

## Bell Ringer: Resolving Vectors – ID: 13342

Time required  
15 minutes

Topic: Fundamentals

- *Resolve a vector into perpendicular components graphically and trigonometrically.*

Activity Overview

*In this activity, students observe the relationship between a vector and its x- and y-components. They graphically determine the magnitudes and directions of the x- and y-components. They also discover the trigonometric functions relating component and sum vectors.*

Materials

*To complete this activity, each student will require the following:*

- *TI-Nspire™ technology*
- *pen or pencil*
- *blank sheet of paper*




TI-Nspire Applications  
*Graphs & Geometry, Notes*

Teacher Preparation

*Students should be familiar with the concept of vectors before carrying out this activity.*

- *The screenshots on pages 2–5 demonstrate expected student results. Refer to the screenshots on page 6 for a preview of the student TI-Nspire document (.tns file). The solution .tns file contains sample responses to the questions.*
- ***To download the student .tns file and solution .tns file, go to [education.ti.com/exchange](http://education.ti.com/exchange) and enter “13342” in the search box.***
- *For a more extensive exploration of this content, use activity 9899: Resolving Vectors. Activity 9899, which is longer than this bell ringer, was designed for a full class period. You can download the files for activity 9899 at [education.ti.com/exchange](http://education.ti.com/exchange).*

Classroom Management

- *This activity is designed to be **teacher-led**, with students following along on their handhelds. You may use the following pages to present the material to the class and encourage discussion. Note that the majority of the ideas and concepts are presented only in **this** document, so you should make sure to cover all the material necessary for students to comprehend the concepts.*
- *If you wish, you may modify this document for use as a student instruction sheet. You may also wish to use an overhead projector and TI-Nspire computer software to demonstrate the use of the TI-Nspire to students.*
- *The extension questions may be answered for homework or in small groups during class time. If students do not have sufficient time to complete the main questions, they may also be completed as homework.*
- *In some cases, these instructions are specific to those students using TI-Nspire handheld devices, but the activity can easily be done using TI-Nspire computer software.*
- *The Graphs & Geometry applications on students' devices will need to be set to Degree mode instead of Radian or Gradian mode for the calculations to work properly. To change these settings, press , and select System Info > Graphs & Geometry Settings. Press  to move between settings, and  to select a setting.*

The following question will guide student exploration in this activity:

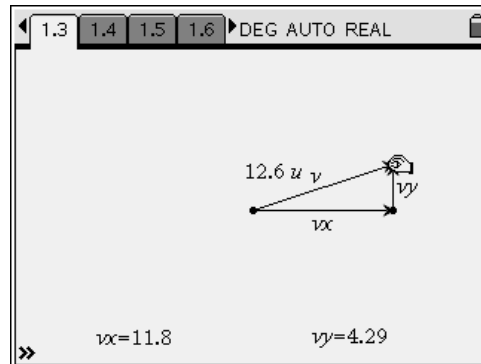
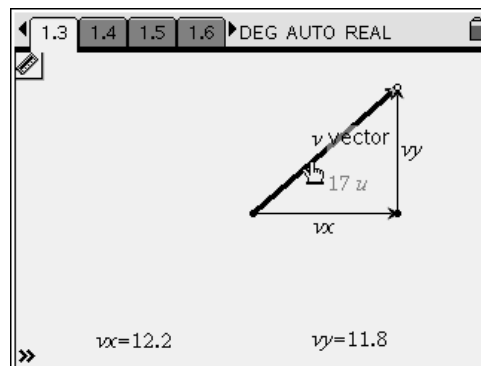
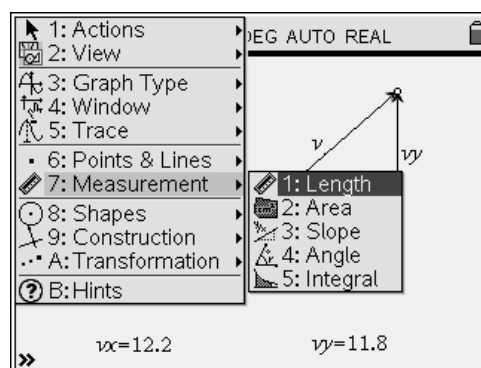
- How can a vector be resolved into perpendicular component vectors?

Students will determine the mathematical relationship between the length of a vector and the lengths of its component vectors. They will then discover the trigonometric relationships between the length of the vector and the lengths of its component vectors.

**Identifying x- and y-components of a vector**

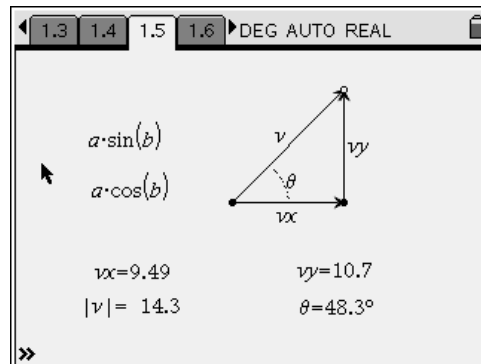
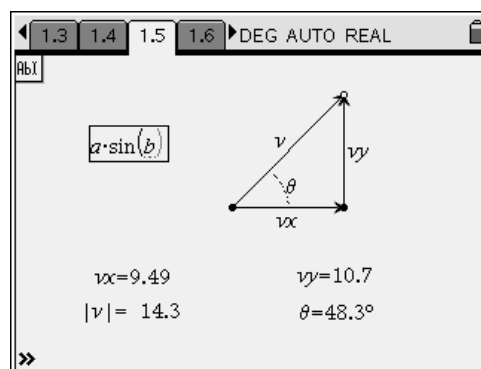
**Step 1:** Students should open the file **PhysBR\_week04\_VectResolution.tns** and read the first two pages. (Students can press **ctrl** and **right arrow** and **ctrl** and **left arrow** to move between pages in the .tns file.)

**Step 2:** After reading the first two pages, students should move to page 1.3, which shows a vector ( $v$ ) and its  $x$ - and  $y$ -components ( $v_x$  and  $v_y$ , respectively). Students should use the **Length Measurement tool (Menu > Measurement > Length)** to measure the length of vector  $v$ . (To use the **Length** tool, students should first click on the object to be measured—in this case, vector  $v$ . The length of the vector should appear on the screen. They should drag the length measurement to an appropriate part of the screen and press **enter** to release it. They should press **esc** to exit the tool.) They should grab and drag the open point at the end of vector  $v$  to vary the magnitude and direction of the vector. (To grab the point, they should use the NavPad to move the cursor until it is located above the point. The cursor will turn into an open hand. They should press and hold **enter** until the cursor changes to a closed hand, indicating that the point has been "grabbed." They can then use the NavPad to drag the point across the screen.) Then, they should answer questions 1 and 2.

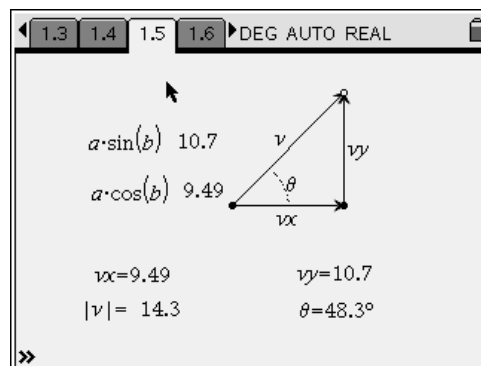
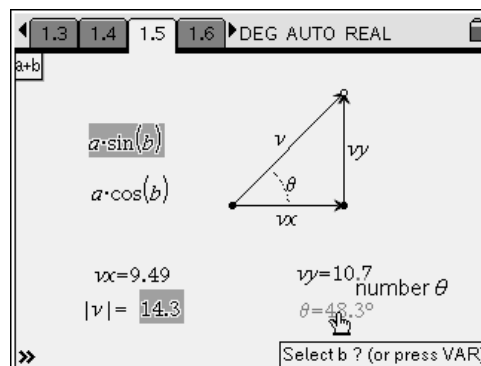
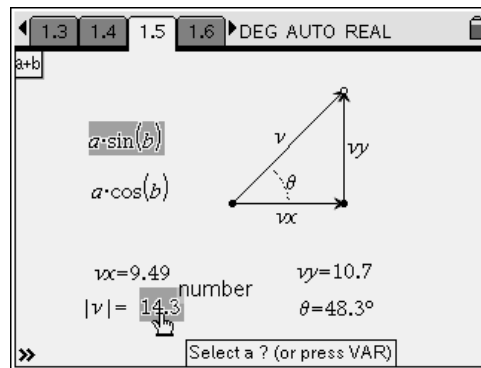


- Q1.** What is the relationship between the length of vector  $v$  and the lengths of components  $v_x$  and  $v_y$ ?
- A.** *The square of the length of  $v$  is equal to the sum of the squares of the lengths of  $v_x$  and  $v_y$  ( $|v|^2 = |v_x|^2 + |v_y|^2$ ). If students struggle with this, point out that  $v$ ,  $v_x$ , and  $v_y$  form a right triangle, with  $v$  as the hypotenuse. Remind them of the equation relating the length of the hypotenuse to the lengths of the two sides of a right triangle (the Pythagorean theorem). Encourage students to test this relationship by varying the direction and magnitude of  $v$  and observing the results.*
- Q2.** What is the relationship between the direction of vector  $v$  and the signs of  $v_x$  and  $v_y$ ?
- A.** *When  $v$  points from left to right,  $v_x$  is positive;  $v_x$  is negative when  $v$  points from right to left. When  $v$  points up,  $v_y$  is positive; when  $v$  points down,  $v_y$  is negative.*



**Step 3:** Next, students should move to page 1.5, which again shows vectors  $v$ ,  $v_x$ , and  $v_y$ . This simulation also shows the length of vector  $v$  and the angle ( $\theta$ ) between  $v$  and  $v_x$ . Students should use this simulation to determine the relationship between the magnitude of vector  $v$  and the magnitudes of its  $x$ - and  $y$ -components using trigonometric functions. Students should use the **Text tool (Menu > Actions > Text)** to enter the expressions  $a \cdot \cos b$  and  $a \cdot \sin b$  in text boxes on the page. (After selecting the **Text** tool from the menu, students should click on an empty area of the screen to place a text box there. They should then type in the expression using the TI-Nspire keyboard. When they have entered the expression, they should press  $\text{enter}$  to finish. They should press  $\text{esc}$  to exit the tool.)



**Step 4:** Next, students should use the **Calculate** tool (**Menu > Actions > Calculate**) to determine the values of these two expressions for the vectors shown on the screen. (To use the **Calculate** tool, they should click on the expression whose value they wish to calculate. They will be prompted to select the value of variable  $a$ . They should click on the number to use for that variable. They will then be prompted to select the value of  $b$ . They should click on the number to use for that variable. They should use the magnitude of  $v$  for  $a$  and the value of  $\theta$  for  $b$  in each expression.) Then, they should answer questions 3–5.

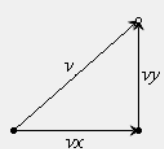


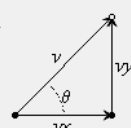
- Q3.** What are the relationships between the magnitude of vector  $v$ , angle  $\theta$ , and the magnitudes of components  $v_x$  and  $v_y$ ?
- A.** Students should compare the values calculated for the two expressions with the lengths of  $v_x$  and  $v_y$ . The correct relationships are given below:
- $$|v_x| = |v| \cos \theta$$
- $$|v_y| = |v| \sin \theta$$

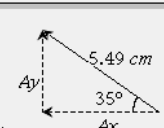
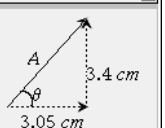
- Q4.** Calculate the lengths of components  $A_x$  and  $A_y$  using only the information shown below. Confirm your calculations using the **Length** measurement tool.
- A.** *Students should use the trigonometric relationships identified in question 3 to calculate the lengths of component vectors  $A_x$  and  $A_y$ . They should type in their predictions in the lower left-hand box on page 1.7. Vector  $A_x$  has a length of 4.5 cm, and vector  $A_y$  has a length of 3.15 cm. Students can press   to move between the three portions of the screen.*
- Q5.** Calculate the length of vector  $A$  and the value of angle  $\theta$  using only the information shown below. Confirm your calculation using the **Angle** measurement tool.
- A.** *Students should use the Pythagorean relationship identified in question 1 to calculate the length of vector  $A$  and either the trigonometric relationships identified in question 3 or standard trigonometric functions to calculate the value of the angle  $\theta$ . They should type in their predictions in the lower left-hand box on page 1.8. Vector  $A$  has a length of 4.57 cm, and angle  $\theta$  has a value of  $47.1^\circ$ .*

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(Student)TI-Nspire File: *PhysBR\_week04\_VectResolution.tns*

<p>1.1 1.2 1.3 1.4 ▸ DEG AUTO REAL</p> <hr/> <p style="text-align: center;"><b>RESOLVING VECTORS</b></p> <hr/> <p style="text-align: center;"><b>Physics</b></p> <p style="text-align: center;">Kinematics</p>	<p>1.1 1.2 1.3 1.4 ▸ DEG AUTO REAL</p> <p>Any vector can be described by a set of perpendicular components. Consider the vector <math>v</math> on the next page. Change the length and direction of the vector by grabbing the open point at the end of the arrow. Observe how the lengths of the <math>x</math>- and <math>y</math>-components of <math>v</math> change as you change the length and direction of <math>v</math>.</p>	<p>1.1 1.2 1.3 1.4 ▸ DEG AUTO REAL</p> <div style="text-align: center;">  </div> <p style="text-align: center;"><math>v_x = 12.2</math>      <math>v_y = 11.8</math></p>
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<p>1.1 1.2 1.3 1.4 ▸ DEG AUTO REAL</p> <p>1. What is the relationship between the length of vector <math>v</math> and the lengths of components <math>v_x</math> and <math>v_y</math>?</p> <p>2. What is the relationship between the direction of vector <math>v</math> and the signs of <math>v_x</math> and <math>v_y</math>?</p>	<p>1.2 1.3 1.4 1.5 ▸ DEG AUTO REAL</p> <div style="text-align: center;">  </div> <p style="text-align: center;"><math>v_x = 9.49</math>      <math>v_y = 10.7</math>  <math> v  = 14.3</math>      <math>\theta = 48.3^\circ</math></p>	<p>1.3 1.4 1.5 1.6 ▸ DEG AUTO REAL</p> <p>3. What are the relationships between the magnitude of vector <math>v</math>, angle <math>\theta</math>, and the magnitudes of components <math>v_x</math> and <math>v_y</math>?</p>
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<p>1.4 1.5 1.6 1.7 ▸ DEG AUTO REAL</p> <p>4. Calculate the lengths of components <math>A_x</math> and <math>A_y</math> using only the information shown below. Confirm your calculations using the <b>Length</b> measurement tool.</p> <div style="display: flex; align-items: flex-start;"> <div style="margin-right: 20px;"> <p>Predictions</p> <p><math>A_x</math> length:</p> <p><math>A_y</math> length:</p> </div> <div style="text-align: center;">  </div> </div>	<p>1.5 1.6 1.7 1.8 DEG AUTO REAL</p> <p>5. Calculate the length of vector <math>A</math> and the value of angle <math>\theta</math> using only the information shown below. Confirm your calculation using the <b>Angle</b> measurement tool.</p> <div style="display: flex; align-items: flex-start;"> <div style="margin-right: 20px;"> <p>Predictions</p> <p><math>\theta</math>:</p> <p><math>A</math> length:</p> </div> <div style="text-align: center;">  </div> </div>
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