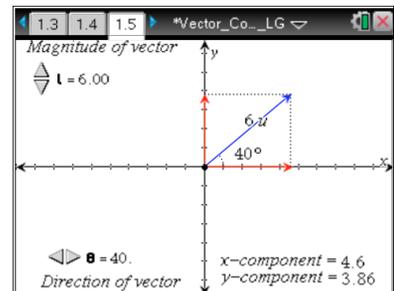
1. Read the introductory material on pages 1.2, 1.3, and 1.4.

Press **ctrl** and **ctrl** to navigate through the lesson.

To change the value of a length or angle slider you may either click on the arrows, or you may click the number and change it directly.

**Move to page 1.5. Answer the following questions here.**

2. Use the slider controls to adjust the magnitude ( $l$ ) and the direction ( $\theta$ ) of the vector. As the vector changes, observe the corresponding changes in the  $x$  and  $y$  components of the vector. You will be asked to describe patterns that express the relationship between a vector and its components.



- Q1. With the vector in the first quadrant, change the length of the vector while keeping the angle constant. Describe what happens to the  $x$  and  $y$  components of the vector as you increase and decrease its length.
- Q2. Double the length of the vector. How do the  $x$  and  $y$  components change as a result of the increase in length?



Q3. Keep the length of the vector constant and manipulate the angle to move the vector within the 1<sup>st</sup> quadrant. What happens to the components as the vector moves toward the x-axis (decreasing the angle)?

Q4. What happens to the components as the vector moves toward the y-axis (increasing the angle)?

Q5. At what angle are the two components equal?

Q6. Set the length of the vector to 8 units and the direction to 30°. Write the values of the x and y components below.

x component = \_\_\_\_\_

y component = \_\_\_\_\_

Q7. The y component can be drawn from the tip of the x component so that the two components form the sides of a right triangle.

The vector will be the hypotenuse. Using trigonometry and this

picture, write equations for calculating the x and y components

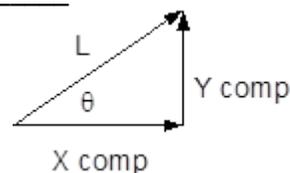
of a vector with length  $L$  and angle  $\theta$ . Verify that your equations

work by using them to calculate the components of the vector

in the previous question.

x component = \_\_\_\_\_

y component = \_\_\_\_\_



Q8. Increase the angle of the vector so that it is greater than 90° and is in the 2<sup>nd</sup> quadrant. Move the vector into the 2<sup>nd</sup> quadrant, and describe what happens to the x and y components.

Q9. Set the vector length to 8 units and the direction to 115°. Write the values of the x and y components below. Verify that your equations for calculating the components give you the same results.

x component = \_\_\_\_\_

y component = \_\_\_\_\_

Q10. What happens to the x and y components as you move the vector into the third and fourth quadrants?



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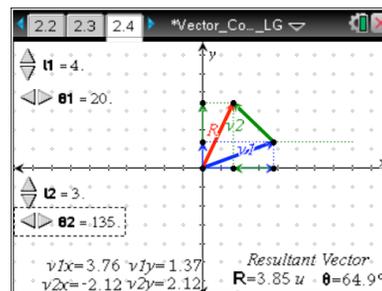
Class \_\_\_\_\_

Move to pages 2.2 and 2.3.

3. In many physics problems, vectors are added to produce a resultant vector. Read the background information describing vector addition on pages 2.2 and 2.3.

Move to page 2.4. Answer the following questions here.

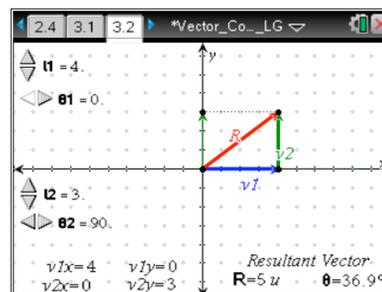
Q11. Set vector 1 to a length of 5 units and a direction of  $20^\circ$ . Set vector 2 to a length of 3 units. Describe the resultant vector when you make the direction of vector 2 the same as vector 1 ( $20^\circ$ ).



Q12. Change the direction of vector 2 so that it points opposite to vector 1 ( $\theta_2 = 200^\circ$ ). Describe the resultant vector.

Move to page 3.2. Answer the following questions here.

Q13. When two vectors are perpendicular, what equation relates the length of their resultant vector,  $R$ , to the lengths of the two vectors,  $l_1$  and  $l_2$ ? Show that this equation works when  $l_1 = 4$  units and  $l_2 = 3$  units.



Q14. What equation can be used to calculate the angle of the resultant vector using  $l_1$  and  $l_2$  (think about trigonometry)? Show that this equation works when  $l_1 = 4$  units and  $l_2 = 3$  units.

Q15. Adjust the length of vector 2 until it is the same as the length of vector 1, but keep  $\theta_1 = 0^\circ$  and  $\theta_2 = 90^\circ$ . Observe the magnitude and direction of the resultant vector. **Show** how the **magnitude** and **direction** are calculated using the equations you identified above.



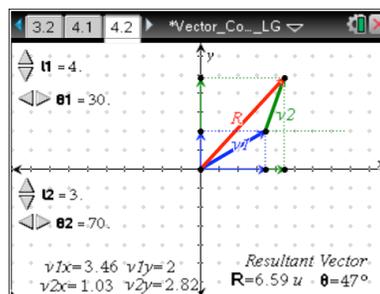
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Move to page 4.2. Answer the following questions here.



Q16. Set vector 1 to 4 units at  $20^\circ$ . Set vector 2 to 3 units at  $70^\circ$ . Record the x and y components of each vector below and then add each column to get the x and y components of the resultant. Calculate the **magnitude** and **direction** of the resultant vector using the x and y components. **Show** your work below. Verify that your calculation matches the magnitude and direction displayed in the simulation.

Vector	x component	y component
4 units at $20^\circ$		
3 units at $70^\circ$		
<b>Resultant Vector</b>		

Show your work.

Q17. Set vector 1 to 3.5 units at  $30^\circ$ . Set vector 2 to 2 units at  $145^\circ$ . Record the x and y components of each vector below and then add each column to get the x and y components of the resultant. Calculate the **magnitude** and **direction** of the resultant using. **Show** your work below. Verify that your calculation matches the magnitude and direction displayed on the simulation.

Vector	x component	y component
3.5 units at $30^\circ$		
2 units at $145^\circ$		
<b>Resultant Vector</b>		

Show your work.

Q18. Make up your own vector addition problem. Complete the table below. Calculate the magnitude and direction of the resultant vector. Show your work below. Verify that your calculation matches the magnitude and direction displayed on the simulation page. (Note: If the x component of the resultant vector is negative, you will need to add  $180^\circ$  to your calculated angle to match the direction.)

Vector	x component	y component
_____ units at _____ $^\circ$		
_____ units at _____ $^\circ$		
<b>Resultant Vector</b>		

Show your work.